Designation: F3105 – 14

# Standard Specification for Externally Loaded Strength Training Equipment, Strength Training Benches and External Weight Storage Equipment[1]

This standard is issued under the fixed designation F3105; 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 this specification is to promote proper design and manufacturing practices for externally loaded strength training equipment, strength training benches and external weight storage equipment. Through these specifications, this specification aims to assist designers and manufactures in reducing the possibility of injury when these products are used in accordance with the operational instructions. The equipment user must recognize, however, that a standard alone will not necessarily prevent injuries. Like other physical activities, exercise involving externally loaded strength training equipment, strength training benches and external weight storage equipment involves the risk of injury, particularly if the equipment is used improperly or 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 the risk of serious injury.

## 1. Scope

1.1 This specification establishes parameters for the design and manufacture of externally loaded strength training equipment, strength training benches and external weight storage equipment as defined in 3.1.

1.2 It is intended that these fitness products be used in an indoor setting or environment.

1.3 It is the intent of this standard to specify fitness products for use only by an individual age 13 and older.

1.4 This standard is to be used in conjunction with Specification F2276, Test Methods F2571, and Test Methods F3104.

1.5 This standard takes precedence over Specification F2276 and Test Methods F2571 in areas that are specific to Externally Loaded Strength Training Equipment, Strength Training Benches and External Weight Storage Equipment.

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

1.7 *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]

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

F2216 Specification for Selectorized Strength Equipment

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

F3104 Test Methods for Evaluating Design and Performance Characteristics of Externally Loaded Strength Training Equipment, Strength Training Benches and External Weight Storage Equipment

2.2 *Federal Standard:*[3]

Department of Justice (DOJ) 2010 Standard for Accessible Design, United States Department of Justice, Title II (28 CFR 35) and Title III (28 CFR 36)

[1] This specification is under the jurisdiction of ASTM Committee F08 on Sports Equipment, Playing Surfaces, and Facilities and is 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 U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

## 3. Terminology

3.1 *Definitions*—The terms listed below are unique to this specification. For terms not defined below, refer to Specification F2276.

3.1.1 *barbell, n*—a long bar shaped device, usually made of steel or aluminum used for holding weight discs to perform certain exercises. Used in conjunction with certain benches and racks.

3.1.2 *break, v*—shall not separate from the structure or fail to support the load for the intended function.

3.1.3 *catch, n*—rest or holder for an barbell, Smith press, or sled leg press carriage from which the user begins the exercise lift and returns the bar or sled to at the completion of the exercise.

3.1.4 *dumbbell, n*—a device of fixed mass designed to be gripped with one hand. Selectively variable dumbbells where the amount of resistance is selected by the user are included in this definition.

3.1.5 *externally loaded strength training equipment, n*—strength training equipment that relies on user applied weight discs on the movement arm for as primary means of resistance.

3.1.6 *external weight storage equipment, n*—any piece of equipment whose sole function is to store external weights such as weight discs or dumbbells while not in use on externally loaded strength equipment or other means of strength training.

3.1.7 *maximum storage load, n*—maximum load that can be applied to weight post and/or external weight storage equipment as set forth by the manufacturer.

3.1.8 *maximum specified training load, n*—maximum working load as set forth by the manufacture. This load does not include the user weight.

3.1.9 *movement arm, n*—a component of certain strength training devices that allows for a controlled and directed motion of a resistance means for a specific exercise.

3.1.10 *olympic, adj*—a system of external training resistance that allows higher levels of resistance than standard weight discs and describing barbell combinations. One feature is the use of a large bore diameter [approximately 50 mm (1.98 in.)] for the interface between weight discs and barbells.

3.1.11 *rack, n*—a structure often described as a cage or squat rack that will support an Olympic bar on catch assemblies or hooks allowing the user to perform multiple freestyle exercises such as Olympic lifts, squats and similar exercises. The catch assemblies or structures may be vertical or positioned along an upward sloping frame structure typically 45° or greater.

3.1.12 *Smith press, n*—a substantially vertical frame structure with a constrained bar for loading Olympic weight plates onto that travels along linear shafts with indexing engagement means that allow the bar to be started and stopped at multiple positions along the range of travel.

3.1.13 *strength training benches, n*—a piece of equipment used to support the body of a user and/or the training load during certain strength training exercises. A strength training bench does not have integral features to increase training resistance but may have integral features for external weight storage.

3.1.14 *training load, n*—the amount of weight plates added to the machine or bar to provide training resistance to the user.

3.1.15 *training resistance, n*—the force exerted by the user to move lifting arm which may or may not be the same as the training load.

3.1.16 *weight disc, n*—a means for a given mass, usually of steel or iron, for externally loaded equipment. Contains a bore in the center of the disc for attachment to weight post.

3.1.17 *weight post, n*—a structure protruding from the frame of externally loaded strength equipment for the purpose of holding weight discs either for a resistance means or for storage.

## 4. Equipment Types

4.1 *Externally Loaded Strength Training Equipment, work arm actuated (Type 1)*—The external load is attached directly or indirectly to a movement arm that is displaced intentionally by the user, as shown in Fig. 1.

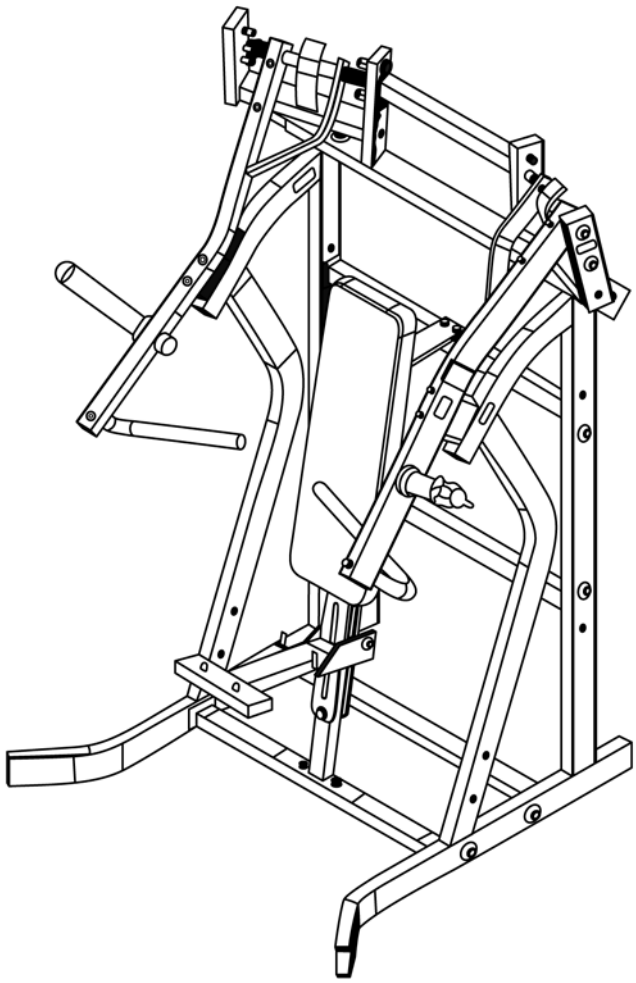

**FIG. 1 Type 1 Work Arm Actuated**

4.2 *Externally Loaded Strength Training Equipment, linear slide actuated (Type 2)*—The external load is placed on a weight post affixed to a carriage that's motion is limited via a linear slide.

4.2.1 *Type 2a*—A machine that has an angle, from horizontal, greater than 45°. This type includes the Smith Machine as shown in Fig. 2.

4.2.2 *Type 2b*—A machine that has an angle, from horizontal, of 45° or less. This type includes the sled style leg press as shown in Fig. 3.

4.3 *Strength Training Benches, designed for use with a barbell (Type 3)*—Any bench that has integral hooks or catches for a standard or Olympic style barbell. This classification also encompasses stand alone barbell supports. See Fig. 4.

4.4 *Strength Training Benches, designed for independent use or for use with optional equipment (Type 4)*—Any bench that is not included in the definition of a Type 3. Benches that are movable, for use in Smith or rack style devices are included in this type. This type also contains specialty equipment such as body weight style equipment. See Fig. 5.

4.5 *External Weight Storage Equipment, any device with the sole purpose to store external weights (Type 5)*—These devices only store weight, and are not used directly for fitness exercises. This type includes weight trees and dumbbell racks. See Fig. 6.

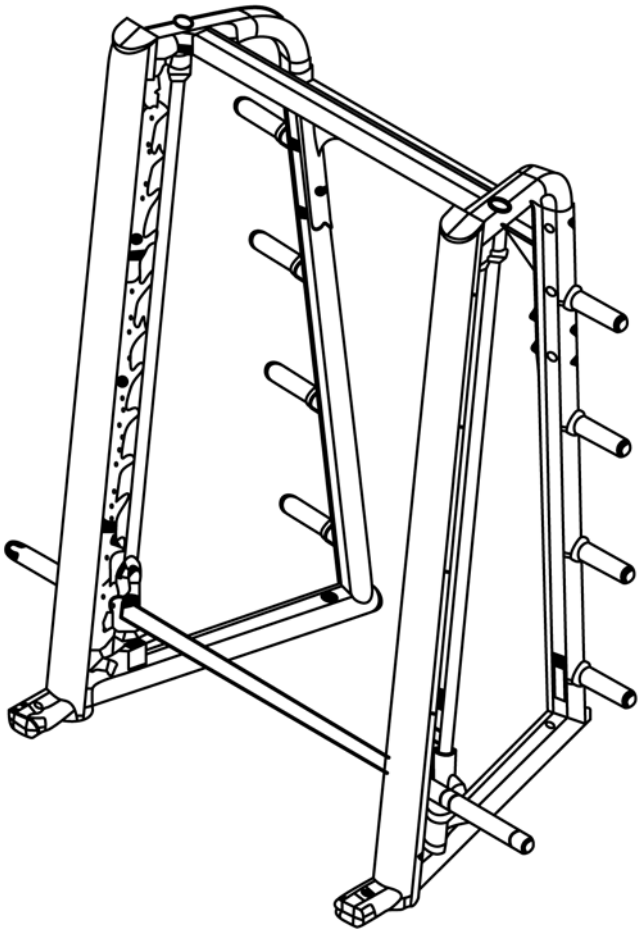

**FIG. 2 Type 2a Linear Slide Greater Than 45°**

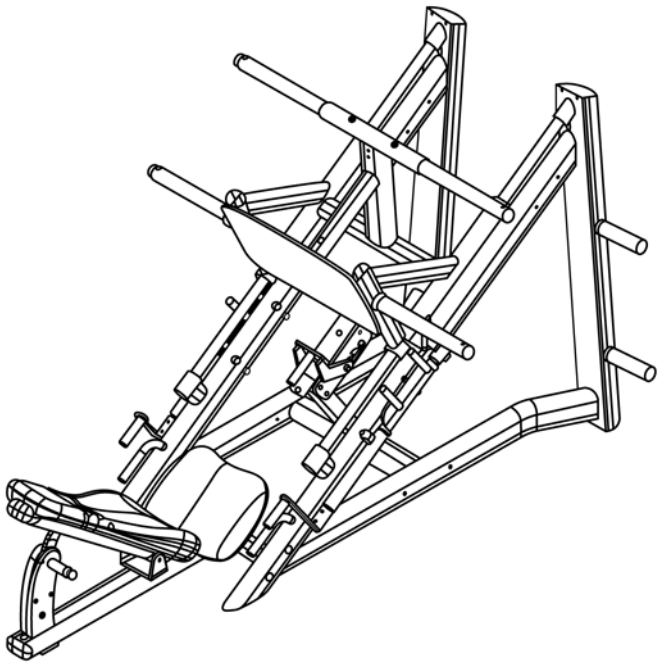

**FIG. 3 Type 2b Linear Slide 45° or Less**

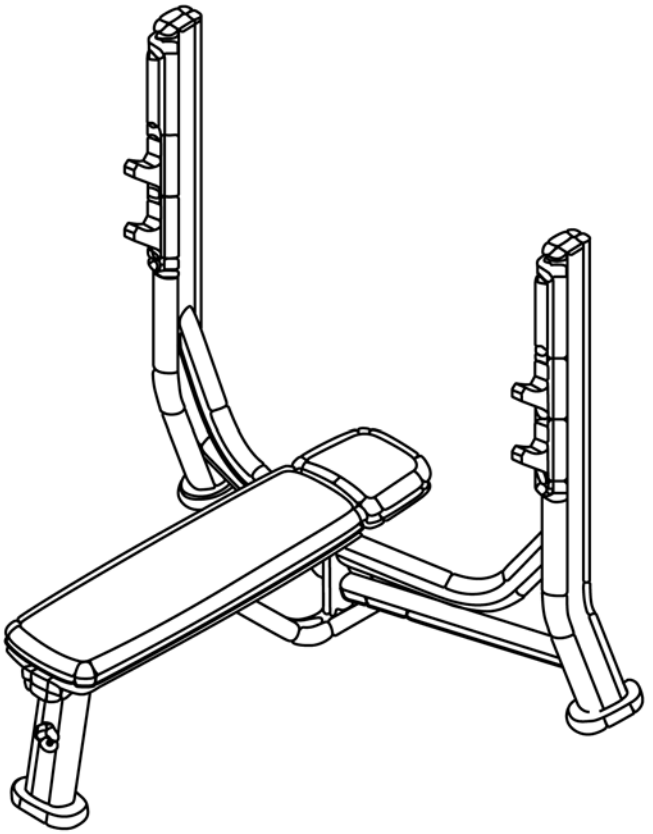

**FIG. 4 Type 3 Strength Training Bench With Barbell Support**

4.6 *Multi Function Systems, a machine whose function incorporates more than one station or operation intended for separate exercises (Type 6)*—This equipment may contain functionality of equipment Types 1-4. Each station or function

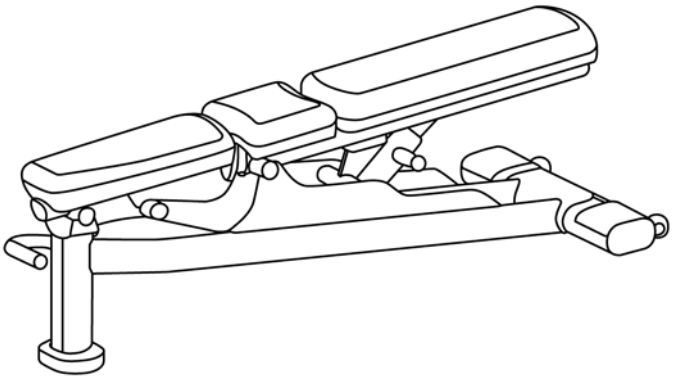

FIG. 5 Type 4 Independent Use Strength Training Bench

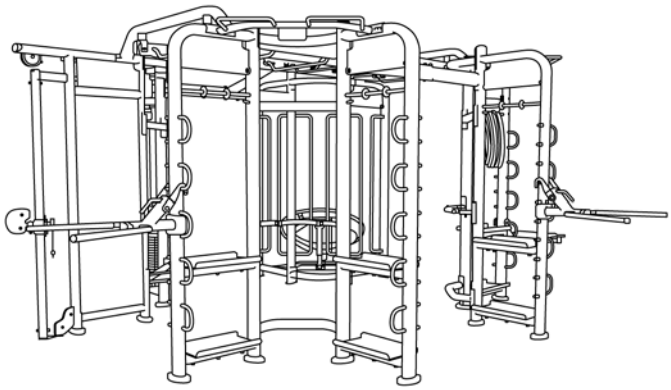

FIG. 7 Type 6 Multi Function Apparatus

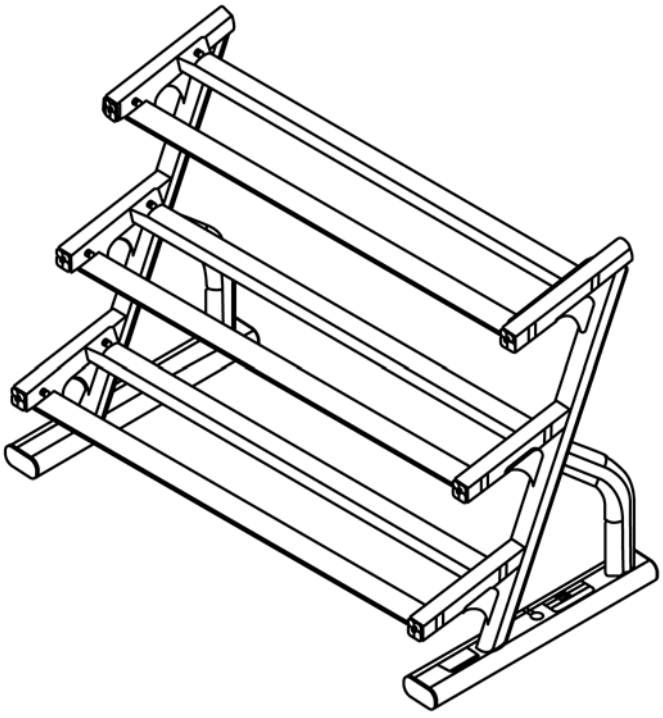

FIG. 6 Type 5 External Weight Storage—Dumbbells

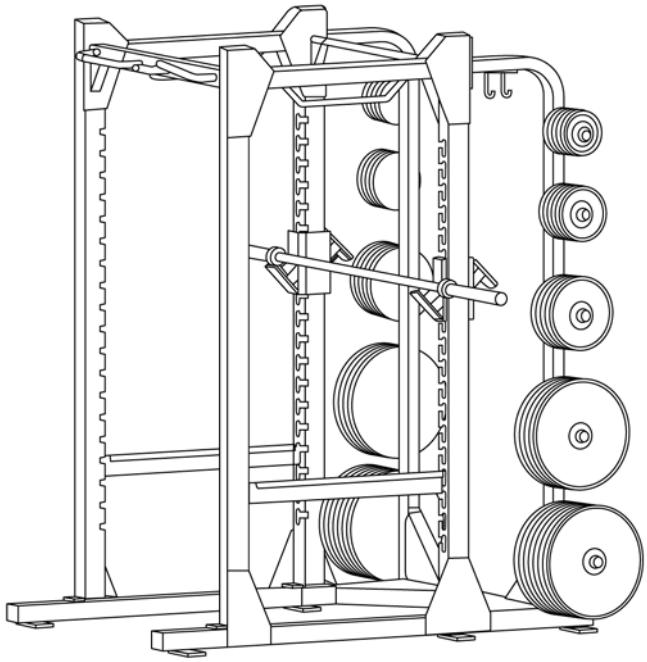

FIG. 8 Type 7 Rack Station

shall meet the requirements for the equipment type as listed in 4.1 – 4.4. If the equipment also contains a selectorized station, then the requirements of Specification F2216 and Test Methods F2277 are applicable to that station or function. See Fig. 7.

4.7 *Rack Stations (Type 7)*—Apparatus or structures designed to support an Olympic bar in multiple positions that allow freestyle or unguided exercise with the Olympic bar. See Fig. 8.

## 5. Design and Construction Requirements

5.1 *Weight Discs—Discussion*—There is great variability in the dimensions of available weights discs. The dimensions of the weight discs are instrumental for requirements in this standard and its test method. To this extent it is necessary to define key dimensions for use with this standard. If the design restricts the dimensional limits for weight discs and/or the capacities of each weight post, it will supersede the dimensions that follow.

5.1.1 The maximum diameter for a weight disc considered for use with externally loaded strength training equipment shall be 460 mm (18 in.) unless specified by the manufacturer.

5.1.2 The minimum thickness for a weight disc considered for use with externally loaded strength training equipment shall be 37 mm (1.45 in.) unless specified by the manufacturer.

5.1.3 The maximum size weight disc ( diameter and thickness) considered for use with externally loaded strength training equipment shall be either 45 lb (standard Olympic weight) or 25 kg (metric Olympic weight) unless specified by the manufacturer.

5.2 In addition to the requirements of Specification F2276, the following requirements are applicable.

5.2.1 *Adjustable Stops*—All Type 2 equipment shall be provided with adjustable stops to limit the travel of the training load. Appropriate warnings and instructions on the use of the stops shall be provided—refer to Sections 6 and 7 of this document.

5.2.1.1 *Smith Machines, Squat Racks and Lifting Cages*—These apparatus shall be equipped with an adjustable stop on each side that shall limit the downward travel of the lifting bar. One set of stop position shall stop the bar 711 mm (28 in.) or higher from the floor (measured to the underside of the bar). This position shall be identified with a site specific label indicating that for squat exercises the stops shall not be placed below this level.

5.2.1.2 *Sled Leg Press Machines (Type 2b)* shall be outfitted with permanent dead stops that stop the downward travel of the lifting sled. These dead stops shall stop the sled so that there is at least 266 mm (10.5 in.) of space between the lowest most portion of the foot platform and the front edge of the seat assembly.

5.2.2 *Weight Disc Retention*—All weight posts used for application of the training resistance shall contain a retention means. Acceptable means include: Detent pins, clips or angling of the weight post above horizontal. If angling of the weight post is used then the weight post shall be angled 2° or greater with respect to horizontal throughout the entire range of motion.

5.2.2.1 If weight posts are designed for weight plate size less than 45 lb or 25 kg (as defined in 5.1), then the unit shall limit the use of such discs through the use of a site specific label. Institutional Equipment may use mechanical interference to limit the capacity as referenced in 5.2.4.2.

5.2.3 *Barbell Support Hook Dimensions*—The rear part of the barbell hook shall be at least 80 mm (3.15 in.) higher than the front of the hook. The depth of the hook (front to back) shall be a minimum of 40 mm (1.57 in.). The height of the front of the barbell hook, a, shall be between 20 mm (0.78 in.) and 40 mm (1.57 in.) when measured from the bottom of a 30 mm (1.18 in.) barbell at rest in the hook. See Fig. 9.

5.2.4 *Weight Disc Clearance*—The distance between weight discs and other movable or fixed parts shall be greater than 25 mm (0.98 in.).

5.2.4.1 Weight discs on the same weight post are exempt from this requirement.

5.2.4.2 If a mechanical interference device is used to limit the use of certain size weight plates, such as a pin parallel to the weight posts, then it shall be exempt from the clearance requirement between the weight disc and mechanical interference device. A site specific warning shall be present in the immediate area to warn as to the maximum weight plate size. For consumer equipment, weight plate size restriction may be specified in the owner's manual.

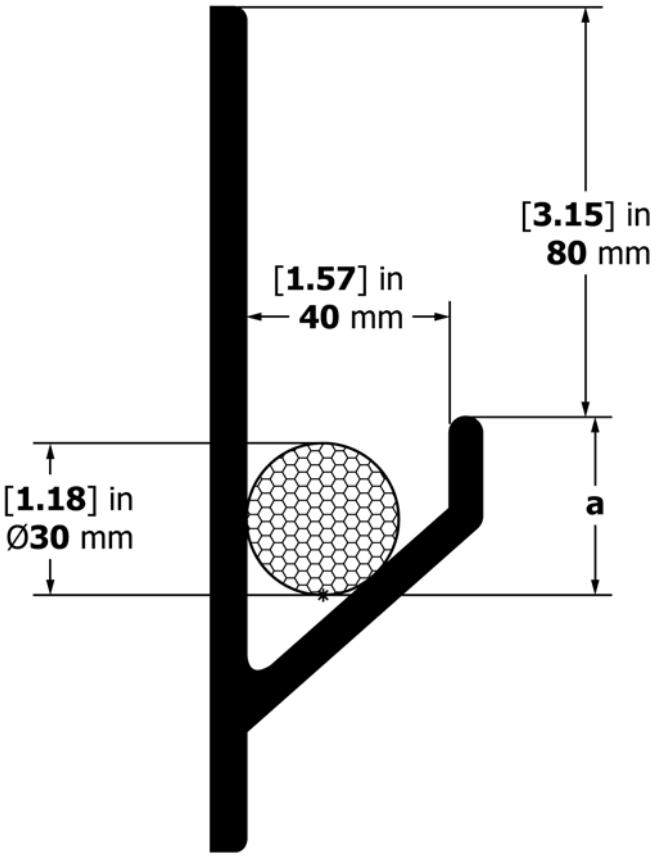


**FIG. 9 Barbell Support Dimensions**

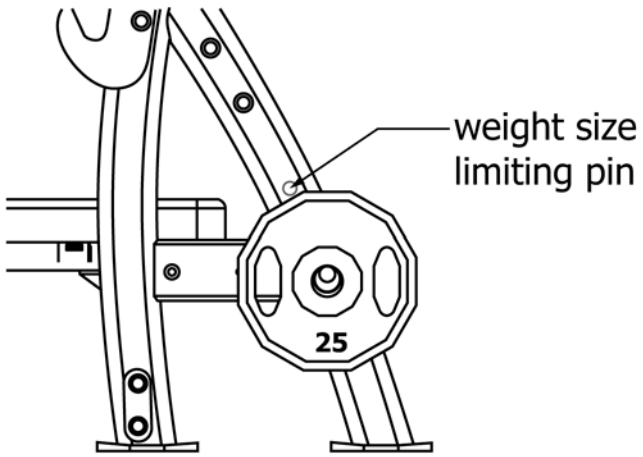


**FIG. 10 Weight Size Limit Pin**

5.3 *Stability—Discussion*—Externally Loaded Strength Equipment requires additional stability guidelines over those set forth in Specification F2276. The equipment shall be stable in the unloaded, intrinsically and the extrinsically loaded conditions. The equipment shall be stable with weights applied to only one side and both sides of the equipment, supported lifting bar or carriage. In addition, weight posts intended for storage shall be evaluated separately from weight posts intended for training resistance. The most onerous condition for stability shall be evaluated.

5.3.1 Notice to the owner or user of the product that the machine meets industry standards for stability when used for its intended purpose in accordance with the instructions provided by the manufacturer shall be provided. Warnings shall be included instructing that using the machine for support during stretching or allowing resistance straps, ropes or other means to be attached to it may result in serious injury—see Sections 6 and 7 of this document.

5.4 *Loading*—In addition to Specification F2276 the following loading requirements shall be applicable.

5.4.1 *Weight Posts Intended for Training Load—Institutional*—Weight posts utilized for training loads shall

withstand a single static load of 6.0 times the maximum specified training load. Following the load requirements of Specification F2276, the unit shall be loaded through the weight post intended for training resistance while the user contact surface is held stationary. The evaluation shall be conducted with the work arm suspended away from any and all stops and rests in its most onerous position. Consumer: Weight posts utilized for training loads shall withstand a single static load of 4.0 times the maximum specified training load.

5.4.2 *Weight Posts Intended for Storage*—Weight Posts intended for storage on institutional equipment shall withstand a single static load equal to 4.0 times the maximum storage load that can be applied on the weight posts. Consumer: Weight posts utilized for storage shall withstand a single static load of 2.5 times the maximum specified storage load.

5.4.3 *Adjustable and Fixed Stops*—All equipment with load stops, such as squat racks, shall endure a dynamic impact test onto the stops, including adjustable stops. The drop shall be from a minimum of 457 mm (18 in.) at maximum load. Institutional equipment shall be dropped 10 times; consumer equipment shall be 1 time. The unit shall not break and the load must still be supported by the stop.

5.4.3.1 Equipment designed with catch systems or features for use with a barbell, guided bar or carriage shall endure a dynamic impact onto the catches from a minimum of 150 mm (5.9 in.) at maximum load for surfaces that support the barbell or guided assembly. Institutional equipment shall be dropped 10 times; consumer equipment shall be 1 time. The unit shall not break and the load must still be supported by the catch.

5.4.4 *Type 3 Equipment*—Type 3 equipment must be able to absorb the dynamic impact of a barbell loaded to the maximum training weight applied to the rear part of the barbell support as defined in test specification.

5.4.5 *Endurance Loading*—Type 1 and Type 2 equipment shall be subjected to endurance loading as set forth in Specification F2276 with the following modifications:

5.4.5.1 *Type 1 Equipment*—The weight posts shall be loaded with the maximum training weight and the lifting arms shall either travel through 80 % of the complete range of motion or to the point that the arm is loaded with the maximum force (whichever occurs first).

5.4.5.2 *Type 2 Equipment*—The weight posts shall be loaded with the maximum training weight and the carriage or lifting bar shall be raised a minimum of 150 mm (5.9 in.).

5.4.6 *Load Rating*—The equipment specified in this specification shall be load rated. The extrinsic load equation of Specification F2276 and the test protocol defined in Test Methods F3104 shall be used in making this determination. The load rating for the equipment will therefore, be a value based on the maximum user weight percentage supported by the machine and the maximum training weight as defined by the manufacturer. The maximum load rating for the bench shall be no more than this percentage of the user's body weight supported plus the maximum load experienced during usage of the machine.

5.4.6.1 The test load to be applied for the verification of this rating is specified by the following equation:

$$F_{test} = (W_p + 1.5\,F_a)S \quad (1)$$

where:

$F_{test}$ = the total reactionary load to be applied during the test, expressed in kilograms or pounds depending on factor $S$ and the values $W_p$ and $F_a$,

$F_a$ = the maximum user applied load at the point of user contact with the machine for the maximum capacity of the machine as stated by the manufacturer, expressed in kilograms or pounds,

$W_p$ = the proportionate amount of the user's body weight being applied to the machine component being tested. This value is to be expressed as the proportionate amount of either 135 kg (297 lb) or the maximum user weight as specified by the manufacturer, whichever is greater,

1.5 = dynamic coefficient, and

$S$ = factor of safety. This shall be 4 for institutional fitness equipment and shall be 2.5 for consumer fitness equipment.

5.4.6.2 *Example*—An institutional Olympic Supine Bench Press is designed for a 136 kg (300 lb) user and a standard Olympic Bar with 10 weights at 20.5 kg (45 lb) each for a total of 225 kg (495 lb) and is thus rated by the manufacturer for 361 kg (795 lb) A conservative application of the above equation to verify this rating would be to assume that the bench supports 100% of the user setting $W_p$ = 136 kg (300 lb). The applied load is $F_a$ = 225 kg (495 lb). The load to be applied, per the Test Specification F3104 is therefore:

$$F_{test} = (136 + 1.5\,(225))4 = 1894\ \text{kg}(4170\quad 1\ \text{b})$$

## 6. Documentation

6.1 *Owner's/User's Manuals*—Equipment shall be accompanied by appropriate documentation set forth in Specification F2276 and shall also include the information from the following sections. A single manual may be used by manufacturers to address commonalities of specific product lines offered by the manufacturer. If individual machines in the product line have unique usage or safety concerns then they shall be addressed in separate sections within the manual.

6.2 *Operational Instructions*—In addition to the requirements of Specification F2276, the following topics shall be included.

6.2.1 The function of any racking mechanism.

6.2.2 The function and appropriate set up of all adjustable stops.

6.2.3 Instructions for safe mounting and dismounting of the equipment.

6.2.4 Description of weight specified for machine, including bore size of plate etc. Amounts and total load for all positions, including integrated storage.

6.2.5 Proper procedure for loading and unloading external weight on the unit.

6.2.5.1 For Type 3 equipment designed for use with a barbell, the procedure shall include instructions on even loading of the barbell. The instruction shall state to load one disc at a time per side on the barbell and to alternate sides that the weight discs are applied. The difference in load between the sides of the barbell shall never exceed 25 kg or 45 lb, depending on the set of weight discs in use.

6.2.6 Recommendations for using weight retention devices on barbells.

6.2.7 *Consumer Equipment Weight Plate Restrictions*—If the equipment is designed for restricted size weight disc then instructions stating the correct weight disc shall be provided in the operational instructions.

6.2.8 Notice to the owner or user of the product that the machine meets industry standards for stability when used for its intended purpose in accordance with the instructions provided by the manufacturer shall be provided. Warnings shall be included instructing that using the machine for support during stretching or allowing resistance straps, ropes or other means to be attached to it may result in serious injury.

6.3 *Installation Instructions*—The installation instructions or owner's/user's manual or both shall follow Specification F2276 and include the following information:

6.3.1 The requirement that a complete visual inspection and test of the features and functions of the assembled equipment be made prior to use.

6.3.2 Procedures for proper storage, movement, and placement of the equipment.

6.3.3 The equipment shall be set up and operated on a solid level surface.

6.3.4 Instructions shall be provided that indicate the minimum clearance required around each machine for access to and passage around the machine. These instructions shall provide specifications detailing the maximum dimensions of the machine at rest and during operation.

6.3.4.1 *Discussion*—The dimensions stated in the installation instructions are the recommended minimum dimensions as set forth by the manufacturer. The actual area for access and passage shall be the responsibility of the facility and should take into account this training envelope and any required ADA requirements, local codes or regulations.

6.3.5 Equipment that requires attachment to the floor shall include instructions on how to secure the equipment to the floor.

6.4 *Maintenance Instructions*—Care and necessary maintenance advice shall be provided. This shall include a review of all applicable warning notices. Special attention shall be drawn to adjustable stops and catch assemblies.

6.4.1 *Discussion*—The safety and integrity designed into a machine can only be maintained when the equipment is regularly examined for damage and repair. It is the sole responsibility of the user/owner or facility operator to ensure that regular maintenance is performed. Worn or damaged components shall be replaced immediately or the equipment removed from service until the repair is made. Only manufacturer supplied components shall be used to maintain/repair the equipment. The maintenance instructions shall call the reader's attention to these facts.

6.5 *Operational Instructions*—Each intended use of Type 1, 2 and 3 machines shall be explained in operation instructions. The first category of the operational instructions shall call the user's attention to read and understand the other warnings affixed to the machine. In the case of institutional machines, these intended use instructions shall be affixed directly to the machine. The use of graphics may be provided to assist in proper depiction of the use of the equipment. For consumer equipment, the instructions may take the form of booklets, posters or instruction placards, or may be a section of the owner's/user's manual.

## 7. Warnings

7.1 *Warnings*—In addition to the warnings outlined in Specifications F2276 and F1749, the warnings shall include as a minimum the following when applicable:

7.1.1 *Owner's Manual Warnings*—The warnings presented in the owner's manual shall be designed in accordance with Specifications F1749 and F2276 and include the following additional items:

7.1.1.1 All warning posted on the product shall be shown in the owner's manual.

7.1.1.2 Additional warning label giving instruction for any safety mechanism.

7.1.1.3 Additional information concerning the load limits and weight capacity for the unit.

7.1.2 *General Warning Label*—The warnings presented in the general warning label shall be designed in accordance with Specifications F1749 and F2276 and include the following additional items:

7.1.2.1 Warning to not exceed the capacity of the unit.

7.1.3 *Site Specific Labels*—In addition to the site specific warnings outlined in Specifications F1749 and F2276, the following site specific labels shall be used.

7.1.3.1 *Type 2 Equipment*—Directions for use of adjustable stops, if applicable.

*(1)* Smith Machines, Squat Racks and Lifting Cages shall have the following warnings in addition to those set forth in this section and in Specifications F1749 and F2276 (Fig. 9 depicts an exemplar label):

*(2)* Warnings that adjustable stops must be used for all exercises.

*(3)* Warning that death or serious crippling injury can occur if the lifting bar drops suddenly.

*(4)* Warning that visual assurance that the lifting catches are fully engaged and seated before lessening the load and exiting the machine.

*(5)* Warning to always use spotters when working out on the machine.

*(6)* Warnings/instructions following the example shown in Fig. 11 that instruct, at a minimum on the proper adjustment/placement of stop assemblies for the squat exercise.

*(7)* Site specific warning affixed to each side of the machine shall alert the user as to the lowest adjustment position to maintain at least 711 mm (28 in.) spacing between the lifting bar and the floor to prevent spinal injury if failure occurs during the squat movement—Fig. 11b.

*(8)* Site specific warnings shall be affixed to each stop assembly warning that stops shall be used for all exercises—Fig. 11c.

*(9)* Sled Leg Press—Warnings that adjustable stops must be used at all times when doing calf exercises.

7.1.3.2 *Type 3 Equipment*—Directions for use of adjustable racks and stops, if applicable.

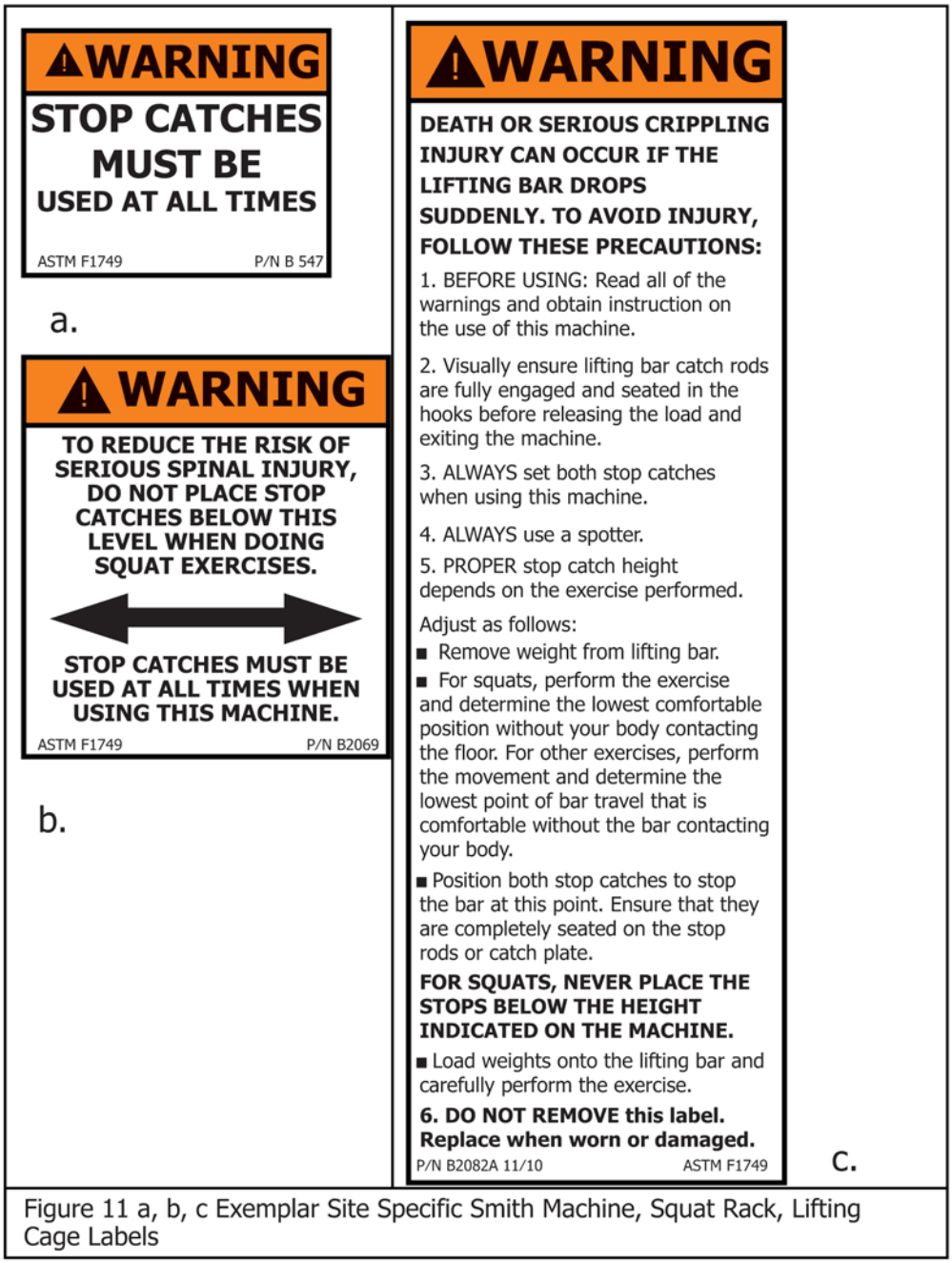


**FIG. 11 Exemplar Site Specific Smith Machine, Squat Rack, Lifting Cage Labels**

*(1)* For Institutional benches a warning to use a spotter when using the bench shall be present. For consumer benches this warning may be on the bench or be included in the manual.

7.1.3.3 *Restricted Weight Disc Use*—If the use of certain size weight plates is restricted, then a label notifying the user is required. The Signal word for such a label shall be "Warning". The label shall indicate to the user the possibility of serious injury or damage to the equipment is possible if a weight disc other than those approved is used.

7.1.4 *Load Limit*—The load rating for the equipment shall be posted on the equipment in close proximity to the intended use label or general warning label. This limit shall include notice of the maximum user weight for the machine and the maximum training load.

## 8. Keywords

8.1 free weight equipment; Olympic training equipment; weight benches

# APPENDIX

**(Nonmandatory Information)**

## X1. ADDITIONAL READINGS

X1.1 EN 957-1 Stationary Training Equipment—Part 1: General Safety Requirements and Test Methods

X1.2 EN 957-4 Stationary Training Equipment—Part 4: Strength Training Benches, Additional Specific Safety Requirements and Test Methods