Designation: F2697 – 15

# Standard Test Methods for Physical Assault on Overhead Horizontal Fixed Barriers for Detention and Correctional Facilities[1]

This standard is issued under the fixed designation F2697; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 These test methods cover requirements for simulated service tests and testing equipment for determining the performance characteristics of horizontal fixed barriers designed to incarcerate inmates in detention and correctional institutions. The testing equipment provides for the setup and testing of sample barriers and installation systems.

1.2 It is the intent of these test methods to help ensure that detention security horizontal fixed barriers perform at or above minimum acceptable levels for control of passage to unauthorized or secure areas, to confine inmates, and to delay and frustrate escape attempts. Provide security grilles, access doors, light fixtures, and similar assemblies compatible with these levels of performance, with test apparatus adjustments as required to suit the particular product.

1.3 These test methods apply to horizontal fixed barriers enclosing or separating secure areas of detention/correctional facilities.

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

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

F1450 Test Methods for Hollow Metal Swinging Door Assemblies for Detention and Correctional Facilities

F1592 Test Methods for Detention Hollow Metal Vision Systems

F1915 Test Methods for Glazing for Detention Facilities

F2322 Test Methods for Physical Assault on Vertical Fixed Barriers for Detention and Correctional Facilities

## 3. Terminology

3.1 *Definitions:*

3.1.1 *detention security*—assurance of the restriction of mobility of inmates to designated areas within a correctional or detention facility.

3.1.2 *forcible egress*—an opening created in the test ceiling which allows a 5 in. (127 mm) by 8 in. (203 mm) by 8 in. (203 mm) rigid rectangular box to be passed through it with force not exceeding 10 lbf (44.5 N).

3.1.3 *interstitial space*—the space above the ceiling and below the building floor or roof structure above.

3.1.4 *manufacturer*—the party responsible for the construction, fabrication, or supply of the test samples or components used to construct the test samples.

3.1.5 *performance characteristic*—the response of the ceiling in any one of the tests described herein.

3.1.6 *tamper-resistant security screw*—screw that is designed to be removed only by special tools kept by detention/correctional facility maintenance personnel.

3.1.7 *test completion*—conduct of one test sequence for each ceiling.

3.1.8 *testing laboratory*—an independent materials testing laboratory not associated with the manufacturer.

## 4. Significance and Use

4.1 A major concern for administrative officials is the security of barriers used in detention/correctional facilities. These test methods are designed to aid in identifying levels of physical security for horizontal fixed barriers, which serve to enclose or separate secure areas. This does not apply to the passage of contraband or vandalism.

4.2 These test methods are not intended to provide a measure of resistance for a ceiling subjected to attack by corrosive agents, by high-powered rifles, explosives, sawing,

[1] These test methods are under the jurisdiction of ASTM Committee F33 on Detention and Correctional Facilities and is the direct responsibility of Subcommittee F33.02 on Physical Barriers.

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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.

or other such methods not typically available to inmates. These test methods are intended to evaluate the resistance of a ceiling to violent attacks by sustained manpower using battering devices, such as benches, barbells, bunks, or tables; and by an upward static force such that could be applied by an inmate pushing against the ceiling with his hands, feet, or back (that is, squat position on a top bunk in a cell). Attacks from outside the facility and fire resistance ratings are not addressed in this standard.

4.3 The primary purpose or result of these test methods is to approximate the levels of abuse to which horizontal fixed barriers could possibly be subjected in the field. The desired result of its use is to help provide assurance of protection to the public, to facility personnel, and to the inmates themselves.

4.4 It is recommended that detention/correctional facility administration provide adequate training, supervision, and preventive maintenance programs to enable horizontal fixed barriers to function as intended throughout the expected service life.

## 5. Sampling

5.1 Sample ceiling shall be constructed in accordance with 6.1.

5.2 Test reports shall include complete details of the test samples, details, photographs, or a combination thereof, of the testing apparatus and installation or construction instructions (See Section 9).

5.3 In the event of failure in one or more of the performance tests, the manufacturer shall provide another complete test sample or shall continue testing in another location on the ceiling, subject to the direction of the testing laboratory.

## 6. Specimen Preparation

6.1 *Construction:*

6.1.1 The construction of the test ceiling shall be representative of the ceiling as it will be placed in service.

6.1.2 Required results indicated in Table 1 are based upon a sample size of 8 ft (2438 mm) long by 8 ft (2438 mm) wide ± 1 in. (25.4 mm).

6.2 *Impact Test Fixture:*

6.2.1 The test ceiling support fixture shall simulate the rigidity normally provided to a ceiling in a building by adjoining walls and by support from the floor or roof above (Fig. 1).

6.2.2 It is acceptable to modify the test ceiling support fixture from that shown in order to accommodate longer lengths or larger sizes of test samples.

6.2.3 *Description of the Test Ceiling*—The test ceiling shall be constructed and mounted horizontally in the test fixture and shall be supported as described in 6.2.1 throughout the testing procedure. The ceiling specification shall be included as part of the test report.

6.3 *Ceiling Construction or Mounting for Impact Testing:*

6.3.1 Construct and install the test ceiling as shown in Fig. 1. The ceiling test sample shown in Fig. 1 represents a ceiling design which requires a structural support at the center of the test opening. Ceiling systems that do not require a center support shall be installed such that the ceiling panels span the 8 ft (2438 mm) test opening and are not supported by the overhead structural channel support. Position the specified test apparatus underneath the test ceiling in preparation to administer the series of impacts and static loads described in 7.1.4 and 7.2.4.

## 7. Procedures

7.1 *Ceiling System Impact Test:*

7.1.1 *Scope*—This test method is designed to evaluate the capability of a complete test ceiling to resist repetitive impact forces at the designated critical areas.

7.1.2 *Significance and Use:*

7.1.2.1 This test method is intended to closely simulate a sustained, vertical battering ram style attack and provide an evaluation of the capability of the assembly to prevent, delay, and frustrate escape or access, or both, into overhead "interstitial" spaces and other unauthorized areas. The test has the potential to be used to aid in identifying a level of physical security for various configurations of horizontal fixed barriers.

7.1.2.2 An impact test of this design performed on a complete test ceiling evaluates the impact fatigue strength and the quality of construction and fabrication techniques as well as the strengths of materials used.

7.1.3 *Apparatus:*

7.1.3.1 *Impact and Static Load Test Fixture,* constructed using structural steel tubing, channel, and plate to provide a means for mounting a test section of ceiling in the horizontal position (Fig. 1), and for applying the required series of impacts applied upward at the target areas designated in Table 1.

7.1.3.2 The impact test device (Fig. 2) shall consist of a portable impactor that converts vertically downward impact energy to the equivalent vertically upward impact energy, and that upon release will deliver impacts against the test ceiling. The impactor arm shall be fabricated as shown in Fig. 2, and shall be balanced, smooth operating, and frictionless to within 6 lmb placed at mass end of the impactor arm, prior to attachment of the 133 lbm impact mass. The apparatus shall be designed and calibrated to deliver impacts of 200 ft·lbf (271.2 J) against the test ceiling and shall be portable in order to be positioned under the target locations designated in Table 1. The vertical ram shall be constructed such that the blunt impactor (Fig. 3) or the sharp impactor (Fig. 4) can be attached for the purpose of conducting the impact sequences.

7.1.3.3 *Blunt Impactor*—The blunt impactor shall be fabricated from C1010-1020 carbon steel and shall be attachable to the steel impact ram in accordance with Fig. 3. The striking surface of the impactor shall have a surface area of 4 ± 0.04 $in.^2$ (2580 ± 25.8 $mm^2$) and shall have rounded edges similar to a 10 lb (4.54 kg) sledge hammer head.

7.1.3.4 *Sharp Impactor*—The sharp impactor shall be fabricated from C1010-1020 carbon steel and shall be attachable to the steel impact ram in accordance with Fig. 4. The sharpness of the impact point shall be similar to the end of a new Fireman's axe at the beginning of the test sequence.

7.1.4 *Procedure:*

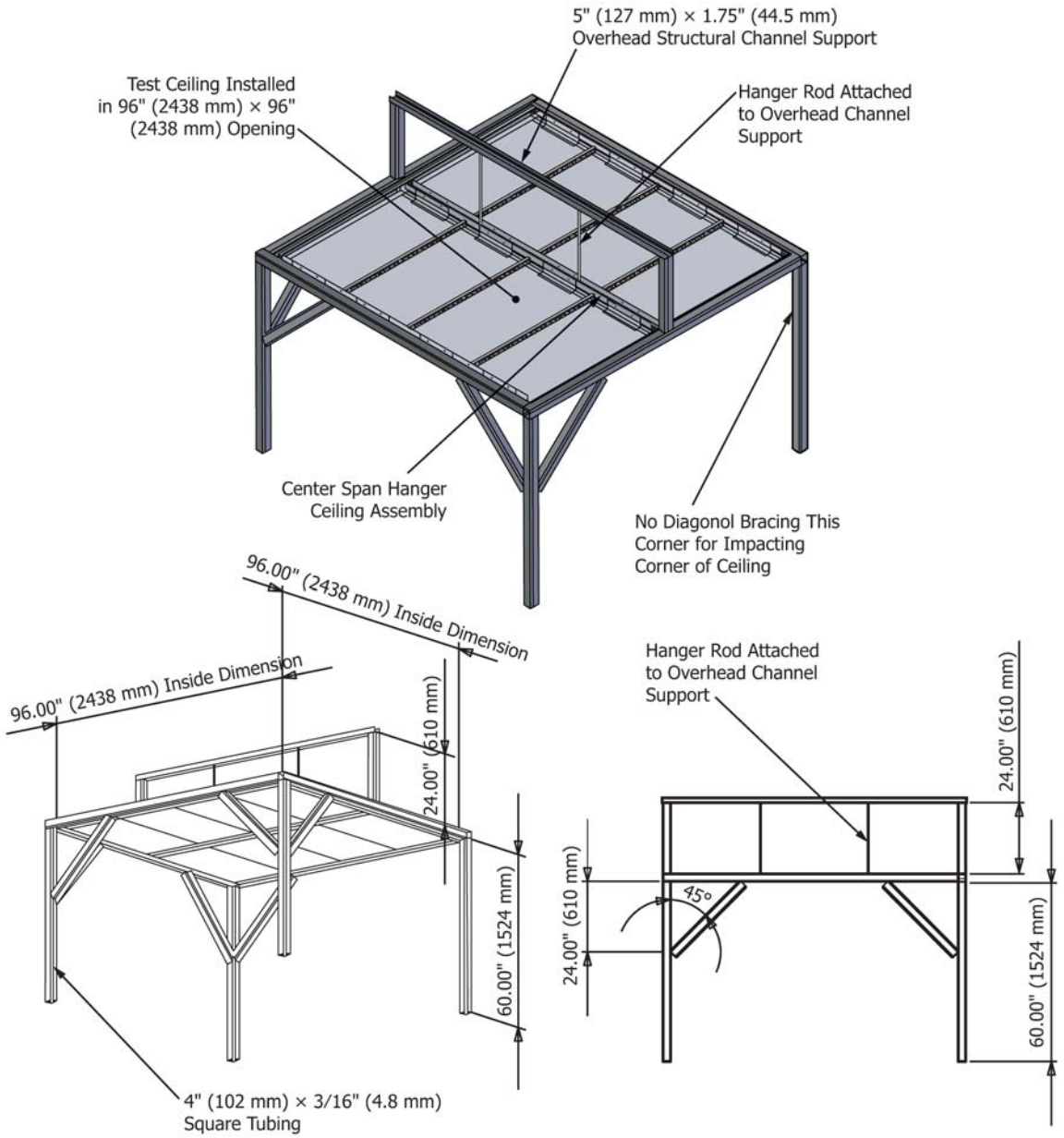


**FIG. 1 Fixed Overhead Barrier Test Fixture**

7.1.4.1 With the test fixture and apparatus, deliver the series of impacts listed in Table 1 to the test ceiling.

7.1.4.2 Construct and mount the 8 ft (2438 mm) high by 8 ft (2438 mm) ± 1 in. (25.4 mm) wide test ceiling supported on all four sides from the ceiling test fixture illustrated in Fig. 1 in the manner that it would be supported in an actual field installation. If the ceiling design requires control joints or seams, these control joints or seams shall be included in the test ceiling for the purpose of testing. Impact testing against the interstitial space side of the ceiling sample is not required.

7.1.4.3 Install the ceiling panel with the exposed, or "room," side surface facing downward and the unexposed, or "interstitial space," side surface facing upward.

7.1.4.4 Apply the required number of impacts in accordance with Table 1 to the underneath, or "room," side of the test ceiling. If there are no predicted weak points in the test ceiling, apply the impacts to target areas designated in Table 1. If there are predicted weak points other than the target locations, such as seams, unsupported edges, or other types of ceiling joints, apply the impacts at one of those locations. Repeatability of impact location during each series shall be ±2 in. (51 mm) horizontally from the designated impact target.

7.1.4.5 Using the test apparatus in accordance with 7.1.3, begin the series of strikes against the selected target area of the test ceiling for the number of required impacts, first with the blunt impactor followed by the sharp impactor attached to the ram in cyclic sequences of 50 impacts each. The required impact energy for the blunt impactors is 200 ft·lbf (271.2 J) per impact, and the required impact energy for the sharp impactor is 100 ft·lbf (135.6 J) per impact.

7.1.4.6 During the test, reposition the impact device as necessary to produce the maximum possible duress on the test

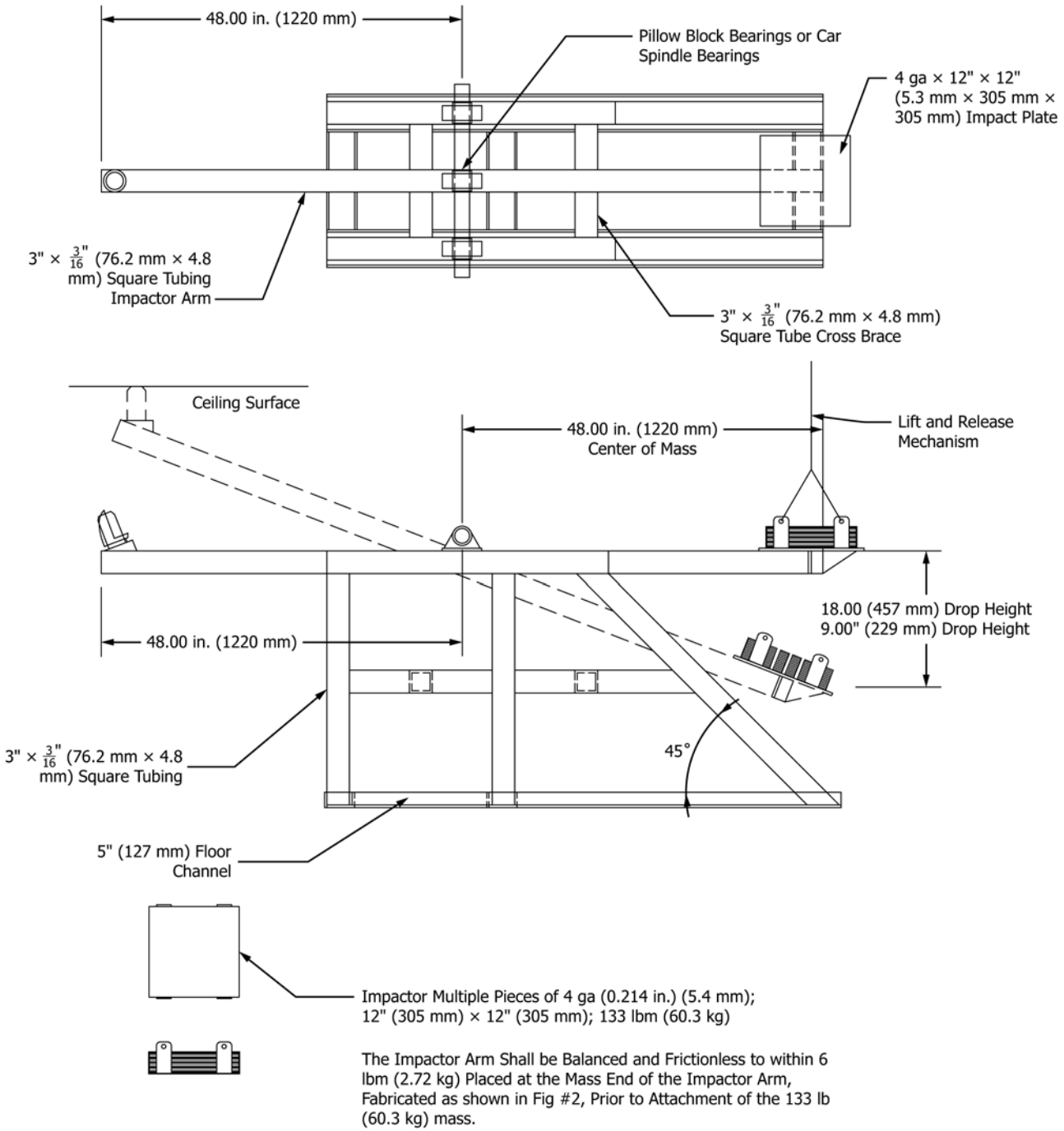


**FIG. 2 Portable Impact Apparatus**

ceiling, leading to ceiling failure. The time for repositioning and changing of the impactors is not to be included in the test duration time. Record the number of strikes required to produce the first penetration of the ceiling, and the number of strikes required to produce an opening large enough to achieve forcible egress.

7.1.4.7 Apply the required number of impacts to each location in accordance with Table 1.

7.1.5 *Required Result:*

7.1.5.1 The ceiling must remain in place throughout the testing procedure.

7.1.5.2 Failure is constituted by the ceiling being damaged to the extent that forcible egress can be achieved, or to the extent that the impact test cannot be continued in a practical manner in accordance with 7.1.4 and 7.1.5.

7.1.6 *Precision and Bias*—The precision and bias of this test method for evaluating the impact resistance of a horizontal fixed barrier are being determined.

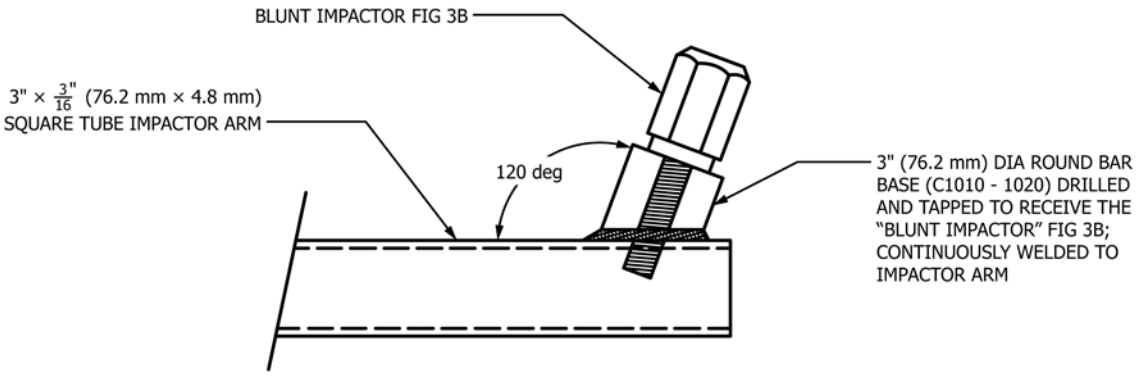


**FIG 3A: BLUNT IMPACTOR ATTACHMENT**


**FIG 3B: BLUNT IMPACTOR**

**FIG. 3 Blunt Impactor Assembly**

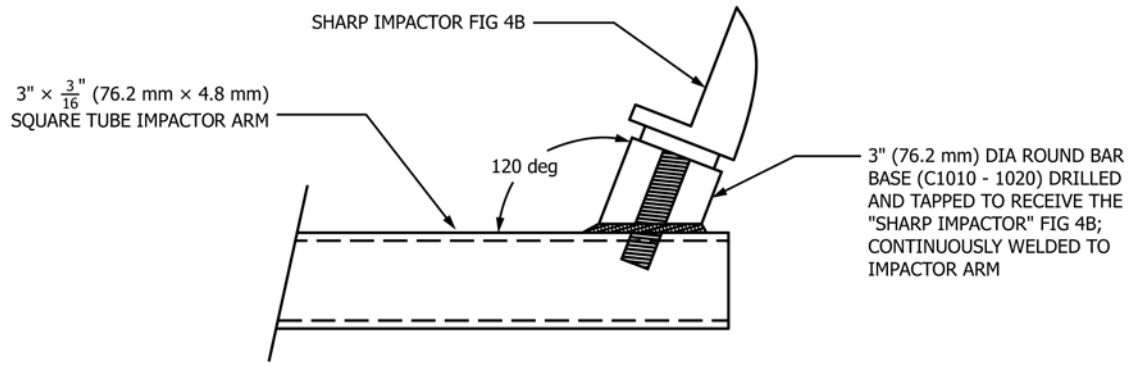


FIG 4A: SHARP IMPACTOR ATTACHMENT

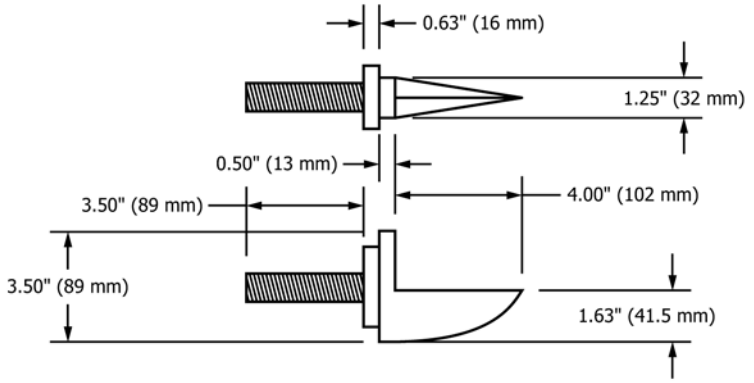


FIG 4B: SHARP IMPACTOR

**FIG. 4 Sharp Impactor Assembly**

7.2 *Ceiling Static Load Test:*

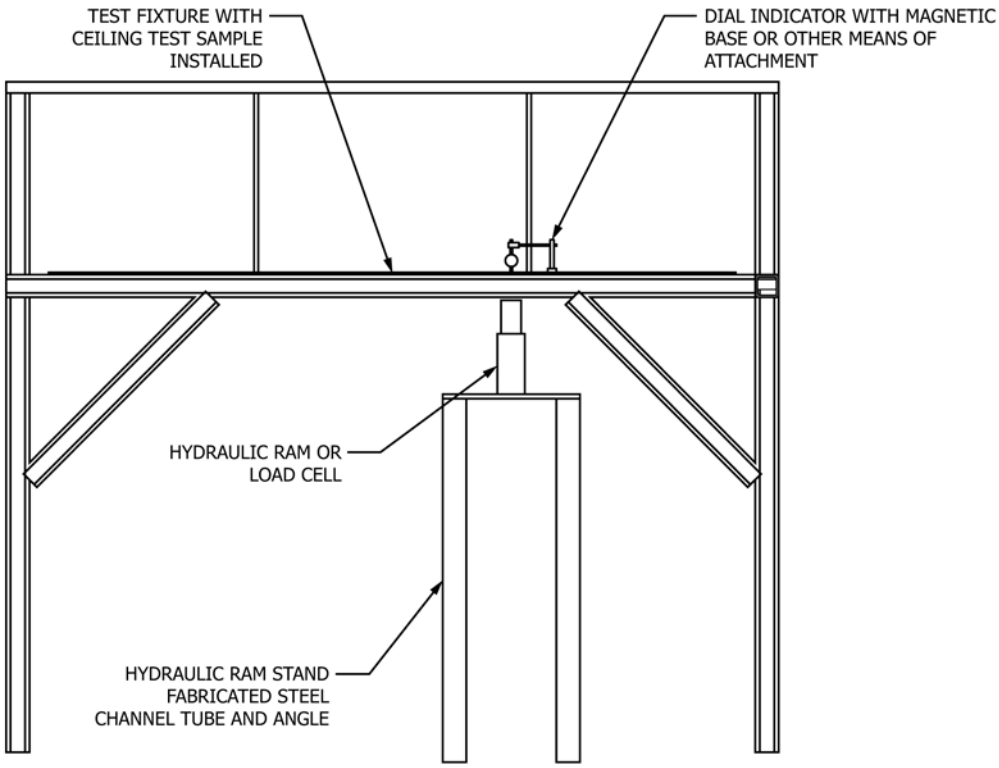


**FIG. 5 Fixed Overhead Barrier Static Load Fixture**

7.2.1 *Scope*—This test method is designed to evaluate the capability of a section of ceiling to resist a steadily increasing force applied at a small area concentrated at the center of the section.

7.2.2 *Significance and Use*—This test method is intended to simulate an inmate pushing against the ceiling with his feet, hands, or back (from a squat position) from either the top bunk in a cell or other elevated object in a cell or day room in an attempt to damage, dislodge, or break through the ceiling for purpose of escaping out of the secure area, through the interstitial space, into unsecured areas, and ultimately to freedom.

7.2.3 *Apparatus:*

7.2.3.1 *Impact and Static Load Test Fixture,* constructed using structural steel tubing, I-beam, angle, and plate to provide a means for mounting a test section of ceiling in the horizontal position (Fig. 1), and for applying an increasing static load upward at target areas designated in Table 1.

7.2.3.2 *1-in. (25 mm) Travel Dial Indicator,* with resolution of 0.001 in. (0.02 mm) and support stand, such that center point of deflection of the test sample can be accurately measured as the static load is applied. The indicator shall be permitted to be mechanical or digital.

7.2.3.3 *Hydraulic Ram and Pump,* equipped with a gauge, or a load cell, to provide the static load (Fig. 5). The pump, ram, and gauge shall be calibrated by the testing laboratory and a chart provided that converts pounds-force per square inch gauge (kPa) to pounds-force (Newtons). If a load cell is used, it shall be certified by the testing laboratory prior to use.

7.2.3.4 Static load testing fixtures of alternate designs other than that shown in Fig. 5 shall be permitted to be submitted to the testing laboratory for evaluation and approval.

7.2.4 *Procedure:*

7.2.4.1 A ceiling section 8 ft (2438 mm) long by 8 ft (2438 mm) wide ± 1 in. (25.4 mm) shall be tested. Larger samples are permitted to be tested in a modified test apparatus in order to accommodate the ceiling design subject to testing.

7.2.4.2 Mount the sample ceiling into the static load test fixture at all four (4) edges, in the horizontal position with its exposed side (room side) facing downward, using support systems designed for the particular ceiling system under investigation, and attached to the fixture in the same manner that the ceiling is attached to a typical wall in an actual installation.

7.2.4.3 Position the hydraulic ram at locations in accordance with Table 1, locations 1 through 4, and the desired Security Grade number such that steadily increasing static force can be applied upward against designated locations on the sample. Position a ¼ in., 4 Ga. (6.4 mm) thick by 12 in. (305 mm) square "contact plate" centered on top of the hydraulic ram between the ram and the sample.

7.2.4.4 Position the dial indicator vertically on the opposite side of the sample from the ram and centered at the location of the ram. Position the dial indicator such that it is depressed approximately 10 % of its travel and set it at zero. This applies for either a mechanical or digital indicator.

7.2.4.5 Apply the steadily increasing force against the sample and record the force in pounds-force (Newtons) and

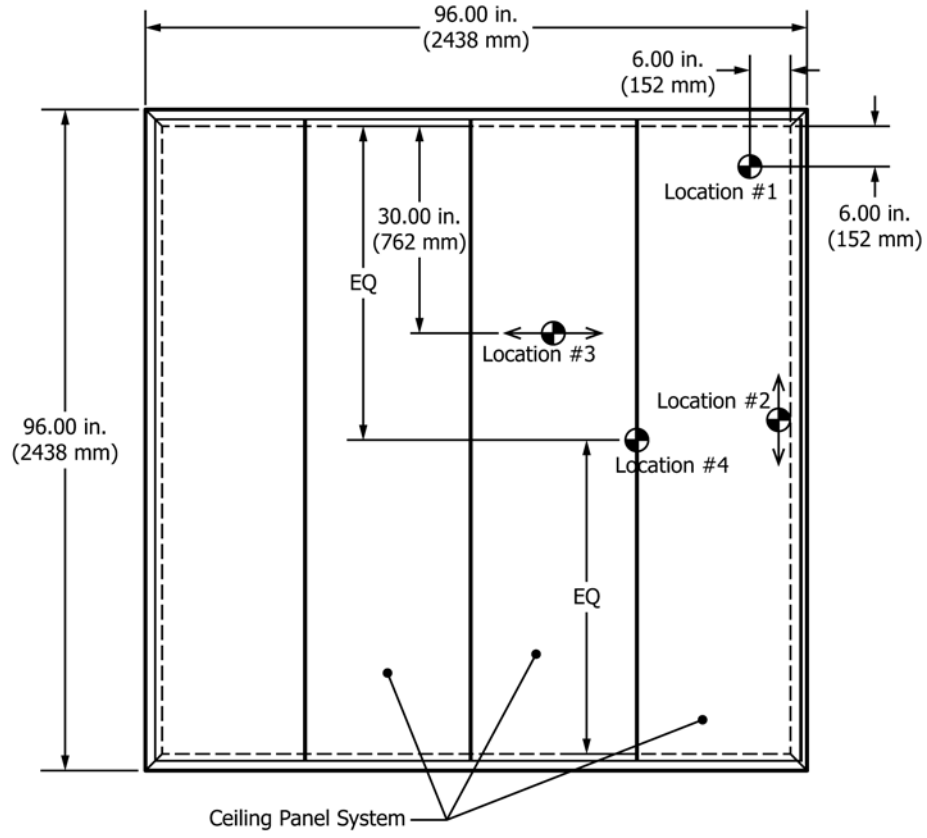


**Figure 6a Sample Impact Target Locations**

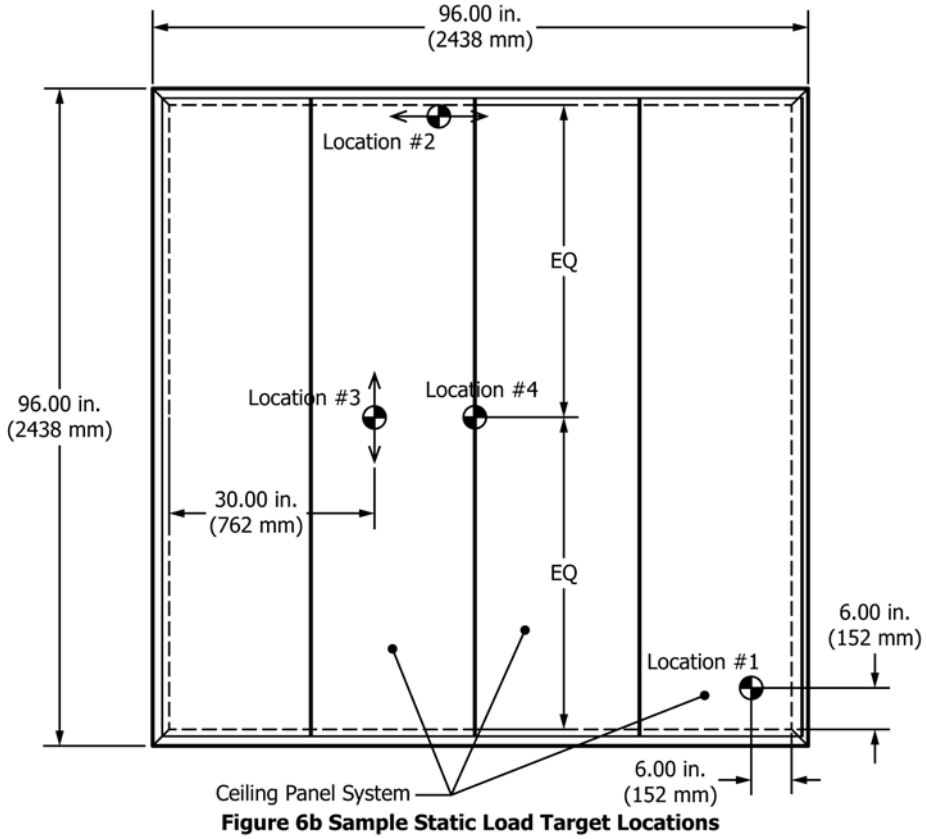


**Figure 6b Sample Static Load Target Locations**

**FIG. 6 Sample Target Locations for Table 1 Locations 1 – 4.**

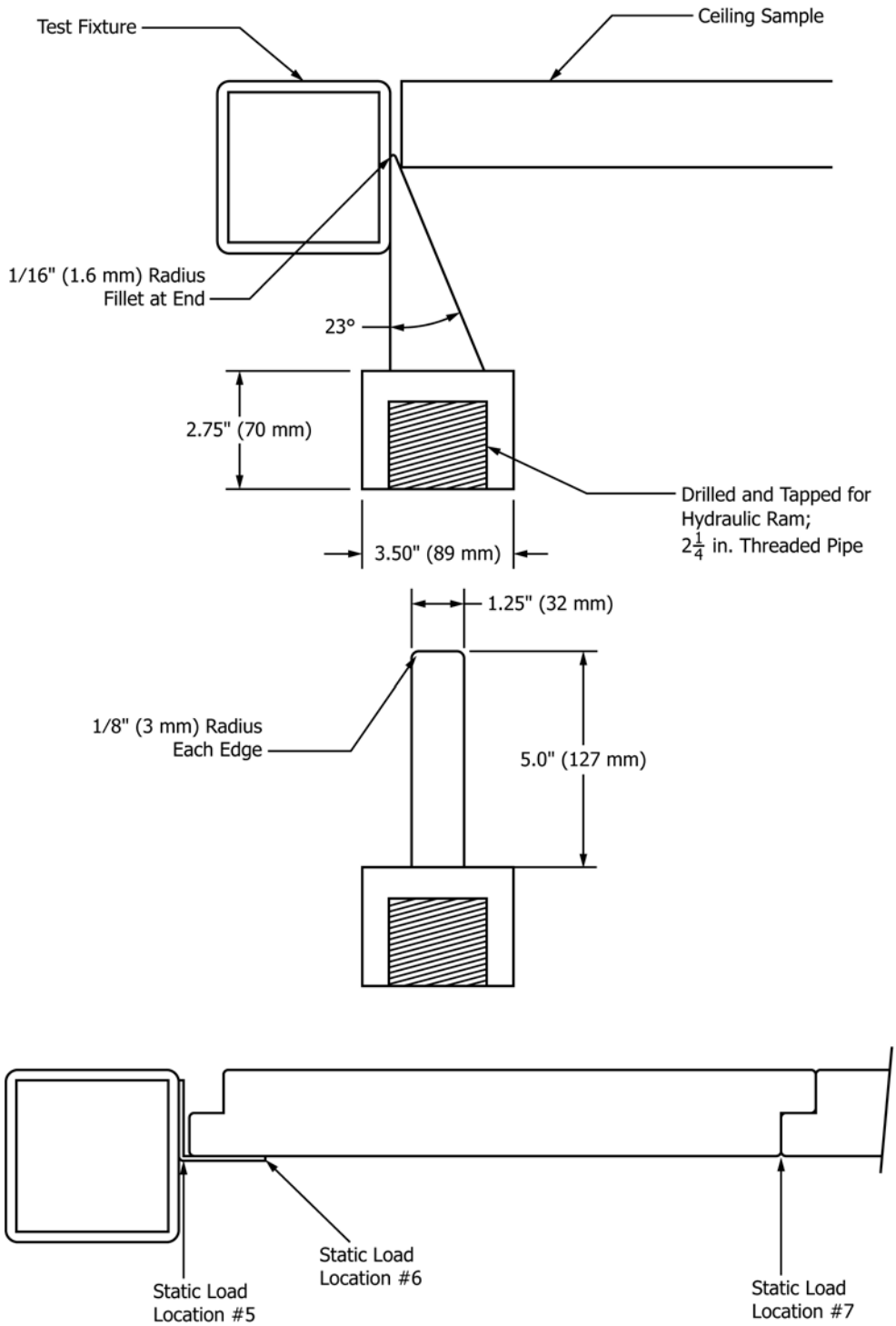


**FIG. 7 Hydraulic Pry Test Adapter Static Load Table 1 Locations 5 – 7**

deflection in inches (millimetres) in increments of 500 lbf (2224 N) to produce a graph of static load versus deflection. Increase the static load until target loads are reached (Table 1).

7.2.4.6 After reaching the maximum required load required by Table 1, record the maximum deflection. The maximum allowable deflection (A) under load shall be L/180 in. (mm), where L = The unsupported length of the sample being tested. Record the permanent deflection within 1 min after release of load. The maximum allowable permanent deflection shall be 0.25 × A in. (mm). Perform the static load test at each location designated in Table 1

7.2.4.7 Required results for location 5, 6, and 7 are that the seam is not permitted to open more than 0.50 in. (12.7 mm), and that no fasteners are permitted to break or pull out.

7.2.5 *Required Results*—The required loads, impacts, and results are as shown in Table 1 for the security grades being

**TABLE 1 Security Grades and Load Requirements for Ceiling Panels**

| Grade Number[A] | Recommended Ceiling Panel Face Sheet Thickness[B] in. (mm) gauge | Number of Impacts at Each Target Location (total/time) | Static Load lbf (N) |
|---|---|---|---|
| 1 | 0.093 (2.3) 12 Hollow Metal Panel | 600 (2400/4 h) | 3000 (13 345) |
| 2 | 0.067 (2.3) 14 Hollow Metal Panel | 400 (1600/2 h min.) | 20000 (8896) |
| 3 | 0.093 (1.7) 12 Single Sheet Pan | 200 (800/1 h min.) | 1000 (4448) |
| 4 | 0.067 (1.7) 14 Single Sheet Pan | 100 (400/40 min.) | 750 (3336) |
| Location Number | Target Locations for Ceiling Impact Test and Ceiling Static Load Test Target Location[C] | | |
| 1 | Static Load and Impact: Against the ceiling, within 6 in. (152 mm) of a corner selected by the lab test director (Fig. 6). | | |
| 2 | Static Load and Impact: Against the ceiling along one length of the ceiling wall attachment within 1 in. (25.4 mm) of the attachment of the wall and the ceiling panel selected by the lab test director (Fig. 6). | | |
| 3 | Static Load and Impact: Against the ceiling at a distance of 30 in. (762 mm) from the attachment between the ceiling and the test fixture (wall attachment) selected by the lab test director (Fig. 6). | | |
| 4 | Static Load and Impact: Against the ceiling directly against a seam at or near center span of the seam selected by lab test director (Fig. 6). | | |
| 5 | Static load only: In the seam between the test fixture and ceiling wall anchor at a location selected by the lab test director using the “Pry Test Adapter” (Fig. 7). | | |
| 6 | Static Load only: Gap at a present horizontal seam (Fig. 7). | | |
| 7 | Static load only: In the seam in the middle of ceiling selected by test director 24 in. away from edge (Fig. 7). | | |

[A]Grades 1 and 2 shall be identified as a containment ceiling. Grades 3 and 4 shall be identified as a concealment ceiling.
[B]Alternate materials and methods of construction that promote product innovation including non-metallic or square panel ceilings, or both, which meet the aforementioned performance criteria shall be permitted.
[C]Impact locations and static load locations may be selected by the lab test director such that no two test locations are within 12 in. (305 mm) of each other.

obtained. The lengths of test samples are specified to be 8 ft (2438 mm) or longer. Test results at this length are acceptable for a ceiling system of the same design, but of shorter length.

7.2.6 *Precision and Bias*—The precision and bias of this test method for evaluating the static load resistance of a horizontal fixed barrier are being determined.

## 8. Certification

8.1 *Certification*—The manufacturer shall provide test reports by an independent testing laboratory which certify that the test horizontal fixed barriers were successfully tested in accordance with these test methods and that comply with Section 9.

## 9. Report

9.1 Report the following information:

9.1.1 Name and address of laboratory,

9.1.2 Date laboratory completed tests,

9.1.3 Name and address of ceiling manufacturer,

9.1.4 Description of identifying markings on the test ceiling,

9.1.5 Diagrams, details, and photographs of testing equipment,

9.1.6 Complete description of the test ceiling including drawings, ceiling specifications, and ceiling testing conditions such as load bearing conditions, and

9.1.7 All related test data, including resulting grade level achieved (Table 1).

9.2 Provide the following:

9.2.1 Digital video recording of the entire test(s) from inception of the physical test to pro duct failure or termination of the test.

9.2.2 Still color photographs of the salient stages of the test such as:

9.2.2.1 Initial penetration.

9.2.2.2 Conclusion of test.

9.2.2.3 Each penetration which allows forcible egress shall be reported including photographs.

## 10. Keywords

10.1 battering ram; correctional facility; detention ceiling; detention facility; detention security; escape; fire resistance test (ceiling); impact test (ceiling); physical security; security ceiling

# APPENDIXES

**(Nonmandatory Information)**

## X1. APPLICATIONS AND REQUIREMENTS

X1.1 Examples of horizontal fixed barriers enclosing or separating the secure areas of detention and correctional facilities are those in day rooms, control rooms, cells, and sally ports.

X1.2 Security grade requirements shown in Table 1 are comparable to the security grade requirements described in the following related standards: Test Methods F1450, Test Methods F1592, Test Method F1915, and Test Methods F2322.

## X2. TEST APPARATUS

X2.1 Test equipment suitable for use in evaluating the physical security of horizontal fixed barriers is described in this appendix. While certain commercial instruments are identified to adequately describe the test equipment, in no case does such identification imply recommendation or endorsement, nor does it imply that the material or equipment described is necessarily the best for the purpose.

X2.2 Figs. 1 and 2 show the fixtures and equipment necessary to carry out the test methods described in 7.2.

X2.3 Information on equipment necessary to perform the tests described in 7.1 and 7.2 is included in the referenced test methods.

X2.4 *Manufacturer's Procedure*—The manufacturer may elect to contract with the test laboratory to provide the manufacturer with a certified procedure and security labeling service for the construction of tested assemblies with factory follow-up inspection service as an option.

## X3. ATTACK WEAPONS

X3.1 This standard addresses only those threats to horizontal fixed barriers which would be anticipated based on the limited weapons, tools, and resources available to inmates within detention and correctional facilities. Where a fixed barrier is also accessible to external assault with weapons, tools, and resources available in the free world outside of the facility, consider applying additional standards that address this type of assault.

X3.2 ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

X3.3 This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years if not revised, either re-approved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing, you should make your views known to the ASTM Committee on Standards, 100 Barr Harbor Drive, West Conshohocken, PA 19428–2959.

## X4. REPRESENTATIVE BARRIER DURATION TIME

X4.1 The element of time shown in Table 1 is based upon historical testing observation that indicates that sustained manpower can deliver 600 blows of 200 ft·lb (271.2 J) each in one (1) hour. Table 1 includes total numbers of impacts for each Grade Level, and total approximate times to deliver these numbers, excluding set up times for cyclic sequences. This is offered solely as supplementary design information to assist the user in matching security grades with the attack resistance times and staff response times required for each opening in the facility.

## X5. TESTING SCHEDULE

X5.1 The detention and correction industry relies heavily upon the credibility of the testing of security horizontal fixed barrier assemblies in accordance with these test methods, and the performance that successful testing helps to ensure. In consideration of the importance placed by the industry upon this product performance testing, the developers and reviewers of these test methods agree that retesting every five (5) years will help ensure that product designs and production methods remain reliable and do not exhibit performance degradation over time. This five (5) year retesting schedule coordinates well with the five (5) year review that is mandated by ASTM for all standards. By following this schedule, the industry is assured that if a review precipitates changes or additions to the testing procedures, then these new procedures will be utilized by the manufacturers and laboratories upon their next retesting cycle, thereby providing assurance that products are always being tested and retested in accordance with the most current revisions of the standards. However, in the interest of not requiring unnecessary testing, if the revisions to a standard during its review are editorial only, or if the standard is reapproved with no changes, retesting may be waived.