



Standard Specification for Impact Attenuation of Turf Playing Systems as Measured in the Field¹

This standard is issued under the fixed designation F1936; 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 impact attenuation of turf playing systems can be measured in a laboratory, but such tests are often conducted under optimal or tightly controlled conditions. To accurately assess the impact attenuation an athlete will encounter on an installed field, that specific field must be tested *in situ*. That objective was the impetus for the development of this specification. Initially, the stated scope of the specification was limited to measuring the impact attenuation of North American football fields. The scope of the current revision encompasses a broader range of sport-specific field configurations and a protocol for conducting tests on multi-sport fields.

1. Scope

1.1 This specification establishes an *in situ* test method and maximum impact attenuation value for all types of turf playing systems and for a number of sport-specific field layouts. It also includes a protocol for determining test point locations on fields that are lined for multiple sports.

1.1.1 Turf playing systems may be located outdoors or indoors, and typically include field areas within the in-bounds lines and areas outside the in-bounds lines extending to sport-specific limit lines; areas where an athlete should expect to encounter impact attenuation performance that complies with this specification.

1.1.2 Site-specific conditions may exist wherein non-turf surface materials, such as track surfacing and/or covers over subsurface structures, are found within the boundaries of the limit lines. These alternate surface materials are not included in the scope of this specification.

1.2 This specification establishes a method for reporting test results and identifying areas within an existing turf playing system where impact attenuation measurements exceed required threshold values.

1.3 Nothing in this specification is intended to impose limitations on what fields can be tested, or how a particular field can be used. Test providers can adapt the procedures and guidelines contained herein to tests performed on any turf playing system.

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 F08.65 on Artificial Turf Surfaces and Systems.

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1.4 This specification does not imply that an impact-related injury cannot be incurred if a turf playing system complies with its g-max performance requirement.

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

1.6 *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.*

1.7 *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

[E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods](#)

[E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method](#)

[F355 Test Method for Impact Attenuation of Playing Surface Systems, Other Protective Sport Systems, and Materials](#)

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.

Used for Athletics, Recreation and Play

F1292 Specification for Impact Attenuation of Surfacing Materials Within the Use Zone of Playground Equipment

F1551 Test Methods for Comprehensive Characterization of Synthetic Turf Playing Surfaces and Materials

F1702 Test Method for Measuring Impact-Attenuation Characteristics of Natural Playing Surface Systems Using a Lightweight Portable Apparatus

F2650 Terminology Relating to Impact Testing of Sports Surfaces and Equipment

2.2 ISO Standard:

ISO 6587 Paper, board and pulps – Determination of conductivity of aqueous extracts³

NOTE 1—Additional references are listed at the end of this specification.

3. Terminology

3.1 *Definitions*: Except as noted, definitions in this standard are in accordance with Terminology **F2650**.

3.1.1 *abnormal drop*—any drop of the missile which, due to operator or equipment problem(s) or uncertainty, results in a reading which is questionable.

3.1.2 *average g-max*—sum of the *g-max* of the second and third drops divided by two and rounded to the nearest whole number.

3.1.3 *combination turf system*—a turf playing system consisting of a natural turf surface which is enhanced by use of synthetic elements such as synthetic turf substructures, excluding water/drainage systems and single layer mesh fabrics, which are used for the sole purpose of soil stabilization.

3.1.4 *drop test*—a set of three successive drops of the impact missile at a test point, where each drop has been performed and recorded in accordance with prescribed guidelines.

3.1.5 *infill turf system*—a turf playing system having a long pile height and one or more substances in the face of the fabric to provide desired performance properties. Infill materials can include sand, rubber, other substances, or combinations thereof.

3.1.6 *impact velocity*—the velocity of the missile as it impacts the turf playing system.

3.1.7 *limit lines*—limits beyond the in-bounds boundaries that represent the extent to which the out-of-bounds areas should remain free of hazards and obstructions, and where an athlete may anticipate consistent surface characteristics. These limits are defined by the appropriate governing body or regulating standard for each specific sport.

3.1.8 *natural turf system*—a turf playing system which is comprised of living grass or similar plant materials which are rooted in soil.

3.1.9 *pile*—a surface texture composed of many individual thin strands or groups of strands bound to a backing fabric in a repetitive array.

3.1.10 *pile layover*—a horizontal motion of the pile under the influence of impact.

3.1.11 *restraining ring*—a rigid circular device with a smooth or polished surface, creating little or no friction, used to restrict the horizontal movement of the missile at impact.

3.1.12 *synthetic turf system*—a composite of synthetic contact surface material, any fill material used in the contact surface, energy absorbing material, fabric layers, adhesives, if any, and other constructed layers (as applicable to the individual system).

3.1.13 *test point*—a location on the turf playing system at which a series of measurements is taken.

3.1.14 *theoretical drop height*—the drop height (*h*) that, under standard conditions, would result in an impact velocity equal to a missile's measured impact velocity (*V₀*).

4. Summary of Test Method

4.1 Turf playing systems are tested according to this specification and Test Method **F355**, Procedure A. A theoretical drop height of 24 in. (61 cm), as measured from the bottom of the missile face to the top of the turf playing system, shall be used. At each test point, the impact missile is dropped onto the turf playing system three times, with an interval of 1.0 ± 0.5 min (60 ± 30 s) between successive drops. The *g-max* value for each drop is recorded and reported. Following the third drop, the average *g-max* value for the test point is calculated and reported.

5. Significance and Use

5.1 Data obtained from the use of this specification are indicative of the impact attenuation performance of individual test points on an installed turf playing system. The data may be used to make comparisons between values measured in accordance with this specification and performance requirements herein or elsewhere specified. Data may also be used to determine the need for maintenance and or replacement of the turf playing system.

6. Performance Requirements

6.1 When tested in accordance with this specification, the average *g-max* at each test point shall be less than 200 *g*'s.

6.2 If a turf playing system is tested in accordance with this specification, and the reported average *g-max* of one or more test points is equal to or greater than 200 *g*'s, the turf playing system should be brought into compliance and should not be used in the interim.

6.3 Nothing in this specification is intended to keep an owner, architect, engineer or other specifier from establishing more stringent performance requirements for a turf playing system. However, reports prepared in accordance with this specification shall assess performance per the requirements described in **6.1** and **6.2**.

7. Test Apparatus

7.1 The impacting missile shall be cylindrical with a circular, flat, metal, impacting surface. It shall weigh 20 lb (9.1 kg), and have a 20 in.² (129 cm²) surface face with the impacting edges slightly beveled to eliminate sharp edges. The

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

design of the missile shall provide for mounting the accelerometer within $\pm 1^\circ$ of the vertical axis of the missile, and allow the missile to achieve a velocity of 11.35 ± 0.56 ft/s (3.46 ± 0.17 m/s) (referenced in Section 27 of Test Methods F1551 as the velocity corresponding to a theoretical drop height of 24 in. (61 cm) at sea level) upon impact from the drop height.

7.2 To restrict the influence of pile layover, the test equipment shall be designed to include a rigid restraining ring with a smooth or polished surface, creating little or no friction, having an interior dimension not to exceed the diameter of the missile by more than 0.039 in. (1 mm). The ring shall be securely mounted horizontal to the surface such that a minimum of $\frac{1}{4}$ of the missile shall freely pass through it prior to striking the surface, ensuring a vertical impact and precluding the missile's rebound onto the top of the ring. Other guidance systems can be utilized, provided they do not allow lateral movement greater than 0.039 in. (1 mm) upon impact and rebound of the missile.

7.3 The test equipment shall have sufficient stability to eliminate undesirable vibrations in the apparatus which might be recorded on the acceleration-time curve. It shall also allow sufficient vertical fall for the missile to achieve a velocity corresponding to a theoretical drop height of 24 in. (61 cm).

7.4 The signal from the acceleration transducer shall be conditioned with a low pass filter: complying to Channel Class 1000 as specified in Specification F1292 (ISO 6587).

7.5 The acceleration recording system must be capable of accurately resolving the deceleration to a minimum of $\pm 1\%$ of true value.

7.6 The acceleration transducer must be capable of withstanding impacts of at least 1000 g without damage.

7.7 The minimum required system sampling rate is 20 000 Hz.

7.8 The test equipment shall be capable of visually displaying and recording the acceleration-time curve of each drop.

NOTE 2—The Clegg Hammer, as defined in Test Method F1702, is not an appropriate device for testing under this specification. Results obtained with a Clegg Hammer and subsequently adjusted by conversion factors or regression equations are not appropriate for inclusion in a report prepared in accordance with this specification.

8. Test Point Locations

8.1 The following sections describe suggested test point locations for each listed field configuration. The descriptions are supplemented by accompanying illustrations. The number of test points listed for each field configuration constitutes a minimum requirement. As noted in 8.11, additional points may be tested.

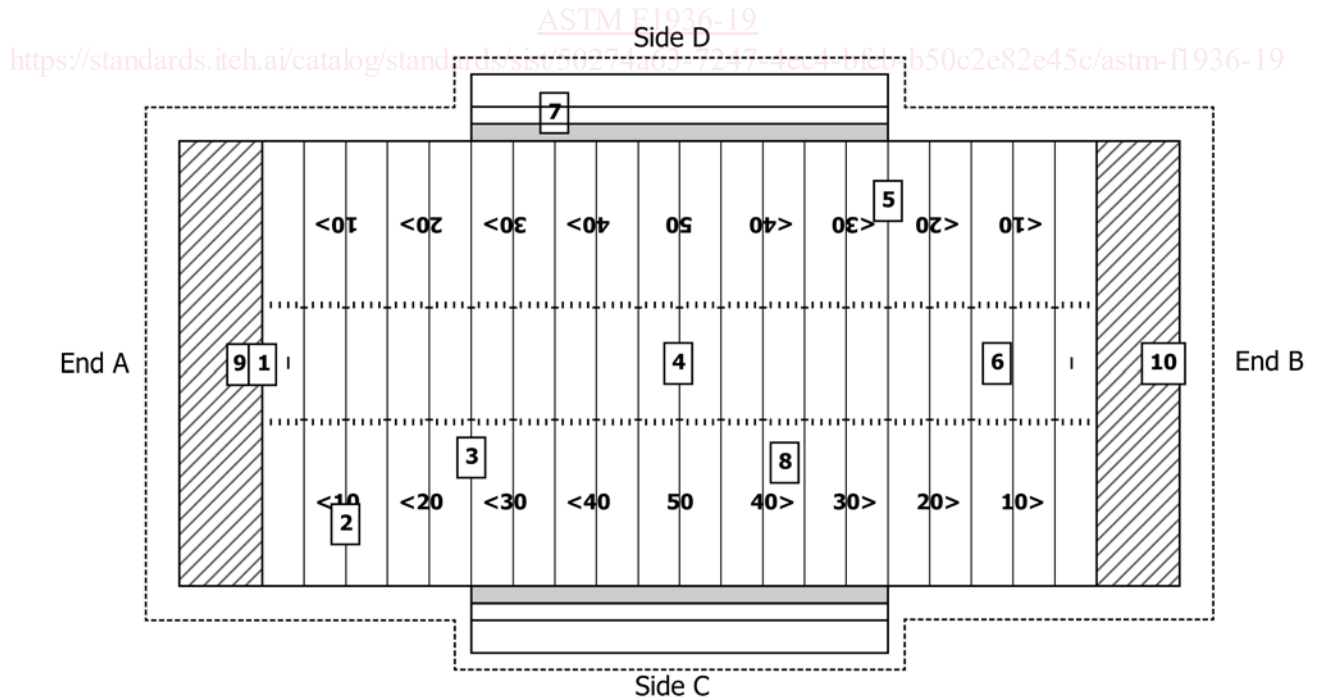
8.1.1 On fields lined for multiple sports, the selection of test point locations will be determined by the sport which appears first on the following list: football (American football, Canadian football, and rugby), soccer, men's lacrosse, women's lacrosse, baseball, softball, field hockey.

8.1.2 Actual drop sites may be located anywhere within a 36 in. (91 cm) radius of a described test point location. Deviations that exceed this requirement must be recorded as site abnormalities, per 11.1.15.

8.1.3 This specification cannot anticipate all possible field configurations. Persons using it are expected to select the most appropriate set of test points for the field being tested, from among the options specified below.

8.2 Football (American football, Canadian football, and rugby) (see Fig. 1):

8.2.1 Point 1—Goal Line, End A, center of field;



NOTE 1—Test points 7 and 8 are shown for information purposes only. Actual locations are selected at the time of the test and may vary from those illustrated.

FIG. 1 Test Point Locations for North American Football

8.2.2 *Point 2*—10 Yard Line, End A, 63 ft from center of field to Side C;

8.2.3 *Point 3*—25 Yard Line, End A, 40 ft from center of field to Side C;

8.2.4 *Point 4*—Center of the field;

8.2.5 *Point 5*—25 Yard Line, End B, 63 ft from center of field to Side D;

8.2.6 *Point 6*—12 Yard Line, End B, center of field;

8.2.7 *Point 7*—A test point selected by the tester, with the objective of identifying and testing a high-wear area located within the limit lines but outside the in-bounds lines;

8.2.7.1 Football limit lines are typically 12 ft beyond the in-bounds lines.

8.2.8 *Point 8*—A test point selected by the tester, with the objective of identifying and testing an area within the limit lines (to include the in-bounds area) that may have different impact attenuation performance than points previously tested;

8.2.9 *Point 9*—6 ft from the Goal Line to the back of the End Zone, End A, center of field;

8.2.10 *Point 10*—6 ft from the back of the End Zone to the Goal Line, End B, center of field.

8.2.11 If the field is lined for Canadian football or rugby and not for American football, refer to 8.9.1 for instructions regarding test point placement.

8.3 *Soccer* (see Fig. 2):

8.3.1 *Point 1*—Penalty Mark, End A, center of field;

8.3.2 *Point 2*—Corner of Penalty Area at End A and closest to Touch Line C;

8.3.3 *Point 3*—75 ft from Halfway Line to End A, 40 ft from center of field to Touch Line C;

8.3.4 *Point 4*—Center Mark;

8.3.5 *Point 5*—75 ft from Halfway Line to End B, 63 ft from center of field to Touch Line D;

8.3.6 *Point 6*— $\frac{1}{2}$ the distance from Penalty Arc to leading edge of Penalty Area at End B, center of field;

8.3.7 *Point 7*—A test point selected by the tester, with the objective of identifying and testing a high-wear area located anywhere within the limit lines, but outside the in-bounds lines:

8.3.7.1 Limit lines are 10 ft beyond the in-bounds lines on high school soccer fields, and 20 ft beyond the in-bounds lines on NCAA soccer fields.

8.3.8 *Point 8*—A test point selected by the tester, with the objective of identifying and testing a point within the limit lines (to include the in-bounds area) that may have different impact attenuation performance than points previously tested;

8.3.9 *Point 9*—3 ft from Goal Line to Halfway Line, End A, center of field;

8.3.10 *Point 10*—15 ft from Goal Line to Halfway Line, End B, center of field.

8.3.11 If the field is less than 300 ft in length or less than 120 ft in width, or both, refer to 8.9.2.

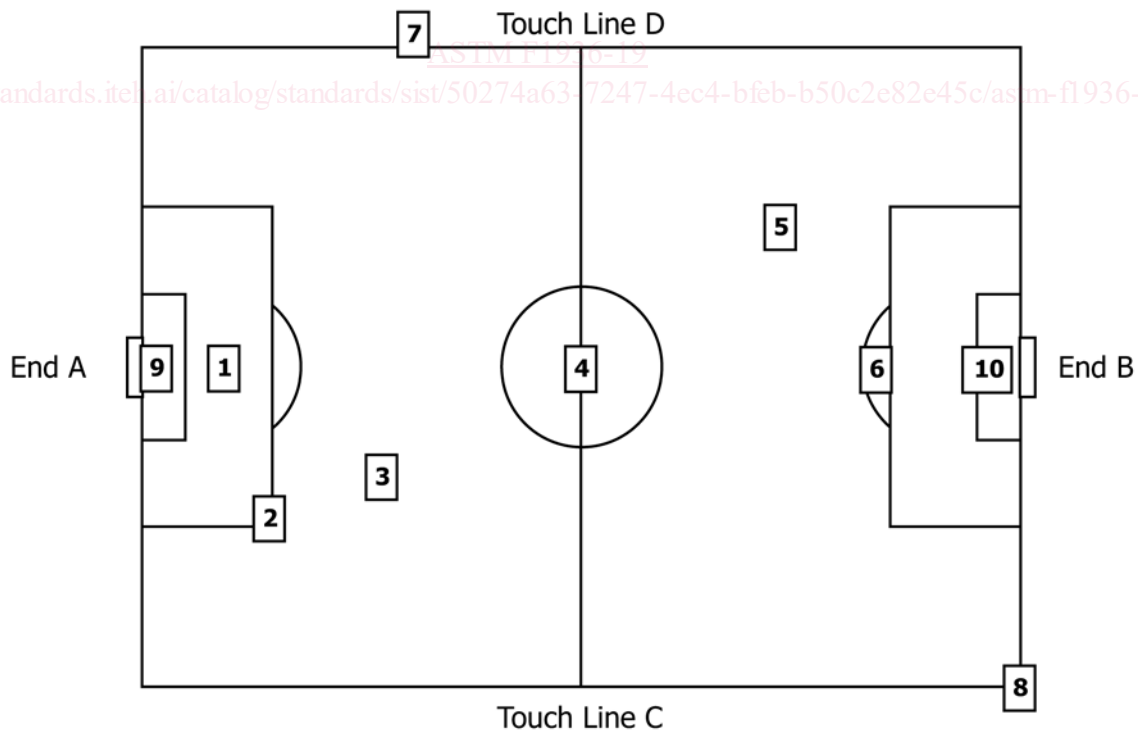
8.4 *Men's Lacrosse* (see Fig. 3):

8.4.1 *Point 1*—25 ft from Goal Line to End Line, End A, center of field;

8.4.2 *Point 2*—63 ft from mid-point of Goal Line to Sideline C, End A;

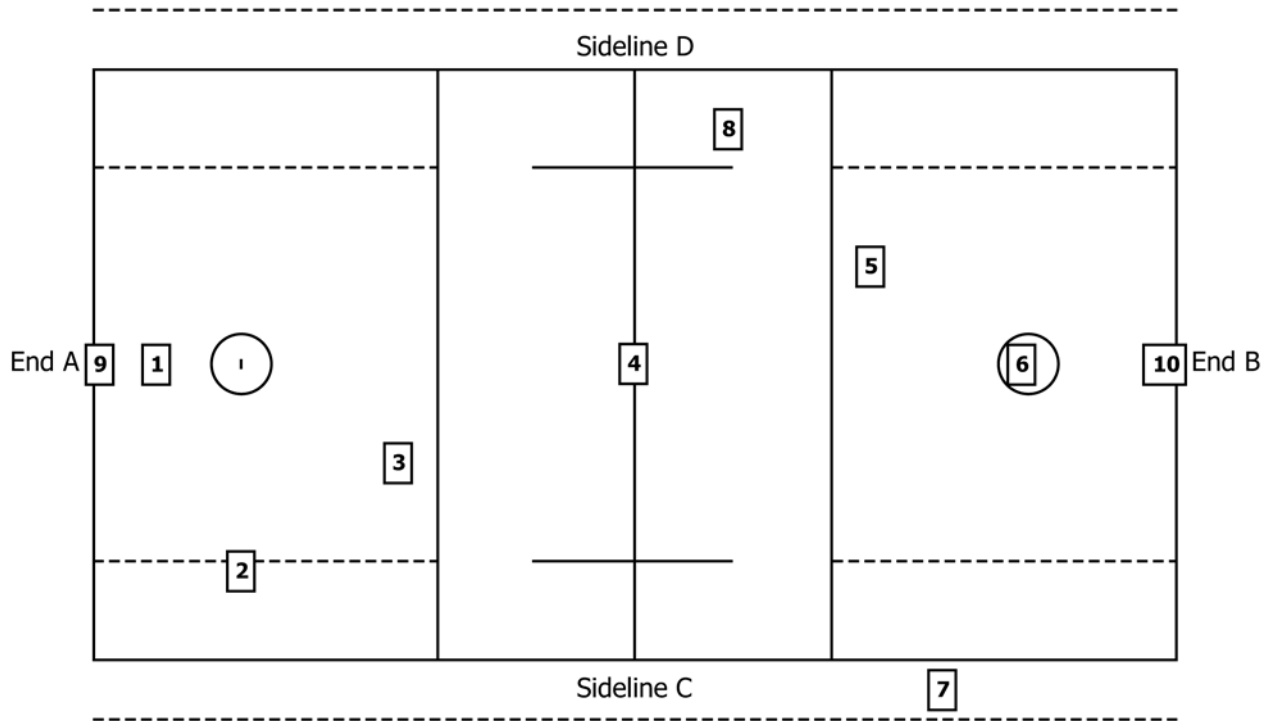
8.4.3 *Point 3*—75 ft from Center Line to End A, 40 ft from center of field to Sideline C;

8.4.4 *Point 4*—Center of the field;



NOTE 1—Test points 7 and 8 are shown for information purposes only. Actual locations are selected at the time of the test and may vary from those illustrated.

FIG. 2 Test Point Locations for Soccer



NOTE 1—Test points 7 and 8 are shown for information purposes only. Their locations are selected at the time of the test.

FIG. 3 Test Point Locations for Men's Lacrosse

8.4.5 *Point 5*—75 ft from Center Line to End B, 63 ft from center of field to Sideline D;

8.4.6 *Point 6*—3 ft from Goal Line to Center Line, End B, center of field;

8.4.7 *Point 7*—A test point selected by the tester, with the objective of identifying and testing a high-wear area located anywhere within the limit lines, but outside the in-bounds lines;

8.4.7.1 No limit lines are specified for men's lacrosse fields. Use the 18 ft width of the Coach's Area as the maximum distance from the inbounds lines for test points 7 and 8.

8.4.8 *Point 8*—A test point selected by the tester, with the objective of identifying and testing a point within the limit lines (to include the in-bounds area) that may have different impact attenuation performance than points previously tested;

8.4.9 *Point 9*—3 ft from the End Line to the Center Line, End A, center of field;

8.4.10 *Point 10*—3 ft from the End Line to the Center Line, End B, center of field.

8.5 *Women's Lacrosse* (see Fig. 4):

8.5.1 *Point 1*—3 ft from Goal Line to Center Line, End A, center of field;

8.5.2 *Point 2*—30 ft from Goal Line at End A to Center Line, 63 ft from center of field to Side C;

8.5.3 *Point 3*—75 ft from Goal Line at End A to Center Line, 40 ft from center of field to Side C;

8.5.4 *Point 4*—Center of the field;

8.5.5 *Point 5*—75 ft from Goal Line at End B to Center Line, 63 ft from center of field to Side D;

8.5.6 *Point 6*—3 ft from 8-Meter-Arc to Goal Line, End B, center of field;

8.5.7 *Point 7*—A test point selected by the tester, with the objective of identifying and testing a high-wear area located anywhere within the boundary lines but outside the lined area of the field;

8.5.7.1 Limit (boundary) lines on women's lacrosse fields are variable. The location of the limit lines will be determined by conditions at each test site.

8.5.8 *Point 8*—A test point selected by the tester, with the objective of identifying and testing a point within the boundary lines (including the field of play) that may have different impact attenuation performance than points previously tested.

8.5.9 *Point 9*—3 ft from the End Line at End A to Center Line, center of field;

8.5.10 *Point 10*—3 ft from the End Line at End B to Center Line, center of field.

8.6 *Field Hockey* (see Fig. 5):

8.6.1 *Point 1*—3 ft from Goal Line to Center Line, End A, center of the field;

8.6.2 *Point 2*—30 ft from Goal Line at End A to Center Line, 63 ft from center of the field to Sideline C;

8.6.3 *Point 3*—25 Yard Line, End A, 40 ft from center of field to Sideline C;

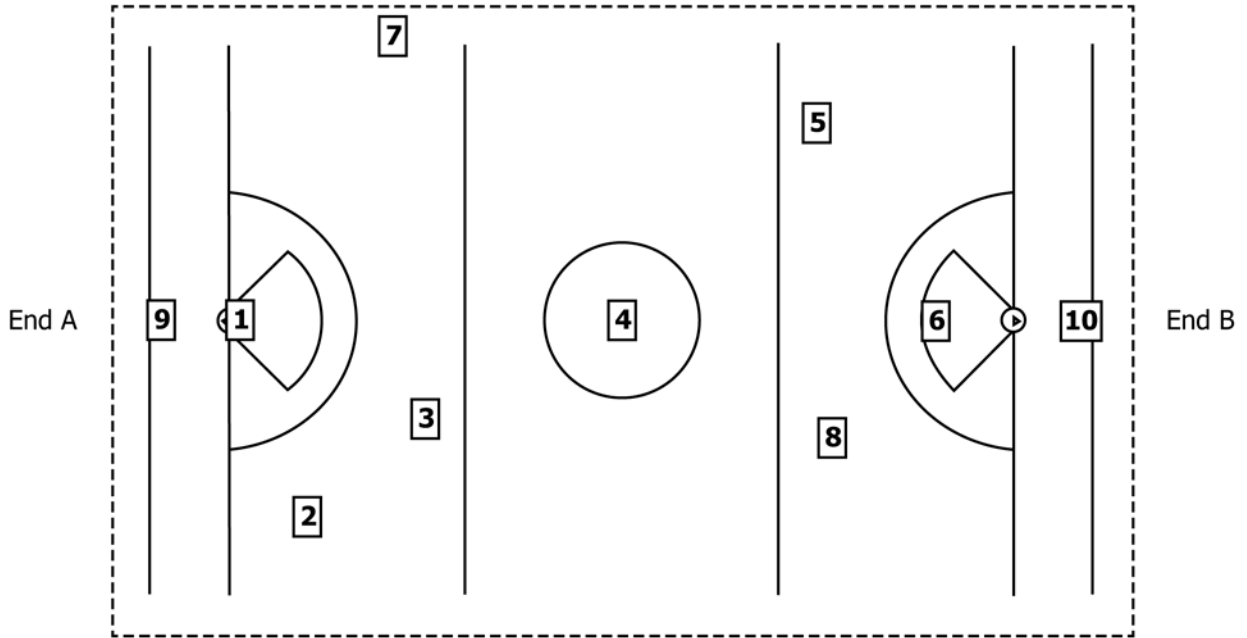
8.6.4 *Point 4*—Center of the field;

8.6.5 *Point 5*—25 Yard Line, End B, 63 ft from center of field to Sideline D;

8.6.6 *Point 6*—12 ft from edge of Striking Circle to Goal Line, End B, center of field;

8.6.7 *Point 7*—A test point selected by the tester, with the objective of identifying and testing a high-wear area located anywhere within the limit lines, but outside the in-bounds lines;

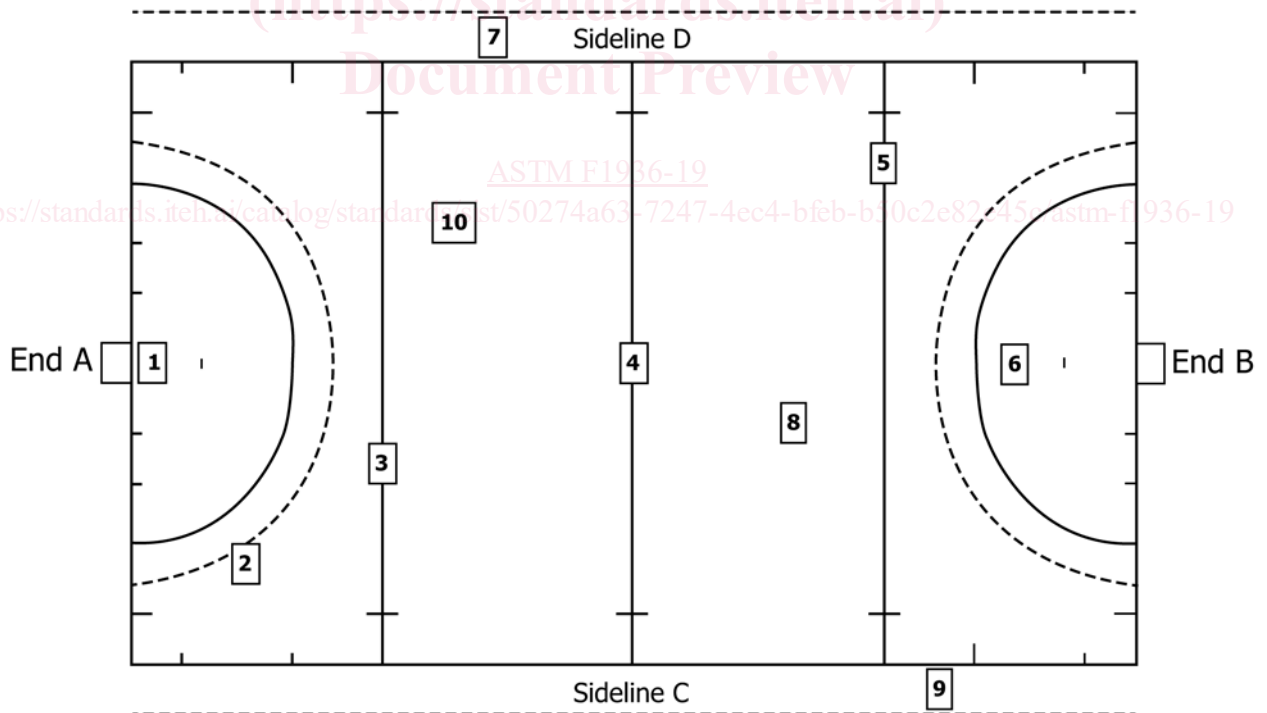
Side D



Side C

NOTE 1—Test points 7 and 8 are shown for information purposes only. Their locations are selected at the time of the test and may vary from those illustrated.

FIG. 4 Test Point Locations for Women's Lacrosse



NOTE 1—Test points 7, 8, 9, and 10 are shown for information purposes only. Their locations are selected at the time of the test and may vary from those illustrated.

FIG. 5 Test Point Locations for Field Hockey

8.6.7.1 Limit lines are 15 ft outside the in-bounds lines on field hockey fields.

8.6.8 Point 8—A test point selected by the tester, with the objective of identifying and testing a point within the limit