



# Standard Test Methods for Measuring High-Speed Bat Performance<sup>1</sup>

This standard is issued under the fixed designation F 2219; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

## 1. Scope

1.1 These test methods define a method for determining bat performance by measuring the bat-ball coefficient of restitution (BBCOR), deriving the ball exit speed ratio (BESR), and calculating a batted-ball speed (BBS). It is applicable to baseball and softball bats of any construction or material. The test methods provide quantitative measures of bat dynamic performance that may be used for comparison purposes.

1.2 The BBCOR, BESR, and BBS are each calculated from measurements taken in the laboratory on test equipment meeting the requirements defined in this specification.

1.3 The values stated in English units are to be regarded as the standard.

1.4 *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 to determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

F 1887 Test Method for Measuring the Coefficient of Restitution (COR) of Baseballs and Softballs

F 1888 Test Method for Compression-Displacement of Baseballs and Softballs

F 2398 Test Method for Measuring Moment of Inertia and Center of Percussion of a Baseball or Softball Bat

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *balance point (BP)*,  $n$ —distance to the center of mass of a bat when measured from the distal end of the bat knob.

3.1.2 *ball exit speed ( $V_p$ )*,  $n$ —outbound speed of a ball following impact with a bat as defined in these test methods.

3.1.3 *ball exit speed ratio (BESR)*,  $n$ —ratio of ball exit speed ( $v_r$ ) to ball inbound speed ( $v_i$ ) plus one-half, as determined by these test methods.

3.1.4 *ball inbound speed ( $v_i$ )*,  $n$ —inbound speed of a ball prior to impact with a bat as defined in this test method.

3.1.5 *bat-ball coefficient of restitution (BBCOR)*—COR of a specific ball colliding with a bat as defined in these test methods. See *coefficient of restitution (COR)*.

3.1.6 *center of percussion (COP)*,  $n$ —also known as the center of oscillation, the length of a simple pendulum with the same period as a physical pendulum, as in a bat oscillating on a pivot. Forces and impacts at this location will not induce axial reactions at the pivot point.

3.1.7 *coefficient of restitution (COR)*,  $n$ —measure of impact efficiency calculated as the relative speed of the objects after impact divided by the relative speed of the objects before impact.

3.1.8 *moment of inertia (MOI)*,  $n$ —measure of mass distribution relative to an axis of rotation. It is the product of the mass multiplied by the square of the distance to the mass, summed over the entire bat.

## 4. Significance and Use

4.1 This test method offers a laboratory the means to measure the performance of baseball and softball bats.

4.2 Use of this test method can provide sports governing bodies a means to compare calculated batted-ball speed and other physical properties of bats.

## 5. Apparatus and Equipment

5.1 *Test Balls*—Official baseballs and softballs approved for play and tested in accordance with the following procedures.

5.1.1 *Baseballs:*

5.1.1.1 *Compression*—300 to 375 lb at 0.25-in. deflection (1335 to 1668 N at 6.4 mm deflection), as determined in accordance with Test Method F 1888. Balls to be labeled with compression value.

5.1.1.2 *Weight*—5.00 to 5.25 oz (142 to 149 g). Balls to be labeled with weight value.

5.1.1.3 *Size*—9.00 to 9.50 in. circumference (228.6 to 241.3 mm). Balls to be labeled with size value.

5.1.1.4 *Ball COR*—.525 to .550, as determined in accordance with Test Method F 1887. Balls to be labeled with COR value and test speed in ft/s.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee F08 on Sports Equipment and Facilities and is the direct responsibility of Subcommittee F08.26 on Baseball and Softball Equipment.

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<sup>2</sup> 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.

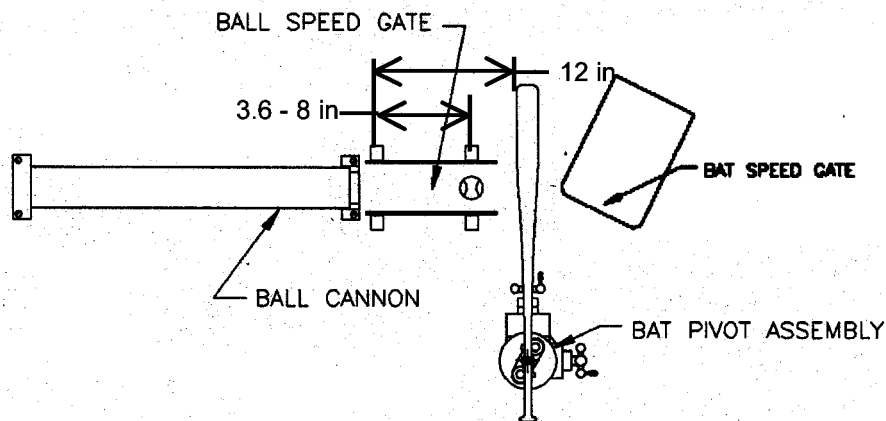


FIG. 1 Bat Testing Machine

5.1.2 Softballs:

5.1.2.1 *Compression*—350 to 375 lb at 0.25-in. deflection (1557 to 1668 N at 6.4 mm deflection), as determined in accordance with Test Method F 1888. Balls to be labeled with compression value.

5.1.2.2 *Weight*—6.75 to 7.00 oz (191.0 to 198.1 g). Balls to be labeled with weight value.

5.1.2.3 *Size*—12.00 to 12.25 in. circumference (304.8 to 311.1 mm). Balls to be labeled with size value.

5.1.2.4 *Ball COR*—.430 to .440, as determined in accordance with Test Method F 1887. Balls to be labeled with COR value and test speed in ft/s.

5.2 Bat-Ball COR Test Apparatus:

5.2.1 *Ball Cannon*—A device capable of shooting a ball at speeds up to 161.3 ft/s (49.1 m/s). The ball shall not have a spin rate in excess of 10 rpm. Typical pitching machines cannot yield the aiming accuracy required by this test method. Cannon exhaust air must not cause motion of the bat in the absence of an impact. The ball cannon can be any distance from the impact location, as long as it can meet the ball aim requirements and provide six valid impacts in twelve shots or less.

5.2.2 *Ball Speed Gate*—A light trap device, or an equivalent, capable of measuring a sphere traveling at speeds in excess of 161.3 ft/s (49.1 m/s) with an accuracy of  $\pm 1.61$  ft/s or better (0.49 m/s). The device shall measure across a length of no less than half the ball diameter to avoid centering error. For example, the device shall sense an object across a 2.0 in. (50.8 mm) line. The first sensor shall trigger when the ball is no more than 18.0 in. (457.2 mm) from the bat surface. The second sensor shall trigger between 12.0 in. (304.8 mm) and 14.0 in. (355.6 mm) from the first sensor. The second sensor is located between the first sensor and the bat surface. The distance between sensors must be measured and maintained within  $\pm 0.005$  in. ( $\pm 0.13$  mm) (see Fig. 1). The device must be able to measure the ball exit speed. This requires the device to reset and arm quickly enough to capture the ball traveling back through the speed gate.

5.2.3 *Bat Pivot Support*—A turntable, rotating in the horizontal plane, with clamps to support and align the bat in the path of the ball. The clamp surfaces shall be a 45° Vee clamp with a radius no greater than 2.0 in. (50.8 mm). The rotating clamp and shaft assembly shall not weigh more than 6 lb (2.7

kg) and shall spin freely via ball bearings (see Fig. 1). The polar MOI for the clamp turntable assembly shall not exceed 192 oz-in.<sup>2</sup> (35 117 g-cm<sup>2</sup>). The actual MOI of the clamp turntable assembly shall be determined and used in the performance calculations.

6. Calibration and Standardization

6.1 *Ball Speed Gate*—The distances between the sensors of the speed gates must be known and recorded to the stated tolerances. The accuracy of the timers used in the velocity sensors must be adequate to provide the stated velocity accuracy at maximum stated speeds. The timers used shall be calibrated on at least a yearly basis.

6.2 *Reference Standards and Blanks*—A standard bat and ball shall be used for reference purposes to verify proper machine operation.

7. Conditioning

7.1 *Ball and Bat Conditioning:*

7.1.1 Balls shall be stored in an environmentally controlled space for at least 14 days immediately before testing. Wood bats shall be stored at these environmental conditions for at least 24 h prior to testing. Non-wood bats shall be stored at these test environmental conditions for at least 2 h prior to testing.

7.1.2 Temperature is to be maintained at  $72 \pm 4^\circ\text{F}$  ( $22 \pm 2^\circ\text{C}$ ).

7.1.3 Relative humidity is to be maintained at  $50 \pm 10\%$ .

7.1.4 Bats and balls are to be tested within 1 h after removal from controlled area.

7.2 *Test Room Conditions:*

7.2.1 The test room will be controlled environmentally.

7.2.2 Temperature is to be maintained at  $72 \pm 4^\circ\text{F}$  ( $22 \pm 2^\circ\text{C}$ ).

7.2.3 Relative humidity is to be maintained between 20 and 60 %.

8. Procedure

8.1 *Determination of Bat Features and Test Location*—Determine bat balance point (BP), bat MOI, and bat COP in accordance with Test Method F 2398.