# NATIONAL COLLEGIATE ATHLETIC ASSOCIATION STANDARD FOR TESTING BASEBALL BAT PERFORMANCE

# BAT-BALL COEFFICIENT OF RESTITUTION (*BBCOR*)

Updated: **October 5, 2017**

## Introduction

The following protocol has been adopted by the NCAA, is effective **October 5, 2017**, and must be followed when baseball bats are submitted for *BBCOR* certification. All bats must meet the *BBCOR* standard to be used in NCAA competition. This protocol has been adopted as an addendum to the NCAA baseball rules and does not supersede the rules. Baseball bats must also meet the provisions of Rule 1-12 in the NCAA Baseball Rules Book to be used in NCAA competition.

## Manufacturer's Responsibilities

Bats must be designed so that their performance remains *BBCOR* compliant (as described below) throughout the life of the bat. Thus, approved bat designs must account for the effects of wear and test and manufacturing variation. The design of production bats must be identical to the bat submitted for certification. Production bats must be representative of the bat submitted for certification.

## Wood Bats

Solid, one-piece wood bats (as defined by NCAA Baseball Rule 1-12-a) are automatically approved. To use the *BBCOR* certification mark, one length of each model must be submitted with a certification request. The bat is not required to pass the "Bat Testing Procedure" or meet the weight and moment on inertia requirements in "Test Bat Preparation" described below.

Solid barrel, multi-piece wood bats (as determined by the NCAA) must comply with the *BBCOR* protocol except for the "Bat Testing Procedure" described below. Two 33 inch samples of each model must be submitted with a certification request. Multi-piece wood bats will be examined to verify a solid barrel construction.

## Non-Wood Bats

All non-wood bats must pass the complete *BBCOR* protocol for approval. To use the *BBCOR* certification mark, two samples of each length of each model must be submitted with a certification request. The certification center will select and subject one sample to the BBCOR protocol. The second sample, identified as a sister bat, is stored in the event that future testing is needed.

## Performance Test Request

All certified bats will be listed on the NCAA's *BBCOR* approved bat list[1]. The certification is valid from the date of the certification test for four or six years according to:

[1] http://www.mme.wsu-ssl.org/certifiedbaseballbats.aspx

- Four years if $0.500 \geq BBCOR > 0.480$
- Six years if $0.480 \geq BBCOR$.

To continue producing a bat design beyond the certification test expiration, a new certification test is required. Bats produced from a design certification that is expired will be found noncompliant.

The following must be provided for each certified model and length combination:

- planned date of first sale
- bat company (entity whose name appears on the bat)
- model name
- model number
- barrel classification (metal and/or composite and/or wood)
- bat length
- bat weight
- maximum barrel diameter
- minimum handle diameter
- materials in the bat (e.g., alloys, composites, any filling or deadening materials)
- image of final graphics (cannot change for a given model number)
- two bats (without grips, final graphics on the bats are not required)

Test requests are to be made at http://www.mme.wsu-ssl.org/Account/Login.aspx.

**Indemnification**

The registering party agrees to defend, indemnify, and hold harmless the NCAA, other governing bodies that use BBCOR and the certification laboratory ("Indemnification Parties") from claims or legal actions arising from the use of the registering party's product; or bat testing or certification of the registering party's products only. The registering party's obligations hereunder are strictly related to the registering party's products and do not include allegations related to the adoption or appropriateness of the test standards, test protocols, the test standards nor to the negligence or willful misconduct of the Indemnified Parties.

**Certification Mark**

Approved bats must display an official NCAA certification mark signifying compliance with the NCAA's bat performance standard to be allowed in regular-season and post-season competition.

Production bats must clearly display the certification mark within a region that is 12 to 24 inches from the knob end of the bat using a silk-screen or other approved permanent method. **The certification mark and model number must be clearly displayed in a color that contrasts the color of the bat barrel.** The manufacturer may use the certification mark in descriptive materials (such as catalogs) to identify bats that comply with this testing standard, but may not make other use of the mark. Use of the certification mark to advertise or promote the sale or distribution of bats is expressly prohibited.

### Test Results

Prior to certification, the test sponsor owns the test results and bats that are submitted for testing. Upon certification, the test results, test bats and the untested sister bats become confidential property of the NCAA. The NCAA reserves the right to use and/or publish blinded results for research, public dissemination.

Manufacturers may, at their discretion, disclose the results, including test data, of bats that they have manufactured. If a manufacturer discloses such information, the NCAA may disclose information from the same test.

### Testing Expenses

The test sponsor is responsible for all testing expenses and should work directly with the certification laboratory regarding the testing expenses.

### Compliance Testing

The NCAA will conduct discretionary periodic testing of bats at its expense to ensure compliance with the standard. Bats may be obtained from dealer stock and/or play. Teams that provide bats for compliance testing will be reimbursed by the NCAA for the costs of those bats. If any nonconforming bats are identified, the NCAA will notify the manufacturer in writing of its findings.

A particular bat model and length will be declared nonconforming if at least three of five compliance tests of that model and length result in failure. Upon identification of a nonconforming bat, all bat lengths of that model will be tested for compliance. Bat manufacturers will be notified of the failure of specific bat models and lengths and that subsequent testing of the other lengths of a given model will be conducted.

The manufacturer will be given the opportunity to review the compliance report and will be allowed an appeal in writing of the findings to the NCAA within 14 days upon receipt of the notice. This right to appeal will include the right to have the certification center retest the compliance bats in question, the original certification bat, and the sister bat, at the manufacturer's expense. Once retesting is complete, the rules committee will act on the appeal and notify the manufacturer of its decision within seven days. The NCAA retains the right to announce publicly a bat that has failed a compliance test. Noncompliant bats will be removed from the approved bat list.

## Testing Protocol

### Test Apparatus

A bat test apparatus, consisting of an air cannon, ball speed gate, bat pivot with speed measurement and environmental control as described in ASTM F2219.

**A load frame and anvils capable of measuring barrel compression according to ASTM F2844.**

### Standard Bat Calibration

The purpose of the Standard Bat is to ensure test uniformity over time and between laboratories. Standard Bats shall have a length 34 ± 0.07 in, inertia 11,250 ± 100 oz in$^2$ (ASTM F2398), wall

thickness at 6 inches from the endcap of 0.165 ± 0.003 in, and a *BBCOR* of 0.495 ± 0.005. Order requests for a Standard Bat may be placed at info.ssl@wsu.edu. To reduce variation, Standard Bats are impacted at the identified circumferential location, and not rotated between impacts.

The *BBCOR* of a Standard Bat is established from 48 baseballs. To calibrate a Standard Bat, a new and existing Standard Bat are each impacted at 6 inches from the endcap with 24 different baseballs. The groups of 24 balls are then exchanged between the new and existing Standards Bats for an additional 24 impacts on each bat. The calibrated *BBCOR* of the new Standard Bat, $e_n$, is found from

$$e_n = e_e - \overline{e}_e + \overline{e}_n \tag{1a}$$

where $e_e$ is the original calibrated *BBCOR* of the existing Standard Bat, and $\overline{e}_n$and $\overline{e}_e$ are the average *BBCOR* from the 48 impacts with the new and existing Standard Bats, respectively.

### *C*$_{ball}$ Bat Calibration

*C*$_{ball}$ Bats shall have the same design as the Standard bat and are used for test ball preparation. To reduce variation, *C*$_{ball}$ Bats are impacted at the identified circumferential location, and not rotated between impacts.

The *BBCOR* of a *C*$_{ball}$ Bat is established from 48 baseballs. To calibrate a *C*$_{ball}$ Bat, it and a Standard Bat are impacted at 6 inches from the endcap with 24 different baseballs. The groups of 24 balls are then exchanged between the *C*$_{ball}$ and Standards Bats for an additional 24 impacts on each bat. The calibrated *BBCOR* of the *C*$_{ball}$ Bat, $e_c$, is found from

$$e_c = e_n - \overline{e}_n + \overline{e}_c \tag{1b}$$

where $e_n$ is the calibrated *BBCOR* of the Standard Bat, and $\overline{e}_n$ and $\overline{e}_c$ are the average *BBCOR* from the 48 impacts with the Standard and *C*$_{ball}$ Bats, respectively. *C*$_{ball}$ bats are to be recalibrated annually.

### Performance Calculations

Calculate the uncorrected bat-ball coefficient of restitution, *e*, using

$$e = \frac{v_R}{v_I}(1 + r) + r \tag{2}$$

where *r* is

$$r = m\left[\frac{1}{W} + \frac{(L - BP - z)^2}{I - W(BP - 6)^2}\right] \tag{3}$$

and where, *m* is the weight of the ball; $v_I$ and $v_R$ are the ball inbound and rebound speeds, respectively; *W* is the weight of the bat, *I* is the moment of inertia of the bat, and *z* is the impact location relative to the endcap of the bat.

### Calculate the corrected bat-ball coefficient of restitution, *BBCOR*, using

$$\boldsymbol{BBCOR = e + C_{ball} + C_{lot}} \quad \textbf{(4)}$$

**where $C_{ball}$ and $C_{lot}$ are defined in "Test Ball Preparation."**

**Test Ball Preparation**

**Test balls shall have lot correction to account for changes in ball performance with use. A ball lot is defined by its *date code*[2]. For each lot, 1% of balls will be randomly selected and impacted 20 times at 136 ± 1 mph against the $C_{ball}$ Bat. Results from balls that yield less than 15 valid hits will be discarded. The average performance of the first four impacts, $e_{1\text{-}4}$ , will be compared to the average performance of impacts 5-20, $e_{5\text{-}20}$, to obtain a lot correction factor, $C_{lot}$, as**

$$\boldsymbol{C_{lot} = e_{1\text{-}4} - e_{5\text{-}20}}$$

**And shall be recorded.**

Test balls shall be impacted at 6 in. from the endcap against a $C_{ball}$ Bat, as described in ASTM F2219. The $C_{ball}$ Bat shall be impacted at the certified circumferential location, and not rotated between impacts.

Test balls shall be **Rawlings Model FSR1NCAA baseballs.** Each ball shall be impacted at a speed of **136 ± 1 mph** until two valid impacts are achieved; the results are calculated using Eq. 2 and denoted $e_1$ and $e_2$, respectively. Mark the ball surface to track the number of impacts. If $|e_1 - e_2| > 0.005$ the result of neither impact is used, and the ball is either retested or discarded.

The test date and correction factor, $C_{ball}$, defined by

$$C_{ball} = e_c - e \quad (5)$$

shall be recorded on each test ball.

**Test Bat Preparation**

1. **Record model name and model number**
2. **Verify the maximum barrel diameter by passing the bat through a ring that is 1 in. long and of inside diameter 2.655 ±0.003 in.**
3. **Measure the bat length, $L$ (in), weight, $W$ (oz), and maximum barrel diameter (in).**
4. **For length classification, round the bat length, $L$, to nearest ½ in. to obtain $L_c$.**
5. **Verify that W – Lc > -3.0.**
6. **Measure the moment of inertia, $I$ (oz in$^2$), and balance point, $BP$ (in), according to ASTM F2398.**
7. **Verify that $I > 0.0278\ L_c^{3.615}$.**
8. **If the bat barrel contains a composite material or shows increased performance with use (as determined by the NCAA)[2], it is deemed a "composite bat", and the initial barrel**

[2] The date code is typically found to the right of the "NCAA" logo near the seam. It is a 5 character code with numbers and letters.

**compression is measured according to ASTM F2844. If the bat has a ring (or similar stiffening device) at the 6 inch location, changes in barrel compression may be observed at another barrel location.**

## Bat Testing Procedure

1. Mount the bat into the grip as described in F2219. The grip may include a compliant material between the clamps and the bat to allow for the rotation of the bat in the grip between hits.
2. Select a test ball. Test balls must have less than 20 impacts (5 per ear), at least a 4 hour rest between impacts and weigh 5.13 ±0.07 oz. Mark the ball impact surface to track the number of ball impacts.
3. Select the impact location, *z*, relative to the distal end of the bat. Set the ball cannon to fire the ball at a target speed, $V_T$, of

$$V_T = 66\left(\frac{L-6-z}{L-12}\right) + 70 \quad (6)$$

4. Accept only impacts where $\boldsymbol{|V_T - V_i| \leq 1\ mph}$ and which meet the criteria described in ASTM F2219.
5. Rotate non-wood bats between impacts, unless the bat has a designated impact orientation.
6. The *BBCOR* at each location is the average of six valid impacts at that location.
7. Identify the maximum performance location by moving the impact location in ½ in. increments. Bats with a ring (or similar stiffening device) in the barrel must be scanned on both sides of the ring. The minimum *BBCOR* on either side of the peak must be at least 0.003 less than the peak *BBCOR*.

## Pass Criteria

1. **The peak *BBCOR* must be less than or equal to 0.500.**
2. **The bat must not have evidence of visual damage.**
3. **The bat inertia must be within 100 oz in$^2$ of that measured in Test Bat Preparation. (interior damage may cause bat inertia to change)**
4. **The bat must pass the ring test, as described in step 2 of Test Bat Preparation.**
5. **Composite bats or other designs that show increased performance with use must also undergo the Accelerated Break-In Test Procedure.**

## Accelerated Break-In Test Procedure

1. **Measure the barrel compression according to ASTM F2844. If the bat has a ring (or other similar stiffening device) at the 6 inch location, changes in barrel compression may be observed at another barrel location.**
2. **If the reduction in barrel compression from the performance test is more than 15% go to step 4**
3. **Roll the bat following the Barrel Rolling Procedure (below).**
4. **Measure the *BBCOR* according to the Bat Test Procedure above.**
    a. **Stop if the bat is damaged so that the *BBCOR* test cannot be completed**
        i. **The bat fails if the partial *BBCOR* at any location with two or more valid impacts is greater than 0.500.**

ii. **The bat passes if the partial BBCOR exceeds 0.500 if those locations involve only one valid impact.**

b. **Stop if the *BBCOR* decreases by more than 0.018 from its maximum value (bat passes)**

c. **Stop if the BBCOR exceeds 0.500 (bat fails).**

5. **Go to step 1.**

## Cosmetic Changes

Manufacturers may request a cosmetic change from a previously certified result. Cosmetic changes are approved at the discretion of the NCAA for bats that change only in appearance. Cosmetic changes can be used to add a new model number, model name, or distributor name. Cosmetic change forms can be found at http://www.mme.wsu-ssl.org/Account/Login.aspx.

## Custom Graphic Bats

**To use custom graphics on a bat model, manufactures must receive approval from the certification center prior to graphic application. Manufacturers must define the customization for each bat model, identifying areas of the bat that will be customized. The location of the bat model number and the BBCOR certification mark must be consistent and cannot be part of the customization. The bat model number and the BBCOR certification mark must be in a contrasting color to the location of its placement on the bat barrel. Manufacturers should contact the NCAA regarding questions about the customized bat process. Bats approved for customized graphics do not require cosmetic change requests for each custom graphic.**

## Additional Testing

The NCAA and its certification laboratory reserve the right to conduct additional testing on any bat submitted for testing at the expense of the NCAA or the certification laboratory.

## Revisions

The NCAA will revise the protocol as needed and reserves the right to change the test equipment, test location and the testing personnel. The NCAA will announce in a timely manner any future changes to the rules or protocol as well as any amendments to the protocol.

**Barrel Rolling**

Apparatus

- Two nylon wheels – 1.5 to 3.0 in. in diameter
- Fixture to press wheels into barrel in **up to** 0.012-in. increments
- Device to roll the barrel

Procedure:

1. Place the barrel of the bat in the fixture with the 0º orientation (as identified in F2844) facing up.
2. Bring roller in contact with the barrel. Displace the rollers approximately **0.050 in.** for the initial rolling. For subsequent rolling, increase the rolling displacement by **up to** 0.012 in increments. Note: when approaching the desired reduction in barrel compression, it may not be necessary to increase the rolling depth.
3. Roll the barrel to within 2.0 to 2.5 in. of the endcap and past the taper (no contact between rollers and bat) as shown in Fig. 1. Roll the bat approximately 10 times in each direction. Popping and cracking sounds during this process are normal.
4. Unload the bat.
5. Repeat steps 2-4 at 45º, 90º, and 135º from the initial location.
6. **Measure the $BC_A$.**
7. **Continue steps 1-6 until the $BC_A$ from rolling decreases by 5%.**

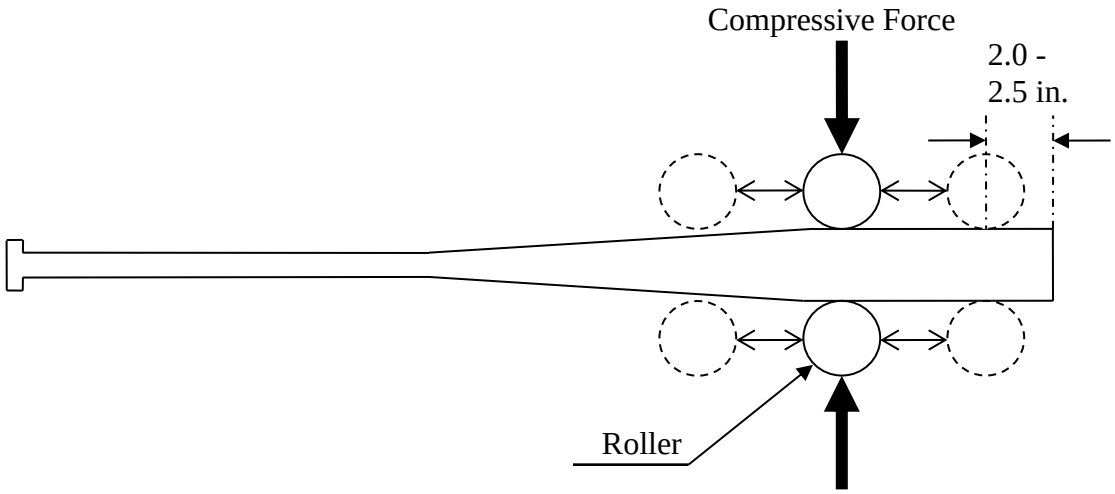


Fig. 1 Diagram of rolling describing the rolling process.