



United States Golf Association and R&A Rules Limited

ACTUAL LAUNCH CONDITIONS
OVERALL DISTANCE AND SYMMETRY
TEST PROCEDURE
(PHASE II)

Revision 1

June 1, 2004

This document details the procedure for evaluating the conformance of golf balls using Actual Launch Conditions and the Indoor Test Range.

Change Record

| Page | Section | Date | Details |
|-------------|----------------|-------------|-----------------------------------------------------------------------------------------------------------------------|
| Title | N/A | 6/1/04 | The Royal and Ancient Golf Club of St. Andrews changed to R&A Rules Limited |
| 1 | N/A | 6/1/04 | Record of changes added |
| 1 | N/A | 6/1/04 | The Royal and Ancient Golf Club of St. Andrews changed to R&A Rules Limited |
| 2 | 1.2 | 6/1/04 | The Royal and Ancient Golf Club of St. Andrews changed to R&A Rules Limited |
| 2 | 2.1 | 6/1/04 | The Indoor Test Range (ITR) Technical Description and Operation Manual, changed to Version 2 |
| 3 | 5.2 | 6/1/04 | Number of balls to be identified and marked increased from 6 to 12 |
| 3 | 5.5 | 6/1/04 | Mechanical golfer calibration ball identified as “USGA/R&A Calibration” |
| 3 | Table 5.5 | 6/1/04 | Description of reference ball speed included |
| 4 | 5.8 | 6/1/04 | Increased repeat of steps to reflect increase in number of ball samples used for testing |
| 4 | 6.2 | 6/1/04 | Number of balls to be measured increased from 6 to 12 |
| 4 | 6.5 | 6/1/04 | The allowable range of the expected nominal value of the C_L and C_D for the calibration ball is set at $\pm 5\%$ |
| 4 | 6.6 | 6/1/04 | Number of balls to be tested increased from 6 to 12 |
| 4 | 6.7 | 6/1/04 | Number of balls to be tested increased from 6 to 12 |
| 4 | 6.8 | 6/1/04 | Number of ITR test settings set to 15 |
| 5 | 6.9 | 6/1/04 | Reference to The Indoor Test Range (ITR) Technical Description and Operation Manual, changed to Version 2 |
| 6 | 7.1 | 6/1/04 | Reference to The Indoor Test Range (ITR) Technical Description and Operation Manual, changed to Version 2 |
| 6 | 7.3.4 | 6/1/04 | Notification to manufacturer and request for corrective action changed from “should” to “shall” |
| 7 | App. A | 6/1/04 | Appendix detailing Test club and ball specifications added |
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United States Golf Association and R&A Rules Limited

ACTUAL LAUNCH CONDITIONS OVERALL DISTANCE AND SYMMETRY TEST PROCEDURE (PHASE II)

1. Scope

- 1.1 This method covers the procedure for performing the overall distance and symmetry conformance tests for golf balls as administered by the United States Golf Association (USGA).
- 1.2 The results of the conformance tests are used by R&A Rules Limited (R&A) and the USGA in determining conformity of the golf balls to the Rules of Golf.
- 1.3 The values stated in imperial units are to be regarded as standard. The values stated in SI units are for information only.

2. Applicable Documents

- 2.1 USGA and R&A documents:
 - Rules of Golf
 - List of Conforming Golf Balls
 - The Indoor Test Range (ITR) Technical Description and Operation Manual, Version 2
 - USGA Indoor Test Range (ITR) Data Analysis Software, Version 2.0.0

3. Summary of Method

- 3.1 Using equipment at the USGA Research and Test Center, currently referred to as the Indoor Test Range (ITR), the aerodynamic properties of a sample lot of golf balls are

completely characterized by the coefficient of lift (C_L), and coefficient of drag (C_D).

- 3.2 Using the aerodynamic coefficients, the overall distance (carry plus roll) of a sample lot, as well as its spherical symmetry, is determined for a specific combination of launch conditions (ball speed, spin rate and launch angle) as determined by a mechanical golfer.

4. Significance

- 4.1 This method is used to determine the overall distance and symmetry of golf balls for a given set of launch conditions. The data obtained from this method is used to ascertain the conformance of the golf balls to the Overall Distance and Symmetry Standards as stated in the Rules of Golf (Appendix III).

The overall distance of the ball shall not be greater than **320.0** yards. A maximum test tolerance of **3.0** yards is associated with this test.

In addition, the ball must not be designed, manufactured or intentionally modified to have properties that differ from those of a spherically symmetric ball. A spherically symmetric ball shall not exhibit statistically significant differences in carry distance greater than **4.0** yards or in flight time of

more than **0.40** seconds regardless of which axis the ball is spinning about when launched.

- 4.2 Letters are sent to the golf ball manufacturers advising of those brands of golf balls that do not conform to the Overall Distance or Symmetry Standards or which fall within the test tolerances.
- 4.3 Only those balls that have already passed the conformance tests for Weight, Size, and Initial Velocity will be tested for conformance to the Overall Distance and Symmetry Standards.
- 4.4 Golf balls that conform to the Weight, Size, Initial Velocity, Symmetry, and Overall Distance Standards are included in the List of Conforming Golf Balls, published monthly by the USGA and R&A.
- 4.5 Intermediate screening procedures may be used to determine ball conformance and increase testing efficiency. However, no ball will be ruled non-conforming unless it has been tested according to this protocol.

5. Determination of Launch Conditions

- 5.1 At this point in the conformance testing process the balls should be separated into two individual boxes labeled Dozen 1 and Dozen 2. Each ball should have a USGA Lot number as well as an individual ball number. Verify that the markings and the USGA Lot number on the balls match those on the boxes and that balls numbered 1 through 12 are contained in Dozen 1 and that balls numbered 13 through 24 are contained in Dozen 2.
- 5.2 Identify and mark the seam and pole locations on balls numbered 13 through 24. (Figure 5.2)
- 5.3 Once the balls are properly marked, they should be stored in the incubator at a temperature of $75.0 \pm 1.0^{\circ}\text{F}$ (23.9°C) for at least 3 hours.

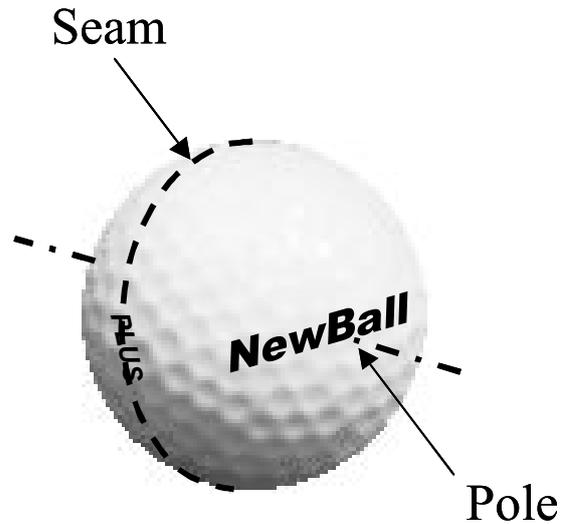


Figure 5.2 - Ball Pole and Seam Marks

- 5.4 Ensure good mechanical operation and proper warm-up of the mechanical golfer.
- 5.5 Verify calibration of the mechanical golfer by hitting 6 “USGA/R&A Calibration” balls and measuring the launch conditions.
 - 5.5.1 If the average value of the launch conditions falls within the ranges specified in Table 5.5 then proceed to step 5.6.
 - 5.5.2 If the average value of any of the launch conditions falls outside of the ranges specified in Table 5.5 then the mechanical golfer setup must be re-calibrated and Section 5 repeated.

Table 5.5 - Mechanical Golfer Calibration Conditions

| Launch Condition | Mean | Acceptable Range |
|------------------|---------|------------------|
| Angle | 10° | +0.5° |
| Spin | 42 rps | +2.0 rps |
| Swing Speed | 120 mph | +0.5 mph |
| Ball Speed | 256 fps | Reference* |

* The reference ball speed of 256 fps represents the speed after initial aging to a near steady-state condition.

- 5.6 Place ball 13 of the sample lot on the tee and strike it so that it is launched to produce a back spin about an axis described by a line that would pass through the poles of the ball and that would lie in horizontal plane and be perpendicular to the direction of flight (Figure 5.6.) This orientation is referred to as "poles horizontal" (PH).
- 5.7 Measure and record the launch angle, spin rate and velocity for the shot.
- 5.8 Repeat steps 5.6 through 5.7 for balls 14 through 24.
- 5.9 Calculate the means of the launch angle, back spin and speed values measured in steps 5.7 and 5.8. These are the launch conditions for the sample lot that will be used to determine conformance to the Overall Distance and Symmetry Standards.

(To maximize testing efficiency multiple sample lots may be tested during a single session. When multiple lots are tested, calibration of the mechanical golfer, step 5.5, should also be performed at the conclusion of testing.)

6. Determination of Aerodynamic Properties

- 6.1 Ensure that the room temperature is kept at $75 \pm 2^\circ\text{F}$ (23.9°C).
- 6.2 Measure the outside diameter of balls numbered 13 through 24 along three axes, one from pole to pole and in two orthogonal directions across the seam (equator), and calculate the average ball diameter.
- 6.3 Ensure good mechanical operation and proper warm-up of the test equipment.
- 6.4 Set the launcher wheel speeds to produce the desired ball velocity and spin rate described in the ITR Manual.
- 6.5 Fire six calibration balls down the range. After each shot verify that data was

obtained from each measurement station and that the predicted C_L and C_D are within the allowable range.

(Note: The allowable range is set at $\pm 5\%$ of the expected nominal value of the C_L and C_D for the calibration ball. This step is used as a gross indicator of potential ITR problems not as a statistical process control.)

- 6.6 Repeat 6.5 using balls 13 through 24 of the test lot with the balls launched in the "poles horizontal" (PH) orientation (i.e. such that they spin about an axis described by a line that would pass through the poles of the ball and that would lie in horizontal plane and be perpendicular to the direction of flight, Figure 5.6.)
- 6.7 Repeat step 6.6 using balls 13 through 24 of the test lot with the balls launched such that they spin about the axis described by a line that would pass through the seam (equator) of the ball and that would lie in horizontal plane and be perpendicular to the direction of flight (Figure 6.7.) This orientation is referred to as "pole-over-pole" (PP).

(To maximize testing efficiency multiple sample lots may be tested during a single session.)

- 6.8 Repeat steps 6.4 through 6.7 until data has been obtained at each of the full set of 15 test settings (i.e. launch velocity and spin rate) described in the ITR Manual.

(Note: The USGA and R&A reserve the right to change the settings at any time to increase the accuracy and/or efficiency of the test.)

- 6.9 From the data collected in steps 6.5 through 6.8, calculate the coefficients of lift (C_L) and drag (C_D) for the calibration ball and both orientations of all tested sample lots. (Ref. USGA Indoor Test Range (ITR) Data Analysis Software, Version 2.0 and The

ITR Technical Description and Operation Manual, Version 2)

6.10 Verify that the performance of the calibration ball is within acceptable limits.

6.10.1 If the calibration ball performance is within acceptable limits then proceed to step 7.

6.10.2 If the calibration ball performance is not within acceptable limits, then the ITR must be re-calibrated and step 6 repeated.

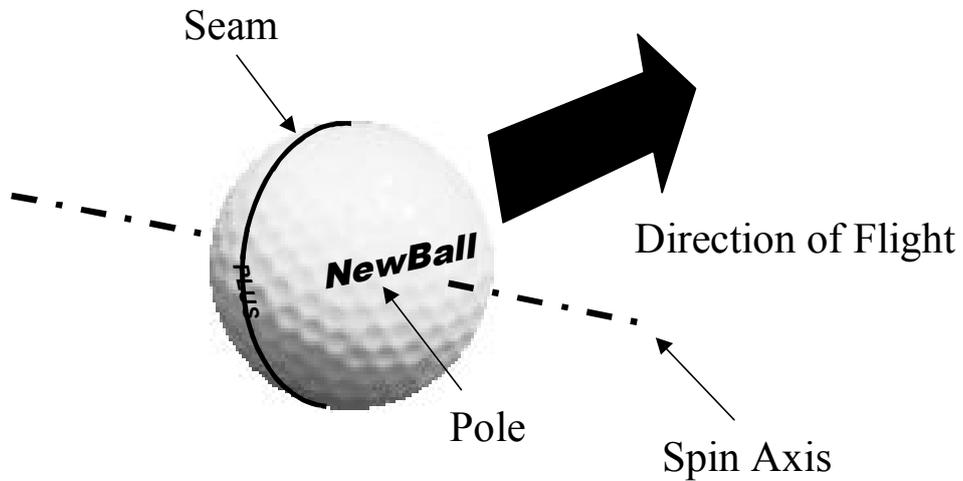


Figure 5.6- Poles Horizontal (PH) Ball Orientation

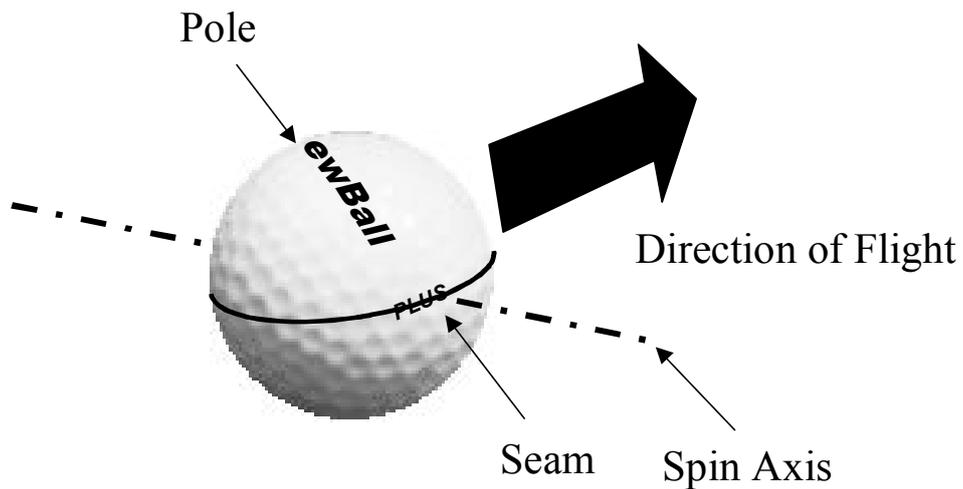


Figure 6.7- Poles over Pole (PP) Ball Orientation

7. Conformance Determination

7.1 Using the launch conditions calculated in section 5 and the C_L and C_D calculated in step 6.9, determine the carry distance, overall distance and flight time at standard environmental conditions (75°F, 30.0 in Hg and 50% relative humidity) for the sample lots in both orientations, PP and PH. (Ref. USGA Indoor Test Range (ITR) Data Analysis Software, Version 2.0.0 and The ITR Technical Description and Operation Manual, Version 2)

7.2 Overall Distance Evaluation

7.2.1 From the overall distances calculated in 7.1, select the orientation (PP or PH) that produces the greatest overall distance for the sample lot.

7.2.2 If the overall distance determined in 7.2.1 is less than **317.0** yards then the overall distance evaluation is complete and the sample lot conforms to the Overall Distance Standard of the Rules of Golf.

7.2.3 If the overall distance determined in 7.2.1 is greater than **317.0** yards but less than or equal to **320.0** yards then the overall distance evaluation is complete and the sample lot conforms to the Overall Distance Standard of the Rules of Golf. However, a warning letter should be issued to the manufacturer informing them that the overall distance of the sample lot falls within the test tolerance. Any future tests of balls with identical markings from any source could result in a ruling of non-conformance to the Overall Distance Standard.

7.2.4 If the overall distance determined in 7.2.1 is greater than **320.0** yards the ball does not conform to the Rules of Golf.

7.3 Symmetry Evaluation

7.3.1 Using the launch conditions calculated in Section 5 and the C_L and C_D calculated in step 6.9, determine the carry distance, and flight time at standard environmental conditions (75°F, 30.0 in Hg and 50% relative humidity) for the sample lots in both orientations, PP and PH. (Ref. USGA Indoor Test Range (ITR) Data Analysis Software, Version 2.0.0 and The ITR Technical Description and Operation Manual, Version 2)

7.3.2 Calculate the differences between the carry distances and times of flight for each ball in the two orientations and compute the mean of these differences

7.3.3 If the mean of the differences in the carry distance calculated in 7.3.2 is greater than **4.0** yards and that value is statistically significant, or if the mean of the differences in the time of flight is more than **0.40** seconds, and that value is statistically significant, then the sample lot does not conform to the Rules of Golf.

7.3.4 The manufacturer shall be notified that the lot has failed the symmetry test and that the lot will be included in the Conforming List of Golf Balls on a conditional basis. The manufacturer shall be requested to take corrective action and re-submit the lot within six-months. If no statistically significant changes in performance are made within that period, then the lot will be removed from the next published list.

Appendix A – Test ball and club specifications:

The test head may be purchased directly from the USGA. The calibration ball is available from Bridgestone Sports. The specifications for these are given below.

Test Head Specifications

Construction: Cast 6-4 titanium body, forged SP-700 titanium face

Manufacturer: Fu Sheng Industrial Co., Ltd

Model: TI-360 USGA

| Parameter | Units | Nominal Value |
|---------------------------|---------------------------------------------|----------------------|
| Face Depth | inches (mm) | 2.0 (51) |
| Face Width | inches (mm) | 3.9 (99) |
| Mass | ounces (grams) | 7.0 (198) |
| Volume | cubic inches (cc) | 22.0 (360) |
| Hosel Diameter | inches (mm) | 0.339 (8.61) |
| Lie | degrees | 58 |
| Loft | degrees | 9 |
| Bulge | inches (mm) | 12.0 (305) |
| Roll | inches (mm) | 10.0 (254) |
| CG (face center) up | inches (mm) | 0.19 (4.8) |
| CG (face center) to heel | inches (mm) | 0.06 (1.6) |
| CG (face center) back | inches (mm) | 1.38 (35.0) |
| CG (above ground) | inches (mm) | 1.38 (35.0) |
| CG (from shaft axis-toe) | inches (mm) | 1.73 (44.0) |
| CG (shaft axis-back) | inches (mm) | 0.63 (16.0) |
| Moment of Inertia (pitch) | ounce-in ² (gm-cm ²) | 13.1 (2400) |
| Moment of Inertia (yaw) | ounce-in ² (gm-cm ²) | 23.3 (4250) |
| Moment of Inertia (roll) | ounce-in ² (gm-cm ²) | 21.9 (4000) |
| COR | | 0.820 |

Set-up Ball Specifications

Construction: 2-piece

Manufacturer: Bridgestone

Model: “USGA / R&A Calibration”

| Parameter | Nominal Value |
|-------------------------|-----------------------------|
| Diameter | 1.682” (42.72 mm) |
| Weight | 1.59 oz (45.2 grams) |
| Ball Compression (Atti) | 89 |
| Cover material | Surlyn |
| Cover hardness | 60 Shore D |
| Cover thickness | 0.083” (2.1 mm) |
| Core diameter | 1.516” (38.5 mm) |
| Dimple pattern | Quasi-Icosahedron 432 |
| Initial velocity | 253.8 fps (77.4 m/s) |
| COR (rigid block) | 0.778 @143.8 fps (43.8 m/s) |