



**R&A Rules Limited  
And  
United States Golf Association**

INITIAL VELOCITY TEST  
PROCEDURE  
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# R&A Rules Limited and United States Golf Association

## INITIAL VELOCITY TEST PROCEDURE

### 1. Scope

- 1.1 This method covers the procedures for initial velocity conformance for golf balls as administered by the United States Golf Association (USGA). The procedures are performed by utilising the Illinois Tool Works (ITW) test machine and a hierarchy of statistically designed tests.
- 1.2 The results of the conformance test 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 English units are to be regarded as standard. The values stated in SI units are for information only.

### 2. Applicable Documents

- 2.1 USGA documents:
  - Rules of Golf
  - Conforming Ball list
  - Impact Reaction Tester Operating and Maintenance Manual
- 2.2 R&A documents:
  - Rules of Golf
  - Conforming Golf Balls list

### 3. Summary of Method

- 3.1 The ITW tester is operated with a rotating wheel equipped with a striker that impacts a test golf ball. The wheel speed and impact

velocity can be varied to achieve desired conditions.

- 3.2 The initial velocity of the test golf ball is measured. The initial velocity is defined as the speed of the ball as it travels 2 feet after impact with the striker. The measurement is made by electronically timing the ball as it passes through a light source and ballistic screen separated by a fixed distance of about 6.283 feet. The light source is located approximately 8.75 inches from the point of impact.
- 3.3 Statistical analysis is performed on the measured data to determine initial velocity characteristics for the test golf balls.
- 3.4 Based on the analytical results, additional measurements of the initial velocity may be required for full characterisation.

### 4. Significance

- 4.1 This method is used to determine the initial velocity properties of golf balls. The data obtained from this method is used to ascertain the conformance of the golf balls to the initial velocity standard as stated in the Rules of Golf (Appendix III). The velocity of the ball shall not be greater than 250 feet (76.2 m) per second. A maximum tolerance of 2% will be allowed.
- 4.2 Letters are sent to the golf ball manufacturer advising of golf balls that do not pass the initial velocity tests or that

marginally conform to the initial velocity standard. The specific conditions for sending a warning letter are listed in Section 7.8.

- 4.3 Golf balls that conform to the weight, size, spherical symmetry, initial velocity, and overall distance standard are included on the Conforming Ball list, published by R&A Rules Ltd and the USGA.

## 5. Apparatus and Materials

5.1 *Illinois Tool Works (ITW) Impact-Reaction Tester*, described in Appendix A1.

5.2 *IVTEST software program*, described in Appendix B1.

5.3 *Incubator*, shown in Figure 5.

5.4 *Test Golf Balls*, submitted by manufacturers. A total sample of two dozen (24) golf balls is required for the conformance test.

## 6. Preparation of Apparatus and Conformance Screening Test Procedure

6.1 Prior to testing the balls should be separated into two individual boxes labeled Dozen 1 and Dozen 2. Each ball should have an individual ball number. Verify that the markings on the balls match those on the boxes and that ball numbers 1 through 12 are contained in Dozen 1 and that ball numbers 13 through 24 are contained in Dozen 2

6.2 Ensure that the room temperature is kept at  $75 \pm 2^\circ\text{F}$  ( $23.9^\circ\text{C}$ ).

6.3 Set the incubator temperature to  $75.0 \pm 1.0^\circ\text{F}$  ( $23.9^\circ\text{C}$ ) and store the test golf balls in the incubator for at least 3 hours.

6.4 Ensure good mechanical operation of the test equipment and proper warm-up and calibration of the ITW test machine.

6.5 Remove the test golf balls from the incubator. For conformance testing, begin by selecting the first 6 balls from Dozen 1 and set aside the remaining balls of Dozen 1 and the 12 balls of Dozen 2 for future testing (if necessary).

6.6 Place the selected balls into the ITW test machine in sequential order.

6.7 Press the "LOAD" button to set a ball on the tee and press the "FASTER" or "SLOWER" button until the electronic counter reads  $43.69 \pm 0.01$  milliseconds. This corresponds to a wheel speed of 1373 rpm and a striker impact velocity of 143.8 ft/sec.

6.8 With the electronic counter at the value specified in 6.7, hit each ball once by pressing the "FIRE" button. After each hit, the velocity is automatically measured by the IVTEST software program. It records the velocities as  $v_i$  where  $i = 1, \dots, n$ , where  $n$  is the number of balls tested.

Note: An electronic tone is signaled after each hit, indicating a positive measurement of the velocity. If no tone is signaled after a hit, then the bad must be hit again before continuing.

6.9 After all balls are hit, use the IVTEST software program to calculate:

the average velocity,  $\bar{v}$

the standard deviation,  $s$

6.10 The IVTEST software program is used to analyse the measured data.

6.11 Use the IVTEST software program to analyse the measured data in accordance with Section 7, repeating the test as required.

## 7. Conformance Test Analysis Procedure

If any combination of four or more balls from the two dozen submitted, fail the size, weight or initial velocity (Ref. USGA Weight and Size Test Procedure) tests, then the submitted lot does not conform to the Rules of Golf.

7.1 The following criteria should be used for evaluating the conformance of the test golf balls with regard to initial velocity. Conformance to the initial velocity standard is based on the results of the initial velocity measurements for Dozen 1 and Dozen 2 (if necessary). and can be determined after measuring the initial velocity once, twice, or four times for each dozen.

### 7.2 One measurement. Dozen 1

After the measurement of the initial velocity of 6 balls in Dozen 1, judgment is made based on the following relationships:

$$\bar{v} < 253 \text{ and } \bar{v} + 3s < 255$$

7.2.1 If the average velocity is less than 253 ft/sec, and the 3-sigma value is less than 255 ft/sec, then the test is complete. The balls conform to the initial velocity requirement in the Rules of Golf.

$$\bar{v} \geq 253 \text{ or } \bar{v} + 3s \geq 255$$

7.2.2 If the average velocity is greater than or equal to 253 ft/sec, or the 3-sigma value is greater than or equal to 255 ft/sec, then the remaining 6 balls of Dozen 1 must also be tested. Repeat Sections 6.6 through 6.9 with the six balls remaining from Dozen 1 and analyse the data in accordance with Sections 7.2.3 through 7.2.6.

$$v_i < 254.5 \text{ and } \bar{v} < 253 \text{ and } \bar{v} + 3s < 255$$

7.2.3 If the recorded velocities of all 12 balls are less than 254.5 ft/sec, and the average velocity is less than 253 ft/sec,

and the 3-sigma value is less than 255 ft/sec, then the test is complete. The balls conform to the initial velocity requirement in the Rules of Golf.

$$v_i < 254.5 \text{ and } \bar{v} \geq 253 \text{ and } \bar{v} + 3s < 255$$

7.2.4 If the recorded velocities of all 12 balls are less than 254.5 ft/sec, and the average velocity is greater than or equal to 253 ft/sec, and the 3-sigma value is less than 255 ft/sec, then the testing of Dozen 1 is complete. However, the balls in Dozen 2 must also be tested to determine conformance to the initial velocity requirement in the Rules of Golf. Repeat Sections 6.6 through 6.9 with the balls of Dozen 2 and analyse the data in accordance with Section 7.5.

$$v_i < 254.5 \text{ and } \bar{v} + 3s \geq 255$$

7.2.5 If the recorded velocities of all 12 balls are less than 254.5 ft/sec and the 3-sigma value is greater than or equal to 255 ft/sec, then the 12 balls of Dozen 1 must be tested once more to determine conformance. Repeat Sections 6.6 through 6.9 with the same balls and analyse the data in accordance with Section 7.3.

$$v_i \geq 254.5$$

7.2.6 If any of the recorded velocities are greater than or equal to 254.5 ft/sec, then the 12 balls of Dozen 1 must be tested an additional 3 times to determine conformance. Repeat Sections 6.6 through 6.8 three times with the same balls and analyse the data in accordance with Section 7.4.

### 7.3 Two measurements. Dozen 1

After two initial velocity measurements of the balls in Dozen 1, record the larger of the two velocities for each ball. Label this collection of 12 values  $v_{max_i}$  where  $i = 1, \dots, 12$ . With the 12

values of  $v_{max_i}$ , use the IVTEST software program to calculate:

the average velocity,  $\bar{v}_{max}$

the standard deviation,  $s_{max}$

Conformance judgment is then based on the following relationships:

$$v_{max_i} < 254.5 \text{ and } \bar{v}_{max} < 253 \text{ and } \bar{v}_{max} + s_{max} < 255$$

7.3.1 If the recorded velocities of all 12 balls are less than 254.5 ft/sec, and the average velocity is less than 253 ft/sec, and the 1-sigma value is less than 255 ft/sec, then the test is complete. The balls conform to the initial velocity requirements in the Rules of Golf.

$$v_{max_i} < 254.5 \text{ and } \bar{v}_{max} \geq 253 \text{ and } \bar{v}_{max} + s_{max} < 255$$

7.3.2 If the recorded velocities of all 12 balls are less than 254.5 ft/sec, and the average velocity is greater than or equal to 253 ft/sec, and the 1-sigma value is less than 255 ft/sec, then the testing of Dozen 1 is complete. However, the balls in Dozen 2 must also be tested to determine conformance to the initial velocity requirements in the Rules of Golf. Repeat Sections 6.6 and 6.9 with the balls of Dozen 2 and analyse the data in accordance with Section 7.5.

$$v_{max_i} \geq 254.5 \text{ or } \bar{v}_{max} + s_{max} \geq 255$$

7.3.3 If any of the record velocities are greater than or equal to 254.5 ft/sec or the 1-sigma value is greater than or equal to 255 ft/sec, then the 12 balls of Dozen 1 must be tested an additional 2 times to determine conformance. Repeat Sections 6.6 through 6.8 two times with the same balls and analyse the data in accordance with Section 7.4.

#### 7.4 Four measurements, Dozen 1

After four initial velocity measurements of the balls in Dozen 1, discard the largest and smallest velocity on each ball. Use the IVTEST program to calculate the average of the two remaining values for each of the 12 balls. Label this collection of 12 values  $v_{mid_i}$ , where  $i = 1, \dots, 12$ . With the 12 values of  $v_{mid_i}$  use the IVTEST software program to calculate:

the average velocity,  $\bar{v}_{mid}$

the standard deviation,  $s_{mid}$

Conformance judgment is then based on the following relationships:

$$v_{mid_i} \leq 255 \text{ and } \bar{v}_{mid} < 253$$

7.4.1 If the recorded velocities of all 12 balls are less than or equal to 255 ft/sec and the average velocity is less than 253 ft/sec, then the test is complete. The balls conform to the initial velocity requirements in the Rules of Golf.

$$v_{mid_i} \leq 255 \text{ and } 253 \leq \bar{v}_{mid} \leq 254 \text{ and } \bar{v}_{mid} + 2s_{mid} \leq 255$$

7.4.2 If the recorded velocities of all 12 balls are less than or equal to 255 ft/sec, and the average velocity is between 253 ft/sec and 254 ft/sec, inclusive, and the 2-sigma value is less than or equal to 255 ft/sec, then the testing of Dozen 1 is complete. However, the balls in Dozen 2 must also be tested to determine conformance to the initial velocity requirements in the Rules of Golf. Repeat Sections 6.6 and 6.9 with the balls of Dozen 2 and analyse the data in accordance with Section 7.5.

$$v_{mid_i} > 255 \text{ or } \bar{v}_{mid} > 254 \text{ or } (\bar{v}_{mid} + 2s_{mid} > 255 \text{ and } \bar{v}_{mid} \geq 253)$$

7.4.3 If any of the recorded velocities are greater than 255 ft/sec or the average velocity is greater than 254 ft/sec, or the the 2-sigma value is greater than

255 ft/sec and the average velocity is greater than or equal to 253 ft/sec, then all of the balls of Dozen 2 must be tested to determine conformance. Each of the balls with  $v_{mid_i}$  greater than 255 ft/sec is considered to have failed the initial velocity test. Repeat Sections 6.6 through 6.9 with the balls of Dozen 2 and analyse the data in accordance with Section 7.5.

### 7.5 One measurement, Dozen 2

After one measurement of the initial velocity of the balls in Dozen 2, judgment is made based on the following relationships:

$$v_i < 254.5 \text{ and } \bar{v} + 3s < 255$$

7.5.1 If the recorded velocities of all 12 balls are less than 254.5 ft/sec and the 3-sigma value is less than 255 ft/sec, then the test is complete. The balls conform to the initial velocity requirement in the Rules of Golf.

$$v_i < 254.5 \text{ and } \bar{v} + 3s \geq 255$$

7.5.2 If the recorded velocities of all 12 balls are less than 254.5 ft/sec and the 3-sigma value is greater than or equal to 255 ft/sec, then the 12 balls of Dozen 2 must be tested once more to determine conformance. Repeat Sections 6.6 through 6.8 with the same balls and analyse the data in accordance with Section 7.6.

$$v_i \geq 254.5$$

7.5.3 If any of the recorded velocities are greater than or equal to 254.5 ft/sec, then the 12 balls of Dozen 2 must be tested an additional 3 times to determine conformance. Repeat Sections 6.6 through 6.8 three times with the same balls and analyse the data in accordance with Section 7.7.

### 7.6 Two measurements, Dozen 2

After two initial velocity measurements of the balls in Dozen 2, record the larger of the two velocities for each ball. Label this collection of 12 values  $v_{max_i}$  where  $i = 1, \dots, 12$ . With the 12 values of  $v_{max_i}$  use the IVTEST software program to calculate:

the average velocity,  $\bar{v}_{max}$

the standard deviation,  $s_{max}$

Conformance judgment is then based on the following relationships:

$$v_{max_i} < 254.5 \text{ and } \bar{v}_{max} + s_{max} < 255$$

7.6.1 If the recorded velocities of all 12 balls are less than 254.5 ft/sec and the 1-sigma value is less than 255 ft/sec, then the test is complete. The balls conform to the initial velocity requirement in Rules of Golf.

$$v_{max_i} \geq 254.5 \text{ and } \bar{v}_{max} + s_{max} \geq 255$$

7.6.2 If any of the recorded velocities are greater than or equal to 254.5 ft/sec or the 1-sigma value is greater than or equal to 255 ft/sec, then the 12 balls of Dozen 2 must be tested an additional 2 times to determine conformance. Repeat Section 6.6 through 6.8 two times with the same balls and analyse the data in accordance with Section 7.7.

### 7.7 Four measurements, Dozen 2

After four initial velocity measurements of the balls in Dozen 2, discard the largest and smallest velocity on each ball. Use the IVTEST program to calculate the average of the two remaining values for each of the 12 balls. Label this collection of 12 values  $v_{mid_i}$  where  $i = 1, \dots, 12$ . With the 12 values of  $v_{mid_i}$  use the

IVTEST software program to calculate:

the average velocity,  $\bar{v}_{mid}$

the standard deviation,  $s_{mid}$

Conformance judgment is then based on the following relationship:

$$v_{mid_i} > 255$$

7.7.1 Each ball with  $v_{mid_i}$  greater than 255 ft/sec is considered to have failed the initial velocity test. Otherwise, the ball is considered to conform to the initial velocity requirement in the Rules of Golf.

Note: If the total number of balls in the two dozens that fail either the initial velocity test, weight test or the size test is less than or equal to three then the lot conforms to the Rules of Golf. Otherwise, the lot does not conform.

#### 7.8 Warning Letter for Initial Velocity

If a lot conforms to the Rules of Golf and any one of the following three conditions occurs for either of the two dozens after four measurements per ball, then send a warning letter and the appropriate test data from either Dozen 1 or Dozen 2 to the manufacturer:

$$v_{mid_i} > 255 \text{ ft/sec}$$

$$\bar{v}_{mid} > 254 \text{ ft/sec}$$

$$\bar{v}_{mid} + 2s_{mid} > 255 \text{ ft/sec}$$

#### 8. Damage

Balls damaged during the test should be replaced with a randomly chosen ball from the remaining sample lot. Measured data from the newly selected ball should be used in place of the damaged ball. If four or more balls are damaged during the test then the entire lot shall

be deemed as having failed to pass the initial velocity test.

## **APPENDICES**

### **A1. Description of the Illinois Tool Works Impact-Reaction Tester**

(Portions of the following have been taken from the Impact-Reaction Tester Operating and Maintenance Manual)

The machine described here is a measuring device used to assure manufacturing compliance with initial velocity requirements as stated in the Rules of Golf. A test golf ball is loaded into the machine and is automatically positioned on a tee and, on operator command, is struck and driven over a measured flight path. The speed of the striker and the speed of the flight of the ball over the measured flight path are both precisely measured by electronic means each time a ball is driven.

The Impact-Reaction Testing machine consists of a variable speed testing unit and a computer control unit, interconnected by power and control cables. The testing unit contains a main drive motor that powers a striker wheel. The wheel houses a retractable striker that emerges on command to impact a golf ball. Also contained in the testing unit is the golf ball flight path travelling tube. A laser at the entrance of the tube and a light screen positioned at the exit from the tube are used to measure the golf ball velocity. At the end of the travelling tube is an impact curtain and access panel. After a ball is hit, it returns to the control area through the ball return tube.

## **B I. Description of the IVTEST Software Program**

(Portions of the following have been taken from the IVTEST Manual)

The IVTEST program is designed both to facilitate the execution of the Initial Velocity Test and to create a database for one portion of the USGA conformance tests. The program consists of a data entry routine, an entry correction routine, a sequential testing procedure, a statistical data analysis, a display procedure, a hard-copy option, a data storage option, a data retrieval option, and an error protection routine.

The program database is accessed by the lot number assigned to the submitted sample. The following data are included in the program and are displayed on the screen:

- Lot number
- Dozen number (for conformance testing)
- Brand name
- Ball markings
- Ball type

The following data are entered when performing the initial velocity test:

- Test date (six digit integer, for example: 030199 for March 1, 1999)
- Tester (initials of the technician performing the test)
- Starting time of the test (four digit integer, for example: 1430 for 2:30 P.M.)
- Number of balls to be hit
- Type of test (test service or conformance testing)

The program automatically records the initial velocity of each ball as it is hit. It also calculates the average, mean and standard deviation.