



# **United States Golf Association and R&A Rules Limited**

**INITIAL VELOCITY TEST  
PROCEDURE**

**USGA-TPX3007**

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## *Change Record*

[illegible]

# United States Golf Association and R&A Rules Limited

## 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 utilizing 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 the USGA and R&A Rules Limited (R&A) 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 Golf Balls booklet
  - Impact Reaction Tester Operating and Maintenance Manual
- 2.2 R&A documents:
  - Rules of Golf
  - Conforming Golf Balls booklet

### 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  $2\pi$  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 characterization.

### 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 listed in the Conforming Golf Balls booklet, published by the USGA.

## 5. Apparatus and Materials

5.1 *Illinois Tool Works (ITW) Impact-Reaction Tester*, described in Appendix A1 and illustrated in Figures 1 through 4.

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 are required for the conformance test.

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

6.1 Prior to testing the balls should be separated into two individual boxes labeled Dozen 1 and Dozen 2. Verify that the 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 Verify that the incubator temperature is set 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.

6.8 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.

6.9 After all balls are hit, the IVTEST software program calculates:

·the average velocity,  $\bar{v}$

·the standard deviation,  $s$

6.10 The IVTEST software program analyzes the measured data in accordance with Section 7 and directs additional testing as required.

## 7. I.V. Test Program Conformance 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 Procedures) tests, then the submitted lot does not conform to the Rules of Golf.

7.1 The following criteria are used in the I.V. Testing program 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, conformance determination is 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 and the data analyzed by the I.V. Test program 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 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 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 and the data analyzed by the I.V. Test program

in accordance with Section 7.5 to determine conformance

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

- 7.2.5 If the 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 and the data analyzed by the I.V. Test program in accordance with Section 7.3 to determine conformance

$$v_i \geq 254.5$$

- 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 and the data analyzed by the I.V. Test program in accordance with Section 7.4 to determine conformance

## 7.3 Two measurements. Dozen 1

After two initial velocity measurements of the balls in Dozen 1, the larger of the two velocities is recorded for each ball. This collection of 12 values is labeled;  $v_{max_i}$ , where  $i = 1, \dots, 12$ . With the 12 values of  $v_{max_i}$ , and the IVTEST software program calculates:

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

·the standard deviation,  $s_{max}$

Conformance determination is 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 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 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 and the data analyzed by the I.V. Test program in accordance with Section 7.5 to determine conformance

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

7.3.3 If any of the 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 and the data analyzed by the I.V. Test program in accordance with Section 7.4 to determine conformance

#### 7.4 Four measurements. Dozen 1

After four initial velocity measurements of the balls in Dozen1, the largest and smallest velocity on each ball are discarded. The average of the two remaining values is calculated for each of the 12 balls. This collection of 12 values is labeled;  $v_{mid_i}$ , where  $i = 1, \dots, 12$ . With the 12 values of  $v_{mid_i}$  and the IVTEST software program calculates:

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

·the standard deviation,  $s_{mid}$

Conformance determination is based on the following relationships:

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

7.4.1 If the 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 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, 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 and the data analyzed by the I.V. Test program in accordance with Section 7.5 to determine conformance

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

7.4.3 If any of the velocities are greater than 255 ft/sec or the average velocity is greater than 254 ft/sec, or 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 and the data analyzed by the I.V. Test program in accordance with Section 7.5 to determine conformance

#### 7.5 One measurement, Dozen 2

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

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

7.5.1 If the 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 and the data analyzed by the I.V. Test program in accordance with Section 7.6 to determine conformance

$$v_i \geq 254.5$$

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 and the data analyzed by the I.V. Test program in accordance with Section 7.7 to determine conformance

#### 7.6 Two measurements, Dozen 2

After two initial velocity measurements of the balls in Dozen 2, the larger of the two velocities for each ball is recorded. This collection of 12 values is labeled;  $v_{max_i}$ , where  $i = 1, \dots, 12$ . With the 12 values of  $v_{max_i}$  and the IVTEST software program calculates:

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

·the standard deviation,  $s_{max}$

Conformance determination is based on the following relationships:

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

7.6.1 If the 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 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 and the data analyzed by the I.V. Test program in accordance with Section 7.7 to determine conformance

#### 7.7 Four measurements, Dozen 2

After four initial velocity measurements of the balls in Dozen 2, the largest and smallest velocity on each ball are discarded. The average of the two remaining values is calculated for each of the 12 balls. This collection of 12 values is labeled;  $v_{mid_i}$ , where

$i = 1, \dots, 12$ . With the 12 values of  $v_{mid_i}$  and the IVTEST software program calculates:

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

·the standard deviation,  $s_{mid}$

Conformance determination is 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 then send a warning letter and the appropriate test data from either Dozen 1 or Dozen 2 to the manufacturer:

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

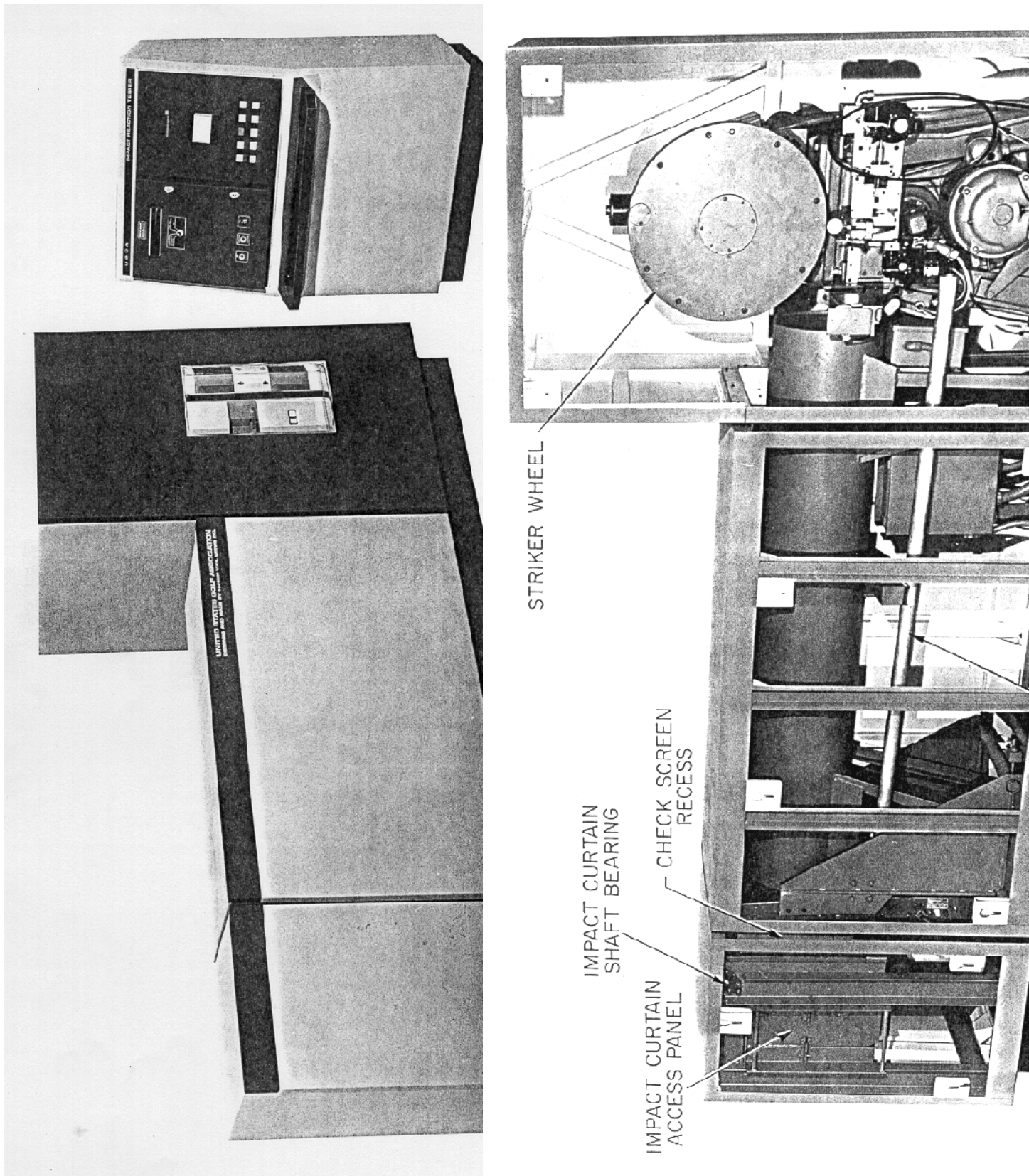
$$\bar{v}_{mid} > 254 \text{ ft/sec}$$

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

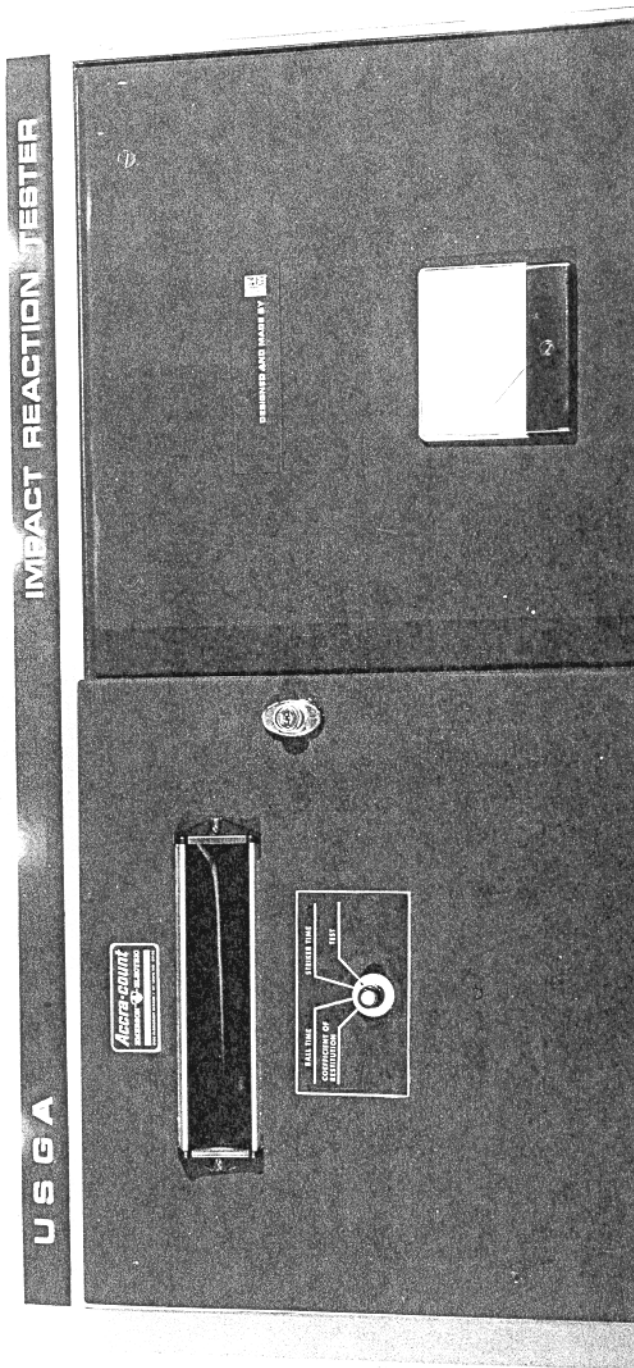
## 8. Damage

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.

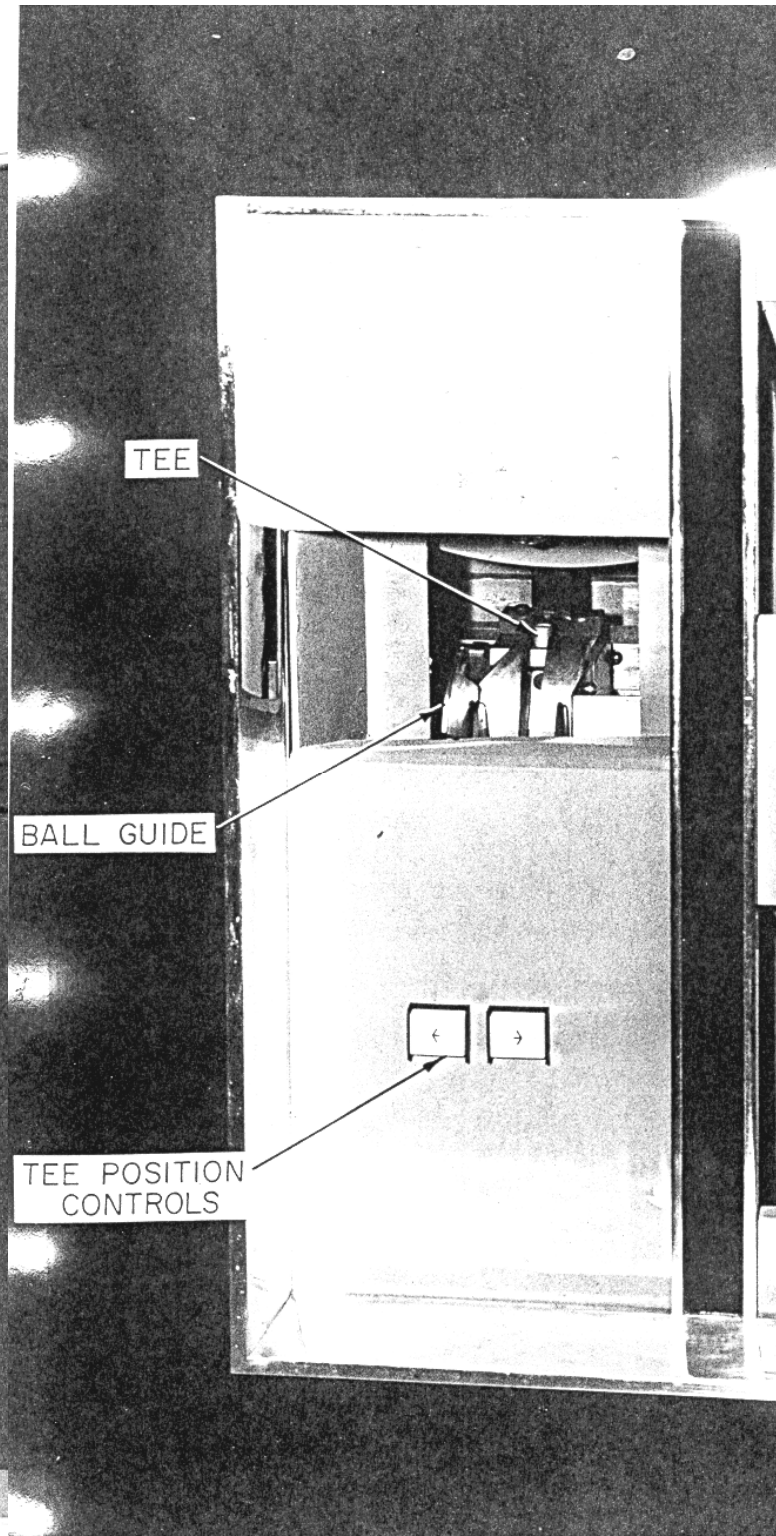




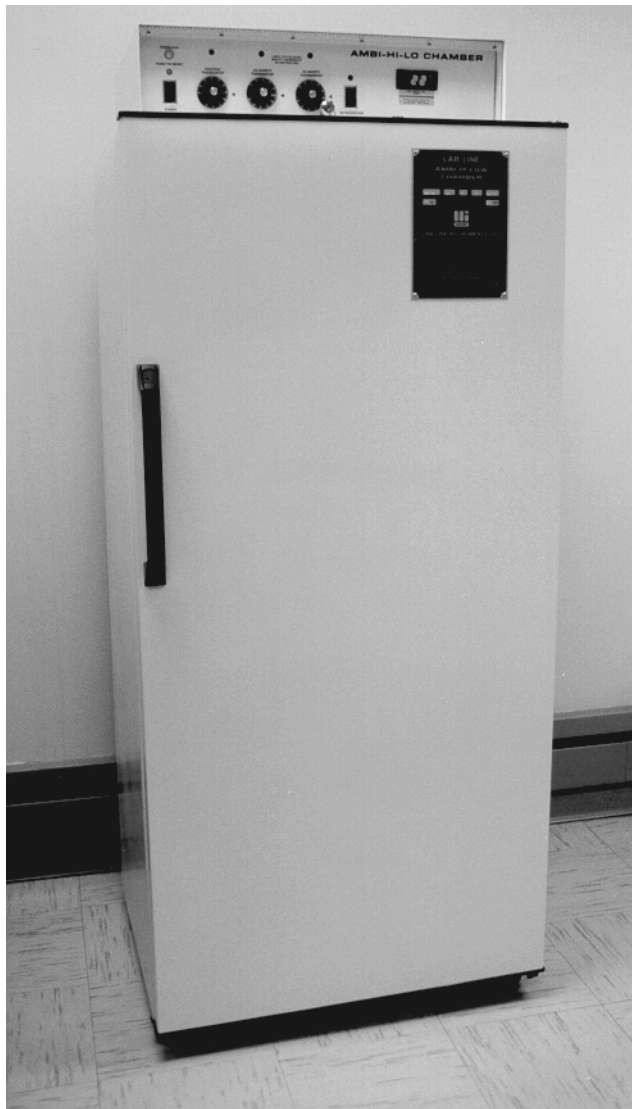
**FIGURE 1 - USGA Impact-Reaction Tester and Control Console**      eaction Tester w



**FIGURE 3 - USGA Impact-Reaction Tester**



**FIGURE 4 - Close-up of USGA Impact-Reaction Tester Load and Return Chamber**



**FIGURE 5 - Incubator**

## **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 (See Figure 1). 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. Figure 2 shows the testing unit with the access panels removed.

The operator's control console contains all of the functions, except for longitudinal adjustment of the tee position, needed to operate the tester (See Figure 3).

The tee position area is shown in Figure 4. Test golf balls are loaded in the upper chute and positioned on the tee by the ball guide. The tee can be adjusted longitudinally by the control buttons. The balls return to the lower chute after being hit.

