



United States Golf Association and R&A Rules Limited

**Interim Procedure for Measuring the Coefficient of
Restitution of an Iron Clubhead Relative to a Baseline
Plate**

Revision 1.3

January 1, 2006

1.0 Summary

This document outlines the interim procedure used to determine the Coefficient of Restitution (e) of an iron clubhead relative to a baseline plate.

2.0 Preparation of Clubhead

- 2.1 Assign an official log number to the iron clubhead upon submission.
- 2.2 If the club is shafted, remove the shaft from the clubhead.
- 2.3 Measure and record the mass of the clubhead in grams.
- 2.4 Mark the clubface for mapping.
 - 2.4.1 Using a marker, mark a vertical gridline on the face of the club at the geometric center of the clubface, mark additional vertical gridlines at 1/8-inch spacing across the face. The actual grooves designed into the clubface, if they exist, are used for the horizontal gridlines. If there are no horizontal grooves, then mark horizontal gridlines in the same manner as the vertical gridlines.
- 2.5 Label the x-coordinate alphabetically from left to right and the y-coordinate numerically from top to bottom.

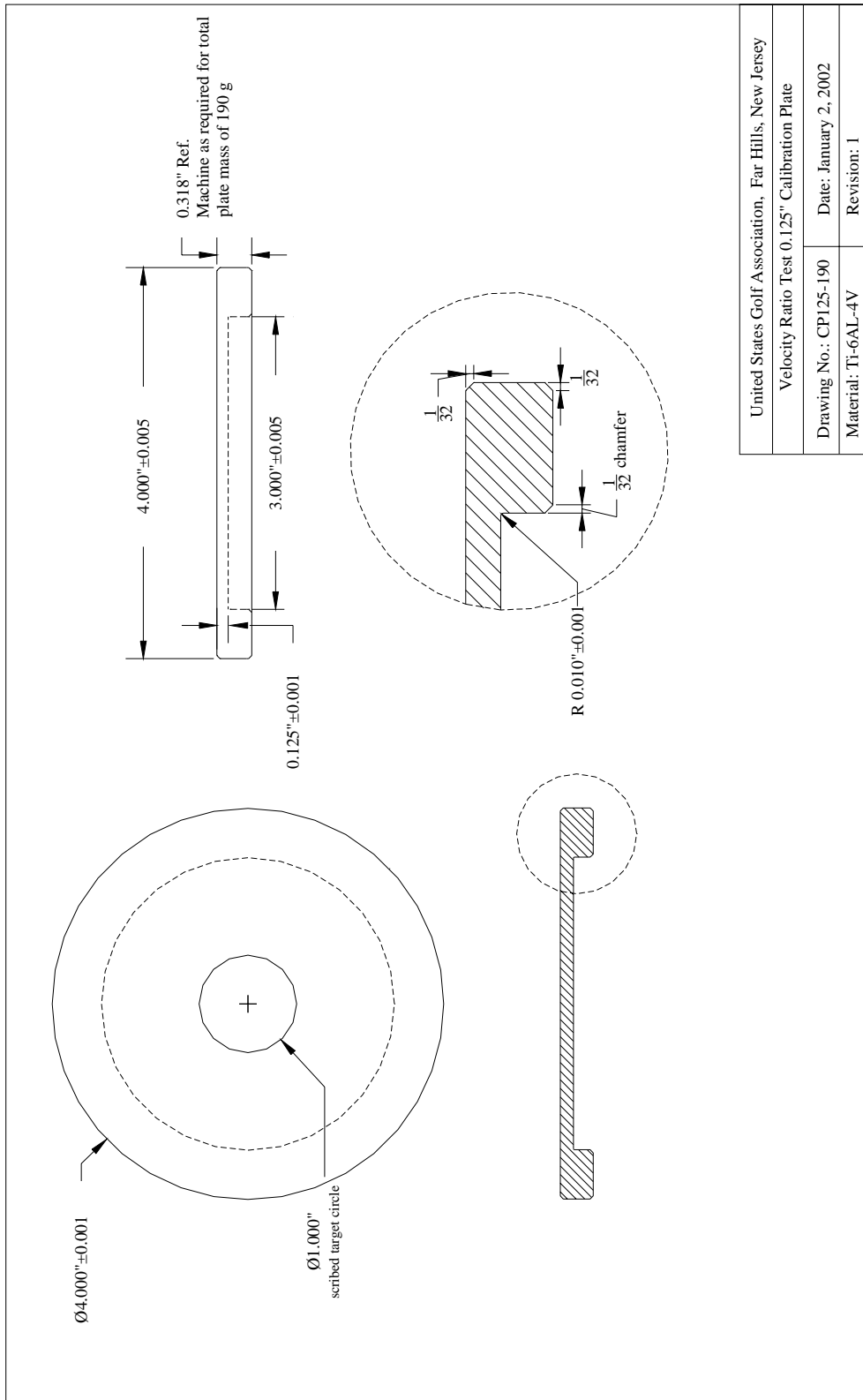
3.0 Baseline Plate Calibration

The baseline calibration plate has a membrane thickness of 0.125-in and a mass of 190.0 grams. The plate is constructed of Ti-6Al-4V alloy, ASTM B348 GR. 5 to the dimensions specified in Figure 3.0.

- 3.1 Set the launching device to produce a ball velocity of 133 ± 0.5 fps
- 3.2 Attach carbon paper to the face of plate and position the plate on the support pins of the plate support fixture.
- 3.3 Fire the ball into the plate and examine the position of ball imprint relative to the target circle.
- 3.4 Adjust the position of the plate and repeat Step 3.3 until the imprint is completely within the target circle.
- 3.5 Record the incoming ball velocity, outbound ball velocity and velocity ratio (outbound velocity/ incoming velocity, (V_{rat}))
- 3.6 Repeat steps 3.2 through 3.5 until 10 shots within the target circle are obtained.
- 3.7 From the 10 measured data points obtained, discard the data points with the highest and lowest velocity ratios.
- 3.8 Calculate the mean of the remaining eight data points. This value is the baseline velocity ratio.
- 3.9 Substituting the baseline velocity ratio and plate mass into Equation (3.9-1), calculate the baseline coefficient of restitution.

$$e_{baseline} = [(V_{rat})(M + m) + m]/M \quad (3.9-1)$$

where: M is the plate mass and
m is the ball mass



United States Golf Association, Far Hills, New Jersey	
Velocity Ratio Test 0.125" Calibration Plate	
Drawing No.: CP125-190	Date: January 2, 2002
Material: Ti-6AL-4V	Revision: 1

FIGURE 3.0 - Titanium Baseline Calibration Plate

4.0 Clubhead Mapping to Determine Sweet Spot

To expedite the mapping process, determine the approximate location of the sweet spot using a center of gravity balance indicator.

4.1 Prepare Apparatus and Club for Mapping

- 4.1.1 Set the launching device to produce a ball velocity of 133 ± 0.5 fps
- 4.1.2 Attach carbon paper to the face of the clubhead in order to obtain an imprint of the area where the ball impacts the clubface.
- 4.1.3 Mount the clubhead (sole down) on the support pedestal, using the clubface square to insure that the impact will be normal to the clubface.
- 4.1.4 Fire the ball into the clubhead and determine the alphanumeric coordinate of the center of the imprint area.
- 4.1.5 Make gross adjustments in the positioning of the support base and repeat step 4.1.2 through 4.1.4, as necessary, in order to obtain impacts with centers at the approximate location of the sweet spot coordinate identified in step 4.0.

4.2 Map the Clubface

- 4.2.1 Mount the clubhead (sole down) on the support pedestal, using the clubface square to insure that the impact will be normal to the clubface and that the sweet spot coordinate of the club and the center of the clubface square are in alignment.
- 4.2.2 Fire the golf ball and record the incoming ball velocity, outgoing ball velocity, ball identification number, and alphanumeric coordinate of imprint center.
- 4.2.3 Replace the carbon paper and repeat steps 4.2.1 and 4.2.2 for 2 additional shots.
- 4.2.4 Repeat steps 4.2.1 to 4.2.2 moving the position of the sweet spot coordinate of the iron by 0.25 inch left, 0.25 inch right, above and below (as permitted) the center of the clubface square.
- 4.2.5 From the mapping data, determine the coordinates of the impacted area (interpolating as necessary) with the highest ratio of outbound velocity to incoming velocity.
- 4.2.6 Using the impact area coordinates determined in step 4.2.5 as the center, mark a 30-mm diameter circle on the clubface.

5.0 COR Test of the Clubhead

It is important that balls from the same dozen(s) used in the baseline plate calibration be used in the COR testing.

- 5.0.1 Set the launching device to produce a ball velocity of 133 ± 0.5 fps.
- 5.0.2 Attach carbon paper to the face of the clubhead and position the clubhead (sole down) on the support cup.
- 5.0.3 Fire the ball into the clubhead and examine the position of ball imprint relative to the target circle.
- 5.0.4 Adjust the position of the clubhead and repeat Steps 5.0.2 and 5.0.3 until the imprint area is completely within the target circle.
- 5.0.5 Record the incoming ball velocity, outbound ball velocity and velocity ratio (outbound velocity/ incoming velocity, (V_{rat}))

5.0.6 Repeat steps 5.0.2 through 5.0.5 until 10 data points are obtained

5.1 Calculation of the Clubhead COR

5.1.1 From the 10 measured data points obtained in step 5.0, discard the data points with the highest and lowest velocity ratios.

5.1.2 Calculate the mean of the remaining eight data points. This value is the iron clubhead velocity ratio.

5.1.3 Substituting the iron velocity ratio and iron clubhead mass into Equation (5.1.3-1), calculate the iron coefficient of restitution.

$$e_{iron} = [(V_{rat})(M + m) + m]/M \quad (5.1.3-1)$$

where: M is the iron clubhead mass and
m is the ball mass

6.0 Clubhead Conformance Assessment

6.1 Subtract the baseline value calculated in 3.9 from the clubhead coefficient of restitution calculated in 5.1.3. This is the clubhead coefficient of restitution conformance differential.

6.1.1 If the adjusted clubhead coefficient of restitution conformance differential calculated in step 6.1 is less than or equal to 0.008, then the clubhead conforms.

6.1.2 If the adjusted clubhead coefficient of restitution conformance differential calculated in step 6.1 is greater than 0.008, then the clubhead does not conform.