Prediction of ALC ball speed using IV-test derived values at 125 mph clubhead speed

United States Golf Association, R&A Rules, Ltd.

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1 Introduction

The Overall Distance and Symmetry Test Protocol (1) includes the measurement of a golf ball's "Actual Launch Conditions" (ALC), including ball speed, spin and angle.

The setup for this test at a nominal club speed at 120 mph is based on achieving a ball speed for the USGA/R&A Calibration ball. A 2025 study (2) was conducted demonstrating the use of the outputs from the Initial Velocity test (3) to control for ball condition in establishing the appropriate setup ball speed for this test. The study relied on a significant number of golf ball constructions tested over several years and demonstrated a strong relationship between contact time (t_C) and coefficient of restitution (e) as predictors of ALC speed at 120 mph. These independent variables were measured using Hye PTM3 (a device used to measure Initial Velocity or IV) normalized to an impact speed of 143.8 ft/s.

In 2023, R&A Rules, Ltd. and the USGA announced the test speed for the Overall Distance and Symmetry test would increase from 120 MPH to 125 MPH (4). This report provides the method for determining appropriate USGA/R&A Calibration ball speed for that test.

2 Samples used

A selection of golf balls (n=88) was tested at R&A Rules, Ltd. and USGA test sites with a clubhead speed of 125 MPH as measured by the USGA laser array which defined clubhead speed for the Overall Distance Standard.

These samples had a range of coefficients of restitution of 0.723 – 0.797, the range of contact times was 420 – 580 microseconds, and the range of ALC speed (V_{ALC}) at 120 mph of 251 – 260 ft/s (these are similar ranges to the larger ball population used in the earlier study).

A subset of these golf balls was tested in two locations for a total of 98 trials. Samples additionally included USGA/R&A Calibration golf balls of different ages and in different conditions.

3 Results

3.1 Regression and statistics

The regression equation is given by Equation 1, with a Pearson R^2 value of 91.6%.

$$V_{ALC,125} = 195.96 + 123.71e - 0.05632t_C$$

Equation 1

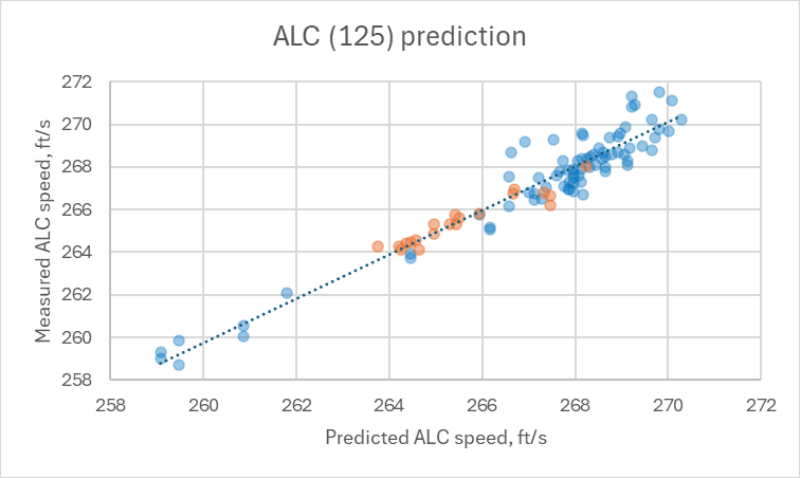

Figure 1: Measured ALC ball speed vs. predicted ALC ball speed for 98 trials. USGA/R&A Calibration balls are highlighted in orange.

Predicted and measured values are shown in Figure 1. Both contact time and coefficient of restitution are significant in the regression (see Table 1). A plot of residuals (Figure 2) against predicted ball speed does not show correlation over this range.

Table 1: ANOVA of the regression.

Source	DF	Adj. Sum of Squares	Adj. Mean Squares	F-Value	P-Value
Regression	2	657.341	328.670	518.18	< 0.001
e	1	158.235	158.235	249.47	< 0.001
t_C	1	314.769	314.769	496.26	< 0.001
Error	95	60.257	0.634	-	-
Total	97	717.597	-	-	-

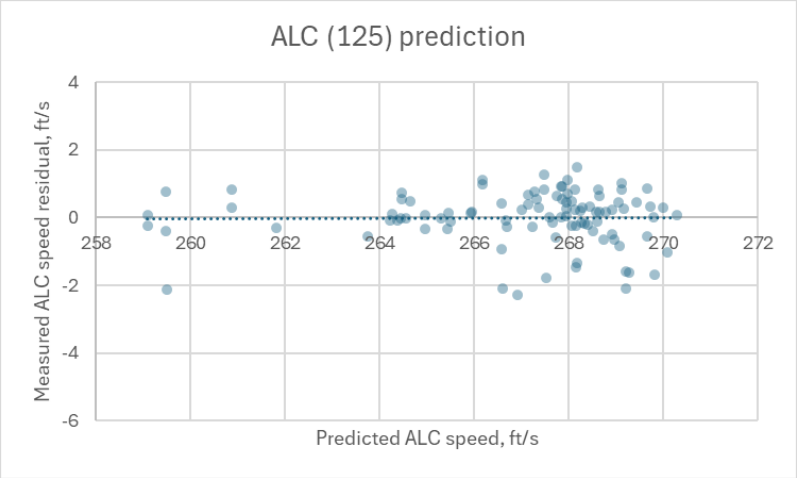

Figure 2: Residual as a function of predicted ALC ball speed at 125 mph. Residuals are uncorrelated to ball speed.

3.2 Application to USGA/R&A Calibration golf balls

The sample used in testing and regression included USGA/R&A Calibration golf balls: these were manufactured over the span 2006 – 2024, and included newer balls artificially aged through, for example, storage in hot and humid conditions (5). These USGA/R&A Calibration balls had a tested range of coefficient of restitution 0.758 – 0.792 at 143.8 ft/s impact speed and a range of contact time of 450 – 481 microseconds. The measured range of ALC ball speed at 120 mph clubhead speed was 253.6 – 258.3 ft/s

The results of applying Equation 1 to the USGA/R&A Calibration balls of different age and condition tested for this study are also highlighted in Figure 1, showing good agreement, with an average difference of 0.1 ft/s. This is comparable to the level of difference previously demonstrated at 120 mph (2).

3.3 Contribution to variability

An Initial Velocity Gage R&R study conducted in 2023 recorded the Coefficient of Restitution and Contact Time for the golf ball types used in the study. As with previous study, the availability of these data permits a Gage R&R analysis of the predicted ALC ball speed at 125 mph. As is shown in Table 2**Error! Reference source not found.**, the process standard deviation is 0.137 ft/s, substantially less than the variation in ALC ball speed measurement. As such, the contribution of using predicted ball speed to ALC measurement variation is expected to be very small (on the order of 0.01 ft/s).

Table 2: Gage R&R study results for predicted ALC ball speed. Process standard deviation is approximately one-quarter of that of ALC speed measurement.

Source	StdDev (SD)	Study Var (6 × SD)	%Study Var (%SV)
Total Gage R&R	0.13747	0.7080	3.11
Repeatability	0.13747	0.7080	3.11
Reproducibility	0.00000	0.0000	0.00

Operator	0.00000	0.0000	0.00
Part-To-Part	4.42355	22.7813	99.95
Total Variation	4.42568	26.7923	100.00

4 Conclusions

The regression represented in Equation 1 has been demonstrated to be effective over a wide range of ball construction and conditions. As in previous work, this approach predicts calibration ball speed well for balls of different ages and conditions, with an average difference of 0.1 ft/s.

5 References

1. **R&A Rules Ltd., United States Golf Association.** *Overall Distance Standard and Symmetry Test Protocol.* St Andrews, Liberty Corner : R&A Rules Ltd., United States Golf Association, 2025.

2. **USGA, R&A Rules, Ltd.** *Prediction of ALC ball speed using IV-derived test values.* Liberty Corner, St Andrews : United States Golf Association, R&A Rules, Ltd., 2025.

3. **R&A Rules Ltd., United States Golf Association.** *Initial Velocity Test Protocol (TPX3007).* St Andrews, Liberty Corner : s.n., 2019.

4. **R&A Rules, Ltd., USGA.** *Notice of Decision - Update to the Conformance Testing of Golf Balls to the.* St Andrews, Liberty Corner : R&A Rules, Ltd., United States Golf Association, 2023.

5. **USGA.** *2021 Calibration Ball Aging Study.* Liberty Corner : United States Golf Association, 2023.