Designation: E2658 – 15 (Reapproved 2023)

Standard Practices for Verification of Speed for Material Testing Machines[1]

This standard is issued under the fixed designation E2658; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These practices cover procedures and requirements for the calibration and verification of testing machine speed by means of standard calibration devices. This practice is not intended to be complete purchase specifications for testing machines.

1.2 These practices apply to the verification of the speed application and measuring systems associated with the testing machine, such as a scale, dial, marked or unmarked recorder chart, digital display, setting, etc. *In all cases the buyer/owner/user must designate the speed-measuring system(s) to be verified.*

1.3 These practices give guidance, recommendations, and examples, specific to electro-mechanical testing machines. The practice may also be used to verify actuator speed for hydraulic testing machines.

1.4 This standard cannot be used to verify cycle counting or frequency related to cyclic fatigue testing applications.

1.5 Since conversion factors are not required in this practice, either SI units (mm/min), or English [in/min], can be used as the standard.

1.6 Speed measurement values and or settings on displays/printouts of testing machine data systems-be they instantaneous, delayed, stored, or retransmitted-which are within the Classification criteria listed in Table 1, comply with Practices E2658.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E2309 Practices for Verification of Displacement Measuring Systems and Devices Used in Material Testing Machines

3. Terminology

3.1 *Definitions:*

3.1.1 *percent error, n*—in the case of a speed measuring system, the ratio, expressed as a percent, of the error to the reference value of the applied speed.

3.1.1.1 *Discussion*—The speed, as measured by the testing machine, and the speed, as computed from the readings of the calibration devices, shall be recorded at each verified speed. The percent error, shall be calculated from this data as follows:

$$Percent\ Error = [(TMsp - Refsp)/Refsp] \times 100 \quad (1)$$

where:

TMsp = speed measured by the machine being verified, mm/min [in/min], and

Refsp = reference value of the measured speed, mm/min [in/min], as determined by the calibration device.

Not all testing machines have available indicated speed values. In such cases, the verification of the testing machine's speed setting is applicable. The percent error for the testing machine speed settings, shall be calculated as follows:

$$Percent\ Error = [(TMsps - Refsp)/Refsp] \times 100 \quad (2)$$

where:

TMsps = testing machine speed setting, mm/min (in/min), and

Refsp = reference value of the measured speed, mm/min (in/min), as determined by the calibration device.

3.1.2 *ramp-to-speed condition, n*—during a speed verification run, it is the time and or change in displacement required to achieve a constant speed condition.

[1] These practices are under the jurisdiction of ASTM Committee E28 on Mechanical Testing and is the direct responsibility of Subcommittee E28.01 on Calibration of Mechanical Testing Machines and Apparatus.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.1.3 *reference standards, n*—devices used to verify either the speed of a testing machine or the speed indicated by a testing machine.

3.1.4 *speed measuring system, n*—a device or set of devices comprising of a speed transducer and associated instrumentation or a displacement transducer with associated timer and instrumentation.

3.1.5 *tolerance, n*—the allowable deviation from a reference value.

3.1.6 *speed, n*—displacement divided by time expressed in terms of millimeters/minute, inches/minute, etc.

3.1.7 *verification speed, n*—a speed with traceability derived from national standards of length and time, with a specific uncertainty of measurement, which can be applied to speed measuring systems.

TABLE 1 Classification of Speed Application Measuring Systems

Classification	Resolution % of Reading[A]	Percent Error [B]
Class A	±0.25	±0.5
Class B	±0.5	±1.0
Class C	±1.0	±2.0
Class D	±2.5	±5.0
Class E	±5.0	±10
Class F	±10	±20

[A]Resolution is not criteria for classification when speed application only, is verified.
[B]Percent Error of application or indication of speed.

4. Significance and Use

4.1 Material testing requires repeatable and predictable testing machine speed. The speed measuring devices integral to the testing machines may be used for measurement of crosshead speed over a defined range of operation. The accuracy of the speed value shall be traceable to a National or International Standards Laboratory. Practices E2658 provides procedures to verify testing machines, in order that the indicated speed values may be traceable. A key element to having traceability is that the devices used in the verification produce known speed characteristics, and have been calibrated in accordance with adequate calibration standards.

4.2 Verification of testing machine speed at a minimum consists of either or both of the following options:

4.2.1 Verifying the capability of the testing machine to move the crosshead at the speed selected.

4.2.2 Verifying the capability of the testing machine to adequately indicate the speed of the crosshead.

4.3 Where applicable, determine the testing machine's ramp-to-speed condition. This condition can be significant especially when verifying fast speeds or testing conditions with very short testing durations.

4.4 This procedure will establish the relationship between the actual crosshead speed and the testing machine indicated speed and or selected setting. It is this relationship that will allow confidence in the reported displacement over time data acquired by the testing machine during use.

NOTE 1—Many material tests never reach the desired test speed. Unless the actual data from the material test is examined, it is often impossible to know if the test speed has been reached or is repeatable from test to test.

5. Calibration Devices

5.1 Reference standards used for verification of speed measuring systems shall have estimated measurement uncertainties. The measurement uncertainty of verification results, contain the combination of the uncertainty of the displacement calibration device and time indicating device. The combined estimate of uncertainty for the reference standards shall be equal to or less than ⅓ the allowable error for the measuring system. The estimated measurement uncertainty of the reference standards should have a confidence level of 95 % (k=2).

5.2 It is recommended that the testing machine have its displacement measuring systems verified in compliance with Practices E2309 prior to performing this verification. Often the same displacement calibration devices can be used to perform Practices E2309 and this practice. It may be possible to attach the Displacement Calibration Device one time and perform both verification practices.

5.3 *Displacement Calibration Devices:*

5.3.1 *Digital Linear Scales and Displacement Measuring Transducers*—These devices typically have sufficient resolution and accuracy to perform verification of all speed settings. It is important to assess the minimum measurement capability of the device. At very slow speeds it may take considerable time to reach an end displacement value that is adequate for the use of the device.

5.3.1.1 These devices may also have the capability to be automated.

5.4 *Time Indicating Devices:*

5.4.1 Time pieces such as quartz wrist and stop watches can be used for slower speed settings. The time piece shall have a calibration traceable to a national metrology institute. For most purposes, a time piece with an accuracy of ±0.02% (approximately 2 second in 3 hours) is sufficient. The uncertainty of the calibration of the time piece shall be at most ⅓ the accuracy of the time piece and shall not significantly contribute to the uncertainty of the speed measurement. See NIST Special Publication 960-12.[3] With automated computer software, accuracies of ±0.01 seconds may be achieved. However, care must be taken in designing such systems to avoid errors due to things such as timer resolution, programming language limitations, competing interrupts and processes, etc. Third party software is available to track and adjust the computer clock referenced to NIST.

6. System Verification

6.1 Speed measuring systems shall be verified as a system with the speed sensing and measuring devices in place and operating as in actual use.

6.2 System verification is invalid if the speed sensing devices are removed and checked independently of the testing machine.

[3] Gust, J.C., Graham, R.M., Lombardi, M.A. Special Publication 960-12 Stopwatch and Timer Calibrations National Institute of Standards and Technology 2004