



Standard Practice for Measuring the Change in Length of Fasteners Using the Ultrasonic Pulse-Echo Technique¹

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1. Scope

1.1 This practice covers a procedure for measuring changes in length of threaded fasteners using conventional ultrasonic pulse-echo bolt-measuring instrumentation which has been properly calibrated.

1.2 This procedure is normally intended for metal bolting 0.25 in. (6.4 mm) or more in nominal diameter with effective length-to-diameter ratios of 2:1 or greater.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

E 6 Terminology Relating to Methods of Mechanical Testing²

E 1316 Terminology for Nondestructive Examinations³

E 1544 Practice for Construction of a Stepped Block and Its Use to Estimate Errors Produced by Speed-of-Sound Measurement Systems for Use on Solids²

3. Terminology

3.1 The definitions in this practice are in accordance with Terminology E 6 and Section I of Terminology E 1316.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *change in length*—physical change in length of a threaded fastener due to a change in tension within the fastener.

3.2.2 *effective length*—the length of a bolt that is responsive to stress.

3.2.2.1 *Discussion*—This quantity lies somewhere between the overall length of the bolt and the grip length. It is usually

estimated as the grip length plus one half the thickness of the head and one half the thickness of the nut.

3.2.3 *longitudinal wave*—those waves in which the particle motion of the material is in the same direction as the wave propagation.

3.2.4 *pulse-echo bolt-measuring equipment*—an assembly of ultrasonic instruments designed specifically to measure changes in the lengths of bolts. See Appendix X1.

3.2.5 *reference length*—the ultrasonic time of flight in the test specimen multiplied by a reference propagation velocity.

3.2.6 *reference propagation velocity*—the velocity of propagation of the ultrasonic wavefront in a calibration test block or in the bolts whose changes of length are being measured.

3.2.7 *time of flight*—the measured time interval between the launching of an ultrasonic pulse at the start of a path of travel and the reception of the pulse at the end of the path.

4. Summary of Practice

4.1 This practice describes a procedure for determining the change in length of a threaded fastener due to a change in tension in the fastener. Measurements of the ultrasonic time of flight are made before and after the fastener tension is changed, and a calculation of the change in length is made from the change in the time of flight.

4.1.1 Brief bursts of ultrasound (pulses) are generated by applying high-voltage electrical signals to an electroacoustic transducer having a resonant frequency in the 5 to 10-MHz range. The pulses enter the bolt through the transducer/bolt interface, travel to the far end of the bolt, and reflect back (echo) to the transducer. The time of flight required for the signal to make its round-trip is measured electronically. By measuring the change in the time of flight due to a change in tension within the bolt, the equipment can determine the change in the length of the bolt due to the change in tension. Compensation for the direct effect of stress on the propagation velocity in the bolt is automatically done by a computer or microprocessor within the equipment.

¹ This practice is under the jurisdiction of ASTM Committee E28 on Mechanical Testing and is the direct responsibility of Subcommittee E28.13 on Residual Stress Measurement.

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² *Annual Book of ASTM Standards*, Vol 03.01.

³ *Annual Book of ASTM Standards*, Vol 03.03.