



Designation: D7400/D7400M – 19

## Standard Test Methods for Downhole Seismic Testing<sup>1</sup>

This standard is issued under the fixed designation D7400/D7400M; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

### 1. Scope\*

1.1 These test methods address compression (P) and shear (S) waves propagating in the downward direction in a nearly vertical plane. The seismic waves can be denoted as  $P_V$  or  $P_Z$  for a downward propagating compression wave and as  $S_{VH}$  or  $S_{ZX}$  for downward propagating and horizontally polarized shear wave. The  $S_{VH}$  or  $S_{ZX}$  is also referred to as an  $S_H$  wave. These test methods are limited to the determination of the interval velocities from arrival times and relative arrival times of compression (P) waves and vertically (SV) and horizontally (SH) oriented shear (S) seismic waves which are generated near surface and travel down to an array of vertically installed seismic sensors. Two methods are discussed, which include using either one or two downhole sensors (receivers).

1.2 Various applications of the data will be addressed and acceptable procedures and equipment, such as seismic sources, receivers, and recording systems will be discussed. Other items addressed include source-to-receiver spacing, drilling, casing, grouting, a procedure for borehole installation, and conducting actual borehole and seismic cone tests. Data reduction and interpretation is limited to the identification of various seismic wave types, apparent velocity relation to true velocity, example computations, use of Snell's law of refraction, and assumptions.

1.3 There are several acceptable devices that can be used to generate a high-quality P or SV source wave or both and SH source waves. Several types of commercially available receivers and recording systems can also be used to conduct an acceptable downhole survey. Special consideration should be given to the types of receivers used and their configuration to provide an output that accurately reflects the input motion. These test methods primarily concern the actual test procedure, data interpretation, and specifications for equipment which will yield uniform test results.

1.4 All recorded and calculated values shall conform to the guide for significant digits and rounding established in Practice D6026.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.09 on Cyclic and Dynamic Properties of Soils.

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1.4.1 The procedures used to specify how data are collected/recorded and calculated in these test methods are regarded as the industry standard. In addition, they are representative of the significant digits that should generally be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyond the scope of these test methods to consider significant digits used in analysis methods for engineering design.

1.4.2 Measurements made to more significant digits or better sensitivity than specified in these test methods shall not be regarded as nonconformance with this standard.

1.5 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.5.1 The gravitational system of inch-pound units is used when dealing with inch-pound units. In this system, the pound (lbf) represents a unit of force (weight), while the unit for mass is slugs. The rationalized slug unit is not given, unless dynamic ( $F = ma$ ) calculations are involved.

1.5.2 It is common practice in the engineering/construction profession to concurrently use pounds to represent both a unit of mass (lbm) and of force (lbf). This implicitly combines two separate systems of units; that is, the absolute system and the gravitational system. It is scientifically undesirable to combine the use of two separate sets of inch-pound units within a single standard. As stated, this standard includes the gravitational system of inch-pound units and does not use/present the slug unit for mass. However, the use of balances or scales recording pounds of mass (lbm) or recording density in lbm/ft<sup>3</sup> shall not be regarded as nonconformance with this standard.

1.6 *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.*

\*A Summary of Changes section appears at the end of this standard