



Designation: D4044/D4044M – 15

Standard Test Method for (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers¹

This standard is issued under the fixed designation D4044/D4044M; 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 This test method covers the field procedure for performing an in situ instantaneous change in head (slug) test.

1.2 This test method is used in conjunction with an analytical procedure such as Test Method D4104 to data analysis and to determine aquifer properties.

1.3 *Units*—The values stated in either SI Units or inch-pound units are to be regarded separately as standard. The values 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. Reporting of test results in units other than SI shall not be regarded as nonconformance with this test method.

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

1.4.1 The procedures used to specify how data are collected/recorded and calculated in the standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should 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 data.

1.5 *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.*

¹ This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Groundwater and Vadose Zone Investigations.

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2. Referenced Documents

2.1 *ASTM Standards*:²

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4043 Guide for Selection of Aquifer Test Method in Determining Hydraulic Properties by Well Techniques

D4104 Test Method (Analytical Procedure) for Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Tests)

D5785 Test Method for (Analytical Procedure) for Determining Transmissivity of Confined Nonleaky Aquifers by Underdamped Well Response to Instantaneous Change in Head (Slug Test)

D5881 Test Method for (Analytical Procedure) Determining Transmissivity of Confined Nonleaky Aquifers by Critically Damped Well Response to Instantaneous Change in Head (Slug)

D5912 Test Method for (Analytical Procedure) Determining Hydraulic Conductivity of an Unconfined Aquifer by Overdamped Well Response to Instantaneous Change in Head (Slug) (Withdrawn 2013)³

D6026 Practice for Using Significant Digits in Geotechnical Data

3. Terminology

3.1 *Definitions*:

3.1.1 For definitions of common technical terms used in this standard, refer to Terminology D653.

4. Summary of Test Method

4.1 This test method describes the field procedures involved in conducting an instantaneous head (slug) test. The slug test

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 The last approved version of this historical standard is referenced on www.astm.org.

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

method involves causing a sudden change in head in a control well and measuring the water level response within that control well. Head change may be induced by suddenly injecting or removing a known quantity or “slug” of water into the well, rapid removal of a mechanical “slug” from below the water level, increasing or decreasing the air pressure in the well casing, or emplacement of a mechanical slug into the water column.

4.2 The water-level response in the well is a function of the mass of water in the well and the transmissivity and coefficient of storage of the aquifer. One method of analysis of the data from this field practice is described in Test Method **D4104**.

5. Significance and Use

5.1 This slug test field procedure is used in conjunction with a slug test analytical procedure, such as Test Method **D4104** to provide quick and relatively inexpensive estimates of transmissivity.

5.2 The slug test provides an advantage over pumping tests in that it does not require the disposal of the large quantities of water that may be produced. This is of special importance when testing a potentially contaminated aquifer. However, slug tests reflect conditions near the well, therefore are influenced by near-well conditions, such as gravel pack, poor well development, and skin effects, as a result, slug test results should be viewed as semi-quantitative in comparison to pumping test results.

5.3 Slug tests may be made in aquifer materials of lower hydraulic conductivity than generally considered suitable for hydraulic testing with pumping tests.

5.4 The method of data analysis (analytical procedure) should be known prior to the field testing to ensure that all appropriate dimensions and measurements are properly recorded. Selection of the analytical procedure can be aided by using Guide **D4043**, Test Method **D5785**, Test Method **D5881**, and Test Method **D5912**.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice **D3740** are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice **D3740** does not in itself assure reliable results. Reliable results depend on many factors; Practice **D3740** provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Slug-Inducing Equipment*—This test method describes the types of equipment that can be used. Because of the infinite variety of testing conditions and because similar results can be achieved with different apparatus, engineering specifications for apparatus are not appropriate. This test method specifies the results to be achieved by the equipment to satisfy the requirements of this practice.

6.2 *Water-Level Measurement Equipment*—The method of water level measurement may be dependent on the method selected for injection or withdrawal of water, and the nature of the response of the well. For an open-well test, that is, where access to the water level is open to the surface, measure water

levels manually, by an automatic recording device linked to a float, or with a pressure transducer linked to a data logger or display device. A pressure transducer linked to a data logger will be necessary for a test in a closed well in which water-level changes are induced by vacuum or pressure on the control well and where manual measurements do not provide measurements of adequate frequency (see **10.3**).

6.3 *Barometric Pressure*—Barometric pressures should be determined and routinely logged.

7. Conditioning

7.1 Pre-Test Procedure:

7.1.1 *Measuring Pre-Test Water Levels*—Measure the water level in the control well before beginning the test for a period longer than the duration of the test to determine the pre-test water level fluctuations and to establish the status pre-test water-level trend and to determine a pre-test reference water level.

7.1.2 *Well Development*—Prior to slug testing the well must be adequately developed (or re-developed) to provide the most representative test results. Failure to perform adequate development may result in low-biased determinations of formation hydraulic conductivity and transmissivity exceeding an order of magnitude. If a well has been inactive for several months or years since its original installation and development a re-development may be required. Development may consist of surging and purging the well with one of several methods. Purging with a bailer may be adequate in some wells where sufficient energy can be injected into the surrounding aquifer to remove fines and damage caused due to well installation and construction activities. Use of an inertial pump may also be effective, especially if a surge block is applied alternately. Over pumping the well may be more effective in larger wells with a high yield. In low permeability formations (for example, sand to silty clay) these development methods may not be appropriate and could lead to a clogged filter pack or well screen.

7.1.3 *Verify Development*—It is possible to verify adequate development of well in permeable formations by performing repeat slug tests using the same initial head. Usually three to five repeat tests can be conducted in less than an hour in permeable formations. Often visual inspection/comparison of the test response curve in the field can be used to assess well performance. Significant changes in the magnitude of the response curve or shape of the response curve between repeat tests indicates that further development or redevelopment is required.

8. Procedure

8.1 Cause a change in water level, either a rise or decline, by one of the following methods:

8.1.1 *Water Slug*—Inject or withdraw water of a known quantity into or from the control well.

8.1.2 *Mechanical Slug*—Inject a mechanical slug to below the water level in the well, or withdraw the mechanical slug below the water level in the well. The water within the control well will then rise or decline an amount equal to the volume of the mechanical slug.