INTERNATIONAL

Designation: ~~D5/D5M – 19a~~ D5/D5M – 20

Standard Test Method for Penetration of Bituminous Materials[1]

This standard is issued under the fixed designation D5/D5M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers determination of the penetration of semi-solid and solid bituminous materials.

1.2 The needles, containers, and other conditions described in this test method provide for the determinations of penetrations up to 500.

NOTE 1—See the section on Penetration of Test Methods D244 for information and precision and bias on testing emulsion residue.

1.3 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.

1.4 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

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

1.6 *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]

D8 Terminology Relating to Materials for Roads and Pavements
D36/D36M Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
D244 Test Methods and Practices for Emulsified Asphalts
D3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
D8055 Guide for Selecting an Appropriate Electronic Thermometer for Replacing Mercury Thermometers in D04 Road and Paving Standards
E1 Specification for ASTM Liquid-in-Glass Thermometers
E77 Test Method for Inspection and Verification of Thermometers
~~E1137/E1137M~~E563 ~~Specification for Industrial Platinum Resistance Thermometers~~Practice for Preparation and Use of an Ice-Point Bath as a Reference Temperature
~~E2251~~E644 ~~Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids~~Test Methods for Testing Industrial Resistance Thermometers

2.2 *ANSI Standard:*[3]

B46.1 Surface Texture

[1] This test method is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.44 on Rheological Tests.

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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] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

2.3 *ISO Standard:*[3]
ISO Standard 468 Surface Roughness—Parameters, Their Values and General Rules for Specifying Requirements

3. Terminology

3.1 *Definitions*—Definitions for many terms common to asphalt cement and asphalt binder are found in Terminology D8.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *penetration, n*—consistency of a bituminous material expressed as the distance in tenths of a millimetre that a standard needle vertically penetrates a sample of the material under known conditions of loading, time, and temperature.

4. Summary of Test Method

4.1 The sample is melted (if starting at ambient temperature) and cooled under controlled conditions. The penetration is measured with a penetrometer by means of which a standard needle is applied to the sample under specific conditions.

5. Significance and Use

5.1 The penetration test is used as a measure of consistency. Higher values of penetration indicate softer consistency.

NOTE 2—The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of Specification D3666 are generally considered capable of competent and objective testing, sampling, inspection, etc. Users of this standard are cautioned that compliance with Specification D3666 alone does not completely ensure reliable results. Reliable results depend on many factors; following the suggestions of Specification D3666 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.

6. Apparatus

6.1 *Penetration Apparatus*—Any apparatus that permits the needle holder (spindle) to move vertically without measurable friction and is capable of indicating the depth of penetration to the nearest 0.1 mm will be acceptable. The weight of the spindle shall be 47.5 ± 0.05 g. The total weight of the needle and spindle assembly shall be 50.0 ± 0.05 g. Weights of 50 ± 0.05 g and 100 ± 0.05 g shall also be provided for total loads of 100 and 200 g, as required for some conditions of the test. The surface on which the sample container rests shall be flat, and the axis of the plunger shall be at approximately 90° to this surface. The apparatus shall have a leveling indicator. The spindle shall be easily detached for checking its weight.

6.1.1 The leveling indicator shall be verified at least annually with a handheld level.

6.2 *Penetration Needle:*

6.2.1 The needle (see Fig. 1) shall be made from fully hardened and tempered stainless steel, Grade 440-C or equal, HRC 54 to 60. The standard needle shall be approximately 50 mm [2 in.] in length, the long needle approximately 60 mm [2.4 in.]. The diameter of all needles shall be 1.00 to 1.02 mm [0.0394 to 0.0402 in.]. It shall be symmetrically tapered at one end by grinding to a cone having an angle between 8.7 and 9.7° over the entire cone length. The cone ~~should~~shall be coaxial with the straight body of the needle. The total axial variation of the intersection between the conical and straight surfaces shall not be in excess of 0.2 mm [0.008 in.]. The truncated tip of the cone shall be within the diameter limits of 0.14 and 0.16 mm [0.0055 and 0.0063 in.] and square to the needle axis within 2°. The entire edge of the truncated surface at the tip shall be sharp and free of burrs. When the surface texture is measured in accordance with American National Standard B46.1 or ISO 468 the surface roughness height, Ra, of the tapered cone shall be 0.2 to 0.3 µm [8 to 12 µin.] arithmetic average. The surface roughness height, Ra, of the needle shank shall be 0.025 to 0.125 µm [1 to 5 µin.]. The needle shall be mounted in a non-corroding metal ferrule. The ferrule shall be 3.2 ± 0.05 mm [0.126 ± 0.002 in.] in diameter and 38 ± 1 mm [1.50 ± 0.04 in.] in length. The exposed length of the standard needle shall be within the limits of 40 to 45 mm [1.57 to 1.77 in.], and the exposed length of the long needle shall be 50 to 55 mm [1.97 to 2.17 in.]. The needle shall be rigidly mounted in the ferrule. The run-out (total indicator reading) of the needle tip and any portion of the needle relative to the ferrule axis shall not exceed 1 mm [0.04 in.]. The weight of the ferrule needle assembly shall be 2.50 ± 0.05 g. (A drill hole at the end of the ferrule or a flat on the side is permissible to control the weight.) Individual identification markings shall be placed on the ferrule of each needle; the same markings shall not be repeated by a manufacturer within a three-year period.

6.2.2 Needles used in testing materials for conformance to specifications shall be shown to have met the requirements of 6.2.1. Needles shall be checked every twelve months.

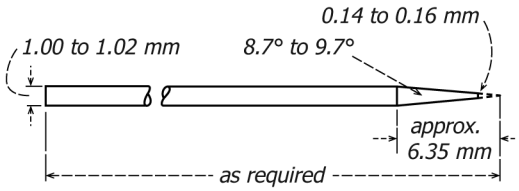

FIG. 1 Needle for Penetration Test

6.3 *Sample Container*—A metal or glass cylindrical, flat-bottom container of essentially the following dimensions shall be used:

For penetrations below 40:	
Diameter, mm	33–50
Internal depth, mm	8–16
For penetrations below 200:	
Diameter, mm	48–56
Internal depth, mm	34–40
For penetrations between 200 and 350:	
Diameter, mm	55–80
Internal depth, mm	45–70
For penetrations 350 to 500	
Diameter, mm	55–70
Internal depth, mm	70–80

NOTE 3—Commonly available metal container sizes are 33 by 8 mm, 40 by 15 mm, 55 by 35 mm, 70 by 45 mm, 80 by 50 mm, and 70 by 80 mm.

6.3.1 For referee testing, the container shall essentially be 55 by 35 mm for materials with penetrations below 200; 70 by 45 mm for penetrations between 200 and 350; and 70 by 80 mm for penetrations above 350.

6.4 *Water Bath*—A bath capable of maintaining a temperature of 25 ± 0.1 °C [77 ± 0.2 °F] or any other temperature of test within 0.1 °C [0.2 °F]. The bath shall have a perforated shelf supported in a position not less than 50 mm from the bottom and not less than 100 mm below the liquid level in the bath. If penetration tests are to be made in the bath itself, an additional shelf strong enough to support the penetrometer shall be provided. Brine may be used in the bath for determinations at low temperatures.

NOTE 4—The use of distilled water is recommended for the bath. Take care to avoid contamination of the bath water by surface active agents, release agents, or other chemicals, as their presence may affect the penetration values obtained.

6.5 *Transfer Dish*—When used, the transfer dish shall have a capacity of at least 350 mL and sufficient depth of water to cover the large sample container. It shall be provided with some means for obtaining a firm bearing and preventing rocking of the container. A three-legged stand with three-point contact for the sample container is a convenient way of ensuring this.

6.6 *Timing Device*—For hand-operated penetrometers, any convenient timing device such as an electric timer, a stop watch, or other spring-activated device may be used provided it is graduated in 0.1 s or less and is accurate to within ±0.1 s for a 60-s interval. An audible seconds counter adjusted to provide one beat each 0.5 s may also be used. The time for an eleven-count interval shall be 5 ± 0.1 s. Any automatic timing device attached to a penetrometer shall be accurately calibrated to provide the desired test interval within ±0.1 s.

6.7 ~~*Thermometers*—*Thermometer*—Calibrated liquid-in-glass thermometers of suitable range with subdivisions and maximum~~A thermometer, to be used in measuring the temperature of the water bath described in 6.2 ~~scale error of 0.1 °C [0.2 °F] or any other thermometric~~while completing the test procedure as described in Section 9~~device of equal accuracy, precision, and sensitivity shall be used. Thermometers shall conform to the requirements of Specification~~ . The thermometer shall be one of ~~E1 or Specification E2251. Other thermometric devices shall conform to the requirements of~~the following (see Note 5~~Specification):E1137/E1137M.~~

6.7.1 ~~Suitable thermometers commonly used are:~~A liquid-in-glass partial immersion thermometer

~~ASTM Number~~	~~Range~~
~~17C or 17F~~	~~19 to 27 °C [66 to 80 °F]~~
~~63C or 63F~~	~~−8 to +32 °C [18 to 89 °F]~~
~~64C or 64F~~	~~25 to 55 °C [77 to 131 °F]~~

of suitable range with subdivisions and maximum scale error of 0.1 °C [0.2 °F] which conforms to the requirements of Specification E1. Standardize the thermometer in accordance with one of the methods in Test Method E77 or verify its original standardization at the ice point in accordance with Practice E563. If the thermometer does not read 0.0 ± 0.1 °C [32.0 ± 0.2 °F] at the ice point, then the thermometer should be re-standardized.

6.7.1.1 Suitable liquid-in-glass thermometers commonly used are:

ASTM Number	Range
17C or 17F	19 to 27 °C [66 to 80 °F]
63C or 63F	−8 to +32 °C [18 to 89 °F]
64C or 64F	25 to 55 °C [77 to 131 °F]

6.7.2 A platinum resistance thermometer (PRT) readable to the nearest 0.1 °C [0.2 °F], with a Pt 100 Class AA tolerance rating and either a three- or four-wire configuration and an overall sheath length at least 50 mm [2 in.] greater than the immersion depth. Standardize the PRT system (probe and readout device) in accordance with Test Methods E644. Corrections shall be applied to ensure accurate measurements within 0.1 °C [0.2 °F].

6.7.3 ~~The thermometer used for the water bath shall be periodically calibrated~~ A metal-sheathed thermistor readable to the nearest 0.1 °C [0.2 °F] with an overall sheath length at least 50 mm [2 in.] greater than the immersion depth. Standardize the thermistor system (probe and readout device) in accordance with Test ~~Method~~Methods ~~E77~~E644. ~~An alternate thermometric device shall be periodically calibrated in accordance with Specification~~Corrections shall be applied to ensure accurate measurements within ~~E1137/E1137M.~~0.1 °C [0.2 °F].