
Standard Method of Test for

**Penetration of Bituminous
Materials**

AASHTO Designation: T 49-22

Technically Revised: 2022

Technical Subcommittee: 2b, Liquid Asphalt

ASTM Designation: D5/D5M-13



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AASHTO T 49-22 is identical to ASTM D5/D5M-13 except for the following provisions:

1. Replace all references to ASTM D36 with AASHTO T 53.
2. Add reference in Section 2 for the AASHTO standard:
 - M 339M/M 339, Thermometers Used in the Testing of Construction Materials
3. Add references in Section 2 for ASTM standards:
 - E230/E230M, Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
 - E879, Standard Specification for Thermistor Sensors for General Purpose and Laboratory Temperature Measurements
 - E1137/E1137M, Standard Specification for Industrial Platinum Resistance Thermometers
 - E2251, Standard Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids
 - E2877, Standard Guide for Digital Contact Thermometers
4. Delete references in Section 2 for ASTM standards that no longer apply:
 - E77, Test Method for Inspection and Verification of Thermometers
 - E563, Practice for Preparation and Use of an Ice-Point Bath as a Reference Temperature
 - E644, Test Methods for Testing Industrial Resistance Thermometers
5. Add the following to Section 2:

2.3 *International Electrotechnical Commission Standards:*

 - IEC 60584-1:2013, Thermocouples - Part 1: EMF Specifications and Tolerances
 - IEC 60751:2008, Industrial Platinum Resistance Thermometers and Platinum Temperature Sensors
6. Add the following to Section 2:

2.4 *Federal Standard:*

 - Fed. Std. No. 29, CFR 1910.1200 OSHA Hazard Communication Standard; see also Permissible Exposure Limits—Annotated Tables, available at <https://www.osha.gov/dsg/annotated-pels/>

7. Replace the last sentence of Section 6.1 with the following:
The weight of the spindle shall be checked.
8. Replace all of Section 6.7 (including subsections 6.7.1 through 6.7.3 and existing Note 5) with the following:
Thermometer—A thermometer for measuring water bath temperature, described in Section 6.4, while completing the test procedure as described in Section 9, shall meet the requirements of M 339M/M 339 with a temperature range of at least 19 to 55°C (66 to 131°F), and an accuracy of $\pm 0.05^\circ\text{C}$ ($\pm 0.09^\circ\text{F}$) (see Note 5).
Note 5—Thermometer types suitable for use include ASTM E1 mercury thermometers 17C (17F), 63C (63F) or 64C (64F); ASTM E2251 low-hazard precision thermometer S63C (S63F) or S64C (S64F); ASTM E879 thermistor thermometer; ASTM E1137/E1137M Pt-100 RTD platinum resistance thermometer, Special order; or IEC 60751: 2008 Pt-100 RTD platinum resistance thermometer, Special order.
9. Add new Section 6.8 for Thermometer for measuring air temperature as follows:
Thermometer—A thermometer for measuring air temperature, as described in Section 7.3, shall meet the requirements of M 339M/M 339 with a temperature range of at least 10 to 35°C (50 to 95°F), and an accuracy of $\pm 1^\circ\text{C}$ ($\pm 1.8^\circ\text{F}$) (see Note 6).
Note 6—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E230/E230M thermocouple thermometer, Type T, Standard Class; IEC 60584 thermocouple thermometer, Type T, Class 2; ASTM E2877 digital metal stem thermometer; or dial gauge metal stem (bi-metal) thermometer.
10. Add new Section 6.9 for heating requirements as follows:
Oven or heating apparatus—The oven or heating apparatus shall be used for heating samples, as described in Section 7.1, with operating temperatures of up to 175°C (347°F). Ovens, when used, shall be capable of operation at the temperatures required, as corrected, if necessary, by standardization. More than one oven may be used, provided each is used within its proper operating temperature range. The thermometer for measuring the temperature of samples, regardless of heating apparatus used, shall meet the requirements of M 339M/M 339 with a temperature range of at least 25 to 175°C (77 to 347°F), and an accuracy of $\pm 1.25^\circ\text{C}$ ($\pm 2.25^\circ\text{F}$) (see Note 7).
Note 7—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E230/E230M thermocouple thermometer, Type T, Standard Class; or IEC 60584 thermocouple thermometer, Type T, Class 2.
11. Renumber existing Notes 6 through 8 as Notes 8 through 10 respectively.
12. Add the following sentence to the end of Section 7.2:
If air bubbles are visible in the surface of the specimen, briefly flash the top of the specimen with a flame.
13. Replace Section 11 with the following:
11. Precision and Bias
11.1 *Precision*—Criteria for judging the acceptability of penetration of asphalt binder results obtained by this method are given in Table X.
Note: Precision data for penetration on asphalt residue of emulsified asphalt can be found in T 59.
11.1.1 *Single-Operator Precision (Repeatability)*—The figures in Column 2 of Table X are the standard deviations that have been found to be appropriate for the conditions of test described in Column 1. Two results obtained in the same laboratory, by the same operator

using the same equipment, in the shortest practical period of time, should not be considered suspect unless the difference in the two results exceeds the values given in Table X, Column 3.

11.1.2 *Multilaboratory Precision (Reproducibility)*—The figures in Column 2 of Table X are the standard deviations that have been found to be appropriate for the conditions of test described in Column 1. Two results submitted by two different operators testing the same material in different laboratories shall not be considered suspect unless the difference in the two results exceeds the values given in Table X, Column 3.

Table X—Precision Estimates of Penetration of Bituminous Materials

Condition of Test and Test Property		Standard Deviation $1s^{a,b}$	Acceptable Range of Two Test Results $d2s^{a,b}$
Single-Operator Precision:			
4°C	Original	$1s = 0.01X + 0.8$	$d2s = (0.01X + 0.8) \times 2.83$
	RTFO	$1s = 0.02X + 0.4$	$d2s = (0.03X + 0.3) \times 2.83$
25°C	Original	$1s = 0.01X + 0.7$	$d2s = (0.01X + 0.6) \times 2.83$
	RTFO	$1s = 0.01X + 0.5$	$d2s = (0.02X + 0.5) \times 2.83$
Multilaboratory Precision:			
4°C	Original	$1s = 0.06X + 1.9$	$d2s = (0.06X + 2.0) \times 2.83$
	RTFO	$1s = 0.06X + 1.5$	$d2s = (0.07X + 1.5) \times 2.83$
25°C	Original	$1s = 0.03X + 1.3$	$d2s = (0.02X + 1.8) \times 2.83$
	RTFO	$1s = 0.04X + 1.2$	$d2s = (0.04X + 1.2) \times 2.83$

^a These values represent the 1s and d2s limits described in ASTM Practice C670.

^b The value of X represents the average value of two test results.

Note: The precision estimates given in Table X are based on the analysis of test results from 21 pairs of AMRL Viscosity Graded Asphalt Cement proficiency samples. The data analyzed consisted of results from 71 to 97 laboratories for each of the pairs of samples. The analysis included original asphalt cements with the average penetration value of 11.7 units to 44 units at 4°C and 33.4 units to 128.9 units at 25°C and RTFO residue with the average penetration value of 7.8 units to 27.2 units at 4°C and 19.8 units to 68.4 units at 25°C.

11.2 *Bias*—No information can be presented on the bias of the procedure because no comparison with a material having an accepted reference value was conducted.