



Standard Test Method for Smoke Density in Flue Gases from Burning Distillate Fuels¹

This standard is issued under the fixed designation D 2156; 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 Department of Defense.

1. Scope

1.1 This test method covers the evaluation of smoke density in the flue gases from burning distillate fuels. It is intended primarily for use with home heating equipment burning kerosene or heating oils. It can be used in the laboratory or in the field to compare fuels for clean burning or to compare heating equipment.

1.2 The values stated in SI units are to be regarded as the standard. The values in parentheses are provided for information only. Arbitrary and relative units are also used.

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 97 Test Method for Directional Reflectance Factor, 45-deg 0-deg, of Opaque Specimens by Broad-Band Filter Reflectometry²

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *smoke spot number*—the number of the spot on the standard scale most closely matching the color (or shade) of the test spot.

4. Summary of Test Method

4.1 A test smoke spot is obtained by pulling a fixed volume of flue gas through a fixed area of standard filter paper. The color (or shade) of the spot thus produced is visually matched with a standard scale, and the smoke density is expressed as a “smoke spot number.”

5. Significance and Use

5.1 This test method provides a means of controlling smoke production in home heating equipment to an acceptable level.

Excessive smoke density adversely affects efficiency by heat-exchanger fouling.

5.2 The range of smoke densities covered by this test method is that which has been found particularly pertinent to home-heating application. It is more sensitive to small amounts of smoke than several other smoke tests as indicated in the following comparison:

Smoke Spot Number	Transmittance, percent	Ringelmann Smoke Number
0	100	0
2	95	0
4	80	0
6	54	0
8	18	0
9	0	0
9	0	0 to 5

6. Apparatus

6.1 *Sampling Device*—A suitable device providing a total flue gas sample volume of $36\,900 \pm 1650 \text{ cm}^3$ at 16°C , 1 atm ($2250 \pm 100 \text{ in.}^3$ at 60°F , 1 atm) for each 6.45 cm^2 (1 in.^2) effective surface area of filter paper shall be employed. The sampling device and connections shall be of such construction that the total travel of flue gas sample from flue to filter paper shall not exceed 410 mm (16 in.). The device shall provide for cooling the sample below the charring temperature for the filter paper but not below the dew point of the sample. Suitable laboratory and portable field service equipment is illustrated in Fig. 1 and Fig. 2.

6.2 *Smoke Scale*—The smoke scale required consists of ten spots numbered consecutively from 0 to 9, ranging in equal photometric steps from white through neutral shades of gray to black, imprinted or otherwise processed on white paper or plastic stock having a surface reflectance of between 82.5 and 87.5 % 45° , 0° daylight luminous directional reflectance in accordance with Test Method E 97. The smoke scale spot number is defined as the reduction (due to smoke) in reflected incident light divided by 10. Thus, the first spot, which is the color of the unimprinted scale, will be No. 0, since in the case of this spot there will be no reduction in reflected incident light directed thereon. The last spot, however, is very dark, reflecting only 10% of the incident light directed thereon; thus in this case the reduction in reflected incident light is 90 %, which gives to this darkest spot the No. 9. Intermediate spot numbers are similarly established. Limits of permissible reflectance variation of any smoke scale spot shall not exceed $\pm 3\%$

¹ This method is under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricants and is the direct responsibility of subcommittee D.02.E on Burner, Diesel and Gas Turbine Fuel Oils

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² *Annual Book of ASTM Standards*, Vol 06.01.