



Standard Test Methods for Natural Gas Odor Intensity¹

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1. Scope

1.1 These test methods cover the procedures for determining the odor intensity of natural gas through the use of instruments that dilute and mix the sampled natural gas with air. The mixed gas stream is then sniffed by the operator for the purpose of determining the threshold detection level or the readily detection level, or both, for odorant in the natural gas stream.

1.2 *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:²

D4150 Terminology Relating to Gaseous Fuels

D5287 Practice for Automatic Sampling of Gaseous Fuels

E253 Terminology Relating to Sensory Evaluation of Materials and Products

2.2 Other Standards

49 CFR Part 192.625 Odorization of gas³

3. Terminology

3.1 Definitions:

3.1.1 *odorant, n*—sulfur-bearing compound that gives natural gas a distinctive odor. For the purpose of these test methods, natural gas odorants may be compounds that are present at the wellhead or commercial mixtures that are added to the gas stream, or both.

¹ These test methods are under the jurisdiction of Committee D03 on Gaseous Fuels and is the direct responsibility of Subcommittee D03.05 on Determination of Special Constituents of Gaseous Fuels.

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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 Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.

3.1.2 *olfactory fatigue, n*—desensitization of the sense of smell through either prolonged exposure or repeated exposure over a short period of time to an odor, a mixture of odors, or series of odors.

3.1.3 *sniff, vi*—smell or snuff with short, audible inhalations.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *high pressure, n*—for the purpose of these test methods, high pressure refers to natural gas pressure greater than the maximum inlet pressure specified by the manufacturer of the gas dilution apparatus.

3.2.2 *intensity, n*—the magnitude of odor perceived by the operator.

3.2.3 *low pressure, n*—for the purpose of these test methods, low pressure refers to natural gas pressure less than or equal to the maximum inlet pressure specified by the manufacturer of the gas dilution apparatus.

3.2.4 *operator(s), n*—the person(s) performing the testing described in these test methods. Because of the nature of the testing described herein, the operator shall be qualified to perform this work (see 5.2).

3.2.5 *readily detectable level, n*—the concentration of natural gas and odorant mixture in air which the operator is able to detect and identify natural gas odor.

3.2.6 *threshold detection level, n*—the concentration of natural gas and odorant mixture in air which the operator is barely able to detect an odor.

3.3 For definitions of terms related to natural gas that are used in these test methods, refer to Practice D5287.

3.4 For definitions of terms related to olfactory testing that are used in these test methods, refer to Terminology E253.

4. Significance and Use

4.1 Federal regulations (49 CFR Part 192.625) state: “A combustible gas in a distribution line must contain a natural odorant or be odorized so that at a concentration in air of one-fifth of the lower explosive limit, the gas is readily detectable by a person with a normal sense of smell.” These regulations state further that “each operator shall conduct periodic sampling of combustible gases to assure the proper concentration of odorant in accordance with this section.” Additionally, a number of states have enacted legislation that requires natural gas to be odorized so that it is detectable at

concentrations less than one fifth of the lower explosive limit. See note **Note 1**. While regulations do not specify the exact method for determining compliance, it has been documented that compliance testing must be olfactory in nature.⁴

NOTE 1—For example, Massachusetts Section 192.625 MFS Standards requires that "... a concentration of fifteen hundredths of one percent gas in the air is readily perceptible to the normal or average olfactory senses of a person"

4.2 These test methods cover procedures to measure the odor level of natural gas by way of olfactory determination. No direct correlation may be ascertained between these test methods and those methods available or under development that quantitatively measure the concentration of sulfur compounds in natural gas.

4.3 These test methods outline general procedures to measure the odor detection levels of natural gas. It is the responsibility of persons using these test methods to develop and maintain equipment and specific operating procedures to ensure public safety and compliance with all appropriate regulations.

5. Interferences and Precautions

5.1 The location to be tested should be sheltered from wind and isolated from sources of interfering odors such as those from certain industrial plants and landfills. The equipment and sampling lines used in testing shall be clean and free of odor.

5.2 Operators shall be trained to perform odor testing of natural gas and in the proper use and care of test instrumentation. It is preferred that operators should be nonsmokers, or, if smokers, they shall not smoke for at least 30 min before performing the test. Additionally, operators shall not chew tobacco or gum or eat food of pungent taste or odor for at least 30 min before performing the test. Operators should have no cold, allergies, or other physical conditions that would affect their sense of smell.

5.3 Prolonged use of the sense of smell may result in olfactory fatigue. Sufficient time shall be allotted between tests to ensure that the tester's sense of smell is not adversely affected by the previous test.

6. Apparatus

6.1 *Gas Dilution Apparatus*—This apparatus shall consist of a gas inlet control valve, a gas/air mixing chamber, a sample port for sniffing the gas/air mixture, and a method to determine the relative concentration of the gas/air mixture. All components that come in contact with natural gas shall be inert to odorant compounds.

6.2 *Natural Gas Pressure Regulator(s)*—This item may be required to lower the gas pressure at the sampling location to a level that is safe for the gas dilution apparatus as specified by the manufacturer. This regulator may need to be a heated regulator if an extremely large pressure drop is required, for example, when compressed natural gas or gas at transmission line pressure is to be tested. More than one regulator may be required to perform this function satisfactorily.

6.2.1 The gas dilution apparatus shall never be subjected to natural gas pressures greater than that specified by the manufacturer. Excessive natural gas pressure may result in instrument failure and cause an excessive amount of gas to vent out of the instrument.

6.2.2 The regulator shall be a heated regulator when compressed natural gas (CNG) is to be tested or when it is anticipated that liquid hydrocarbons may condense from the gas stream as a result of Joule-Thompson Expansion. Odorant compounds have a preference for liquid hydrocarbons when present.

6.3 *Sample Line*—The sample line shall be clean and consist of material that is inert to natural gas odorant compounds. Sample lines shall be tested periodically by performing a blank determination as specified in 9.1 and replaced as required. Rubber or copper tubing shall not be used. Appropriate material for sample lines include stainless steel, aluminum, urethane, PTFE, PVC, and PEK.

6.4 *Sample Probe*—A stainless steel sample probe shall be used where appropriate to prevent the possibility of pipeline contaminants from entering the sample stream. (See Section 6 of Practice **D5287** for specifics on sample probe construction and installation.)

7. Hazards

7.1 Because these test methods involve the sampling of natural gas and the venting of a gas/air mixture, only qualified persons shall perform the testing described. These test methods shall not be performed near open flames. Failure to follow manufacturer's instructions for the instrumentation used in these test methods may result in a hazardous condition.

7.2 These test methods shall never be performed at locations that potentially contain sour gas. High concentrations of hydrogen sulfide can quickly poison the operator resulting in death or permanent injury.

7.3 Caution must be exercised in selecting appropriate instrumentation used in application of this test method. Odor intensity instrumentation should be operated and suited for the intended use including suitability to area classification and measurement environment.

8. Sampling

8.1 Location:

8.1.1 The location shall be far enough from an odorizing station to ensure that the odorant is well mixed within the gas stream.

8.1.2 In systems fed by more than one odorizer, test points shall be located to ensure that the odorant concentration supplied by each individual odorizer is evaluated.

8.1.3 In large systems, test points also shall be selected at or near the end of the system to ensure adequate odorant concentration.

8.2 Frequency:

8.2.1 Sampling frequency shall be established in accordance with applicable regulations and company policy.

8.3 Low-Pressure Sampling:

⁴ American Gas Association Operating Section Technical Note CAS-2-1-95, "Natural Gas Odorization: Compliance with Federal Regulations."

8.3.1 In low-pressure sampling, the gas dilution apparatus is connected directly to the gas source with the appropriate tubing as specified in 6.3. Connections shall be made to the appropriate gas dilution apparatus port in accordance with the manufacturer's instructions.

8.4 *High-Pressure Sampling:*

8.4.1 In high-pressure sampling, a regulator is connected directly to the gas source with the appropriate tubing as specified in 6.3.

8.4.1.1 In addition to other precautions, the gas pressure should be taken into consideration when selecting the tubing that connects the gas source with the inlet of the regulator. Stainless steel shall be the only material used for this purpose when the sampling source is CNG.

8.4.2 If a heated regulator is used, then the temperature shall be set high enough to prevent hydrocarbon condensation.

NOTE 2—A regulator set temperature of 140°F (60°C) has been found to be adequate in most circumstances.

8.4.3 The tubing connection between the regulator outlet and the gas dilution apparatus shall be as specified in 8.3.1.

9. Calibration and Maintenance

9.1 *Blank Determination*—This test should be performed every 30 days with each gas dilution apparatus.

9.1.1 The gas dilution apparatus shall not be connected to a natural gas source.

9.1.2 Power on the apparatus and allow air to flow.

9.1.3 Sniff at the apparatus exhaust. The nose shall be approximately three fourths of an inch from the exhaust.

9.1.4 If an odor is detected, allow the instrument to operate for an additional 2 to 3 min, then repeat 9.1.3. If an odor is still detected, return the instrument to the manufacturer for repair.

9.2 Other calibration and maintenance of the gas dilution apparatus shall be performed in accordance with the manufacturer's instructions.

10. Procedure

10.1 These procedures may be performed by two persons. When this occurs, one person should operate the gas dilution apparatus' operating valves and the other act as the observer.

10.2 *Odor Concentration Method:*

10.2.1 Ensure that the gas inlet valve on the gas dilution apparatus is in the closed or "OFF" position.

10.2.2 Connect the gas dilution apparatus to the natural gas supply source in accordance with Section 8. Open the gas inlet valve to ensure that air is purged from the sample line. Close the gas inlet valve.

10.2.3 Turn the gas dilution apparatus power switch to the "ON" position.

10.2.4 Sniff at the apparatus exhaust. The nose shall be approximately three fourths of an inch from the exhaust.

10.2.5 If an odor is detected, allow the instrument to operate for an additional 2 to 3 min, then repeat 10.2.4. If an odor is still detected, perform a blank determination as specified in 9.1.

10.2.6 Slowly open the gas inlet valve. Periodically sniff the gas/air mixture at the apparatus exhaust. Breathe fresh air through the nose between sniffs of the gas-air mixture. Continue until a faint odor is observed. Determine the gas in air concentration in accordance with manufacturer's instructions. This is the *threshold detection level*.

10.2.7 Continue to open the gas inlet valve. Periodically sniff the gas/air mixture at the apparatus exhaust. Continue until a readily detectable odor of gas is observed. Determine the gas in air concentration in accordance with manufacturer's instructions. This is the *readily detectable level*.

10.3 *Odor Intensity Method:*

10.3.1 Ensure that the gas inlet valve on the gas dilution apparatus is in the closed or "OFF" position.

10.3.2 Connect the gas dilution apparatus to the natural gas supply source in accordance with Section 8. Open the gas inlet valve to ensure that air is purged from the sample line. Close the gas inlet valve.

10.3.3 Turn the gas dilution apparatus power switch to the "ON" position.

10.3.4 Sniff at the apparatus exhaust. The nose shall be approximately three fourths of an inch from the exhaust.

10.3.5 If an odor is detected, allow the instrument to operate for an additional 2 to 3 min, then repeat 10.3.4. If an odor is still detected, perform a blank determination as specified in 9.1.

10.3.6 Slowly open the gas valve. Increase the gas flow through the gas dilution apparatus until the desired gas concentration in air is achieved.

10.3.7 Sniff at the apparatus exhaust.

10.3.8 Rate the intensity of the odor as: (1) absent, (2) barely detectable, (3) readily detectable, (4) strong, or (5) very strong or obnoxious.

NOTE 3—Other odor intensity rating terms may be used as appropriate.

NOTE 4—If this test is performed independently of the odor concentration method described in 10.2, then the threshold detection level should be determined as outlined in 10.2.6 just before performing this test in order that a comparative baseline is established by the operator.

11. Precision and Bias

11.1 Because the values obtained in these test methods are functions of individual sensitivities, interlaboratory tests cannot be interpreted statistically in the usual way, and a general statement regarding precision and bias cannot be made.

12. Keywords

12.1 compressed natural gas (CNG); natural gas; odor; odorant; sensory evaluation

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