



Designation: D8080 – 21

Standard Specification for Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG) Used as a Motor Vehicle Fuel¹

This standard is issued under the fixed designation D8080; 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 specification defines the minimum fuel quality requirements for gaseous fuels consisting primarily of methane when used as an internal combustion engine fuel.

1.2 This specification defines the criteria for compressed natural gas (CNG), liquefied natural gas (LNG), or biogas when used as a fuel for internal combustion engines in motor vehicles.

1.3 This specification covers the needs of internal combustion engines designed for use in motor vehicles.

1.4 Fuels that have been enriched with hydrogen are outside the scope of this specification.

1.5 This specification applies to the fuel as delivered into the on-board fuel tanks of a motor vehicle either as a compressed gas or cryogenic liquified gas.

1.6 This specification may serve as a guide to gaseous fuel quality requirements for internal combustion engines used in stationary applications.

1.7 This specification is not a natural gas pipeline standard; those requirements are determined by national and regional tariffs.

1.8 *Units*—The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.9 *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.*

1.10 *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 Recom-*

mendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:²

- D1142 Test Method for Water Vapor Content of Gaseous Fuels by Measurement of Dew-Point Temperature
- D1945 Test Method for Analysis of Natural Gas by Gas Chromatography
- D3588 Practice for Calculating Heat Value, Compressibility Factor, and Relative Density of Gaseous Fuels
- D4150 Terminology Relating to Gaseous Fuels
- D4468 Test Method for Total Sulfur in Gaseous Fuels by Hydrogenolysis and Rateometric Colorimetry
- D5454 Test Method for Water Vapor Content of Gaseous Fuels Using Electronic Moisture Analyzers
- D5504 Test Method for Determination of Sulfur Compounds in Natural Gas and Gaseous Fuels by Gas Chromatography and Chemiluminescence
- D6228 Test Method for Determination of Sulfur Compounds in Natural Gas and Gaseous Fuels by Gas Chromatography and Flame Photometric Detection
- D6968 Test Method for Simultaneous Measurement of Sulfur Compounds and Minor Hydrocarbons in Natural Gas and Gaseous Fuels by Gas Chromatography and Atomic Emission Detection
- D7165 Practice for Gas Chromatograph Based On-line/At-line Analysis for Sulfur Content of Gaseous Fuels
- D7493 Test Method for Online Measurement of Sulfur Compounds in Natural Gas and Gaseous Fuels by Gas Chromatograph and Electrochemical Detection
- D7551 Test Method for Determination of Total Volatile Sulfur in Gaseous Hydrocarbons and Liquefied Petroleum Gases and Natural Gas by Ultraviolet Fluorescence
- D7607 Test Method for Analysis of Oxygen in Gaseous Fuels (Electrochemical Sensor Method)
- D7651 Test Method for Gravimetric Measurement of Particulate Concentration of Hydrogen Fuel

¹ This specification is under the jurisdiction of ASTM Committee D03 on Gaseous Fuels and is the direct responsibility of Subcommittee D03.92 on Terminology Classification and Specifications.

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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.

D7833 Test Method for Determination of Hydrocarbons and Non-Hydrocarbon Gases in Gaseous Mixtures by Gas Chromatography

D7904 Test Method for Determination of Water Vapor (Moisture Concentration) in Natural Gas by Tunable Diode Laser Spectroscopy (TDLAS)

D8221 Practice for Determining the Calculated Methane Number (MNC) of Gaseous Fuels Used in Internal Combustion Engines

D8230 Test Method for Measurement of Volatile Silicon-Containing Compounds in a Gaseous Fuel Sample Using Gas Chromatography with Spectroscopic Detection

2.2 *ISO Standard*.³

ISO 6976 Natural gas – Calculation of calorific values, density, relative density and Wobbe index from composition

2.3 *ASHRAE Standard*.⁴

American Society of Heating, Refrigerating and Air Conditioning Engineer's (ASHRAE) Handbook 1989 Fundamentals Volume

3. Terminology

3.1 For definitions of general terms used in D03 Gaseous Fuels standards, refer to Terminology **D4150**.

3.2 *Acronyms*:

3.2.1 *CFR*—cooperative fuel research

3.2.2 *CNG*—compressed natural gas

3.2.3 *HHV*—higher heating value

3.2.4 *LHV*—lower heating value

3.2.5 *LNG*—liquified natural gas

3.2.6 *MN*—methane number

3.2.7 *MNC*—calculated methane number

3.2.8 *MON*—motor octane number

4. Sampling

4.1 Review relevant test methods prior to sampling to understand the importance and effects of sampling technique, proper containers, and any special handling required for each test method.

4.2 Samples shall be collected directly from the fuel dispenser.

4.3 CNG samples shall be representative of the product as dispensed into an on-board motor vehicle fuel tank and shall be collected by a suitable sampling procedure.

4.4 LNG samples shall be representative of the product as dispensed into an on-board motor vehicle fuel tank and shall be collected by a suitable sampling procedure.

4.5 *Sample Size*—A volume of sample suitable for performing fuel quality measurements as listed in **Table 1** is required. This should be determined in consultation with the testing laboratory.

4.6 Follow all safety procedures when sampling natural gas.

4.6.1 Never store LNG in a sealed container.

NOTE 1—Warning: Natural gas is a highly flammable substance and poses an asphyxiation hazard. Always perform measurements in a well-ventilated location in the absence of flames or spark sources. CNG and LNG containers can pose an explosion hazard if not handled properly. CNG is stored at high pressures and can pose both an explosion and freezing hazard because of a sudden release of gas. LNG is a cryogenic liquid and can pose a freezing hazard and an explosion hazard as result of liquid vaporization.

5. Detailed Chemical Composition, and Other Requirements

5.1 Natural gas used as a fuel for internal combustion engines in motor vehicles fuel shall conform to the detailed requirements of **Table 1**.

5.2 The criteria contained within this specification were primarily constructed from data collected from North American natural gas distribution systems and engine and vehicle manufacturers. As the data ensemble increases, this specification may be revised based upon the additional data.

6. Workmanship

6.1 The gaseous fuel shall be free of any adulterants or contaminants that can render the fuel unacceptable for its intended use in an internal combustion engine.

7. Test Methods

7.1 Requirements satisfying this specification shall be determined in accordance with the methods listed below.

7.2 *Composition*—Test Method **D7833** or **D1945**. Test Method **D7833** is preferred. All composition values shall be calculated in % by Volume. The volume composition of the gaseous fuel shall be determined for component amount of 0.1 % or more.

7.3 *Calculated Methane Number MNC*—Practice **D8221**. The MNC is determined from the composition of the fuel.

7.4 *Wobbe Index*—ISO 6976-95. The Wobbe Index shall be calculated based on the higher heating value at the reference conditions of 101.325 kPa and 15.55 °C.

7.5 *Lower Heating Values*—Test Method **D3588**. Calculations shall be made at the reference conditions of 101.325 kPa and 15.55 °C.

7.6 *Hydrogen*—Test Methods **D7833** or **D1945**. Test Method **D7833** is preferred.

7.7 *Oxygen*—Test Methods **D7833**, **D1945**, or **D7607**. Test Method **D7833** is preferred.

7.8 *Water Dew Point*—Test Methods **D1142**, **D5454**, or **D7904**.

7.9 *Total Sulfur*—Test Methods **D4468**, **D5504**, **D6228**, **D6968**, **D7165**, **D7493**, or **D7551**. The concentration of sulfur containing all compounds is determined and shall be reported

³ Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <https://www.iso.org>.

⁴ Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329, <http://www.ashrae.org>.

TABLE 1 Detailed Requirements for Natural Gas Fuel

Substance/Property	Units	Test Methods	Fuel Grades					
			MNc 65 S5	MNc 65 S16	MNc 65 S32	MNc 75 S5	MNc 75 S16	MNc 75 S32
Calculated Methane Number	MNc per Practice D8221 , min	D8221	65	65	65	75	75	75
Wobbe Index (based on Higher Heating Value) ^A	MJ/m ³	ISO 6976	46 to 53	46 to 53	46 to 53	46 to 53	46 to 53	46 to 53
Lower Heating Value ^B	MJ/m ³ , min	D3588	33.2	33.2	33.2	33.2	33.2	33.2
Hydrogen	% by volume, max	D1945, D7833	0.3	0.3	0.3	0.3	0.3	0.3
Oxygen	% by volume, max	D1945, D7607, D7833	1	1	1	1	1	1
Water Dew Point ^C	°C max below the 99.0 % winter design temperature at dispenser	D1142, D5454, D7904	6	6	6	6	6	6
Total Sulfur (includes odorant) ^D	ppmv, max	D4468, D5504, D6228, D6968, D7165, D7493, D7551	5	16	32	5	16	32
Hydrogen Sulfide ^E	ppmv, max	D4468, D5504, D6228, D6968, D7165, D7493, D7551, D1945, D7833	5	5	5	5	5	5
Maximum Particulates	mg/kg, max	D7651	1	1	1	1	1	1
Siloxanes ^F	mg of Si/m ³ , max	D8230	0.1	0.1	0.1	0.1	0.1	0.1
Compressor Oil	mg/kg, max	WK49305 ^G	10	10	10	10	10	10

^A Wobbe Index of the gas mixture is calculated based on the Higher Heating Value (HHV) on a volumetric basis at 101.325 kPa and 15.55 °C reference conditions, divided by the square root of the relative density at the same specified metering reference conditions. ISO 6976 uses the term Superior Heating Value in place of the term Higher Heating Value.

^B Lower Heating Value is calculated based on at 101.325 kPa and 15.55 °C reference conditions.

^C Refer to the American Society of Heating, Refrigerating and Air Conditioning Engineer's (ASHRAE) Handbook, 1989 fundamentals volume. For the United States, refer to Chapter 24, Table 1, Climatic Conditions for the United States; for Canada, refer to Chapter 24, Table 2, Climatic Conditions for Canada; and for the rest of the world, refer to Chapter 24, Table 3, Climatic Conditions of Other Countries. For regions not listed, it is recommended that this reference be consulted for methodology used to calculate the 99 % minimum temperature.

^D Report in ppmv [μmol of S from all Sulfur compounds/mol of Gas]: As a minimum, total sulfur compounds include, for example, hydrogen sulfide (H₂S), carbonyl sulfide (COS), carbon disulfide (CS₂) Sulfides, thiols, and mercaptans. (See **Appendix X1**).

^E Report in ppmv [μmol of S from H₂S/mol of Gas]: Refer to **Appendix X2**.

^F Reference conditions for Test Method **D8230** are 101.325 kPa and 25 °C.

^GWork Item: Practice for Determining Compressor Oil Carryover in Compressed Natural Gas Used as a Natural Gas Motor Vehicle Fuel.

as Total Sulfur in part per million by volume (μmol of S from all sulfur compounds/mol of Gas). If only total sulfur is measured by the test method, then the Hydrogen Sulfide limit shall be considered the maximum total sulfur limit.

7.10 Hydrogen Sulfide—Test Methods **D4468, D5504, D6228, D6968, D7165, D7493** or **D7551**. The concentration of hydrogen sulfide is determined and shall be reported as Hydrogen Sulfide as Sulfur in part per million by volume (μmol of S from H₂S/mol of Gas).

7.11 Particulate Concentration—Test Method **D7651**. Particulate concentration shall be determined as mg/kg of gaseous fuel.

7.12 Siloxanes—Test method **D8230**. Siloxanes compounds measure and results shall be determined as total silicon.

8. Keywords

8.1 calculated methane number, MNc; compressed natural gas, CNG; liquefied natural gas, LNG; natural gas