

CGA G-8.1 — 2024

6TH EDITION

STANDARD FOR NITROUS OXIDE SYSTEMS AT CUSTOMER SITES

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1 Introduction

At atmospheric pressure and temperature, nitrous oxide is a colorless, practically odorless, tasteless, and non-toxic gas about 50% heavier than air. It is quite soluble in water, vegetable oils, and other liquids. Its main use is as an anesthetic. It is also used as a propellant in pressure package containers, in analytical instruments, as a leak detector, and in other specialized applications.

Nitrous oxide is available in the compressed, liquefied form either in high pressure containers or low pressure insulated containers conforming to the specifications of the U.S. Department of Transportation (DOT), Transport Canada (TC) or in relatively low pressure bulk containers maintained at reduced temperatures. Below the critical point of 97.7 °F (36.5 °C) liquid nitrous oxide is in equilibrium with its vapor at a pressure dependent upon the temperature. For specific data see the *Handbook of Compressed Gases* [1].¹ Under normal conditions of storage and use, nitrous oxide is stable in both gas and liquid phases and is noncorrosive. It does not form an acid in water.

As with oxygen, ignition of combustible materials can occur more readily in a nitrous oxide-enriched atmosphere than in air with combustion proceeding at a faster rate. Nitrous oxide also decomposes exothermally under conditions of high temperature and pressure. If sufficient heat is added, the decomposition can be self-sustaining and with the resulting high temperature and pressure, the nitrous oxide can explode. Refer to CGA G-8.3, *Safe Practices for the Storage and Handling of Nitrous Oxide* [2]. Therefore, this standard provides primarily for protection of the nitrous oxide system from fire from sources apart from the system itself. It is important to locate nitrous oxide systems in well-ventilated locations since nitrous oxide-enriched atmospheres can collect temporarily in confined areas in the event of the functioning of a pressure relief device (PRD) or leakage from the system.

The properties of nitrous oxide are shown in Tables 1 and 2.

2 Scope

This standard covers the general principles recommended for the installation of nitrous oxide systems on medical or industrial customer premises.

Such systems consist of a central supply, which can be either cylinders connected to a common manifold or bulk liquid containers and the associated equipment and piping required for connecting the central supply to the line supplying the nitrous oxide to the point of use.

The authority having jurisdiction (AHJ) may authorize the continued use of an existing nitrous oxide system, which is not in strict compliance with the provisions of this standard, where such continued use will not constitute a hazard to life or adjacent property.

This standard does not apply to nitrous oxide manufacturing plants and normally does not apply to distributor bulk stations. However, where distributor bulk stations interface closely with business or facilities unrelated to the handling of nitrous oxide, or where the general public can be exposed to such bulk facilities, the applicable safety provisions of this standard shall be followed.

Additional requirements for nitrous oxide systems are contained in NFPA 99, *Health Care Facilities Code*, NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, and CSA Z305.1, *Nonflammable Medical Gas Piping Systems* [3, 4, 5].

¹ References are shown by bracketed numbers and are listed in order of appearance in the reference section.

Table 1—Physical constants of nitrous oxide

	U.S. Units	SI Units
Molecular weight	44.0128	44.0128
Density of the gas at 59 °F (15.0 °C) and 1 atm at 70 °F (21.1 °C) and 1 atm	0.1172 lb/ft ³ 0.1146 lb/ft ³	1.877 kg/m ³ 1.947 kg/m ³
Specific gravity of the gas at 70 °F (21.1 °C) and 1 atm (air = 1)	1.5297	1.5297
Specific volume of the gas at 59 °F (15.0 °C) and 1 atm at 70 °F (21.1 °C) and 1 atm	8.538 ft ³ /lb 8.726 ft ³ /lb	0.533 m ³ /kg 0.5447 m ³ /kg
Density of the liquid at boiling point and 1 atm	76.6 lb/ft ³	1227 kg/m ³
Boiling point at 1 atm	−127.0 °F	−88.3 °C
Melting point at 1 atm	−131.5 °F	−90.8 °C
Critical temperature	97.7 °F	36.5 °C
Critical pressure	1051 psia	7246 kPa, abs
Critical density	28.15 lb/ft ³	450.4 kg/m ³
Latent heat of vaporization at boiling point at 32 °F (0 °C) at 70 °F (21.1 °C)	161.8 Btu/lb 107.5 Btu/lb 77.7 Btu/lb	376.3 kJ/kg 249.9 kJ/kg 180.6 kJ/kg
Latent heat of fusion at melting point	64.0 Btu/lb	148.9 kJ/kg
Specific heat of the gas at 59 °F (15.0 °C) and 1 atm C_p C_v	0.207 Btu/(lb)(°F) 0.158 Btu/(lb)(°F)	0.866 kJ/(kg)(°C) 0.665 kJ/(kg)(°C)
Ratio of specific heats, C_p/C_v at 59 °F (15.0 °C) and 1 atm	1.303	1.303
Solubility in water, vol/vol, at 1 atm at 32 °F (0 °C) at 68 °F (20.0 °C) at 77 °F (25.0 °C)	1.3 0.68 0.59	1.3 0.68 0.59
Viscosity of the gas at 32 °F (0 °C) at 80 °F (26.7 °C)	0.0326 lb/(ft)(hr) 0.0360 lb/(ft)(hr)	0.135 x 10 ^{−4} Pa(s) 0.149 x 10 ^{−4} Pa(s)
Thermal conductivity of the gas at 32 °F (0 °C) at 212 °F (100 °C)	0.0083 Btu (ft)/hr(ft ²)(°F) 0.0135 Btu (ft)/hr(ft ²)(°F)	0.0144 W/m(°C) 0.0233 W/m(°C)

Table 2—Properties of saturated liquid

Temperature		Vapor pressure		Density	
°F	°C	psi	kPa	lb/gal	kg/ m ³
−127	−88	0	0	10.70	1280
−120	−84	4	30	10.56	1270
−100	−73	20	140	10.16	1220
−80	−62	43	300	9.89	1190
−60	−51	76	525	9.43	1130
−40	−40	122	845	9.09	1090
−20	−29	188	1300	8.76	1050
−10	−23	225	1550	8.40	1010
−5	−21	240	1655	8.34	999
0	−18	260	1790	8.23	986
5	−15	290	2000	8.13	974
10	−12	315	2170	8.02	961
15	−9	345	2380	7.90	947
20	−7	365	2515	7.83	938
30	−1	430	2965	7.58	909
40	4	490	3380	7.37	883
50	10	565	3895	7.09	849
60	16	655	4515	6.77	810
70	21	735	5070	6.45	773
80	27	840	5790	5.98	717
90	32	945	6515	5.44	652
98	37	1040	7170	3.78	453

3 Definitions

For the purposes of this standard, the following definitions apply.

3.1 Publication terminology

3.1.1 Shall

Indicates that the procedure is mandatory. It is used wherever the criterion for conformance to specific recommendations allows no deviation.

3.1.2 Should

Indicates that a procedure is recommended.

3.1.3 May

Indicates that the procedure is optional.

3.1.4 Will

Is used only to indicate the future, not a degree of requirement.

3.1.5 Can

Indicates a possibility or ability.

3.2 Technical definitions

3.2.1 Combustible liquid

Liquid having a closed cup flash point at or above 100 °F (37.8 °C).