

# NFPA® 51

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## Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes

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2018



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## NFPA® 51

### Standard for the

## Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes

### 2018 Edition

This edition of NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes*, was prepared by the Technical Committee on Industrial and Medical Gases. It was issued by the Standards Council on July 22, 2016, with an effective date of August 11, 2016, and supersedes all previous editions.

This edition of NFPA 51 was approved as an American National Standard on August 11, 2016, 2016.

### Origin and Development of NFPA 51

NFPA standards for the construction, installation, and use of acetylene gas machines and for the storage of calcium carbide date from 1900. The first edition of NFPA 51 was adopted in 1925.

Subsequent editions of NFPA 51 were dated 1927, 1936, 1942, 1944, 1946, 1951, 1953, 1957, 1958, 1960, 1961, 1964, 1969, 1973, 1974, 1977, 1983, 1987, and 1992. In June 1966, responsibility for NFPA 51 was reassigned from the Committee on Gases and its Sectional Committee on Industrial Gases to the Committee on Industrial and Medical Gases.

The 1997 edition was revised editorially to make the standard easier to use, understand, and enforce.

The 2002 edition of NFPA 51 contained relatively few changes. The most significant changes were clarification of the size of small systems to which the standard would not apply and the requirements for leak testing piping systems. In addition, the document was revised to conform to the 2002 edition of *Manual of Style for NFPA Technical Committee Documents*, including reordering of the chapters and adoption of SI units as primary units.

The changes to the 2007 edition of NFPA 51 were as follows:

- (1) Use of standard NFPA text for retroactivity and equivalency
- (2) Changes in Chapters 4 through 9 to be consistent with the 2005 edition of NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*, particularly the storage amounts
- (3) Adoption of definitions of *fuel gas*, *limited combustible*, and *noncombustible material* that are consistent with the subject matter of the document
- (4) Elimination of several terms that could not be enforced

The 2013 edition was reorganized to coordinate maximum allowable quantities (MAQs) and building controls as used in NFPA 55, *Compressed Gases and Cryogenic Fluids Code*; NFPA 1, *Fire Code*; NFPA 5000®, *Building Construction and Safety Code*®; and NFPA 400, *Hazardous Materials Code*; with updates to Chapter 4 and the definitions in Chapter 3. Allowable pressures and other requirements for oxygen manifolds were updated and clarified. New protocols for mobile acetylene trailer systems (MATS) were added to coordinate with NFPA 51A, *Standard for Acetylene Cylinder Charging Plants*.

The 2018 edition primarily updates information extracted from and references to NFPA 55, ensuring consistency between the two documents.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

**Committee Scope:** This Committee shall have primary responsibility for documents on the storage, transfer, and use of industrial gases. Included are the storage and handling of such gases in their gaseous or liquid phases; the installation of associated storage, piping, and distribution equipment; and operating practices. The Committee also has a technical responsibility for contributions in the same areas for medical gases and clean rooms. The Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee.

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## NFPA 51

## Standard for the

# Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes

2018 Edition

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**NOTICE:** An asterisk (\*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex B. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex B.

## Chapter 1 Administration

### 1.1 Scope.

1.1.1 This standard applies to the following:

- (1) Design and installation of oxygen-fuel gas welding and cutting systems and allied processes (see 3.3.2), except for systems meeting the criteria in 1.1.5
- (2) Utilization of gaseous fuels generated from flammable liquids under pressure where such fuels are used with oxygen
- (3) Storage on the site of a welding and cutting system installation of the following:
  - (a) Gases to be used with such systems where more than one cylinder each of oxygen and fuel gas are stored

in any single storage area [includes storage of more than one cylinder each in any single storage area even though all such stored cylinders may be intended for use in systems of the kind described in 1.1.1(1)]

- (b) Calcium carbide

1.1.2 Unless specifically indicated otherwise, the term *welding and cutting systems* shall be considered to include *allied processes* in this standard.

1.1.3 Where only a portion of a fuel gas system is to be used for welding, cutting, or allied processes, only that portion of the system need comply with this standard.

1.1.4 Where only a portion of an oxygen system is to be used with fuel gas for welding, cutting, or allied processes, only that portion of the system need comply with this standard.

1.1.5 This standard shall not apply to the following:

- (1)\* Systems consisting of a single cylinder not exceeding 120 ft<sup>3</sup> (3.4 m<sup>3</sup>) of oxygen and a single cylinder not exceeding 120 ft<sup>3</sup> (3.4 m<sup>3</sup>) of fuel gas used for welding and cutting
- (2) Systems in which fuel gases are not to be used with oxygen, as described in NFPA 54 and NFPA 58
- (3) The manufacture of gases and the filling of cylinders
- (4) Storage of empty cylinders
- (5) Compressed air-fuel gas systems

1.2 **Purpose.** The purpose of this standard is to reduce the risk of fires and explosions in oxygen-fuel gas cutting and welding systems.

1.3 **Retroactivity.** The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.3.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.3.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.3.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction and only where it is clearly evident that a reasonable degree of safety is provided.

1.4 **Equivalency.** Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.4.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.4.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

## 1.5 Fuel Gases in the Liquid Phase.

**1.5.1** The use of liquid acetylene shall be prohibited.

**1.5.2** Fuel gases in the liquid phase shall not be piped into any building except as permitted in the following:

- (1) Buildings used exclusively to house equipment for vaporization, pressure reduction, or gas mixing
- (2) Buildings or separate fire divisions of buildings used exclusively for research and experimental laboratories

## 1.6 Operations and Fire Prevention Practices.

**1.6.1** Operating safe practices shall be in accordance with ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*.

**1.6.2** Fire prevention practices in relation to cutting and welding shall be in accordance with NFPA 51B.

**1.7\* Material–Oxygen Compatibility.** Oxygen system components, including, but not limited to, containers, valves, valve seats, lubricants, fittings, gaskets, and interconnecting equipment, including hoses, shall have adequate compatibility with oxygen under the conditions of temperature and pressure to which the components might be exposed in the containment and use of oxygen. Easily ignitable materials shall not be used unless they are parts of equipment or systems that are approved, listed, or proved suitable by tests or by past experience.

**1.8 Cylinders and Containers.** The terms *cylinder* and *container* are used interchangeably in this standard and include any portable vessel used to supply a fuel gas or oxygen.

## 1.9 Units and Formulas.

**1.9.1** The units of measure in this standard are presented first in U.S. customary units (inch-pound units), followed by International System (SI) units in parentheses.

**1.9.2** Either system of units shall be acceptable for satisfying the requirements in this standard.

**1.9.3** Users of this standard shall apply one system of units consistently and shall not alternate between units.

**1.9.4** The values presented for measurements in this standard are expressed with a degree of precision appropriate for practical application and enforcement. It is not intended that the application or enforcement of these values be more precise than the precision expressed.

**1.9.5** Where extracted text contains values expressed in only one system of units, the values in the extracted text have been retained without conversion to preserve the values established by the responsible technical committee in the source document.

## Chapter 2 Referenced Publications

**2.1 General.** The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

**2.2 NFPA Publications.** National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2013 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2016 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2014 edition.

NFPA 54, *National Fuel Gas Code*, 2015 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2016 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2017 edition.

NFPA 70®, *National Electrical Code®*, 2017 edition.

NFPA 101®, *Life Safety Code®*, 2015 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 2013 edition.

NFPA 5000®, *Building Construction and Safety Code®*, 2015 edition.

## 2.3 Other Publications.

**2.3.1 ASME Publications.** ASME International, Two Park Avenue, New York, NY 10016-5990.

ASME B31.3, *Process Piping*, 2014.

*Boiler and Pressure Vessel Code*, 2015.

**2.3.2 ASTM Publications.** ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM B88, *Standard Specification for Seamless Copper Water Tube*, 2014.

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 2015.

ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, 2012.

**2.3.3 AWS Publications.** American Welding Society, 8669 NW 36 Street, #130, Miami, FL 33166-6672.

ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, 2012.

**2.3.4 CGA Publications.** Compressed Gas Association, 14501 George Carter Way, Suite 103, Chantilly, VA 20151-1788.

CGA C-7, *Guide to the Classification and Labeling of Compressed Gases*, 10th edition, 2014.

CGA E-1, *Standard for Rubber Welding Hose and Hose Connections for Gas Welding, Cutting, and Allied Processes*, 2009.

CGA E-3, *Low Pressure Pipeline Station Outlet/Regulator Inlet Connection Standard*, 2008.

CGA G-1.6, *Standard for Mobile Acetylene Trailer Systems*, 2011.

CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*, 2013.

**2.3.5 UL Publications.** Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 723, *Tests for Surface Burning Characteristics of Building Materials*, 2008, revised 2013.

## 2.3.6 Other Publications.

*Merriam-Webster's Collegiate Dictionary*, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

## 2.4 References for Extracts in Mandatory Sections.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2016 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2017 edition.

NFPA 400, *Hazardous Materials Code*, 2016 edition.

## Chapter 3 Definitions

**3.1 General.** The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

### 3.2 NFPA Official Definitions.

**3.2.1\* Approved.** Acceptable to the authority having jurisdiction.

**3.2.2\* Authority Having Jurisdiction (AHJ).** An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

**3.2.3 Labeled.** Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

**3.2.4\* Listed.** Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

**3.2.5 Shall.** Indicates a mandatory requirement.

**3.2.6 Should.** Indicates a recommendation or that which is advised but not required.

### 3.3 General Definitions.

#### 3.3.1 Acetylene.

**3.3.1.1 Low-Pressure Acetylene.** Acetylene at a pressure not exceeding 1 psig (gauge pressure of 6.9 kPa).

**3.3.1.2 Medium-Pressure Acetylene.** Acetylene at pressures exceeding 1 psig (gauge pressure of 6.9 kPa) but not exceeding 15 psig (gauge pressure of 103 kPa).

**3.3.2 Allied Processes.** Those processes using oxygen-fuel gas mixtures for operations such as scarfing, heat treating, heating, or thermal spraying.

**3.3.3 Backflow Check Valve.** A device designed to allow flow in only one direction.

**3.3.4 Building Code.** The building or construction code adopted by the jurisdiction. [55, 2016]

**3.3.5 Control Area.** A building or portion of a building or outdoor area within which hazardous materials are allowed to be stored, dispensed, used, or handled in quantities not exceeding the MAQ. [400, 2016]

**3.3.6 Cylinder.** A pressure vessel designed for absolute pressures higher than 40 psi (276 kPa) and having a circular cross-section. It does not include a portable tank, multiunit tank car tank, cargo tank, or tank car. [55, 2016]

**3.3.7 Cylinder Storage.** Cylinders of compressed gas standing by on the site (not those in use or attached ready for use).

**3.3.8\* DOT.** U.S. Department of Transportation.

**3.3.9\* Exhausted Enclosure.** An appliance or piece of equipment that consists of a top, a back, and two sides that provides a means of local exhaust for capturing gases, fumes, vapors, and mists. [55, 2016]

**3.3.10\* Fast-Acting Fire Detection System.** A detection system designed to detect a fire more rapidly than standard smoke or heat detectors.

**3.3.11 Fire Code.** The fire prevention code adopted by the jurisdiction. [55, 2016]

**3.3.12 Fuel Gas.** Acetylene; hydrogen; natural gas; LP-Gas; propylene; methylacetylene-propadiene, stabilized gas mixtures; and other liquefied and nonliquefied flammable gases that are stable because of their composition or because of the conditions of storage and utilization stipulated in this standard.

**3.3.13\* Gas Cabinet.** A fully enclosed, noncombustible enclosure used to provide an isolated environment for compressed gas cylinders in storage or use. [55, 2016]

**3.3.14 Gas Room.** A separately ventilated, fully enclosed room in which only compressed gases, cryogenic fluids, associated equipment, and supplies are stored or used. [55, 2016]

**3.3.15 Limited-Combustible Material.** Refers to a building construction material not complying with the definition of *noncombustible* that, in the form in which it is used, has a potential heat value not exceeding 3500 Btu/lb (8141 kJ/kg) when tested in accordance with NFPA 259 and includes either (1) materials having a structural base of noncombustible material, with a surfacing not exceeding a thickness of  $\frac{1}{8}$  in. (3.2 mm) that has a flame spread index not greater than 50, or (2) materials, in the form and thickness used having neither a flame spread index greater than 25 nor evidence of continued progressive combustion, and of such composition that surfaces that would be exposed by cutting through the material on any plane would have neither a flame spread index greater than 25 nor evidence of continued progressive combustion when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or UL 723, *Tests for Surface Burning Characteristics of Building Materials*.

**3.3.16\* Liquefied Petroleum Gas (LP-Gas).** Any material having a vapor pressure not exceeding that allowed for commercial propane that is composed predominantly of the following hydrocarbons, either by themselves (except propylene) or as mixtures: propane, propylene, butane (normal butane or isobutane), and butylenes. [58, 2017]