



Standard for Ovens and Furnaces





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NFPA® 86

Standard for

Ovens and Furnaces

2019 Edition

This edition of NFPA 86, *Standard for Ovens and Furnaces*, was prepared by the Technical Committee on Ovens and Furnaces. It was issued by the Standards Council on May 4, 2018, with an effective date of May 24, 2018, and supersedes all previous editions.

This edition of NFPA 86 was approved as an American National Standard on May 24, 2018.

Origin and Development of NFPA 86

The history of the NFPA standards for ovens and furnaces goes back to NBFU 34, Regulations of the Board of Fire Underwriters for Finishing Processes (other than paint spraying) Dip Tanks, Hardening and Tempering Tanks, Flow Coat Work, Japanning and Enameling Including Ovens as Recommended by the National Fire Protection Association, issued in 1926. Subsequently, the ovens part of NBFU 34 was separated and issued as NBFU 86, Regulations of the National Board of Fire Underwriters for Ovens For Japan, Enamel, and Other Flammable Finishes as Recommended by the National Fire Protection Association, in 1931. In 1948, NBFU 86 became NFPA 86-T, Tentative Standards for Class A Oven Design, Location and Equipment. The document was issued as a standard in 1950 and titled NFPA 86, Standards for Class A Ovens and Furnace Design, Location and Equipment.

The 1985 edition of NFPA 86 was the first edition of the standard in its current form. It was created from the combination of the former NFPA 86A, *Standard for Ovens and Furnaces — Design, Location and Equipment*, and NFPA 86B, *Standard for Industrial Furnaces — Design, Location and Equipment*.

The committee introduced changes in the definitions of Class A and Class B ovens, which were published in the 1982 edition of NFPA 86B and added as a tentative interim amendment in 1983 to the 1977 edition of NFPA 86A. The changes in the definitions eliminated the principal differences between the two standards, except for the ventilation requirements in NFPA 86A. By providing a separate chapter for ventilation requirements in the 1985 edition (Chapter 5), the committee found it was no longer necessary or desirable to maintain two separate documents that addressed the same subjects.

Changes that were incorporated into the 1985 edition included the following:

- (1) A new chapter dealing with low-oxygen atmosphere ovens was added.
- (2) The definitions of subjects in the text were updated and new definitions provided.
- (3) The text was refined in an effort to make the document more understandable.
- (4) The material was rearranged to comply with the NFPA Manual of Style.

The 1995 edition of NFPA 86 correlated with NFPA 86C, *Standard for Industrial Furnaces Using a Special Processing Atmosphere*, and NFPA 86D, *Standard for Industrial Furnaces Using Vacuum as an Atmosphere*. Revisions also refined and updated the standard to more current technologies, provided increased requirements in several areas, and expanded the explanatory material in the appendices.

The 1999 edition of NFPA 86 included changes to the technical requirements in several areas and many refinements that clarified the technical requirements. Changes were also provided to more clearly distinguish mandatory requirements from nonmandatory recommendations and explanatory material. Nonmandatory notes were relocated to the appendices.

The 2003 edition of NFPA 86 was a complete revision that incorporated NFPA 86C, *Standard for Industrial Furnaces Using a Special Processing Atmosphere*, and NFPA 86D, *Standard for Industrial Furnaces Using Vacuum as an Atmosphere*. This new, combined document provided one standard for ovens and furnaces of all types. Also, in accordance with the *Manual of Style for NFPA Technical Committee Documents*, referenced publications were listed in Chapter 2 and all definitions moved to Chapter 3.

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The 2007 edition of NFPA 86 continued to bring the standard into compliance with the *Manual of Style for NFPA Technical Committee Documents* and to update requirements. Requirements for logic systems and programmable logic controller–based systems replaced the requirement that programmable logic controllers be listed specifically for combustion safety service, since listed controllers were no longer available. Unenforceable text was (1) revised to be enforceable, (2) deleted, or (3) relocated to Annex A. Where appropriate, repetitive text was replaced by tables. The former Chapter 14, Inspection, Testing, and Maintenance, was renumbered and renamed as Chapter 7, Commissioning, Operations, Maintenance, Inspection, and Testing. Requirements for operations and maintenance throughout the standard were then relocated to that chapter.

In the 2011 edition, the scope of NFPA 86 was clarified to exclude fluid heaters, and reference was made to the new NFPA 87, *Recommended Practice for Fluid Heaters*. All requirements for fire protection were relocated to Chapter 9. Chapter 13, which covers Class C furnaces, was revised to clarify the requirements for the introduction and removal of special atmospheres. The requirements for repeated preignition purge were revised to recognize the unique characteristics of ovens using pulse firing of burners. In addition, the requirements were clarified for safety shutoff valves that must close when a burner experiences a loss of flame signal.

The 2015 edition of NFPA 86 includes several changes to Chapter 3 due to the addition of definitions for *burner management system, flame failure response time, flame detector, hardwired, combustion safeguard*, and types of pressure regulators. The committee also deleted requirements from Chapter 12 applicable to arc melting furnaces (or electric arc furnaces) because the provisions have not been maintained and the committee no longer has the relevant expertise. The committee added procedures for placing equipment into service based on purging practices in NFPA 54, *National Fuel Gas Code*, and NFPA 56, *Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems*. The committee modified the standard to clarify the types of acceptable devices used for combustion safety service. The committee added a requirement prohibiting manifolding vent lines from different pressure levels. As a result of introducing definitions for *burner management system* and *combustion safeguard*, the committee modified requirements in Chapter 8 for logic systems for both BMS logic and programmable logic controller (PLC) systems. The committee modified requirements for Class A and Class C ovens and furnaces, including the development of new requirements on fire protection and safety ventilation for Class A ovens.

The 2019 edition of NFPA 86 included a number of minor changes to the standard to clarify certain requirements. Definitions for *open and closed cooling systems* were added, and requirements in Chapter 5 were modified to be consistent with the new definitions. Some of the explosion relief exceptions were clarified in Chapter 5, and requirements for radiant tubes were revised in multiple sections to reflect performance-based criteria rather than material-based criteria. The committee also changed the requirements for emergency switches to allow for flexibility in cases where a full system power-down creates unintended hazards (e.g., in some Class C furnaces). A table for relighting without purging was added to an annex to clarify the requirements in Chapter 8.

86-2

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Committee Scope: This Committee shall have primary responsibility for documents on safeguarding against fire and explosion hazards associated with industrial ovens, furnaces, and related equipment that are used in the processing of combustible or non-combustible materials in the presence of air, vacuum, or other special atmospheres and are heated by electricity, fossil fuels, or other heating sources.

Contents

Chapter	1 Administration	86– 6
$1.\bar{1}$	Scope	86– 6
1.2	Purpose.	86– 6
1.3	Application.	86– 6
1.4	Retroactivity.	86-7
1.5	Fauivalency	86-7
1.6	Units and Formulas	86 – 7
1.0	enits and ronnuas.	00-7
Chapter	2 Referenced Publications	86– 7
$2.\hat{1}$	General.	86 –7
2.2	NFPA Publications.	86– 7
2.3	Other Publications.	86 – 7
2.4	References for Extracts in Mandatory Sections	86– 8
Chanter	3 Definitions	86-8
3.1	Ceneral	86-8
2.9	NEPA Official Definitions	86 8
9.4	Con anal Definitions	00- 0
5.5	General Demittoris.	00– 0
Chapter	4 General	86– 14
4.1	Approvals, Plans, and Specifications	86– 14
4.2	Safety Labeling	86– 14
4.3	Pressure Vessels.	86– 15
Chapter	5 Location and Construction	86– 15
5.1	Location.	86– 15
5.2	Furnace Design.	86– 15
5.3	Explosion Relief.	86– 16
5.4	Ventilation and Exhaust System.	86– 17
5.5	Mountings and Auxiliary Equipment.	86 –17
C1 /		00 10
Chapter	b Furnace Heating Systems	86-18
6.1	General.	86 – 18
6.2	Fuel Gas–Fired Units.	86– 18
6.3	Oil-Fired Units	86– 20
6.4	Oxygen-Enhanced Fuel-Fired Units.	86– 22
6.5	Flue Product Venting	86– 22
6.6	Electrically Heated Units.	86– 22
6.7	Fluid Heating Systems.	86– 23
Chapter	7 Commissioning, Operations, Maintenance,	
•	Inspection, and Testing	86– 23
7.1	Commissioning.	86– 23
7.9	Training	86- 24
7.3	Operations	86- 24
74	Inspection Testing and Maintenance	86_94
7.5	Posord Potontion	86 95
7.5	Procedures	86 – 25
		00 10
Chapter	8 Safety Equipment and Application	86– 25
8.1	General.	86– 25
8.2	Safety Device Requirements.	86– 25
8.3		
8.4	Burner Management System Logic.	86– 25
	Burner Management System Logic Programmable Logic Controller Systems	86 – 25 86 – 26
8.5	Burner Management System Logic Programmable Logic Controller Systems Safety Control Application for Fuel-Fired Heating	86– 25 86– 26
8.5	Burner Management System Logic Programmable Logic Controller Systems Safety Control Application for Fuel-Fired Heating Systems	86 - 25 86 - 26 86 - 26
8.5 8.6	Burner Management System Logic Programmable Logic Controller Systems Safety Control Application for Fuel-Fired Heating Systems Ventilation Safety Devices	86 - 25 86 - 26 86 - 26 86 - 97
8.5 8.6 8.7	Burner Management System Logic Programmable Logic Controller Systems Safety Control Application for Fuel-Fired Heating Systems Ventilation Safety Devices	86 - 25 86 - 26 86 - 26 86 - 27 86 - 27
8.5 8.6 8.7 8.8	Burner Management System Logic Programmable Logic Controller Systems Safety Control Application for Fuel-Fired Heating Systems Ventilation Safety Devices	86 -25 86 -26 86 -27 86 -27 86 -27 86 -28
8.5 8.6 8.7 8.8 8.9	Burner Management System Logic Programmable Logic Controller Systems Safety Control Application for Fuel-Fired Heating Systems	86 - 25 86 - 26 86 - 26 86 - 27 86 - 27 86 - 27 86 - 28 86 - 28 86 - 20
8.5 8.6 8.7 8.8 8.9	Burner Management System Logic Programmable Logic Controller Systems Safety Control Application for Fuel-Fired Heating Systems Ventilation Safety Devices Combustion Air Safety Devices Safety Shutoff Valves (Fuel Gas or Oil) Fuel Pressure Switches (Gas or Oil)	86 - 25 86 - 26 86 - 26 86 - 27 86 - 27 86 - 27 86 - 28 86 - 29 86 - 29
8.5 8.6 8.7 8.8 8.9 8.10	Burner Management System Logic Programmable Logic Controller Systems	86-25 86-26 86-27 86-27 86-27 86-27 86-28 86-29 86-29
8.5 8.6 8.7 8.8 8.9 8.10 8.11	Burner Management System Logic Programmable Logic Controller Systems Safety Control Application for Fuel-Fired Heating Systems Ventilation Safety Devices Combustion Air Safety Devices Safety Shutoff Valves (Fuel Gas or Oil) Fuel Pressure Switches (Gas or Oil) Flame Supervision Fuel Oil Atomization (Other Than Mechanical	86 - 25 86 - 26 86 - 26 86 - 27 86 - 27 86 - 27 86 - 29 86 - 29 86 - 29 86 - 29
8.5 8.6 8.7 8.8 8.9 8.10 8.11	Burner Management System Logic	86 - 25 86 - 26 86 - 26 86 - 27 86 - 27 86 - 27 86 - 29 86 - 29 86 - 29 86 - 29
8.5 8.6 8.7 8.8 8.9 8.10 8.11 8.12	Burner Management System Logic	86 - 25 86 - 26 86 - 26 86 - 27 86 - 27 86 - 27 86 - 29 86 - 29 86 - 29 86 - 29 86 - 29
8.5 8.6 8.7 8.8 8.9 8.10 8.11 8.12 8.13	Burner Management System Logic	86-25 86-26 86-27 86-27 86-27 86-28 86-29 86-29 86-29 86-29 86-30
8.5 8.6 8.7 8.8 8.9 8.10 8.11 8.12 8.13 8.14	Burner Management System Logic	86-25 86-26 86-26 86-27 86-27 86-28 86-29 86-29 86-29 86-29 86-29 86-30 86-30
8.5 8.6 8.7 8.8 8.9 8.10 8.11 8.12 8.13 8.14 8.15	Burner Management System Logic	86-25 86-26 86-27 86-27 86-27 86-28 86-29 86-29 86-29 86-29 86-29 86-30 86-30 86-30

Annex B	B Example of Class A Furnace Operational and Maintenance Checklist	86– 129
Annex A	Explanatory Material	86– 62
	Sarety Equipment.	00-08
14.5	Inspection, and Testing	86 58
14.4	Commissioning, Operations, Maintenance,	
14.3	Heating Systems	86– 58
14.2	Location and Construction.	86– 57
14.1	General	86– 57
Chapter	14 Class D Furnaces	86– 57
13.6	Fire Protection	86– 57
13.5	Safety Equipment.	86– 41
	Inspection, and Testing.	86– 41
13.4	Commissioning, Operations, Maintenance,	
13.3	Heating Systems	86– 41
13.2	Location and Construction.	86– 41
13.1	General	86– 41
	Furnaces	86– 41
Chapter	13 Special Atmospheres for Class C Ovens and	
14.0	merrowenon. (neserveu)	00-11
12.5	Fire Protection. (Reserved)	86– 41
19.5	Safety Fouinment	86 - 41
14.4	Inspection and Testing (Reserved)	86_ 41
12.3	Commissioning Operations Maintenance	ou- 41
12.2	Location and Construction. (Reserved)	80-41 86 41
12.1	General. (Reserved)	86-41
Chapter	12 Class B Ovens and Furnaces	86-41
Charte	19 Class D. Orong and Frances	OC 41
	Solvent Recovery.	86– 39
11.7	Low-Oxygen Atmosphere Class A Ovens with	
11.6	Safety Ventilation for Class A Ovens.	86– 34
11.5	Fire Protection.	86– 34
	Inspection, and Testing.	86– 34
11.4	Commissioning, Operations, Maintenance.	1
11.3	Heating Systems. (Reserved)	86 – 34
11.2	Location and Construction. (Reserved)	86– 34
11.1	General. (Reserved)	86– 34
Chapter	11 Class A Ovens and Furnaces	86– 34
10.6	Safety Equipment and Application	86– 33
10.5	Fire Protection.	86-33
10 5	Inspection, and Testing	86 – 33
10.4	Commissioning, Operations, Maintenance,	0.0
10.3	Heating Systems.	86– 33
10.2	Location and Construction.	86– 32
10.1	General	86– 32
Chapter	10 Thermal Oxidizer	86– 32
	Protection Equipment.	80- 32
9.6	Inspection, Testing, and Maintenance of Fire	86 29
9.5	Means of Access.	86 – 32
9.4	Drawings and Calculations.	86 – 32
9.3	Special Considerations.	86 – 32
9.2	Types of Fire Protection Systems	86-32
9.1	General.	86 – 32
Chapter	9 Fire Protection	86 – 32
0.10	Limit Interlock.	86– 31
8.19	Fluid-Heated Systems — Excess Temperature	00-51
8.18	Flectrical Heating Systems	86_ 31
0.10 8.17	1400°E (760°C) Burges Interlock	86 30
0.10	Environ Transmission I in it Interali	00 20

Example of Class A or Class B Furnace Operational and Maintenance Checklist	86– 130
The Lower Limit of Flammability and the	
Autogenous Ignition Temperature of	
Certain Common Solvent Vapors	
Encountered in Ovens	86– 130
Continuous Solvent Vapor Concentration	
Indicator and Controller	86– 131
Steam Extinguishing Systems	86– 132
Example of Class C Furnace Operational and Maintenance Checklist	86– 133
	Example of Class A or Class B Furnace Operational and Maintenance Checklist The Lower Limit of Flammability and the Autogenous Ignition Temperature of Certain Common Solvent Vapors Encountered in Ovens Continuous Solvent Vapor Concentration Indicator and Controller Steam Extinguishing Systems Example of Class C Furnace Operational and Maintenance Checklist

Annex H	Vacuum Furnace Maintenance Checklist	86– 135
Annex I	Pump Data	86– 136
Annex J	Engineering Data	86– 138
Annex K	Vacuum Symbols	86– 143
Annex L	Design Standard References	86– 146
Annex M	Informational References	86– 146
Index		86– 149

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

Chapter 1 Administration

△ 1.1* Scope. This standard shall apply to Class A, Class B, Class C, and Class D ovens, dryers, and furnaces; thermal oxidizers; and any other heated systems and related equipment used for processing of materials.

1.1.1 The terms *ovens, dryers,* and *furnaces* are used interchangeably and shall also apply to other heated enclosures used for processing of materials.

1.1.2* Within the scope of this standard, a Class A, Class B, or Class C oven is any heated enclosure operating at approximately atmospheric pressure and used for commercial and industrial processing of materials.

1.1.3 A Class A oven shall be permitted to utilize a low-oxygen atmosphere.

1.1.4 This standard shall apply to bakery ovens and Class A ovens, in all respects, and where reference is made to ANSI Z50.1, *Bakery Equipment* — *Safety Requirements*, those requirements shall apply to bakery oven construction and safety.

1.1.5 This standard shall apply to atmosphere generators and atmosphere supply systems serving Class C furnaces and to furnaces with integral quench tanks or molten salt baths.

1.1.6* This standard shall apply to Class D ovens and furnaces operating above ambient temperatures to over 5000°F (2760°C) and at pressures normally below atmospheric to 10^{-8} torr (1.33 × 10⁻⁶ Pa).

 Δ 1.1.7 This standard shall not apply to the following:

- (1)* Coal or other solid fuel-firing systems
- (2) Listed equipment with a heating system(s) that supplies a total input not exceeding 150,000 Btu/hr (44 kW)
- (3) Fired heaters in petroleum refineries and petrochemical facilities that are designed and installed in accordance with API STD 560, Fired Heaters for General Refinery Services; API RP 556, Instrumentation and Control Systems for Fired Heaters and Steam Generators; and API RP 2001, Fire Protection in Refineries
- (4) Fluid heaters as defined in NFPA 87
- (5) Electric arc furnaces and submerged arc furnaces

1.2 Purpose. This standard provides the requirements for furnaces to minimize the fire and explosion hazards that can endanger the furnace, the building, or personnel.

1.3 Application.

1.3.1* This entire standard shall apply to new installations and to alterations or extensions to existing equipment.

1.3.2 The requirements of Chapters 1 through 10 shall apply to equipment described in subsequent chapters except as modified by those chapters.

- 1.3.3 Chapter 7 shall apply to all operating furnaces.
- **1.3.4** Section 6.2 shall apply to the following:
- (1) Furnace heating systems fired with fuel gases, including the following:
 - (a) Natural gas
 - (b) Mixed gas
 - (c) Manufactured gas
 - (d) Liquefied petroleum gas (LP-Gas) in the vapor phase
 - (e) LP-Gas/air systems
- (2) Gas-burning portions of dual-fuel or combination burners

1.3.5 Section 6.3 shall apply to the following:

- Combustion systems for furnaces fired with No. 2, No. 4, No. 5, and No. 6 industrial fuel oils as specified by ASTM D396, Standard Specifications for Fuel Oils
- (2) Oil-burning portions of dual-fuel and combination burners

1.3.6 Section 6.4 shall apply to combustion systems using oxygen (oxy-fuel) or oxygen-enriched air with gas or liquid fuels.

1.3.7 Section 6.6 shall apply to all types of heating systems where electrical energy is used as the source of heat.

Shaded text = Revisions. Δ = Text deletions and figure/table revisions. • = Section deletions. N = New material.

1.3.8 Section 6.7 shall apply to the following:

- (1) All types of systems where water, steam, or other heattransfer fluids are the source of heat through the use of heat exchangers
- (2) Heat-transfer fluid system between the oven supply and the return isolation valves for the oven being served

1.4 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.

\Delta 1.4.1 Unless specified to be retroactive, 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.

1.4.2* 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.

1.4.3 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.

1.5* 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.

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

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

1.6 Units and Formulas.

1.6.1 SI Units. Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI).

1.6.2 Primary and Equivalent Values. If a value for a measurement as given in this standard is followed by an equivalent value in other units, the first stated value shall be regarded as the requirement. A given equivalent value might be approximate.

1.6.3 Conversion Procedure. SI units have been converted by multiplying the quantity by the conversion factor and then rounding the result to the appropriate number of significant digits.

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, 2017 edition. NFPA 11, Standard for Low-, Medium-, and High-Expansion Foam, 2016 edition. NFPA 12, Standard on Carbon Dioxide Extinguishing Systems, 2018 edition.

NFPA 13, Standard for the Installation of Sprinkler Systems, 2019 edition.

NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection, 2017 edition.

NFPA 17, Standard for Dry Chemical Extinguishing Systems, 2017 edition.

NFPA 17A, Standard for Wet Chemical Extinguishing Systems, 2017 edition.

NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, 2017 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2018 edition.

NFPA 31, Standard for the Installation of Oil-Burning Equipment, 2016 edition.

NFPA 54, National Fuel Gas Code, 2018 edition.

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

NFPA 58, Liquefied Petroleum Gas Code, 2017 edition.

NFPA 68, Standard on Explosion Protection by Deflagration Venting, 2018 edition.

NFPA 69, Standard on Explosion Prevention Systems, 2014 edition.

NFPA 70[®], National Electrical Code[®], 2017 edition.

NFPA 79, *Electrical Standard for Industrial Machinery*, 2018 edition.

NFPA 87, Standard for Fluid Heaters, 2018 edition.

NFPA 91, Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids, 2015 edition.

NFPA 750, Standard on Water Mist Fire Protection Systems, 2019 edition.

2.3 Other Publications.

2.3.1 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI Z50.1, Bakery Equipment — Safety Requirements, 2006.

2.3.2 API Publications. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070.

API STD 560, Fired Heaters for General Refinery Services, 2016.

API RP 556, Instrumentation and Control Systems for Fired Heaters and Steam Generators, 2011.

API RP 2001, Fire Protection in Refineries, 2012.

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

ASME B31.1, Power Piping, 2016.

ASME B31.3, Process Piping, 2016.

Boiler and Pressure Vessel Code, 2015.

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

ASTM D396, Standard Specifications for Fuel Oils, 2015b.

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

CGA G-4.1, Cleaning Equipment for Oxygen Service, 2009.

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