First Revision No. 14-NFPA 12-2016 [Section No. 1.2.2]

1.2.2 Equivalency.

Nothing in this standard is intended to ~~restrict new technologies or alternative arrangements, provided the level of safety prescribed by the standard is not lowered~~ 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 .

1.2.2.1

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

1.2.2.2

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

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Mar 18 10:35:11 EDT 2016

Committee Statement

Committee Statement: The equivalency statement has been revised to use the standard language.
Response Message:

First Revision No. 15-NFPA 12-2016 [Sections 1.3.4, 1.3.5]

1.3.4*

Existing systems shall ~~be upgraded to~~ meet the requirements for safety signs in 4.3.2, lockout valves in 4.3.3.4 and 4.3.3.4.1, and pneumatic time delays and pneumatic predischarge alarms in 4.5.6.2.

~~**1.3.5**~~

~~The upgrades shall be completed by December 31, 2008.~~

Supplemental Information

File Name	Description
12-FR_15.docx	Annex material

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Mar 18 10:46:13 EDT 2016

Committee Statement

Committee Statement: All existing systems should meet these retroactive safety requirements.
Response Message:

A.1.3.4 A.1.3.5

Exposure to carbon dioxide discharge poses a hazard to personnel; therefore, additional safety features for all new installations and for retrofitting of existing systems are provided in Section 4.3.

Safety to personnel is of paramount importance; therefore, these additional safety features should be have been installed as soon as possible but no later than by December 31, 2008.

The installation of the safety signs per 4.3.2 does not require any modifications to the installation and should be accomplished immediately.

The addition of supervised lockout valves, per 4.3.3.4 and 4.3.3.4.1, and pneumatic predischarge alarms and pneumatic time delays, per 4.5.5.7, require that the system flow calculations be verified and be in accordance with this standard. That is, the addition of piping equipment (valve and time delay) adds equivalent pipe length to the system. The pneumatic predischarge alarm requires carbon dioxide flow to sound. The revised design should be in accordance with the agent quantity requirements of this standard.

These modifications could necessitate revisions to, upgrading of, or replacement of system components, including control units.

As part of the process of implementing these modifications, the authority having jurisdiction should be consulted for additional recommendations or requirements.

First Revision No. 1-NFPA 12-2016 [Chapter 2]

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 4, *Standard for Integrated Fire Protection and Life Safety System Testing,* 2018 edition.

NFPA 70®, National Electrical Code®, ~~2014~~ 2017 edition.

NFPA 72®, National Fire Alarm and Signaling Code, ~~2013~~ 2016 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/IEEE C2, *National Electrical Safety Code* , 2012.~~

ANSI Z535.2 , *Standard for Environmental and Facility Safety Signs*, 2011.

2.3.2 API Publications.

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

API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases*, Pre–July 1, 1961.

2.3.3 ASME Publications.

American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME B31.1, *Power Piping Code*, ~~2012~~ 2014 .

2.3.4 ASTM Publications.

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

ASTM A53/A53M , *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*, 2012.

ASTM A106/A106M , *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*, ~~2011~~ 2015 .

ASTM A120, *Specification for Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless for Ordinary Uses*, 1984 (withdrawn 1987).

ASTM A182/A182M , *Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service*, ~~2012~~ 2015 .

2.3.5 CGA Publications.

Compressed Gas Association, 14501 George Carter Way, Suite 103, Chantilly, VA 20151-2923.

CGA ~~G6.2~~ G-6.2 , *Commodity Specification for Carbon Dioxide*, 2011.

2.3.6 CSA Group Publications.

Canadian Standards Association, ~~5060 Spectrum Way, Mississauga, ON, L4W 5N6~~ 178 Rexdale Blvd., Toronto, ON M9W 1R3 , Canada.

CSA C22.1, *Canadian Electrical Code*, 2012.

2.3.7 IEEE Publications.

IEEE Standards Association, 3 Park Avenue, 17th Floor, New York, NY 10016-5997.

IEEE C2, *National Electrical Safety Code* , 2012.

2.3.8 U.S. Government Publications.

U.S. Government ~~Printing~~ Publishing Office, 732 North Capitol Street, NW, Washington, DC ~~20402~~ 20401-0001 .

Title 46, Code of Federal Regulations, Part 58.20.

Title 46, Code of Federal Regulations, Part 72.

Title 49, Code of Federal Regulations, Parts 171–190 (Department of Transportation).

Coward, H. F., and G. W. Jones, *Limits of Flammability of Gases and Vapors*, U.S. Bureau of Mines Bulletin 503,1952.

Zabetakis, Michael G., *Flammability Characteristics of Combustible Gases and Vapors*, U.S. Bureau of Mines Bulletin 627, 1965.

2.3.9 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

NFPA 1, *Fire Code,* ~~2015~~ 2018 edition.

NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities,* 2015 edition.

NFPA 820, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities,* ~~2012~~ 2016 edition.

Submitter Information Verification

Submitter Full Name: Barry Chase
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Street Address:
City:
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Submittal Date: Thu Mar 17 00:17:10 EDT 2016

Committee Statement

Committee Statement: Reference updates.

Public Input No. 23-NFPA 12-2016 [Section No. 2.2]

Public Input No. 2-NFPA 12-2015 [Chapter 2]

First Revision No. 3-NFPA 12-2016 [Section No. 3.3.2]

3.3.2 Fire Watch.

The assignment of a person or persons to an area for the express purpose of notifying the fire department, the building occupants, or both of an emergency; preventing a fire from occurring; extinguishing small fires; ~~or~~ protecting the public from fire ~~or~~ and life safety dangers. [**1,** ~~2015~~ 2018].

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Mar 17 00:34:47 EDT 2016

Committee Statement

Committee Statement: Extract update, per First Revision No. 11 of the NFPA 1-2018 First Draft Report.

First Revision No. 4-NFPA 12-2016 [Section No. 3.3.3]

3.3.3 Inspection.

A ~~visible~~ visual examination of a system or portion thereof to verify that it appears to be in operating condition and is free of physical damage. [**820,** ~~2012~~ 2016]

Submitter Information Verification

Submitter Full Name:	Barry Chase
Organization:	[Not Specified]
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Mar 17 00:39:18 EDT 2016

Committee Statement

Committee Statement: Extract correction and update.

Public Input No. 8-NFPA 12-2015 [Section No. 3.3.3]

First Revision No. 5-NFPA 12-2016 [Section No. 4.3.2.2]

4.3.2.2

The safety sign format, color, letter style of signal words, message panel lettering, lettering size, and the safety provisions of symbols shall be in accordance with ANSI Z535.2 .

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Mar 17 00:51:20 EDT 2016

Committee Statement

Committee Statement: Reference correction.

First Revision No. 6-NFPA 12-2016 [New Section after 4.4.1.2]

4.4.1.3

Integrated fire protection and life safety system testing shall be in accordance with NFPA 4 .

Submitter Information Verification

Submitter Full Name:	Barry Chase
Organization:	[Not Specified]
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Fri Mar 18 10:00:11 EDT 2016

Committee Statement

Committee Statement: Many installations utilize various individual systems (fire suppression, fire alarm or signaling system, emergency communication system, fire doors, dampers, elevators, smoke control, HVAC, supervising station, etc.) for fire protection and life safety, where each may utilize their own code, standard, or acceptance criteria. NFPA 4 is a new standard that provides requirements for testing integrated systems together so that the entire fire protection and life safety system objective is accomplished.

Response Message:

Public Input No. 22-NFPA 12-2016 [New Section after 4.4.1.2]

First Revision No. 27-NFPA 12-2016 [Section No. 4.5.4.8.1]

4.5.4.8.1

Manual controls shall not require a pull of more than 40 ~~lb~~ lbf ~~(force)~~ (178 N) nor a movement of more than 14 in. (356 mm) to secure operation.

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: National Fire Protection Assoc
Street Address:
City:
State:
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Submittal Date: Fri Apr 08 10:39:08 EDT 2016

Committee Statement

Committee Statement: The unit, "lb (force)," was changed to "lbf" to comply with the Manual of Style.
Response Message:

First Revision No. 17-NFPA 12-2016 [Section No. 4.5.5.3]

4.5.5.3*

Interconnections between the components that are necessary for the control of the system and life safety shall be supervised.

~~*Exception: Normally unpressurized interconnections of pipe and tube shall not be required to be supervised.*~~

4.5.5.4

Normally unpressurized interconnections of pipe and tube shall not be required to ~~be supervised~~ <u>comply with 4.5.5.3</u> .

Submitter Information Verification

Submitter Full Name: Barry Chase

Organization: National Fire Protection Assoc

Street Address:

City:

State:

Zip:

Submittal Date: Thu Apr 07 13:54:24 EDT 2016

Committee Statement

Committee Statement: The section was revised to eliminate the exception, in accordance with the Manual of Style.

Response Message:

First Revision No. 7-NFPA 12-2016 [Section No. 4.7.1.5.1.3]

4.7.1.5.1.3

Flanged joints downstream of stop valves or in systems with no stop valves shall be permitted to be Class 300. ~~Threaded unions shall, as a minimum, be equivalent to Class 2000 forged steel.~~

4.7.1.5.1.4

Threaded unions shall, as a minimum, be equivalent to Class 2000 forged steel.

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Mar 18 10:02:24 EDT 2016

Committee Statement

Committee Statement: The paragraph is broken into two sections, per the Manual of Style.
Response Message:

Public Input No. 20-NFPA 12-2016 [Section No. 4.7.1.5.1.3]

Public Input No. 21-NFPA 12-2016 [Section No. 4.7.1.5.1.4]

First Revision No. 18-NFPA 12-2016 [Section No. 4.7.1.6.3]

4.7.1.6.3

Where hex bushings are used for one pipe size reduction, a Class 3000 ~~lb (207 bar)~~ steel bushing shall be provided to maintain adequate strength.

Submitter Information Verification

Submitter Full Name: Barry Chase

Organization: National Fire Protection Assoc

Street Address:

City:

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Zip:

Submittal Date: Thu Apr 07 14:00:55 EDT 2016

Committee Statement

Committee Statement: The appropriate term for these fittings is "Class 3000," not "3000 lb." The metric conversion was deleted, as it is not applicable.

Response Message:

First Revision No. 9-NFPA 12-2016 [Section No. 4.7.2 [Excluding any Sub-Sections]]

The piping system shall ~~be securely supported with due allowance for agent thrust forces and thermal expansion and contraction and shall~~ not be subject to ~~mechanical, chemical, or other~~ damage.

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Mar 18 10:09:41 EDT 2016

Committee Statement

Committee Statement: This revision removes unenforceable language. The requirements for hanging and bracing are now located in 4.7.6 (FR 16).

Annex A.4.7.2 is deleted. A mandatory reference to ANSI B31.1 is included in the new section 4.7.6.

Response Message:

Public Input No. 16-NFPA 12-2015 [Section No. 4.7.2 [Excluding any Sub-Sections]]

Public Input No. 19-NFPA 12-2015 [Section No. A.4.7.2]

First Revision No. 10-NFPA 12-2016 [Section No. 4.7.2.1]

~~**4.7.2.1**~~

~~Where explosions are possible, the piping system shall be hung from supports that are least likely to be displaced.~~

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Mar 18 10:13:22 EDT 2016

Committee Statement

Committee Statement: Removes unenforceable language.
Response Message:

Public Input No. 17-NFPA 12-2015 [Section No. 4.7.2.1]

First Revision No. 16-NFPA 12-2016 [New Section after 4.7.5]

4.7.6* Pipe Hangers and Supports.

All pipe hangers and supports shall be in accordance with ASME B31.1.

4.7.6.1

All pipe hangers and supports shall be attached directly to the building structure.

4.7.6.2

Rigid hangers are required wherever a change in direction or elevation occurs.

4.7.6.3

On long straight runs in excess of 20 ft (6.1 m), every other hanger shall be rigid.

4.7.6.4

All hangers and components shall be ferrous.

4.7.6.5

All piping shall be attached to rigid hangers by means of u-bolts fastened with double nuts.

4.7.6.5.1*

The pipe shall be free to move longitudinally within the u-bolt unless the piping design requires it to be anchored.

4.7.6.5.2

All pipe supports shall be designed and installed to prevent movement of supported pipe during system discharge.

4.7.6.5.3

The maximum distance between hangers shall not exceed that specified in Table 4.7.6.5.3 .

Table 4.7.6.5.3 Maximum Spacing Between Supports for Threaded or Welded Pipe.

Nominal Pipe Size		Maximum Span	
in.	mm	ft	m
1/4	6	5	1.5
1/2	15	5	1.5
3/4	20	6	1.8
1	25	7	2.1
1 1/4	32	8	2.4
1 1/2	40	9	2.7
2	50	10	3.0
2 1/2	65	11	3.4
3	80	12	3.7
4	100	14	4.3
5	125	16	4.9
6	150	17	5.2
8	200	19	5.8

4.7.6.6

Where required, seismic bracing shall be in accordance with NFPA 13 .

Supplemental Information

File Name	Description
12-FR_16.docx	Annex material and new table

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Mar 18 15:07:00 EDT 2016

Committee Statement

Committee Statement: Presently there is little guidance on the proper support of CO2 system piping (low pressure systems only – see Section 4.7.2) and no guidance for support of high pressure systems at all. Due to the potential for pipe movement and dislodgement due to agent forces and thermal expansion/contraction, there is a need to specify rigid pipe supports at critical points of the system and dead weight support for the remainder of the system piping. There are no requirements presently for seismic bracing of CO2 system piping.

Response Message:

Public Input No. 18-NFPA 12-2015 [New Section after 4.7.5.3.2]

1) INSERT ANNEX A.4.7.6

A.4.7.6 The FSSA *Pipe Design Guide for Use with Special Hazard Fire Suppression Systems* provides guidance on pipe supports.

2) INSERT ANNEX A.4.7.6.5.1

A.4.7.6.5.1 Hangers and pipe should be designed to allow longitudinal movement due to agent thrust forces and thermal expansion.

3) INSERT TABLE 4.7.6.5.3

Table 4.7.6.5.3 Maximum Spacing Between Supports For Threaded or Welded Pipe.

Nominal Pipe Size		**Maximum Span**	
in.	**mm**	**ft**	**m**
1/4	6	5	1.5
1/2	15	5	1.5
3/4	20	6	1.8
1	25	7	2.1
1 1/4	32	8	2.4
1 1/2	40	9	2.7
2	50	10	3.0
2 1/2	65	11	3.4
3	80	12	3.7
4	100	14	4.3
5	125	16	4.9
6	150	17	5.2
8	200	19	5.8

First Revision No. 11-NFPA 12-2016 [Section No. 5.3.2.2]

5.3.2.2*

Table 5.3.2.2 shall be used to determine the minimum carbon dioxide concentrations for the liquids and gases shown in the table.

Table 5.3.2.2 Minimum Carbon Dioxide Concentrations for Extinguishment

Material	Theoretical Minimum CO_2 Concentration (%)	Minimum Design CO_2 Concentration (%)
Acetylene	55	66
Acetone	27*	34
Aviation gas grades 115/145	30	36
Benzol, benzene	31	37
Butadiene	34	41
Butane	28	34
Butane-I	31	37
Carbon disulfide	60	72
Carbon monoxide	53	64
Coal or natural gas	31*	37
Cyclopropane	31	37
Diethyl ether	33	40
Dimethyl ether	33	40
Dowtherm	38*	46
Ethane	33	40
Ethyl alcohol	36	43
Ethyl ether	38*	46
Ethylene	41	49
Ethylene dichloride	21	34
Ethylene oxide	44	53
Gasoline	28	34
~~Hexane~~	~~29~~	~~35~~
Higher paraffin hydrocarbons $C_n H$~~2m~~ 2n+2 , ~~+ 2m -~~ n≥ 5	28	34
Hydrogen	62	75
Hydrogen sulfide	30	36
Isobutane	30*	36
Isobutylene	26	34
Isobutyl formate	26	34
JP-4	30	36
Kerosene	28	34
Methane	25	34
Methyl acetate	29	35
Methyl alcohol	33	40
Methyl butene-I	30	36
Methyl ethyl ketone	33	40
Methyl formate	32	39

Material	Theoretical Minimum CO_2 Concentration (%)	Minimum Design CO_2 Concentration (%)
Pentane	29	35
Propane	30	36
Propylene	30	36
Quench, lube oils	28	34

Note: The theoretical minimum extinguishing concentrations in air for the materials in the table were obtained from a compilation of Bureau of Mines, Bulletins 503 and 627.

*Calculated from accepted residual oxygen values.

Supplemental Information

File Name	Description
12-FR_11.docx	FOR STAFF USE

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Mar 18 10:17:02 EDT 2016

Committee Statement

Committee Statement: The intended “Higher paraffin” text is from the caption of Figure 35 of U.S. Bureau of Mines Bulletin 627.

The “Higher paraffin” line, with n = 6 (hexane), has a column #2 value = 28 % (and MDC = 34 %), while directly above is “Hexane” with a column #2 value = 29 % (and MDC = 35 %). Thus, the “Hexane” line and the “Higher paraffin” line are in conflict. Close examination of the hexane flammability data in both U.S. Bureau of Mines Bulletins 503 and 627 clearly indicates that the 28 % for hexane “Minimum Theoretical Concentration” is correct.

Response Message:

Public Input No. 11-NFPA 12-2015 [Section No. 5.3.2.2]

First Revision No. 19-NFPA 12-2016 [Section No. A.4.4.3.2]

A.4.4.3.2

FM Approvals 5420~~, *Approval Standard for Carbon Dioxide Extinguishing Systems*~~ , should be consulted for possible listing requirements.

Submitter Information Verification

Submitter Full Name: Barry Chase
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Street Address:
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Submittal Date: Thu Apr 07 14:07:10 EDT 2016

Committee Statement

Committee Statement: The referenced document title was removed for consistency. All other references use the shortened form.
Response Message:

First Revision No. 21-NFPA 12-2016 [Section No. A.4.5.3]

A.4.5.3

Detectors installed at the maximum spacing as listed or approved for fire alarm use can result in excessive delay in agent release.

For additional information on detectors, refer to *NFPA 72*.

The *FSSA Application Guide Detection & Control for Fire Suppression Systems* offers the designer information on the various types of detection and control equipment.

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: National Fire Protection Assoc
Street Address:
City:
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Submittal Date: Thu Apr 07 14:16:07 EDT 2016

Committee Statement

Committee Statement: The section was revised to italicize "FSSA," as it is part of the referenced document title.
Response Message:

First Revision No. 22-NFPA 12-2016 [Section No. A.4.6.5.2]

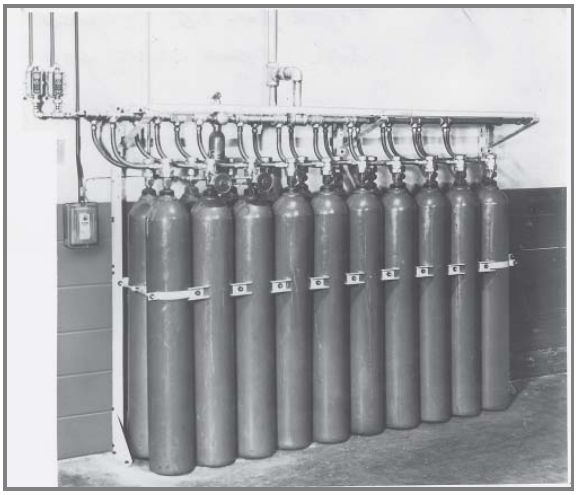
A.4.6.5.2

Transporting a charged cylinder might be illegal if the cylinder has been damaged or exposed to fire. Federal and local regulations should be consulted.

The ~~Fire Suppression Systems Association publication,~~ *FSSA Test Guide for Use with Special Hazard Fire Suppression Systems Containers*, provides useful information on testing requirements and safety precautions for handling and transporting high-pressure carbon dioxide cylinders.

A typical high-pressure storage facility using a number of cylinders is shown in Figure A.4.6.5.2. A flexible connector is used between each cylinder and the common manifold to facilitate the weight checking of cylinders and replacing them after use. Each cylinder is provided with its own valve with a dip tube extending to the bottom. Some older types of cylinders do not have dip tubes and are installed upside down to ensure discharge of liquid carbon dioxide.

Figure A.4.6.5.2 A Typical High-Pressure Storage Facility.



Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Thu Apr 07 14:18:37 EDT 2016

Committee Statement

Committee Statement: The referenced document title was updated.
Response Message:

First Revision No. 23-NFPA 12-2016 [Section No. A.4.7.1.7.1]

A.4.7.1.7.1

In performing the calculation to determine pipe thickness, the guidelines provided in the *FSSA* ~~publication,~~ *Pipe Design Handbook for Use with Special Hazard Fire Suppression Systems* should be consulted.

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Thu Apr 07 14:20:26 EDT 2016

Committee Statement

Committee Statement: The referenced document title was updated.
Response Message:

First Revision No. 24-NFPA 12-2016 [Section No. A.4.8.3.3]

A.4.8.3.3

The maintenance report provides the owner with valuable information pertaining to the fire system, its condition, and recommendations. The servicing company should review its maintenance report to ensure that it captures the necessary data and performs the maintenance in a thorough and safe manner. The ~~Fire Suppression Systems Association publication~~ *FSSA* *Fire Protection Systems Inspection Form Guidelines* can be used to evaluate the service company's maintenance report.

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Thu Apr 07 14:21:43 EDT 2016

Committee Statement

Committee Statement: The referenced document title was updated.
Response Message:

First Revision No. 25-NFPA 12-2016 [Section No. A.6.4.1]

A.6.4.1

The practical application of the rate-by-area method is explained in the *FSSA Design Guidelines for Carbon Dioxide Local Application Rate-by-Area*. The guide assists the user through the entire process of a rate-by-area CO_2 system design with examples. The user will gain an understanding of the steps involved with the layout, calculation, and overall design of the system.

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: National Fire Protection Assoc
Street Address:
City:
State:
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Submittal Date: Thu Apr 07 14:22:57 EDT 2016

Committee Statement

Committee Statement: The section was revised to italicize "FSSA," as it is part of the referenced document title.
Response Message:

First Revision No. 26-NFPA 12-2016 [Section No. A.6.5.1]

A.6.5.1

The practical application of the rate-by-volume method is complicated. The design of a system can be aided by examples and a walk-through calculation of a system. The ~~guide,~~ *FSSA Design Guidelines for Carbon Dioxide Local Application Rate-by-Volume* describes how to design a carbon dioxide system using the rate-by-volume method.

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Thu Apr 07 14:23:54 EDT 2016

Committee Statement

Committee Statement: The section was revised to italicize "FSSA," as it is part of the referenced document title.
Response Message:

First Revision No. 20-NFPA 12-2016 [Section No. B.1]

B.1 Introduction.

The following annex material is provided to show typical examples of how various fire hazards can be protected with fixed carbon dioxide extinguishing systems. It should be noted that the methods described are not to be construed as being the only ones that can be used. They are meant to help only in interpreting and elaborating on the intent of the standard where proper application could be subject to question.

Submitter Information Verification

Submitter Full Name: Barry Chase
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Thu Apr 07 14:12:00 EDT 2016

Committee Statement

Committee Statement: A section title was added for consistency with the remainder of the chapter.
Response Message:

First Revision No. 13-NFPA 12-2016 [Section No. C.1]

C.1

Computing pipe sizes for carbon dioxide systems is complicated by the fact that the pressure drop is nonlinear with respect to the pipeline. Carbon dioxide leaves the storage vessel as a liquid at saturation pressure. As the pressure drops due to pipeline friction, the liquid boils and produces a mixture of liquid and vapor. Consequently, the volume of the flowing mixture increases and the velocity of flow must also increase. Thus, the pressure drop per unit length of pipe is greater near the end of the pipeline than it is at the beginning.

Pressure drop information for designing piping systems can best be obtained from curves of pressure versus equivalent length for various flow rates and pipe sizes. Such curves can be plotted using the theoretical equation given in 4.7.5.1. The *Y* and *Z* factors in the equation in that paragraph depend on storage pressure and line pressure. In the following equations, *Z* is a dimensionless ratio, and the *Y* factor has units of pressure times density and will therefore change the system of units. The *Y* and *Z* factors can be evaluated as follows:

$$Y = -\int_{P_1}^{P} \rho \, dP$$

$$Z = -\int_{\rho_1}^{\rho} \frac{d\rho}{\rho} = \ln \frac{\rho_1}{\rho} \qquad \textbf{[C.1a]}$$

where:

P = pressure at end of pipeline [psi (kPa)]

P_1 = storage pressure [psi (kPa)]

ρ = density at pressure P [lb/ft^3 (kg/m^3)]

ρ_1 = density at pressure P_1 [lb/ft^3 (kg/m^3)]

ln = natural logarithm

The storage pressure is an important factor in carbon dioxide flow. In low-pressure storage, the starting pressure in the storage vessel will recede to a lower level, depending on whether all or only part of the supply is discharged. Because of this, the average pressure during discharge will be about 285 psi (1965 kPa). The flow equation is based on absolute pressure; therefore, 300 psi (2068 kPa) is used for calculations involving low-pressure systems.

In high-pressure systems, the storage pressure depends on the ambient temperature. Normal ambient temperature is assumed to be 70°F (21°C). For this condition, the average pressure in the cylinder during discharge of the liquid portion will be about 750 psi (5171 kPa). This pressure has therefore been selected for calculations involving high-pressure systems.

Using the base pressures of 300 psi (2068 kPa) and 750 psi (5171 kPa), values have been determined for the *Y* and *Z* factors in the flow equation. These values are listed in Table C.1(a) and Table C.1(b).

Table C.1(a) Values of Y and Z for 300 psi Initial Storage Pressure

Pressure (psi)	Z	Y 0	1	2	3	4	5	6	7	8	9
300	0.000	0	0	0	0	0	0	0	0	0	0
290	0.135	596	540	483	426	367	308	248	187	126	63
280	0.264	1119	1070	1020	969	918	866	814	760	706	652
270	0.387	1580	1536	1492	1448	1402	1357	1310	1263	1216	1168
260	0.505	1989	1950	1911	1871	1831	1790	1749	1708	1666	1623
250	0.620	2352	2318	2283	2248	2212	2176	2139	2102	2065	2027
240	0.732	2677	2646	2615	2583	2552	2519	2487	2454	2420	2386
230	0.841	2968	2940	2912	2884	2855	2826	2797	2768	2738	2708
220	0.950	3228	3204	3179	3153	3128	3102	3075	3049	3022	2995

		Y									
Pressure (psi)	Z	0	1	2	3	4	5	6	7	8	9
210	1.057	3462	3440	3418	3395	3372	3349	3325	3301	3277	3253
200	1.165	3673	3653	3632	3612	3591	3570	3549	3528	3506	3485
190	1.274	3861	3843	3825	3807	3788	3769	3750	3731	3712	3692
180	1.384	4030	4014	3998	3981	3965	3948	3931	3914	3896	3879
170	1.497	4181	4167	4152	4138	4123	4108	4093	4077	4062	4046
160	1.612	4316	4303	4291	4277	4264	4251	4237	4223	4210	4196
150	1.731	4436	4425	4413	4402	4390	4378	4366	4354	4341	4329

Table C.1(b) Values of Y and Z for 750 psi Initial Storage Pressure

		Y									
Pressure (psi)	Z	0	1	2	3	4	5	6	7	8	9
750	0.000	0	0	0	0	0	0	0	0	0	0
740	0.038	497	448	399	350	300	251	201	151	101	51
730	0.075	975	928	881	833	786	738	690	642	594	545
720	0.110	1436	1391	1345	1299	1254	1208	1161	1115	1068	1022
710	0.143	1882	1838	1794	1750	1706	1661	1616	1572	1527	1481
700	0.174	2314	2271	2229	2186	2143	2100	2057	2013	1970	1926
690	0.205	2733	2691	2650	2608	2567	2525	2483	2441	2399	2357
680	0.235	3139	3099	3059	3018	2978	2937	2897	2856	2815	2774
670	0.265	3533	3494	3455	3416	3377	3338	3298	3259	3219	3179
660	0.296	3916	3878	3840	3802	3764	3726	3688	3649	3611	3572
650	0.327	4286	4250	4213	4176	4139	4102	4065	4028	3991	3953
640	0.360	4645	4610	4575	4539	4503	4467	4431	4395	4359	4323
630	0.393	4993	4959	4924	4890	4855	4821	4786	4751	4716	4681
620	0.427	5329	5296	5263	5229	5196	5162	5129	5095	5061	5027
610	0.462	5653	5621	5589	5557	5525	5493	5460	5427	5395	5362
600	0.498	5967	5936	5905	5874	5843	5811	5780	5749	5717	5685
590	0.535	6268	6239	6209	6179	6149	6119	6089	6058	6028	5997
580	0.572	6560	6531	6502	6473	6444	6415	6386	6357	6328	6298
570	0.609	6840	6812	6785	6757	6729	6701	6673	6645	6616	6588
560	0.646	7110	7084	7057	7030	7003	6976	6949	6922	6895	6868
550	0.683	7371	7345	7320	7294	7268	7242	7216	7190	7163	7137
540	0.719	7622	7597	7572	7548	7523	7498	7472	7447	7422	7396
530	0.756	7864	7840	7816	7792	7768	7744	7720	7696	7671	7647
520	0.792	8098	8075	8052	8028	8005	7982	7958	7935	7911	7888
510	0.827	8323	8301	8278	8256	8234	8211	8189	8166	8143	8120
500	0.863	8540	8519	8497	8476	8454	8433	8411	8389	8367	8345
490	0.898	8750	8730	8709	8688	8667	8646	8625	8604	8583	8562
480	0.933	8953	8933	8913	8893	8873	8852	8832	8812	8791	8771
470	0.967	9149	9129	9110	9091	9071	9052	9032	9012	8993	8973
460	1.002	9338	9319	9301	9282	9263	9244	9225	9206	9187	9168
450	1.038	9520	9502	9484	9466	9448	9430	9412	9393	9375	9356

Pressure (psi)	Z	Y 0	1	2	3	4	5	6	7	8	9
440	1.073	9697	9680	9662	9644	9627	9609	9592	9574	9556	9538
430	1.109	9866	9850	9833	9816	9799	9782	9765	9748	9731	9714
420	1.146	10030	10014	9998	9982	9966	9949	9933	9916	9900	9883
410	1.184	10188	10173	10157	10141	10126	10110	10094	10078	10062	10046
400	1.222	10340	10325	10310	10295	10280	10265	10250	10234	10219	10204
390	1.262	10486	10472	10458	10443	10429	10414	10399	10385	10370	10355
380	1.302	10627	10613	10599	10585	10571	10557	10543	10529	10515	10501
370	1.344	10762	10749	10735	10722	10708	10695	10681	10668	10654	10641
360	1.386	10891	10878	10866	10853	10840	10827	10814	10801	10788	10775
350	1.429	11015	11003	10991	10978	10966	10954	10941	10929	10916	10904
340	1.473	11134	11122	11110	11099	11087	11075	11063	11051	11039	11027
330	1.518	11247	11236	11225	11214	11202	11191	11180	11168	11157	11145
320	1.564	11356	11345	11334	11323	11313	11302	11291	11280	11269	11258
310	1.610	11459	11449	11439	11428	11418	11408	11398	11387	11377	11366
300	1.657	11558	11548	11539	11529	11519	11509	11499	11489	11479	11469

For practical application, it is desirable to plot curves for each pipe size that can be used. However, the flow equation can be rearranged as shown in the following equation:

$$\frac{L}{D^{1.25}} = \frac{3647Y}{\left(\frac{Q}{D^2}\right)^2} - 8.08Z \quad \text{[C.1b]}$$

Thus, by plotting values of $L/D^{1.25}$ and Q/D^2, it is possible to use one family of curves for any pipe size. Figure C.1(a) gives flow information for 0°F (−18°C) storage temperature on this basis. Figure C.1(b) gives similar information for high-pressure storage at 70°F (21°C). For an inside pipe diameter of exactly 1 in., D^2 and $D^{1.25}$ reduce to unity and cancel out. For other pipe sizes, it is necessary to convert the flow rate and equivalent length by dividing or multiplying by these factors. Table C.1(c) gives values for D.

Figure C.1(a) Pressure Drop in Pipeline for 300 psi (2068 kPa) Storage Pressure.

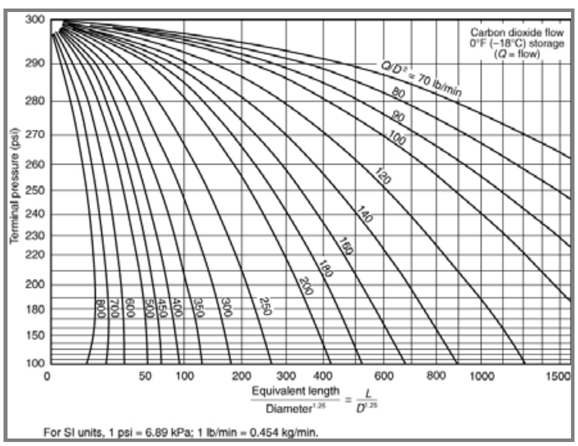

Figure C.1(b) Pressure Drop in Pipeline for 750 psi (5171 kPa) Storage Pressure.

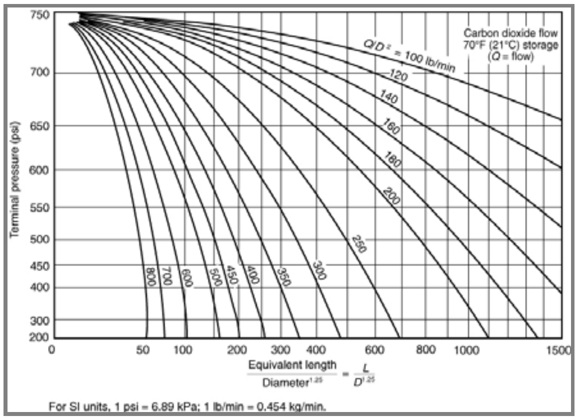

Table C.1(c) Values of $D^{1.25}$ and D^2 for Various Pipe Sizes

Pipe Size and Type	Inside Diameter (in.)	$D^{1.25}$	D^2
½ Std.	0.622	0.5521	0.3869
¾ Std.	0.824	0.785	0.679
1 Std.	1.049	1.0615	1.100
1 XH	0.957	0.9465	0.9158
1¼ Std.	1.380	1.496	1.904
1¼ XH	1.278	1.359	1.633
1½ Std.	1.610	1.813	2.592
1½ XH	1.500	1.660	2.250
2 Std.	2.067	2.475	4.272
2 XH	1.939	2.288	3.760
2½ Std.	2.469	3.09	6.096
2½ XH	2.323	2.865	5.396
3 Std.	3.068	4.06	9.413
3 XH	2.900	3.79	8.410
4 Std.	4.026	5.71	16.21
4 XH	3.826	5.34	14.64
5 Std.	5.047	7.54	25.47
5 XH	4.813	7.14	23.16
6 Std.	6.065	9.50	36.78
6 XH	5.761	8.92	33.19

These curves can be used for designing systems or for checking possible flow rates. For example, assume the problem is to determine the terminal pressure for a low-pressure system consisting of a single 2 in. Schedule 40 pipeline with an equivalent length of 500 ft and a flow rate of 1000 lb/min. The flow rate and the equivalent length must be converted to terms of Figure C.1(a) as follows:

$$\frac{Q}{D^2} = \frac{1000}{4.28} = 234\ \text{lb/min} \cdot D^2 \qquad \frac{Q}{D^2} = \frac{1000}{4.28} = 234\ \text{lb/min} \cdot \text{in.}^2$$

$$\frac{L}{D^{1.25}} = \frac{500}{2.48} = 201\ \text{ft} \cdot D^{1.25} \qquad \frac{L}{D^{1.25}} = \frac{500}{2.48} = 201\ \text{ft} \cdot \text{in.}^{1.25} \quad \text{[C.1c]}$$

From Figure C.1(a), the terminal pressure is found to be about 228 psi at the point where the interpolated flow rate of 234 lb/min intersects the equivalent length scale at 201 ft.

If this line terminates in a single nozzle, the equivalent orifice area must be matched to the terminal pressure in order to control the flow rate at the desired level of 1000 lb/min. Referring to Table 4.7.5.2.1, it will be noted that the discharge rate will be 1410 lb/min·in.^{2} of equivalent orifice area when the orifice pressure is 230 psi. The required equivalent orifice area of the nozzle is thus equal to the total flow rate divided by the rate per square inch, as shown in the following equation:

$$\text{Equivalent orifice area} = \frac{1000\ \text{lb/min}}{1410\ \text{lb/min}\cdot\text{in.}^2} = 0.709\ \text{in.}^2 \qquad \textbf{[C.1d]}$$

From a practical viewpoint, the designer would select a standard nozzle having an equivalent area nearest to the computed area. If the orifice area happened to be a little larger, the actual flow rate would be slightly higher and the terminal pressure would be somewhat lower than the estimated 228 psi (1572 kPa).

If, in the previous example, instead of terminating with one large nozzle, the pipeline branched into two smaller pipelines, it would be necessary to determine the pressure at the end of each branch line. To illustrate this procedure, assume that the branch lines are equal and consist of 1½ in. Schedule 40 pipe with equivalent lengths of 200 ft (61 m) and that the flow in each branch line is to be 500 lb/min (227 kg/min). Converting to terms used in Figure C.1(a), the following equations result:

$$\frac{Q}{D^2} = \frac{500}{2.592} = 193\ \text{lb/min}\cdot D^2 \qquad \frac{Q}{D^2} = \frac{500}{2.592} = 193\ \text{lb/min}\cdot\text{in.}^2$$

$$\frac{L}{D^{1.25}} = \frac{200}{1.813} = 110\ \text{ft}\cdot D^{1.25} \qquad \frac{L}{D^{1.25}} = \frac{200}{1.813} = 110\ \text{ft}\cdot\text{in.}^{1.25} \qquad \textbf{[C.1e]}$$

From Figure C.1(a), the starting pressure of 228 psi (1572 kPa) (terminal pressure of main line) intersects the flow rate line [193 lb/min (87.6 kg/min)] at an equivalent length of about 300 ft (91.4 m). In other words, if the branch line started at the storage vessel, the liquid carbon dioxide would have to flow through 300 ft (91.4 m) of pipeline before the pressure dropped to 228 psi (1572 kPa). This length thus becomes the starting point for the equivalent length of the branch line. The terminal pressure of the branch line is then found to be 165 psi (1138 kPa) at the point where the 193 lb/min (87.6 kg/min) flow rate line intersects the total equivalent length line of 410 ft (125 m), or 300 ft + 110 ft (91 m + 34 m). With this new terminal pressure [165 psi (1138 kPa)] and flow rate [500 lb/min (227 kg/min)], the required equivalent nozzle area at the end of each branch line will be approximately 0.567 in.^{2} (366 mm^2). This is about the same as the single large nozzle example, except that the discharge rate is cut in half due to the reduced pressure.

The design of the piping distribution system is based on the flow rate desired at each nozzle. This in turn determines the required flow rate in the branch lines and the main pipeline. From practical experience, it is possible to estimate the approximate pipe sizes required. The pressure at each nozzle can be determined from suitable flow curves. The nozzle orifice sizes are then selected on the basis of nozzle pressure from the data given in 4.7.5.2.

In high-pressure systems, the main header is supplied by a number of separate cylinders. The total flow is thus divided by the number of cylinders to obtain the flow rate from each cylinder. The flow capacity of the cylinder valve and the connector to the header vary with each manufacturer, depending on design and size. For any particular valve, dip tube, and connector assembly, the equivalent length can be determined in terms of feet of standard pipe size. With this information, the flow equation can be used to prepare a curve of flow rate versus pressure drop. This curve provides a convenient method of determining header pressure for a specific valve and connector combination.

Table C.1(d) and Table C.1(e) list the equivalent lengths of pipe fittings for determining the equivalent length of piping systems. Table C.1(d) is for threaded joints, and Table C.1(e) is for welded joints. Both tables were computed for Schedule 40 pipe sizes; however, for all practical purposes, the same figures can also be used for Schedule 80 pipe sizes.

Table C.1(d) Equivalent Lengths in Feet of Threaded Pipe Fitting

Pipe Size (in.)	Elbow Std. 45 Degrees	Elbow Std. 90 Degrees	Elbow 90 Degrees Long Radius and Tee Thru Flow	Tee Side	Union Coupling or Gate Valve
⅜	0.6	1.3	0.8	2.7	0.3

Pipe Size (in.)	Elbow Std. 45 Degrees	Elbow Std. 90 Degrees	Elbow 90 Degrees Long Radius and Tee Thru Flow	Tee Side	Union Coupling or Gate Valve
½	0.8	1.7	1.0	3.4	0.4
¾	1.0	2.2	1.4	4.5	0.5
1	1.3	2.8	1.8	5.7	0.6
1¼	1.7	3.7	2.3	7.5	0.8
1½	2.0	4.3	2.7	8.7	0.9
2	2.6	5.5	3.5	11.2	1.2
2½	3.1	6.6	4.1	13.4	1.4
3	3.8	8.2	5.1	16.6	1.8
4	5.0	10.7	6.7	21.8	2.4
5	6.3	13.4	8.4	27.4	3.0
6	7.6	16.2	10.1	32.8	3.5

For SI units, 1 ft = 0.3048 m.

Table C.1(e) Equivalent Lengths in Feet of Welded Pipe Fitting

Pipe Size (in.)	Elbow Std. 45 Degrees	Elbow Std. 90 Degrees	Elbow 90 Degrees Long Radius and Tee Thru Flow	Tee Side	Gate Valve
⅜	0.2	0.7	0.5	1.6	0.3
½	0.3	0.8	0.7	2.1	0.4
¾	0.4	1.1	0.9	2.8	0.5
1	0.5	1.4	1.1	3.5	0.6
1¼	0.7	1.8	1.5	4.6	0.8
1½	0.8	2.1	1.7	5.4	0.9
2	1.0	2.8	2.2	6.9	1.2
2½	1.2	3.3	2.7	8.2	1.4
3	1.8	4.1	3.3	10.2	1.8
4	2.0	5.4	4.4	13.4	2.4
5	2.5	6.7	5.5	16.8	3.0
6	3.0	8.1	6.6	20.2	3.5

For SI units, 1 ft = 0.3048 m.

For nominal changes in elevation of piping, the change in head pressure is negligible. However, if there is a substantial change in elevation, this factor should be taken into account. The head pressure correction per foot of elevation depends on the average line pressure where the elevation takes place because the density changes with pressure. Correction factors are given in Table C.1(f) and Table C.1(g) for low-pressure and high-pressure systems, respectively. The correction is subtracted from the terminal pressure when the flow is upward and is added to the terminal pressure when the flow is downward.

Table C.1(f) Elevation Correction Factors for Low-Pressure System

Average Line Pressure		Elevation Correction	
psi	kPa	psi/ft	kPa/m
300	2068	0.443	10.00
280	1930	0.343	7.76
260	1792	0.265	5.99
240	1655	0.207	4.68

Average Line Pressure		Elevation Correction	
psi	kPa	psi/ft	kPa/m
220	1517	0.167	3.78
200	1379	0.134	3.03
180	1241	0.107	2.42
160	1103	0.085	1.92
140	965	0.067	1.52

Table C.1(g) Elevation Correction Factors for High-Pressure System

Average Line Pressure		Elevation Correction	
psi	kPa	psi/ft	kPa/m
750	5171	0.352	7.96
700	4826	0.300	6.79
650	4482	0.255	5.77
600	4137	0.215	4.86
550	3792	0.177	4.00
500	3447	0.150	3.39
450	3103	0.125	2.83
400	2758	0.105	2.38
350	2413	0.085	1.92
300	2068	0.070	1.58

Supplemental Information

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Committee Statement

Committee Statement: The original equations incorrectly uses “D2” (pipe diameter) in the units rather than “in” (inch), which is the correct unit of pipe diameter.

In Table C.1(c), corrected a typo in the second line, which is supposed to be "3/4 in.".

Response Message:

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First Revision No. 2-NFPA 12-2016 [Section No. H.1]

H.1 Referenced Publications.

The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

H.1.1 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers*, ~~2013~~ 2017 edition.

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

NFPA 72®, *National Fire Alarm and Signaling Code*, ~~2013~~ 2016 edition.

NFPA 77, *Recommended Practice on Static Electricity*, 2014 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, ~~2014~~ 2017 edition.

NFPA *101®*, *Life Safety Code®*, ~~2015~~ 2018 edition.

H.1.2 Other Publications.

H.1.2.1 ASME Publications.

American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME B31.1, *Power Piping Code*, ~~2012~~ 2014 .

H.1.2.2 ASTM Publications.

ASTM International, 100 Barr Harbor Drive, P.O. Box C 700, West Conshohocken, PA 19428-2959.

ASTM SI10, *American National Standard for Metric Practice*, 2010.

H.1.2.3 DHHS Publications.

Department of Health and Human Services, National Institute of Safety and Health, Robert A. Taft Laboratory, 4676 Columbia Parkway, Cincinnati, OH 45226.

DHHS (NIOSH) Publication 76-194, *Criteria for a Recommended Standard: Occupational Exposure to Carbon Dioxide,*1976.

H.1.2.4 EPA Publications.

Environmental Protection Agency, William Jefferson Clinton East Bldg., 1200 Pennsylvania Avenue, NW, Washington, DC 20460.

EPA 430-R-00-002, "Carbon Dioxide as a Fire Suppressant: Examining the Risks," February 2000.

H.1.2.5 FM Global Publications.

FM Global, 1175 Boston-Providence Turnpike, P.O. Box 9102, Norwood, MA, 02062.

FM Approvals 5420, *Approval Standard for Carbon Dioxide Extinguishing Systems*, April 2007.

H.1.2.6 FSSA Publications.

Fire Suppression Systems Association, ~~5024-R Campbell Boulevard~~ 3601 E. Joppa Road , Baltimore, MD 21234. (www.fssa.net)

FSSA Application Guide Detection & Control for Fire Suppression Systems, November 2010.

FSSA Design Guide for Use with Carbon Dioxide Total Flooding Applications, 1st edition, February 2011.

FSSA Design Guidelines for Carbon Dioxide Local Application Rate by Area, January 2010.

FSSA Design Guidelines for Carbon Dioxide Local Application Rate by Volume, December 2005.

FSSA Fire Protection Systems Inspection Form Guidelines, January 2012.

FSSA Pipe Design Handbook for Use with Special Hazard Fire Suppression Systems, 2nd edition, 2011.

FSSA Test Guide for Use with Special Hazard Fire Suppression Systems Containers, 3rd edition, January 2012.

H.1.2.7 SFPE Publications.

Society of Fire Protection Engineers, 9711 Washingtonian Blvd, Suite 380, Gaithersburg, MD 20878.

SFPE *Handbook of Fire Protection Engineering* , 5th Edition.

H.1.2.8 U.S. Government Publications.

U.S. Government ~~Printing~~ Publishing Office, 732 North Capitol Street, NW Washington, DC ~~20402~~ 20401-0001 .

Title 46, Code of Federal Regulations, Part 119, “Machinery Installations.”

Title 49, Code of Federal Regulations, Parts 171–190 (Department of Transportation).

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Committee Statement

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