



NATIONAL FIRE PROTECTION ASSOCIATION

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DATE: August 7, 2020 (Revised September 17, 2020)

TO: Technical Committee on Gaseous Fire Extinguishing Systems

FROM: Barry Chase, *Staff Liaison*
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SUBJECT: Agenda for the NFPA 12/12A/2001 Second Draft Meeting (Annual 2021 revision cycle)
September 9th, 10th, 15th, 17th, 25th, October 6th and 7th, 2020
Microsoft Teams Meeting

- 2020-09-1 **Call to Order – Sept 9, 2020, 10:00 am ET**
- 2020-09-2 **Chair’s comments**
- 2020-09-3 **Previous minutes** [[April 24-26, 2019, Memphis, TN](#)]
- 2020-09-4 **NFPA Staff Liaison Presentation**
- [NFPA Standards Development Process](#)
 - [NFPA Resources](#)
- 2020-09-5 **NFPA 2001 Second Draft**
- a. Public comments [see attached]
 - o Significant topics to be discussed:
 - Toxicity of Impurities
 - New Clean Agent, HB-55
 - b. Task Group on Chapter 1 Reorganization (Related to FR 35) [J. Senecal]
 - o The task group report was submitted as Public Comments 5, 7, 8, 9, 10, 11, 12, 13, 15, and 16.
 - c. Task Group on Section 4.3 Reorganization (Related to FR 36) [K. Adrian]
 - o The task group report is attached.
 - d. Task Group on Chapter 5 Reorganization (Related to FR 37) [T. Wysocki]
 - o The task group found no issues requiring the Committee’s attention.
 - e. Task Group on Impairment Procedures for Clean Agent Systems (Related to CI 21, attached) [M. Fessenden]
 - o Task group report is attached
 - f. Task Group on Applying Local Application to Leaky Enclosures (Related to CI 24, attached) [M. Fessenden]
 - o Task group report not submitted
 - g. Task Group on Inert Gas Flooding Factors (Related to FR 26) [J. Senecal]
 - o The task group report was submitted as Public Comment 17.
 - h. Committee revisions
 - i. Staff notes and editorial issues (see attached)
- 2020-09-6 **NFPA 12 Second Draft**
- a. Public comments [see attached]
 - b. Task Group on Carbon Dioxide Left in Pipe (Related to FR 5) [T. Wysocki]
 - o The task group report is attached.
 - c. Committee revisions
- 2020-09-7 **NFPA 12A Second Draft**
- a. No public comments received
-

	b. Committee revisions
2020-09-8	Other business
2020-09-9	Next meeting location and dates

All NFPA Technical Committee meetings are open to the public. Please contact me for information on attending a meeting as a guest. If a guest wishes to address the committee regarding a specific agenda item, the request should be submitted at least seven days before the meeting. Read NFPA's [Regulations Governing Committee Projects](#) (Section 3.3.3.3) for further information.

Additional Meeting Information:

See the [Meeting Notice](#) on the Document Information Page (nfpa.org/12, nfpa.org/12A, or nfpa.org/2001) for meeting location details. If you have any questions, please feel free to contact **Yiu Lee**, *Committee Administrator* at 617-984-7683 or by email ylee@nfpa.org.

C. Standards Administration



Public Comment No. 8-NFPA 2001-2019 [New Section after 1.1]

TITLE OF NEW CONTENT

Type your content here ...A.1.1

The designer is cautioned that this standard is not to be used as a design handbook. Clean agent fire extinguishing systems are complex, with new technology in this area being developed continuously. The designer will need to apply engineering judgement in conjunction with this standard when designing clean agent fire extinguishing systems.

A designer is expected to be granted some latitude when encountering special or unusual design problems, as long as the designer applies a complete and rigorous analysis to the situation. In such cases, the designer is responsible for demonstrating the validity of the approach.

Statement of Problem and Substantiation for Public Comment

Moves original 1.3, which is not enforceable to Annex of Scope.Original 1.3 to be deleted.

Related Item

- FR

Submitter Information Verification

Submitter Full Name: Joseph Senecal

Organization: Firemetrics LLC

Street Address:

City:

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Submittal Date: Tue Nov 05 10:41:04 EST 2019

Committee: GFE-AAA



Public Comment No. 5-NFPA 2001-2019 [Section No. 1.1]

1.1 Scope.

1.1.1*

This standard contains minimum requirements for the design, installation, approval, and maintenance of total-flooding and local-application fire-extinguishing systems that use one of the gaseous agents in Table 1.1.1.

Table 1.1.1 Agents Addressed in NFPA 2001

Agent Designation	Chemical Name	Chemistry	
FK-5-1-12	Dodecafluoro-2-methylpentan-3-one	CF ₃ CF ₂ C(O)CF(CF ₃) ₂	
HCFC Blend A	Dichlorotrifluoroethane HCFC-123 (4.75%)	CHCl ₂ CF ₃	
	-	Chlorodifluoromethane HCFC-22 (82%)	CHClF ₂
	-	Chlorotetrafluoroethane HCFC-124 (9.5%)	CHClF ₂ CF ₃
	-	Isopropenyl-1-methylcyclohexene (3.75%)	-
HCFC-124	Chlorotetrafluoroethane	CHClF ₂ CF ₃	
HFC-125	Pentafluoroethane	CHF ₂ CF ₃	
HFC-227ea	Heptafluoropropane	CF ₃ CHFCF ₃	
HFC-23	Trifluoromethane	CHF ₃	
HFC-236fa	Hexafluoropropane	CF ₃ CH ₂ CF ₃	
FIC-1311	Trifluoroiodide	CF ₃ I	
IG-01	Argon	Ar	
IG-100	Nitrogen	N ₂	
IG-541	Nitrogen (52%)	N ₂	
	-	Argon (40%)	Ar
	-	Carbon dioxide (8%)	CO ₂
IG-55	Nitrogen (50%)	N ₂	
	-	Argon (50%)	Ar
HFC Blend B	Tetrafluoroethane (86%)	CH ₂ FCF ₃	
	-	Pentafluoroethane (9%)	CHF ₂ CF ₃
	-	Carbon dioxide (5%)	CO ₂

Notes:

(1) Other agents could become available at later dates. Such agents could be added via the NFPA process in future editions or by amendments to the standard.

(2) Composition of inert gas agents is given in percent by volume. Composition of HCFC Blend A is given in percent by weight.

(3) The full analogous ASHRAE nomenclature for FK-5-1-12 is FK-5-1-12mmy2.

1.1.2

~~The scope of this standard does not include fire-~~ Fire extinguishing systems that use carbon dioxide or water as the primary extinguishing media, which are addressed by other NFPA documents, are not within the scope of this standard.

Statement of Problem and Substantiation for Public Comment

The current wording of this section is cumbersome. Suggest rewording it to clarify its meaning.

Related Item

- PI

Submitter Information Verification

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Submittal Date: Tue Nov 05 10:23:41 EST 2019

Committee: GFE-AAA



Public Comment No. 7-NFPA 2001-2019 [Section No. 1.2]

1.2* Purpose.

This standard is prepared for the use by and guidance of those charged with purchasing, designing, installing, testing, inspecting, approving, listing, operating, and maintaining engineered or pre-engineered clean agent extinguishing systems, so that such equipment will function as intended throughout its life .

Statement of Problem and Substantiation for Public Comment

Improve clarity of the statement.

Related Item

- FR

Submitter Information Verification

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Submittal Date: Tue Nov 05 10:34:12 EST 2019

Committee: GFE-AAA



Public Comment No. 9-NFPA 2001-2019 [Section No. 1.3]

Delete 1.3

– Application.

No standard can be promulgated that will provide all the necessary criteria for the implementation of a clean agent fire-extinguishing system. Technology in this area is under constant development, and this will be reflected in revisions to this standard. The user of this standard must recognize the complexity of clean agent fire-extinguishing systems. Therefore, the designer is cautioned that the standard is not a design handbook. The standard does not do away with the need for the engineer or for competent engineering judgment. It is intended that a designer capable of applying a more complete and rigorous analysis to special or unusual problems shall have latitude in the development of such designs. In such cases, the designer is responsible for demonstrating the validity of the approach.

Statement of Problem and Substantiation for Public Comment

1.3 is not enforceable. Its intent is moved to new A.1.1 under Scope.

Related Item

- FR

Submitter Information Verification

Submitter Full Name: Joseph Senecal

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Submittal Date: Tue Nov 05 10:43:45 EST 2019

Committee: GFE-AAA



Public Comment No. 10-NFPA 2001-2019 [Section No. 1.4.4]

1.4.4

Requirements that are retroactively applied in accordance with this standard shall be permitted to be modified if

~~their application clearly would be impractical~~

both of the following conditions are met in the judgment of the authority having jurisdiction

~~, and only where it is clearly evident that a~~

~~:~~

(1) Application of the original, full requirement would be impractical.

(2) A reasonable degree of safety is provided by the modified requirement .

Statement of Problem and Substantiation for Public Comment

To improve clarity and eliminate potential confusion the section is reworded as indicated.

Related Item

- FR

Submitter Information Verification

Submitter Full Name: Joseph Senecal

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Submittal Date: Tue Nov 05 10:46:17 EST 2019

Committee: GFE-AAA



Public Comment No. 11-NFPA 2001-2019 [Section No. 1.6.2.3]

1.6.2.3

Where text extracted ~~text~~ from a source document 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~~.

Statement of Problem and Substantiation for Public Comment

Simplify and improve clarity.

Related Item

- FR

Submitter Information Verification

Submitter Full Name: Joseph Senecal

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Submittal Date: Tue Nov 05 10:50:46 EST 2019

Committee: GFE-AAA



Public Comment No. 2-NFPA 2001-2019 [Section No. 3.3.38]

3.3.38* Smoldering (Deep-Seated) Combustion.

A form of combustion without flame that occurs in fuel that is comprised of finely divided fibers or particles that have a relatively large surface area-to-mass ratio.

Replace the above with:

3.3.38* Deep-Seated Combustion.

A form of combustion without flame that occurs within the mass of a fuel that is comprised of finely divided fibers or particles that have a relatively large surface area-to-mass ratio.

Statement of Problem and Substantiation for Public Comment

This definition is linked to the restriction on the use of Clean Agents set forth in 4.2.2 (5).

Although two types of smoldering combustion:

- 1) smoldering that is not "deep-seated" which occurs in a shallow surface layer of fuel
 - 2) smoldering that is "deep-seated" which occurs within the mass of fuel below the surface layer
- are recognized in the Annex to 3.3.38, the related caution in 4.2.2 (5) applies only to deep-seated combustion.

Changing the definition will clarify that deep-seated combustion occurs within the mass of fuel and makes it clear that 4.2.2 (5) applies only to deep-seated combustion.

Related Item

- FR 38

Submitter Information Verification

Submitter Full Name: John Spalding

Organization: Healey Fire Protection Inc

Affiliation: Fire Suppression Systems Association (FSSA)

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Submittal Date: Thu Oct 24 16:03:17 EDT 2019

Committee: GFE-AAA

**Public Comment No. 12-NFPA 2001-2019 [Section No. 4.2.2]****4.2.2 Incompatible Hazards.**

Clean agents, except as noted in (5), shall not be used on fires involving the following materials unless the agents have been tested to the satisfaction of the authority having jurisdiction:

- (1) Certain chemicals or mixtures of chemicals, such as cellulose nitrate and gunpowder, which are capable of rapid oxidation in the absence of air
- (2) Reactive metals such as lithium, sodium, potassium, magnesium, titanium, zirconium, uranium, and plutonium
- (3) Metal hydrides
- (4) Chemicals capable of undergoing autothermal decomposition, such as certain organic peroxides, pyrophoric materials, and hydrazine
- (5) Class A fuels subject to smoldering (deep-seated) combustion. Exception: Inert-gas agents may be used in such applications. [see 3.3.38, *Smoldering (Deep-Seated) Combustion*]

Statement of Problem and Substantiation for Public Comment

There is no reason to disallow use of inert gas agents in deep-seated applications. NFPA 12 addresses use of CO₂ for deep-seated fire applications in "5.4 Carbon Dioxide Requirements for Deep-Seated Fires." Like CO₂, an inert gas agent displaces air and reduces availability of oxygen to a deep-seated combustion zone.

Related Item

- FR

Submitter Information Verification

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Submittal Date: Tue Nov 05 10:56:04 EST 2019

Committee: GFE-AAA



Public Comment No. 3-NFPA 2001-2019 [Section No. 4.2.2]

4.2.2 Incompatible Hazards.

Clean agents shall not be used on fires involving the following materials unless the agents have been tested to the satisfaction of the authority having jurisdiction:

- (1) Certain chemicals or mixtures of chemicals, such as cellulose nitrate and gunpowder, which are capable of rapid oxidation in the absence of air
- (2) Reactive metals such as lithium, sodium, potassium, magnesium, titanium, zirconium, uranium, and plutonium
- (3) Metal hydrides
- (4) Chemicals capable of undergoing autothermal decomposition, such as certain organic peroxides, pyrophoric materials, and hydrazine
- (5) Class A fuels subject to smoldering (deep-seated) combustion [see 3.3.38, *Smoldering (Deep-Seated) Combustion*]

Replace (5) above with:

(5) Fuels subject to deep-seated combustion. {see 3.3.38, *Deep-Seated Combustion*}

Statement of Problem and Substantiation for Public Comment

Clarifies that the caution is addressing deep-seated combustion which requires testing to the satisfaction of the authority having jurisdiction and aligns with the new definition, [3.3.38 Deep-Seated Combustion].

Related Item

- FR 39

Submitter Information Verification

Submitter Full Name: John Spalding

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Affiliation: Fire Suppression Systems Association (FSSA)

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Submittal Date: Fri Oct 25 10:35:19 EDT 2019

Committee: GFE-AAA

**Public Comment No. 13-NFPA 2001-2019 [Section No. 4.3.3]****4.3.3* Exposure to Inert Gas Agents.**

~~Unnecessary exposure to inert gas agent systems resulting in~~ Unnecessary personnel exposure to low-oxygen atmospheres shall resulting from discharge of inert gas agent systems shall be avoided.

4.3.3.1

Means shall be provided to limit exposure to low-oxygen atmospheres to no longer than 5 minutes.

4.3.3.2

The atmospheric correction factors specified in Table 7.3.3.3 shall be considered when determining the inert gas design concentrations.

4.3.3.3*

A pre-discharge alarm and time delay shall be provided in accordance with the provisions of Section 9.7 of this standard.

4.3.3.4

Unprotected personnel shall not enter the protected space during or after agent discharge.

4.3.3.5

The following additional provisions shall apply:

- (1) Inert gas systems designed to concentrations below 43 percent (corresponding to an oxygen concentration of 12 percent, sea level equivalent of oxygen) shall be permitted where means are provided to limit exposure to no longer than 5 minutes.
- (2) Inert gas systems designed to concentrations between 43 and 52 percent (corresponding to between 12 and 10 percent oxygen, sea level equivalent of oxygen) shall be permitted where means are provided to limit exposure to no longer than 3 minutes.
- (3) Inert gas systems designed to concentrations between 52 and 62 percent (corresponding to between 10 and 8 percent oxygen, sea level equivalent of oxygen) shall be permitted given the following:
 - (4) The space is normally unoccupied.
 - (5) Where personnel could possibly be exposed, means are provided to limit the exposure to less than 30 seconds.
- (6) Inert gas systems designed to concentrations above 62 percent (corresponding to 8 percent oxygen or below, sea level equivalent of oxygen) shall be used only in unoccupied areas where personnel are not exposed to such oxygen depletion.

Statement of Problem and Substantiation for Public Comment

Editorial simplifying change.

Related Item

- FR

Submitter Information Verification

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Submittal Date:	Tue Nov 05 11:10:36 EST 2019
Committee:	GFE-AAA

**Public Comment No. 14-NFPA 2001-2019 [Section No. 4.3.3]****4.3.3* Exposure to Inert Gas Agents.**

Unnecessary exposure to inert gas agent systems resulting in low-oxygen atmospheres shall be avoided.

4.3.3.1

Means shall be provided to limit personnel exposure to low-oxygen atmospheres to no longer than 5 minutes.

4.3.3.2

The atmospheric correction factors specified in Table 7.3.3.3 shall be considered when determining the inert gas design concentrations.

4.3.3.3*

A pre-discharge alarm and time delay shall be provided in accordance with the provisions of Section 9.7 of this standard.

4.3.3.4

Unprotected personnel shall not enter the protected space during or after agent discharge.

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The following additional provisions shall apply:

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- (2) Inert gas systems designed to concentrations between 43 and 52 percent (corresponding to between 12 and 10 percent oxygen, sea level equivalent of oxygen) shall be permitted where means are provided to limit exposure to no longer than 3 minutes.
- (3) Inert gas systems designed to concentrations between 52 and 62 percent (corresponding to between 10 and 8 percent oxygen, sea level equivalent of oxygen) shall be permitted given the following:
 - (4) The space is normally unoccupied.
 - (5) Where personnel could possibly be exposed, means are provided to limit the exposure to less than 30 seconds.
- (6) Inert gas systems designed to concentrations above 62 percent (corresponding to 8 percent oxygen or below, sea level equivalent of oxygen) shall be used only in unoccupied areas where personnel are not exposed to such oxygen depletion.

Statement of Problem and Substantiation for Public Comment

Clarifying editorial change.

Related Item

- FR

Submitter Information Verification

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Submittal Date:	Tue Nov 05 11:17:42 EST 2019
Committee:	GFE-AAA



Public Comment No. 15-NFPA 2001-2019 [Section No. 4.3.3.4]

4.3.3.4

~~Unprotected personnel shall.~~ Personnel without proper personal protective equipment shall not enter the protected space during or the protected space during agent discharge, or after agent discharge while a low-oxygen atmosphere still exists .

Statement of Problem and Substantiation for Public Comment

Clarifying editorial change.

Related Item

- FR

Submitter Information Verification

Submitter Full Name: Joseph Senecal

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Submittal Date: Tue Nov 05 11:19:49 EST 2019

Committee: GFE-AAA

**Public Comment No. 16-NFPA 2001-2019 [Section No. 4.3.3.5]****4.3.3.5**

The following additional provisions shall apply:

- (1) Inert gas systems designed to concentrations below 43 percent (corresponding to an oxygen concentration of 12 percent, sea level equivalent of oxygen) shall be permitted where means are provided to limit personnel exposure to no longer than 5 minutes.
- (2) Inert gas systems designed to concentrations between 43 and 52 percent (corresponding to between 12 and 10 percent oxygen, sea level equivalent of oxygen) shall be permitted where means are provided to limit personnel exposure to no longer than 3 minutes.
- (3) Inert gas systems designed to concentrations between 52 and 62 percent (corresponding to between 10 and 8 percent oxygen, sea level equivalent of oxygen) shall be permitted given the following:
 - (4) The space is normally unoccupied.
 - (5) Where personnel could possibly be exposed, means are provided to limit the exposure to less than 30 seconds.
- (6) Inert gas systems designed to concentrations above 62 percent (corresponding to 8 percent oxygen or below, sea level equivalent of oxygen) shall be used only in unoccupied areas where personnel are not exposed to such oxygen depletion.

Statement of Problem and Substantiation for Public Comment

Clarifying editorial change.

Related Item

- FR

Submitter Information Verification

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Submittal Date: Tue Nov 05 11:21:44 EST 2019

Committee: GFE-AAA



Public Comment No. 23-NFPA 2001-2019 [Section No. 5.1.2]

5.1.2* Quality.

Agent, including recycled agent, shall meet the standards of quality given in Table 5.1.2(a) through Table 5.1.2(d). Each batch of agent, both recycled and newly manufactured, shall be tested and certified to the specifications given in the tables. Agent blends shall remain homogeneous in storage and use within the listed temperature range and conditions of service that they will encounter.

5.1.2.1* Upper limit threshold concentrations shall be established for any impurity that may result in acute toxicity at concentrations below the cardiac sensitization NOEL.

A.4.1.2.1 The NFPA 2001 purity specifications and cardiac sensitization NOEL help to address the safety of agents included in the standard. Historically, the unstated safety assumptions have been as follows:

- The NOEL for cardiac sensitization will be protective for all other end points of acute toxicity
- 99% purity precludes the presence of impurities that could impact the NOEL for agent acute toxicity

However, impurities less than 1% can result in a NOEL for acute toxicity below the cardiac sensitization threshold.

Table 5.1.2(a) Halogenated Agent Quality Requirements

Property	Specification
Agent purity, mole %, minimum	99.0
Acidity, ppm (by weight HCl equivalent), maximum	3.0
Water content, weight %, maximum	0.001
Nonvolatile residues, g/100 ml maximum	0.05
Cis + trans kinetic dimer of HFP, ppm maximum*	1000
Thermodynamic dimer of HFP + HF addition product, ppm maximum**	100

Note:

The quality specifications for the kinetic and thermodynamic dimers noted below shall apply for agents manufactured using hexafluoropropylene – HFP (CAS 116-15-4) in the process:

*cis + trans kinetic dimer of HFP (CAS 2070-70-4)

** thermodynamic dimer of HFP (CAS 1584-03-8) + HF adduct of the thermodynamic dimer of HFP (CAS 30320-28-6)

Table 5.1.2(b) Inert Gas Agent Quality Requirements

Composition	Gas	IG-01	IG-100	IG-541	IG-55		
Composition, % by volume	N ₂	-		Minimum 99.9%	52% ± 4%	50% ± 5%	
	-	Ar	Minimum 99.9%	-		40% ± 4%	50% ± 5%
	-	CO ₂	-	-			8% + 1% - 0.0%
Water content, % by weight	-		Maximum 0.005%	Maximum 0.005%	Maximum 0.005%	Maximum 0.005%	

Table 5.1.2(c) HCFC Blend A Quality Requirements

Component	Amount (weight %)
HCFC-22	82% ± 0.8%
HCFC-124	9.50% ± 0.9%
HCFC-123	4.75% ± 0.5%
Isopropenyl-1-methylcyclohexene	3.75% ± 0.5%

Table 5.1.2(d) HFC Blend B Quality Requirements

Component	Amount
-----------	--------

	(weight %)
HFC-134a	86% ± 5%
HFC-125	9% ± 3%
CO ₂	5% ± 2%

Statement of Problem and Substantiation for Public Comment

This was deferred to the 2nd Revision Meeting for discussion pending review by the US EPA. The NFPA 2001 purity specifications and cardiac sensitization NOAEL help to address the safety of agents included in the standard. But, the unstated safety assumptions ignore the possibility that impurity levels less than 1.0% can result in a NOAEL for acute toxicity below the cardiac sensitization NOAEL. Inclusion of upper limit impurity thresholds in industry standards for these impurities provides transparency on the need to address these impurities to preserve the safety of agent supplied from all manufacturers and all agent manufacturing processes.

Related Item

- NFPA GFE (2001) PI 74 – Quality requirements change

Submitter Information Verification

Submitter Full Name: Paul Rivers

Organization: 3M Scott Safety

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Submittal Date: Thu Nov 14 15:01:39 EST 2019

Committee: GFE-AAA

**Public Comment No. 4-NFPA 2001-2019 [Section No. 5.2.1.6]****5.2.1.6** Dirt Trap.**5.2.1.6.1**

A dirt trap consisting of a tee with a capped nipple, at least 2 in. (50 mm) and not more than 4 pipe diameters long, shall be installed after the last nozzle on each pipe run.

5.2.1.6.2

Single nozzle systems with a single pipe run from a clean agent container to the nozzle shall not be required to have a dirt trap.

Remove Section 5.2.1.6., 5.2.1.6.1 and 5.2.1.6.2.

Statement of Problem and Substantiation for Public Comment

The standard currently addresses the need for internal cleaning and swabbing of the distribution piping in 4.2.1.5. Further, the current standard, 7.4.15 requires: "A flow test using nitrogen or an inert gas shall be performed on the piping network to verify that flow is continuous."

The concept of the dirt trap was borrowed from NFPA 12 which covers carbon dioxide extinguishing systems. Generally, the clean agent fire suppression system's piping networks are shorter in overall length and the nozzle orifices are typically larger than those found in CO2 systems. The cleanliness of the piping network is accomplished by the previously stated two (2) standing requirements and the need for the dirt trap is unnecessary.

Related Item

- FR 9

Submitter Information Verification

Submitter Full Name: John Spalding

Organization: Healey Fire Protection Inc

Affiliation: Fire Suppression Systems Association (FSSA)

Street Address:

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Submission Date: Fri Oct 25 12:00:58 EDT 2019

Committee: GFE-AAA



Public Comment No. 22-NFPA 2001-2019 [Section No. 11.3 [Excluding any Sub-Sections]]

At least semiannually, the agent quantity and pressure of ~~refillable~~ containers shall be checked.

Statement of Problem and Substantiation for Public Comment

This statement is overly restrictive in it's application as it should relate to both agent storage containers intended to be refilled or replaced.

Related Item

- PI-63, FR-11

Submitter Information Verification

Submitter Full Name: Blake Shugarman

Organization: UL LLC

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Submittal Date: Thu Nov 14 14:45:54 EST 2019

Committee: GFE-AAA



Public Comment No. 18-NFPA 2001-2019 [Section No. A.7.2.2.2.1]

A.7.2.2.2.1

This standard requires that the flame-extinguishing concentration of a gaseous agent for a Class B fuel be determined by the cup burner method. Cup burner testing in the past has involved a variety of techniques, apparatus, and investigators. It was reported by Senecal (2005) that significant inconsistencies are apparent in Class B flame-extinguishing data for inert gases currently in use in national and international standards. In 2003, the Technical Committee for NFPA 2001 appointed a task group to develop an improved cup burner test method. Through this effort, the degree of standardization of the cup burner test method was significantly improved. A standard cup burner test procedure with defined apparatus has now been established and is outlined in Annex B. Values for minimum flame-extinguishing concentration (MEC) for gaseous agents addressed in this standard, ~~as determined by the revised test method, are standard are~~ given in Table A.7.2.2.2.1. ~~Values for MEC that were determined by the 2004 test method are retained in this edition for the purpose of providing an MEC reference where data obtained by the revised test method were not available. It is intended that in subsequent editions the 2004 MEC data can be deleted.~~ While MEC data is presented for n-heptane, this does not replace the requirement to determine the MEC for the specific fuel. Other fuels can require significantly higher extinguishing concentrations.

Table A [A revised Table A .7.2.2.2.1 Minimum Flame Extinguishing Concentration (Fuel: n-heptane)
- MEC (vol %) Agent 2004 Test Method 2008 Test Method** FIC-13i1 3.2* - FK-5-1-12 4.5 - HCFC Blend A 9.9 - HCFC-124 6.6 - HFC-125 8.7 - HFC-227ea 6.6† 6.62 HFC-23 12.9 - HFC-236fa 6.3 - HFC Blend B 11.3 - IG-01 42 - IG-100 31* 32.2 IG-541 31 - IG-55 35 -

*Not derived from standardized cup burner method.

†A value of cup burner extinguishing concentration of 6.7 percent for HCF-227ea for commercial heptane fuel.

**A working group appointed by the then NFPA 2001 technical committee revised Annex B to include a refinement of the method reported in the 2004 and earlier editions.

1 is included in the supporting attachment.]

Additional Proposed Changes

File Name	Description	Approved
Comments_on_NFPA_2001_A.5.4.2.1_191106.docx	Comments for 7.2.2.2.1	
FM_Witness_Report_January_2003_3016214.pdf	FM witness report for IG cup burner tests	

Statement of Problem and Substantiation for Public Comment

1. There is only one test method, as given in Annex B (Cup Burner Method for Determining the Minimum Concentration of Gaseous Agent for Flame Extinguishment), adopted in 2008. Reference to earlier versions of Annex B are unnecessary.
2. The 2018 edition stated "It is intended that in subsequent editions that the 2004 MEC data can be deleted."
3. NFPA-GFE, by including MEC values in Table A.7.2.2.2.1, implicitly approves the values. Some MEC values currently listed appear without suitable technical substantiation. It is in the interest of good fire protection that only verified data be included in this table. Revising the inert gas MEC values as proposed also bring Table A.7.2.2.2.1 into better alignment with the inert gas Class B MEC values reported in ISO 14520, which are: ISO 14520 Part 12, IG-01 MEC = 39.1 vol %; ISO 14520 Part 13, IG-100 MEC = 32.3 vol %; ISO 14520 Part 14, IG-55 MEC = 36.5 vol %; ISO 14520 Part 15, IG-541 MEC = 33.8 vol %. Note that that the uncertainty in cup burner MEC values from different laboratories is about 0.7 % for IG-100 and about 0.14 % for HFC-227ea (Senecal 2008), which is assumed to approximate the experimental uncertainties for the other inert gas and halocarbon agents, respectively.

Related Item

- FR

Submitter Information Verification

Submitter Full Name: K. Penden

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Submittal Date:	Wed Nov 06 11:34:31 EST 2019
Committee:	GFE-AAA

A.7.2.2.2.1

Comment:

Revise text as follows:

“This standard requires that the flame extinguishing concentration of a gaseous agent for a Class B fuel be determined by the cup burner method. Cup burner testing in the past has involved a variety of techniques, apparatus, and investigators. It was reported by Senecal (2005) that significant inconsistencies are apparent in Class B flame extinguishing data for inert gases currently in use in national and international standards. In 2003, the Technical Committee for NFPA 2001 appointed a task group to develop an improved cup burner test method. Through this effort, the degree of standardization of the cup burner test method has been significantly improved. A standard cup burner test procedure with defined apparatus has now been established and is outlined in Annex B. Values for minimum flame extinguishing concentration (MEC) for gaseous agents addressed in this standard, as determined by the revised test method, are given in Table A.7.2.2.2.1. ~~Values for MEC that were determined by the 2004 test method are retained in this edition for the purpose of providing an MEC reference where data obtained by the revised test method were not available. It is intended that in subsequent editions the 2004 MEC data can be deleted.~~”

Substantiation:

1. There is only one test method, as given in Annex B (Cup Burner Method for Determining the Minimum Concentration of Gaseous Agent for Flame Extinguishment), adopted in 2008. Reference to earlier versions of Annex B are unnecessary.
2. The 2018 edition stated “It is intended that in subsequent editions that the 2004 MEC data can be deleted.”

Table A.7.2.2.1**Comment:**

1. Remove column "2004 Test Method"
2. Change remaining column heading from "2008 Test Method" to "MEC (vol %)."
3. Delete existing footnotes.
4. Include Class B MEC values which have been verified for n-Heptane fuel.*

*A cup burner MEC value is verified if it was determined in accordance with Annex B (Cup Burner) as affirmed by a listing or approval body, a peer reviewed study, an ISO 17025 accredited laboratory, or similar report by a qualified laboratory acceptable to the NFPA-GFE technical committee, which has final authority on data acceptance.

5. Revise Table A.7.2.2.1 as shown, including revised MEC values for the inert gas agents.

Table A.7.2.2.1 Minimum Flame Extinguishing Concentration (Fuel: n-Heptane)

Agent	By 2004 Test Method	By 2008 Test Method**	MEC (vol %)	Note
FIC-13I1	3.2*	TBD		
FK-5-1-12	4.5	TBD	4.5	Ref by 3M
HCFC Blend A	9.9	TBD		
HCFC-124	6.6	TBD		
HFC-125	8.7	TBD	8.7	Ref by Chemours
HCFC-227ea	6.6†	6.62	6.62	See ref. 1
HFC-23	12.9	TBD	12.9	Ref by Chemours
HFC-236fa	6.3	TBD	6.3	Ref by Chemours
IG-01	42	TBD	<u>43.2</u>	See ref. 2
IG-100	31*	32.2	<u>32.6</u>	See ref. 2
IG-541	31	TBD	<u>34.4</u>	See ref. 2
IG-55	35	TBD	<u>36.2</u>	See ref. 2

~~*Not derived from standardized cup burner method.~~

~~†A value of cup burner extinguishing concentration of 6.7 percent for HCF-227ea for commercial heptane fuel.~~

~~** A working group appointed by the then NFPA 2001 technical committee revised Annex B to include refinements of the method reported in the 2004 and earlier editions.~~

References

1. Senecal, J.A., "Standardizing the Measurement of Minimum Extinguishing Concentrations of Gaseous Agents," *Fire Technology*, Vol. 44, No. 3, pp. 207-220, September 2008. [This reference is in Annex E.]
2. FM Approvals Contract Test Report, "Comparative cup burner Class B extinguishment tests of inert gas fire extinguishing agents," Project 3016214, January 6, 2005. [Copy submitted with this comment.]

Substantiation. NFPA-GFE, by including MEC values in Table A.7.2.2.1, implicitly approves the values. Some MEC values currently listed appear without suitable technical substantiation. It is in the interest of good fire protection that only verified data be included in this table. Revising the inert gas MEC values as proposed also bring Table A.7.2.2.1 into better alignment with the inert gas Class B MEC values reported in ISO 14520, which are: ISO 14520 Part 12, IG-01 MEC = 39.1 vol %; ISO 14520 Part 13, IG-100 MEC = 32.3 vol %; ISO 14520 Part 14, IG-55 MEC = 36.5 vol %; ISO 14520 Part 15, IG-541 MEC = 33.8 vol %. Note that that the uncertainty in cup burner MEC values from different laboratories is about 0.7 % for IG-100 and about 0.14 % for HFC-227ea (Senecal 2008), which is assumed to approximate the experimental uncertainties for the other inert gas and halocarbon agents, respectively.



Public Comment No. 21-NFPA 2001-2019 [Section No. A.7.2.2.2.1]

A.7.2.2.2.1

This standard requires that the flame-extinguishing concentration of a gaseous agent for a Class B fuel be determined by the cup burner method. Cup burner testing in the past has involved a variety of techniques, apparatus, and investigators. It was reported by Senecal (2005) that significant inconsistencies are apparent in Class B flame-extinguishing data for inert gases currently in use in national and international standards. In 2003, the Technical Committee for NFPA 2001 appointed a task group to develop an improved cup burner test method. Through this effort, the degree of standardization of the cup burner test method was significantly improved. A standard cup burner test procedure with defined apparatus has now been established and is outlined in Annex B. Values for minimum flame-extinguishing concentration (MEC) for gaseous agents addressed in this standard, as determined by the revised test method, are given in Table A.7.2.2.2.1. Values for MEC that were determined by the 2004 test method are retained in this edition for the purpose of providing an MEC reference where data obtained by the revised test method were not available. It is intended that in subsequent editions the 2004 MEC data can be deleted. While MEC data is presented for n-heptane, this does not replace the requirement to determine the MEC for the specific fuel. Other fuels can require significantly higher extinguishing concentrations.

Table A.7.2.2.2.1 Minimum Flame Extinguishing Concentration (Fuel: n-heptane)

Agent	2004 Test Method	MEC (vol %)
		2008 Test Method**
<u>Halocarbon Blend 55</u>		<u>5.4</u>
FIC-1311	3.2*	-
FK-5-1-12	4.5	-
HCFC Blend A	9.9	-
HCFC-124	6.6	-
HFC-125	8.7	-
HFC-227ea	6.6†	6.62
HFC-23	12.9	-
HFC-236fa	6.3	-
HFC Blend B	11.3	-
IG-01	42	-
IG-100	31*	32.2
IG-541	31	-
IG-55	35	-

*Not derived from standardized cup burner method.

†A value of cup burner extinguishing concentration of 6.7 percent for HCF-227ea for commercial heptane fuel.

**A working group appointed by the then NFPA 2001 technical committee revised Annex B to include a refinement of the method reported in the 2004 and earlier editions.

Statement of Problem and Substantiation for Public Comment

Enter Halocarbon Blend 55 MEC of 5.4 Vol% to the Table A.7.2.2.2.1

Substantiation: Addition of MEC for new agent "Halocarbon Blend 55" from NFPA cup burner test with n-heptane fuel. UL witnessed test report is in the development and will be available prior to the 2nd Draft meeting.

Related Item

- FR

Submitter Information Verification

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Submittal Date: Thu Nov 14 10:25:24 EST 2019

Committee: GFE-AAA



Public Comment No. 17-NFPA 2001-2019 [Section No. A.7.3.2]

A.7.3.2

The volume of inert gas clean agent required to develop a given concentration will be greater than the final volume remaining in the same enclosure. In most cases, the inert gas clean agent must be applied in a manner that promotes progressive mixing of the atmosphere. As the clean agent is injected, the displaced atmosphere is exhausted freely from the enclosure through small openings or through special vents. Some inert gas clean agent is therefore lost with the vented atmosphere. This loss becomes greater at high concentrations. This method of application is called "free efflux" flooding.

Under these conditions, the volume of inert gas clean agent required to develop a given concentration in the atmosphere is expressed by one of the following equations:

$$e^x = \frac{100}{100 - \% \text{ IG}} \quad [\text{A.7.3.2a}]$$

or

$$X = 2.303 \log_{10} \frac{100}{100 - \% \text{ IG}} \quad [\text{A.7.3.2b}]$$

where:

% IG = volume percent of inert gas

X = volume of inert gas added per volume of space

Table A.7.3.2(a) through Table A.7.3.2(h) provide the quantity of clean agent needed to achieve design concentration. Insert revised Tables A.7.3.2(a) through A.7.3.2(h), attached to this Comment.

Table A.7.3.2(a) IG-01 Total Flooding Quantity (US Units)^a

Temp (t)	Volume (s)	Volume Requirements of Agent per Unit Volume of Hazard (V _{agent} /V _{enclosure}) ^b							
		Design Concentration (% by Volume) ^e							
		34	37	40	42	47	49	58	62
(°F) ^c	(ft ³ /lb) ^d								
-40	7.774	0.524	0.583	0.645	0.687	0.801	0.850	1.095	1.221
-30	7.959	0.512	0.569	0.630	0.671	0.782	0.830	1.069	1.192
-20	8.144	0.500	0.556	0.615	0.656	0.765	0.811	1.045	1.165
-10	8.329	0.489	0.544	0.602	0.642	0.748	0.793	1.022	1.140
0	8.514	0.479	0.532	0.589	0.628	0.731	0.776	0.999	1.115
10	8.699	0.469	0.521	0.576	0.614	0.716	0.759	0.978	1.091
20	8.884	0.459	0.510	0.564	0.601	0.701	0.743	0.958	1.068
30	9.069	0.449	0.500	0.553	0.589	0.687	0.728	0.938	1.047
40	9.254	0.440	0.490	0.541	0.577	0.673	0.714	0.920	1.026
50	9.439	0.432	0.480	0.531	0.566	0.660	0.700	0.902	1.006
60	9.624	0.424	0.471	0.521	0.555	0.647	0.686	0.884	0.986
70	9.809	0.416	0.462	0.511	0.545	0.635	0.673	0.868	0.968
80	9.994	0.408	0.453	0.501	0.535	0.623	0.661	0.851	0.950
90	10.179	0.400	0.445	0.492	0.525	0.612	0.649	0.836	0.932
100	10.364	0.393	0.437	0.483	0.516	0.601	0.637	0.821	0.916
110	10.549	0.386	0.430	0.475	0.507	0.590	0.626	0.807	0.900
120	10.734	0.380	0.422	0.467	0.498	0.580	0.615	0.793	0.884
130	10.919	0.373	0.415	0.459	0.489	0.570	0.605	0.779	0.869
140	11.104	0.367	0.408	0.451	0.481	0.561	0.595	0.766	0.855
150	11.289	0.361	0.401	0.444	0.473	0.552	0.585	0.754	0.841
160	11.474	0.355	0.395	0.437	0.466	0.543	0.576	0.742	0.827

Temp (t)	Specific	Volume Requirements of Agent per Unit Volume of Hazard (V _{agent} /V _{enclosure}) ^b							
	Vapor								
	Volume (s)	Design Concentration (% by Volume) ^e							
(°F) ^c	(ft ³ /lb) ^d	34	37	40	42	47	49	58	62
170	11.659	0.350	0.389	0.430	0.458	0.534	0.567	0.730	0.814
180	11.844	0.344	0.383	0.423	0.451	0.526	0.558	0.718	0.801
190	12.029	0.339	0.377	0.417	0.444	0.518	0.549	0.707	0.789
200	12.214	0.334	0.371	0.410	0.437	0.510	0.541	0.697	0.777

^aThe manufacturer's listing specifies the temperature range for operation.

^bX [agent volume requirements (ft³/ft³)] = volume of agent required per cubic foot of protected volume to produce indicated concentration at temperature specified.

$$X = 2.303 \left(\frac{s_0}{s} \right) \log_{10} \left(\frac{100}{100-C} \right) = \left(\frac{s_0}{s} \right) \ln \left(\frac{100}{100-C} \right)$$

where:

s_0 [specific volume (ft³/lb)] = specific volume of inert gas agent at 70°F and 14.7 psi absolute

t [temperature (°F)] = design temperature in the hazard area.

s [specific volume (ft³/lb)] = specific volume of IG-01 vapor can be approximated by $s = 8.514 + 0.0185t$, where t = temperature (°F).

^eC [concentration (%)] = volumetric concentration of IG-01 in air at the temperature indicated.

Table A.7.3.2(b) IG-01 Total Flooding Quantity (SI Units)^a

Temp (t)	Specific	Volume Requirements of Agent per Unit Volume of Hazard (V _{agent} /V _{enclosure}) ^b							
	Vapor								
	Volume (s)	Design Concentration (% by Volume) ^e							
(°C) ^c	(m ³ /kg) ^d	34	37	40	42	47	49	58	62
-20	0.5269	0.4828	0.5368	0.5935	0.6329	0.7376	0.7823	1.0079	1.1242
-10	0.5477	0.4644	0.5164	0.5710	0.6089	0.7096	0.7526	0.9696	1.0815
0	0.5685	0.4474	0.4975	0.5501	0.5866	0.6837	0.7251	0.9342	1.0419
10	0.5893	0.4316	0.4800	0.5307	0.5659	0.6595	0.6995	0.9012	1.0052
15	0.6101	0.4169	0.4636	0.5126	0.5466	0.6370	0.6756	0.8705	0.9709
20	0.6309	0.4032	0.4483	0.4957	0.5286	0.616	0.6534	0.8418	0.9389
30	0.6517	0.3903	0.4340	0.4798	0.5117	0.5964	0.6325	0.8149	0.9089
35	0.6725	0.3782	0.4206	0.4650	0.4959	0.5779	0.6129	0.7897	0.8808
40	0.6933	0.3669	0.4080	0.4511	0.4810	0.5606	0.5946	0.7660	0.8544
50	0.7141	0.3562	0.3961	0.4379	0.4670	0.5443	0.5772	0.7437	0.8295
60	0.7349	0.3461	0.3849	0.4255	0.4538	0.5289	0.5609	0.7226	0.8060
70	0.7557	0.3366	0.3743	0.4138	0.4413	0.5143	0.5455	0.7027	0.7838
80	0.7765	0.3276	0.3643	0.4027	0.4295	0.5005	0.5309	0.6839	0.7628
90	0.7973	0.3190	0.3548	0.3922	0.4183	0.4875	0.5170	0.6661	0.7429
100	0.8181	0.3109	0.3457	0.3822	0.4076	0.4751	0.5039	0.6491	0.724
110	0.5269	0.4828	0.5368	0.5935	0.6329	0.7376	0.7823	1.0079	1.1242

Temp (t) (°C) ^c	Specific Vapor	Volume Requirements of Agent per Unit Volume of Hazard (V _{agent} /V _{enclosure}) ^b							
	Volume (s)	Design Concentration (% by Volume) ^e							
	(m ³ /kg) ^d	34	37	40	42	47	49	58	62
120	0.5477	0.4644	0.5164	0.5710	0.6089	0.7096	0.7526	0.9696	1.0815

^aThe manufacturer's listing specifies the temperature range for operation.

^bX [agent volume requirements (m³/m³)] = volume of agent required per cubic meter of protected volume to produce indicated concentration at temperature specified.

$$X = 2.303 \left(\frac{s_0}{s} \right) \log_{10} \left(\frac{100}{100 - C} \right) = \left(\frac{s_0}{s} \right) \ln \left(\frac{100}{100 - C} \right)$$

where:

s_0 [specific volume (m³/kg)] = specific volume of inert gas agent at 21°C and 1.013 bar absolute

t [temperature (°C)] = design temperature in the hazard area.

s [specific volume (m³/kg)] = specific volume of IG-01 vapor can be approximated by $s = 0.5685 + 0.00208t$, where t = temperature (°C).

^eC [concentration (%)] = volumetric concentration of IG-01 in air at the temperature indicated.

Table A.7.3.2(c) IG-100 Total Flooding Quantity (U.S. Units)^a

Temp (t) (°F) ^c	Specific Vapor	Volume Requirements of Agent per Unit Volume of Hazard (V _{agent} /V _{enclosure}) ^b							
	Volume (s)	Design Concentration (% by Volume) ^e							
	(ft ³ /lb) ^d	34	37	40	42	47	49	58	62
-40	10.934	0.522	0.581	0.642	0.685	0.798	0.847	1.091	1.216
-30	11.195	0.510	0.567	0.627	0.669	0.780	0.827	1.065	1.188
-20	11.455	0.499	0.554	0.613	0.654	0.762	0.808	1.041	1.161
-10	11.716	0.488	0.542	0.599	0.639	0.745	0.790	1.018	1.135
0	11.976	0.477	0.530	0.586	0.625	0.729	0.773	0.996	1.111
10	12.237	0.467	0.519	0.574	0.612	0.713	0.756	0.975	1.087
20	12.497	0.457	0.508	0.562	0.599	0.698	0.741	0.954	1.064
30	12.758	0.448	0.498	0.550	0.587	0.684	0.726	0.935	1.043
40	13.018	0.439	0.488	0.539	0.575	0.670	0.711	0.916	1.022
50	13.279	0.430	0.478	0.529	0.564	0.657	0.697	0.898	1.002
60	13.540	0.422	0.469	0.519	0.553	0.645	0.684	0.881	0.982
70	13.800	0.414	0.460	0.509	0.543	0.632	0.671	0.864	0.964
80	14.061	0.406	0.452	0.499	0.533	0.621	0.658	0.848	0.946
90	14.321	0.399	0.444	0.490	0.523	0.609	0.646	0.833	0.929
100	14.582	0.392	0.436	0.482	0.514	0.599	0.635	0.818	0.912
110	14.842	0.385	0.428	0.473	0.505	0.588	0.624	0.803	0.896
120	15.103	0.378	0.421	0.465	0.496	0.578	0.613	0.790	0.881
130	15.363	0.372	0.413	0.457	0.487	0.568	0.602	0.776	0.866
140	15.624	0.366	0.407	0.449	0.479	0.559	0.592	0.763	0.851

Temp (t)	Volume (s)	Volume Requirements of Agent per Unit Volume of Hazard (V _{agent} /V _{enclosure}) ^b							
		Design Concentration (% by Volume) ^e							
		34	37	40	42	47	49	58	62
(°F) ^c	(ft ³ /lb) ^d								
150	15.885	0.360	0.400	0.442	0.471	0.549	0.583	0.751	0.837
160	16.145	0.354	0.393	0.435	0.464	0.541	0.573	0.739	0.824
170	16.406	0.348	0.387	0.428	0.456	0.532	0.564	0.727	0.811
180	16.666	0.343	0.381	0.421	0.449	0.524	0.555	0.716	0.798
190	16.927	0.337	0.375	0.415	0.442	0.516	0.547	0.705	0.786
200	17.187	0.332	0.370	0.409	0.436	0.508	0.539	0.694	0.774

^aThe manufacturer's listing specifies the temperature range for operation.

^bX [agent volume requirements (ft³/ft³)] = volume of agent required per cubic foot of protected volume to produce indicated concentration at temperature specified.

$$X = 2.303 \left(\frac{s_0}{s} \right) \log_{10} \left(\frac{100}{100-C} \right) = \left(\frac{s_0}{s} \right) \ln \left(\frac{100}{100-C} \right)$$

where:

s₀ [specific volume (ft³/lb)] = specific volume of inert gas agent at 70°F and 14.7 psi absolute

t [temperature (°F)] = design temperature in the hazard area.

^ds [specific volume (ft³/lb)] = specific volume of IG-100 vapor can be approximated by s = 11.976 + 0.02606t, where t = temperature (°F).

^eC [concentration (%)] = volumetric concentration of IG-100 in air at the temperature indicated.

Table A.7.3.2(d) IG-100 Total Flooding Quantity (SI Units)^a

Temp (t)	Volume (s)	Volume Requirements of Agent per Unit Volume of Hazard (V _{agent} /V _{enclosure}) ^b							
		Design Concentration (% by Volume) ^e							
		34	37	40	42	47	49	58	62
(°C) ^c	(m ³ /kg) ^d								
-40	0.6826	0.5225	0.5809	0.6423	0.6849	0.7983	0.8466	1.0908	1.2166
-30	0.7119	0.5009	0.5570	0.6159	0.6567	0.7654	0.8118	1.0459	1.1665
-20	0.7412	0.4811	0.5350	0.5915	0.6308	0.7352	0.7797	1.0045	1.1204
-10	0.7704	0.4629	0.5147	0.5691	0.6069	0.7073	0.7501	0.9664	1.0779
0	0.7997	0.4459	0.4959	0.5482	0.5846	0.6814	0.7227	0.9310	1.0384
10	0.8290	0.4302	0.4783	0.5289	0.5640	0.6573	0.6971	0.8981	1.0017
20	0.8582	0.4155	0.4621	0.5109	0.5448	0.6349	0.6734	0.8676	0.9677
30	0.8875	0.4018	0.4468	0.4940	0.5268	0.6140	0.6512	0.8389	0.9357
40	0.9168	0.3890	0.4325	0.4782	0.5100	0.5943	0.6304	0.8121	0.9058
50	0.9461	0.3769	0.4191	0.4634	0.4942	0.5759	0.6108	0.7870	0.8778
60	0.9753	0.3657	0.4066	0.4495	0.4794	0.5587	0.5925	0.7634	0.8515
70	1.0046	0.3550	0.3947	0.4364	0.4654	0.5424	0.5753	0.7411	0.8266
80	1.0339	0.3449	0.3835	0.4241	0.4522	0.5270	0.5590	0.7201	0.8032
90	1.0631	0.3355	0.3730	0.4124	0.4398	0.5126	0.5436	0.7004	0.7812

Temp (t)	Specific Vapor	Volume Requirements of Agent per Unit Volume of Hazard (V _{agent} /V _{enclosure}) ^b							
	Volume (s)	Design Concentration (% by Volume) ^e							
	(°C) ^c	(m ³ /kg) ^d	34	37	40	42	47	49	58
100	1.0924	0.3265	0.3630	0.4013	0.4280	0.4988	0.5290	0.6816	0.7602

^aThe manufacturer's listing specifies the temperature range for operation.

^bX [agent volume requirements (m³/m³)] = volume of agent required per cubic meter of protected volume to produce indicated concentration at temperature specified.

$$X = 2.303 \left(\frac{s_0}{s} \right) \log_{10} \left(\frac{100}{100 - C} \right) = \left(\frac{s_0}{s} \right) \ln \left(\frac{100}{100 - C} \right)$$

where:

s_0 [specific volume (m³/kg)] = specific volume of inert gas agent at 21°C and 1.013 bar absolute

t [temperature (°C)] = design temperature in the hazard area.

s [specific volume (m³/kg)] = specific volume of IG-100 vapor can be approximated by $s = 0.7997 + 0.00293t$, where t = temperature (°C).

^eC [concentration (%)] = volumetric concentration of IG-100 in air at the temperature indicated.

Table A.7.3.2(e) IG-541 Total Flooding Quantity (U.S. Units)^a

Temp (t)	Specific	Volume Requirements of Agent per Unit Volume of Hazard							
	Vapor	(V _{agent} /V _{enclosure}) ^b							
	Volume (s)	Design Concentration (% by Volume) ^e							
	(°F) ^c	(ft ³ /lb) ^d	34	38	42	46	50	54	58
−40	9.001	0.524	0.603	0.686	0.802	0.873	0.977	1.096	1.218
−30	9.215	0.513	0.590	0.672	0.760	0.855	0.958	1.070	1.194
−20	9.429	0.501	0.576	0.657	0.743	0.836	0.936	1.046	1.166
−10	9.644	0.490	0.563	0.642	0.726	0.817	0.915	1.022	1.140
0	9.858	0.479	0.551	0.628	0.710	0.799	0.895	1.000	1.116
10	10.072	0.469	0.539	0.615	0.695	0.782	0.876	0.979	1.092
20	10.286	0.459	0.528	0.602	0.681	0.766	0.858	0.958	1.069
30	10.501	0.450	0.517	0.590	0.667	0.750	0.840	0.939	1.047
40	10.715	0.441	0.507	0.578	0.653	0.735	0.824	0.920	1.026
50	10.929	0.432	0.497	0.566	0.641	0.721	0.807	0.902	1.006
60	11.144	0.424	0.487	0.555	0.628	0.707	0.792	0.885	0.987
70	11.358	0.416	0.478	0.545	0.616	0.693	0.777	0.868	0.968
80	11.572	0.408	0.469	0.535	0.605	0.681	0.762	0.852	0.950
90	11.787	0.401	0.461	0.525	0.594	0.668	0.749	0.836	0.933
100	12.001	0.393	0.453	0.516	0.583	0.656	0.735	0.821	0.916
110	12.215	0.386	0.445	0.507	0.573	0.645	0.722	0.807	0.900
120	12.429	0.380	0.437	0.498	0.563	0.634	0.710	0.793	0.884
130	12.644	0.373	0.430	0.489	0.554	0.623	0.698	0.779	0.869
140	12.858	0.367	0.422	0.481	0.544	0.612	0.686	0.766	0.855

Temp (t)	Volume (s)	Volume Requirements of Agent per Unit Volume of Hazard (V _{agent} /V _{enclosure}) ^b							
		Design Concentration (% by Volume) ^e							
(°F) ^c	(ft ³ /lb) ^d	34	38	42	46	50	54	58	62
150	13.072	0.361	0.415	0.473	0.535	0.602	0.675	0.754	0.841
160	13.287	0.355	0.409	0.466	0.527	0.593	0.664	0.742	0.827
170	13.501	0.350	0.402	0.458	0.518	0.583	0.653	0.730	0.814
180	13.715	0.344	0.396	0.451	0.510	0.574	0.643	0.718	0.801
190	13.930	0.339	0.390	0.444	0.502	0.565	0.633	0.707	0.789
200	14.144	0.334	0.384	0.437	0.495	0.557	0.624	0.697	0.777

^aThe manufacturer's listing specifies the temperature range for operation.

^bX [agent volume requirements (ft³/ft³) = volume of agent required per cubic foot of protected volume to produce indicated concentration at temperature specified.

$$X = 2.303 \left(\frac{s_0}{s} \right) \log_{10} \left(\frac{100}{100-C} \right) = \left(\frac{s_0}{s} \right) \ln \left(\frac{100}{100-C} \right)$$

where:

s_0 [specific volume (ft³/lb)] = specific volume of inert gas agent at 70°F and 14.7 psi absolute

t [temperature (°F)] = design temperature in the hazard area.

s [specific volume (ft³/lb)] = specific volume of IG-541 vapor can be approximated by $s = 9.8579 + 0.02143t$, where t = temperature (°F).

^eC [concentration (%)] = volumetric concentration of IG-541 in air at the temperature indicated.

Table A.7.3.2(f) IG-541 Total Flooding Quantity (SI Units)^a

Temp (t)	Volume (s)	Volume Requirements of Agent per Unit Volume of Hazard (V _{agent} /V _{enclosure}) ^b							
		Design Concentration (% by Volume) ^e							
(°C) ^c	(m ³ /kg) ^d	34	38	42	46	50	54	58	62
-40	0.562	0.524	0.602	0.686	0.776	0.873	0.978	1.093	1.219
-30	0.586	0.502	0.578	0.658	0.745	0.838	0.938	1.048	1.169
-20	0.610	0.482	0.555	0.633	0.716	0.805	0.902	1.007	1.124
-10	0.634	0.464	0.534	0.609	0.689	0.775	0.868	0.969	1.081
0	0.659	0.447	0.515	0.587	0.664	0.746	0.836	0.934	1.042
10	0.683	0.432	0.497	0.566	0.640	0.720	0.807	0.901	1.005
20	0.707	0.417	0.480	0.547	0.619	0.696	0.780	0.871	0.971
30	0.731	0.403	0.464	0.529	0.598	0.673	0.754	0.842	0.940
40	0.755	0.391	0.449	0.512	0.579	0.652	0.730	0.816	0.910
50	0.779	0.379	0.436	0.496	0.562	0.632	0.708	0.791	0.882
60	0.803	0.367	0.423	0.482	0.545	0.613	0.687	0.767	0.855
70	0.827	0.357	0.410	0.468	0.529	0.595	0.667	0.745	0.831
80	0.851	0.347	0.399	0.455	0.514	0.578	0.648	0.724	0.807
90	0.875	0.337	0.388	0.442	0.500	0.563	0.630	0.704	0.785

Temp (t)	Volume (s)	Volume Requirements of Agent per Unit Volume of Hazard (V _{agent} /V _{enclosure}) ^b							
		Design Concentration (% by Volume) ^e							
		34	38	42	46	50	54	58	62
(°C) ^c	(m ³ /kg) ^d								
100	0.900	0.328	0.378	0.430	0.487	0.548	0.613	0.685	0.764

^a The manufacturer's listing specifies the temperature range for operation.

^b X [agent volume requirements (m³/m³) = volume of agent required per cubic meter of protected volume to produce indicated concentration at temperature specified.

$$X = 2.303 \left(\frac{s_0}{s} \right) \log_{10} \left(\frac{100}{100 - C} \right) = \left(\frac{s_0}{s} \right) \ln \left(\frac{100}{100 - C} \right)$$

where:

s₀ [specific volume (m³/kg)] = specific volume of inert gas agent at 21°C and 1.013 bar absolute

C_t [temperature (°C)] = design temperature in the hazard area.

d_s [specific volume (m³/kg)] = specific volume of IG-541 vapor can be approximated by $s = 0.65799 + 0.00239t$, where t = temperature (°C).

^eC [concentration (%)] = volumetric concentration of IG-541 in air at the temperature indicated.

Table A.7.3.2(g) IG-55 Total Flooding Quantity (U.S. Units)^a

Temp (t)	Volume (s)	Volume Requirements of Agent per Unit Volume of Hazard (V _{agent} /V _{enclosure}) ^b							
		Design Concentration (% by Volume) ^e							
		34	38	42	46	50	54	58	62
(°F) ^c	(ft ³ /lb) ^d								
-40	9.02108	0.524	0.603	0.688	0.778	0.875	0.980	1.095	1.221
-30	9.23603	0.512	0.589	0.672	0.760	0.854	0.957	1.069	1.193
-20	9.45099	0.501	0.576	0.656	0.742	0.835	0.935	1.045	1.166
-10	9.66594	0.489	0.563	0.642	0.726	0.816	0.915	1.022	1.140
0	9.88090	0.479	0.551	0.628	0.710	0.799	0.895	1.000	1.115
10	10.09586	0.469	0.539	0.614	0.695	0.782	0.876	0.978	1.091
20	10.31081	0.459	0.528	0.602	0.680	0.765	0.857	0.958	1.068
30	10.52577	0.449	0.517	0.589	0.667	0.750	0.840	0.938	1.047
40	10.74073	0.440	0.507	0.577	0.653	0.735	0.823	0.920	1.026
50	10.95568	0.432	0.497	0.566	0.640	0.720	0.807	0.902	1.006
60	11.17064	0.424	0.487	0.555	0.628	0.706	0.791	0.884	0.986
70	11.38560	0.416	0.478	0.545	0.616	0.693	0.777	0.868	0.968
80	11.60055	0.408	0.469	0.535	0.605	0.680	0.762	0.851	0.950
90	11.81551	0.400	0.461	0.525	0.594	0.668	0.748	0.836	0.932
100	12.03046	0.393	0.452	0.516	0.583	0.656	0.735	0.821	0.916
110	12.24542	0.386	0.444	0.506	0.573	0.644	0.722	0.807	0.900
120	12.46038	0.380	0.437	0.498	0.563	0.633	0.710	0.793	0.884
130	12.67533	0.373	0.429	0.489	0.553	0.623	0.698	0.779	0.869
140	12.89029	0.367	0.422	0.481	0.544	0.612	0.686	0.766	0.855

Temp (t)	Volume (s)	Volume Requirements of Agent per Unit Volume of Hazard (V _{agent} /V _{enclosure}) ^b							
		Design Concentration (% by Volume) ^e							
		34	38	42	46	50	54	58	62
(°F) ^c	(ft ³ /lb) ^d								
150	13.10525	0.361	0.415	0.473	0.535	0.602	0.675	0.754	0.841
160	13.32020	0.355	0.409	0.466	0.527	0.592	0.664	0.742	0.827
170	13.53516	0.350	0.402	0.458	0.518	0.583	0.653	0.730	0.814
180	13.75012	0.344	0.396	0.451	0.510	0.574	0.643	0.718	0.801
190	13.96507	0.339	0.390	0.444	0.502	0.565	0.633	0.707	0.789
200	14.18003	0.334	0.384	0.437	0.495	0.557	0.623	0.697	0.777

Note: V_s = the term $X = \ln [100/(100 - C)]$ gives the volume at a rated concentration (%) and temperature to reach an air-agent mixture at the end of flooding time in a volume of 1 ft³.

^aThe manufacturer's listing specifies the temperature range for operation.

^b X [agent volume requirements (lb/ft³)] = volume of agent required per cubic foot of protected volume to produce indicated concentration at temperature specified.

$$X = 2.303 \left(\frac{s_0}{s} \right) \log_{10} \left(\frac{100}{100 - C} \right) = \left(\frac{s_0}{s} \right) \ln \left(\frac{100}{100 - C} \right)$$

where:

s_0 [specific volume (ft³/lb)] = specific volume of inert gas agent at 70°F and 14.7 psi absolute

t [temperature (°F)] = design temperature in the hazard area.

s [specific volume (ft³/lb)] = specific volume of IG-55 vapor can be approximated by $s = 9.8809 + 0.0215t$, where t = temperature (°F).

^e C [concentration (%)] = volumetric concentration of IG-55 in air at the temperature indicated.

Table A.7.3.2(h) IG-55 Total Flooding Quantity (SI Units)^a

Temp (t)	Volume (s)	Volume Requirements of Agent per Unit Volume of Hazard (V _{agent} /V _{enclosure}) ^b							
		Design Concentration (% by Volume) ^e							
		34	38	42	46	50	54	58	62
(°C) ^c	(m ³ /kg) ^d								
-40	0.56317	0.524	0.603	0.688	0.778	0.875	0.980	1.095	1.221
-35	0.56324	0.513	0.591	0.673	0.761	0.856	0.959	1.072	1.196
-30	0.58732	0.503	0.579	0.659	0.746	0.839	0.940	1.050	1.171
-25	0.59940	0.493	0.567	0.646	0.731	0.822	0.921	1.029	1.147
-20	0.61148	0.483	0.556	0.633	0.716	0.806	0.903	1.008	1.125
-15	0.62355	0.474	0.545	0.621	0.702	0.790	0.885	0.989	1.103
-10	0.63563	0.465	0.535	0.609	0.689	0.775	0.868	0.970	1.082
-5	0.64771	0.456	0.525	0.598	0.676	0.761	0.852	0.952	1.062
0	0.65979	0.448	0.515	0.587	0.664	0.747	0.837	0.935	1.042
5	0.67186	0.440	0.506	0.576	0.652	0.733	0.822	0.918	1.024
10	0.68394	0.432	0.497	0.566	0.640	0.720	0.807	0.902	1.006
15	0.69602	0.424	0.488	0.556	0.629	0.708	0.793	0.886	0.988

Temp (t)	Specific Vapor Volume (s)	Volume Requirements of Agent per Unit Volume of Hazard (V _{agent} /V _{enclosure}) ^b							
		Design Concentration (% by Volume) ^e							
		34	38	42	46	50	54	58	62
(°C) ^c	(m ³ /kg) ^d								
20	0.70810	0.417	0.480	0.547	0.619	0.696	0.779	0.871	0.971
25	0.72017	0.410	0.472	0.538	0.608	0.684	0.766	0.856	0.955
30	0.73225	0.403	0.464	0.529	0.598	0.673	0.754	0.842	0.939
35	0.74433	0.397	0.456	0.520	0.588	0.662	0.742	0.828	0.924
40	0.75641	0.390	0.449	0.512	0.579	0.651	0.730	0.815	0.909
45	0.76848	0.384	0.442	0.504	0.570	0.641	0.718	0.802	0.895
50	0.78056	0.378	0.435	0.496	0.561	0.631	0.707	0.790	0.881
55	0.79264	0.373	0.429	0.488	0.553	0.622	0.696	0.778	0.868
60	0.80471	0.367	0.422	0.481	0.544	0.612	0.686	0.766	0.855
65	0.81679	0.362	0.416	0.474	0.536	0.603	0.676	0.755	0.842
70	0.82887	0.356	0.410	0.467	0.528	0.594	0.666	0.744	0.830
75	0.84095	0.351	0.404	0.460	0.521	0.586	0.656	0.733	0.818
80	0.85302	0.346	0.398	0.454	0.513	0.578	0.647	0.723	0.806
85	0.86510	0.341	0.393	0.448	0.506	0.569	0.638	0.713	0.795
90	0.87718	0.337	0.387	0.441	0.499	0.562	0.629	0.703	0.784
95	0.88926	0.332	0.382	0.435	0.493	0.554	0.621	0.693	0.773
100	0.90133	0.328	0.377	0.430	0.486	0.547	0.612	0.684	0.763

^aThe manufacturer's listing specifies the temperature range for operation.

^bX [agent volume requirements (m³/m³) = volume of agent required per cubic meter of protected volume to produce indicated concentration at temperature specified.

$$X = 2.303 \left(\frac{s_0}{s} \right) \log_{10} \left(\frac{100}{100-C} \right) = \left(\frac{s_0}{s} \right) \ln \left(\frac{100}{100-C} \right)$$

where:

s_0 [specific volume (m³/kg)] = specific volume of inert gas agent at 21°C and 1.013 bar absolute

t [temperature (°C)] = design temperature in the hazard area.

s [specific volume (m³/kg)] = specific volume of IG-55 vapor can be approximated by $s = 0.6598 + 0.00242t$, where t = temperature (°C).

^eC [concentration (%)] = volumetric concentration of IG-55 in air at the temperature indicated.

Additional Proposed Changes

File Name	Description	Approved
Inert_Gas_FF_Tables_-_Final.docx	Inert gas agent total flooding tables, revised	

Statement of Problem and Substantiation for Public Comment

The flooding factor tables for the inert gas agents have small inconsistencies in relation to the flooding factor values that are calculated using the values of k_1 and k_2 below each table A.7.3.2(a) through A.7.3.2(h). The revised tables contain recalculated flooding factor values consistent with the values of k_1 and k_2 for each agent.

Related Item

- FR

Submitter Information Verification**Submitter Full Name:** Joseph Senecal**Organization:** Firemetrics LLC**Street Address:****City:****State:****Zip:****Submittal Date:** Tue Nov 05 18:17:47 EST 2019**Committee:** GFE-AAA

Date: November 5, 2019

To: Mark Robin
cc: Brent Ehmke, Barry Chase

Subject: NFPA 2001 Flooding Factor Task Group – Comments Final

Mark,

Below are the recalculated flooding factor tables for the inert gas agents. The tables in the First Draft Report have slight inconsistencies. I have recalculated the FF values using the equation

$$s = k_1 + k_2 \times t$$

and the values of k_1 and k_2 given below each table. FF values are reported to four significant figures and calculated as

$$FF = \frac{s_o}{s_t} \ln \left(\frac{100}{100 - C} \right)$$

where s_o is the specific volume at the reference temperature, 70 °F for NFPA 2001. Interestingly, the FF values in SI units differ very slightly from the values in the ISO 14520 parts because the reference temperature for NFPA 2001 is 21 °C and in ISO 14520 it is 20 °C.

An interesting point of the inert gas FF tables is that they are identical for the four agents for a given set of units when expressed in terms of (Volume agent)/(Volume enclosure). It does not matter what the agent specific volume is. See a comparison on last page. This would not be the case if the FF tables were expressed as (Mass agent)/(Volume enclosure), an approach I prefer. The manufacturer publishes the container contents in its manual. This works well when the design equation is for agent mass (m), as

$$m = \frac{s(t)}{V} \ln \left(\frac{100}{100 - C} \right)$$

Where $s(t)$ is the agent specific volume at the design temperature.

The user community is probably used to the Volume approach so there is probably not much interest in changing the approach.

Regards,

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Table A.7.3.2(a) IG-01 Total Flooding Quantity (U.S. Units)									
Temp. (t)	Specific Vapor Volume (s) ft ³ /lb	Volume Requirements of Agent per Unit Volume of Hazard Flooding Factor: (V agent / V enclosure)							
		Design Concentration (% by Volume)							
°F		34	37	40	42	47	49	58	62
-40	7.774	0.5243	0.5830	0.6445	0.6873	0.8011	0.8496	1.0946	1.2209
-30	7.959	0.5121	0.5694	0.6296	0.6713	0.7825	0.8299	1.0691	1.1925
-20	8.144	0.5005	0.5565	0.6153	0.6561	0.7647	0.8110	1.0449	1.1654
-10	8.329	0.4893	0.5441	0.6016	0.6415	0.7477	0.7930	1.0216	1.1395
0	8.514	0.4787	0.5323	0.5885	0.6276	0.7314	0.7758	0.9994	1.1148
10	8.699	0.4685	0.5210	0.5760	0.6142	0.7159	0.7593	0.9782	1.0910
20	8.884	0.4588	0.5101	0.5640	0.6014	0.7010	0.7435	0.9578	1.0683
30	9.069	0.4494	0.4997	0.5525	0.5892	0.6867	0.7283	0.9383	1.0465
40	9.254	0.4404	0.4897	0.5415	0.5774	0.6730	0.7137	0.9195	1.0256
50	9.439	0.4318	0.4801	0.5308	0.5661	0.6598	0.6997	0.9015	1.0055
60	9.624	0.4235	0.4709	0.5206	0.5552	0.6471	0.6863	0.8842	0.9862
70	9.809	0.4155	0.4620	0.5108	0.5447	0.6349	0.6733	0.8675	0.9676
80	9.994	0.4078	0.4535	0.5014	0.5346	0.6231	0.6609	0.8514	0.9497
90	10.179	0.4004	0.4452	0.4923	0.5249	0.6118	0.6489	0.8360	0.9324
100	10.364	0.3933	0.4373	0.4835	0.5156	0.6009	0.6373	0.8210	0.9158
110	10.549	0.3864	0.4296	0.4750	0.5065	0.5903	0.6261	0.8066	0.8997
120	10.734	0.3797	0.4222	0.4668	0.4978	0.5802	0.6153	0.7927	0.8842
130	10.919	0.3733	0.4151	0.4589	0.4894	0.5703	0.6049	0.7793	0.8692
140	11.104	0.3671	0.4082	0.4513	0.4812	0.5608	0.5948	0.7663	0.8547
150	11.289	0.3610	0.4015	0.4439	0.4733	0.5516	0.5851	0.7538	0.8407
160	11.474	0.3552	0.3950	0.4367	0.4657	0.5428	0.5756	0.7416	0.8272
170	11.659	0.3496	0.3887	0.4298	0.4583	0.5341	0.5665	0.7298	0.8141
180	11.844	0.3441	0.3826	0.4231	0.4511	0.5258	0.5577	0.7184	0.8013
190	12.029	0.3388	0.3768	0.4166	0.4442	0.5177	0.5491	0.7074	0.7890
200	12.214	0.3337	0.3711	0.4102	0.4375	0.5099	0.5408	0.6967	0.7771

Table A.7.3.2(b) IG-01 Total Flooding Quantity (SI Units)									
Temp. (t)	Specific Vapor Volume (s) m ³ /kg	Volume Requirements of Agent per Unit Volume of Hazard Flooding Factor: (V agent / V enclosure)							
		Design Concentration (% by Volume)							
°C	m ³ /kg	34	37	40	42	47	49	58	62
-40	0.4853	0.5242	0.5828	0.6444	0.6871	0.8009	0.8494	1.0943	1.2206
-30	0.5061	0.5026	0.5589	0.6179	0.6589	0.7680	0.8145	1.0493	1.1704
-20	0.5269	0.4828	0.5368	0.5935	0.6329	0.7376	0.7823	1.0079	1.1242
-10	0.5477	0.4644	0.5164	0.5710	0.6089	0.7096	0.7526	0.9696	1.0815
0	0.5685	0.4474	0.4975	0.5501	0.5866	0.6837	0.7251	0.9342	1.0419
10	0.5893	0.4316	0.4800	0.5307	0.5659	0.6595	0.6995	0.9012	1.0052
20	0.6101	0.4169	0.4636	0.5126	0.5466	0.6370	0.6756	0.8705	0.9709
30	0.6309	0.4032	0.4483	0.4957	0.5286	0.6160	0.6534	0.8418	0.9389
40	0.6517	0.3903	0.4340	0.4798	0.5117	0.5964	0.6325	0.8149	0.9089
50	0.6725	0.3782	0.4206	0.4650	0.4959	0.5779	0.6129	0.7897	0.8808
60	0.6933	0.3669	0.4080	0.4511	0.4810	0.5606	0.5946	0.7660	0.8544
70	0.7141	0.3562	0.3961	0.4379	0.4670	0.5443	0.5772	0.7437	0.8295
80	0.7349	0.3461	0.3849	0.4255	0.4538	0.5289	0.5609	0.7226	0.8060
90	0.7557	0.3366	0.3743	0.4138	0.4413	0.5143	0.5455	0.7027	0.7838
100	0.7765	0.3276	0.3643	0.4027	0.4295	0.5005	0.5309	0.6839	0.7628
110	0.7973	0.3190	0.3548	0.3922	0.4183	0.4875	0.5170	0.6661	0.7429
120	0.8181	0.3109	0.3457	0.3822	0.4076	0.4751	0.5039	0.6491	0.7240

Table A.7.3.2(c) IG-100 Total Flooding Quantity (U.S. Units)									
Temp. (t)	Specific Vapor Volume (s)	Volume Requirements of Agent per Unit Volume of Hazard Flooding Factor: (V agent / V enclosure)							
		Design Concentration (% by Volume)							
(°F)	(ft³/lb)	34	37	40	42	47	49	58	62
-40	10.93	0.5245	0.5832	0.6448	0.6875	0.8013	0.8499	1.0949	1.2213
-30	11.19	0.5122	0.5696	0.6297	0.6715	0.7827	0.8301	1.0695	1.1928
-20	11.45	0.5006	0.5566	0.6154	0.6563	0.7649	0.8112	1.0451	1.1657
-10	11.72	0.4895	0.5443	0.6017	0.6417	0.7479	0.7932	1.0219	1.1398
0	11.98	0.4788	0.5324	0.5886	0.6277	0.7316	0.7759	0.9996	1.1150
10	12.24	0.4686	0.5211	0.5761	0.6143	0.7160	0.7594	0.9784	1.0912
20	12.50	0.4588	0.5102	0.5641	0.6015	0.7011	0.7435	0.9579	1.0685
30	12.76	0.4495	0.4998	0.5526	0.5892	0.6868	0.7284	0.9384	1.0466
40	13.02	0.4405	0.4898	0.5415	0.5774	0.6730	0.7138	0.9196	1.0257
50	13.28	0.4318	0.4802	0.5309	0.5661	0.6598	0.6998	0.9015	1.0056
60	13.54	0.4235	0.4709	0.5207	0.5552	0.6471	0.6863	0.8842	0.9862
70	13.80	0.4155	0.4620	0.5108	0.5447	0.6349	0.6733	0.8675	0.9676
80	14.06	0.4078	0.4535	0.5014	0.5346	0.6231	0.6609	0.8514	0.9497
90	14.32	0.4004	0.4452	0.4922	0.5249	0.6118	0.6488	0.8359	0.9324
100	14.58	0.3932	0.4373	0.4834	0.5155	0.6008	0.6372	0.8210	0.9157
110	14.84	0.3863	0.4296	0.4750	0.5065	0.5903	0.6261	0.8066	0.8996
120	15.10	0.3797	0.4222	0.4668	0.4977	0.5801	0.6153	0.7927	0.8841
130	15.36	0.3732	0.4150	0.4588	0.4893	0.5703	0.6048	0.7792	0.8691
140	15.62	0.3670	0.4081	0.4512	0.4811	0.5608	0.5947	0.7662	0.8546
150	15.89	0.3610	0.4014	0.4438	0.4732	0.5516	0.5850	0.7536	0.8406
160	16.15	0.3552	0.3949	0.4366	0.4656	0.5427	0.5755	0.7415	0.8270
170	16.41	0.3495	0.3886	0.4297	0.4582	0.5340	0.5664	0.7297	0.8139
180	16.67	0.3440	0.3826	0.4230	0.4510	0.5257	0.5575	0.7183	0.8012
190	16.93	0.3388	0.3767	0.4165	0.4441	0.5176	0.5489	0.7072	0.7888
200	17.19	0.3336	0.3710	0.4101	0.4374	0.5097	0.5406	0.6965	0.7769

Table A.7.3.2(d) IG-100 Total Flooding Quantity (SI Units)									
Temp. (t) (°C)	Specific Vapor Volume (s) (m ³ /kg)	Volume Requirements of Agent per Unit Volume of Hazard Flooding Factor: (V agent / V enclosure)							
		Design Concentration (% by Volume)							
		34	37	40	42	47	49	58	62
-40	0.6825	0.5243	0.5830	0.6446	0.6874	0.8011	0.8497	1.0947	1.2210
-30	0.7118	0.5027	0.5590	0.6181	0.6591	0.7682	0.8147	1.0496	1.1707
-20	0.7411	0.4829	0.5369	0.5936	0.6330	0.7378	0.7825	1.0081	1.1244
-10	0.7704	0.4645	0.5165	0.5711	0.6090	0.7097	0.7527	0.9698	1.0817
0	0.7997	0.4475	0.4976	0.5501	0.5866	0.6837	0.7252	0.9342	1.0420
10	0.8290	0.4317	0.4800	0.5307	0.5659	0.6596	0.6995	0.9012	1.0052
20	0.8583	0.4169	0.4636	0.5126	0.5466	0.6370	0.6756	0.8705	0.9709
30	0.8876	0.4032	0.4483	0.4956	0.5285	0.6160	0.6533	0.8417	0.9388
40	0.9169	0.3903	0.4340	0.4798	0.5117	0.5963	0.6325	0.8148	0.9088
50	0.9462	0.3782	0.4205	0.4650	0.4958	0.5779	0.6129	0.7896	0.8807
60	0.9755	0.3668	0.4079	0.4510	0.4809	0.5605	0.5945	0.7659	0.8542
70	1.0048	0.3561	0.3960	0.4378	0.4669	0.5442	0.5771	0.7435	0.8293
80	1.0341	0.3461	0.3848	0.4254	0.4537	0.5287	0.5608	0.7225	0.8058
90	1.0634	0.3365	0.3742	0.4137	0.4412	0.5142	0.5453	0.7026	0.7836
100	1.0927	0.3275	0.3642	0.4026	0.4293	0.5004	0.5307	0.6837	0.7626

Table A.7.3.2(e) IG-541 Total Flooding Quantity (U.S. Units)									
Temp. (t)	Specific Vapor Volume (s)	Volume Requirements of Agent per Unit Volume of Hazard Flooding Factor: (V agent / V enclosure)							
		Design Concentration (% by Volume)							
(°F)	(ft³/lb)	34	38	42	46	50	54	58	62
-40	9.00	0.5243	0.6032	0.6874	0.7776	0.8747	0.9799	1.0947	1.2210
-30	9.22	0.5121	0.5892	0.6714	0.7595	0.8543	0.9571	1.0692	1.1926
-20	9.43	0.5005	0.5758	0.6561	0.7422	0.8349	0.9354	1.0449	1.1655
-10	9.64	0.4894	0.5630	0.6416	0.7257	0.8164	0.9146	1.0217	1.1396
0	9.86	0.4787	0.5508	0.6276	0.7100	0.7986	0.8947	0.9995	1.1148
10	10.07	0.4686	0.5391	0.6143	0.6948	0.7816	0.8757	0.9782	1.0911
20	10.29	0.4588	0.5278	0.6015	0.6804	0.7653	0.8574	0.9579	1.0684
30	10.50	0.4494	0.5171	0.5892	0.6665	0.7497	0.8399	0.9383	1.0466
40	10.72	0.4404	0.5067	0.5774	0.6532	0.7347	0.8231	0.9196	1.0256
50	10.93	0.4318	0.4968	0.5661	0.6404	0.7203	0.8070	0.9015	1.0055
60	11.14	0.4235	0.4872	0.5552	0.6280	0.7065	0.7915	0.8842	0.9862
70	11.36	0.4155	0.4780	0.5447	0.6162	0.6931	0.7765	0.8675	0.9676
80	11.57	0.4078	0.4692	0.5346	0.6048	0.6803	0.7621	0.8514	0.9497
90	11.79	0.4004	0.4607	0.5249	0.5938	0.6679	0.7483	0.8360	0.9324
100	12.00	0.3933	0.4524	0.5155	0.5832	0.6560	0.7349	0.8210	0.9157
110	12.22	0.3864	0.4445	0.5065	0.5729	0.6445	0.7220	0.8066	0.8997
120	12.43	0.3797	0.4368	0.4978	0.5631	0.6334	0.7096	0.7927	0.8842
130	12.64	0.3733	0.4294	0.4893	0.5535	0.6227	0.6976	0.7793	0.8692
140	12.86	0.3670	0.4223	0.4812	0.5443	0.6123	0.6859	0.7663	0.8547
150	13.07	0.3610	0.4153	0.4733	0.5354	0.6022	0.6747	0.7537	0.8407
160	13.29	0.3552	0.4086	0.4657	0.5267	0.5925	0.6638	0.7416	0.8271
170	13.50	0.3496	0.4022	0.4583	0.5184	0.5831	0.6533	0.7298	0.8140
180	13.72	0.3441	0.3959	0.4511	0.5103	0.5740	0.6431	0.7184	0.8013
190	13.93	0.3388	0.3898	0.4442	0.5024	0.5652	0.6332	0.7073	0.7890
200	14.14	0.3337	0.3839	0.4374	0.4948	0.5566	0.6236	0.6966	0.7770

Table A.7.3.2(f) IG-541 Total Flooding Quantity (SI Units)									
Temp, (t)	Specific Vapor Volume (s)	Volume Requirements of Agent per Unit Volume of Hazard Flooding Factor: (V agent / V enclosure)							
		Design Concentration (% by Volume)							
°C	m³/kg	34	38	42	46	50	54	58	62
-40	0.5624	0.5232	0.6020	0.6859	0.7759	0.8728	0.9778	1.0924	1.2184
-30	0.5863	0.5019	0.5774	0.6580	0.7443	0.8373	0.9380	1.0479	1.1687
-20	0.6102	0.4822	0.5548	0.6322	0.7151	0.8045	0.9012	1.0068	1.1230
-10	0.6341	0.4641	0.5339	0.6084	0.6882	0.7741	0.8673	0.9689	1.0806
0	0.6580	0.4472	0.5145	0.5863	0.6632	0.7460	0.8358	0.9337	1.0414
10	0.6819	0.4315	0.4965	0.5657	0.6399	0.7199	0.8065	0.9009	1.0049
20	0.7058	0.4169	0.4797	0.5466	0.6183	0.6955	0.7792	0.8704	0.9709
30	0.7297	0.4033	0.4639	0.5287	0.5980	0.6727	0.7536	0.8419	0.9391
40	0.7536	0.3905	0.4492	0.5119	0.5791	0.6514	0.7297	0.8152	0.9093
50	0.7775	0.3785	0.4354	0.4962	0.5613	0.6314	0.7073	0.7902	0.8813
60	0.8014	0.3672	0.4224	0.4814	0.5445	0.6125	0.6862	0.7666	0.8550
70	0.8253	0.3566	0.4102	0.4674	0.5287	0.5948	0.6663	0.7444	0.8303
80	0.8492	0.3465	0.3987	0.4543	0.5139	0.5780	0.6476	0.7235	0.8069
90	0.8731	0.3370	0.3877	0.4418	0.4998	0.5622	0.6299	0.7036	0.7848
100	0.8970	0.3281	0.3774	0.4301	0.4865	0.5472	0.6131	0.6849	0.7639

Table A.7.3.2(g) IG-55 Total Flooding Quantity (U.S. Units)									
Temp, (t)	Specific Vapor Volume (s)	Volume Requirements of Agent per Unit Volume of Hazard Flooding Factor: (V agent / V enclosure)							
		Design Concentration (% by Volume)							
(°F)	(ft³/lb)	34	38	42	46	50	54	58	62
-40	9.02	0.5245	0.6034	0.6875	0.7777	0.8749	0.9801	1.0949	1.2213
-30	9.24	0.5122	0.5893	0.6715	0.7596	0.8545	0.9573	1.0694	1.1928
-20	9.45	0.5006	0.5759	0.6563	0.7423	0.8351	0.9355	1.0451	1.1657
-10	9.67	0.4895	0.5631	0.6417	0.7258	0.8165	0.9147	1.0219	1.1398
0	9.88	0.4788	0.5508	0.6277	0.7100	0.7987	0.8948	0.9996	1.1150
10	10.10	0.4686	0.5391	0.6143	0.6949	0.7817	0.8757	0.9783	1.0912
20	10.31	0.4588	0.5279	0.6015	0.6804	0.7654	0.8575	0.9579	1.0685
30	10.53	0.4495	0.5171	0.5892	0.6665	0.7498	0.8400	0.9384	1.0466
40	10.74	0.4405	0.5067	0.5774	0.6532	0.7348	0.8232	0.9196	1.0257
50	10.96	0.4318	0.4968	0.5661	0.6404	0.7204	0.8070	0.9015	1.0056
60	11.17	0.4235	0.4872	0.5552	0.6280	0.7065	0.7915	0.8842	0.9862
70	11.39	0.4155	0.4780	0.5447	0.6162	0.6931	0.7765	0.8675	0.9676
80	11.60	0.4078	0.4692	0.5346	0.6048	0.6803	0.7621	0.8514	0.9497
90	11.82	0.4004	0.4606	0.5249	0.5938	0.6679	0.7483	0.8359	0.9324
100	12.03	0.3932	0.4524	0.5155	0.5832	0.6560	0.7349	0.8210	0.9157
110	12.25	0.3863	0.4445	0.5065	0.5729	0.6445	0.7220	0.8066	0.8996
120	12.46	0.3797	0.4368	0.4977	0.5630	0.6333	0.7095	0.7927	0.8841
130	12.68	0.3732	0.4294	0.4893	0.5535	0.6226	0.6975	0.7792	0.8691
140	12.89	0.3670	0.4222	0.4811	0.5442	0.6122	0.6859	0.7662	0.8546
150	13.11	0.3610	0.4153	0.4732	0.5353	0.6022	0.6746	0.7537	0.8406
160	13.32	0.3552	0.4086	0.4656	0.5267	0.5925	0.6637	0.7415	0.8270
170	13.54	0.3495	0.4021	0.4582	0.5183	0.5830	0.6532	0.7297	0.8139
180	13.75	0.3441	0.3958	0.4510	0.5102	0.5739	0.6430	0.7183	0.8012
190	13.97	0.3388	0.3897	0.4441	0.5024	0.5651	0.6331	0.7072	0.7888
200	14.18	0.3336	0.3838	0.4374	0.4947	0.5565	0.6235	0.6965	0.7769

Table A.7.3.2(h) IG-55 Total Flooding Quantity (SI Units)									
Temp, (t)	Specific Vapor Volume (s)	Volume Requirements of Agent per Unit Volume of Hazard Flooding Factor: (V agent / V enclosure)							
		Design Concentration (% by Volume)							
°C	m³/kg	34	38	42	46	50	54	58	62
-40	0.5630	0.5245	0.6034	0.6876	0.7778	0.8749	0.9801	1.0950	1.2213
-35	0.5751	0.5134	0.5907	0.6731	0.7614	0.8565	0.9595	1.0719	1.1956
-30	0.5872	0.5029	0.5785	0.6592	0.7457	0.8388	0.9397	1.0498	1.1710
-25	0.5993	0.4927	0.5668	0.6459	0.7306	0.8219	0.9208	1.0286	1.1473
-20	0.6114	0.4829	0.5556	0.6331	0.7162	0.8056	0.9025	1.0083	1.1246
-15	0.6235	0.4736	0.5448	0.6208	0.7023	0.7900	0.8850	0.9887	1.1028
-10	0.6356	0.4646	0.5345	0.6090	0.6889	0.7750	0.8682	0.9699	1.0818
-5	0.6477	0.4559	0.5245	0.5976	0.6760	0.7605	0.8520	0.9518	1.0616
0	0.6598	0.4475	0.5149	0.5867	0.6636	0.7465	0.8363	0.9343	1.0421
5	0.6719	0.4395	0.5056	0.5761	0.6517	0.7331	0.8213	0.9175	1.0233
10	0.6840	0.4317	0.4966	0.5659	0.6402	0.7201	0.8067	0.9013	1.0052
15	0.6961	0.4242	0.4880	0.5561	0.6290	0.7076	0.7927	0.8856	0.9878
20	0.7082	0.4169	0.4797	0.5466	0.6183	0.6955	0.7792	0.8705	0.9709
25	0.7203	0.4099	0.4716	0.5374	0.6079	0.6838	0.7661	0.8558	0.9546
30	0.7324	0.4032	0.4638	0.5285	0.5979	0.6725	0.7534	0.8417	0.9388
35	0.7445	0.3966	0.4563	0.5199	0.5881	0.6616	0.7412	0.8280	0.9236
40	0.7566	0.3903	0.4490	0.5116	0.5787	0.6510	0.7293	0.8148	0.9088
45	0.7687	0.3841	0.4419	0.5036	0.5696	0.6408	0.7179	0.8020	0.8945
50	0.7808	0.3782	0.4351	0.4958	0.5608	0.6308	0.7067	0.7895	0.8806
55	0.7929	0.3724	0.4284	0.4882	0.5522	0.6212	0.6959	0.7775	0.8672
60	0.8050	0.3668	0.4220	0.4809	0.5439	0.6119	0.6855	0.7658	0.8541
65	0.8171	0.3614	0.4157	0.4737	0.5359	0.6028	0.6753	0.7545	0.8415
70	0.8292	0.3561	0.4097	0.4668	0.5281	0.5940	0.6655	0.7434	0.8292
75	0.8413	0.3510	0.4038	0.4601	0.5205	0.5855	0.6559	0.7328	0.8173
80	0.8534	0.3460	0.3981	0.4536	0.5131	0.5772	0.6466	0.7224	0.8057
85	0.8655	0.3412	0.3925	0.4472	0.5059	0.5691	0.6376	0.7123	0.7944
90	0.8776	0.3365	0.3871	0.4411	0.4989	0.5613	0.6288	0.7024	0.7835
95	0.8897	0.3319	0.3818	0.4351	0.4922	0.5536	0.6202	0.6929	0.7728
100	0.9018	0.3274	0.3767	0.4292	0.4856	0.5462	0.6119	0.6836	0.7625

All inert gas FF tables are the same when expressed as (Vol agent) / (Vol enclosure)

	k1	k2		
IG-01	8.514	0.0185		
t, F	s, ft3/lb	40	45	50
30	9.069	0.5525	0.6466	0.7497
40	9.254	0.5415	0.6337	0.7347
50	9.439	0.5308	0.6213	0.7203
60	9.624	0.5206	0.6093	0.7065
70	9.809	0.5108	0.5978	0.6931
80	9.994	0.5014	0.5868	0.6803
90	10.179	0.4923	0.5761	0.6680
100	10.364	0.4835	0.5658	0.6560
110	10.549	0.4750	0.5559	0.6445

	k1	k2		
IG-100	11.976	0.02606		
t, F	s, ft3/lb	40	45	50
30	12.758	0.5526	0.6467	0.7498
40	13.018	0.5415	0.6337	0.7348
50	13.279	0.5309	0.6213	0.7204
60	13.540	0.5207	0.6093	0.7065
70	13.800	0.5108	0.5978	0.6931
80	14.061	0.5014	0.5868	0.6803
90	14.321	0.4922	0.5761	0.6679
100	14.582	0.4834	0.5658	0.6560
110	14.843	0.4750	0.5559	0.6445

	k1	k2		
IG-541	9.8579	0.02143		
t, F	s, ft3/lb	40	45	50
30	10.501	0.5525	0.6466	0.7497
40	10.715	0.5415	0.6337	0.7347
50	10.929	0.5309	0.6213	0.7203
60	11.144	0.5206	0.6093	0.7065
70	11.358	0.5108	0.5978	0.6931
80	11.572	0.5014	0.5868	0.6803
90	11.787	0.4923	0.5761	0.6679
100	12.001	0.4835	0.5658	0.6560
110	12.215	0.4750	0.5559	0.6445

	k1	k2		
IG-55	9.8809	0.0215		
t, F	s, ft3/lb	40	45	50
30	10.526	0.5526	0.6467	0.7498
40	10.741	0.5415	0.6337	0.7348
50	10.956	0.5309	0.6213	0.7204
60	11.171	0.5207	0.6093	0.7065
70	11.386	0.5108	0.5978	0.6931
80	11.601	0.5014	0.5868	0.6803
90	11.816	0.4922	0.5761	0.6679
100	12.031	0.4834	0.5658	0.6560
110	12.246	0.4750	0.5559	0.6445

**Public Comment No. 24-NFPA 2001-2019 [Section No. G.1.2.5]****G.1.2.5** ASTM Publications.

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

ASTM E176, *Standard Terminology of Fire Standards*, -2015 _ 2018a .

ASTM E177, *Standard Practice for Use of the Terms Precision and Bias in ASTM Test Methods*, 2014.

ASTM E456, *Standard Terminology Relating to Quality and Statistics*, 2013.

ASTM E691, *Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method*, 2016.

ASTM E779, *Standard Test Method for Determining Air Leakage Rate by Fan Pressurization*, 2010.

ASTM E1258, *Standard Test Method for Airflow Calibration of Fan Pressurization Devices*, 1988 (2012).

ASTM E1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*, -2016 _ 2017 .

ASTM E1827, *Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door*, 2011.

ASTM F1387, *Standard Specification for Performance of Piping and Tubing Mechanically Attached Fittings*, 1999 (2012).

Statement of Problem and Substantiation for Public Comment

updates

Related Item

- fr3

Submitter Information Verification

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Submittal Date: Thu Nov 14 22:00:01 EST 2019

Committee: GFE-AAA

Chapter 9 Detection, Actuation, Alarm and Control Systems for Clean Agent Releasing Applications

Paragraph	Section	New Section 9 Proposed Text	Task Group Question(s)	Submitter	Proposed New Text if any
9.1.1 and 9.1.1.1	Control Panel for Releasing Service	4-3-1-9.1.1 Control Panel for Releasing Service. Detection, actuation, alarm, and control systems shall be installed, tested, and maintained in accordance with appropriate NFPA protective signaling systems standards (NFPA 72. (See NFPA 70 and NFPA 72). In Canada refer to CAN/ULC 5524-14 and CAN/ULC 5529-16). A-4-3-1-9.1.1 The FSSA Application Guide Detection & Control for Fire Suppression Systems offers the designer information of the various types of detection and control equipment. 4-3-1-9.1.1.1 The clean agent suppression system or group of systems shall be controlled by a listed clean agent releasing control panel(s) that is listed for monitoring the associated initiating devices, meets the listed compatibility requirements per 4-3-4-9.4.8 and 9.4.9 for actuation of the associated suppression system releasing device(s), and controls the associated suppression system notification appliances.	Is it really the intent that clean agent systems must be controlled by a listed releasing panel in accordance with NFPA 72? Is it still acceptable to have a fully mechanical system (i.e., pneumatic detection, pneumatic siren, and mechanical manual stations) in non-marine applications (12.5 overrides these requirements for marine applications)? If a listed releasing panel and compliance with NFPA 72 are required, I think that there are other requirements in this chapter that can be considered redundant.	Chase	Leave and addressing in 9.1.2.1
9.1.1.2	Control Panel for Releasing Service	4-3-2-9.1.1.2 Adequate and reliable primary and 24-hour minimum standby sources of energy shall be used to provide for operation of the detection, signaling, control, and actuation requirements of the system.	Is this intended to modify the power requirements in NFPA 72 9.1.1.2 – Is this intended to modify the power requirements in NFPA 72 [covered by reference to NFPA 72 in 9.1.1]? Is primary source of energy intended to be electrically hardwired and standby source of energy intended to be by battery?	Shugarman	A dedicated primary power feed and 24 hour minimum standby with a minimum 5 minute or more alarm current shall be used to provide for operation of the detection, signaling, control and actuation requirements of the system
9.1.1.2	Control Panel for Releasing Service		Is it not required to mention that the battery capacity need to be calculated for 24 hours of quiescent current followed by 5 minutes of alarm current?	Ateeq	
9.1.1.2	Control Panel for Releasing Service		The word "adequate" is vague and unenforceable. Perhaps this section should refer to Chapter 10 of NFPA 72 for the secondary power supply capacity requirements?	Chase	
9.1.1.4	Control Panel for Releasing Service	4-3-1-9.1.1.4 If the clean agent suppression system releasing control panel is located in a protected premises having a separate building fire alarm system, the releasing control panel shall be monitored by the building fire alarm system for alarm, supervisory, and trouble signals.	Would like to add an annex section here about not having to sync the strobe with the building alarm panel	Adrian	A 9.1.1.4 "When more than 2 are in sight see NFPA 72"
9.1.1.5	Control Panel for Releasing Service		Section mandates a separate manual release, which contradicts the information of 9.3. One of the most frequent questions I get is whether the detectors monitored by a building fire alarm system can be used to initiate a clean agent release via a signal from the building fire alarm panel (dry contact, in most cases). In my opinion, the only way to comply with 9.1.1.5 is to have the release-initiating detectors monitored directly by the releasing panel (unless the releasing panel and the building fire alarm panel are listed as a single system). Could the committee clarify – in either a requirement or explanatory text – whether the releasing panel is permitted to be initiated by the building fire alarm system?	Shugarman	9.3 is dealing with a manual release not a control panel and further clarification is found in 9.3.1
9.1.1.5 & 9.2	Control Panel for Releasing Service	The clean agent suppression system releasing control panel shall not be dependent upon or affected by the operation or failure of the protected premises building fire alarm panel.		Chase	No the FACP cannot be used and only the FSRCP should be utilized. See A.9.1.1.3
9.1.2.1 add A9.1.2.1	Control Panel for Releasing Service		Adding annex material for clarification	Task Group	A fully mechanical system (i.e., pneumatic detection, pneumatic siren, and mechanical manual stations) in non-marine applications
9.3.1	Manual Release	9.3.1 Manual release shall be accomplished by a mechanical manual release or by an electrical manual release when the control equipment monitors the battery voltage level of the standby battery supply and provides a low-battery signal.	Is the requirement to monitor the battery voltage level redundant if a listed panel is required? I think this might be a leftover requirement from the days when a 120VAC supply would be run through a heat detector or a manual pull station directly to the control head.	Chase	Strike Requirement
9.3.3	Manual Release	4-3-3-9.3.3* A discharge pressure switch that provides an alarm-initiating signal to the releasing panel shall be required where a releasing panel is used and mechanical system actuation is possible.	I added the words "where a releasing panel is used" for clarity in the First Draft. This could be revised/deleted if a listed releasing panel is always required.	Chase	Agreed
9.3.5	Manual Release	4-3-3-9.3.5 The normal manual control(s) for actuation shall be located for easy accessibility at all times, including at the time of a fire.	The word "easy" is vague and unenforceable.	Chase	The manual control(s) for actuation shall be accessible at all times
9.3.6	Manual Release	4-3-3-9.3.6 The manual control(s) shall be of distinct appearance and clearly recognizable for the purpose intended.	The words "distinct" and "clearly" are vague and unenforceable. Also, it might be helpful to add annex material on methods for distinguishing clean agent release stations from fire alarm pull boxes (e.g., box color, wall color, signs). A reference to the signage requirements in 4.3.8 might also be helpful.	Chase	Create Annex Material to address this A 9.3.6 Manufactured devices provide labeling options and placards should be utilized at the actuation device.
9.3.8	Manual Release	4-3-3-9.3.8 Manual controls shall not require a pull of more than 40 lb (178 N) nor a movement of more than 14 in. (356 mm) to secure operation.	The statement should start with, 'Mechanical manual control' instead of Manual control.	Ateeq	Okay to add "Mechanical"
9.4.1	Operating Devices and Control Equipment for Agent Release, Discharge Control and Equipment	4-3-3-9.4.1 Operation of agent-releasing devices or valves, discharge controls, and shutdown equipment necessary for successful performance of the system shall be by listed mechanical, electrical, or pneumatic means. A sufficient adequate and reliable source of energy shall be used.	Is this intended to modify the power requirements in NFPA 72 [covered by reference to NFPA 72 in 9.1.1]? Does adequate and reliable mean primary with 24 hour standby?	Shugarman	No
9.4.1	Operating Devices and Control Equipment for Agent Release, Discharge Control and Equipment		The word "adequate" is vague and unenforceable.	Chase	remove words "adequate and"
9.4.2	Operating Devices and Control Equipment for Agent Release, Discharge Control and Equipment	4-3-3-9.4.2 Operating devices shall be designed for the service they will encounter.	What does this requirement mean? Is it enforceable?	Chase	Operating devices shall be suitable for application in the environment they are employed
9.4.3	Operating Devices and Control Equipment for Agent Release, Discharge Control and Equipment	3-4.3 Operating devices shall not readily be rendered inoperative or susceptible to accidental operation.	The word "readily" is vague and unenforceable. Also, what does this requirement mean? Is it enforceable?	Chase	Key accessibility, This is so the owners can not lock it out.

A 9.4.10 & 9.4.10.1	Operating Devices and Control Equipment for Agent Release, Discharge Control and Equipment Shutdown	A-4-3-4-2A.9.4.10 NFPA 72, [4.2.6.4], requires that "Suppression systems shall be secured from inadvertent actuation, including disconnection of releasing solenoids or electric actuators, closing of valves, other actions, or combinations thereof, for the specific system, for the duration of the fire alarm system testing." Clean agent systems generally have a device attached to one or more agent storage container discharge valves that, upon signal from the fire system releasing control unit, causes the discharge valve(s) to operate to release the agent. The device is referred to as an electric actuator. These actuators are typically either a solenoid operated device or a squib operated device. During system maintenance, it is a common procedure to remove the solenoid operated actuators from the agent storage container discharge valve to prevent accidental discharge of the system and permit functional testing of the actuator. Some systems that incorporate selector valves also have electric actuators attached to the selector valves to control their operation by electrical signal from the control panel. These electric actuators might also need to be routinely removed from their selector valves during maintenance. Since the electrical connection between the solenoid and the system control panel is not broken by this maintenance procedure, special provision is required to provide an indication of system impairment at the releasing control panel when the electric actuator is physically removed from the valve it controls. There have been numerous reports of systems inadvertently left disabled after maintenance because the technician failed to reinstall the actuator on its valve. Fortunately in all reported cases, the impairment was discovered before the system was required to operate, and only successful extinguishments have been reported — no failures to operate under fire conditions have come to the attention of the technical committee responsible for this standard. Squib actuators are covered by this requirement only if the manufacturer's maintenance instruction requires physical removal of the squib operated device from the valve it controls. With the evolution of technology, cost effective means to monitor the placement of actuators can be developed. Because of the time required to develop hardware and to obtain listings and approvals for the hardware, the effective date for this provision of the standard is January 1, 2016.	Are 9.4.10.1 and the last paragraph in A.9.4.10 still necessary, since the effectivity date was 4 years ago?	Chase	Keep
9.4.10.1	Operating Devices and Control Equipment for Agent Release, Discharge Control and Equipment Shutdown	4-3-4-2-19.4.10.1 Paragraph 4-3-4-22.4.10 shall become effective January 1, 2016.	NFPA 72 requires a mechanical disconnect which is to annunciate a supervisory condition when actuated (reference NFPA 72, Section 23.11.5). Is this covered by 9.8?	Shugarman	Delete
9.4.10.2	Operating Devices and Control Equipment for Agent Release, Discharge Control and Equipment Shutdown	4-3-4-2-29.4.10.2 Paragraph 4-3-4-22.4.10 shall not apply to systems covered under Chapter 9 of this standard with the exception of those systems included under Section 9.6.	In all other cases where the requirements for marine systems differ from land-based, the exception is specified in the marine chapter, not the generic chapter. See 12.1. Should this requirement be moved to Chapter 12 for consistency?	Chase	Okay to move to Marine chapter 12
9.4.11	Operating Devices and Control Equipment for Agent Release, Discharge Control and Equipment Shutdown	4-3-4-22.4.11 The control equipment shall supervise the actuating devices and associated wiring and, as required, cause actuation.	Is the requirement for supervision of the actuation devices and circuit redundant if a listed panel is required and if NFPA 72 must be followed?	Chase	Yes since it wouldn't apply to a manual system but should keep reiterate
9.4.12	Operating Devices and Control Equipment for Agent Release, Discharge Control and Equipment Shutdown	4-3-4-59.4.12 Removal of the primary agent container actuating device from the discharge valve and/or selector valve shall cause a trouble or supervisory signal at the releasing control unit.	How is this requirement different from 9.4.10? If specifying the type of signal is important, why not incorporate that into 9.4.10 instead of having two requirements?	Chase	rewrite on 9.4.10
9.4.14	Operating Devices and Control Equipment for Agent Release, Discharge Control and Equipment Shutdown	9.4.14 Where installations of pneumatic control equipment could be exposed to conditions that could lead to loss of integrity of the pneumatic lines, special precautions shall be taken to ensure that no loss of integrity will occur. The control equipment shall be specifically listed for the number and type of actuating devices utilized, and their compatibility shall have been listed.	What are "special precautions"? Is this enforceable? Could explanatory text be added?	Chase	Remove
9.5.2	Operating Alarms and Indicators	9.5.2 The type (audible, visual, or olfactory), number, and location of the indicating devices shall be such that their purpose is satisfactorily accomplished.	The word "satisfactorily" is vague and unenforceable.	Chase	Remove
9.5.3	Operating Alarms and Indicators	9.5.3 The extent and type of alarms or indicator equipment or both shall be approved.	The word "extent" is a bit strange here. I think it is supposed to refer to the extent of coverage provided by the notification devices. Would a better word be "location(s)" or "number"? Is this requirement even necessary, if 6.1.2.5 (working plans) and 6.1.3 (approval of plans) already require approval of the design? Or alternatively, should it simply say: "the notification system shall be designed to operate in accordance with the requirements of the building's emergency response plan"?	Chase	The type of alarms or indicator equipment or both shall be approved.
9.5.6	Operating Alarms and Indicators	4-3-5-19.5.6 Alarms indicating failure of supervised devices or equipment shall give prompt and positive indication of any failure and shall be that is distinctive from alarms indicating operation or hazardous conditions.	Where (location) is the indication to be annunciated?	Shugarman	At the control panel
9.5.6	Operating Alarms and Indicators	4-3-5-19.5.6 Alarms indicating failure of supervised devices or equipment shall give prompt and positive indication of any failure and shall be that is distinctive from alarms indicating operation or hazardous conditions.	"Alarms indicating failure of supervised devices or equipment shall give prompt and positive indication at the control panel, that is distinctive from alarms indicating operation or hazardous conditions." At the control panel is suggested to be inserted in the statement.	Ateeq	Alarms indicating failure of supervised devices or equipment shall give prompt and positive indication at the control panel, that is distinctive from alarms indicating operation or hazardous conditions.
9.6	Abort Switches	4-3-6-32.6* Abort Switches. Abort switches shall be permitted to be installed for clean agent releasing systems.	The charging sentence ("Abort switches shall be permitted...") was added in the First Draft. I get a lot of questions on whether abort switches are permitted or required, so I thought that this was a pretty harmless addition that clarifies the intent. I just wanted to bring it to your attention, in case you disagree.	Chase	Leave it alone

A 9.6.1	Abort Switches	9.6.1* Abort switches, where provided, shall be located within the protected area and shall be located near the means of egress for the area. A.4.2.5.3A.9.6.1 <u>A telephone should be located near the abort switch.</u>	Is it recommended to locate a telephone near the abort switch?	Ateeq	should add back "where provided" then strike Annex material
9.6.4	Abort Switches	9.6.4 Operation of the abort function shall result in both audible and distinct visual indication of system impairment.	The word "distinct" is vague and unenforceable.	Chase	Take out "distinct". At the releasing control panel
9.7.2	Time Delays	9.7.2* For hazard areas subject to fast growth fires, where the provision of a time delay would seriously increase the threat to life and property, a time delay shall be permitted to be eliminated.	The word "seriously" is vague and unenforceable.	Chase	take out "seriously"

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NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*

Chapter 12 Impairment

12.1* General.

A.12.1

The general model for impairment procedures is based on Chapter 15 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*. It is recognized that clean agent fire extinguishing systems will commonly exist alongside water-based fire protection systems and should follow essentially the same impairment procedures.

12.1.1 Minimum Requirements.

12.1.1.1

This chapter shall provide the minimum requirements for a fire protection system impairment program.

12.1.1.2

Measures shall be taken during the impairment to ensure that increased risks are minimized and the duration of the impairment is limited.

12.2 Impairment Coordinator.

12.2.1

The property owner or designated representative shall assign an impairment coordinator to comply with the requirements of this chapter.

12.2.2

In the absence of a specific designee, the property owner or designated representative shall be considered the impairment coordinator.

12.2.3

Where the lease, written use agreement, or management contract specifically grants the authority for inspection, testing, and maintenance of the fire protection system(s) to the tenant, management firm, or managing individual, the tenant, management firm, or managing individual shall assign a person as impairment coordinator.

12.3 Tag Impairment System.

12.3.1*

A tag shall be used to indicate that a system, or part thereof, has been removed from service.

A.12.3.1

A clearly visible tag alerts building occupants and the fire department that all or part of the fire protection system is out of service. The tag should be weather resistant, plainly visible, and of sufficient size [typically 100 mm × 150 mm (4 in. × 6 in.)]. The tag should identify which system is impaired, the date and time impairment began, and the person responsible.

12.3.2*

The tag shall be posted at the clean agent system control valve(s), fire alarm control panel and other locations required by the authority having jurisdiction, indicating which system, or part thereof, has been removed from service.

A.12.3.2

An impairment tag should be placed on the clean agent system control valve, fire alarm control panel or location(s) designated by the AHJ to alert responding fire fighters of an abnormal condition. An impairment tag that is located only on the clean agent system equipment could go unnoticed for an extended period if fire fighters encounter difficulty in gaining complete access to the building or fire protection control room.

12.4 Impaired Equipment.

12.4.1

The impaired equipment shall be considered to be the fire protection system, or part thereof, that is removed from service.

12.5* Preplanned Impairment Programs.

A.12.5

The need for temporary fire protection, termination of all hazardous operations, and frequency of inspections in the areas involved should be determined. All work possible should be done in advance to minimize the length of the impairment.

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12.5.1

All preplanned impairments shall be authorized by the impairment coordinator.

12.5.2

Before authorization is given, the impairment coordinator shall be responsible for verifying that the following procedures have been implemented:

- (1) The extent and expected duration of the impairment have been determined.
- (2) The areas or buildings involved have been inspected and the increased risks determined.
- (3) Recommendations to mitigate any increased risks have been submitted to management or the property owner or designated representative.
- (4) Where a clean agent fire protection system is out of service for more than 10 hours in a 24-hour period, the impairment coordinator shall arrange for one of the following, when the clean agent fire extinguishing system is primary protection:
 - (a) Evacuation of the building or portion of the building affected by the system out of service
 - (b) *An approved fire watch
 - (d) *Establishment and implementation of an approved program to eliminate potential ignition sources and limit the amount of fuel available to the fire
- (5) The fire department has been notified.
- (6) The insurance carrier, the alarm company, property owner or designated representative, and other authorities having jurisdiction have been notified.
- (7) The supervisors in the areas to be affected have been notified.
- (8) A tag impairment system has been implemented. (See Section 12.3.)
- (9) All necessary tools and materials have been assembled on the impairment site.

A.12.5.2(4)(b)

When a clean agent fire extinguishing system is providing primary protection, e.g. no sprinkler protection present, a fire watch should consist of trained personnel who continuously patrol the affected area. Ready access to fire extinguishers and the ability to promptly notify the fire department are important items to consider. During the patrol of the area, the person should not only be looking for fire, but making sure that the other fire protection features of the building such as egress routes and alarm systems are available and functioning properly.

A.12.5.2(4)(d)

Depending on the use and occupancy of the building, it could be enough in some circumstances to stop certain processes in the building or to cut off the flow of fuel or source of energy to some machines. It is also helpful to implement "No Smoking" and "No Hot Work" (cutting, grinding, or welding) policies while the system is out of service because these activities are responsible for many fire ignitions.

12.6 Emergency Impairments.

12.6.1

Emergency impairments shall include, but are not limited to, interruption of clean agent supply, ruptured or damaged piping, and equipment failure, and includes impairments found during inspection, testing, or maintenance activities.

12.6.2*

The coordinator shall implement the steps outlined in Section 12.5.

A.12.6.2

When one or more impairments are discovered during inspection, testing, and maintenance activities, the owner or owner's authorized representative should be notified in writing.

12.7 Restoring Systems to Service.

When all impaired equipment is restored to normal working order, the impairment coordinator shall verify that the following procedures have been implemented:

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- (1) Any necessary inspections and tests have been conducted to verify that affected systems are operational. The appropriate chapter of this standard shall be consulted for guidance on the type of inspection and test required.
- (2) Supervisors have been advised that protection is restored.
- (3) The fire department has been advised that protection is restored.
- (4) The property owner or designated representative, insurance carrier, alarm company, and other authorities having jurisdiction have been advised that protection is restored.
- (5) The impairment tag has been removed.

**Committee Input No. 21-NFPA 2001-2019 [New Section after 8.8]****8.9* Impairments.****A.8.9**

The term impairments encompasses a broad range of circumstances wherein a system or portion thereof is taken out of service for a variety of reasons. Systems are routinely impaired to allow hot work (e.g., open flame operations) to be performed in areas with automatic detection, construction, painting, and so forth, as well as to conduct normal system maintenance and testing. Impairments can be limited to specific initiating devices and/or functions (e.g., disconnecting the supervising station connection during system testing), or they can involve taking entire systems or portions of systems out of service. Section 8.9 is intended to help building owners control impairments of the system(s) in their building(s) and to ensure that systems are restored to full operation and/or returned to service afterward.

8.9.1

The system owner or the owner's designated representative shall be notified when a system or part thereof is impaired. Impairments to systems shall include out-of-service events.

8.9.2

A record of the impairments shall be maintained by the system owner or the owner's designated representative for a period of 1 year from the date the impairment is corrected.

8.9.3*

The service provider shall report to the authority having jurisdiction any system that is out of service for more than 8 hours.

A.8.9.3

It is important for the authority having jurisdiction, typically the local fire official, to be informed when systems have been out of service for more than 8 hours so that appropriate measures can be taken. The term out of service is meant to refer to the entire system or a substantial portion thereof.

8.9.4*

Where required by the authority having jurisdiction, mitigating measures shall be implemented for the period that the system is impaired.

A.8.9.4

The need for mitigating measures is typically determined on a case-by-case basis. This considers the building, occupancy type, nature and duration of impairment, building occupancy level during impairment period, active work being conducted on the system during the impairment, condition of other fire protection systems and features (i.e., sprinklers, structural compartmentation, etc.), and hazards and assets at risk.

Appropriate mitigating measures range from simple occupant notification to full-time fire watch. Determining factors vary from testing-related impairments and maintenance activities during normal business through extensive impairments to high-value, high-hazard situations.

8.9.5

The system owner or the owner's designated representative and the authority having jurisdiction shall be notified when an impairment period ends.

Supplemental Information

<u>File Name</u>	<u>Description Approved</u>
2001_CI21_8.9.docx	✓

Submitter Information Verification

Committee: GFE-AAA

Submittal Date: Thu Apr 25 14:41:35 EDT 2019

Committee Statement and Meeting Notes

Committee Statement: The committee proposes new text on impairment, which is not currently addressed in this standard. A task group has been assigned to review this material for inclusion at the Second Draft stage.

Response Message: CI-21-NFPA 2001-2019

Ballot Results

 This item has not been balloted

[2001, CI-21]

8.9* Impairments.

A.8.9

The term *impairments* encompasses a broad range of circumstances wherein a system or portion thereof is taken out of service for a variety of reasons. Systems are routinely impaired to allow hot work (e.g., open flame operations) to be performed in areas with automatic detection, construction, painting, and so forth, as well as to conduct normal system maintenance and testing. Impairments can be limited to specific initiating devices and/or functions (e.g., disconnecting the supervising station connection during system testing), or they can involve taking entire systems or portions of systems out of service. Section 8.9 is intended to help building owners control impairments of the system(s) in their building(s) and to ensure that systems are restored to full operation and/or returned to service afterward.

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The system owner or the owner's designated representative shall be notified when a system or part thereof is impaired. Impairments to systems shall include out-of-service events.

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A record of the impairments shall be maintained by the system owner or the owner's designated representative for a period of 1 year from the date the impairment is corrected.

8.9.3*

The service provider shall report to the authority having jurisdiction any system that is out of service for more than 8 hours.

A.8.9.3

It is important for the authority having jurisdiction, typically the local fire official, to be informed when systems have been out of service for more than 8 hours so that appropriate measures can be taken. The term *out of service* is meant to refer to the entire system or a substantial portion thereof.

8.9.4*

Where required by the authority having jurisdiction, mitigating measures shall be implemented for the period that the system is impaired.

A.8.9.4

The need for mitigating measures is typically determined on a case-by-case basis. This considers the building, occupancy type, nature and duration of impairment, building occupancy level during impairment period, active work being conducted on the system during the impairment, condition of other fire protection systems and features (i.e., sprinklers, structural compartmentation, etc.), and hazards and assets at risk.

Appropriate mitigating measures range from simple occupant notification to full-time fire watch.

Determining factors vary from testing-related impairments and maintenance activities during normal business through extensive impairments to high-value, high-hazard situations.

8.9.5

The system owner or the owner's designated representative and the authority having jurisdiction shall be notified when an impairment period ends.



Committee Input No. 24-NFPA 2001-2019 [Section No. 6.1.1]

6.1.1—*_ Uses.

Local application systems shall be used for the extinguishment of surface fires in flammable liquids, gases, and shallow solids where the hazard is not enclosed or where the enclosure does not conform to the requirements for total flooding.

A.6.1.1

In a local application system, agent can be discharged either directly onto the hazard being protected or into a piece of equipment, such as a cabinet enclosure or similar structure.

Submitter Information Verification

Committee: GFE-AAA

Submittal Date: Thu Apr 25 15:07:09 EDT 2019

Committee Statement and Meeting Notes

Committee Statement: The committee proposes text to address protection of servers and other equipment that do not have enclosures capable of meeting the requirements for total flooding. A task group has been appointed to study this issue for further development at the Second Draft stage.

Response Message: CI-24-NFPA 2001-2019

Ballot Results

This item has not been balloted

STAFF NOTES FOR 2021 EDITIONS

SECOND DRAFT MEETING

NFPA 12

No notes

NFPA 12A

No notes

NFPA 2001

4.2.1.1.1.2 – “readily identifiable” is vague and unenforceable.

5.1.4.1 – eliminate heading and multiple requirements, per MOS.

6.1.2.5.1 – “clearly” is vague and unenforceable.

6.1.2.5.4 – “adequately” is vague and unenforceable.

6.7.1 – the single subdivision should be eliminated (i.e., there is a 5.7.1.1 but no 5.7.1.2).
Combine 5.7.1 and 5.7.1.1 into a single heading “Initial Discharge Rate”?

7.2.2.1.2(2) – change “minimum extinguishing concentration” to “flame extinguishing concentration”

7.3.3.3 – The reference to Table 7.3.3.3 should be reformatted as mandatory language.

7.5.1 – 7.5.1 contains only one subdivision (7.5.1.1). Can the header at 7.5.1 be eliminated and 7.5.1.1 be promoted?
Should the title for 7.5.1.1 be changed to “Initial Discharge Time” to be congruous with 7.5.2?

7.5.1.1.1 and 7.5.1.1.2 – 7.5.1.1.1 for halocarbons specifies a safety factor of 20 percent, but 7.5.1.1.2 for inert gases does not specify a safety factor. Should these be harmonized? If protecting a Class B or C hazard, should the higher safety factor be used for calculating discharge time? Should both of these paragraphs point to 7.5.1.1.3 instead?

7.5.1.1.3 – needs to be worded as mandatory text.

8.6 – is this section still needed with the addition of new Chapter 9?

9.1.1.2 – “adequate” is vague and unenforceable. (Refer to Chapter 10 of NFPA 72?)

9.3.5 – “easy” is vague and unenforceable.

9.3.6 – “distinct” and “clearly” are vague and unenforceable.

9.4.1 – “adequate” is vague and unenforceable.

9.4.3 – “readily” is vague and unenforceable.

9.5.2 – “satisfactorily” is vague and unenforceable.

9.6.4 – “distinct” is vague and unenforceable.

9.7.2 – “seriously” is vague and unenforceable.

11.5.2 – “promptly” is vague and unenforceable.

12.5.2.2 – Why does this section on routing of actuation circuits reference the section on manual release (9.3)? Should 12.5.2.2 reference 9.4.5 (protection of operating devices) instead? [Note: It has been this way since the marine chapter was originally added in the 2000 edition. At that time, the text in 9.4.5 (then 2-3.3.4) was originally located adjacent to the text in 9.3 (then 2-3.3.5), so this would have been an understandable error in the original proposal.]

A.4.2.4 & E.1.2.8 – the FSSA white paper title should be “Effect of Sound Waves on Data Storage Devices”

A.7.3.3.2 – “engineered halon alternative systems” should be changed to “engineered clean agent systems”.

A.11.5 – x-refs in (16)(b) should be changed to “11.3.1, 11.3.2, or 11.3.4”

C.16 & C.17 – These sections are reserved. Was there an intention to add material here? Should a task group be formed for the next revision cycle? If not, consider deleting the headers.

C.18.1 – the reference to “P. Mackay memorandum, 18 May 2004” in the following endnote needs a citation in Annex E:

¹²A systematic study showed that for one halocarbon agent, the extinguishing concentration was linearly related to the humidity of the supplied air. The MEC for 100 percent RH air (~21°C) was ~11 percent (relative) less than that determined for ~0 percent RH air. (P. Mackay memorandum, 18 May 2004.) In addition, analysis (J. A. Senecal, July 2004) of humidity effects on inert gas (i.e., nitrogen) extinguishment indicates that feasible variations in humidity of air supplied to the cup burner can affect the extinguishing concentration, X_G . Specifically, it is estimated that in the two extremes of (a) dry air and (b) 70 percent RH air at 25°C, the variation in X_G is approximately $0.313 < X_G < 0.295$, or 6 percent, which is at least twice the estimated uncertainty of the measurement. An RH correction to results could be necessary.

This endnote is applicable to the following text:

B.9.2.1.2 Humidity.

Air supplied to the cup burner should be dry.¹²

Alternatively, if this is not a publicly available source, should the reference in the paragraph be deleted?



Public Comment No. 1-NFPA 12-2019 [Section No. 4.3.4.1]

4.3.4.1*

All system components shall be located so as to maintain minimum clearances from live parts as shown in Table 4.3.4.1 and Figure 4.3.4.1.

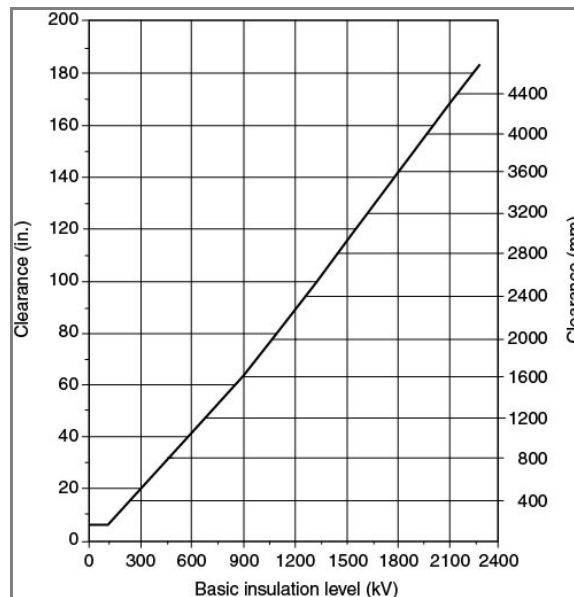
Table 4.3.4.1 Clearance from Carbon Dioxide Equipment to Live Uninsulated Electrical Components

Nominal	Maximum					
System	System	Design	Minimum†			
Voltage	Voltage	BIL *	Clearance			
(kV)	(kV)	(kV)	in.	mm		
≤13.8	14.5	110	7	178		
≤23.0	24.3	150	10	254		
≤34.5	36.5	200	13	330		
≤46.0	48.3	250	17	432		
≤69.0	72.5	350	25	635		
≤115.024	121.0	550	42	1067		
≤138.0	145.0	650	50	1270		
≤161.0	169.0	750	58	1473		
≤230.0	242.0	900	76	1930		
		-	-	1050	84	2134
≤345.0	362.0	1050	84	2134		
		-	-	1300	104	2642
≤500.0	550.0	1500	124	3150		
		-	-	1800	144	3658
≤765.0	800.0	2050	167	4242		

*Basic insulation level (BIL) values are expressed as kilovolts (kV), the number being the crest value of the full wave impulse test that the electrical equipment is designed to withstand. For BIL values that are not listed in the table, clearances can be found by interpolation.

†For voltages up to 161 kV, the clearances are taken from *NFPA 70*. For voltages 230 kV and above, the clearances are taken from Table 124 of ANSI/IEEE C2. In Canada, refer to CSA C22.1.

Figure 4.3.4.1 Clearance from Carbon Dioxide Equipment to Live Uninsulated Electrical Components.



Statement of Problem and Substantiation for Public Comment

according to Numerical range of normal voltages (<115), this maximum voltage (21) is not acceptable, and based on more searches 121 value has been identified.

Related Item

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Submittal Date: Mon Oct 14 07:07:19 EDT 2019

Committee: GFE-AAA



Public Comment No. 2-NFPA 12-2019 [Section No. A.4.6.6]

A.4.6.6

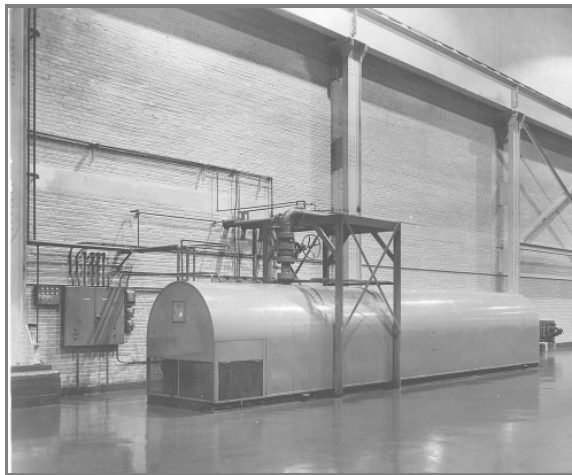
In low-pressure storage systems, the temperature of the contained carbon dioxide is controlled at about 0°F (–18°C) by means of insulation and refrigeration. The normal pressure is thus maintained at about 300 psi (2068 kPa). Welded pressure vessels are used for this service, and there is no special limitation on size.

The filling density has no effect on the pressure as long as there is sufficient vapor space to allow for expansion of the liquid at the maximum storage temperature and pressure. This filling density would be determined by the setting of the pressure relief valves. In general, the filling density can range from 90 percent to 95 percent. The maximum liquid level is controlled, during filling, by means of a short dip tube that returns excess liquid to the delivery unit when the liquid reaches the maximum filling level in the storage unit. A liquid level gauge is also provided to indicate the quantity of carbon dioxide in storage.

For low pressure CO2 systems, the flow calculations estimate the quantity of CO2 which discharges from the system nozzles from the start of discharge until the selector valve closes. The amount of CO2 remaining in the pipe between the selector valve and the nozzles is not typically estimated. If there is a large volume of pipe between the selector valve and the system nozzles, a considerable quantity of CO2 could be contained in the pipe when the selector valve closes and should be considered when sizing the low pressure storage unit. The pipe volume downstream of the selector valve and thus the amount of CO2 held in the pipe downstream of the selector valve can often be minimized by using a Master valve on the tank header in conjunction with a Selector valve near the protected hazard.

A typical low-pressure storage facility is shown in Figure A.4.6.6. In this unit, the insulated pressure vessel is covered with an outer metal housing that is sealed to keep out water moisture. A standard air-cooled refrigeration unit is mounted at one end, with its cooling coils mounted within the pressure vessel. This unit is electrically powered and automatically controlled by means of a pressure switch.

Figure A.4.6.6 A Typical Low-Pressure Storage Facility.



Statement of Problem and Substantiation for Public Comment

The additional information provides guidance to system designers in cases where large volumes of pipe could exist downstream of system selector valves.

Related Item

- FR 5

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Submittal Date: Tue Oct 15 14:19:40 EDT 2019

Committee: GFE-AAA

Report of the NFPA 12 Task Group on Carbon Dioxide Left in Pipe

Members: Tom Wysocki

Report Date: June 7, 2019 (submitted via email)

I ran a few calculations to see how much CO₂ a 4 inch pipeline might hold. The numbers look like this:

Main Pipe Run Between Storage Unit and take off for nozzles.		
Nominal Pipe Size	Length	Approximate CO ₂ (lbs) left in main pipe run when discharge valve is shut.
4 inch Schedule 40	100 ft	520 lbs
4 inch Schedule 40	200 ft	1000 lbs
4 inch Schedule 40	400 ft	1800 lbs

There would be some variation depending on the flow rate and pressure drop in the pipe – but these numbers should be in the ballpark. I sent these to Norb Makowka for a “sanity check” and Norb came up with similar numbers (not exactly the same but close enough considering the various flow rates with attendant pressure drops and resulting CO₂ densities in the pipeline). The bottom line is for a very long pipeline the amount of CO₂ that could be in the pipeline when a discharge valve closes could have an effect on the required tank size if someone is cutting the tank size “close.”

Matthew Taylor wrote to me last week and asked for more information on this subject (outside the scope of NFPA 12 involvement). I gave him the following thoughts which might be useful background for consideration by the GFE TC members:

“The typical LP CO₂ calc program estimates the quantity of CO₂ which discharges from the nozzles within a given time period. It does not estimate the amount of CO₂ which might remain in the pipe once the discharge valve closes.

You are correct that there could be a considerable amount of CO₂ remaining in the pipe at the time the discharge valve closes.

Depending on the valve configuration in the system, the amount of CO₂ discharged after the discharge valve closes could be considerable or minimal. The CO₂ in the pipe downstream of the selector valve (or Master-Selector valve) will continue to discharge from the nozzles until either the pressure in the pipeline reaches atmospheric pressure (this would be the case if there were enough heat flux into the CO₂ to evaporate the residual CO₂ before the pressure reached the triple point) or the pressure in the pipeline reaches the triple point of CO₂.

Given the same distance from the tank to the hazard, if the system uses a Master-Selector valve, the amount of extra CO₂ discharged into the hazard will be greater than if the system uses a Master valve on the tank header and a Selector valve near the hazard. In the latter case, the CO₂ held between the Master and Selector valves would in time generally flow back into the storage unit – only the CO₂ held downstream of the selector valve would flow into the hazard after the selector valve closed.”