Public Input No. 36-NFPA 2001-2023 [Global Input]

Create a metric task group to review the standard for consistency (Example: kPa and bar)

Statement of Problem and Substantiation for Public Input

Tables use a mix of kPa and bar in different tables

Submitter Information Verification

Submitter Full Name: Katherine Adrian
Organization: Johnson Controls
Street Address:
City:
State:
Zip:

Submittal Date: Wed Jan 04 11:44:10 EST 2023
Committee: GFE-AAA

Committee Statement

Resolution: CI-24-NFPA 2001-2023

Statement: Tables use a mix of kPa and bar in different tables

Task Group has been formed to review metric conversion and provide recommendation for Second Draft.

Public Input No. 30-NFPA 2001-2022 [Section No. 2.3.9]

2.3.9 UL Publications.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

~~UL 2127~~ CAN/UL/ULC 2127 , *Inert Gas Clean Agent Extinguishing System Units*, ~~2017 (R2020)~~ 2021 . ~~UL 2166~~

CAN/UL/ULC 2166 , *Halocarbon Clean Agent Extinguishing System Units*, ~~2017 (R2020)~~ 2021 .

Statement of Problem and Substantiation for Public Input

This PI updates current UL references and changes the UL standard to a Bi national standard.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 31-NFPA 2001-2022 [Section No. G.1.2.14]	

Submitter Information Verification

Submitter Full Name: Kelly Nicolello

Organization: UL LLC

Street Address:

City:

State:

Zip:

Submittal Date: Mon Dec 26 16:59:50 EST 2022

Committee: GFE-AAA

Committee Statement

Resolution: FR-15-NFPA 2001-2023

Statement: Updated to align with most recent editions of referenced publications

Public Input No. 21-NFPA 2001-2022 [Section No. 3.3.30]

3.3.30 No Observed Adverse Effect Level (NOAEL).

The highest concentration at which no adverse physiological or toxicological effect has been observed for the exposure times permitted by this standard .

Statement of Problem and Substantiation for Public Input

The current definitions does not consider exposure time when determining the NOAEL. The revised definition would consider the permitted exposure time in determining the NOAEL. For example, adverse effects might be observed only after continuous exposure to an agent for a number of days with no adverse effects observed after exposure to the agent for a few hours. Since this standard limits personnel exposure to 5 minutes, should not the duration of exposure be considered in determining the NOAEL?

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 4-NFPA 2001-2022 [Section No. B.1.1]	PI 4 considers determination of NOAEL

Submitter Information Verification

Submitter Full Name: Thomas Wysocki

Organization: Guardian Services, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Mon Sep 19 17:18:51 EDT 2022

Committee: GFE-AAA

Committee Statement

Resolution: Upon consideration of toxicity experts, the definition as written is appropriate.

Public Input No. 34-NFPA 2001-2023 [Section No. 4.3.2.3]

4.3.2.3*

The following additional provisions shall apply:

(1) Halocarbon systems for spaces that are normally occupied and designed to concentrations up to the NOAEL *[see Table 4.3.2.3(a)]* shall be permitted.

(2) Halocarbon systems for spaces that are normally occupied and designed to concentrations above the NOAEL *[see Table 4.3.2.3(a)]* shall be permitted if means are provided to limit exposure to the design concentrations shown in Table 4.3.2.3(b) through Table 4.3.2.3(e) that correspond to an allowable human exposure time of 5 minutes.

(3) Higher design concentrations associated with human exposure times less than 5 minutes as shown in Table 4.3.2.3(b) through Table 4.3.2.3(e) shall not be permitted in normally occupied spaces.

(4) In spaces that are not normally occupied and that are protected by a halocarbon system designed to concentrations above the lowest observable adverse effects level (LOAEL) *[see Table 4.3.2.3(a)]* and where personnel could possibly be exposed, means shall be provided to limit exposure times using Table 4.3.2.3(b) through Table 4.3.2.3(e).

(5) In spaces that are not normally occupied and in the absence of the information needed to fulfill the conditions in 4.3.2.3(4), the following provisions shall apply:

   (6) Where egress takes longer than 30 seconds but less than 1 minute, the halocarbon agent shall not be used in a concentration exceeding its LOAEL.

   (7) Concentrations exceeding the LOAEL shall be permitted provided that any personnel in the area can escape within 30 seconds

   (a)

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

Table 4.3.2.3(a) Information for Halocarbon Clean Agents

Agent	NOAEL (vol %)	LOAEL (vol %)
FK-5-1-12	10.0	>10.0
HCFC Blend A	10.0	>10.0
HCFC-124	1.0	2.5
HFC-125	7.5	10.0
HFC-227ea	9.0	10.5
HFC-23	30	>30
HFC-236fa	10	15
HFC Blend B*	5.0*	7.5*
HB-55	8.7%	>8.7%

*These values are for the largest component of the blend (HFC 134A).

Table 4.3.2.3(b) Time for Safe Human Exposure at Stated Concentrations for HFC-125

HFC-125 Concentration		Maximum Permitted Human Exposure Time
vol %	ppm	(min)
7.5	75,000	5.00

HFC-125 Concentration		Maximum Permitted Human Exposure Time
vol %	ppm	(min)
8.0	80,000	5.00
8.5	85,000	5.00
9.0	90,000	5.00
9.5	95,000	5.00
10.0	100,000	5.00
10.5	105,000	5.00
11.0	110,000	5.00
11.5	115,000	5.00
12.0	120,000	1.67
12.5	125,000	0.59
13.0	130,000	0.54
13.5	135,000	0.49

Notes:

(1) Data derived from the EPA-approved and peer-reviewed physiologically based pharmacokinetic (PBPK) model or its equivalent.

(2) Based on LOAEL of 10.0 percent in dogs.

Table 4.3.2.3(c) Time for Safe Human Exposure at Stated Concentrations for HFC-227ea

HFC-227ea Concentration		Maximum Permitted Human Exposure Time
vol %	ppm	(min)
9.0	90,000	5.00
9.5	95,000	5.00
10.0	100,000	5.00
10.5	105,000	5.00
11.0	110,000	1.13
11.5	115,000	0.60
12.0	120,000	0.49

Notes:

(1) Data derived from the EPA-approved and peer-reviewed PBPK model or its equivalent.

(2) Based on LOAEL of 10.5 percent in dogs.

Table 4.3.2.3(d) Time for Safe Human Exposure at Stated Concentrations for HFC-236fa

HFC-236fa Concentration		Maximum Permitted Human Exposure Time
vol %	ppm	(min)
10.0	100,000	5.00

HFC-236fa Concentration		Maximum Permitted Human Exposure Time
vol %	ppm	(min)
10.5	105,000	5.00
11.0	110,000	5.00
11.5	115,000	5.00
12.0	120,000	5.00
12.5	125,000	5.00
13.0	130,000	1.65
13.5	135,000	0.92
14.0	140,000	0.79
14.5	145,000	0.64
15.0	150,000	0.49

Notes:

(1) Data derived from the EPA-approved and peer-reviewed PBPK model or its equivalent.

(2) Based on LOAEL of 15.0 percent in dogs.

Table 4.3.2.3(e) Time for Safe Human Exposure at Stated Concentrations for FIC-13I1

FIC-13I1 Concentration		Maximum Permitted Human Exposure Time
vol %	ppm	(min)
0.20	2000	5.00
0.25	2500	5.00
0.30	3000	5.00
0.35	3500	4.30
0.40	4000	0.85
0.45	4500	0.49
0.50	5000	0.35

Notes:

(1) Data derived from the EPA-approved and peer-reviewed PBPK model or its equivalent.

(2) Based on LOAEL of 0.4 percent in dogs.

Statement of Problem and Substantiation for Public Input

The provision of audible and visual alarms is inconsistent and incorrect. It is good practice for all systems to have a pre-discharge alarm and time delay. Move this to cover all agents and all applications.

Submitter Information Verification

Submitter Full Name: Katherine Adrian

Organization: Johnson Controls

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jan 04 11:27:07 EST 2023

Committee: GFE-AAA

Committee Statement

Resolution: FR-25-NFPA 2001-2023

Statement: Eliminates confusion as to when time delay is required and is consistent with Inert Gas Section 4.3.3.3.

Public Input No. 5-NFPA 2001-2022 [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.

(7) Purge Fan to be installed at room protect by Clean Agent Fire Extinguishing Systems.

Statement of Problem and Substantiation for Public Input

Purge Fan requested to add for the protected by Clean Agent Fire Extinguishing systems and shall be manual operated after fire being extinguished to purge the Extinguishing Gas out of the Room.

Submitter Information Verification

Submitter Full Name: Alaaeldin Mosallam

Organization: Gulf Engineering

Street Address:

City:

State:

Zip:

Submittal Date: Sat Jun 18 03:02:06 EDT 2022

Committee: GFE-AAA

Committee Statement

Resolution: There are many ways in which agent enriched atmosphere could be purged. The standard should not restrict it to one method.

Public Input No. 35-NFPA 2001-2023 [Section No. 4.4.1]

4.4.1

Before system cylinders are handled or moved, the following steps shall be taken:

(1) Cylinder outlets shall be fitted with anti-recoil devices ~~, cylinder caps, or both,~~ whenever the cylinder outlet is not connected to the system ~~pipe inlet.~~ <u>. Cylinder caps, shall also be fitted whenever the cylinder is being moved / transported.</u>

(2) Actuators shall be disabled or removed before cylinders are removed from retaining bracketing.

Statement of Problem and Substantiation for Public Input

This implies valve protection is sufficient, but recoil caps should be fitted to outlets at all times unless connected to the system. Make outlet caps mandatory.

Submitter Information Verification

Submitter Full Name: Katherine Adrian

Organization: Johnson Controls

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jan 04 11:34:13 EST 2023

Committee: GFE-AAA

Committee Statement

Resolution: It's unclear whether the submitter meant for this to apply to all cylinders and what it is intended to protect.

Public Input No. 37-NFPA 2001-2023 [Section No. 6.2.2.2]

6.2.2.2

The equivalent length of the container valve shall include the siphon tube, valve, discharge head, and flexible connector, where applicable .

Statement of Problem and Substantiation for Public Input

Siphon tubes and flexible connectors may not always be present. Amend to allow such permutations.

Submitter Information Verification

Submitter Full Name: Katherine Adrian

Organization: Johnson Controls

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jan 04 11:54:43 EST 2023

Committee: GFE-AAA

Committee Statement

Resolution: FR-3-NFPA 2001-2023

Statement: Siphon tubes and flexible connectors are not always present, depending on the design of the system.

Public Input No. 23-NFPA 2001-2022 [Section No. 7.1.7.1]

7.1.7.1

~~If not shut down or closed automatically~~ Unless automatically isolated from the hazard prior to discharge of agent , the volume of ~~the self-contained recirculating undampered~~ ventilation system ducts and components ~~mounted below the ceiling height of the protected space~~ shall be considered as part of the total hazard volume when determining the quantity of agent.

Statement of Problem and Substantiation for Public Input

Unless ventilation system ducts are totally isolated from the protected volume, agent will infiltrate the ducts. If, in addition to the agent required to flood the protected volume, sufficient agent to flood any connected ventilation system ducts and components is not provided, the agent concentration in the protected volume will very likely be less than required.

Submitter Information Verification

Submitter Full Name: Thomas Wysocki

Organization: Guardian Services, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Tue Nov 01 10:47:06 EDT 2022

Committee: GFE-AAA

Committee Statement

Resolution: FR-4-NFPA 2001-2023

Statement: Unless ventilation system ducts are totally isolated from the protected volume, agent will infiltrate the ducts. If, in addition to the agent required to flood the protected volume, sufficient agent to flood any connected ventilation system ducts and components is not provided, the agent concentration in the protected volume will very likely be less than required. Just shutting down the fans would not isolate the environment.

Public Input No. 39-NFPA 2001-2023 [Section No. 7.1.7.1]

7.1.7.1

If not shut down or closed automatically, the volume of the self-contained recirculating undampered ventilation system ducts and ~~components mounted below the ceiling height of the protected space shall~~ components shall be considered as part of the total hazard volume when determining the quantity of agent.

Statement of Problem and Substantiation for Public Input

"below the ceiling" - the ceiling bears little or no relevance

Submitter Information Verification

Submitter Full Name: Katherine Adrian

Organization: Johnson Controls

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jan 04 12:07:11 EST 2023

Committee: GFE-AAA

Committee Statement

Resolution: FR-4-NFPA 2001-2023

Statement: Unless ventilation system ducts are totally isolated from the protected volume, agent will infiltrate the ducts. If, in addition to the agent required to flood the protected volume, sufficient agent to flood any connected ventilation system ducts and components is not provided, the agent concentration in the protected volume will very likely be less than required. Just shutting down the fans would not isolate the environment.

Public Input No. 40-NFPA 2001-2023 [Section No. 7.1.7.2]

7.1.7.2

Ventilation systems necessary to ensure safety or business continuity shall not be required to be shut down upon activation of the fire suppression system.

Statement of Problem and Substantiation for Public Input

To ensure safety, but many systems are to preserve business continuity.

Submitter Information Verification

Submitter Full Name: Katherine Adrian
Organization: Johnson Controls
Street Address:
City:
State:
Zip:

Submittal Date: Wed Jan 04 12:09:17 EST 2023
Committee: GFE-AAA

Committee Statement

Resolution: FR-5-NFPA 2001-2023

Statement: Section 7.1.7.2 was removed since it was redundant with 7.1.7.

7.1.7.3 was modified to reflect the removal of 7.1.7.2. "If required" was added because an extended discharge may not be necessary. For example, if the ventilation system is fully recirculating and adequate hold time is achieved.

Public Input No. 41-NFPA 2001-2023 [Section No. 7.1.7.3]

7.1.7.3

Where a ventilation system is permitted to remain in operation in accordance with 7.1.7.2, an extended agent discharge shall be provided ~~to~~ , if required, to maintain the design concentration for the required duration of protection.

Statement of Problem and Substantiation for Public Input

An extended discharge may not be required e.g. if recirculatory and with adequate hold time this is not necessary.

Submitter Information Verification

Submitter Full Name: Katherine Adrian

Organization: Johnson Controls

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jan 04 12:11:52 EST 2023

Committee: GFE-AAA

Committee Statement

Resolution: FR-5-NFPA 2001-2023

Statement: Section 7.1.7.2 was removed since it was redundant with 7.1.7.

7.1.7.3 was modified to reflect the removal of 7.1.7.2. "If required" was added because an extended discharge may not be necessary. For example, if the ventilation system is fully recirculating and adequate hold time is achieved.

Public Input No. 42-NFPA 2001-2023 [Section No. 7.1.8.2]

7.1.8.2

Designers shall consult the system manufacturer's recommended procedures relative to enclosure venting or use an approved methodology e .g. ISO 21805. *[For pressure relief vent area or equivalent leakage area, see 6.1.2.5(28).]*

Statement of Problem and Substantiation for Public Input

NFPA has global influence and it would be worth recognizing internationally accepted methodologies such as ISO 21805.

Submitter Information Verification

Submitter Full Name: Katherine Adrian
Organization: Johnson Controls
Street Address:
City:
State:
Zip:

Submittal Date: Wed Jan 04 12:14:31 EST 2023
Committee: GFE-AAA

Committee Statement

Resolution: Standard adequately addresses enclosure venting. Submitter did not submit a copy of the ISO Standard (21805) for review by the Technical Committee. The proposed change does not align with NFPA Manual of Style. Examples should be added as Annex Language.

Public Input No. 1-NFPA 2001-2021 [New Section after 7.2.3.3]

7.2.3.4

The temperature at which inerting concentrations are employed shall be in accordance with the manufacturer's listed installation manual.

Statement of Problem and Substantiation for Public Input

Halocarbon agent installation manuals and listings generally only reflect the temperature range required to support extinguishing concentrations.

Temperature requirements for effectively achieving an inerting concentration is not currently addressed in either the system listing or manufacturer's installation manual. To close this gap, the current standard should be updated to reflect the proposed content (in order to ensure fire protection designers and engineers specify and design systems in accordance with the manufacturer's listing limitations and/or installation manual). E.g.: depending on the agent and system configuration, utilizing the extinguishing minimum temperature of 32F could result in the inability to achieve the required inerting concentration (not enough heat physically present in the protected enclosure to allow the agent to change phases as it exits the nozzle); the system engineer may not be aware of this issue/gap since generally there is no guidance on inerting temperature limits in the system listing or installation manual.

Submitter Information Verification

Submitter Full Name: Brendan Karchere

Organization: ConocoPhillips Alaska, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Mon Nov 01 18:48:32 EDT 2021

Committee: GFE-AAA

Committee Statement

Resolution: Substantiation provided does not support the change proposed by the submitter. The technical committee has formed a task group to review the temperature issue of insufficient heat to vaporize the agent to reach its minimum inerting concentration.

Public Input No. 10-NFPA 2001-2022 [New Section after 7.4]

TITLE OF NEW CONTENT

Type your content here ... **7.4.3.** Means shall be provided to determine and indicate the agent concentration within the protected hazard.

Statement of Problem and Substantiation for Public Input

Substantiation. This is necessary to verify that the required agent concentration is maintained within the hazard space for the required duration of protection.

Submitter Information Verification

Submitter Full Name: Joseph Senecal

Organization: Firemetrics

Street Address:

City:

State:

Zip:

Submittal Date: Sat Jul 16 11:14:57 EDT 2022

Committee: GFE-AAA

Committee Statement

Resolution: Multiple analysis are performed during the design phase for the system. Providing a means to validate the concentration level during a fire scenario would not be beneficial.

Public Input No. 8-NFPA 2001-2022 [Section No. 7.4.1]

7.4.1

For flame-extinguishing systems, a minimum concentration of 85 percent of the minimum design concentration shall be held at the highest height of protected content within the hazard for a period of 10 minutes or for a ~~time~~ period sufficient to allow for response by trained personnel.

Statement of Problem and Substantiation for Public Input

Substantiation. The word “time” is deleted to make consistent the previous use of “period,” to mean a span of time in two places in the same sentence.

Submitter Information Verification

Submitter Full Name: Joseph Senecal

Organization: Firemetrics

Street Address:

City:

State:

Zip:

Submittal Date: Sat Jul 16 10:52:25 EDT 2022

Committee: GFE-AAA

Committee Statement

Resolution: FR-26-NFPA 2001-2023

Statement: The word “time” is deleted to make consistent the previous use of “period,” to mean a span of time in two places in the same sentence.

Public Input No. 9-NFPA 2001-2022 [Section No. 7.4.2]

7.4.2

For inerting systems, ~~a minimum concentration not less than the~~ the agent concentration shall be at least 91 % of the minimum design inerting concentration determined in accordance with 7.2.3. ~~1~~ 3 and shall be held throughout the protected space for a ~~time~~ period sufficient to allow for response by trained personnel.

Statement of Problem and Substantiation for Public Input

Substantiation. (1) Relating the minimum required concentration to the “inerting concentration” is one step removed from the design concentration. How does the inspector to know what the inerting concentration is? The inspector can know what the design concentration is and can calculate 91 % of that value. (2) The word “time” is deleted to make consistent the use of “period,” to mean a span of time, as used in 7.4.1.

Submitter Information Verification

Submitter Full Name: Joseph Senecal

Organization: Firemetrics

Street Address:

City:

State:

Zip:

Submittal Date: Sat Jul 16 10:54:24 EDT 2022

Committee: GFE-AAA

Committee Statement

Resolution: The use of 91% of the minimum design inerting concentration adds confusion since 91% of the minimum design concentration is the inerting concentration.

Public Input No. 38-NFPA 2001-2023 [Section No. 7.5.2.2]

7.5.2.2

The performance of the extended discharge system shall be confirmed by test ~~.~~ or as otherwised required by the authority having jurisdiction

Statement of Problem and Substantiation for Public Input

This will allow for emerging techniques to be utilized.

Submitter Information Verification

Submitter Full Name: Katherine Adrian

Organization: Johnson Controls

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jan 04 12:00:46 EST 2023

Committee: GFE-AAA

Committee Statement

Resolution: FR-10-NFPA 2001-2023

Statement: This will allow for emerging techniques to be utilized.

Public Input No. 43-NFPA 2001-2023 [Section No. 7.6.3]

7.6.3

The type of nozzles selected, their number, and their placement shall be such that the design concentration will be established in all parts of the hazard enclosure and such that the discharge will not unduly splash flammable liquids or create dust clouds that could extend the fire, create an explosion, or otherwise adversely affect the contents ~~or~~ , personnel or integrity of the enclosure.

Statement of Problem and Substantiation for Public Input

Adding personnel safety for consideration in nozzle placement.

Submitter Information Verification

Submitter Full Name: Katherine Adrian

Organization: Johnson Controls

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jan 04 12:20:36 EST 2023

Committee: GFE-AAA

Committee Statement

Resolution: FR-11-NFPA 2001-2023

Statement: It is important to consider nozzle placement for personnel safety and egress.

Public Input No. 44-NFPA 2001-2023 [New Section after 10.4.14.3]

10.4.14.4

All closed-section pipework and pipework upstream of pressure-reducing devices shall be hydrostatically tested to a minimum of 1.5 times the maximum working pressure for 2 minutes with no leakage. On completion of the test, the pipework shall be purged to remove moisture.

Statement of Problem and Substantiation for Public Input

Add in requirements for closed section testing which may be exposed to higher pressures. This should mirror the closed section test as ISO / EN clause 8.2.3.12.(b)

Submitter Information Verification

Submitter Full Name: Katherine Adrian

Organization: Johnson Controls

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jan 04 12:34:37 EST 2023

Committee: GFE-AAA

Committee Statement

Resolution: Hydrostatically testing piping components where water is not part of normal operation could interact with the discharge of clean agent and/or cause corrosion and other future degradation to the pipe.

Public Input No. 3-NFPA 2001-2022 [Section No. 11.3]

Replace existing 11.3

*

through 11.3.2 with the following:

11.3* Semiannual Service and Inspection.

11.3.1 At least semiannually,

the

agent

quantity and pressure of

containers shall be

checked.

11.3.1

For halocarbon clean agents with a means of pressure indication, if a container shows a loss in agent quantity of more than 5 percent or a loss in pressure (adjusted for temperature) of more than 10 percent, it shall be refilled or replaced.

11.3.2

For halocarbon agent containers without a means of pressure indication, if a container shows a loss in agent quantity of more than 5 percent, it shall be refilled or replaced

11.3.4 *

For inert gas clean agents, if a container shows a loss in pressure (adjusted for temperature) of more than 5 percent, it shall be refilled or replaced

inspected for agent quantity and for pressure, if pressurized .

11.3.

3 *

Halocarbon clean agent removed from containers during service or maintenance procedures shall be recovered and recycled or disposed of in accordance with any applicable laws and regulations.

1.1 If pressurized, a halocarbon agent container shall have a temperature-corrected pressure not less than 90 % of its minimum design value .

11.3.

5

Where container pressure gauges are used to comply with 11.3.4 , they shall be compared to a separate calibrated device at least annually

1.2 An agent container shall contain not less than 95 % of its design agent quantity .

11.3. 6

Where the quantity of agent in the container is determined by special measuring devices, these devices shall be listed.

~~**11.3.7**~~

~~The following information shall be recorded on a tag attached to the container:~~

(1) ~~Date of inspection~~

(2) ~~Person performing the inspection~~

(3) ~~Type of agent~~

(4) ~~Gross weight of the container and net weight of agent~~ ~~*(halocarbon clean agents only)*~~

(5) ~~Container pressure and temperature~~ ~~*(halocarbon clean agents with a gauge and inert gas clean agents)*~~

2 A container that is not compliant based on either pressure or agent content shall be made compliant or removed from service. 11.3 * Semiannual Service and Inspection.

Statement of Problem and Substantiation for Public Input

Proposed changes will clarify and make more specific the intended requirements.

Submitter Information Verification

Submitter Full Name: Joseph Senecal
Organization: Firemetrics
Street Address:
City:
State:
Zip:
Submittal Date: Sat Feb 05 13:18:38 EST 2022
Committee: GFE-AAA

Committee Statement

Resolution: The proposed changes could create confusion among users of the document.

Public Input No. 11-NFPA 2001-2022 [Section No. 11.3 [Excluding any Sub-Sections]]

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

Statement of Problem and Substantiation for Public Input

The existing 11.3 states three requirements for agent containers in one sentence.
a. Frequency of inspection,
b. Inspect for pressure,
c. Inspect for agent quantity.
Clarity is improved if only one requirement is stated per paragraph or subparagraph.

2. Existing 11.3.1 begins with a qualifying statement that is both unnecessary and technically incorrect: “For halocarbon clean agents with a means of pressure indication, …”
a. It is semantically incorrect. It states “For halocarbon agents with a means of pressure indication, …” It is the container, not the agent, that may have a means of pressure detection.
b. It is unnecessary because all pressurized containers are required to include a listed pressure gauge, per UL 2166, 13.1, which also notes that a pressure gauge is not required for a “… system unit that is filled with a halocarbon extinguishing agent only ...”
3. The existing language of 11.3 expresses requirements in relation to “loss” of pressure or of agent quantity, which is a negative attribute made after determining the value of pressure or agent in the container at the time of inspection. Stating what the values of minimum pressure or agent quantity, in a positive sense, results in a clearer statement of the requirements.
4. The proposed revisions address these issues.

Submitter Information Verification

Submitter Full Name:	Joseph Senecal
Organization:	Firemetrics
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sat Jul 16 14:40:02 EDT 2022
Committee:	GFE-AAA

Committee Statement

Resolution: The proposed changes could create confusion among users of the document.

Public Input No. 12-NFPA 2001-2022 [Section No. 11.3.1]

11.3.1

~~For halocarbon clean agents with a means of pressure indication, if a container shows a loss in agent quantity of more than 5 percent or a loss in pressure (adjusted for temperature) of more than 10 percent, it shall be refilled or replaced~~ 11.3.1 Agent containers shall be inspected at least semiannually to determine quantity of agent and pressure, if applicable .

Statement of Problem and Substantiation for Public Input

State single requirement per numbered paragraph.

Submitter Information Verification

Submitter Full Name: Joseph Senecal

Organization: Firemetrics

Street Address:

City:

State:

Zip:

Submittal Date: Sat Jul 16 14:42:17 EDT 2022

Committee: GFE-AAA

Committee Statement

Resolution: Reassessment of the adequacy of Public Input 3 indicates that the attached Public Inputs do not add practical requirements to the standard.

Public Input No. 13-NFPA 2001-2022 [Section No. 11.3.2]

11.3.2

~~For halocarbon agent containers without a means of pressure indication, if a container shows a loss in agent quantity of more than 5 percent, it shall be refilled or replaced~~

11.3.2 Halocarbon agent containers

11.3.2.1 A container filled with halocarbon agent shall contain at least 95 % of its design agent quantity.

11.3.2.2 A container filled with both halocarbon agent and expellant gas shall have a temperature-corrected pressure that is at least 90 % of its minimum design pressure .

Statement of Problem and Substantiation for Public Input

State requirements of halocarbon containers separately from inert gas containers.

Clarity is improved if only one requirement is stated per paragraph or subparagraph.

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Submittal Date: Sat Jul 16 14:44:35 EDT 2022
Committee: GFE-AAA

Committee Statement

Resolution: Reassessment of the adequacy of Public Input 3 indicates that the attached Public Inputs do not add practical requirements to the standard.

Public Input No. 14-NFPA 2001-2022 [Section No. 11.3.4]

11.3.4*

~~For inert gas clean agents, if a container shows a loss in pressure (adjusted for temperature) of more than 5 percent, it shall be refilled or replaced~~

11.3.4 Inert gas agent containers

11.3.4.1 A container filled with inert gas agent shall contain at least 95 % of its design agent quantity.

11.3.4.2 * Where the quantity of inert gas agent is computed based on the temperature and pressure of the container, the computational method shall consider the compressibility of the inert gas at the container storage conditions .

Statement of Problem and Substantiation for Public Input

Substantiation.
1. The minimum quantity of halocarbon agent in a container is 95 % of its design quantity.
2. The minimum quantity of inert gas agent in a container should also be 95 % of its design quantity, which is consistent with the requirement for a halocarbon agent container.
3. For inert gas agents, the requirement of 11.3.4 the 2022 edition ("… if a container shows a loss in pressure (adjusted for temperature) of more than 5 percent, …") does not correspond to a loss of 5 % of the agent because it does not consider the compressibility factor of the inert gas agent at the storage conditions.
4. The associated Public Input A.11.3.3.2 provides technical guidance to account for inert gas compressibility.

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Submittal Date: Sat Jul 16 14:54:24 EDT 2022

Committee: GFE-AAA

Committee Statement

Resolution: Reassessment of the adequacy of Public Input 3 indicates that the attached Public Inputs do not add practical requirements to the standard.

Public Input No. 45-NFPA 2001-2023 [Section No. 11.3.7]

11.3.7

The following information shall be recorded on a tag attached to the container:

(1) Date of inspection

(2) Person and organization performing the inspection

(3) Type of agent

(4) Gross weight of the container and net weight of agent *(halocarbon clean agents only)*

(5) Container pressure and temperature *(halocarbon clean agents with a gauge and inert gas clean agents)*

Statement of Problem and Substantiation for Public Input

Inspection record - lacks detail of organization, this should be recorded too.

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Submittal Date: Wed Jan 04 12:43:14 EST 2023

Committee: GFE-AAA

Committee Statement

Resolution: FR-12-NFPA 2001-2023

Statement: The Inspection record lacks the detail of organization performing the inspection. This should also be recorded.

Public Input No. 33-NFPA 2001-2023 [Section No. A.4.2.4]

A.4.2.4

~~Information~~ Determine whether it is necessary to take measures designed to reduce the noise reaching sensitive equipment, such as certain hard disk drives, by selection and location of system components and the enclosure design. This could include installing the sensitive equipment in soundproof enclosures, changing the nozzle spacings, and /or using nozzles and alarms that have been developed to reduce the sound output. Further information can be found in the following references:

(1) Brian P. Rawson and Kent C. Green, "Inert Gas Data Center Fire Protection and Hard Disk Drive Damage," *Data Center Journal*, August 27, 2012 (http://www.datacenterjournal.com/it/inert-gas-data-center-fire-protection-and-hard-disk-drive-damage/).

(2) Eurofeu, "Fixed Extinguishing Installation Section, Guidance paper on Impact of noise on Computer hard drives," October 2012.

(3) FSSA White Paper, "Effect of Sound Waves on Data Storage Devices," Fire Suppression Systems Association, Baltimore, MD, 2018.

(4) Juan Jose Merlo Latorre, "Hard Drive Damage," *Industrial Fire Journal,* Autumn 2013, issue no. 93, pp 12–14.

(5) Sandahl, D., A. Elder, and A. Barnard, "Impact of Sound on Computer Hard Disk Drives and Risk Mitigation Measures," Johnson Controls Form No. T-2016367-01, 2018.

(6) Section D.3 of NFPA 75.

(7) Siemens White Paper, "Potential damage to hard disk drives during discharges of dry extinguishing systems," Siemens, September 2012.

Statement of Problem and Substantiation for Public Input

NFPA has global influence and it would be good to have parity with ISO 14520 when possible. Offer abatement suggestions e.g. augment from ISO 14520-1 clause 7.5

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Submittal Date: Wed Jan 04 11:13:12 EST 2023
Committee: GFE-AAA

Committee Statement

Resolution: The proposed changes are covered by requirements in the body of the standard. The proposed information is also included in one or more referenced documents given in the Annex.

Public Input No. 32-NFPA 2001-2023 [Section No. A.7.2.2.3]

A.7.2.2.3

The following steps detail the fire extinguishment/area coverage fire test procedure for engineered and pre-engineered clean-agent-extinguishing-system units:

(1) The general procedures are as follows:

(2) An engineered or pre-engineered extinguishing system should mix and distribute its extinguishing agent and should totally flood an enclosure when tested in accordance with the recommendations of A.7.2.2.3(1)(c) through A.7.2.2.3(6)(f) under the maximum design limitations and most severe installation instructions. See also A.7.2.2.3(1)(b) .

(3) When tested as described in A.7.2.2.3(2)(a) through A.7.2.2.3(5)(b) , an extinguishing system unit should extinguish all fires within 30 seconds after the end of system discharge. When tested as described in A.7.2.2.3(2)(a) through A.7.2.2.3(3)(c) and A.7.2.2.3(6)(a) through A.7.2.2.3(6)(f) , an extinguishing system should prevent reignition of the wood crib after a 10-minute soak period.

(4) The tests described in A.7.2.2.3(2)(a) through A.7.2.2.3(6)(f) should be carried out. Consider the intended use and limitations of the extinguishing system, with specific reference to the following:

(5) The area coverage for each type of nozzle

(6) The operating temperature range of the system

(7) Location of the nozzles in the protected area

(8) Either maximum length and size of piping and number of fittings to each nozzle or minimum nozzle pressure

(9) Maximum discharge time

(10) Maximum fill density

(11) The test enclosure construction is as follows:

(12) The enclosure for the test should be constructed of either indoor- or outdoor-grade minimum 3⁄8 in. (9.5 mm)–thick plywood or equivalent material.

(13) An enclosure(s) is to be constructed having the maximum area coverage for the extinguishing-system unit or nozzle being tested and the minimum and maximum protected area height limitations.

The test enclosure(s) for the maximum height, flammable liquid, and wood crib fire extinguishment tests need not have the maximum coverage area, but should be at least 13.1 ft (4.0 m) wide by 13.1 ft (4.0 m) long and 3531 ft^3 (100 m^3) in volume.

(14) The extinguishing system is as follows:

(15) A pre-engineered type of extinguishing system unit is to be assembled using its maximum piping limitations with respect to number of fittings and length of pipe to the discharge nozzles and nozzle configuration(s), as specified in the manufacturer’s design and installation instructions.

(16) An engineered-type extinguishing system unit is to be assembled using a piping arrangement that results in the minimum nozzle design pressure at 70°F (21°C).

(17) Except for the flammable liquid fire test using the 2.5 ft^2 (0.23 m^2) square pan and the wood crib extinguishment test, the cylinders are to be conditioned to the minimum operating temperature specified in the manufacturer’s installation instructions.

(18) The extinguishing concentration is as follows:

(19) The extinguishing agent concentration for each Class A test is to be 83.34 percent of the intended end use design concentration specified in the manufacturer's design and installation instructions at the ambient temperature of approximately 70°F (21°C) within the enclosure.

(20) The extinguishing agent concentration for each Class B test is to be 76.9 percent of the intended end-use design concentration specified in the manufacturer's design and installation instructions at the ambient temperature of approximately 70°F (21°C) within the enclosure.

(21) The concentration for inert gas clean agents can be adjusted to take into consideration actual leakage measured from the test enclosure.

(22) The concentration within the enclosure for halocarbon clean agents should be calculated using the following formula unless it is demonstrated that the test enclosure exhibits significant leakage. If significant test enclosure leakage does exist, the formula used to determine the test enclosure concentration of halocarbon clean agents can be modified to account for the leakage measured.

$$W = \frac{V}{s}\left(\frac{C}{100 - C}\right) \qquad \textbf{[A.7.2.2.3a]}$$

where:

W = weight of clean agents [lb (kg)]

V = volume of test enclosure [ft^3 (m^3)]

s = specific volume of clean agent at test temperature [ft^3/lb (m^3/kg)]

C = concentration (vol %)

(23) The flammable liquid extinguishment tests are as follows:

(24) Steel test cans having a nominal thickness of 0.216 in. (5.5 mm) (such as Schedule 40 pipe) and 3.0 in. to 3.5 in. (76.2 mm to 88.9 mm) in diameter and at least 4 in. (102 mm) high, containing either heptane or heptane and water, are to be placed within 2 in. (50.8 mm) of the corners of the test enclosure(s) and directly behind the baffle, and located vertically within 12 in. (305 mm) of the top or bottom of the enclosure or both the top and bottom if the enclosure permits such placement. If the cans contain heptane and water, the heptane is to be at least 2 in. (50.8 mm) deep. The level of heptane in the cans should be at least 2 in. (50.8 mm) below the top of the can. For the minimum room height area coverage test, closable openings are provided directly above the cans to allow for venting prior to system installation. In addition, for the minimum height limitation area coverage test, a baffle is to be installed between the floor and ceiling in the center of the enclosure. The baffle is to be perpendicular to the direction of nozzle discharge and to be 20 percent of the length or width of the enclosure, whichever is applicable with respect to nozzle location. For the maximum room height extinguishment test, an additional test is to be conducted using a 2.5 ft^2 (0.23 m^2) square pan located in the center of the room and the storage cylinder conditioned to 70°F (21°C). The test pan is to contain at least 2 in. (50.8 mm) of heptane, with the heptane level at least 2 in. (50.8 mm) below the top of the pan. For all tests, the heptane is to be ignited and allowed to burn for 30 seconds, at which time all openings are to be closed and the extinguishing system is to be manually actuated. At the time of actuation, the percent of oxygen within the enclosure should be at least 20 percent.

(25) The heptane is to be commercial grade having the following characteristics:

(26) Initial boiling point: 194°F (90°C) minimum

(27) Dry point: 212°F (100°C) maximum

(28) Specific gravity: 0.69–0.73

(29) The wood crib extinguishment tests are as follows:

(30) The storage cylinder is to be conditioned to 70°F (21°C). The test enclosure is to have the maximum ceiling height as specified in the manufacturer's installation instructions.

(31) The wood crib is to consist of four layers of six, trade size 2 by 2 (1 1⁄2 in. by 1 1⁄2 in.) by 18 in. long, kiln spruce or fir lumber having a moisture content between 9 percent and 13 percent. The alternate layers of the wood members are to be placed at right angles to one another. The individual wood members in each layer are to be evenly spaced, forming a square determined by the specified length of the wood members. The wood members forming the outside edges of the crib are to be stapled or nailed together.

(32) Ignition of the crib is to be achieved by the burning of commercial-grade heptane in a square steel pan 2.5 ft^2 (0.23 m^2) in area and not less than 4 in. (101.6 mm) in height. The crib is to be centered with the bottom of the crib 12 in. to 24 in. (304 to 609.6 mm) above the top of the pan, and the test stand constructed so as to allow for the bottom of the crib to be exposed to the atmosphere.

(33) The heptane is to be ignited, and the crib is to be allowed to burn freely for approximately 6 minutes outside the test enclosure. The heptane fire is to burn for 3 to 3 1⁄2 minutes. Approximately 1⁄4 gal (0.95 L) of heptane will provide a 3 to 3 1⁄2 minute burn time. Just prior to the end of the pre-burn period, the crib is to be moved into the test enclosure and placed on a stand such that the bottom of the crib is between 20 in. and 28 in. (508 mm and 711 mm) above the floor. The closure is then to be sealed.

(34) After the crib is allowed to burn for 6 minutes, the system is to be actuated. At the time of actuation, the percent of oxygen within the enclosure at the level of the crib should be at least 20 percent.

(35) After the end of system discharge, the enclosure is to remain sealed for 10 minutes. After the 10-minute soak period, the crib is to be removed from the enclosure and observed to determine whether sufficient fuel remains to sustain combustion and to detect signs of re-ignition.

(36) The following is a schematic of the process to determine the design quantity:

(37) Determine hazard features, as follows:

(38) Fuel type: Extinguishing concentration (EC) per 7.2.2 or inerting concentration (IC) per 7.2.3

(39) Enclosure volume

(40) Enclosure temperature

(41) Enclosure barometric pressure

(42) Determine the agent minimum design concentration (MDC) by multiplying EC or IC by the safety factor (SF):

$$\text{MDC} = (\text{EC or IC})\ \text{SF} \quad \textbf{[A.7.2.2.3b]}$$

(43) Determine the agent minimum design quantity (MDQ) by referring to 7.3.1 for halocarbons or 7.3.2 for inert gases

(44) Determine whether design factors (DF) apply. See 7.3.3 to determine individual DF [DF(i)] and then determine sum:

$$DF = \Sigma DF(i) \quad \text{[A.7.2.2.3c]}$$

(45) Determine the agent adjusted minimum design quantity (AMDQ):

$$AMDQ = MDQ\ (1 + DF) \quad \text{[A.7.2.2.3d]}$$

(46) Determine the pressure correction factor (PCF) per 7.3.3.3

(47) Determine the final design quantity (FDQ) as follows:

$$FDQ = AMDQ \times PCF \quad \text{[A.7.2.2.3e]}$$

Where any of the following conditions exist, higher extinguishing concentrations might be required:

(1) Cable bundles greater than 4 in. (100 mm) in diameter

(2) Cable trays with a fill density greater than 20 percent of the tray cross section

(3) Horizontal or vertical stacks of cable trays less than 10 in. (250 mm) apart

(4) Equipment energized during the extinguishment period where the collective power consumption exceeds 5 kW

Fire extinguishment tests for (noncellulosic) Class A surface fires. The purpose of the tests outlined in this procedure is to develop the minimum extinguishing concentration (MEC) for a gaseous fire suppression agent for a range of noncellulosic, solid polymeric combustibles. It is intended that the MEC will be increased by appropriate safety factors and flooding factors as provided for in the standard.

These Class A tests should be conducted in a draft-free room with a volume of at least 3530 ft^3 (100 m^3) and a minimum height of 11.5 ft (3.5 m) and each wall at least 13.1 ft (4 m) long. Provisions should be made for relief venting if required.

The test objects are as follows:

(1) The polymer fuel array consists of four sheets of polymer, ⅜ in. (9.53 mm) thick, 16 in. (406 mm) tall, and 8 in. (203 mm) wide. Sheets are spaced and located per Figure A.7.2.2.3(a). The bottom of the fuel array is located 8 in. (203 mm) from the floor. The fuel sheets should be mechanically fixed at the required spacing.

(2) A fuel shield is provided around the fuel array as indicated in Figure A.7.2.2.3(a). The fuel shield is 15 in. (381 mm) wide, 33.5 in. (851 mm) high, and 24 in. (610 mm) deep. The 24 in. (610 mm) wide × 33.5 in. (851 mm) high sides and the 24 in. (610 mm) × 15 in. (381 mm) top are sheet metal. The remaining two sides and the bottom are open. The fuel array is oriented in the fuel shield such that the 8 in. (203 mm) dimension of the fuel array is parallel to the 24 in. (610 mm) side of the fuel shield.

(3) Two external baffles measuring 40 in. × 40 in. (1 m × 1 m) and 12 in. (0.3 m) tall are located around the exterior of the fuel shield as shown in Figure A.7.2.2.3(a) and Figure A.7.2.2.3(b). The baffles are placed 3.5 in. (0.09 m) above the floor. The top baffle is rotated 45 degrees with respect to the bottom baffle.

(4) Tests are conducted for three plastic fuels — polymethyl methacrylate (PMMA), polypropylene (PP), and acrylonitrile-butadiene-styrene (ABS) polymer. Plastic properties are given in Table A.7.2.2.3(a).

(5) The ignition source is a heptane pan 2 in. × 2 in. × ⅞ in. deep (51 mm × 51 mm × 22 mm deep) centered ½ in. (12 mm) below the bottom of the plastic sheets. The pan is filled with 3.0 ml of heptane to provide 90 seconds of burning.

(6) The agent delivery system should be distributed through an approved nozzle. The system should be operated at the minimum nozzle pressure (±10 percent) and the maximum discharge time (±1 second).

The test procedure is as follows:

(1) The procedures for ignition are as follows:

  (2) The heptane pan is ignited and allowed to burn for 90 seconds.

  (3) The agent is discharged 210 seconds after ignition of heptane.

  (4) The compartment remains sealed for 600 seconds after the end of discharge. Extinguishment time is noted. If the fire is not extinguished within 600 seconds of the end of agent discharge, a higher minimum extinguishing concentration must be utilized.

  (5) The test is repeated two times for each fuel for each concentration evaluated and the extinguishment time averaged for each fuel. Any one test with an extinguishment time above 600 seconds is considered a failure.

  (6) If the fire is extinguished during the discharge period, the test is repeated at a lower concentration or additional baffling provided to ensure that local transient discharge effects are not affecting the extinguishment process.

  (7) At the beginning of the tests, the oxygen concentration must be within 2 percent (approximately 0.5 percent by volume O_2) of ambient value.

  (8) During the post-discharge period, the oxygen concentration should not fall below 0.5 percent by volume of the oxygen level measured at the end of agent discharge.

(9) The observation and recording procedures are as follows:

  (10) The following data must be recorded continuously during the test:

    (11) Oxygen concentration (±0.5 percent)

    (12) Fuel mass loss (±5 percent)

    (13) Agent concentration (±5 percent) (Inert gas concentration can be calculated based on oxygen concentration.)

  (14) The following events are timed and recorded:

    (15) Time at which heptane is ignited

    (16) Time of heptane pan burnout

    (17) Time of plastic sheet ignition

    (18) Time of beginning of agent discharge

    (19) Time of end of agent discharge

    (20) Time all visible flame is extinguished

The minimum extinguishing concentration is determined by all of the following conditions:

(1) All visible flame is extinguished within 600 seconds of agent discharge.

(2) The fuel weight loss between 10 seconds and 600 seconds after the end of discharge does not exceed 0.5 oz (15 g).

(3) There is no ignition of the fuel at the end of the 600-second soak time and subsequent test compartment ventilation.

Wood crib and polymeric sheet Class A fire tests might not adequately indicate extinguishing concentrations suitable for the protection of certain plastic fuel hazards (e.g., electrical- and electronic-type hazards involving grouped power or data cables such as computer and control room underfloor voids and telecommunication facilities).

The values in Table A.7.2.2.3(b) are representative of the minimum extinguishing concentrations and design concentrations for various agents. The concentrations required can vary by equipment manufacturer. Equipment manufacturers should be contacted for the concentration required for their specific system.

Figure A.7.2.2.3(a) Four-Piece Modified Plastic Setup.

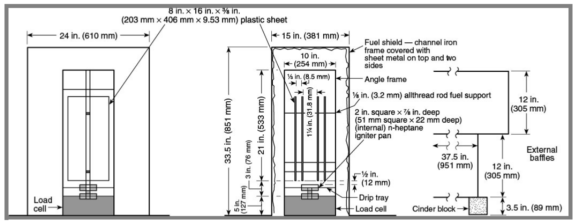

Figure A.7.2.2.3(b) Chamber Plan View.

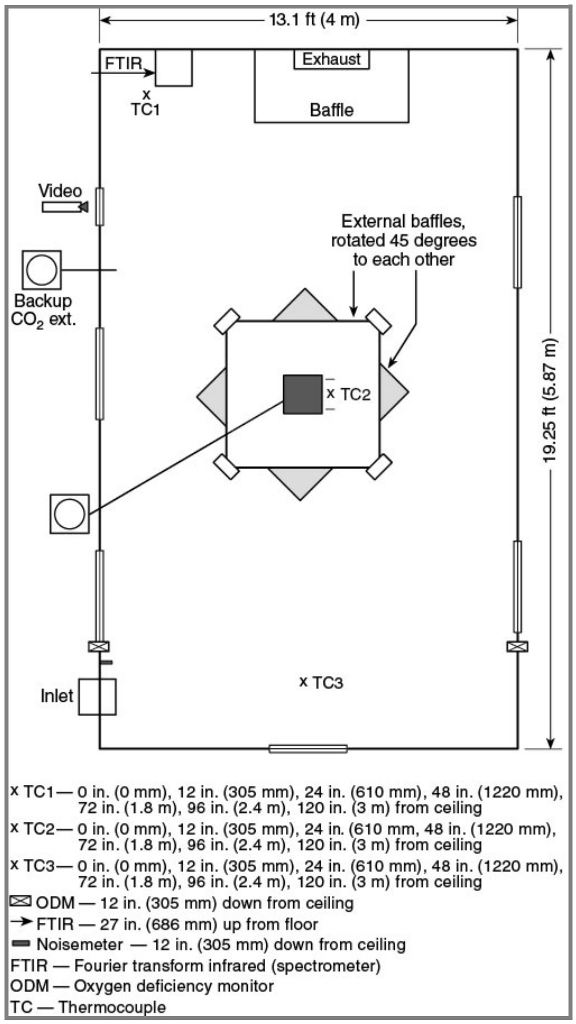

Table A.7.2.2.3(a) Plastic Fuel Properties*

25 kW/m^2 Exposure in Cone Calorimeter — ASTM E1354						
-	-	Density (g/cm^2)	Ignition Time	-	180-Second Average Heat Release	-

								Rate		
Fuel	**Color**	**sec**	**Tolerance**		**-**	**kW/m^2**	**Tolerance**	**-**	**MJ/kg**	**Toleran**
PMMA	Black	1.19	77	±30%	-	286	25%	-	23.3	±15%
PP	Natural (white)	0.905	91	±30%	-	225	25%	-	39.8	±15%
ABS	Natural (cream)	1.04	115	±30%	-	484	25%	-	29.1	±15%

* The fire properties shown in the table above are not necessarily representative of typical plastic materials made of polypropylene (PP), poly(methyl methacrylate) (PMMA) and ABS. A study of 35 materials tested in the cone calorimeter (ASTM E1354) has shown much higher heat release rates, particularly for PP (Reference: Hirschler, M.M., " "Heat release from plastic materials", Chapter 12 a, in "Heat Release in Fires", Elsevier, London, UK, Eds. V. Babrauskas and S.J. Grayson, 1992. pp. 375-422.). This suggests that the materials used in the testing may have contained additives to lower their heat release.

Table A.7.2.2.3(b) Class A Flame Extinguishing and Minimum Design Concentrations Tested to UL 2166 and UL 2127

Agent	Class A MEC	Class A Minimum Design Concentration	Class C Minimum Design Concentration
FK-5-1-12	3.3	4.5	4.5
HFC-125	6.7	8.7	9.0
HFC-227ea	5.2	6.7	7.0
HFC-23	15.0	18.0	20.3
IG-541	28.5	34.2	38.5
IG-55	31.6	37.9	42.7
IG-100	31.0	37.2	41.9

Note: Concentrations reported are at 70°F (21°C). Class A design values are the greater of (1) the Class A extinguishing concentration, determined in accordance with 7.2.2.1.1, times a safety factor of 1.2; or (2) the minimum extinguishing concentration for heptane as determined from 7.2.2.2.1(2).

Statement of Problem and Substantiation for Public Input

The data in the Table A.7.2.2.3(a) may give the impression that these plastic materials are always good fire performers. That is definitely not the case for PP, which is one of the highest heat release plastics in commercial use. In the reference cited, PP exhibits about 10 times as much heat as Douglas fir wood under the same conditions and much more than any one of the other plastics tested. Without some information as a note the user of NFPA 2001 may believe that all plastics are the same: they are not.
Note that the only change proposed is the added note to the table; all other apparent changes are Terra artifacts.

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Submittal Date: Mon Jan 02 18:53:38 EST 2023

Committee: GFE-AAA

Committee Statement

Resolution: This is a test specification with tolerances provided. It is understood specifications outside of tolerances might have unsatisfactory results.

Public Input No. 18-NFPA 2001-2022 [New Section after A.11.3]

TITLE OF NEW CONTENT

Type your content here ... 11.3.5 A container that is not compliant with 11.3.2.1, 11.3.2.2, or 11.3.4.1 shall be removed from service.

Statement of Problem and Substantiation for Public Input

Substantiation. This new section consolidates the same requirements of 11.3.1, 11.3.2, and 11.3.4 for halocarbon and inert gas containers.

Submitter Information Verification

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Submittal Date: Sat Jul 16 15:06:43 EDT 2022
Committee: GFE-AAA

Committee Statement

Resolution: Reassessment of the adequacy of Public Input 3 indicates that the attached Public Inputs do not add practical requirements to the standard.

Public Input No. 15-NFPA 2001-2022 [Section No. A.11.3]

* A.11.3 —

To

.1 Several methods are available to determine the quantity of halocarbon agent in a

cylinder, the cylinder can be weighed, or a

container. Such methods include direct weighing using a calibrated scale or dedicated in-place weighing system

or a listed device, such as a liquid-level indicator, can be used. Cylinders

; a built-in liquid level indicator; or ultrasonic liquid interface locator; or other liquid-level sensing technologies. An agent container can be heavy and bulky

so proper precautions must

, so if it is to be moved for inspection purposes, appropriate safety precautions should be taken to avoid personal injury

if cylinders are to be weighed.

.

Statement of Problem and Substantiation for Public Input

Substantiation. The proposed A.11.3 rephrases the original A.11.3 and adds recognition of ultrasonic liquid interface locator technology, and other liquid-level sensing technologies.

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Submittal Date: Sat Jul 16 14:57:45 EDT 2022

Committee: GFE-AAA

Committee Statement

Resolution: The current Annex already includes listed devices which covers any emerging and/or alternate testing method.

Public Input No. 16-NFPA 2001-2022 [Section No. A.11.3.4]

A.11.3.4

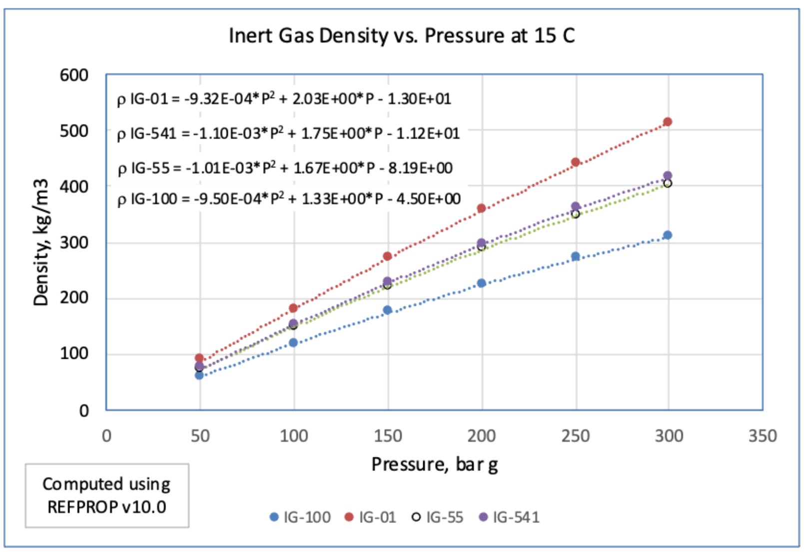
~~For inert gas clean agents that are not liquefied, pressure is an indication of agent quantity. Inert gas clean agents based on those gases normally found in the earth's atmosphere need not be recycled.~~

NEW A.11.3.4.2 The quantity of inert gas agent in a container is equal to its density times the container volume. The density of inert gas agent at storage conditions can be determined by using a suitable equation of state or other recognized method. REFPROP (v10) (see REFERENCE) was used to calculate inert gas agent densities vs. absolute pressure. The results are given below in table and chart form along with quadratic correlations.

Inert Gas Agent Density vs. Pressure at 15 °C (288 K)

P	IG-100	IG-01	IG-55	IG-541
bar g	r, kg/m ^{3}	r, kg/m ^{3}	r, kg/m ^{3}	r, kg/m ^{3}
50	60.2	88.0	73.9	74.9
100	118.5	178.6	147.6	151.1
150	173.7	270.0	219.6	226.2
200	224.3	358.0	286.9	296.5
250	269.4	439.1	347.9	359.5
300	309.2	511.8	402.0	414.6

REFERENCE. Lemmon, E.W., Bell, I.H., Huber, M.L., McLinden, M.O. NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology, Standard Reference Data Program, Gaithersburg, 2018



Correlation equations

ρ (IG-100) = -9.50E-04*P ^{2} + 1.33E+00*P - 4.50E+00

ρ (IG-01) = -9.32E-04*P ^{2} + 2.03E+00*P - 1.30E+01

ρ (IG-55) = -1.01E-03*P ^{2} + 1.67E+00*P - 8.19E+00

ρ (IG-541) = -1.10E-03*P ^{2} + 1.75E+00*P - 1.12E+01

where

ρ = storage density of inert gas agent at 15 °C, kg/m ^{3}

P = storage pressure of inert gas agent, bar g

Substantiation. The table, chart, and correlation equations can be useful in fulfilling the requirements of 11.3.4.2, where used.

Statement of Problem and Substantiation for Public Input

The new material provides specific information about the pressure-temperature characteristics of pressurized containers of IG-01, IG-55, IG-100, and IG-541. The P-T characteristics were derived from use of REFPROP v.10, a NIST thermodynamic VLE calculation tool.

Submitter Information Verification

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Committee:	GFE-AAA

Committee Statement

Resolution: Reassessment of the adequacy of Public Input 3 indicates that the attached Public Inputs do not add practical requirements to the standard.

Public Input No. 17-NFPA 2001-2022 [Section No. A.11.3.4]

A.11.3.4

~~For inert gas clean agents that are not liquefied, pressure is an indication of agent quantity. Inert gas clean agents based on those gases normally found in the earth's atmosphere need not be recycled.~~

NEW A.11.3.4.2 The quantity of inert gas agent in a container is equal to its density times the container volume. The density of inert gas agent at storage conditions can be determined by using a suitable equation of state or other recognized method. REFPROP (v10) (see REFERENCE) was used to calculate inert gas agent densities vs. absolute pressure. The results are given below in table and chart form along with quadratic correlations.

Table: Inert Gas Agent Density vs. Pressure at 15 °C (288 K)

REFERENCE. Lemmon, E.W., Bell, I.H., Huber, M.L., McLinden, M.O. NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology, Standard Reference Data Program, Gaithersburg, 2018

Graph: Inert Gas Density vs. Pressure at 15 C.

Correlation equations

ρ (IG-100) = -9.50E-04*P^2 + 1.33E+00*P - 4.50E+00

ρ (IG-01) = -9.32E-04*P^2 + 2.03E+00*P - 1.30E+01

ρ (IG-55) = -1.01E-03*P^2 + 1.67E+00*P - 8.19E+00

ρ (IG-541) = -1.10E-03*P^2 + 1.75E+00*P - 1.12E+01

where

ρ = storage density of inert gas agent at 15 °C, kg/m^3

P = storage pressure of inert gas agent, bar g

Additional Proposed Changes

File Name	Description	Approved
NEW_A.11.3.4.2_-_Document.docx	Text,Table, and Graph for Public Input for revised A.11.3.4.2	

Statement of Problem and Substantiation for Public Input

Substantiation. The table, chart, and correlation equations can be useful in fulfilling the requirements of 11.3.4.2, where used.

Submitter Information Verification

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Submittal Date: Sat Jul 16 15:01:37 EDT 2022

Committee: GFE-AAA

Committee Statement

Resolution: Reassessment of the adequacy of Public Input 3 indicates that the attached Public Inputs do not add practical requirements to the standard.

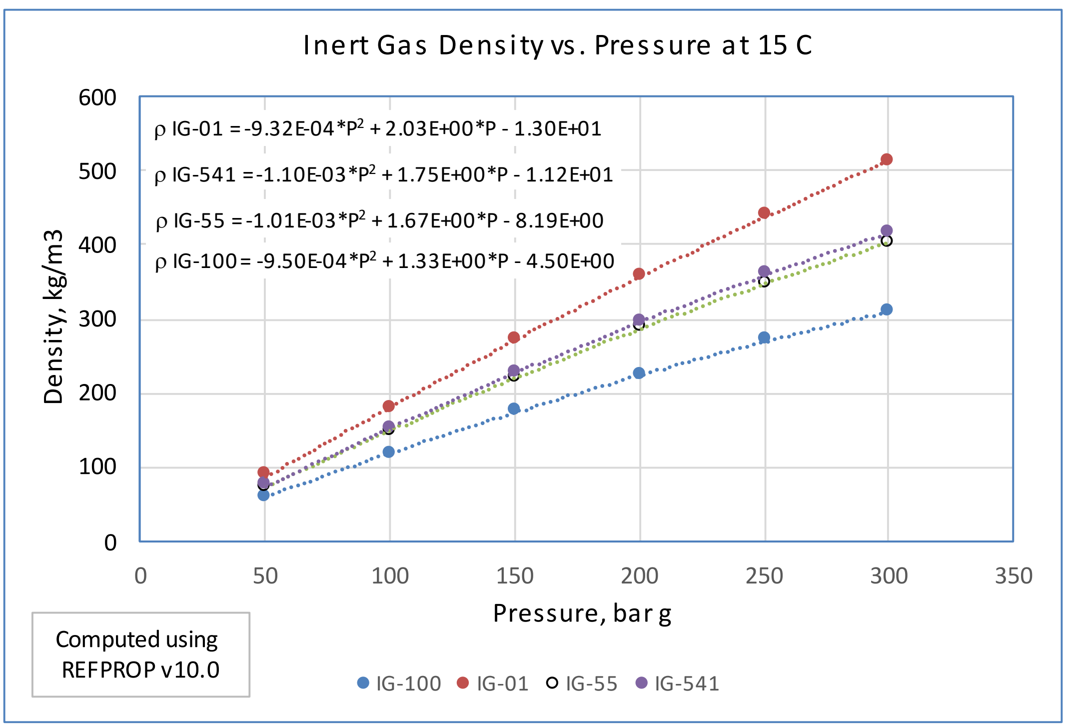
Public Input to NFPA 2001 - NEW A.11.3.4.2

A.11.3.4.2 The quantity of inert gas agent in a container is equal to its density times the container volume. The density of inert gas agent at storage conditions can be determined by using a suitable equation of state or other recognized method. REFPROP (v10) (see REFERENCE) was used to calculate inert gas agent densities vs. absolute pressure. The results are given below in table and chart form along with quadratic correlations.

Inert Gas Agent Density vs. Pressure at 15 °C (288 K)

P	IG-100	IG-01	IG-55	IG-541
bar g	ρ, kg/m³	ρ, kg/m³	ρ, kg/m³	ρ, kg/m³
50	60.2	88.0	73.9	74.9
100	118.5	178.6	147.6	151.1
150	173.7	270.0	219.6	226.2
200	224.3	358.0	286.9	296.5
250	269.4	439.1	347.9	359.5
300	309.2	511.8	402.0	414.6

REFERENCE. Lemmon, E.W., Bell, I.H., Huber, M.L., McLinden, M.O. NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology, Standard Reference Data Program, Gaithersburg, 2018



Correlation equations

$\rho(IG\text{-}100) = -9.50E\text{-}04 * P^2 + 1.33E{+}00 * P - 4.50E{+}00$

$\rho(IG\text{-}01) = -9.32E\text{-}04 * P^2 + 2.03E{+}00 * P - 1.30E{+}01$

$\rho(IG\text{-}55) = -1.01E\text{-}03 * P^2 + 1.67E{+}00 * P - 8.19E{+}00$

$\rho(IG\text{-}541) = -1.10E\text{-}03 * P^2 + 1.75E{+}00 * P - 1.12E{+}01$

where

ρ = storage density of inert gas agent at 15 °C, kg/m^3
P = storage pressure of inert gas agent, bar g

Substantiation. The table, chart, and correlation equations can be useful in fulfilling the requirements of 11.3.4.2, where used.

Public Input No. 4-NFPA 2001-2022 [Section No. B.1.1]

B.1.1 Toxicological Effects of Halocarbon Agents.

Table B.1.1 provides information on the toxicological effects of halocarbon agents covered by this standard. The no observable adverse effect level (NOAEL) is the highest concentration at which no adverse physiological or toxicological effect has been observed. The Cardiac sensitization and central nervous system effects are to be considered. The lowest observable adverse effect level (LOAEL) is the lowest concentration at which an adverse physiological or toxicological effect has been observed.

An appropriate protocol measures the effect in a stepwise manner such that the interval between the LOAEL and NOAEL is sufficiently small to be acceptable to the competent regulatory authority. The EPA includes in its SNAP evaluation this aspect (of the rigor) of the test protocol.

Table B.1.1 Toxicity Information for Halocarbon Clean Agents

Agent	LC_{50} or ALC (%)	NOAEL (%)	LOAEL (%)
FIC-13I1	>12.8	0.2	0.4
FK-5-1-12	>10.0	10	>10.0
HCFC Blend A	64	10	>10.0
HCFC-124	23–29	1	2.5
HFC-125	>70	7.5	10
HFC-227ea	>80	9	10.5
HFC-23	>65	30	>30
HFC-236fa	>45.7	10	15
HFC Blend B	56.7*	5.0*	7.5*
HB-55	>11	8.7	>8.7

Notes:

(1) LC_{50} is the concentration lethal to 50 percent of a rat population during a 4-hour exposure. The ALC is the approximate lethal concentration.

(2) The cardiac sensitization levels are based on the observance or nonobservance of serious heart arrhythmias in a dog. The usual protocol is a 5-minute exposure followed by a challenge with epinephrine.

(3) High concentration values are determined with the addition of oxygen to prevent asphyxiation.

*These values are for the largest component of the blend (HFCB 134A).

~~For halocarbons covered in this standard, the NOAEL and LOAEL are based on the toxicological effect known as cardiac sensitization. Cardiac~~ **Cardiac Sensitization** Cardiac sensitization occurs when a chemical causes an increased sensitivity of the heart to adrenaline, a naturally occurring substance produced by the body during times of stress, leading to the sudden onset of irregular heartbeats and possibly heart attack. Cardiac sensitization is measured in dogs after they have been exposed to a halocarbon agent for 5 minutes. At the 5-minute time period, an external dose of adrenaline (i.e., epinephrine) is administered and an effect is recorded if the dog experiences cardiac sensitization. The cardiac sensitization potential as measured in dogs is a highly conservative indicator of the potential in humans. The conservative nature of the cardiac sensitization test stems from several factors; the two most pertinent are as follows:

(1) Very high doses of adrenaline are given to the dogs during the testing procedure (doses are more than 10 times higher than the highest levels secreted by humans under maximum stress).

(2) Four to ten times more halocarbon is required to cause cardiac sensitization in the absence of externally administered adrenaline, even in artificially created situations of stress or fright in the dog test.

Because the cardiac sensitization potential is measured in dogs, a means of providing human relevance to the concentration at which this cardiac sensitization occurs (LOAEL) has been established through the use of physiologically based pharmacokinetic (PBPK) modeling.

A PBPK model is a computerized tool that describes time-related aspects of a chemical's distribution in a biological system. The PBPK model mathematically describes the uptake of the halocarbon into the body and the subsequent distribution of the halocarbon to the areas of the body where adverse effects can occur. For example, the model describes the breathing rate and uptake of the halocarbon from the exposure atmosphere into the lungs. From there, the model uses the blood flow bathing the lungs to describe the movement of the halocarbon from the lung space into the arterial blood that directly feeds the heart and vital organs of the body.

It is the ability of the model to describe the halocarbon concentration in human arterial blood that provides its primary utility in relating the dog cardiac sensitization test results to a human who is unintentionally exposed to the halocarbon. The concentration of halocarbon in the dog arterial blood at the time the cardiac sensitization event occurs (5-minute exposure) is the critical arterial blood concentration, and this blood parameter is the link to the human system. Once this critical arterial blood concentration has been measured in dogs, the EPA-approved PBPK model simulates how long it will take the human arterial blood concentration to reach the critical arterial blood concentration (as determined in the dog test) during human inhalation of any particular concentration of the halocarbon agent. As long as the simulated human arterial concentration remains below the critical arterial blood concentration, the exposure is considered safe. Inhaled halocarbon concentrations that produce human arterial blood concentrations equal to or greater than the critical arterial blood concentration are considered unsafe because they represent inhaled concentrations that potentially yield arterial blood concentrations where cardiac sensitization events occur in the dog test. Using these critical arterial blood concentrations of halocarbons as the ceiling for allowable human arterial concentrations, any number of halocarbon exposure scenarios can be evaluated using this modeling approach.

For example, in the dog cardiac sensitization test on Halon 1301, a measured dog arterial blood concentration of 25.7 mg/L is measured at the effect concentration (LOAEL) of 7.5 percent after a 5-minute exposure to Halon 1301 and an external intravenous adrenaline injection. The PBPK model predicts the time at which the human arterial blood concentration reaches 25.7 mg/L for given inhaled Halon 1301 concentrations. Using this approach, the model also predicts that at some inhaled halocarbon concentrations, the critical arterial blood concentration is never reached; thus, cardiac sensitization will not occur. Accordingly, in the tables in 4.3.2.3, the time is arbitrarily truncated at 5 minutes, because the dogs were exposed for 5 minutes in the original cardiac sensitization testing protocols.

The time value, estimated by the EPA-approved and peer-reviewed PBPK model or its equivalent, is that required for the human arterial blood level for a given halocarbon to equal the arterial blood level of a dog exposed to the LOAEL for 5 minutes.

For example, if a system is designed to achieve a maximum concentration of 12.0 percent HFC-125, means should be provided such that personnel are exposed for no longer than 1.67 minutes. Examples of suitable exposure-limiting mechanisms include self-contained breathing apparatuses and planned and rehearsed evacuation routes.

The requirement for pre-discharge alarms and time delays is intended to prevent human exposure to agents during firefighting. However, in the unlikely circumstance that an accidental discharge occurs, restrictions on the use of certain halocarbon agents covered in this standard are based on the availability of PBPK modeling information. For those halocarbon agents in which modeling information is available, means should be provided to limit the exposure to those concentrations and times specified in the tables in 4.3.2.3. The concentrations and times given in the tables are those that have been predicted to limit the human arterial blood concentration to below the critical arterial blood concentration associated with cardiac sensitization. For halocarbon agents where the needed data are unavailable, the agents are restricted based on whether the protected space is normally occupied or unoccupied and how quickly egress from the area can be effected. Normally occupied areas are those intended for human occupancy. Normally unoccupied areas are those in which personnel can be present from time to time. Therefore, a comparison of the cardiac sensitization values to the intended design concentration would determine the suitability of a halocarbon for use in normally occupied or unoccupied areas.

In specialized applications that require a very high rate of discharge, where agent concentration is measured at a much faster rate than human respiration periods, brief pulses of high concentration levels can be observed. In these cases, a time-weighted average of the concentration level with a period of one second can be used to compare to the safe levels given in the tables in 4.3.2.3.

Central Nervous System Effects (CNS) Central nervous system effects of inhalation of halocarbons must be considered in determining the NOAEL. CNS effects including tremors, dizziness, confusion. Such effects can diminish a person's ability to safely evacuate a space containing concentrations of halocarbon agents, thus CNS must be considered in establishing the NOAEL.

Toxicity of Blends For clean agents which consist of a blend of more than one chemical, tests to determine the NOAEL and LOAEL must be done using the actual blend.

Statement of Problem and Substantiation for Public Input

Currently the annex material only considers cardiac sensitization in determining NOAEL and LOAEL for halocarbon agents. Because CNS effects can inhibit a person's ability to safely evacuate a space containing concentrations of halocarbon clean agents, the concentration at which CNS effects occur should be considered when assessing NOAEL and LOAEL concentrations for fire protection applications. Even though the CNS effects may be transitory and may be reversed upon removal of exposure, the NOAEL and LOAEL concentrations should be such that personnel exposed to the agent will not be impeded by CNS effects from safely evacuating a space. Further, tests to determine the NOAEL and LOAEL for blended agents should be conducted with the actual blended agent. There are many examples where the NOAEL for a component of a blend is greatly different from the NOAEL for the blend.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 21-NFPA 2001-2022 [Section No. 3.3.30]	

Submitter Information Verification

Submitter Full Name: Thomas Wysocki
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Submittal Date: Tue May 03 13:11:44 EDT 2022
Committee: GFE-AAA

Committee Statement

Resolution: FR-16-NFPA 2001-2023

Statement: Proposed changes provide further clarification of EPA SNAP evaluation. Provides additional information on toxicological considerations for halocarbon agents. Additional information was provided on the evaluation of blends.

Public Input No. 20-NFPA 2001-2022 [Section No. E.1]

E.1

The discharge of a clean agent total flooding fire-extinguishing system into a protected enclosure creates pressure fluctuations therein. Normally, for halocarbon agents, the enclosure will have enough vent area and resistive strength to moderate and resist the pressure changes so that no damage occurs. In some circumstances, however, the enclosure could be damaged by the momentary pressure change. Damaging pressure can develop if there is insufficient vent area provided by normal leakage in the enclosure boundary. Alternatively, enclosure damage might occur due to a relatively weak construction, perhaps because of design or fabrication deficiencies. Damage could occur due to a combination of these factors.

The peak pressure created in an enclosure depends on many factors, including the agent concentration and discharge time, humidity, opening characteristics of the system discharge valve, and the aggregate vent area of the enclosure. The most influential parameter is the aggregate vent area, which comprises all openings, whether unintentional or intentional.

Pressures are developed within an enclosure during the discharge of both inert and halocarbon clean agents. The discharge of an inert agent results in only a positive pressure change, as illustrated by Figure E.1(a).

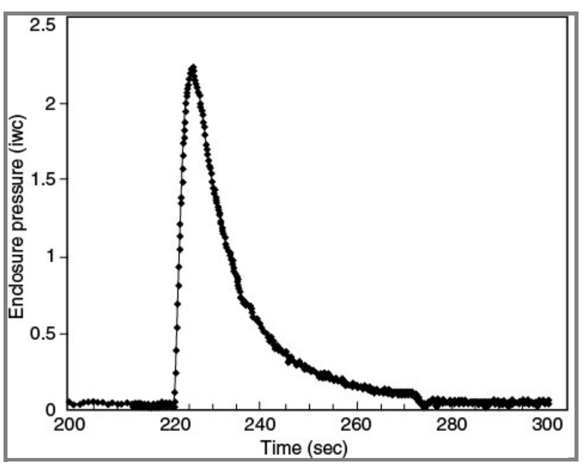
On the other hand, the discharge of a halocarbon agent usually creates an initially negative pressure change followed by a positive pressure change, as illustrated by Figure E.1(b).

Figure E.1(b) shows the measured pressure changes within an enclosure during an actual discharge of halocarbon clean agent. The measured pressure within the enclosure initially dropped to a negative peak value of −387 Pa (8.1 psf), then rose to the positive peak value of +671 Pa (14.0 psf) before falling back down to 0, about 10 seconds after the end of the 5-second discharge.

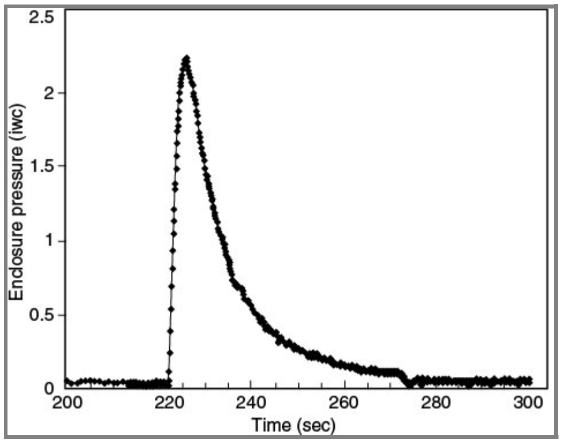
Enclosures must be capable of withstanding peak pressures, whether positive in the case of the inert agents or both negative and positive in the case of the halocarbon agents. To achieve this objective, it is necessary to determine the strength of the enclosure's bounding walls, floor, and ceiling in terms of their ability to resist pressure decreases and increases as applicable to the specific agent.

The strength of the enclosure walls and ceiling usually determines the overall strength of an enclosure. The strength and physical dimensions of the construction elements play an important role. For example, a common wall construction system consists of gypsum wallboard attached to vertical studs of either metal or wood. The inherent strength of the stud system will dictate the overall strength of the wall. The stud material, physical dimensions, and spacing between studs have a significant influence on the overall strength of the stud system.

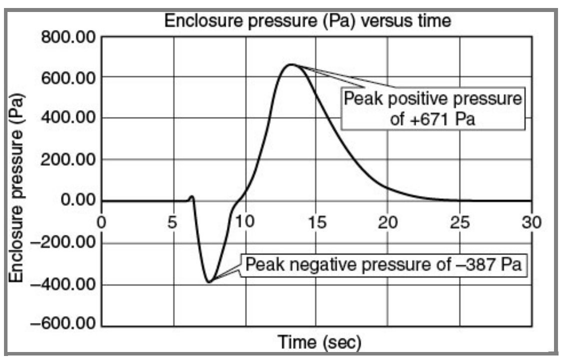
Figure E.1(a) Example of an Actual IG-541 60-Second Discharge Showing Peak Pressure.



~~200 shall be 0, 220 shall be 20, 240 shall be 40, 260 shall be 60, 280 shall be 80, 300 shall be 100.~~



~~Figure E.1(b) Example of an Actual HFC-227ea Discharge Showing Peak Pressures.~~



Additional Proposed Changes

File Name	Description	Approved
121.png	The right drawing	
IG.png	FM	

Statement of Problem and Substantiation for Public Input

The time for "FIGURE E.1(a) Example of an Actual IG-541 60-Second Discharge Showing Peak Pressure.“ is wrong. It more than right time 200s .

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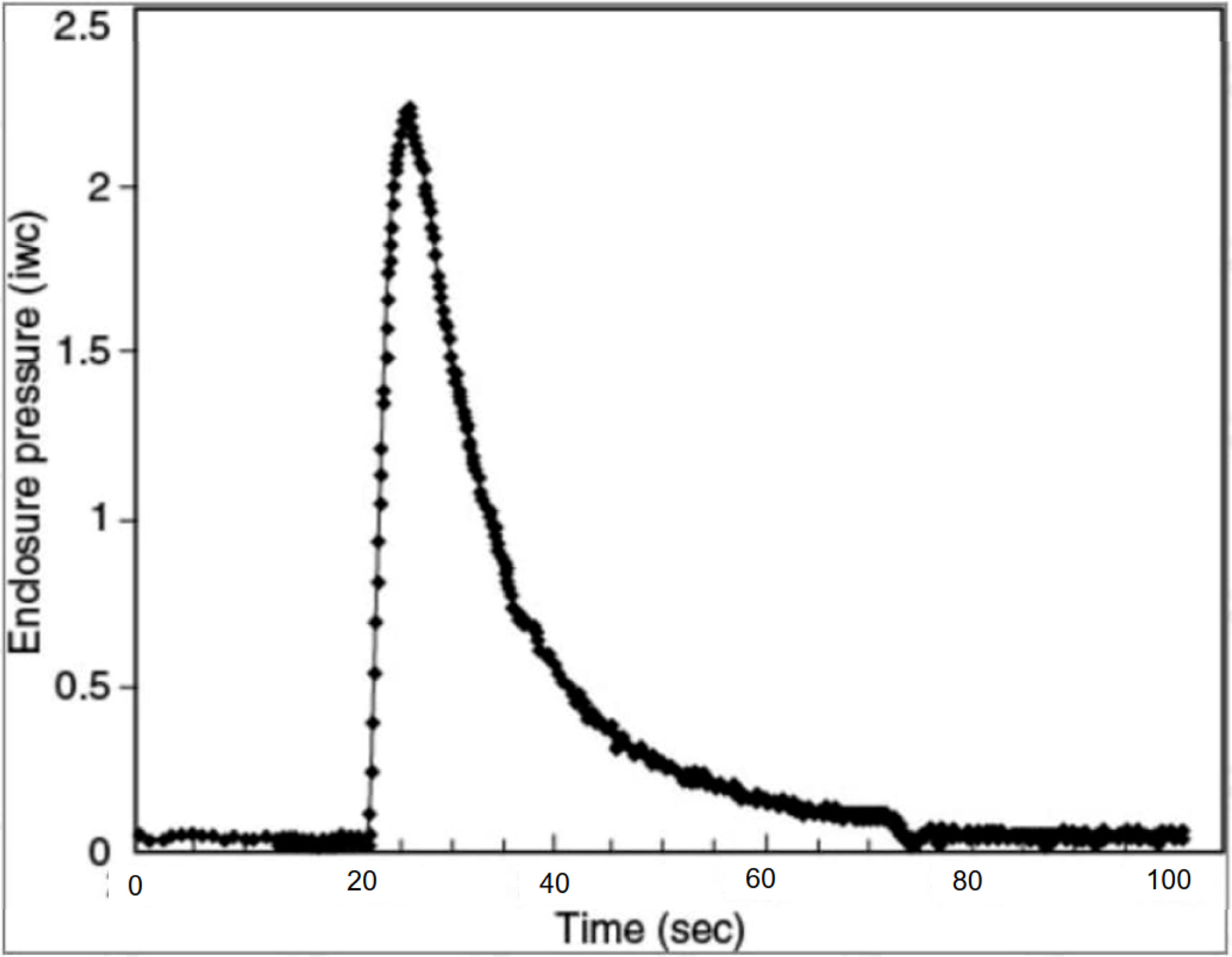
Submittal Date: Mon Jul 25 23:00:51 EDT 2022

Committee: GFE-AAA

Committee Statement

Resolution: The graphs provided were truncated portion of the test results and still represents adequate data.


Enclosure pressure (iwc)
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
Time (sec)

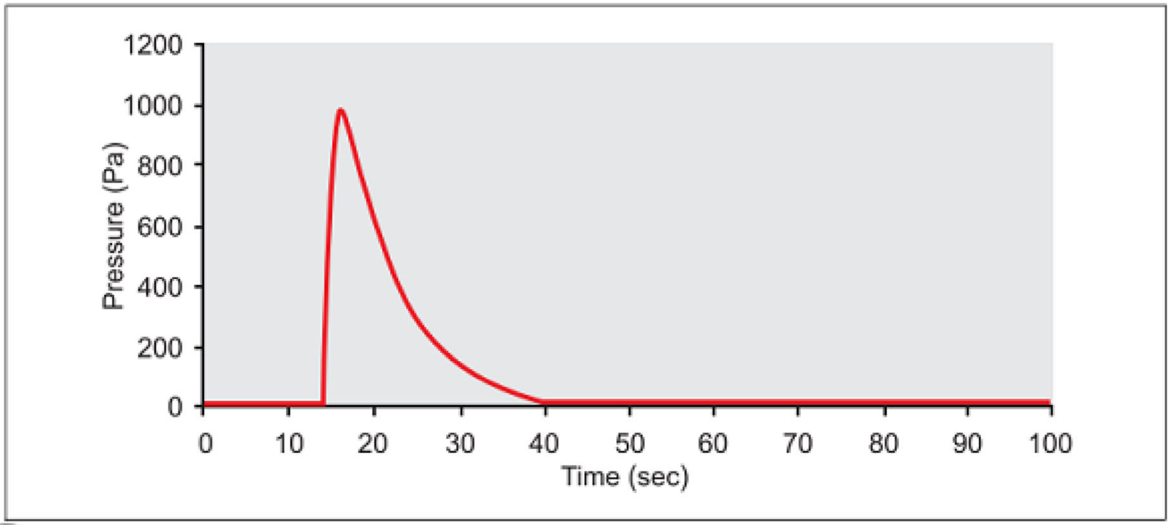


Fig. 1. Pressure in an enclosure protected by an inert gas

Public Input No. 29-NFPA 2001-2022 [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,* ~~2018 (2020).~~ 2021 a e1

ASTM E177, *Standard Practice for Use of the Terms Precision and Bias in ASTM Test Methods*, ~~2019~~ 2020 .

ASTM E456, *Standard Terminology Relating to Quality and Statistics*, ~~2013~~ 2013a (~~2020~~ 2022).

ASTM E691, *Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method*, ~~2019 (2020)~~ 2022 .

ASTM E779, *Standard Test Method for Determining Air Leakage Rate by Fan Pressurization,* 2019.

ASTM E1258, *Standard Test Method for Airflow Calibration of Fan Pressurization Devices*, 1988 (2018).

ASTM E1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter,* ~~2017.~~ 2022c

ASTM E1827, *Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door*, ~~2011 (2017).~~ 2022

ASTM F1387, *Standard Specification for Performance of Piping and Tubing Mechanically Attached Fittings,* 2019.

Statement of Problem and Substantiation for Public Input

date updates

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Committee: GFE-AAA

Committee Statement

Resolution: FR-13-NFPA 2001-2023
Statement: Updated to reflect current edition and titles for all referenced publications.

Public Input No. 31-NFPA 2001-2022 [Section No. G.1.2.14]

G.1.2.14 UL Publications.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062–2096.

~~UL 2127~~ CAN/UL/ULC 2127 , *Inert Gas Clean Agent Extinguishing System Units*, ~~2017(R2020)~~ 2021 . ~~UL 2166~~

CAN/UL/ULC 2166 , *Halocarbon Clean Agent Extinguishing System Units*, ~~2017(R2020)~~ 2021 .

Statement of Problem and Substantiation for Public Input

This PI updates current UL references and changes the UL standard to a Bi national standard.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 30-NFPA 2001-2022 [Section No. 2.3.9]	

Submitter Information Verification

Submitter Full Name: Kelly Nicolello
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Submittal Date: Mon Dec 26 17:01:55 EST 2022
Committee: GFE-AAA

Committee Statement

Resolution: FR-13-NFPA 2001-2023
Statement: Updated to reflect current edition and titles for all referenced publications.