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MINUTES

NFPA Technical Committee on Gaseous Fire Extinguishing Systems (GFE-AAA)
NFPA 12/12A/2001 Second Draft Meeting (F2024)

May 14 – 15, 2024
10:00 a.m. – 2:00 p.m. (Eastern)

Web/Teleconference (Microsoft Teams)

1. **Call to order.** Brent Ehmke, chair, called the meeting to order at 10:06 a.m. on May 14th 2024.
2. **Introductions.** Attendees introduced themselves and identified their affiliation and NFPA staff took attendance.
3. **Chair report.** Brent Ehmke welcomed attendees and provided an overview of the meeting.
4. **Staff liaison report.** Steve Kaitharath provided an overview of the standards development process and the revision cycle schedule.
5. **Previous meeting minutes.** The minutes from May 2023 (Quincy, MA) were approved without revision.
6. **NFPA 12 Second Draft.**
   a. **Review of Public Comments and Committee Inputs.** The Technical Committee reviewed the Public Comments and Committee Inputs and developed Second Revisions as necessary. These will be available in the Second Draft Report at www.nfpa.org/ [doc#].
   b. **Task group report(s).** The following task groups provided their reports and recommendations.
      i. **Secondary Cylinder Task Group**. Chair: Jessica Everest. The task group provided a report. See attached.
      ii. **Maritime Task Group**. Chair: Dan Hubert. The task group provided a report. The Technical Committee asked the report to be revised and to be presented next cycle. No revisions were made by the Technical Committee based on the report. The task group was reconstituted to continue work and would provide their report next cycle. See attached.
7. **NFPA 12A Second Draft.**
   a. **Review of Public Comments and Committee Inputs.** The Technical Committee reviewed the Public Comments and Committee Inputs and developed Second Revisions as necessary. These will be available in the Second Draft Report at www.nfpa.org/ [doc#].

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8. **NFPA 2001 Second Draft.**

   a. **Review of Public Comments and Committee Inputs.** The Technical Committee reviewed the Public Comments and Committee Inputs and developed Second Revisions as necessary. These will be available in the Second Draft Report at www.nfpa.org/ [doc#].

   b. **Task group report(s).** The following task groups provided their reports and recommendations.

      i. **Metric Conversions Task Group**. Chair: Katherine Adrian. The task group did not provide a report. The task group has been discharged.

      ii. **Maritime Task Group**. Chair: Dan Hubert. The task group provided a report. The Technical Committee asked the report to be revised and to be presented next cycle. No revisions were made by the Technical Committee based on the report. The task group was reconstituted to continue work and would provide their report next cycle. See attached.

      iii. **Insufficient Heat Task Group**. Chair: Jessica Hubert. The task group provided a report, revisions were made, and proposed text was incorporated into the document. The task group has been discharged with thanks. See attached.

      iv. **Time Delay Task Group**. Chair: Brad Stillwell. The task group provided a report, revisions were made, and proposed text was incorporated into the document. The task group has been discharged with thanks. See attached.

      v. **Ethyl ether vs diethyl ether**. Chair: Joe Senechal, PhD. The task group provided a report, revisions were made, and proposed text was incorporated into the document. The task group has been discharged with thanks. See attached.

9. **Other Business.**

10. **Future meetings.** This was the final meeting of this committee for the revision cycle. Public Inputs for the next edition are expected to close [Month] [Year]. A meeting notification will be posted at www.nfpa.org/ [doc#]next when the next meeting is scheduled.

11. **Adjournment.** The meeting was adjourned at 02:16 p.m. on May 15, 2024.

<u>Attendees</u>

Committee Members:

✓	**Brent S. Ehmke**	Chair	Ehmke Associates
✓	**Brad T. Stilwell**	Principal	Fike Corporation
✓	**Thomas J. Wysocki**	Principal	Guardian Services, Inc.
	Todd A. Dillon	Principal	AXA XL/Global Asset Protection Services, LLC
✓	**Blake M. Shugarman**	Principal	UL LLC
✓	**Robert Kasiski**	Principal	FM Global
✓	**Mark L. Robin**	Principal	Chemours

✓	**Katherine Adrian**	Principal	Johnson Controls
✓	**Scott A. Hill**	Principal	JENSEN HUGHES
✓	**Raymond N. Hansen**	Principal	US Department of the Air Force
✓	**Giuliano Indovino**	Principal	North American Fire Guardian Technology, Inc.
	Steven Hodges	Principal	Alion Science and Technology
✓	**James R. Richardson**	Principal	Lisle Woodridge Fire District
✓	**Joseph A. Senecal**	Principal	Firemetrics
✓	**Michael Lee Moberly**	Principal	BP
✓	**Karl Fredrik Penden**	Principal	Carrier/Kidde-Fenwal
✓	**William J. Cary**	Principal	Aon Risk Solutions
✓	**Mohamed Mushantat**	Principal	PLC Fire Safety Solutions
✓	**Jesse Cecil**	Principal	Fire King LLC.
✓	**Matt Pognant**	Principal	Liberty Mutual Property
✓	**Daniel J. Hubert**	Principal	Amerex/Janus Fire Systems
✓	**Carl W. Chappell**	Principal	Hilcorp Alaska
✓	**Jessica Everest**	Principal	Siemens
✓	**Jeffrey S. Kidd**	Principal	The Hiller Companies
✓	**Jim Morgan**	Principal	Marsh Advisory
✓	**Todd W. VanGorder**	Principal	Silco Fire & Security
	Joanna Minion	Principal	Honeywell
	Christina Thompson	Principal	US Environmental Protection Agency (US EPA)
✓	**Yunyong Pock Utiskul**	Principal	US Coast Guard
✓	**Justin D. Merrick**	Principal	Pye-Barker Fire & Safety
	Matthew Connolly	Principal	Harrington Group, Inc.
✓	**Charles O. Bauroth**	Alternate	Liberty Mutual
✓	**Alfred J. Thornton**	Alternate	The Chemours Company
✓	**Kevin Holly, Jr.**	Alternate	UL LLC
	Jonathan G. Ingram	Alternate	Carrier/Kidde-Fenwal, Inc.
✓	**Raymond A. Stacy**	Alternate	FM Approvals
	Eric W. Forssell	Alternate	JENSEN HUGHES
✓	**Emma Palumbo**	Alternate	North American Fire Guardian Technology, Inc./Safety Hi-Tech Europe Srl
✓	**Jessica A. Hubert**	Alternate	Guardian Services Inc.
	Andrew S. Carmean	Alternate	US Department of the Air Force
	Grant Smith	Alternate	Fike Corporation
✓	**Paul E. Rivers**	Alternate	Sidsson LLC
	Thomas A. Downey	Alternate	Marsh Risk Consulting
✓	**David A. Pelton**	Alternate	National Association of Fire Equipment Distributors (NAFED)
✓	**Margaret A. Sheppard**	Alternate	US Environmental Protection Agency
	Jeffrey S. Bors	Alternate	US Coast Guard
✓	**Corey Polzin**	Alternate	Johnson Controls
✓	**Josh Fritsch**	Alternate	US Army
✓	**Tom Zornes**	Alternate	Siemens
	Fernando Vigara	Nonvoting Member	APICI

	Ingeborg Schlosser	Nonvoting Member	VdS Schadenverhuetung
✓	**Steve Kaitharath**	Staff Liaison	NFPA

Guests:

Chad Duffy	NFPA
Tom Goss	NFPA
Mohammed Ateeq	Carrier/Kidde-Fenwal
Stefan Sekula	Viking Corp
Michael Kiamanesh	Waysmos

Total number in attendance: 44

NFPA 12 Task Group Report

TG Name	Secondary Cylinder Task Group
Scope	Review terms for secondary or “slave” cylinders that are used throughout the industry to recommend a change for standardization throughout the document.
Task Group Chair	Jessica Everest
Task Group Members	Jessica Hubert, Fred Penden, Scott Hill, Ray Stacy

Section	**PC**	**PAGE**	**DISPOSITION**
4.5.4.6.1			
Proposed Text (PC)			
Committee Text (SR)	~~The emergency manual control shall not be required of slave high-pressure cylinders.~~ Each of the pilot cylinders shall be equipped with an emergency manual control at the cylinder. Additional cylinders shall not be required to have an emergency manual control.		
Statement	Essentially ALL of the cylinders pilot actuate each other. To prevent the use of discriminatory language we reworded DOJ description of this requirement.		

Section	**PC**	**PAGE**	**DISPOSITION**
4.5.4.7.1			
Proposed Text (PC)			
Committee Text (SR)	Where gas pressure from pilot cylinders fed through the system discharge manifold (i.e., using back pressure rather than a separate pilot line) is used to release ~~remaining slave~~ additional cylinders and the supply consists of fewer than three cylinders, at least one cylinder shall be used for such operation.		

Statement	To prevent the use of discriminatory language, we replace "remaining slave" with "additional."

Section	**PC**	**PAGE**	**DISPOSITION**
4.5.4.7.2			
Proposed Text (PC)			
Committee Text (SR)	Where gas pressure from pilot cylinders that is fed through the system discharge manifold (i,e., using back pressure rather than a separate pilot line) is used to release ~~remaining slave~~ additional cylinders, and where the supply consists of three or more cylinders, there shall be at least one pilot cylinder more than the minimum required to actuate the system.		
Statement	To prevent the use of discriminatory language, we replace "remaining slave" with "additional."		

Section	**PC**	**PAGE**	**DISPOSITION**
4.5.4.7.3			
Proposed Text (PC)			
Committee Text (SR)	During the full discharge acceptance test, the extra pilot cylinder shall be arranged ~~to operate as a slave cylinder.~~ so that it discharges without contributing to the initiating pilot actuation.		
Statement	The reasoning behind this requirement is to prove that the system can discharge with one less pilot cylinder than required for the full system. The idea is to disable the extra pilot cylinder from being a part of discharging the remaining cylinders. We reworded the end of the requirement to remove the use of discriminatory language.		

Section	**PC**	**PAGE**	**DISPOSITION**

4.5.5.6			
Proposed Text (PC)			
Committee Text (SR)	High-pressure pneumatic-operated ~~slave~~ cylinder connections immediately adjacent to pilot cylinders shall not be required to be supervised.		
Statement	The use of discriminatory language is not necessary in this sentence as the requirement does not require it to make sense. For that reason, we removed the word "slave" completely.		

Section	**PC**	**PAGE**	**DISPOSITION**
A.4.5.4.7			
Proposed Text (PC)			
Committee Text (SR)	It is not the intent of this standard to prohibit the use of more pilot cylinders than the minimum number required in this paragraph. On systems using discharge pressure from pilot cylinders (discharge manifold back pressure) to activate ~~the slave~~ additional cylinders, one more pilot cylinder than the minimum required to actuate the system is installed. This requirement provides assurance that the system will completely discharge even if one of the pilot cylinders has leaked.		
Statement	To prevent the use of discriminatory language, we replace "the slave" with "additional."		

NFPA 2001 Task Group Report

TG Name	Insufficient Heat Task Group
Scope	Review the submitters substantiation from Public Input 1 to develop annex material to be considered at 2nd Draft.
Task Group Chair	Jessica Hubert
Task Group Members	Jesse Cecil, Eric Forssell, Dan Hubert, Tom Wysocki, Joe Senecal, Fred Penden, Nick Johnson.

Section	**PC**	**PAGE**	**DISPOSITION**
7.2.3.4	N/A	N/A	
Proposed Text (PC)	[Public Input 1 submitted during First Draft] 7.2.3.4 The temperature at which inerting concentrations are employed shall be in accordance with the manufacturer's listed installation manual.		
Committee Text (SR)	7.2.3.4* The temperature of the protected volume in which inerting halocarbons are employed shall be in accordance with the manufacturer's listed installation manual. A.7.2.3.4 Halocarbon agents have the potential to liquify at low temperatures. Particularly in an inerting setting, protected enclosure temperature conditions outside of the manufacturer's approved temperature range can result in lower than required concentrations.		
Statement	Manufacturers listing halocarbon agent systems for inerting should be able to accurately state at which temperatures the agent performs. Halocarbon agents are explicitly mentioned because low protected enclosure temperatures do not pose a risk for inert gas concentrations.		

NFPA 2001 Task Group Report

TG Name	Time Delay Task Group
Scope	Review situations where a time delay may not be appropriate. Committee Input 20 on section 4.3.7 was created as a place holder.
Task Group Chair	Brad Stilwell
Task Group Members	Dan Hubert, Tom Wysocki, Fred Penden, Grant Smith, Jessica Hubert

Section	PC	PAGE	DISPOSITION
9.7.2, 9.7.3			
Proposed Text (PC)			
Committee Text (SR)	9.7.2* For hazard areas ~~subject to fast-growth fires,~~ where the provision of a time delay would increase the threat to life and property, a time delay shall be permitted to be eliminated. A.9.7.2 ~~Hazards associated with fast-growth fires would include, but not be limited to, flammable liquid storage or transfer areas and aerosol filling areas.~~ Examples of hazards where the time delay might be omitted are those subject to fast growth fires such as ignitable liquid storage or handling, aerosol fill rooms, automated paint spray booths. Other hazards which might require elimination of the time delay include certain dust collectors. 9.7.3 Where time delays are omitted, provision shall be made to ensure that the clean agent system is locked out by a supervised system lockout valve any time personnel are present in the protected area or space. 9.7.3 Time delays shall be used only for personnel evacuation or to prepare the hazard area for discharge.		

	9.7.4 Time delays shall not be used as a means of confirming operation of a detection device before automatic actuation occurs.
Statement	The current text focused on fast growth fires and although fast growth fires are a reason to eliminate time delays there are other fires where rapid agent deployment is necessary. The fast-growth fires wording was moved to the appendix. There are instances where the addition of a time delay will result in an unacceptable damage to equipment or processes so there must be a process to ensure personnel safety and allow for the omission of a time delay. A supervised lockout valve is added because it is important that personnel not be exposed to dangerous levels of agent concentration. NFPA 12 also requires the use of a lockout valve is such circumstances.

NFPA 2001 Task Group Report

TG Name	Ethyl ether vs diethyl ether
Scope	Review ethyl ether and diethyl ether for accuracy, they are names for the same substance [Committee Input – 16]
Task Group Chair	Joseph A. Senecal, PhD
Task Group Members	Thomas Wysocki

Section	PC	PAGE	DISPOSITION
5.3.2.2	N/A	N/A	

Proposed Text

5.3.2.2*

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

Table 5.3.2.2 Minimum Carbon Dioxide Concentrations for Extinguishment

Material	Theoretical Minimum CO_2 Concentration (%)	Minimum Design CO_2 Concentration (%)
Acetylene	55	66
Acetone	27*	34
Aviation gas grades 115/145	30	36
Benzol, benzene	31	37
Butadiene	34	41

Material	Theoretical Minimum CO_2 Concentration (%)	Minimum Design CO_2 Concentration (%)
Butane	28	34
Butane-I	31	37
Carbon disulfide	60	72
Carbon monoxide	53	64
Coal or natural gas	31*	37
Cyclopropane	31	37
Diethyl ether	33	40
Dimethyl ether	33	40
Dowtherm	38*	46
Ethane	33	40
Ethyl alcohol	36	43
~~Ethyl ether~~	~~38*~~	~~46~~
Ethylene	41	49
Ethylene dichloride	21	34
Ethylene oxide	44	53
Gasoline	28	34
Higher paraffin hydrocarbons $C_n H_{2n+2}, n \geq 5$	28	34
Hydrogen	62	75
Hydrogen sulfide	30	36

Material	Theoretical Minimum CO_2 Concentration (%)	Minimum Design CO_2 Concentration (%)
Isobutane	30*	36
Isobutylene	26	34
Isobutyl formate	26	34
JP-4	30	36
Kerosene	28	34
Methane	25	34
Methyl acetate	29	35
Methyl alcohol	33	40
Methyl butene-I	30	36
Methyl ethyl ketone	33	40
Methyl formate	32	39
Pentane	29	35
Propane	30	36
Propylene	30	36
Quench, lube oils	28	34

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

*Calculated from accepted residual oxygen values.

Substantiation

Ethyl Ether and Diethyl Ether are alternate names for the same chemical substance. The minimum CO2 concentration listed for Ethyl Ether is 38%. It is noted that this concentration was calculated from accepted residual oxygen concentrations. The minimum CO2 concentration listed for Diethyl Ether is 33%. This concentration is documented in the U.S. Bureau of Mines Bulletin 627; it was determined by test using CO2. Figures 82 and 83 are copied from BOM Bulletin 627.

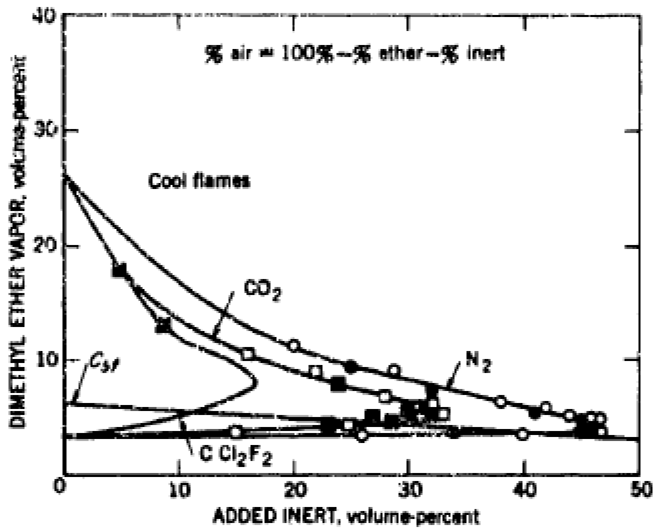

FIGURE 82.—Limits of Flammability of Dimethyl Ether-Carbon Dioxide-Air and Dimethyl Ether-Nitrogen-Air Mixtures at 25° C and Atmospheric Pressure.

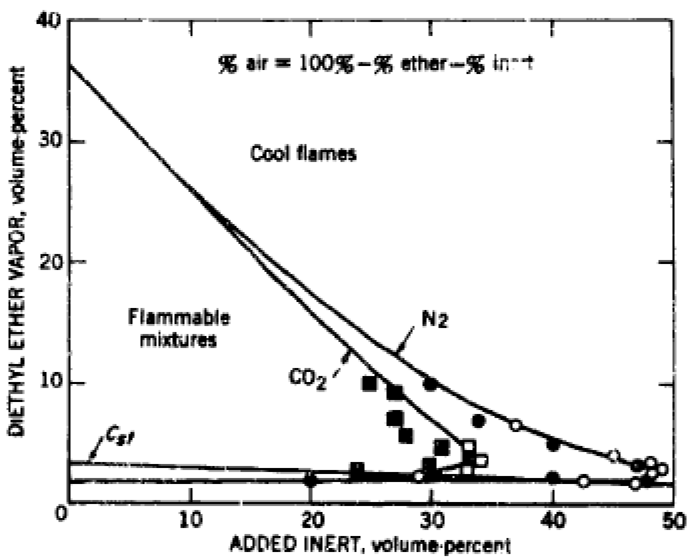

FIGURE 83.—Limits of Flammability of Diethyl Ether-Carbon Dioxide-Air and Diethyl Ether-Nitrogen-Air Mixtures at 25° C and Atmospheric Pressure.

The 33% concentration obtained by test using CO_2 to inert the fuel/air mixture should be retained and the listing shown for Ethyl Ether should be deleted.

NFPA 12: Standard on Carbon Dioxide Extinguishing Systems, 2022 Edition - Chapter 9 Marine Systems

9.1 Special Definitions.

The following definitions shall apply to Chapter 9:

(1) Marine systems *(See 3.4.1.)*
(2) Space
  (a) Cargo space *(See 3.4.2.1.)*
  (b) Electrical equipment space *(See 3.4.2.2.)*
  (c) * Machinery space *(See 3.4.2.3.)*
  (d) *Vehicle space *(See 3.4.2.4.)*

A.9.1(2)(c)
Examples include spaces containing engines used for propulsion, engines that drive electrical generators, oil filling stations, cargo pumps, or heating, ventilation, and air-conditioning machinery.

A.9.1(2)(d)
Carbon dioxide systems are not recommended for vehicle spaces that are accessible to passengers.

(3) **Stop Valves.** Any isolation type valve that requires independent, individual manual control to stop or permit the flow of carbon dioxide into a protected hazard. The activation of the valve can be initiated at the location of the valve or remotely by personnel either mechanically, pneumatically, or hydraulically. The valve is required to provide tight shut-off capability when fully closed and can be a listed selector, gate, globe, ball, butterfly or differential type valve.

Commented [YU1]: Provide a definition for the terminology used throughout the chapter. The definition is in line with other industry accepted standards.

9.2 General.

9.2.1 * Outline.
This chapter outlines the modifications necessary for marine systems.

A.9.2.1
It is intended that NFPA 12, including this chapter, would be used as a stand-alone document for the design, installation, and maintenance of marine carbon dioxide systems. Chapter 9 was added in 1998 to address marine installations. It was intended to be used in lieu of other standards such as ~~46 CFR 119, "Machinery Installations~~ 46 CFR 118, "Fire Protection Equipment."

Commented [YU2]: Update to appropriate CFR reference

9.2.2
All other requirements of this standard shall apply to marine systems except as modified by this chapter.

9.3 System Requirements.

9.3.1 Components.
System components shall be specifically listed or approved for carbon dioxide system marine applications.

9.3.2 Operating Instructions.

9.3.2.1
Instructions for the operation of the system shall be located in a conspicuous place at or near all manual controls and in the carbon dioxide storage room.

9.3.2.2
For systems in which the carbon dioxide storage is not within the protected space, the operating instructions shall include a chart indicating the location of the emergency control to be used if the normal controls fail to operate.

9.3.3 Actuation.

9.3.3.1 *

For spaces greater than 6000 ft^3 (170 m^3), automatic release of the carbon dioxide system shall not be permitted.

A.9.3.3.1

Some internal combustion propulsion engines and generator prime movers draw combustion air from the protected space in which they are installed. Because these types of engines are required to be shut down prior to system discharge, an automatically discharged system in some cases could shut down propulsion or electricity supply when needed most. A nonautomatic system gives the ship's crew the flexibility to decide the best course of action. For example, while navigating in a high-density shipping channel, a ship's ability to maneuver can be more important than immediate system discharge.

9.3.3.2 *

Automatic release shall be permitted for any space of 6000 ft^3 (170 m^3) or less, provided the requirements of 9.3.3.2.1 through 9.3.3.2.4 are met.

A.9.3.3.2

On offshore platforms and on some vessels, small machinery enclosures are often located such that access by personnel at the time of a fire would be difficult and/or dangerous and cause unacceptable delay in system actuation. As long as life safety and vessel navigability are not adversely impacted, automatic actuation of systems protecting such spaces is permissible.

9.3.3.2.1

Horizontal means of egress from the machinery enclosure to the open deck shall be provided.

9.3.3.2.2

The enclosure shall be unmanned during any operation of the equipment.

9.3.3.2.3

The system shall be locked out when persons are present within the enclosure.

9.3.3.2.3.1

The lockout valve shall be installed in the discharge piping prior to the stop valve or selector valves.

9.3.3.2.3.2

The lockout valve design or locking mechanism shall provide a clear indication whether the valve is in open or closed position.

9.3.3.2.3.3

Lockout valves added to existing systems must be approved by AHJ as part of the installed system.

9.3.3.2.4

Automatic actuation of the system shall not interfere with safe navigation of the vessel.

9.3.3.3

For manual operation, two separate valves shall be provided for releasing carbon dioxide into any protected space.

9.3.3.3.1

One valve shall control discharge from the carbon dioxide storage.

9.3.3.3.2

Commented [YU3]: Modified to be consistent with the requirements in CFR.

46 CFR 76.15-50
46 CFR 95.15-50
46 CFR 118.410(f)
46 CFR 181.410(f)(7)
46 CFR 193.15-16

The second valve shall control carbon dioxide discharge into the protected space(s).

9.3.3.3.3
For systems that contain 300 lb (136 kg) of carbon dioxide storage or less, only one valve shall be required to be used for the release of the system, provided that the protected space is normally unoccupied and has horizontal egress.

9.3.3.3.4
Systems with manual operation shall be locked out to provide complete isolation of the system from the protected space during testing or maintenance.

9.3.3.3.4.1
The lockout valve shall be in accordance with 9.3.3.2.3.1 through 9.3.3.2.3.3.

9.3.3.3.4.2
The lockout valve shall be locked in open position at all times, except while testing or maintenance is being performed on the system or within the protected enclosure and the valve is locked in the closed position.

9.3.3.4 * Controls.

A.9.3.3.4

Except for very small protected spaces noted in 9.3.3.3.3, it is the intent of this standard to require two separate manual operations to cause discharge of a marine system. Provision of a separate manually actuated control for each of the discharge control valves required by 9.3.3.3 accomplishes this intent. This requirement is an exception to the "normal manual operation" as defined in 4.5.1.2.

9.3.3.4.1
A separate manually operated control shall be provided to operate each valve required by 9.3.3.3.

9.3.3.4.2
A set of controls shall be located outside at least one of the main means of egress from each protected space.

9.3.3.4.3
A set of controls shall be readily accessible, simple to operate and shall be grouped together in as few locations as possible at positions not likely to be cut off by a fire in a protected space.

9.3.3.5 *
In addition to the manually operated controls required by 9.3.3.4, each of the valves required by 9.3.3.3 shall be provided with its own emergency manual control.

A.9.3.3.5
For a high-pressure carbon dioxide system, the emergency manual control for the supply is the manual operator on the pilot cylinder(s).

9.3.3.6 Release Box.

9.3.3.6.1
Controls for the valves required by 9.3.3.4 shall be located inside a release box clearly identified for the protected space.

Commented [YU4]: Modified to be consistent with the requirements in CFR.

46 CFR 76.15-50
46 CFR 95.15-50
46 CFR 118.410(f)
46 CFR 181.410(f)(7)
46 CFR 193.15-16

Commented [YU5]: Modified to be consistent with the requirements in 46 CFR 95.15-10.

9.3.3.6.2
If the box containing the controls is to be locked, a key to the box shall be provided in a break-glass-type enclosure conspicuously located adjacent to the box.

9.3.3.7 Predischarge Alarm and Time Delay.

9.3.3.7.1
Audible predischarge alarms shall be provided in accordance with 4.5.6.2.

9.3.3.7.2
The time delay required by 4.5.6.2.2 shall be a minimum of 20 seconds.

9.3.3.7 8 * Source of Power.

The systems shall be self-contained and require no electrical power source to function.

A.9.3.3.7 8
Initiation can be mechanical, pneumatic, or hydraulic. If used, Ssufficient carbon dioxide should be provided for the operation of the pneumatic alarm and time delay. Other inert gases may be permitted if tested and listed for the purpose. to power the alarms at their rated pressure for the required time.

9.3.3.7.1
In addition to the requirements of 4.3.3.2, audible predischarge alarms shall be provided that depend on no source of power other than carbon dioxide pressure.

9.3.3.7.2
The time delay required by 4.5.6.2.2 shall be a minimum of 20 seconds and shall depend on no source of power other than carbon dioxide pressure.

9.3.3.8 Odorizing Unit.

Each system shall be equipped with an odorizing unit to produce a distinctive odor, such as the scent of wintergreen, to the discharging carbon dioxide that warns of the presence of carbon dioxide gas.

A.9.3.3.8
There are certain applications where the wintergreen odor would provide no meaningful contribution to safety. These applications include systems that are installed for the protection of limited volume spaces that cannot normally be entered by personnel, either due to the restricted size of the space or the presence of hazardous operating machinery; and systems protecting spaces that are located where the release of gas is unlikely to affect occupied areas. Exemptions for systems without odorizing units for use in these limited applications should be approved by AHJ. Also see A.4.5.6.3.2.

9.3.4 Carbon Dioxide Storage.

9.3.4.1
Carbon dioxide storage shall be permitted inside normally unoccupied protected spaces for systems that contain not more than 300 lb (136 kg) of carbon dioxide storage and are equipped for automatic actuation.

9.3.4.2
Low-pressure systems shall be provided with dual refrigeration units and shall be constructed in accordance with 46 CFR 58.20.

9.3.4.3

Commented [UY(CUC(6]: Modified to be consistent with the requirements in 46 CFR 95.15-30.

Commented [UY(CUC(7]: Modified to be consistent with the requirements in CFR.

46 CFR 76.15-60
46 CFR 95.15-60
46 CFR 118.410(h)
46 CFR 181.410(f)(8)
46 CFR 193.15-17

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When the carbon dioxide containers are located outside a protected space, they shall be stored in a room that shall be situated in a safe and readily accessible location and shall be effectively ventilated so that the agent containers are not exposed to ambient temperatures outlined in 4.6.5.5.

9.3.4.3.1
Common bulkheads and decks located between agent container storage rooms and protected spaces shall be protected with A-60 class structural insulation as defined by 46 CFR 72.

9.3.4.3.2
Doors and other means of closing any opening therein that form the boundaries between such rooms and adjoining protected spaces shall be gastight.

9.3.4.3.3
Agent container storage rooms shall be accessible without having to pass through the space being protected.

9.3.4.3.4
Access doors shall open outward.

9.3.4.3.5
For systems that contain 300 lb (136 kg) of carbon dioxide storage or less, only one valve shall be required to be used for the release of the system, provided that the protected space is normally unoccupied and has horizontal egress.

9.3.5 System Piping.

9.3.5.1
Where necessary, drains shall be provided for the removal of accumulated moisture.

9.3.5.2
Carbon dioxide piping shall not be fitted with drains or other openings within living quarters.

9.3.5.3
Carbon dioxide piping shall be used for no other purpose, except that carbon dioxide piping shall be permitted to be used in an air-sampling-type smoke detection system.

9.3.6 System Design.
System design shall comply with Chapters 5 through 7 except as described in 9.3.6.1 through 9.3.6.4.2.

9.3.6.1* Machinery Spaces.
Machinery spaces shall be designed to a 34 percent concentration based on the gross volume.

A.9.3.6.1 [To include NFPA 2001 section A.13.8.4 and figure and eliminate “net volume” and reference to clean agent, NOAEL and LOAEL]

Commented [YU8]: Add explanatory material for gross volume using similar text from NFPA 2001 Annex.

9.3.6.1.1
Eighty-five percent of the concentration required by 9.3.6.1 shall be achieved within 2 minutes from the start of discharge.

9.3.6.1.2
Gross volume shall include the casing.

9.3.6.2 Cargo Spaces.
Cargo spaces other than vehicle spaces shall be supplied with carbon dioxide based on 1 lb/30 ft³ based on the gross volume.

9.3.6.2.1
The initial quantity of carbon dioxide discharged shall be based on the net volume of the space as determined by the amount of cargo in the cargo space.

9.3.6.2.2 *
Additional carbon dioxide shall be released as needed to maintain control of the fire.

A.9.3.6.2.2
~~An example of where drains would be necessary would be low points in carbon dioxide piping, which are also used by a sampling-type smoke detection system.~~

Cargo hold systems are typically discharged initially from the carbon dioxide supply by opening the appropriate control valve(s) for the affected cargo volume, and followed up by releasing additional required carbon dioxide for the control of the fire.

Fires in cargo spaces may not be completely extinguished by the carbon dioxide discharge. Whether the fire is completely extinguished or only suppressed depends on a number of factors, including the type and quantity of burning material. Some leakage of carbon dioxide–enriched atmosphere from the cargo hold is likely. Therefore, additional carbon dioxide might need to be discharged on an intermittent basis to maintain fire suppression in the cargo hold until the vessel reaches port. Once at port, before the cargo hold is opened, a properly equipped and trained fire brigade should be standing by to effect complete extinguishment of the burning material. IMO FSS Code Chapter 5 paragraph 2.2.1.7 requires the systems be arranged to allow one-third, two-thirds or the entire quantity of carbon dioxide to be discharged.

A remote control station and a local manual release control may be used to accomplish the partial or full discharge of carbon dioxide.

A local manual release control without additional remote controls is an acceptable means for partial and full discharge of carbon dioxide quantities in container spaces, general cargo spaces, and solid bulk cargo spaces, provided that the carbon dioxide storage room is located aft of those spaces or not cut off in the case of a fire.

For a high-pressure system, the local manual release controls may be accomplished by manually opening the required number of cylinders in the carbon dioxide storage room at the cylinder control heads. The time needed to manually open the required number of cylinders should be considered when deciding whether a local manual release control or a remote control station should be used.

For a low-pressure system, the local manual release may be accomplished by opening a manual control valve typically located near the storage container for the time period required for each loading condition.

9.3.6.2.3
Clear instructions shall be posted within the carbon dioxide storage room and at any release control station detailing the carbon dioxide release procedure.

9.3.6.2.4
Pre-discharge alarms and time delay are not required for cargo spaces considered normally unoccupied spaces.

Commented [YU9]: This statement does not appear to be appropriate here under 9.3.6.2.2.

Commented [YU10]: Add explanatory material for systems protecting conventional cargo holds that are normally unoccupied space.

Commented [YU11]: 9.3.6.2.4 and 9.3.6.2.5 are added to be consistent with the requirements in CFR and for clarification.

9.3.6.2.5
Roll-on/roll-off (ro-ro) and refrigerated spaces are considered occupiable. Pre-discharge alarms and time delay are required.

9.3.6.3 Vehicle Spaces.

9.3.6.3.1
Vehicle spaces where the vehicles contain more than 5 gal (19 L) of fuel (gasoline or diesel) shall be designed to a 34 percent concentration based on the gross volume.

9.3.6.3.~~2~~ 1.2
Eighty-five percent of this concentration shall be achieved within 2 minutes from start of discharge.

Commented [YU12]: Editorial and renumbering.

9.3.6.3.2
Vehicle spaces where the vehicles contain 5 gal (19 L) or less of fuel (gasoline or diesel) shall be designed to a 34 percent concentration based on the gross volume.

9.3.6.3.2.1
Two-thirds of this concentration shall be achieved within 10 minutes from start of discharge.

~~**9.3.6.4 Vehicle Spaces.**~~

~~**9.3.6.4.1**~~
~~Vehicle spaces where the vehicles contain 5 gal (19 L) or less of fuel (gasoline or diesel) shall be designed to a 34 percent concentration based on the gross volume.~~

~~**9.3.6.4.2**~~
~~Two-thirds of this concentration shall be achieved within 10 minutes from start of discharge.~~

9.3.6.4~~7~~ Electrical Equipment Spaces.
Electrical equipment spaces shall be treated as a dry electrical hazard in accordance with Chapter 5.

Commented [YU13]: Editorial and renumbering.

9.4 Inspection and Maintenance.
Inspection and maintenance shall comply with 4.8.3 and Section 9.4.

9.4.1 General.
Prior to testing or maintenance of a fixed carbon dioxide system, all personnel shall be evacuated from the protected space. *(See Section 4.3.)*

9.4.2 Approval of Installations.

9.4.2.1
The approval test described in 9.4.2.1.1 through 9.4.2.1.4 shall be conducted prior to the tests required by 4.4.3.

9.4.2.1.1
Pressure tests of the piping shall be performed to meet the requirements of 9.4.2.1.2 through 9.4.2.1.4.

9.4.2.1.2
The test medium shall be a dry, noncorrosive gas such as nitrogen or carbon dioxide.

9.4.2.1.3

When pressurizing the piping, pressure shall be increased in 50 psi (3.5 bar) increments.

9.4.2.1.4
Once the pressure in the pipe has reached the required test pressure, the pressure source shall be shut off and disconnected from the pipe.

Pneumatic pressure testing creates a potential risk of injury to personnel in the area, as a result of airborne projectiles, if rupture of the piping system occurs. Prior to the pneumatic pressure test, the area in which the pipe is located shall be evacuated and appropriate safeguards shall be provided for test personnel.

9.4.2.2 High-Pressure Systems.

9.4.2.2.1 Systems with Stop Valves.

9.4.2.2.1.1
All piping from the carbon dioxide supply to the stop valves shall be subjected to a minimum pressure of 1000 psi (6895 kPa).

9.4.2.2.1.2
The leakage during a 2-minute period shall not exceed a pressure drop of 10 percent.

9.4.2.2.1.3
All piping between the stop valves and the nozzles shall be subjected to a minimum pressure of 600 psi (4137 kPa).

9.4.2.2.1.4
The leakage during a 2-minute period shall not exceed a pressure drop of 10 percent.

9.4.2.2.2 Systems Without Stop Valves.

9.4.2.2.2.1
All piping from the carbon dioxide supply to the nozzles shall be subjected to a minimum pressure of 600 psi (4137 kPa).

9.4.2.2.2.2
The leakage during a 2-minute period shall not exceed a pressure drop of 10 percent.

9.4.2.3 Low-Pressure Systems.

9.4.2.3.1 Normally Pressurized Piping.

9.4.2.3.1.1
All piping that is normally pressurized shall be subjected to a minimum pressure test of 300 psi (2068 kPa).

9.4.2.3.1.2
No leakage shall be permitted from the piping during a 2-minute test.

9.4.2.3.2 Piping Between the Tank Shutoff Valve and Nozzles.

9.4.2.3.2.1
All piping between the tank shutoff valve and the nozzles shall be subjected to a minimum pressure test of 300 psi (2068 kPa).

9.4.2.3.2.2

The leakage during a 2-minute period shall not exceed a pressure drop of 10 percent.

9.4.3 Predischarge Delays, Alarms, and Shutdowns.

9.4.3.1

Predischarge delays and alarms and ventilation shutdowns shall be tested by flowing carbon dioxide into the system.

9.4.3.2

Predischarge delays that are not accurate to within +20 percent/−0 percent at 70°F (21°C) of their rating shall be replaced.

9.4.4 Verification.

Compliance with 9.3.2 shall be verified.

NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems, 2022 Edition - Chapter 13

Marine Systems

13.1 General.
This chapter outlines the deletions, modifications, and additions that are necessary for marine applications. All other requirements of NFPA 2001 shall apply to shipboard systems except as modified by this chapter. Where the provisions of Chapter 13 conflict with the provisions of Chapter 1 through Chapter 11, the provisions of Chapter 13 shall take precedence.

13.1.1 Scope.
This chapter is limited to marine applications of clean agent fire extinguishing systems on commercial and government vessels. Explosion inerting systems were not considered during development of this chapter.

13.1.2 System Components.
System components shall be specifically listed or approved for clean agent fire extinguishing system marine applications.

Commented [YU1]: To be consistent with NFPA 12 and CFR. System components are required to be listed for marine applications.

13.2 Use and Limitations.
13.2.1 *
Total flooding clean agent fire extinguishing systems shall be used primarily to protect hazards that are in enclosures or equipment that, in itself, includes an enclosure to contain the agent.

A.13.2.1
Some typical hazards that could be suitable include, but are not limited to, the following:

(1) Machinery spaces such as main machinery spaces
(2) Emergency generator rooms
(3) Pump rooms
(4) Flammable liquid storage and handling areas and paint lockers
(5) Control rooms and electronic equipment spaces

13.2.2 *
In addition to the limitations given in 4.2.2, clean agent fire extinguishing systems shall not be used to protect the following:

(1) Dry cargo holds
(2) Bulk cargo

A.13.2.2
General cargo should not be protected with halocarbon agents due to the possibility of deep-seated cargo fires and due to wide variations in cargo materials. Dry cargoes, such as containerized cargoes, often comprise a wide mix of commodities that can include materials or storage arrangements not suited for protection with halocarbon agents. The volume of agent needed to protect cargo spaces varies depending on the volume of the

cargo space minus the volume of the cargo carried. This quantity varies as cargo volume changes and can affect fire extinguishing effectiveness or agent toxicity.

13.2.3
The effects of agent decomposition products and combustion products on fire protection effectiveness and equipment shall be considered where using clean agents in hazards with high ambient temperatures (e.g., incinerator rooms, hot machinery and piping).

13.3 Hazards to Personnel.
13.3.1
Other than the engine rooms identified in 13.3.1.1, all other main machinery spaces shall be considered normally occupied spaces.

13.3.1.1
Engine rooms of 6000 ft^3 (170 m^3) or less that are accessed for maintenance only shall not be required to comply with 13.3.1.

13.3.2 *
For marine systems, electrical clearances shall be in accordance with 46 CFR, Subchapter J, "Electrical Engineering."

A.13.3.2
Subchapter J of 46 CFR 111.59 requires busways to comply with Article 368 of *NFPA 70*. Article 368 requires compliance with Article 300 for clearances around busways.

13.4 Agent Supply.
13.4.1
Reserve quantities of agent shall not be required by this standard.

13.4.2 *
Storage container arrangement shall be in accordance with 5.1.3.1 and 5.1.3.3 through 5.1.3.5. Where equipment is subject to extreme weather conditions, the system shall be installed in accordance with the manufacturer's design and installation instructions.

A.13.4.2
Agent cylinder storage spaces should be adequately ventilated. Entrances to such spaces should be from an open deck.

13.4.2.1
Unless installed as required in 13.4.2.2, the cylinders must be stored outside of the protected space.

Commented [YU2]: To be consistent with 46 CFR 95.16-20.

13.4.2.2
The cylinders shall be permitted to be stored inside the protected space provided that the space does not exceed 6000 ft^3 (170 m^3) and the system can be automatically operated by a pneumatic heat actuator as well as a remote manual control.

13.4.2.~~1~~ 3

Except in the case of systems with storage cylinders located within the protected space, pressure containers required for the storage of the agent shall be in accordance with ~~13.4.2.2~~13.4.2.4.

13.4.2.~~2~~ 4

Where the agent containers are located outside a protected space, they shall be stored in a room that shall be situated in a safe and readily accessible location and shall be effectively ventilated so that the agent containers are not exposed to ambient temperatures in excess of 130°F (55°C). Common bulkheads and decks located between clean agent container storage rooms and protected spaces shall be protected with A-60 class structural insulation as defined by 46 CFR 72. Agent container storage rooms shall be accessible without having to pass through the space being protected. Access doors shall open outward, and bulkheads and decks, including doors and other means of closing any opening therein, that form the boundaries between such rooms and adjoining spaces shall be gastight.

13.4.3

Where agent containers are stored in a dedicated space, doors at exits shall swing outward.

13.4.4

Where subject to moisture, containers shall be installed such that a space of at least 2 in. (51 mm) between the deck and the bottom of the container is provided.

13.4.5

In addition to the requirements of 5.1.3.4, containers shall be secured with a minimum of two brackets to prevent movement from vessel motion and vibration.

13.4.6 *

For marine applications, all piping, valves, and fittings of ferrous materials shall be protected inside and out against corrosion except as permitted in 13.4.6.1.

> **A.13.4.6**
>
> Corrosion resistance is required to prevent clogging of nozzles with scale. Examples of suitable materials are hot dipped galvanized steel piping inside and out or stainless steel.

13.4.6.1

Closed sections of pipe and valves and fittings within closed sections of pipe shall be required to be protected against corrosion only on the outside.

13.4.6.2

Other than as permitted in 13.4.6.1, prior to acceptance testing, the inside of the piping shall be cleaned without compromising its corrosion resistance.

13.4.7 *

Pipes, fittings, nozzles, and hangers, including welding filling materials, within the protected space shall have a melting temperature greater than 1600°F (871°C). Aluminum components shall not be used.

A.13.4.7
Fittings conforming to ASTM F1387 and fire tested with zero leakage conform to the requirements of 13.4.7.

13.4.8
Piping shall extend at least 2 in. (51 mm) beyond the last nozzle in each branch line to prevent clogging.

13.5 Detection, Actuation, and Control Systems.
13.5.1 General.
13.5.1.1
Detection, actuation, alarm, and control systems shall be installed, tested, and maintained in accordance with the requirements of the authority having jurisdiction.

13.5.1.2 *
For spaces greater than 6000 ft^3 (170 m^3), automatic release of the fire extinguishing agent shall not be permitted where actuation of the system can interfere with the safe navigation of the vessel. ~~Automatic release of the fire extinguishing agent shall be permitted for any space where actuation of the system will not interfere with the safe navigation of the vessel.~~

Commented [YU3]: Modified to be consistent with 46 CFR 95.16-5

A.13.5.1.2
The intent of this paragraph is to ensure that a suppression system will not interfere with the safe navigation of the vessel. Many internal combustion propulsion engines and generator prime movers draw combustion air from the protected space in which they are installed. Because these types of engines are required to be shut down prior to system discharge, an automatically discharged system would shut down propulsion and electricity supply when needed most. A nonautomatic system gives the ship's crew the flexibility to decide the best course of action. For example, in a high-density shipping channel, a ship's ability to maneuver can be more important than immediate system discharge. For small vessels, the use of automatic systems is considered appropriate, taking into consideration the vessel's mass, cargo, and crew training.

13.5.1.2.1
Automatic release shall be permitted for any space of 6000 ft^3 (170 m^3) or less where actuation of the system will not interfere with the safe navigation of the vessel.

13.5.2 ~~Automatic Detection.~~Actuation

13.5.2.1
The system actuation or controls shall require no electrical power source to function.

13.5.2.2
The alarms in protected spaces shall depend on no source of power other than the extinguishing agent, gas from pilot cylinders, or gas from cylinders specifically provided to power the alarms.

Commented [YU4]: Modified to be consistent with 46 CFR 94.16-1

~~**13.5.2.1**~~
~~Electrical detection, signaling, control, and actuation system(s) shall have at least two sources of power. The primary source shall be from the vessel's emergency bus. For vessels with an emergency bus or battery, the backup source shall be either the vessel's general alarm battery~~

or an internal battery within the system. Internal batteries shall be capable of operating the system for a minimum of 24 hours. All power sources shall be supervised.

13.5.2.1.1
For vessels without an emergency bus or battery, the primary source shall be permitted to be the main electrical supply.

13.5.2.2
In addition to the requirements set forth in Section 9.3, actuation circuits shall not be routed through the protected space where manual electrical actuation is used in marine systems.

13.5.2.2.1
For systems complying with 13.5.2.4, actuation circuits shall be permitted to be routed through the protected space.

13.5.2.3 *
Manual actuation for systems shall not be capable of being put into operation by any single action. Other than as identified in 13.5.2.3.1, manual actuation stations shall be housed in an enclosure.

> **A.13.5.2.3**
> The intent is to prevent accidental or malicious system operation. Some examples of acceptable manual actuation stations are the following:
>
> (1) Breaking a glass enclosure and pulling a handle
> (2) Breaking a glass enclosure and opening a valve
> (3) Opening an enclosure door and flipping a switch

13.5.2.3.1
Manual actuation shall be permitted to be local manual actuation at the cylinder(s) location.

13.5.2.4
Systems must have actuation stations consisting of one control to operate the stop valve to the protected space and a second control to release at least the required amount of agent. These two controls must be located in a box or other enclosure clearly identified for the particular space.

13.5.2.4.1
Systems protecting spaces larger than 6000 ft^3 (170 m^3) shall have a At least one manual actuation station located in the main egress route outside the protected space. In addition, systems protecting spaces larger than 6000 ft^3 (170 m^3) having cylinders within the protected space and systems protecting unattended main machinery spaces shall have an actuation station in a continuously monitored control station outside the protected space.

13.5.2.4.1 2
Systems protecting spaces of 6000 ft^3 (170 m^3) or less shall be permitted to be installed without a stop valve provided a suitable horizontal means of escape from the space exists. have a single actuation station at either of the locations described in 13.5.2.4.

13.5.2.4.3
Actuation stations shall not be located in any space that could be cut off from the operator in the event of fire in the protected space.

Commented [YU5]: Modified to be consistent with 46 CFR 95.16-5

13.5.2.5
Emergency lighting shall be provided for remote actuation stations serving systems protecting main machinery spaces. All manual operating devices shall be labeled to identify the hazards they protect. In addition, the following information shall be provided:

(1) Operating instructions
(2) Length of time delay
(3) Actions to take if system fails to operate
(4) Other actions to take such as closing vents and taking a head count

13.5.2.5.1
For systems having cylinders within the protected space, a means of indicating system discharge shall be provided at the remote actuation station.

~~13.6 Additional Requirements for Systems Protecting Class B Hazards Greater Than 6000 ft^3 (170 m^3) with Stored Cylinders Within the Protected Space.~~

~~13.6.1 *~~
~~An automatic fire detection system shall be installed in the protected space to provide early warning of fire to minimize potential damage to the fire extinguishing system before it can be manually actuated. The detection system shall initiate audible and visual alarms in the protected space and on the navigating bridge upon detection of fire. All detection and alarm devices shall be electrically supervised for continuity, and trouble indication shall be annunciated on the navigating bridge.~~

> **~~A.13.6.1~~**
> ~~Heat detectors are typically used in machinery spaces and are sometimes combined with smoke detectors. Listed or approved optical flame detectors can also be used, provided they are in addition to the required quantity of heat and/or smoke detectors.~~

~~13.6.2 *~~
~~Electrical power circuits connecting the containers shall be monitored for fault conditions and loss of power. Visual and audible alarms shall be provided to indicate this, and the alarms shall be annunciated on the navigating bridge.~~

> **~~A.13.6.2~~**
> ~~This requirement is derived from SOLAS Regulation II-2/Regulation 5.3.~~

Commented [UY(CUC(6]: Modified to be consistent with CFR. This appears to be from 20201 version of SOLAS - Halogenated Hydrocarbon Systems

~~13.6.3 *~~
~~Within the protected space, electrical circuits essential for the release of the system shall be heat resistant, such as mineral-insulated cable compliant with Article 332 of *NFPA 70*, or the equivalent. Piping systems essential for the release of systems designed to be operated hydraulically or pneumatically shall be of steel or other equivalent heat-resistant material.~~

A.13.6.3
This requirement is derived from SOLAS Regulation II-2/Regulation 5.3.

13.6.4 *
The arrangements of containers and the electrical circuits and piping essential for the release of any system shall be such that in the event of damage to any one power release line through fire or explosion in a protected space (i.e., a single fault concept) the entire fire extinguishing charge required for that space can still be discharged.

A.13.6.4
This requirement is derived from SOLAS Regulation II-2/Regulation 5.3.

13.6.5 *
The containers shall be monitored for decrease in pressure due to leakage and discharge. Visual and audible signals in the protected area and either on the navigating bridge or in the space where the fire control equipment is centralized shall be provided to indicate a low-pressure condition.

A.13.6.5
This requirement is derived from SOLAS Regulation II-2/Regulation 5.3.

13.6.6 *
Within the protected space, electrical circuits essential for the release of the system shall be Class A rated in accordance with *NFPA 72*.

A.13.6.6
This requirement is derived from SOLAS Regulation II-2/Regulation 5.3.

13.7 Enclosure.
13.7.1 *
To prevent loss of agent through openings to adjacent hazards or work areas, openings shall be one of the following designs:

(1) Permanently sealed
(2) Equipped with automatic closures
(3) Equipped with manual closures outfitted with an alarm circuit to indicate when these closures are not sealed upon activation of the system

A.13.7.1
A well-sealed enclosure is vital to proper operation of the system and subsequent extinguishment of fires in the protected space. Gastight boundaries of the protected space, such as those constructed of welded steel, offer a highly effective means for holding the fire extinguishing gas concentration. Where the space is fitted with openings, avenues for escape of the gas exist. Automatic closure of openings is the preferred method of ensuring enclosure integrity prior to discharge. Manually closed openings introduce added delay and an added human element into the chain of proper operation of the system. Failure of personnel to properly close all openings has been a recurring cause of gaseous systems not performing as intended. It is recognized that some openings in the enclosures, such as maintenance hatches and watertight doors, cannot be fitted with automatically operated closers due to personnel hazards or other

limitations. In those cases, an indicator is required to alert the system operator that an opening has not been closed as required and thus the system is not ready for operation.

13.7.1.1
Where confinement of agent is not practical, or if the fuel can drain from one compartment to another, such as via a bilge, protection shall be extended to include the adjacent connected compartment or work areas.

13.7.2 *
Prior to agent discharge, all ventilating systems shall be closed and isolated to preclude passage of agent to other compartments or the vessel exterior. Automatic shutdowns or manual shutdowns capable of being closed by one person from a position co-located with the agent discharge station shall be used.

A.13.7.2
Automatic shutdowns are the preferred method for shutting down a ventilation system. Shutdowns requiring personnel to find and manually close dampers far from the fire extinguishing system discharge station should not be permitted.

13.8 Design Concentration Requirements.
13.8.1 Combinations of Fuels.
For combinations of fuels, the design concentration shall be derived from the flame extinguishment value for the fuel requiring the greatest concentration.

13.8.2 Design Concentration.
For a particular fuel, the design concentration referred to in ~~13.8.3~~7.2.2.2 shall be used.

13.8.3 Flame Extinguishment.
The extinguishing concentration of extinguishing agent required for each system must be determined by the cup burner method, described in 7.2.2.2.1 for the specific fuel requiring the highest extinguishing concentration. ~~The minimum design concentration for Class B flammable and combustible liquids shall be as determined following the procedures described in IMO MSC/Circ. 848, *Revised Guidelines for the Approval of Equivalent Fixed Gas Fire-Extinguishing Systems as Referred to in SOLAS 74, for Machinery Spaces and Cargo Pump-Rooms*, as amended by IMO MSC.1/Circ. 1267, *Amendments to Revised Guidelines for the Approval of Equivalent Fixed Gas Fire-Extinguishing Systems, as Referred to in SOLAS 74, for Machinery Spaces and Cargo Pump-Rooms (MSC/Circ. 848)*~~.

13.8.4 * Total Flooding Quantity.
The quantity of agent shall be based on either:

13.8.4.1
The gross volume, including the casing, bilge, and free air contained in air receivers; or

13.8.4.2
The ~~net~~ volume of the space provided that either a full discharge test or enclosure integrity test per Annex C is performed. ~~and~~ The volume shall be in accordance with the requirements of paragraph 5 of IMO MSC/Circular 848, *Revised Guidelines for the Approval of Equivalent Fixed*

Commented [YU7]: Updated to be consistent with 46 CFR 162.161-3(e) and appropriate section for design concentration in Chapter 7

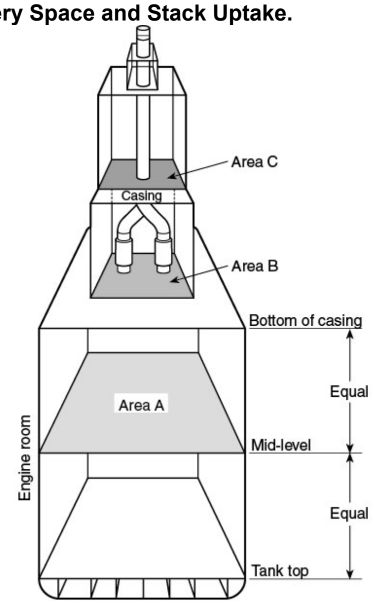
Commented [YU8]: Updated to be consistent with 46 CFR 162.161-3(d) and appropriate section for extinguishing concentration in Chapter 7

Commented [YU9]: Updated to be consistent with 46 CFR 162.161-3(e) and appropriate sections for volume calculation

Gas Fire-Extinguishing Systems as Referred to in SOLAS 74, for Machinery Spaces and Cargo Pump-Rooms, Annex.

A.13.8.4.2
When the net volume of the machinery space is being calculated, the net volume should include the volume of the bilge and the volume of the stack uptake. The volume calculation should be permitted to exclude the portions of the stack uptake that have a horizontal cross-sectional area less than 40 percent of the horizontal cross-sectional area of the main machinery space. The horizontal cross-sectional area of the main machinery space should be measured midway between the lowest level (tank top) and the highest level (bottom of the stack casing). *(See Figure A.13.8.4.)*

Figure A.13.8.4 Machinery Space and Stack Uptake.



For the casing to be considered separate from the gross volume of the machinery space, Area B must be 40 percent or less of Area A.

If Area B is greater than 40 percent of Area A, the volume of casing up to Area C (or where the area is 40 percent or less of Area A) must be included in the gross volume of the space.

Any area of the casing containing boilers, internal combustion machinery, or oil-fired installations must be included in the gross volume of the engine room.

The objects that occupy volume in the protected space should be subtracted from the volume of the space. These objects include, but are not necessarily limited to, the following:

(1) Auxiliary machinery
(2) Boilers

(3) Condensers
(4) Evaporators
(5) Main engines
(6) Reduction gears
(7) Tanks
(8) Trunks

The Maritime Safety Committee, at its 67th session (December 2–6, 1996), approved guidelines for the approval of equivalent fixed gas fire extinguishing systems, as referred to in SOLAS 74, for machinery spaces and cargo pump rooms, as MSC/Circ. 776.

The Subcommittee on Fire Protection, at its 42nd session (December 8–12, 1997), recognized the need for technical improvement to the guidelines contained in MSC/Circ. 776 to assist in their proper implementation and, to that effect, prepared amendments to the guidelines.

The committee, at its 69th session (May 11–20, 1998), approved revised guidelines for the approval of equivalent fixed gas fire extinguishing systems, as referred to in SOLAS 74, for machinery spaces and cargo pump rooms, as set out in the annex, to supersede the guidelines attached to MSC/Circ. 776.

Member governments are invited to apply the annexed guidelines when approving equivalent fixed gas fire extinguishing systems for use in machinery spaces of category A and cargo pump rooms.

The quantity of extinguishing agent for the protected space should be calculated at the minimum expected ambient temperature using the design concentration based on the net volume of the protected space, including the casing.

The net volume of a protected space is that part of the gross volume of the space that is accessible to the free extinguishing agent gas.

In the calculation of the net volume of a protected space, the net volume should include the volume of the bilge, the volume of the casing, and the volume of free air contained in air receivers that in the event of a fire is released into the protected space.

The objects that occupy volume in the protected space should be subtracted from the gross volume of the space. They include, but are not necessarily limited to, the following:

(1) Auxiliary machinery
(2) Boilers
(3) Condensers
(4) Evaporators
(5) Main engines
(6) Reduction gears
(7) Tank
(8) Trunks

Subsequent modifications to the protected space that alter the net volume of the space require the quantity of extinguishing agent to be adjusted to meet the requirements of 13.8.4 and 13.8.5.

No fire suppression agent should be used that is carcinogenic, mutagenic, or teratogenic at concentrations expected during use. No agent should be used in concentrations greater than the cardiac sensitization NOAEL, without the use of controls as provided in SOLAS Regulation II-2/Regulations 5.2. In no case should an agent be used above its LOAEL nor approximate lethal concentration (ALC) calculated on the net volume of the protected space at the maximum expected ambient temperature.

13.8.5 * Duration of Protection.
It is important that the agent design concentration not only shall be achieved, but also shall be maintained for a sufficient period of time to allow effective emergency action by trained ship's personnel. In no case shall the hold time be less than 15 minutes.

A.13.8.5
Maintaining the design concentration is equally important in all classes of fires because a persistent ignition source, such as an electric arc, boiler front, heat source, engine exhaust, turbo charger, hot metal, or deep-seated fire, can lead to resurgence of the initial event once the clean agent has dissipated.

13.9 Distribution System.
13.9.1 Rate of Application.
The minimum design rate of application shall be based on the quantity of agent required for the desired concentration and the time allowed to achieve the desired concentration.

13.9.2 Discharge Time.
13.9.2.1
The discharge time for halocarbon agents shall not exceed 10 seconds or as otherwise required by the authority having jurisdiction.

13.9.2.2
For halocarbon agents, the discharge time period shall be defined as the time required to discharge from the nozzles 95 percent of the agent mass [at 70°F (21°C)] necessary to achieve the minimum design concentration.

13.9.2.3
The discharge time for inert gas agents shall not exceed 120 seconds for 85 percent of the design concentration or as otherwise required by the authority having jurisdiction.

13.10 Nozzle Choice and Location.
For spaces other than those identified in 13.10.1, nozzles shall be of the type listed for the intended purpose. Limitations shall be determined based on testing in accordance with IMO MSC/Circular 848, *Revised Guidelines for the Approval of Equivalent Fixed Gas Fire-Extinguishing Systems as Referred to in SOLAS 74, for Machinery Spaces and Cargo Pump-Rooms*. Nozzle spacing, area coverage, height, and alignment shall not exceed the limitations.

13.10.1

For spaces having only Class A fuels, nozzle placement shall be in accordance with the nozzles' listed limitations.

13.11 Inspection and Tests.
At least annually, all systems shall be inspected and tested for proper operation by competent personnel. Discharge tests shall not be required.

13.11.1
An inspection report with recommendations shall be filed with the vessel's master and the owner's agent. The report shall be available for inspection by the authority having jurisdiction.

13.11.2
At least annually, the agent quantity of refillable containers shall be checked by competent personnel. The container pressure shall be verified and logged at least monthly by the vessel's crew.

13.11.3 *
For halocarbon clean agents, if a container shows a loss in agent of more than 5 percent or a loss in pressure, adjusted for temperature, of more than 10 percent, it shall be refilled or replaced.

A.13.11.3
For determination of container pressure, the original container fill density should be obtained from the system manufacturer and the temperature/pressure relation should be obtained from tables published by the system manufacturer. For determination of container liquid level, the liquid level–temperature relationship should be obtained from the system manufacturer.

13.11.3.1 *
If an inert gas clean agent container shows a loss in pressure, adjusted for temperature, of more than 5 percent, it shall be refilled or replaced. Where container pressure gauges are used for this purpose, they shall be compared to a separate calibrated device at least annually.

A.13.11.3.1
For inert gas clean agents that are not liquefied, pressure is an indication of agent quantity.

13.11.4
The installing contractor shall provide instructions for the operational features and inspection procedures specific to the clean agent system installed on the vessel.

13.12 Approval of Installations.
Prior to acceptance of the system, technical documentation, such as the system design manual, test reports, or the listing report, shall be presented to the authority having jurisdiction. This documentation shall show that the system and its individual components are compatible, employed within tested limitations, and suitable for marine use.

13.12.1
The listing organization shall perform the following functions:

(1) Verify that fire tests were conducted in accordance with a predetermined standard

(2) Verify that component tests were conducted in accordance with a predetermined standard
(3) Review the component quality assurance program
(4) Review the design and installation manual
(5) Identify system and component limitations
(6) Verify flow calculations
(7) Verify the integrity and the reliability of system as a whole
(8) Have a follow-up program
(9) Publish a list of equipment

13.13 Periodic Puff Testing.
A test in accordance with 10.4.15 shall be performed at 24-month intervals. The periodic test program shall include a functional test of all alarms, controls, and time delays.

13.14 Compliance.
Electrical systems shall be in accordance with 46 CFR Subchapter J. For Canadian vessels, electrical installations shall be in accordance with TP 127 E, *Ship Safety Electrical Standards*.