First Revision No. 19-NFPA 318-2019 [Global Input]

Show metric units first specifically in the following sections: 3.3.4, 3.3.5, 3.3.22, 9.3.7.1, 11.2.3.1, A.1.1 and, A.11.2.1(1)(a)

Submitter Information Verification

Committee:

Submittal Date: Fri Jun 07 13:15:26 EDT 2019

Committee Statement

Committee Statement: To be consistent throughout the standard including extracted text.

Response Message: FR-19-NFPA 318-2019

First Revision No. 3-NFPA 318-2019 [Global Input]

Remove ~~“ANSI?”~~ "ANSI/" and “Standard for” from all locations associated with UL Standards.

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Thu May 09 11:27:18 EDT 2019

Committee Statement

Committee Statement: Remove “Standard for” from the title. UL is no longer using that term. Remove ANSI because many years ago, UL preferred the ANSI/UL reference because there was a transition of traditional UL standards towards an ANSI standards development process.

Now, years later, a large majority of UL Standards are ANSI approved and follow the ANSI development and maintenance process. However, sometimes readers are confused because they don't understand the standards are UL standards, not developed by ANSI. There are many other references to standards promulgated by different standards development organizations where they are considered ANSI approved but do not include ANSI in the reference.

Response Message: FR-3-NFPA 318-2019

Public Input No. 19-NFPA 318-2018 [Global Input]

First Revision No. 18-NFPA 318-2019 [Chapter 2]

Chapter 2 Referenced Publications

2.1 General.

The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications.

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

NFPA 1, *Fire Code,* 2018 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems,* ~~2015~~ 2018 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* ~~2016~~ 2019 edition.

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

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines,* 2018 edition.

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

NFPA 70®, *National Electrical Code*®*,* 2017 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*® *,* ~~2016~~ 2019 edition.

NFPA 79, *Electrical Standard for Industrial Machinery,* ~~2015~~ 2018 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems,* 2018 edition.

NFPA 92, *Standard for Smoke Control Systems,* ~~2015~~ 2018 edition.

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

NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids,* 2017 edition.

NFPA 400, *Hazardous Materials Code,* ~~2016~~ 2019 edition.

NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas,* 2017 edition.

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response,* 2017 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems,* ~~2015~~ 2019 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems,* ~~2015~~ 2018 edition.

NFPA 5000®, *Building Construction and Safety Code*®*,* 2018 edition.

2.3 Other Publications.

2.3.1 ASME Publications.

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

ASME A.13.1, *Scheme for the Identifications of Piping Systems*, 2015.

ASME B31.3, *Process Piping*, ~~2014~~ 2018 .

ASME Boiler and Pressure Vessel Code, ~~2017~~ 2019 .

2.3.2 ASTM Publications.

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

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, ~~2015b~~ 2019a .

ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials,*~~2014~~ 2018ce1 .

ASTM E136, *Standard Test Method for ~~Behavior of~~ Assessing Combustibility of Materials in Using a Vertical Tube Furnace at 750°C*, ~~2016~~ 2019 .

2.3.3 CGA Publications.

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

ANSI/CGA G-13, *Storage and Handling of Silane and Silane Mixtures*, ~~2016~~ 2015 .

2.3.4 FM Publications.

FM Global, 270 Central Avenue, P.O. Box 7500, Johnston, RI 02919.

ANSI/FM 4910, *Standard for Cleanroom Materials Flammability Test Protocol*, 2013.

2.3.5 ISO Publications.

International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland.

ISO 14644-1, *Cleanrooms and associated controlled environments — Part 1: Classification of air cleanliness by particle concentration*, 2nd edition, 2015.

2.3.6 SEMI Publications.

Semiconductor Equipment and Materials International, 3081 Zanker Road, San Jose, CA 95134.

SEMI F1, *Specification for Leak Integrity of High-Purity Gas Piping Systems and Components*, 1996.

SEMI S3, *Safety Guideline for Process Liquid Heating Systems*, 2011.

2.3.7 UL Publications.

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

~~ANSI/~~ UL 263, ~~*Standard for*~~ *Fire Tests of Building Construction and Materials*, 2011, revised 2018 .

~~ANSI/~~ UL 723, ~~*Standard for*~~ *Test for Surface Burning Characteristics of Building Materials*, ~~2008, revised 2013~~ 2018 .

~~ANSI/~~ UL 900, ~~*Standard for*~~ *Air Filter Units*, 2015.

~~ANSI/~~ UL 2360, ~~*Standard*~~ *Test Method for Determining the Combustibility Characteristics of Plastics Used in Semiconductor Tool Construction*, ~~2013~~ 2000, revised 2017 .

2.3.8 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

NFPA 1, *Fire Code,* 2018 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* ~~2015~~ 2018 edition.

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

NFPA 69, *Standard on Explosion Prevention Systems,* ~~2014~~ 2019 edition.

NFPA 400, *Hazardous Materials Code,* ~~2016~~ 2019 edition.

NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents,* 2017 edition.

NFPA 5000®, Building Construction and Safety Code®, 2018 edition.

Supplemental Information

File Name	Description	Approved
318-2018_Chapter_2.docx	for staff use	

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Mon Jun 03 10:34:22 EDT 2019

Committee Statement

Committee Statement: Referenced current national consensus standard editions.

Response Message: FR-18-NFPA 318-2019

Public Input No. 14-NFPA 318-2018 [Section No. 2.3]

Public Input No. 20-NFPA 318-2018 [Section No. 2.3.7]

Public Input No. 5-NFPA 318-2018 [Section No. 2.3.2]

First Revision No. 20-NFPA 318-2019 [Section No. 3.3.35]

3.3.35 Subatmospheric Gas Source (SAGS).

3.3.35.1 Subatmospheric Gas Storage and Delivery Source (Type 1 SAGS).

A gas source package that stores and delivers gas at subatmospheric pressure and includes a container (e.g., gas cylinder and outlet valve) that stores and delivers gas at a pressure of less than absolute pressure of ~~14.7 psi~~ 101.3 kPa (14.7 psi) at NTP.

3.3.35.2 Subatmospheric Gas Delivery Source (Type 2 SAGS).

A gas source package that stores compressed gas and delivers gas at subatmospheric pressure and includes a container (e.g., gas cylinder and outlet valve) that stores gas at a pressure greater than absolute pressure of ~~14.7~~ 101.3 kPa (14.7 psi) at NTP and delivers gas at a pressure of less than absolute pressure of ~~14.7 psi~~ 101.3 kPa (14.7 psi) at NTP.

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Fri Jun 07 13:39:45 EDT 2019

Committee Statement

Committee Statement: Adds metric equivalent.

Response Message: FR-20-NFPA 318-2019

First Revision No. 17-NFPA 318-2019 [Section No. 5.5.2 [Excluding any Sub-Sections]]

Hazardous chemicals in the fabrication area shall be limited to those needed for operations and maintenance and as required by 5.5.2.1 through 5.5.2.3, with quantities not exceeding the limitations specified in Table 5.5.2. The limits of Table 5.5.2 shall be permitted to be exceeded, provided a submittal using alternative methods and materials is approved by the authority having jurisdiction (AHJ).

Table 5.5.2 Quantity Limits for Hazardous Materials in a Single Fabrication Area

Hazard Category	Solids		Liquids		Gas	
	kg/m^2	lb/ft^2	L/m^2	gal/ft^2	m^3 @ NTP/m^2	ft^3 @ NTP/ft^2
Physical Hazard Materials						
Combustible liquid						
Class II			0.8	0.02		
Class III-A			1.6	0.04		
Class III-B			Not limited	Not limited		
Combination Class I, II, and III-A			3.26	0.08		
Cryogenic						
Flammable					Note [b]	Note [b]
Oxidizing					0.76	2.5
Flammable gas						
Gaseous					Note [b]	Note [b]
Liquefied					Note [b]	Note [b]
Flammable liquid						
Class I-A			2.04	0.05		
Class I-B			2.04	0.05		
Class I-C			2.04	0.05		
Combination Class I-A, I-B, and I-C			2.04	0.05		
Combination Class I, II, and III-A			3.26	0.08		
Flammable solid	0.032	0.002				
Organic peroxide						
Unclassified detonable	Note [a]	Note [a]	Note [a]	Note [a]		
Class I	Note [a]	Note [a]	Note [a]	Note [a]		
Class II	0.8	0.05	0.1	0.0025		
Class III	3.2	0.2	0.8	0.02		
Class IV	Not limited	Not limited	Not limited	Not limited		
Class V	Not limited	Not limited	Not limited	Not limited		
Oxidizing gas						
Gaseous					0.76	2.5
Liquefied					0.76	2.5
Combination of gaseous and liquefied					0.76	2.5
Oxidizer						
Class 4	Note [a]	Note [a]	Note [a]	Note [a]		
Class 3	0.096	0.006	2.44	0.06		
Class 2	0.096	0.006	2.44	0.06		
Class 1	~~0.096~~ Not limited	~~0.006~~ Not limited	~~2.44~~ Not limited	~~0.06~~		

Hazard Category	Solids		Liquids		Gas	
	kg/m^2	lb/ft^2	L/m^2	gal/ft^2	m^3 @ NTP/m^2	ft^3 @ NTP/ft^2
Combination oxidizer Class ~~1,~~ 2, 3	0.096	0.006	2.44	0.06		
Pyrophoric	Note [a]	Note [a]	~~0.1~~ 0.3	~~0.0025~~ 0.0075	Notes [b] and [c]	Notes [b] and [c]
Unstable reactive						
Class 4	Note [a]	Note [a]	Note [a]	Note [a]	Note [a]	Note [a]
Class 3	0.8	0.05	0.2	0.005	Note [a]	Note [a]
Class 2	3.2	0.2	0.8	0.02	Note [a]	Note [a]
Class 1	Not limited	Not limited	Not limited	Not limited	Not limited	Not limited
Water reactive						
Class 3	Note [b]	Note [b]	~~0.1~~ 0.3	~~0.0025~~ 0.0075		
Class 2	8.0	0.5	2.04	0.05		
Class 1	Not limited	Not limited	Not limited	Not limited		
Health Hazard Materials						
Carcinogens	Not limited	Not limited	Not limited	Not limited	Not limited	Not limited
Corrosives	Not limited	Not limited	Not limited	Not limited	Not limited	Not limited
Highly toxics	Not limited	Not limited	Not limited	Not limited	Note [b]	Note [b]
Irritants	Not limited	Not limited	Not limited	Not limited	Not limited	Not limited
Sensitizers	Not limited	Not limited	Not limited	Not limited	Not limited	Not limited
Other health hazards	Not limited	Not limited	Not limited	Not limited	Not limited	Not limited
Toxics	Not limited	Not limited	Not limited	Not limited	Note [b]	Note [b]

Note: Hazardous materials within piping not to be included in the calculated quantities.

[a]Quantity of hazardous materials in a single fabrication area not to exceed ~~exempt amounts in NFPA 1~~ the maximum allowable quantities (MAQs) contained in NFPA 1, Table 60.4.2.1.1.3, including the 100 percent increases for sprinklers and/or approved cabinet increases where applicable .

[b]The aggregate quantity of flammable, pyrophoric, toxic, and highly toxic gases not to exceed a density limit of 0.66 m^3 per m^2 at NTP (0.2 ft^3 per ft^2 at NTP) .

[c]The aggregate quantity of pyrophoric gases in the building limited to the amounts for which detached storage is not required as set forth in NFPA 1.

Supplemental Information

File Name	Description	Approved
318_Table_5_5_2_CI_docx_w_je_edits_052819.docx	for staff use	

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Wed May 29 10:42:56 EDT 2019

Committee Statement

Committee Statement: Note a - Allowable increases are permitted but not recognized in NFPA 318, Table 5.5.2.2 and terminology was incorrect.

Class 1 Oxidizer was changed due to not increase the combustibility of other materials. The large operating quantities quickly use up the allowable quantity of oxidizers in the fab.

For Class 3 water reactive and pyrophoric liquids the best practice is to maintain the quantities as close to the tools as possible i.e. in the fab. The current quantity limits are close to the actual quantities utilized in manufacturing fabs. Also there are several liquids currently in R&D and these are expected in manufacturing quantities in the near future.

Response Message: FR-17-NFPA 318-2019

First Revision No. 12-NFPA 318-2019 [Section No. 5.5.2.2 [Excluding any Sub-Sections]]

Quantities of hazardous chemicals shall be limited to those in use within the tool or the daily (24-hour) supply of chemicals needed, with quantities not exceeding the limitations specified in Table 5.5.2.2 unless a risk assessment determines that a significant fire is unlikely to take place.

Table 5.5.2.2 Maximum Quantities of Hazardous Chemicals at a Workstation

Hazardous Chemical	State	Maximum Amount
Flammables, highly toxics, and pyrophorics and toxics combined[a]	Gas	Combined aggregate volume of all cylinders at a work station shall not exceed an internal cylinder volume of 150 L (39.6 gal, or 5.29 ft^3).
Hazardous chemical flammables	Liquid	56.8 L (15 gal)[a,b]
	Solid	2.3 kg (5 lb)[a,b]
Corrosives[a]	Gas	Combined aggregate volume of all cylinders at a work station shall not exceed an internal cylinder volume of 150 L (39.6 gal, or 5.29 ft^3).
	Liquid	378.5 L (100 gal)[a,b]
	Solid	9.1 kg (20 lb)
Highly toxics	Liquid	56.8 L (15 gal)[a]
	Solid	2.3 kg (5 lb)[a]
Oxidizers[a]	Gas	Combined aggregate volume of all cylinders at a work station shall not exceed an internal cylinder volume of 150 L (39.6 gal, or 5.29 ft^3).
	Liquid	45.4 L (12 gal)[a,b]
	Solid	9.1 kg (20 lb)[a,b]
Pyrophorics	Liquid	~~20 L (5.3 gal)~~ 2 L (0.5 gal) ~~[c,d]~~
	Solid	2 kg (4.4 lb)
Toxics	Liquid	56.8 L (15 gal)[a,b]
	Solid	2.3 kg (5 lb)[a,b]
Unstable reactives Class 3	Liquid	20 L (5.3 gal)[a,b,d]
	Solid	2.3 kg (5 lb)[a,b]
Water reactives Class 3	Liquid	1.9 L (0.5 gal)[c]

[a]Allowable quantities increased 100 percent for use-closed systems operations. When note b also applies, the increase for both requirements is allowed.

[b]Allowable quantities are allowed to be increased 100 percent when tools are constructed of materials that are listed or approved for use without internal fire extinguishing or suppression or internally protected with an approved automatic fire-extinguishing or suppression system. When note a also applies, the increase for both notes is allowed.

~~[c] Only in tools that are internally protected with an approved automatic fire-extinguishing or fire protection system compatible with the reactivity of materials in use at the workstation.~~

~~[d] 20 L is acceptable, it is more reflective of current practices for volumes of materials used at individual tools.~~

Supplemental Information

File Name	Description	Approved
318_Table_5.5.2.2_CI_.rev_5_28_2019.docx	Table 5.5.2.2 with changes - for staff use	

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Thu May 09 14:35:15 EDT 2019

Committee Statement

Committee Statement: Table 5.5.2.2 is identical to the IFC/ICC Table 2705.2.2 for Maximum Quantities of Hazardous Chemicals at a Workstation (with exception of reference to Pyrophoric Solids).

NOTE C – was moved to a new subsection since table notes cannot contain requirements per the NFPA Manual of Style. See new Section 5.5.2.2.2.

Appendix A.6.4.1 instructs all applications to integrate a fire control methodology to protect the cabinet and surrounding areas – referencing nitrogen inerting and vermiculite as acceptable medias. However, all of these methods have significant limitations in their ability to protect the equipment and surrounding fab areas from fire and particle damage. These methods also do not address personnel safety to exposure hazards associated with unreacted pyrophoric liquid or vapor within the cabinet when the cabinet door is open.

NEW SEMI S30 (as reference) has been approved by committee (April 5, 2019) and scheduled to be released in 2019:

Section 13.2.1 (bulk delivery cabinet) & 15.4.1 (tool delivery cabinet) – Require secondary exhaust ventilation that demonstrates effective (that is, meeting the criteria of SEMI S2 and S6) capture and containment of the energetic material and associated combustion byproducts from reaction with air from the source within the delivery cabinet.

13.4 Fire Risk Management — Based on the integrated risk assessment in accordance with SEMI S14, the equipment supplier should consult with a recognized fire risk management expert to ensure an appropriate fire risk management design is provided. Available fire risk management approaches for energetic materials include adsorption technologies and inerting of the cabinet.

NOTE 41: Designing appropriate fire risk management requires knowledge of both the properties of the relevant energetic materials and of fire risk management means.

NOTE 42: Guidance on inerting can be found in FM Global Property Loss Prevention Data Sheet 7-59, Inerting and Purging of Tanks, Process Vessels, and Equipment. However, there are several possible, undesirable consequences of inerting an energetic materials enclosure, including:

• creation of an asphyxiation hazard

• a leak into such a space might neither ignite nor react with the atmosphere, so it would not be detected by particle or flame detectors, and

• a reaction of the accumulated energetic material with air introduced when a door is opened could both be of greater power than a reaction limited by the rate of release and result in a sudden energy release to which a person is directly exposed.

Response Message: FR-12-NFPA 318-2019

First Revision No. 26-NFPA 318-2019 [New Section after 5.5.2.2.1]

5.5.2.2.2

A maximum quantity of 20 L (5.3 gal) of liquid and 2 kg (4.4 lb) of total liquids and solids shall be allowed at a workstation where conditions are in accordance with Section 6.4 .

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Mon Jun 24 13:49:42 EDT 2019

Committee Statement

Committee Statement: Table footnotes cannot contain requirements, NOTE C as proposed was moved to a new subsection. Requires the use of approved automatic fire-extinguishing or fire protection system for any and all use of pyrophoric liquids within a workstation; however, it is well understood that “there is no way to practically suppress a fire involving pyrophoric liquids” as stated in A.6.4.1. This note is copy of IFC Chapter 2705.2.2 which clearly requires fire protection for pyrophoric liquids for all workstation application when added in 2006; however, Section 6.4 doesn’t address fire protection systems except in Appendix 6.4.1 and reference under 6.4.6 for valve closures.

Response Message: FR-26-NFPA 318-2019

First Revision No. 16-NFPA 318-2019 [Section No. 6.4.1]

6.4.1*

Pyrophoric liquids in containers greater than 2 L (0.5 gal) but not exceeding 20 L (5.3 gal) capacity shall be allowed at workstations when located inside cabinets that comply with the requirements of Section 6.4 .

A.6.4.1

~~There~~ Testing has shown that there is no practical way to ~~practically~~ suppress a fire involving pyrophoric liquids. ~~Nonetheless, a~~ A fire control ~~methodology~~ method should be designed to protect the cabinet and surrounding areas. Acceptable fire control ~~media include, but are not limited to, nitrogen inerting and vermiculite.~~ methods must be capable of performing the following:

(1) Detecting the leak

(2) Capturing, containing, and removing all leaked material and associated combustion by-products

(3) Supervising the removal process to ensure all leaked hazardous material has been fully reacted before allowing personnel to enter the cabinet so that reignition cannot occur when the delivery cabinet is opened

Testing has shown that nitrogen inerting is the only known method to prevent a flame should pyrophoric liquids leak.

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Wed May 29 10:31:59 EDT 2019

Committee Statement

Committee Statement: Table 5.5.2.2 is identical to the IFC/ICC Table 2705.2.2 for Maximum Quantities of Hazardous Chemicals at a Workstation (with exception of reference to Pyrophoric Solids).

NOTE C – Requires the use of approved automatic fire-extinguishing or fire protection system for any and all use of pyrophoric liquids within a workstation; however, it is well understood that “there is no way to practically suppress a fire involving pyrophoric liquids” as stated in A.6.4.1. This note is copy of IFC Chapter 2705.2.2 which clearly requires fire protection for pyrophoric liquids for all workstation application when added in 2006; however, Section 6.4 doesn’t address fire protection systems except in Appendix 6.4.1 and reference under 6.4.6 for valve closures.

Appendix A.6.4.1 instructs all applications to integrate a fire control methodology to protect the cabinet and surrounding areas – referencing nitrogen inerting and vermiculite as acceptable medias. However, all of these methods have significant limitations in their ability to protect the equipment and surrounding fab areas from fire and particle damage. These methods also do not address personnel safety to exposure hazards associated with unreacted pyrophoric liquid or vapor within the cabinet when the cabinet door is open.

NEW SEMI S30 (as reference) has been approved by committee (April 5, 2019) and scheduled to be released in 2019:

Section 13.2.1 (bulk delivery cabinet) & 15.4.1 (tool delivery cabinet) – Require secondary exhaust ventilation that demonstrates effective (that is, meeting the criteria of SEMI S2 and S6) capture and containment of the energetic material and associated combustion byproducts from reaction with air from the source within the delivery cabinet.

13.4 Fire Risk Management — Based on the integrated risk assessment in accordance with SEMI

S14, the equipment supplier should consult with a recognized fire risk management expert to ensure an appropriate fire risk management design is provided. Available fire risk management approaches for energetic materials include adsorption technologies and inerting of the cabinet.

NOTE 41: Designing appropriate fire risk management requires knowledge of both the properties of the relevant energetic materials and of fire risk management means.

NOTE 42: Guidance on inerting can be found in FM Global Property Loss Prevention Data Sheet 7-59, Inerting and Purging of Tanks, Process Vessels, and Equipment. However, there are several possible, undesirable consequences of inerting an energetic materials enclosure, including:

• creation of an asphyxiation hazard

• a leak into such a space might neither ignite nor react with the atmosphere, so it would not be detected by particle or flame detectors, and

• a reaction of the accumulated energetic material with air introduced when a door is opened could both be of greater power than a reaction limited by the rate of release and result in a sudden energy release to which a person is directly exposed.

Response Message: FR-16-NFPA 318-2019

First Revision No. 15-NFPA 318-2019 [New Section after 6.4.7]

6.4.8 Fire Control System.

Cabinets shall be protected with an approved automatic fire control system that is capable of capturing, containing, and abating the pyrophoric material and associated combustion by-products from reaction with air should a leak occur within the cabinet.

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Tue May 28 11:06:12 EDT 2019

Committee Statement

Committee Statement: Table 5.5.2.2 is identical to the IFC/ICC Table 2705.2.2 for Maximum Quantities of Hazardous Chemicals at a Workstation (with exception of reference to Pyrophoric Solids).

NOTE C – Requires the use of approved automatic fire-extinguishing or fire protection system for any and all use of pyrophoric liquids within a workstation; however, it is well understood that “there is no way to practically suppress a fire involving pyrophoric liquids” as stated in A.6.4.1. This note is copy of IFC Chapter 2705.2.2 which clearly requires fire protection for pyrophoric liquids for all workstation application when added in 2006; however, Section 6.4 doesn’t address fire protection systems except in Appendix 6.4.1 and reference under 6.4.6 for valve closures.

Appendix A.6.4.1 instructs all applications to integrate a fire control methodology to protect the cabinet and surrounding areas – referencing nitrogen inerting and vermiculite as acceptable medias. However, all of these methods have significant limitations in their ability to protect the equipment and surrounding fab areas from fire and particle damage. These methods also do not address personnel safety to exposure hazards associated with unreacted pyrophoric liquid or vapor within the cabinet when the cabinet door is open.

NEW SEMI S30 (as reference) has been approved by committee (April 5, 2019) and scheduled to be released in 2019:

Section 13.2.1 (bulk delivery cabinet) & 15.4.1 (tool delivery cabinet) – Require secondary exhaust ventilation that demonstrates effective (that is, meeting the criteria of SEMI S2 and S6) capture and containment of the energetic material and associated combustion byproducts from reaction with air from the source within the delivery cabinet.

13.4 Fire Risk Management — Based on the integrated risk assessment in accordance with SEMI S14, the equipment supplier should consult with a recognized fire risk management expert to ensure an appropriate fire risk management design is provided. Available fire risk management approaches for energetic materials include adsorption technologies and inerting of the cabinet.

NOTE 41: Designing appropriate fire risk management requires knowledge of both the properties of the relevant energetic materials and of fire risk management means.

NOTE 42: Guidance on inerting can be found in FM Global Property Loss Prevention Data Sheet 7-59, Inerting and Purging of Tanks, Process Vessels, and Equipment. However, there are several possible, undesirable consequences of inerting an energetic materials enclosure, including:

• creation of an asphyxiation hazard

• a leak into such a space might neither ignite nor react with the atmosphere, so it would not be detected by particle or flame detectors, and

• a reaction of the accumulated energetic material with air introduced when a door is opened could both be of greater power than a reaction limited by the rate of release and result in a sudden energy release to which a person is directly exposed.

Response Message: FR-15-NFPA 318-2019

First Revision No. 28-NFPA 318-2019 [Section No. 6.5.2.1]

6.5.2.1

Liquids having a hazard ranking of 3 when exceeding 20 L (5.3 gal), or liquids having a hazard ranking of 4 when exceeding 4 L (1.1 gal), shall be transferred by one of the following methods:

(1) From safety cans

(2) Through an approved closed-piping system

(3) From containers or tanks by an approved pump taking suction through an opening in the top of the container or tank

(4) For other than highly toxic liquids, from containers or tanks by gravity through an approved self-closing or automatic-closing valve where the container or tank and dispensing operations are provided with spill control and secondary containment complying with 6.3.1.4.1 through 6.3.1.4.2.10 of NFPA 400

(5) By the use of approved engineered liquid transfer systems

[**400:**6.3.1.7.2]

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Mon Jun 24 14:00:18 EDT 2019

Committee Statement

Committee Statement: Clarifies that referenced sections are referring to NFPA 400.

Response Message: FR-28-NFPA 318-2019

First Revision No. 27-NFPA 318-2019 [Section No. 7.1.3.1 [Excluding any Sub-Sections]]

Piping, tubing, fittings, and related components shall be designed, fabricated, and tested in accordance with the requirements of the applicable parts in ~~ANSI/~~ ASME B31.3, *Process Piping*~~, or other approved standards~~ . [**55:**7.3.1.3]

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Mon Jun 24 13:57:52 EDT 2019

Committee Statement

Committee Statement: Updates extracted text.

Response Message: FR-27-NFPA 318-2019

First Revision No. 6-NFPA 318-2019 [New Section after 7.1.4.8]

7.1.4.8.1

In the case of hazardous production material gas cylinders no greater than 103 kPa (15 psi) cylinder pressure, bulk gas purge sources shall be permitted to be used in place of cylinders.

7.1.4.8.2

Regulation of cylinder pressure shall not be an acceptable means to meet the 103 kPa (15 psi) threshold.

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Thu May 09 12:31:24 EDT 2019

Committee Statement

Committee Statement: Current standard allows for bulk source for sub-atm gas cylinders. But there are many low pressure gases that have the same inherent safety of low pressure that does not have the risk of back feeding into a house purge system (such as house argon). The 15 psig criteria is used in a number of other areas. This includes the DOT criteria for an empty cylinder as well as HPM gases over 15 psig that requires excess flow control. This is to align with the 15 psig criteria and allow these low pressure gases to use a bulk source for a purge panel.

Response Message: FR-6-NFPA 318-2019

Public Input No. 2-NFPA 318-2018 [New Section after 7.1.4.8]

First Revision No. 9-NFPA 318-2019 [Section No. 7.6.4]

7.6.4

Optical flame detection or high-sensitivity smoke detection for silane delivery systems shall be provided as described in 11.2.5.1.

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Thu May 09 13:28:57 EDT 2019

Committee Statement

Committee Statement: The reliable operation of optical flame detection has proven to be challenging based upon varying behavior of sliane to different leak scenarios and size/positioning limitations of semiconductor equipment (gas cabinets, VMB, and tool gas box/jungle as noted below.

1. A fast silane leak (> 2m/s) will result in delayed ignition upon closure of the pneumatic valves after hydride detection.

• The resulting flame scenarios is an instantaneous deflagration of the silane vapors present.

• Flame detection would require detection within 100 milli-seconds

2. A medium silane leak (< 2 m/s) may result in auto-ignition (i.e. through a VCR hole as result of hand tight fitting).

3. Flame detection is required to detect this leak as hydride sensors will not respond (all hydride is consumed during burning)

• Flame detection must be rated for silane

• Flame detection response is factor of fire size vs distance must be within detector specifications

• Flame detector UV sensor must not be absorbed by heavy smoke/SiO2 particle release (typically installed on ceiling of cabinet). This is also a function of flame detector alarm response time.

• Flame detector IR sensor can not be saturated when fire size too large too close. This is also a factor of flame detector response time.

4. Very slow silane leak (< ?? m/s) will result in no ignition – even after hydride detection.

• Silane released by “pin-hole 0.04”, through missing seals in VCR and surface mount equipment resulted in leak with no ignition.

The varying leak scenarios justifies the needs for reliable hydride detection and fire detection at all potential equipment leak points to:

1. Detect a leak of any scenario.

2. Determine the appropriate response for ERT (with ignition or without ignition).

In April 2019, ASM and KFPI recently completed second round of various silane leak scenario tests within an exhausted cylinder cabinet to validate the detection response to various optical flame detector technologies, high-sensitivity smoke detection, and various hydride gas detection. These results will be published at SESHA Symposium on May 2, 2019.

Currently the semiconductor industry requires flame and gas detection at every silane source and transfer point except within the tool gas box/jungle inside the fab where gas hydride detection is the only form of leak detection.

Response Message: FR-9-NFPA 318-2019

First Revision No. 21-NFPA 318-2019 [Section No. 8.5.5.3]

8.5.5.3

Liquid overtemperature protection shall be provided to prevent process liquids from reaching a point where the properties of the liquid create a potentially dangerous situation as shown in Table 8.5.5.3.

Table 8.5.5.3 Maximum Overtemperature Setpoint

Liquid Property	Maximum Overtemperature Setpoint
Noncombustible	Boiling point (bp)
Combustible	Lesser of boiling point (bp) or auto ignition temperature (AIT) less 50˚C (122˚F)
Flammable	Flashpoint (fp) less 10˚C (50˚F)

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Fri Jun 07 13:41:21 EDT 2019

Committee Statement

Committee Statement: Adds U.S. Customary units.

Response Message: FR-21-NFPA 318-2019

First Revision No. 1-NFPA 318-2019 [Section No. 11.1.3.5 [Excluding any Sub-Sections]]

Where smoke detection is installed below a waffle floor to detect smoke in the airstream passing from the cleanroom to the sub-fab, area of coverage of spot-type detector or sampling port shall be limited to ~~18.6 m~~ ^{2} ~~(200 ft~~ ^{2} ~~)~~ 9.3 m ^{2} (100 ft ^{2}) .

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Thu May 09 11:17:38 EDT 2019

Committee Statement

Committee Statement: In fab areas, laminar air flow, from ceiling to floor, is usually well maintained by a significant number of FFUs. Smoke generated at an early (incipient) stage of a fire development, being highly buoyant, is easily pushed down through the perforated floor and is less likely of being dispersed widely in horizontal directions. It therefore stands to reason that if not adequately spaced spot-type detectors or sampling ports placed under the waffle ceiling of the sub-fab have less of an opportunity of intersecting smoke entrained within the air stream. In Asian countries, such as Taiwan, South Korea, etc., this is well understood, and it is common practice within cleanrooms to reduce spacing of spot-type detectors or sampling ports. Spacing of 9m2 (3x3m) has been widely adopted. Experimental results disclose that even under such reduced spacing parameters, an Air Sampling Detection System may still fail to capture smoke from hot-wire tests conducted within the fab.

Recently, CFD modelling was conducted to study smoke distribution characteristics under various fab airflow velocities, and to understand impacts on detection performance, considering differences in spot-type detector and port spacing scenarios. Images included below illustrate smoke dispersion at the sampling plane under a waffle ceiling, with smoke concentration above 0.65%/m, shown in red color. As can be seen, detectors with spacing more than 3x3m were only capable of recording smoke concentration levels of 0.65%/m at lower fab air velocities and an increased fire size (5kW).

Response Message: FR-1-NFPA 318-2019

Public Input No. 3-NFPA 318-2018 [Section No. 11.1.3.5 [Excluding any Sub-Sections]]

First Revision No. 2-NFPA 318-2019 [Section No. 11.1.3.6 [Excluding any Sub-Sections]]

In the absence of performance-based design criteria, where smoke detection is installed at the entry to the return air path, area coverage of spot-type detector or sampling port spacing shall be limited to ~~0.4 m^2 (4.3 ft^2)~~ 1 m^2 (10.8 ft^2) for detecting vertically in front of cooling coils in the sub-fab, and 0.4 m^2 (4.3 ft^2) for detecting horizontally in the entry of return air shafts and ducts .

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Thu May 09 11:20:19 EDT 2019

Committee Statement

Committee Statement: In cleanrooms with dry (cooling) coils vertically located in sub-fab, smoke detection systems normally have spot-type detectors or ports in front of the coils. While those dry coils generally have a large section area, typically occupying majority of a wall, laminar flow conditions are relatively well maintained on the air flow through the coils. It is therefore unnecessary to apply such restrictive coverage practices, which are more reasonably required for duct applications.

Furthermore, extensive tests have been conducted to test detection performance at increased spacing. Sufficient detection performance results were observed when conducting hot wire tests at various distances away from dry coils, i.e. detectors' responses were registered before the smoke concentration of 0.65%/m reached a single point. Guidelines with sampling coverage between 0.6 and 1.2m2 under various fab airflow velocities are developed from experimental and CFD modelling studies and accepted by all the parties as an industry practice. The 1m2 sampling coverage can deal with return air velocities of up to 4.7m/s, which covers relatively wide air re-circulation conditions. After decades of application experience, the 1m2 sampling coverage has recently been adopted in Taiwan local code for cleanroom fire protection.

Response Message: FR-2-NFPA 318-2019

Public Input No. 4-NFPA 318-2018 [Section No. 11.1.3.6 [Excluding any Sub-Sections]]

First Revision No. 10-NFPA 318-2019 [Section No. 11.2.5.1]

11.2.5.1

Optical flame detectors that will respond to the flame signature of silane or high-sensitivity smoke detection shall be provided to detect a fire at potential leak points on the silane delivery system. ~~Coverage shall be provided to address container connections, process gas and purge gas panels, and other potential leak points where unwelded fittings or connections are used.~~

11.2.5.1.1

Coverage shall be provided to address container connections, process gas and purge gas panels, and other potential leak points where unwelded fittings or connections are used.

11.2.5.1.2

~~An optical flame~~ A fire detection system shall be provided inside of ~~VMBs~~ all equipment as defined in 11.2.5.1.3 to detect a fire within the ~~VMB~~ equipment .

11.2.5.1.3

Activation of a fire detection system shall result in the closing of the following nearest isolation valve:

(1) At local gas boxes near the tool or in the tool gas jungle

(2) At VMBs, shut down individual sticks

(3) At the gas cylinder source

(4) At the bulk source

11.2.5.1.4

~~Flame~~ Fire detection shall result in an alarm transmission to the supervising station as well as a local alarm signal that is distinctive from the facility's audible alarm signal and any process equipment alarm signals.

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Thu May 09 13:52:08 EDT 2019

Committee Statement

Committee Statement: The reliable operation of optical flame detection has proven to be challenging based upon varying behavior of sliane to different leak scenarios and size/positioning limitations of semiconductor equipment (gas cabinets, VMB, and tool gas box/jungle as noted below.

1. A fast silane leak (> 2m/s) will result in delayed ignition upon closure of the pneumatic valves after hydride detection.

• The resulting flame scenarios is an instantaneous deflagration of the silane vapors present.

• Flame detection would require detection within 100 milli-seconds

2. A medium silane leak (< 2 m/s) may result in auto-ignition (i.e. through a VCR hole as result of hand tight fitting).

3. Flame detection is required to detect this leak as hydride sensors will not respond (all hydride is consumed during burning)

• Flame detection must be rated for silane

• Flame detection response is factor of fire size vs distance must be within detector specifications

• Flame detector UV sensor must not be absorbed by heavy smoke/SiO_2 particle release (typically installed on ceiling of cabinet). This is also a function of flame detector alarm response time.

• Flame detector IR sensor can not be saturated when fire size too large too close. This is also a factor of flame detector response time.

4. Very slow silane leak (< ?? m/s) will result in no ignition – even after hydride detection.

• Silane released by "pin-hole 0.04", through missing seals in VCR and surface mount equipment resulted in leak with no ignition.

The varying leak scenarios justifies the needs for reliable hydride detection and fire detection at all potential equipment leak points to:

1. Detect a leak of any scenario.

2. Determine the appropriate response for ERT (with ignition or without ignition).

In April 2019, ASM and KFPI recently completed second round of various silane leak scenario tests within an exhausted cylinder cabinet to validate the detection response to various optical flame detector technologies, high-sensitivity smoke detection, and various hydride gas detection. These results will be published at SESHA Symposium on May 2, 2019.

Currently the semiconductor industry requires flame and gas detection at every silane source and transfer point except within the tool gas box/jungle inside the fab where gas hydride detection is the only form of leak detection.

Response Message: FR-10-NFPA 318-2019

First Revision No. 8-NFPA 318-2019 [Section No. 11.2.6.1]

11.2.6.1 Fire Detection System.

Each cabinet shall be equipped with an automatic fire detection system that complies with the following conditions:

(1) *Automatic detection system*: ~~A UV/IR,~~ Optical flame detection that will respond to the flame signature of the chemical or high-sensitivity smoke detection ~~(HSSD) or other approved detection system~~ shall be provided inside each cabinet to detect a fire at potential leak points on the delivery system. Coverage shall be provided to address container connections, process gas, and purge gas panels, and other potential leak points where unwelded fittings or connections are used .

(2) *Automatic shutoff*: Activation of the detection system shall automatically close the shutoff valve(s) on the liquid supply.

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Thu May 09 13:22:04 EDT 2019

Committee Statement

Committee Statement: The term “UV/IR” for “optical flame detector” is technically a specific requirement for light spectrum combination that could prevent the use of other flame detector technologies with varying combinations of light spectrums which are also effective for the chemicals requiring the fire detection.

We should use the appropriate terminology of “optical flame detector” as NFPA 318 already does for Silane Gas Systems (11.2.5.1).

Response Message: FR-8-NFPA 318-2019

First Revision No. 22-NFPA 318-2019 [Section No. A.6.4.2]

A.6.4.2

Careful consideration should be given to the amount of liquid pyrophoric material needed for operations. Many times the 20 L (5.3 gal) quantity is not needed to sustain production.

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Fri Jun 07 13:43:01 EDT 2019

Committee Statement

Committee Statement: Adds U.S. Customary units.

Response Message: FR-22-NFPA 318-2019

First Revision No. 23-NFPA 318-2019 [Section No. A.7.6.2]

A.7.6.2

The use of two single-stage regulators in series will help reduce liquefaction during pressure reduction. Replaceable metal gaskets in DISS connections are preferred over PTFE gaskets that can cold flow and leak at pressures higher than ~~500 psi.~~ 3448 kPa (500 psi) . The use of solid stainless steel pigtail lines is preferred over flexible steel lines. The use of a Venturi eductor to evacuate the gas panel during system purge is strongly recommended. The dome of the pressure regulator should also be vented to a safe location.

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Fri Jun 07 13:43:55 EDT 2019

Committee Statement

Committee Statement: Adds Metric unit.

Response Message: FR-23-NFPA 318-2019

First Revision No. 24-NFPA 318-2019 [Section No. A.8.5.5.1]

A.8.5.5.1

Some organometallic liquids or solids can undergo violent decomposition if overheated, in some cases heating for an extended period below the initiation temperature can also cause the decomposition reaction to occur. These include trimethylaluminum, dimethylzinc, diethylzinc, trimethylindium, and trimethylgallium. Maximum temperatures of 100°C–120°C (212°F–248°F) are recommended.

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Fri Jun 07 13:44:50 EDT 2019

Committee Statement

Committee Statement: Adds U.S. Customary units.

Response Message: FR-24-NFPA 318-2019

First Revision No. 7-NFPA 318-2019 [Chapter D]

Annex D Informational References

D.1 Referenced Publications.

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

D.1.1 NFPA Publications.

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

NFPA 1, *Fire Code*, 2018 edition.

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

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, ~~2014~~ 2019 edition.

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

NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, ~~2013~~ 2018 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2018 edition.

NFPA 287, *Standard Test Methods for Measurement of Flammability of Materials in Cleanrooms Using a Fire Propagation Apparatus (FPA)*, 2017 edition.

NFPA 329, *Recommended Practice for Handling Releases of Flammable and Combustible Liquids and Gases*, ~~2015~~ 2020 edition.

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, 2017 edition.

Fire Protection Handbook, 20th edition, 2008.

D.1.2 Other Publications.

~~**D.1.2.1** ANSI Publications.~~

~~American National Standards Institute, Inc., 25 West 43rd Street, 4th floor, New York, NY 10036.~~

~~ANSI B31.3, *Chemical Plant and Petroleum Refinery Piping*, 2004.~~

~~ANSI/ISA S84.01, *Application of Safety Instrumented Systems for the Process Industries*, 1996.~~

D.1.2.1 ASME Publications.

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

ASME B31.3, *Process Piping*, 2018.

D.1.2.2 ASTM Publications.

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

~~IEEE/~~ ASTM SI 10, *Standard for Use of the International System of Units (SI): The Modern Metric System*, ~~2002~~ 2016 .

ASTM E1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*, ~~2015a~~ 2017 .

ASTM E2058, *Standard Test Methods for Measurement of Synthetic Polymer Material Flammability Using a Fire Propagation Apparatus (FPA)*, 2013a.

D.1.2.3 CGA Publications.

Compressed Gas Association, 14501 George Carter Way, Suite 103, Chantilly, VA 20151-1770.

ANSI/ CGA G-13, *Storage and Handling of Silane and Silane Mixtures*, ~~2006~~ 2015 .

D.1.2.4 FM Publications.

FM Global, 270 Central Avenue, P.O. Box 7500, Johnston, RI 02919.

ANSI/ FM 4910, *Clean Room Materials Flammability Test Protocol*, ~~September 1997~~ 2013 .

FM 4922, *Fume Exhaust Ducts or Fume and Smoke Exhaust Ducts*, April 2001.

D.1.2.5 ISA Publications.

International Society of Automation, 67 T. W. Alexander Drive, PO Box 12277, Research Triangle Park, NC 27709.

ANSI/ISA S84.00.01 P1, *Functional Safety: Safety Instrumented Systems for the Process Industry Sector — Part 1: Framework, Definitions, System, Hardware and Software Requirements* , 2004.

ANSI/ISA S84.00.02 P2, *Functional Safety: Safety Instrumented Systems for the Process Industry Sector — Part 2: Guidelines for the Application of ANSI/ISA S84.00.01-2004 Part 1: Informative* , 2004.

ANSI/ISA S84.00.03 P3, *Functional Safety: Safety Instrumented Systems for the Process Industry Sector — Part 3: Guidance for the Determination of the Required Integrity Levels — Informative* , 2004.

D.1.2.6 SEMI Publications.

Semiconductor Equipment and Materials International, 3081 Zanker Road, San Jose, CA 95134.

SEMI S2~~-0703a~~ , *Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment*, ~~2002~~ 2010 .

SEMI S14, *Safety Guidelines for Fire Risk Assessment and Mitigation for Semiconductor Manufacturing Equipment*, ~~2000~~ 2009 .

D.1.2.7 UL Publications.

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

~~ANSI/~~ UL 2360, ~~*Standard*~~ *Test Method for Determining the Combustibility Characteristics of Plastics Used in Semiconductor Tool Construction*, 2000, revised ~~2013~~ 2017 .

D.1.2.8 US Government Publications.

US Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

Title 29, Code of Federal Regulations, Part 1910.1000, "Air Contaminants."

Title 49, Code of Federal Regulations, Part 173, Appendix A, "Transportation."

D.2 Informational References. (Reserved)

~~The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.~~

D.3 References for Extracts in Informational Sections.

NFPA 1, *Fire Code*, 2018 edition.

NFPA 5000®, Building Construction and Safety Code®, 2018 edition.

Supplemental Information

File Name	Description	Approved
318-2018_Annex_D.docx	for staff use	

Submitter Information Verification

Committee: SCR-AAA

Submittal Date: Thu May 09 13:12:59 EDT 2019

Committee Statement

Committee Statement: Referenced current national consensus editions. Update titles in Sections A.8.3 and A.10.4.3.

Response Message: FR-7-NFPA 318-2019

Public Input No. 13-NFPA 318-2018 [Section No. D.1.2.5]

Public Input No. 6-NFPA 318-2018 [Section No. D.1.2.2]

Public Input No. 15-NFPA 318-2018 [Chapter D]