DELETED

Second Revision No. 84-NFPA 660-2024 [Global Comment]

In A.1.3, replace "core" with "fundamental" (6 instances).

In the first column heading in Table A.1.3, delete "core" so that the heading becomes "Fundamental Chapters"

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Mon Feb 26 09:45:25 EST 2024

Committee Statement

Committee Statement: Previously, the document used various terminology such as fundamental, core, and basic requirements/chapters. These Second Revisions provide consistency throughout the document and is consistent with the title of this committee.

Response Message: SR-84-NFPA 660-2024

Second Revision No. 71-NFPA 660-2024 [Global Input]

~~Type your content here ...~~ **Wherever fundamental requirements in "Chapters 1 through 9" are referenced, change to "Chapters 1 through 10".**

Twice in A.1.3, where "Chapters 4 through 9" are referenced, change to "Chapters 4 through 10".

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 13:33:13 EST 2024

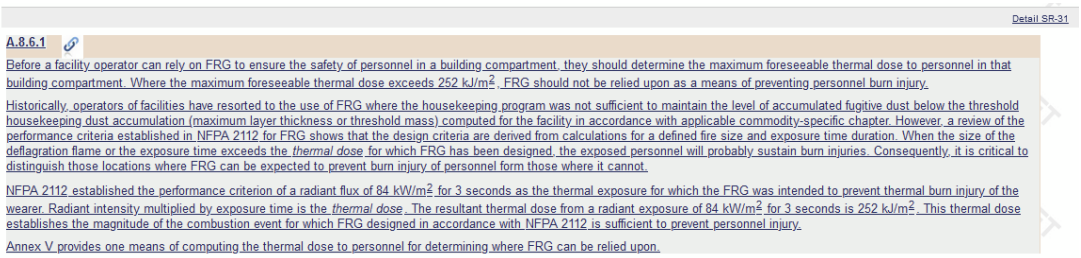
Committee Statement

Committee Statement: Fundamental requirements have been added to Chapter 10, which was previously reserved.

Response Message: SR-71-NFPA 660-2024

Second Revision No. 31-NFPA 660-2024 [Detail]

Add Annex A to 8.6.1 PPE Applicability.



Detail SR-31

A.8.6.1

Before a facility operator can rely on FRG to ensure the safety of personnel in a building compartment, they should determine the maximum foreseeable thermal dose to personnel in that building compartment. Where the maximum foreseeable thermal dose exceeds 252 kJ/m^2, FRG should not be relied upon as a means of preventing personnel burn injury.

Historically, operators of facilities have resorted to the use of FRG where the housekeeping program was not sufficient to maintain the level of accumulated fugitive dust below the threshold housekeeping dust accumulation (maximum layer thickness or threshold mass) computed for the facility in accordance with applicable commodity-specific chapter. However, a review of the performance criteria established in NFPA 2112 for FRG shows that the design criteria are derived from calculations for a defined fire size and exposure time duration. When the size of the deflagration flame or the exposure time exceeds the *thermal dose* for which FRG has been designed, the exposed personnel will probably sustain burn injuries. Consequently, it is critical to distinguish those locations where FRG can be expected to prevent burn injury of personnel form those where it cannot.

NFPA 2112 established the performance criterion of a radiant flux of 84 kW/m^2 for 3 seconds as the thermal exposure for which the FRG was intended to prevent thermal burn injury of the wearer. Radiant intensity multiplied by exposure time is the *thermal dose*. The resultant thermal dose from a radiant exposure of 84 kW/m^2 for 3 seconds is 252 kJ/m^2. This thermal dose establishes the magnitude of the combustion event for which FRG designed in accordance with NFPA 2112 is sufficient to prevent personnel injury.

Annex V provides one means of computing the thermal dose to personnel for determining where FRG can be relied upon.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 13:36:32 EST 2024

Committee Statement

Committee Statement: This annex text is needed to explain the technical basis for the limitation on where FRG can be relied upon. It serves as the pointer for a more detailed presentation on one means by which the user can determine how to comply with the requirement.

Response Message: SR-31-NFPA 660-2024

Public Comment No. 195-NFPA 660-2024 [New Section after 8.6.1.1]

Second Revision No. 40-NFPA 660-2024 [Detail]

Add Annex A to 8.11 Management of Change.

Detail SR-40

A.8.11

See CCPS *Guidelines for the Management of Change for Process Safety* for additional guidance on management of change.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 17:27:26 EST 2024

Committee Statement

Committee Statement: Although the dictionary may define the terms 'change', 'technical', and 'basis', and those definitions may be appropriate for their usage in this standard, management of change is a complicated topic warranting implementation guidance. The CCPS publication listed is an excellent resource for the user community in search of further guidance.

Response Message: SR-40-NFPA 660-2024

Public Comment No. 201-NFPA 660-2024 [Section No. 8.12]

Second Revision No. 49-NFPA 660-2024 [Detail]

In 9.4.4.7.3(4) and (5), replace "DHA" with "risk assessment".

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 18:51:28 EST 2024

Committee Statement

Committee Statement: As written, the application of these controls is more of a risk based assessment rather than a hazard analysis.

Response Message: SR-49-NFPA 660-2024

Public Comment No. 142-NFPA 660-2024 [Section No. 9.4.4.7.3]

Second Revision No. 51-NFPA 660-2024 [Detail]

In 9.4.17.1.1.1(4) and (5), replace "DHA" with "risk assessment".

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 18:55:27 EST 2024

Committee Statement

Committee Statement: As written, the application of these controls is more of a risk based assessment rather than a hazard analysis.

Response Message: SR-51-NFPA 660-2024

Public Comment No. 144-NFPA 660-2024 [Section No. 9.4.17.1.1.1]

Second Revision No. 61-NFPA 660-2024 [Detail]

In A.1.3:

Chapter 15 does not contain a section on Dry AMS ~~controls~~ in 15.9.4.4.3 , but that does not mean there are no requirements for them — rather ~~9.4.3.1.4~~ 9.4.4.3 applies.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 10:35:36 EST 2024

Committee Statement

Committee Statement: The sections were revised at the First Draft stage so the example is no longer correct. This text provides a new example for the user.

Response Message: SR-61-NFPA 660-2024

Public Comment No. 107-NFPA 660-2023 [Section No. A.1.3]

Second Revision No. 65-NFPA 660-2024 [Detail]

Delete the following entry from Z.1.2.21:

Tamanini, F., *Dust Explosion Propagation in Simulated Grain Conveyor Galleries,* ESV-83-067, National Grain and Feed Association Fire and Explosion Research Report, prepared by Factory Mutual Research Corporation, Norwood, MA, July 2002.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 11:23:23 EST 2024

Committee Statement

Committee Statement: The 1983 report is correctly cited in the National Grain and Feed Association Publications section. There was no republication in 2002.

Response Message: SR-65-NFPA 660-2024

Public Comment No. 108-NFPA 660-2023 [Section No. A.9.3.5.3.6]

Second Revision No. 68-NFPA 660-2024 [Detail]

Create new annex on the section currently numbered 8.10.1.2(1), but after being moved will be 10.1.1.2(1):

8.10.1.2 The emergency response plan shall include, but not be limited to, the following:

(1) *A means of notification for occupants in the event of fire and explosion



Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 12:35:30 EST 2024

Committee Statement

Committee Statement: This annex material will guide users to sources of information on occupant notification systems to help ensure the means of notification selected is appropriate.

Response Message: SR-68-NFPA 660-2024

Public Comment No. 209-NFPA 660-2024 [Section No. 8.10.1.2]

Second Revision No. 72-NFPA 660-2024 [Detail]

5.3.2 Thermal Instability Hazard Evaluations.

5.3.2.1

A thermal instability hazard evaluation shall be conducted when one or more of the following conditions exist:

(1) More than 1,000 kg (2,200 lbs.) of combustible particulate are stored for longer than 8 hours in a bin or hopper or bulk pile at a temperature higher than 30°C (104°F).

(2) More than 100 kg (220 lbs.) of particulate product are in an oven or dryer for more than 1 hour.

(3) A scenario where heated material can reside for extended periods of time in process equipment has been identified in the DHA.

5.3.2.2

The thermal instability hazard evaluation method shall be according to either 5.3.2.2.1 or 5.3.2.2.2.

5.3.2.2.1

A documented review of pertinent reactivity literature, safety data sheets, and operating experience shall be conducted, identifying the reactivity of the material, thermal decomposition onset temperature, and, where possible, the reaction byproducts including gases that could be toxic, corrosive, or flammable.

5.3.2.2.2*

Temperature sensitivity testing shall be conducted at temperatures that would correspond to the highest possible temperature the material could attain based on exposure conditions determined from the DHA.

A.5.3.2.2.2

When conducting testing for temperature sensitivity, the use of nitrogen in place of air can help distinguish between an oxidation reaction and a thermal decomposition. Differential scanning calorimetry, thermal gravimetric analysis, and similar thermal analysis test methods are often used to test for thermal decomposition and polymerization reactions. For more information, see Chapter 3 in the CCPS *Guidelines for Safe Handling of Powders and Bulk Solids*.

5.3.3 Water Reactivity Hazard Evaluations.

5.3.3.1

A water reactivity hazard evaluation shall be conducted when one or both of the following conditions exist:

(1) A water-based fire suppression system is used for the combustible particulate material.

(2) Particulate product or dust is exposed to process water, condensed water vapor, or outdoor precipitation.

5.3.3.2

The water reactivity hazard evaluation method shall be according to either 5.3.3.2.1 or 5.3.3.2.2.

5.3.3.2.1*

A documented review of pertinent reactivity literature, reactivity screening software, and operating experience shall be conducted, identifying the reactivity of the material and, where possible, the reaction byproducts including gases that could be toxic, corrosive, or flammable.

A.5.3.3.2.1

The US DOT Pipeline and Hazardous Materials Safety Administration *Emergency Response Guidebook (ERG)* contains the "Table of Water-Reactive Materials Which Produce Toxic Gases." Potential reactivity screening tools include the CCPS Chemical Reactivity Worksheet (CRW) and the AIChE Chemical Hazard Engineering Fundamentals (CHEF) documentation.

5.3.3.2.2

Water reactivity testing shall be conducted using the UN *Recommendations on the Transport of Dangerous Goods, Model Regulations — Manual of Tests and Criteria* water reactivity Test N.5 for potential Division 4.3 water-reactive materials that emit flammable gases, or another test acceptable to the AHJ.

5.3.4 Chemical Reactivity Hazard Evaluations.

5.3.4.1

A chemical reactivity hazard evaluation shall be conducted when particulate product or dust could be exposed to an incompatible material or a reactivity scenario has been otherwise identified in the DHA.

5.3.4.2

The chemical reactivity hazard evaluation method shall be according to either 5.3.4.2.1 or 5.3.4.2.2.

5.3.4.2.1

A documented review of pertinent reactivity literature, reactivity screening software, and operating experience shall be conducted, identifying the reactivity of the material and, where possible, the reaction byproducts including gases that could be toxic, corrosive, or flammable. *(See A.5.3.3.2.1.)*

5.3.4.2.2*

Calorimetry testing shall be used for determining potential chemical reactivity hazards.

A.5.3.4.2.2

Differential scanning calorimetry is often used as a preliminary screening test for reactive materials. Other calorimetric reactivity test methods include ARC, APTAC, and VSP2. For more information, see Chapter 4 in the CCPS *Guidelines for Safe Handling of Powders and Bulk Solids*.

Where the material decomposition products are likely to be hazardous, the identification and quantification of the byproducts should be obtained.

Supplemental Information

File Name	Description	Approved
660_Detail_SR-72_5.3.2-new.docx		

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 15:36:50 EST 2024

Committee Statement

Committee Statement: This section has been reserved without content in the existing and previous editions of 652. The threshold quantities for evaluating thermal instability and chemical reactivity are conservatively low reflections of experience with incidents and with some formal experimental evaluations. The purpose of this section is to identify the potential for such hazards so that the DHA can evaluate suitable mitigations.

Response Message: SR-72-NFPA 660-2024

Second Revision No. 77-NFPA 660-2024 [Detail]

9.4.1 General.~~(Reserved)~~

9.4.1.1* [moved from 9.4.3.1.1]

Where used to handle combustible particulate solids, systems shall be designed by and installed under the supervision of qualified persons who are knowledgeable about these systems and their associated hazards.

A.9.4.1.1 [A.9.4.3.1.1]

The system information and documentation should include the following:

(1) System design specifications

(2) System installation specifications

(3) Equipment specifications

(4) Operational description

(5) Material combustibility and explosibility information

(6) Fire and explosion protection system specifications and design

(7) System mechanical and electrical drawings

(8) System controls and specifications

The design of these systems should be coordinated with the architectural and structural designs of the areas involved.

9.4.1.2* [moved from 9.4.3.1.2]

Where it is necessary to make changes to ~~an~~ existing equipment or systems, all changes shall be managed in accordance with the management of change requirements in Section 8.11.

A.9.4.1.2 [A.9.4.3.1.2]

~~Pneumatic conveying and dust collection systems are designed for specific conveying requirements.~~ Changing ~~any of those requirements~~existing equipment or systems can significantly ~~change~~alter the ability of the system to provide the original design performance. An analysis of any proposed changes should be done to assure the equipment or system will still be able to perform as required to meet safety and operational requirements.

Supplemental Information

File Name	Description	Approved
660_Detail_SR-77_9.4.1.docx		

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 19:45:15 EST 2024

Committee Statement

Committee Statement: Requirements are moving here from 9.4.3.1 so it will no longer be Reserved.

As identified by Correlating Committee Note 23, the requirements should apply to all equipment covered by 9.4, not just pneumatic conveying, dust collection, and centralized vacuum cleaning systems.

Response Message: SR-77-NFPA 660-2024

Public Comment No. 59-NFPA 660-2023 [Section No. 9.4.3.1.1]

Second Revision No. 83-NFPA 660-2024 [Detail]

In A.1.3:
Refer to the applicable industry- or commodity-specific chapter of the standard (Chapters 11through ~~14~~ 15) for additional requirements ...

Submitter Information Verification

Committee: CMD-FUN
Submittal Date: Mon Feb 26 09:42:37 EST 2024

Committee Statement

Committee Statement: The industry- and commodity-specific chapters were renumbered at the First Draft stage, so this reference needs to be corrected.
Response Message: SR-83-NFPA 660-2024

Second Revision No. 86-NFPA 660-2024 [Detail]

Revise the definitions related to Air-Material Separators in attached pdf.

Supplemental Information

File Name	Description	Approved
permission_for_Figure_A.3.3.5.1_1_.pdf	Staff use only	
Copyright_Permission_Request_Form_-_Nederman.pdf	Staff use only	
Copyright_Permission_Request_Form_-_Nilfisk.pdf	Staff use only	
Copyright_Permission_Request_Form_-_Airdusco.pdf	Staff use only	
660_SR_86_3.3.5.docx		
660_Detail_SR-86_3.3.5_Air-Material_Separators.docx	For prod use	
660_Detail_SR-86_3.3.5_definitions_for_ballot.pdf	For ballot	

Submitter Information Verification

Committee: CMD-FUN
Submittal Date: Mon Feb 26 15:17:56 EST 2024

Committee Statement

Committee Statement: The definitions for various AMS types were reviewed and consolidated in one place for ease of use. They were revised to align the formats of each definition and to clarify the previous versions of the definitions.

Response Message: SR-86-NFPA 660-2024

Public Comment No. 85-NFPA 660-2023 [Section No. 3.3.33]

Public Comment No. 113-NFPA 660-2023 [Section No. 3.3.97]

Public Comment No. 114-NFPA 660-2023 [Section No. 3.3.98]

Public Comment No. 83-NFPA 660-2023 [Section No. A.3.3.5]

Public Comment No. 120-NFPA 660-2023 [Section No. 3.3.137]

Public Comment No. 82-NFPA 660-2023 [Section No. 3.3.5]

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3.3.5* Air-Material Separator (AMS).

A device designed to separate the conveying air/gas from the material being conveyed. (CMD-FUN)

A.3.3.5 Air-Material Separator (AMS).

Examples include ~~the following:~~cyclones, enclosureless dust collectors, point-of-use dust collectors, and bin vents.

~~(1) Cyclonic separator (cyclone) — a device utilizing centrifugal forces and geometry to separate the majority particulates from the conveying air/gas. The efficiency of this separation is based upon many factors such as the geometry of the cyclone, material particle size distribution and density, and air/gas velocity. Generally, this unit is considered only an initial or primary separator, and additional separation devices might be needed to meet air pollution control requirements.~~

~~(2) Dust collector — a device utilizing filter media to separate particulates from the conveying air/gas stream. Such devices often have automatic methods for continuous filter cleaning in order to maintain the operational efficiency of the device. Typically the filter medium is either cartridges or bags over metal cages. The operating pressure of this device, especially if operating in a negative pressure (vacuum) condition, is usually limited by its shape and physical construction.~~

~~(3) Filter receiver — similar to a dust collector but can be designed for higher vacuum and pressure applications. Dust loading is often higher than a fugitive dust collection system since these units are typically used as an AMS for a product conveying system.~~

~~(4) Scrubber — a device utilizing geometry, physical barriers, and/or absorption methods, along with a fluid (e.g., sprays and streams) to separate and collect gases and/or dusts.~~

~~(5) Electrostatic precipitator — a device that utilizes differences in electrical charges to remove fine particulates from the gas stream. These are commonly used for large gas flows with abrasive dusts such as fly ash or cement.~~

~~(6) Final filter — a high-efficiency device commonly utilizing a pre-filter and a secondary filter within an enclosure to provide the last particulate removal step before the air is discharged from the system. Final filters are commonly used when the air stream is recirculated to occupied areas. This device can provide protection against the failure of a dust collector or filter receiver upstream of the device. A high-efficiency particulate air (HEPA) filter is an example.~~

An AMS technically could be an oversized section of ductwork (e.g., a drop-box). Typically, an AMS used in a dust collection system will, in addition to separating the conveyed material from the air/gas stream, include the ability to collect the separated material within the AMS to allow for continuous discharge of that material. (CMD-FUN)

3.3.5.1* Cyclone.

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A device that uses geometry (i.e., shape) and centrifugal force to separate the conveying air/gas from the material being conveyed. (CMD-FUN)

A.3.3.5.1 Cyclone.

A ~~Cyclonic~~cyclonic separator (cyclone) is— a device utilizing centrifugal forces and geometry to separate the majority particulates from the conveying air/gas. The efficiency of this separation is based upon many factors such as the geometry of the cyclone, material particle size distribution and density, and air/gas velocity. Generally, this unit is ~~considered only~~used as an initial or primary separator, and additional separation devices might be needed to meet air pollution control requirements. Specially designed cyclones are able to meet air pollution control requirements but require special engineering data and know-how to design. Examples of cyclones are shown in Figure A.3.3.5.1(a) and Figure A.3.3.5.1(b).

Figure A.3.3.5.1(a) Low to Medium Efficiency Cyclone.

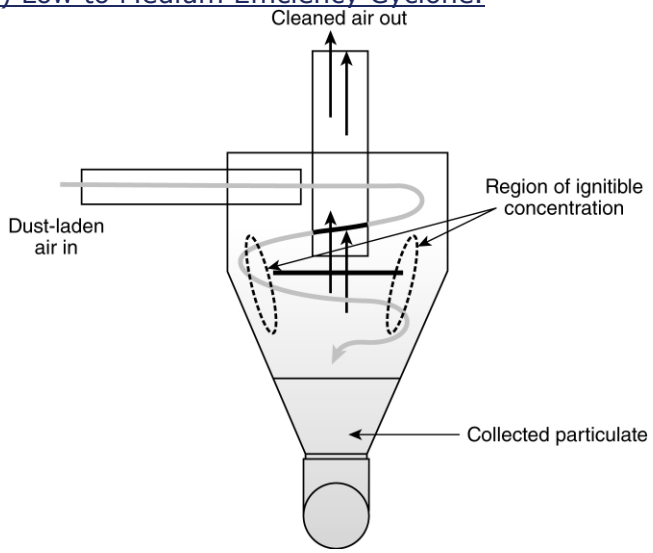
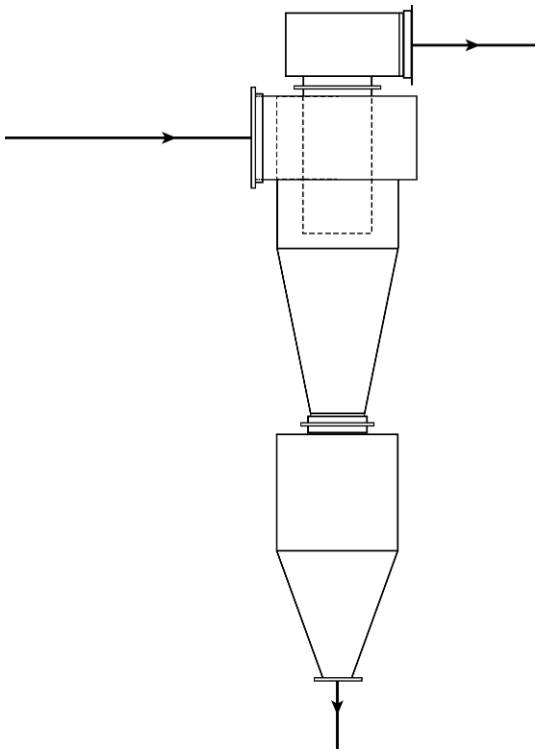


Figure A.3.3.5.1(b) High Efficiency Cyclone.

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3.3.5.2 Dry-Type Air-Material Separator (AMS).

See 3.3.5.3, Dust Collector. (CMD-FUN)

3.3.5.3* Dust Collector.

A device that uses filter media to separate the conveying air/gas from the material being conveyed. (CMD-FUN)

A.3.3.5.3 Dust Collector.

~~Dust collector — a device utilizing filter media to separate particulates from the conveying air/gas stream.~~ Such devices often have automatic methods for continuous filter cleaning in order to maintain the operational efficiency of the device. Typically, the filter medium is either cartridges or bags over metal cages. The operating pressure of this device, especially if operating in a negative pressure (vacuum) condition, is usually limited by its shape and physical construction. Examples of dust collectors are shown in Figure A.3.3.5.3(a) through Figure A.3.3.5.3(e).

Figure A.3.3.5.3(a) Bag Collector with Compressed Air Cleaning.

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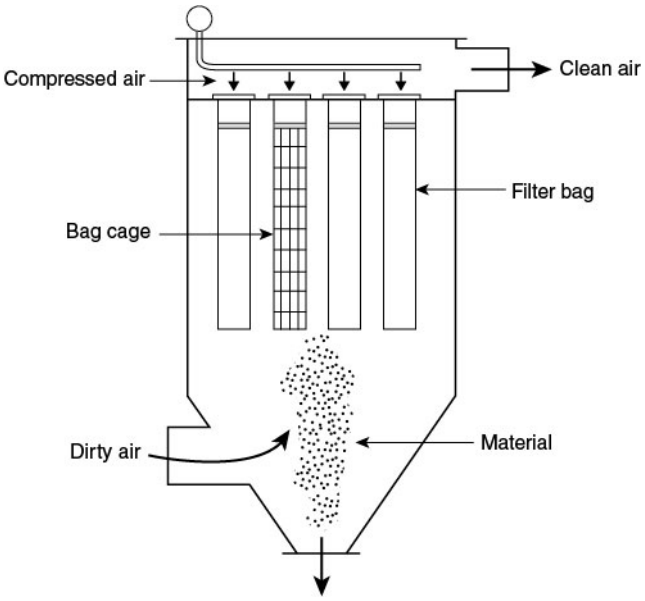


Figure A.3.3.5.3(b) Downflow Cartridge Collector with Compressed Air Cleaning.

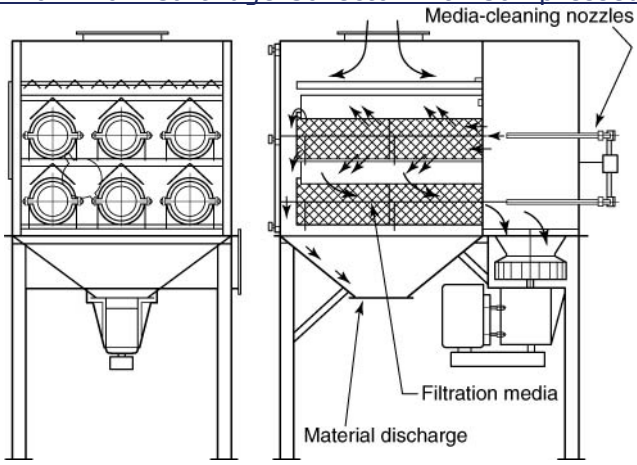


Figure A.3.3.5.3(c) Bag Collector with Dust Collecting on Outside of Bag and with High Pressure Cleaning (Reverse Air).

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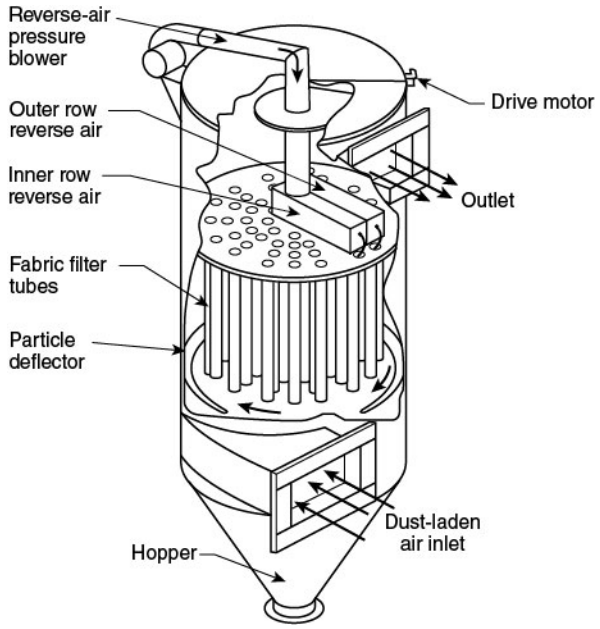


Figure A.3.3.5.3(d) Bag Collector with Dust Collecting on Inside of Bag and with Reverse Air Cleaning.

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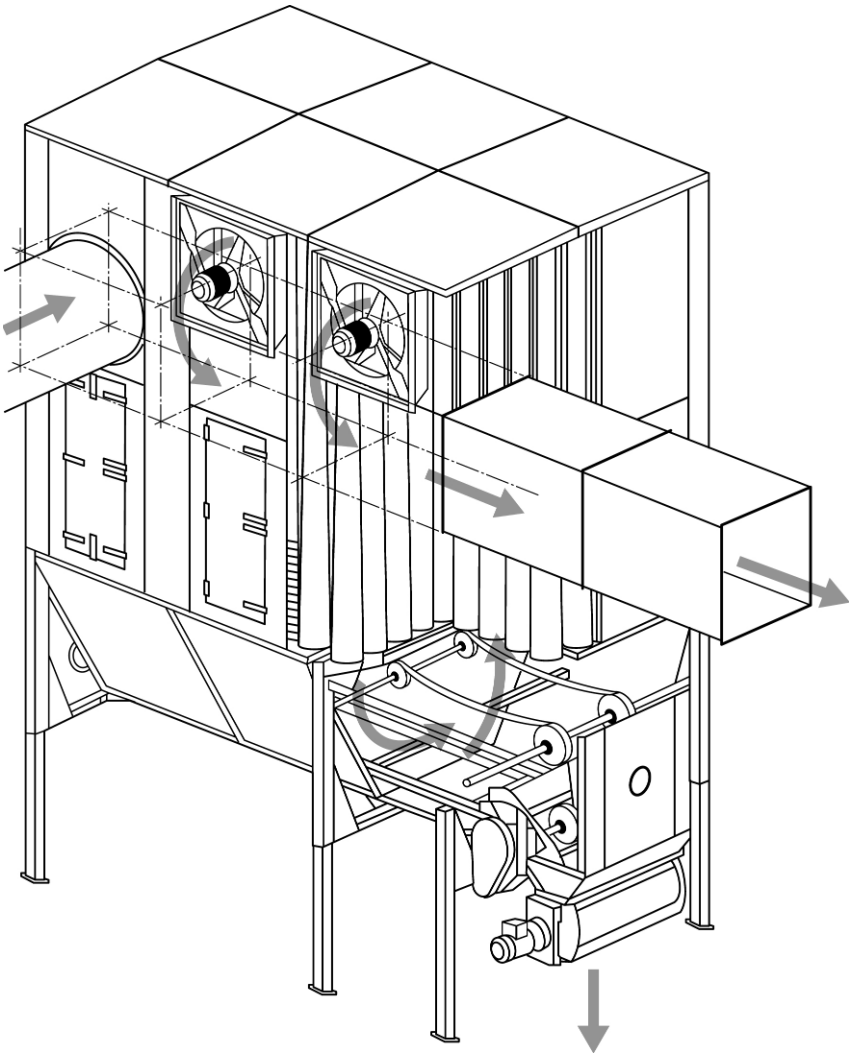
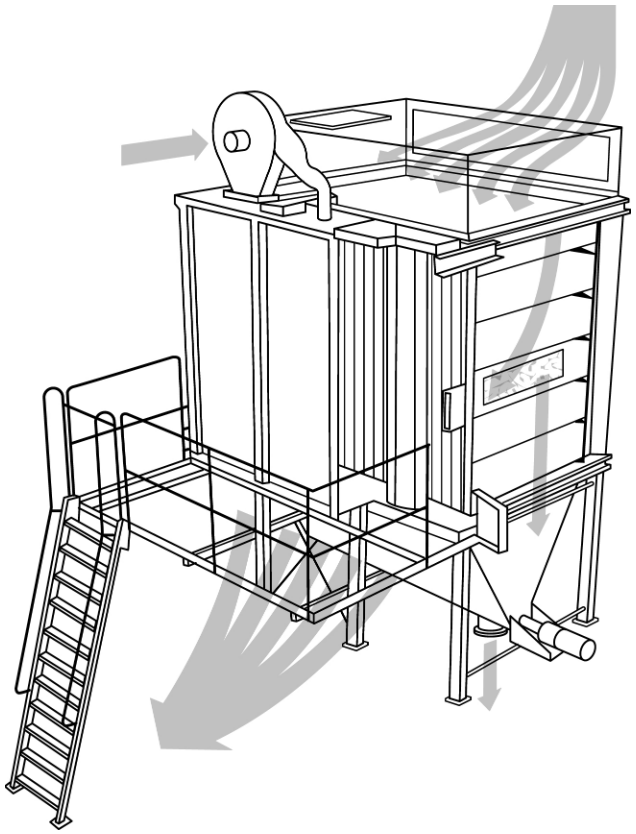


Figure A.3.3.5.3(e) Envelope Bag Collector with Reverse Air Cleaning.

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(CMD-FUN)

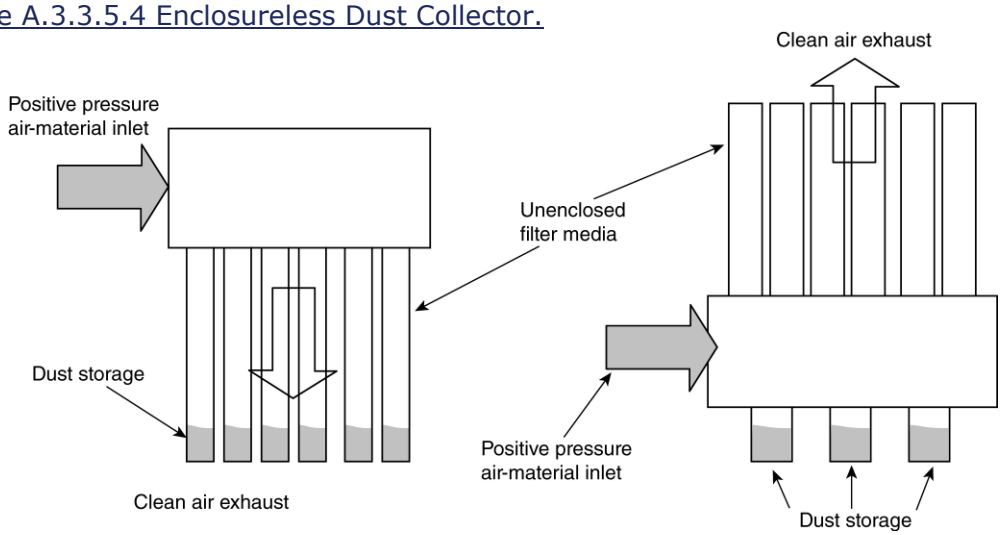
3.3.5.4* Enclosureless AMS.

~~An air-material separator designed to separate the conveying air from the material being conveyed where the filter media are not enclosed or in a continer~~A device using filter media to separate the conveying air/gas from the material being conveyed but without full physical enclosure of the filter media. (CMD-FUN)

A.3.3.5.4 Enclosureless AMS.

An example of an enclosureless AMS is shown in Figure A.3.3.5.4.

Figure A.3.3.5.4 Enclosureless Dust Collector.



3.3.5.5* Filter Receiver.

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A dust collector designed for bulk material flow such as products conveying or a central vacuum system. (CMD-FUN)

A.3.3.5.5 Filter Receiver.

~~Filter receiver — similar~~A filter receiver is similar to a dust collector but can be designed for higher vacuum and pressure applications. Dust loading is often higher than a fugitive dust collection system since these units are typically used as an AMS for a product conveying system. (CMD-FUN)

3.3.5.6 Media Collector.

See 3.3.5.3, Dust Collector. (CMD-FUN)

3.3.5.7 Point-of-Use Dust Collector.

A dust collector integrated with a dust-producing device, usually with an integral AMD used to create negative pressure. (CMD-FUN)

3.3.5.8 Portable Air-Material Separator (AMS) ~~(Dust Collector)~~.

A portable ~~machine designed to collect airborne dust produced from a dust-generating operation~~device used as a dust collector. (CMD-FUN)

3.3.5.9* Portable Vacuum Cleaner.

A movable assembly consisting of a vacuum source (AMD), an AMS ~~using either liquid or filter media~~ within an enclosure, and a vacuum hose, used to remove dusts and particles from surfaces. (CMD-FUN)

A.3.3.5.9 Portable Vacuum Cleaner.

A portable vacuum cleaner is any device that either allows the direct use of a hose (with or without tools) or is used to connect to a fixed-pipe run with hose connection stations. Such a device should have the following:

(a) A method to separate the vacuumed material from the conveying air flow. This is typically either a filter or filters (depending upon size and air flow rate) or a wet separation (impact or partially submerged). It can also include a modified cannister or enclosure of the separation media.

(b) A device and/or method to provide conveying air flow at a sufficient vacuum level to allow use as a vacuum cleaner. This can range from a venturis connected to a compressed air supply to positive displacement, centrifugal, or regenerative vacuum blowers. Smaller units can use integral small vacuum blowers.

The assemblies can range from drum cover units to large assemblies that require a forklift to move from one location to another. Combustible dust hazards and risks must be considered when using these devices. Additional information is provided in Chapter 9. Examples of portable vacuum cleaners are shown in Figure A.3.3.5.9(a) and Figure A.3.3.5.9(b).

Figure A.3.3.5.9(a) Portable Vacuum Cleaner with Built-In Vacuum Source (AMD).

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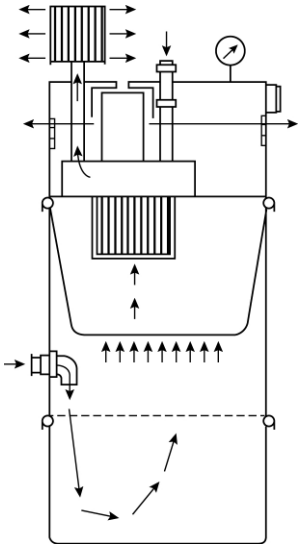
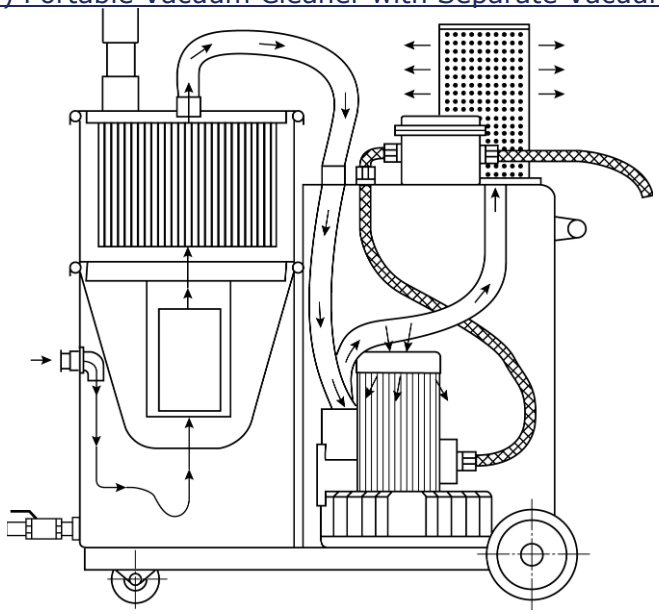


Figure A.3.3.5.9(b) Portable Vacuum Cleaner with Separate Vacuum Source (AMD).



3.3.5.10* Wet Scrubber (Wet-Type AMS).

A device that uses liquid to separate the conveying air/gas from the material being conveyed. (CMD-FUN)

A.3.3.5.10 Wet Scrubber (Wet-Type AMS).

~~Scrubber — a~~A wet scrubber is a device utilizing geometry, physical barriers, and/or absorption methods, along with a fluid (e.g., sprays and streams) to separate and collect gases and/or dusts.

Examples of wet scrubbers are shown in Figure A.3.3.5.10(a) and Figure A.3.3.5.10(b).

Figure A.3.3.5.10(a) Scrubber with Internal Baffles and Water Sump.

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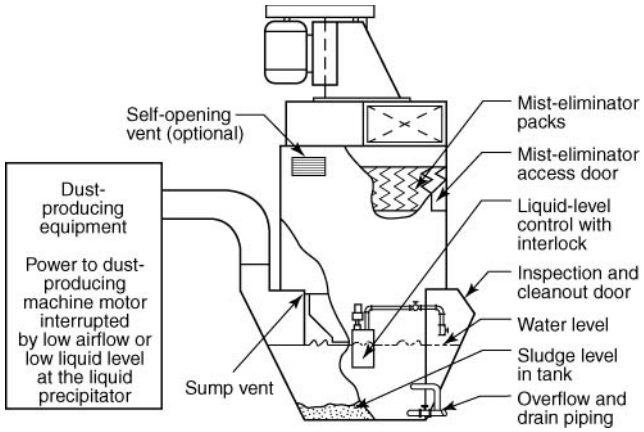
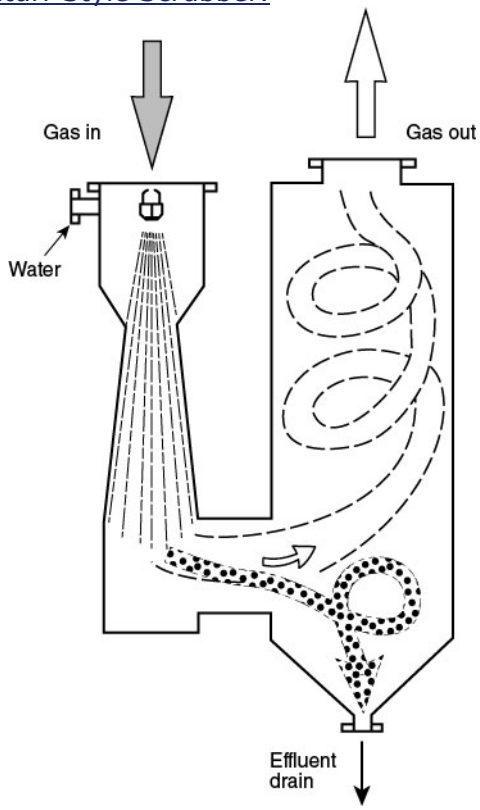


Figure A.3.3.5.10(b) Venturi-Style Scrubber.



(CMD-FUN)

3.3.5.11 Wet-Type Air-Material Separator.

~~An air-material separator (AMS) that uses liquid for the separation of the pneumatically conveyed solid from the air/gas~~See 3.3.5.10, Wet Scrubber. (CMD-FUN)

Second Revision No. 6-NFPA 660-2024 [Section No. 1.1.3]

1.1.3

This standard also addresses the ~~size reduction~~ processing of sulfur and the handling of sulfur in any form, as well as other hazards entailed in processing sulfur, in accordance with the scope of Chapter 13.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Tue Feb 20 12:24:00 EST 2024

Committee Statement

Committee Statement: This aligns with the change made to the scope of Chapter 13 in the First Draft stage.

Response Message: SR-6-NFPA 660-2024

Public Comment No. 21-NFPA 660-2023 [Section No. 1.1.3]

Second Revision No. 7-NFPA 660-2024 [New Section after 1.1.4]

1.1.5

This standard also addresses processes and facilities handling combustible dusts and particulate solids not otherwise covered by Chapters 11 , 12 , 13 , or 14 , in accordance with the scope of Chapter 15 .

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Tue Feb 20 12:27:23 EST 2024

Committee Statement

Committee Statement: The other industry- or commodity-specific chapters are referenced in 1.1 already, and this completes the set of references.

Response Message: SR-7-NFPA 660-2024

Public Comment No. 32-NFPA 660-2023 [New Section after 1.1.4]

Second Revision No. 5-NFPA 660-2024 [New Section after 1.3.1]

1.3.1

The owner/operator shall be responsible for implementing the requirements in this standard.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Tue Feb 20 11:25:14 EST 2024

Committee Statement

Committee Statement: This was previously included in an industry-specific chapter and has been deemed fundamental.

It is important that it is clear whose responsibility it is to achieve compliance with the standard.

Response Message: SR-5-NFPA 660-2024

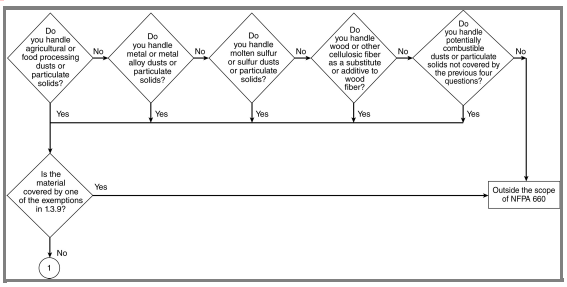
Second Revision No. 8-NFPA 660-2024 [Section No. 1.3.1]

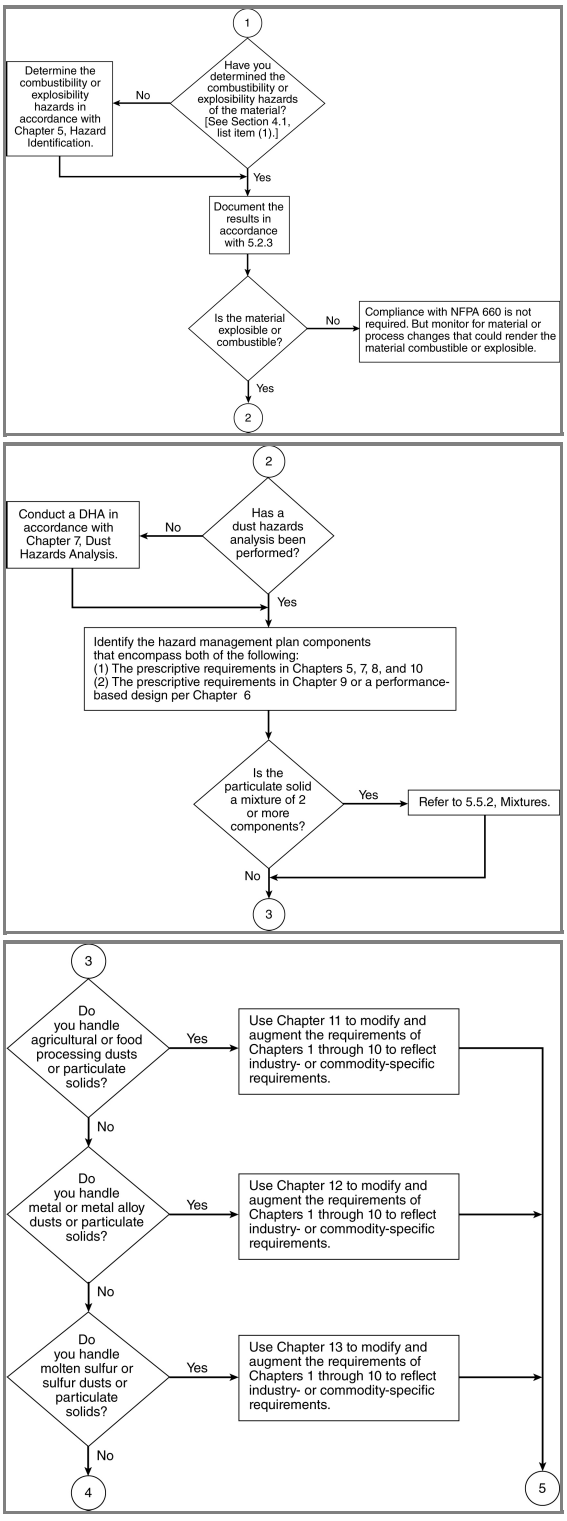
1.3.2

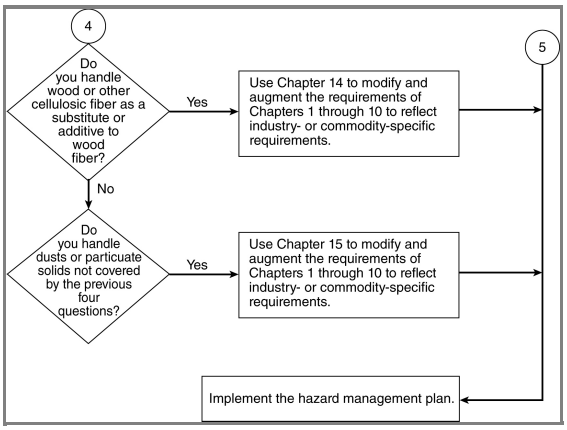
The user shall be permitted to use Figure 1.3.2 for guidance when using this standard.

Figure 1.3.2 Document Flow Diagram for Combustible Dust Hazards Evaluation.

Is the particulate solid a mixture of two or more components?
Yes
Refer to 5.5.2, Mixtures.
No
Is the particulate solid a metal or an alloy?
Yes
Refer to Chapter 12, Combustible Metals.
No
Is the particulate solid an agricultural or a food product?
Yes
Refer to Chapter 11, Agricultural and Food Processing.
No
Is the particulate solid from wood processing or woodworking?
Yes
Refer to Chapter 14, Wood Processing and Woodworking Facilities.
No
Is the particulate solid sulfur?
Yes
Refer to Chapter 13, Sulfur.
No
Refer to Chapter 15, Combustible Dusts and Particulate Solids Not Otherwise Specified.
Modify and implement the hazard management plan if needed based on industry- or occupancy-specific requirements.


Do you handle agricultural or food processing dusts or particulate solids?
No
Do you handle metal or metal alloy dusts or particulate solids?
No
Do you handle molten sulfur or sulfur dusts or particulate solids?
No
Do you handle wood or other cellulosic fiber as a substitute or additive to wood fiber?
No
Do you handle potentially combustible dusts or particulate solids not covered by the previous four questions?
No
Yes
Yes
Yes
Yes
Yes
Is the material covered by one of the exemptions in 1.3.9?
Yes
Outside the scope of NFPA 660
No
1


1
Have you determined the combustibility or explosibility hazards of the material? [See Section 4.1, list item (1).]
No
Determine the combustibility or explosibility hazards in accordance with Chapter 5, Hazard Identification.
Yes
Document the results in accordance with 5.2.3
Is the material explosible or combustible?
No
Compliance with NFPA 660 is not required. But monitor for material or process changes that could render the material combustible or explosible.
Yes
2
2
Has a dust hazards analysis been performed?
No
Conduct a DHA in accordance with Chapter 7, Dust Hazards Analysis.
Yes
Identify the hazard management plan components that encompass both of the following:
(1) The prescriptive requirements in Chapters 5, 7, 8, and 10
(2) The prescriptive requirements in Chapter 9 or a performance-based design per Chapter 6
Is the particulate solid a mixture of 2 or more components?
Yes
Refer to 5.5.2, Mixtures.
No
3
3
Do you handle agricultural or food processing dusts or particulate solids?
Yes
Use Chapter 11 to modify and augment the requirements of Chapters 1 through 10 to reflect industry- or commodity-specific requirements.
No
Do you handle metal or metal alloy dusts or particulate solids?
Yes
Use Chapter 12 to modify and augment the requirements of Chapters 1 through 10 to reflect industry- or commodity-specific requirements.
No
Do you handle molten sulfur or sulfur dusts or particulate solids?
Yes
Use Chapter 13 to modify and augment the requirements of Chapters 1 through 10 to reflect industry- or commodity-specific requirements.
No
4
5



Supplemental Information

File Name	Description	Approved
660_SR_8_Figure_1.3.1.pdf		

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Tue Feb 20 12:55:16 EST 2024

Committee Statement

Committee Statement: The current Figure 1.3.1 did not accurately reflect the logic flow for implementing the requirements of the standard.

Response Message: SR-8-NFPA 660-2024

Public Comment No. 134-NFPA 660-2023 [Section No. 1.3.1]

Second Revision No. 9-NFPA 660-2024 [Section No. 1.4.3]

1.4.3

When ~~renovating~~ modifying or adding to an existing facility, equipment, or process, the provisions of this standard shall apply ~~retroactively~~ to ~~that~~ the affected portion of the facility, equipment, or process ~~that is being modified~~ .

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Tue Feb 20 13:19:39 EST 2024

Committee Statement

Committee Statement: This change improves clarity. It was not clear what was meant by renovating or applying changes retroactively. The facility might not have been covered by the standard previously, but the modification or addition could introduce new hazards that warrant coverage by the standard.

Response Message: SR-9-NFPA 660-2024

Public Comment No. 34-NFPA 660-2023 [Section No. 1.4.3]

Second Revision No. 2-NFPA 660-2024 [Sections 1.6.2, 1.6.3, 1.6.4]

1.6.2*

Where a requirement in an industry- or commodity-specific chapter differs from the requirement specified as a ~~basic~~ fundamental requirement in Chapters 1 through 10, the requirement in the industry- or commodity-specific chapter shall be permitted to be used.

1.6.3

Where an industry- or commodity-specific chapter specifically prohibits a ~~basic~~ fundamental requirement specified in Chapters 1 through 10, the prohibition in the industry- or commodity-specific chapter shall be applied.

1.6.4

Where an industry- or commodity-specific chapter neither prohibits nor provides a requirement, the ~~basic~~ fundamental requirements in Chapters 1 through 10 shall be applied.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Tue Feb 20 11:04:44 EST 2024

Committee Statement

Committee Statement: Previously, the document used various terminology such as fundamental, core, and basic requirements/chapters. These Second Revisions provide consistency throughout the document and is consistent with the title of this committee.

Response Message: SR-2-NFPA 660-2024

Second Revision No. 79-NFPA 660-2024 [Section No. 2.3]

2.3 Other Publications.

2.3.1 AMCA International Publications.

Air Movement and Control Association International, Inc., 30 West University Drive, Arlington Heights, IL 60004-1893.

~~ANSI/~~ AMCA Standard 99, *Standards Handbook,~~Classifications for Spark Resistant Construction~~* ~~,~~ 2016. (Supersedes AMCA Standard 99-0401.)

2.3.2 ASME Publications.

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

ANSI/ASME B31.1, *Power Piping,* 2022.

ASME B31.3, *Process Piping*, ~~2018~~ 2022 .

Boiler and Pressure Vessel Code, ~~2021~~ 2023 .

2.3.3 ASTM Publications.

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

ASTM D378, *Standard Test Methods for Rubber (Elastomeric) Conveyor Belting, Flat Type*, 2010, reapproved 2016.

ASTM E11, *Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves*, 2022.

ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C*, 2022.

ASTM E1226, *Standard Test Method for Explosibility of Dust Clouds*, 2019.

ASTM E1515, *Standard Test Method for Minimum Explosible Concentration of Combustible Dusts*, 2014, reapproved 2022.

ASTM E2019, *Standard Test Method for Minimum Ignition Energy of a Dust Cloud in Air*, 2003, reapproved 2019.

~~ASTM E2931, *Standard Test Method for Limiting Oxygen (Oxidant) Concentration of Combustible Dust Clouds* , 2013, reapproved 2019.~~

ASTM F1002, *Standard Performance Specification for Protective Clothing and Materials for Use by Workers Exposed to Specific Molten Substances and Related Thermal Hazards*, 2015, reapproved 2021.

ISO/ASTM 52900, *Additive Manufacturing — General Principles — Fundamentals and Vocabulary*, 2021.

2.3.4 BSI Publications.

BSI British Standards, 12950 Worldgate Drive, Suite 800, Herndon, VA 20170.

BS EN 17348, *Requirements for design and testing of vacuum cleaners for use in potentially explosive atmospheres* , 2022.

2.3.5 IEC Publications.

International Electrotechnical Commission, 3~~,~~ rue de Varembé, P.O. Box 131, CH-1211 Geneva 20, Switzerland.

IEC 61340-4-4, *Electrostatics — Part 4-4: Standard Test Methods for Specific Applications — Electrostatic Classification of Flexible Intermediate Bulk Containers (FIBC)*, 2018.

2.3.6 ISA Publications.

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

ISA 84.00.01, *Functional Safety*: *Safety Instrumented Systems for the Process Industry Sector*, 2004.

2.3.7 MSHA Publications.

Mine Safety and Health Administration (MSHA), 201 12th Street South, Suite 401, Arlington VA 22202-5450.

MSHA Title 30, Code of Federal Regulations, Part 18, Section 12.18.6.5 and Section 18.65, "2G Test."

2.3.8 UL Publications.

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

UL 4040, *Outline of Investigation for Portable Wet-Type Dust Collectors for Collection of Combustible Metals*, 2016.

UL/CSA 60335-2-69, *Household and similar electrical appliances — Safety — Part 2-69: Particular requirements for wet and dry vacuum cleaners, including power brush for commercial use*, 2022.

2.3.9 UN Publications.

United Nations Publications Customer Service, P.O. Box 960, Herndon, VA 20172.

Recommendations on the Transport of Dangerous Goods: Model Regulations — Manual of Tests and Criteria, 2019.

2.3.10 U. S. Government Publications.

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

Title 29, Code of Federal Regulations, Part 1910.242(b), “Hand and Portable Powered Tools and Equipment, General.”

2.3.11 Other Publications.

Merriam-Webster’s Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2020.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Mon Feb 26 09:02:38 EST 2024

Committee Statement

Committee Statement: Updating references to their most recent editions.

Response Message: SR-79-NFPA 660-2024

Second Revision No. 56-NFPA 660-2024 [Section No. 2.4]

2.4 References for Extracts in Mandatory Sections.

NFPA 30, *Flammable and Combustible Liquids Code,* 2024 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2023 edition.

NFPA 69, *Standard on Explosion Prevention Systems,* ~~2019~~ 2024 edition.

NFPA 70®, *National Electrical Code®,* 2023 edition.

NFPA 77, *Recommended Practice on Electricity,* ~~2019~~ 2024 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* ~~2021~~ 2024 edition.

NFPA 499, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas,* ~~2021~~ 2024 edition.

NFPA 921, *Guide for Fire and Explosion Investigations,* ~~2021~~ 2024 edition.

NFPA 1250, *Recommended Practice in Fire and Emergency Service Organization Risk Management,* 2020 edition.

NFPA 1451, *Standard for a Fire and Emergency Service Vehicle Operations Training Program,* 2018 edition.

NFPA 2112, *Standard on Flame-Resistant Clothing for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire,* ~~2018~~ 2023 edition.

NFPA 2113, *Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire,* ~~2020~~ 2025 edition.

Submitter Information Verification

Committee: CMD-FUN
Submittal Date: Thu Feb 22 00:06:33 EST 2024

Committee Statement

Committee Statement: This revision updates extracted text in accordance with the Extract Policy.
Response Message: SR-56-NFPA 660-2024

Second Revision No. 12-NFPA 660-2024 [Section No. 3.3.45]

3.3.41 Fibers/Flyings.

~~Elongated particulate solids having one or more dimension greater than 500 µm. (CMD-FUN)~~

~~A.3.3.45~~ ~~Fibers/Flyings.~~

~~Fibers and flyings are characterized by a large ratio between the largest and smallest characteristic dimension (length:width, length:diameter, or length:thickness). Examples of fibers/flyings include flat platelet-shaped particulate, such as flakes, and fibrous particulate, such as particle board core material. The 500 µm particle size criterion in the definition differentiates fibers and flyings from dusts. Many accumulations of fibers and flyings are composed of a range of particle sizes and can contain a mixture of fibers/flyings and dust. (CMD-FUN)~~

3.3.41.1* Combustible Fibers/Flyings.

Fibers/flyings ~~that present a flash fire or explosion hazard~~ where any dimension is greater than 500 µm in nominal size, which can form an explosible mixture when suspended in air at standard atmospheric pressure and temperature. [**499,** 2024] (CMD-FUN)

A.3.3.41.1 Combustible Fibers/Flyings.

Section 500.5 of *NFPA 70* defines a Class III location. Combustible fibers/flyings can be similar in physical form to ~~ignitable~~ ignitible fibers/flyings and protected using the same electrical equipment installation methods. Examples of fibers/flyings include flat platelet-shaped particulate, such as metal flake, and fibrous particulate, such as particle board core material. If the smallest dimension of a combustible material is greater than 500 µm, it is unlikely that the material would be combustible fibers/flyings, as determined by test. Finely divided solids with lengths that are large compared to their diameter or thickness usually do not pass through a 500 µm sieve, yet when tested could potentially be determined to be explosible. [**499,** 2024]

The typical test methods for evaluating an explosible mixture are ASTM E1226, *Standard Test Method for Explosibility of Dust Clouds,* ISO 6184-1, *Explosion ~~Protection~~ protection ~~Systems~~ systems — Part 1: Determination of ~~Explosion~~ explosion ~~Indices~~ indices of ~~Combustible~~ combustible ~~Dusts~~ dusts in ~~Air~~ air* , or ISO/IEC/UL 80079-20-2, *Explosive atmospheres — Part 20-2: Material characteristics — Combustible dusts test methods*, for procedures for determining the explosibility of dusts. A material that is found to not present an explosible mixture could still be an ignitible fiber/flying, as defined in 3.3.41.2. Historically, the explosibility condition has been described as presenting a flash fire or explosion hazard. It could be understood that the potential hazard due to the formation of an explosible mixture when suspended in air at standard atmospheric pressure and temperature would include ignition. [**499,** 2024]

While this standard includes larger yet still hazardous materials as a subset of combustible dust, *NFPA 70* addresses them separately for purposes of defining the appropriate electrical classification. Although the hazard is the same when dispersed in a cloud, the electrical installation to prevent ingress of combustible fibers/flyings is different. (CMD-FUN)

3.3.41.2* Ignitible Fibers/Flyings.

Fibers/flyings ~~that do not present a flash fire or explosion hazard in air at standard atmospheric pressure and temperature, but that can~~ where any dimension is greater than 500 µm in nominal size, which are not likely to be in suspension in quantities to produce an explosible mixture, but could produce an ignitible layer fire hazard. [**499**, 2024] (CMD-FUN)

A.3.3.41.2 Ignitible Fibers/Flyings.

Section 500.5 of *NFPA 70* defines a Class III location as one where ignitible fibers/flyings are present, but not likely to be in suspension in the air in quantities sufficient to produce ignitible mixtures. This description addresses fibers/flyings that do not present a flash fire hazard or explosion hazard by test. This could be because those fibers/flyings are too large or too agglomerated to be suspended in air in sufficient concentration, or at all, under typical test conditions. Alternatively, this could be because they burn so slowly that, when suspended in air, they do not propagate combustion at any concentration. [**499**, ~~2021~~ 2024] ~~Where a process-specific oxidizing medium or elevated temperature process is present, ignitible fibers can produce a flash fire or explosion hazard.~~

In this document the zone classification system includes ignitible fibers/flyings as a fire hazard in a layer, which is not addressed in the IEC zone system (see IEC 60079-10-2, *Explosive atmospheres — Part 10-2: Classification of areas — Explosive dust atmospheres*). Where these are present, the user could also consider installation in accordance with Article 503 of *NFPA 70*. [**499**, ~~2021~~ 2024] ~~(CMD-FUN)~~

Where a process-specific oxidizing medium or elevated temperature process is present, ignitible fibers can produce a flash fire or explosion hazard. (CMD-FUN)

Supplemental Information

File Name	Description	Approved
660_SR_12_3.3.45.docx		
660_SR_12_3.3.45_Fibers-Flyings.docx	For prod use	

Submitter Information Verification

Committee: CMD-FUN
Submittal Date: Tue Feb 20 18:19:52 EST 2024

Committee Statement

Committee Statement: The definitions were reverted to retain consistency with those in the NEC and NFPA 499.

The Technical Committee intends to request a Fire Protection Research Foundation project to review the definitions and potentially propose a method to better characterize ignitible fibers/flyings.

Response Message: SR-12-NFPA 660-2024

Public Comment No. 227-NFPA 660-2024 [Section No. 3.3.45]

Public Comment No. 199-NFPA 660-2024 [Section No. 3.3.45]

Public Comment No. 224-NFPA 660-2024 [Section No. 3.3.45]

Public Comment No. 218-NFPA 660-2024 [Section No. A.3.3.45]

Public Comment No. 221-NFPA 660-2024 [Section No. A.3.3.45.2]

Public Comment No. 226-NFPA 660-2024 [Section No. 3.3.45]

Public Comment No. 220-NFPA 660-2024 [Section No. A.3.3.45.1]

Public Comment No. 223-NFPA 660-2024 [Section No. 3.3.45]

Public Comment No. 228-NFPA 660-2024 [Section No. 3.3.45.1]

Second Revision No. 78-NFPA 660-2024 [Section No. 3.3.59]

3.3.55 Grounded (Grounding) .

~~The process of connecting a conductive object to the ground, so that the object is at zero (0) electrical potential; also referred to as *earthing* .~~ [~~**77,** 2019~~] Connected (connecting) to ground or to a conductive body that extends the ground connection. [**70,** 2023] (CMD-FUN)

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Mon Feb 26 08:57:23 EST 2024

Committee Statement

Committee Statement: This revision updates extracted text in accordance with the Extract Policy. NFPA 77 now extracts this definition from NFPA 70 (NEC). For substantiation on any changes, see the first and second draft reports for the source document.

Response Message: SR-78-NFPA 660-2024

Second Revision No. 13-NFPA 660-2024 [New Section after 3.3.66]

3.3.63* Ignitible Liquid.

Any liquid or liquid mixture that has a measurable closed-cup flash point. [**30**, 2024] (CMD-FUN)

A.3.3.63 Ignitible Liquid.

Class I liquids [FP < 100°F (37.8°C)] and Class II and Class III liquids [FP ≥ 100°F (37.8°C)] are all ignitible liquids. (See Annex B of NFPA 30 for more information.) (CMD-FUN)

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Tue Feb 20 18:51:30 EST 2024

Committee Statement

Committee Statement: The definition of ignitible liquid is being extracted from NFPA 30 to explain terminology used in this standard.

Response Message: SR-13-NFPA 660-2024

Public Comment No. 38-NFPA 660-2023 [New Section after 3.3.66]

Second Revision No. 14-NFPA 660-2024 [New Section after 3.3.76]

3.3.74 Management of Change (MOC).

A management system that requires the evaluation of proposed changes to process materials, staffing, job tasks, technology, equipment, procedures, and facilities to evaluate the potential safety significance of the change, to identify any additional needed safety controls, and to identify changes to other management systems required to safely implement the change. (See A.8.11.1) (CMD-FUN)

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 10:04:00 EST 2024

Committee Statement

Committee Statement: Adding this definition is important to the user understanding and properly applying the requirements in 8.12.

Response Message: SR-14-NFPA 660-2024

Public Comment No. 292-NFPA 660-2024 [New Section after 3.3.76]

Second Revision No. 42-NFPA 660-2024 [New Section after 3.3.90]

3.3.89 Operational Readiness Review.

A management system to verify that all required conditions exist and required safety tasks have been completed so that new, modified, or formerly idled facilities can be safely started up. (CMD-FUN)

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 18:01:47 EST 2024

Committee Statement

Committee Statement: A definition of Operational Readiness Review is needed in conjunction with the changes to 8.13.

Response Message: SR-42-NFPA 660-2024

Public Comment No. 298-NFPA 660-2024 [New Section after 3.3.90]

Second Revision No. 16-NFPA 660-2024 [Section No. 4.2.1.1]

4.2.1.1*

The facility, processes, and equipment shall be designed, constructed, equipped, and maintained and management systems shall be implemented to reasonably protect occupants not in the immediate proximity of the ignition from the effects of fire or explosion for the time needed to evacuate, relocate, or take refuge.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 10:28:55 EST 2024

Committee Statement

Committee Statement: This incorporates language from Chapter 15 to include explosions as it has been deemed fundamental.

Response Message: SR-16-NFPA 660-2024

Public Comment No. 40-NFPA 660-2023 [New Section after 4.2.5]

Second Revision No. 85-NFPA 660-2024 [Section No. 4.2.4]

4.2.4 Compliance Options.

The objectives in Section 4.2 shall be deemed to have been met by implementing both of the following:

(1) The prescriptive requirements in Chapters 5, 7, and 8

(2)* A hazard management program in conformance with the prescriptive requirements of Chapter 9and the prescriptive hazard management requirements of the relevant industry- or commodity-specific chapter, or that meets the objectives of ~~a Chapter 9 requirement~~ Chapter 4 and the relevant industry- or commodity-specific chapter through a performance-based design in accordance with Chapter 6

A.4.2.4(2)

Usually a facility or process system is designed using the prescriptive criteria until a prescribed solution is found to be infeasible or impracticable. Then the designer can use the performance-based option to develop a design, addressing the full range of fire, flash fire, and explosion scenarios and the impact on other prescribed design features. Consequently, facilities are usually designed not by using performance-based design methods for all facets of the facility but rather by using a mixture of both design approaches as needed. Refer to Chapters 11 , 12 , 13 , 14 , and 15 for the prescriptive hazard management requirements in the relevant industry- or commodity-specific chapters.

Supplemental Information

File Name	Description	Approved
660_SR_85_4.2.4.docx		
660_SR_85_4.2.4.docx	For prod use	

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Mon Feb 26 09:57:50 EST 2024

Committee Statement

Committee Statement: This section previously did not make reference to the hazard management program requirements in the industry or commodity-specific chapters.

Response Message: SR-85-NFPA 660-2024

Public Comment No. 7-NFPA 660-2023 [Section No. 4.2.4]

Public Comment No. 39-NFPA 660-2023 [Section No. 4.2.4]

Second Revision No. 17-NFPA 660-2024 [New Section after 4.2.6]

4.2.7

Where an industry- or commodity-specific chapter addresses hazards not associated with combustible dusts or particulate solids, those hazards shall be managed in accordance with this standard.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 10:55:00 EST 2024

Committee Statement

Committee Statement: This addresses the hazards covered by other chapters, such as liquid sulfur, sulfur vapor, thermal oil heating systems, and molten metals.

Response Message: SR-17-NFPA 660-2024

Public Comment No. 41-NFPA 660-2023 [Section No. 4.2.5]

Second Revision No. 82-NFPA 660-2024 [Section No. 5.3]

5.3* Self-Heating and Reactivity Hazards. ~~(Reserved)~~

Where self-heating, thermal instability, water reactivity, or chemical reactivity hazards exist, the process, storage, and transport conditions shall be controlled to prevent a fire, explosion, or toxic exposure.

A.5.3

Some materials have multiple potential physical hazards such as combustibility, explosibility, reactivity, and propensity to self-heat. ~~This standard does not specifically address reactivity hazards of solid particulate materials.~~ Reactivity hazards can release energy and produce products that are more readily ignitible than the original material, thus creating or exacerbating a combustion hazard that would be within the scope of a DHA. Reactivity of combustible particulates by means other than self-heating could occur due to thermal instability or contact with an incompatible material. The ensuing chemical reaction could generate heat and gases, and the gases generated could be toxic, corrosive, or flammable.

Identification of potential incompatibility with water should be a high priority because humidity in the air might be sufficient to initiate reactions with materials that are incompatible with water. The need to know whether to avoid material contact with water is important, since water is often present at the site for process use, cleaning, utility use, or emergency response. Water is often the first choice as a fire extinguishing agent, so knowing whether to use or avoid water when extinguishing fires is critical.

Users should consult safety data sheets (SDS) for specific information and guidance on safe handling, personal protective equipment (PPE), and storage and transportation of chemicals.

5.3.1 Self-Heating Hazard Evaluations.

5.3.1.1

A documented self-heating hazard evaluation shall be performed where one or more of the following conditions is present:

(1) Bulk storage or transport of combustible particulate solids in quantities of 1,000 kg (2,203 lb) or larger

(2) More than 10 kg (22 lb) of material is present in dryer discharge bins and hoppers at elevated temperatures

(3) A potential self-heating scenario has been identified in the DHA

5.3.1.2

The self-heating hazard evaluation method shall be according to 5.3.1.2.1 or according to 5.3.1.2.2 and 5.3.1.2.3 .

5.3.1.2.1

A documented review shall be conducted of experience storing and transporting the bulk material in quantities comparable to or larger than those used in the facility, at temperatures comparable to or higher than the expected storage or transport temperatures, and for durations comparable to or longer than the expected storage or transport duration.

5.3.1.2.2*

Laboratory tests shall be conducted to determine self-heating potential and rate.

A.5.3.1.2.2

A typical protocol involves using at least two different size baskets of representative particulate in an oven at several specified temperatures and with temperature sensors in the basket, to determine if and when the particulate temperature exceeds the oven temperature. One commonly used version of the oven basket tests for self-heating is UN Test N.4, "Test Method for Self-heating Substances" in *Recommendations for the Transport of Dangerous Goods: Model Regulations — Manual of Tests and Criteria* , which is used to determine if a material should be designated as Division 4.2, "Substances Liable to Spontaneous Combustion." BS EN 15188, *Determination of the spontaneous ignition behavior of dust accumulations* , is another widely used version of oven basket tests.

5.3.1.2.3*

A theoretically based scaling analysis shall be conducted using the laboratory test data to determine the critical temperatures for self-heating at the scale being used at the facility.

A.5.3.1.2.3

As a simple example, the UN Test N.4 data analysis method designates a material as a self-heating substance if a 100 mm (3.9 in.) sample undergoes self-heating in an oven at 140°C (284°F). More general data analysis methods are described, for example, in J. C. Jones's article, "Recent Developments and Improvements in Test Methods for Propensity Towards Spontaneous Heating," in *Fire and Materials* .

Detail SR-72

5.3.2 Thermal Instability Hazard Evaluations.

5.3.2.1

A thermal instability hazard evaluation shall be conducted when one or more of the following conditions exist:

(1) More than 1,000 kg (2,200 lbs.) of combustible particulate are stored for longer than 8 hours in a bin or hopper or bulk pile at a temperature higher than 30°C (104°F).

(2) More than 100 kg (220 lbs.) of particulate product are in an oven or dryer for more than 1 hour.

(3) A scenario where heated material can reside for extended periods of time in process equipment has been identified in the DHA.

5.3.2.2

The thermal instability hazard evaluation method shall be according to either 5.3.2.2.1 or 5.3.2.2.2 .

5.3.2.2.1

A documented review of pertinent reactivity literature, safety data sheets, and operating experience shall be conducted, identifying the reactivity of the material, thermal decomposition onset temperature, and, where possible, the reaction byproducts including gases that could be toxic, corrosive, or flammable.

5.3.2.2.2*

Temperature sensitivity testing shall be conducted at temperatures that would correspond to the highest possible temperature the material could attain based on exposure conditions determined from the DHA.

5.3.3 Water Reactivity Hazard Evaluations.

5.3.3.1

A water reactivity hazard evaluation shall be conducted when one or both of the following conditions exist:

(1) A water-based fire suppression system is used for the combustible particulate material.

(2) Particulate product or dust is exposed to process water, condensed water vapor, or outdoor precipitation.

5.3.3.2

The water reactivity hazard evaluation method shall be according to either 5.3.3.2.1 or 5.3.3.2.2 .

5.3.3.2.1*

A documented review of pertinent reactivity literature, reactivity screening software, and operating experience shall be conducted, identifying the reactivity of the material and, where possible, the reaction byproducts including gases that could be toxic, corrosive, or flammable.

5.3.3.2.2

Water reactivity testing shall be conducted using the UN *Recommendations on the Transport of Dangerous Goods, Model Regulations — Manual of Tests and Criteria* water reactivity Test N.5 for potential Division 4.3 water-reactive materials that emit flammable gases, or another test acceptable to the AHJ.

5.3.4 Chemical Reactivity Hazard Evaluations.

5.3.4.1

A chemical reactivity hazard evaluation shall be conducted when particulate product or dust could be exposed to an incompatible material or a reactivity scenario has been otherwise identified in the DHA.

5.3.4.2

The chemical reactivity hazard evaluation method shall be according to either 5.3.4.2.1 or 5.3.4.2.2 .

5.3.4.2.1

A documented review of pertinent reactivity literature, reactivity screening software, and operating experience shall be conducted, identifying the reactivity of the material and, where possible, the reaction byproducts including gases that could be toxic, corrosive, or flammable. *(See A.5.3.3.2.1 .)*

5.3.4.2.2*

Calorimetry testing shall be used for determining potential chemical reactivity hazards.

Supplemental Information

File Name	Description	Approved
660_SR_82_5.3.docx		
660_SR-82_5.3.docx	For prod use	

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Mon Feb 26 09:18:45 EST 2024

Committee Statement

Committee Statement:	This section has been reserved without content in the existing and previous editions of 652. The threshold quantities for evaluating self heating are conservatively low reflections of experience with incidents and with some formal experimental evaluations. The purpose of this section is to identify the potential for such hazards so that the DHA can evaluate suitable mitigations.
Response Message:	SR-82-NFPA 660-2024

Second Revision No. 18-NFPA 660-2024 [Section No. 6.1.2]

6.1.2

It shall be permitted to use performance-based alternative designs for a process or part of a process, specific material, or piece of equipment in lieu of the prescriptive requirements found in Chapter 9 and the prescriptive requirements of the relevant industry- or commodity-specific chapter . *[See A.4.2.4(2).]*

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 11:13:43 EST 2024

Committee Statement

Committee Statement: Similar to the change made in 4.2.4, this revision has been made because the section did not reference the hazard management program requirements in the industry or commodity-specific chapters.

Response Message: SR-18-NFPA 660-2024

Public Comment No. 42-NFPA 660-2023 [Section No. 6.1.2]

Second Revision No. 19-NFPA 660-2024 [Section No. 6.3.4]

6.3.4 Mitigation of Fire Spread, ~~of Fires, Flash Fires, and Explosions~~ Explosions, or Releases of Hazardous Materials .

When limitation of fire, flash fire, and explosion spread is to be achieved, all of the following criteria shall be demonstrated:

(1) Adjacent combustibles shall not attain their ignition temperature.

(2) Building design and housekeeping shall prevent combustibles from accumulating exterior to the enclosed process system to a concentration that is capable of supporting propagation.

(3) Particulate processing systems shall prevent fire, flash fire, or explosion from propagating from one process system to an adjacent process system or to the building interior.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 11:17:25 EST 2024

Committee Statement

Committee Statement: The title of 6.3.4 is being revised to match 4.2.3 as revised at the First Draft stage. The other titles in 6.3 match the objectives in 4.2.

Response Message: SR-19-NFPA 660-2024

Public Comment No. 43-NFPA 660-2023 [Section No. 6.3.4]

Second Revision No. 21-NFPA 660-2024 [Section No. 7.2.3]

7.2.3* Documentation.

~~The results of the DHA review shall be documented, including any necessary action items requiring change to the process materials, process operations, equipment, safety systems, or facilities associated with the process.~~

7.2.3.1

The results of the DHA review shall be documented, including any necessary action items requiring change to the process materials, process operations, equipment, safety systems, or facilities associated with the process.

7.2.3.2

The results of the DHA shall be maintained for the life of the process.

Supplemental Information

File Name	Description	Approved
660_SR-21_7.2.3.docx		

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 11:25:01 EST 2024

Committee Statement

Committee Statement: The text added as 7.2.3.2 was previously included in an industry-specific chapter and has been deemed fundamental.

The text previously under 7.2.3 was moved to a new 7.2.3.1 subsection.

Response Message: SR-21-NFPA 660-2024

Public Comment No. 44-NFPA 660-2023 [Section No. 7.2.3]

Second Revision No. 22-NFPA 660-2024 [Section No. 8.1]

8.1* Retroactivity.

This chapter shall be applied retroactively to new and existing facilities and processes where the DHA has determined that a combustible dust or particulate solid fire, flash fire, or explosion hazard exists .

A.8.1

The DHA will determine where fire, flash fire, or explosion hazards exist in process equipment or in building compartments. However, such hazards might not exist uniformly throughout a facility. Certain requirements in this chapter would not be mandatory for equipment or building compartments where the DHA has determined that a fire, flash fire, or explosion hazard does not exist. However, consideration should be given to generally applying a particular requirement when a fire, flash fire, or explosion hazard exists in at least a portion of the facility. For example, operating procedures would be required for equipment where a fire, flash fire, or explosion hazards exist. Rather than seeking to discriminate between those items of equipment that do, or do not, require operating procedures, the owner/operator might find it more effective to provide operating procedures for all process equipment.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 11:41:07 EST 2024

Committee Statement

Committee Statement: Chapter 8 does not apply unless the DHA has identified that a fire, flash fire, or explosion hazard exists. There is no need to emphasize that point for any one particular requirement. However, to reinforce where Chapter 8 applies, Section 8.1 a "DHA phrase" has been added to clarify the role of the DHA and subsequent application of the Chapter 8 requirements.

Response Message: SR-22-NFPA 660-2024

Public Comment No. 139-NFPA 660-2024 [Section No. 8.1]

Second Revision No. 23-NFPA 660-2024 [New Section after 8.3.1]

8.3.2*

Operating and maintenance procedures shall address personal protective equipment (PPE), including flame-resistant garments, in accordance with the workplace hazard assessment required by Section 8.6 .

A.8.3.2

Where a dust explosion hazard or dust flash-fire hazard exists, flame-resistant garments provide a measure of protection for exposed personnel.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 11:45:24 EST 2024

Committee Statement

Committee Statement: This was previously included in an industry-specific chapter and has been deemed fundamental.

Response Message: SR-23-NFPA 660-2024

Public Comment No. 45-NFPA 660-2023 [Section No. 8.3]

Public Comment No. 47-NFPA 660-2023 [New Section after 8.3.1]

Second Revision No. 25-NFPA 660-2024 [Section No. 8.3.1]

8.3.1*

~~Where the DHA identifies a combustible dust or particulate solid fire, flash fire, or explosion hazard, the~~ The owner/operator shall establish written procedures for operating its facility and equipment to prevent or mitigate fires, flash fires, and explosions from combustible dusts or combustible particulate solids.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 12:29:43 EST 2024

Committee Statement

Committee Statement: Chapter 8 does not apply unless the DHA has identified that a fire, flash fire, or explosion hazard exists. There is no need to emphasize that point for any one particular requirement. Therefore, the phrase "where the DHA identifies a combustible dust or particulate solid fire, flash fire, or explosion hazard" is unnecessary.

Response Message: SR-25-NFPA 660-2024

Public Comment No. 138-NFPA 660-2024 [Section No. 8.3.1]

Second Revision No. 24-NFPA 660-2024 [New Section after 8.3.4]

8.3.6

The owner/operator shall perform a documented review of operating procedures as often as necessary, but at least annually, to ensure that they remain current and accurate.

Submitter Information Verification

Committee: CMD-FUN
Submittal Date: Wed Feb 21 11:53:45 EST 2024

Committee Statement

Committee Statement: Review of operating procedures has been added at a time frame that is consistent with OSHA requirements.
Response Message: SR-24-NFPA 660-2024

Public Comment No. 46-NFPA 660-2023 [Section No. 8.3]

Second Revision No. 26-NFPA 660-2024 [Section No. 8.4.2.1.2]

8.4.2.1.2*

The methods used for cleaning surfaces shall be selected on the basis of reducing the potential for creating a combustible dust cloud.

8.4.2.1.2.1

Vacuuming shall be the preferred method of cleaning.

8.4.2.1.2.2

Where vacuuming is impractical, permitted cleaning methods shall include sweeping and water washdown.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 12:36:11 EST 2024

Committee Statement

Committee Statement: This was previously included in an industry-specific chapter and has been deemed fundamental.

Response Message: SR-26-NFPA 660-2024

Public Comment No. 48-NFPA 660-2023 [New Section after 8.4.2.1.2]

Second Revision No. 27-NFPA 660-2024 [Section No. 8.4.2.2.1.3]

8.4.2.2.1.3*

~~The operation of~~ Where used, portable vacuum cleaning devices shall be ~~subject to a dust hazards analysis to ensure that the risk to personnel and facility operations from fires, flash fires, or explosions is minimized~~ incorporated into the DHA .

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 12:42:36 EST 2024

Committee Statement

Committee Statement: A statement to ensure that portable vacuum cleaning equipment is included in the DHA is needed because vacuums are often overlooked as part of a DHA.

Response Message: SR-27-NFPA 660-2024

Public Comment No. 140-NFPA 660-2024 [Section No. 8.4.2.2.1.3]

Second Revision No. 28-NFPA 660-2024 [Section No. 8.4.2.2.1.8]

8.4.2.2.1.8*

Portable vacuum cleaners that meet the following minimum requirements shall be permitted to be used to collect combustible particulate solids in unclassified locations:

(1) Materials of construction shall comply with 9.6.6.1.

(2) Hoses shall be conductive or static dissipative.

(3) All conductive and static dissipative components, including wands and attachments, shall be bonded and grounded.

(4) The fan or blower shall be on the clean side of the primary filtration media or wet separation chamber.

(5) The vacuum cleaner shall not be operated without filter media in place.

(6) Electrical motors shall not be located on the dirty side of the primary filtration media or wet separation chamber unless listed for Class II or Class III, Division 1, as appropriate, or Zone 20 or Zone 21 locations.

(7)* Where liquids or wet materials are picked up by the vacuum cleaner, paper filter elements shall not be used.

A.8.4.2.2.1.8

The intention of this requirement is to provide specifications for vacuum cleaners that could be used to remove incidental amounts of combustible dusts from unclassified areas in order to maintain the unclassified area designation.

If a large quantity of material is spilled in an unclassified area, the bulk material should be collected by sweeping or shoveling or with a portable vacuum cleaner listed as suitable for combustible dust hazardous (classified) locations. Vacuum cleaners meeting the requirements in 8.4.2.2.1 can be used to clean up residual material after the bulk of the spill has been collected.

Supplemental Information

File Name	Description	Approved
660_SR_28_8.4.2.2.1.8.docx		

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 13:05:33 EST 2024

Committee Statement

Committee Statement: This was previously included in an industry-specific chapter and has been deemed fundamental. The other items in 15.8.4.2.2.1 have not been added because they are covered by list item (4).

Response Message: SR-28-NFPA 660-2024

Public Comment No. 49-NFPA 660-2023 [Section No. 8.4.2.2.1.8]

Second Revision No. 30-NFPA 660-2024 [New Section after 8.5.2]

8.5.3

The area affected by the work shall be free from visible airborne combustible dust.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 13:24:07 EST 2024

Committee Statement

Committee Statement: This was previously included in an industry-specific chapter and has been deemed fundamental. Adding the word "visible" makes the requirement qualitative and avoids the absolute requirement.

Response Message: SR-30-NFPA 660-2024

Public Comment No. 51-NFPA 660-2023 [Section No. 8.5.6]

Second Revision No. 32-NFPA 660-2024 [Section No. 8.6.1.2]

8.6.1.2*

Flame-resistant garments shall not be permitted to be the sole safeguard against a propagating deflagration through suspended dust accumulations throughout a building compartment.

A.8.6.1.2

Where the maximum foreseeable thermal dose exceeds 252 kJ/m^2, FRG designed in accordance with NFPA 2112 cannot prevent burn injury of exposed personnel.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 15:13:54 EST 2024

Committee Statement

Committee Statement: This annex is needed to explain that since the thermal dose management capacity of FRG is limited to 252 kJ/m2, the facility operator cannot be permitted to rely on it for personnel safety in those portions of the facility where the hazard exceeds the ability of the management means.

Response Message: SR-32-NFPA 660-2024

Public Comment No. 196-NFPA 660-2024 [New Section after 8.6.1.2]

Second Revision No. 33-NFPA 660-2024 [Section No. 8.7.1]

8.7.1*

Equipment affecting the prevention, control, and mitigation of combustible dust fires, flash fires, and explosions shall be inspected, tested, and maintained in accordance with one of the following: ~~applicable NFPA standard and the manufacturers' recommendations.~~

(1) The applicable NFPA standard and the manufacturers' recommendations~~.~~

(2) Where there is no applicable NFPA standard, the manufacturers' recommendations as modified by operational experience

Supplemental Information

File Name	Description	Approved
660_SR-33_8.7.1.docx		

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 15:20:26 EST 2024

Committee Statement

Committee Statement: This was previously included in an industry-specific chapter and has been deemed fundamental.

Response Message: SR-33-NFPA 660-2024

Public Comment No. 52-NFPA 660-2023 [Section No. 8.7.1]

Second Revision No. 34-NFPA 660-2024 [New Section after 8.7.6]

8.7.7

A qualified person shall conduct inspection and testing, then document the findings and recommendations.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 15:32:12 EST 2024

Committee Statement

Committee Statement: This was previously included in an industry-specific chapter and has been deemed fundamental.

Response Message: SR-34-NFPA 660-2024

Public Comment No. 53-NFPA 660-2023 [New Section after 8.7.6]

Second Revision No. 76-NFPA 660-2024 [Sections 8.8.1, 8.8.2, 8.8.3]

8.8.1*

Employees, contractors, temporary workers, and visitors shall be included in a training program according to the potential exposure to combustible dust hazards and the potential risks to which they might be exposed or could cause.

~~**8.8.2**~~

~~The training provided shall include instruction on actions to be taken in the event of an emergency to prevent or minimize the effects of exposure to fires, flash fires, and explosions, including information on safe evacuation routes in accordance with 8.10.1 .~~

8.8.2*

General safety training and hazard awareness training for combustible dusts and solids shall be provided to all affected employees~~.~~ , to include the following elements:

(1) The hazards present in the working environment

(2) Emergency response plans, including evacuation routes

(3) Site safety rules

8.8.2.1*

Job-specific training shall ensure that employees are knowledgeable about fire, flash fire, and explosion hazards of combustible dusts and particulate solids in their work environment~~.~~ , including the following elements as applicable:

(1) Hazards specific to the work area and equipment, including hazards associated with fire and explosion suppression equipment

(2) Equipment operation procedures, including safe start-up/shutdown, response to upset conditions, and emergency shutdown

(3) Inspection, testing, and maintenance procedures

(4) The necessity for proper functioning of related fire and explosion protection systems

(5) Procedures in response to emergencies, including emergency notification and permissible methods for fighting incipient fires in the work area

(6) The location and operation of fire protection equipment, manual pull stations and alarms, emergency phones, first-aid supplies, and safety equipment

(7) Safe handling, use, storage, and disposal of hazardous materials

(8) Housekeeping requirements including proper cleaning methods

(9) Personal protective equipment requirements and proper use

(10) Reporting of incidents

A.8.8.2.1

Safe work habits are developed and do not occur naturally. The training program should provide enough background information regarding the hazards of the materials and the process so that the employees can understand why it is important to follow the prescribed procedures. ~~Training should address the following:~~

- ~~The hazards of their working environment and procedures in case of emergencies, including fires, flash fires, and explosions, and hazardous materials releases~~
- ~~Operating, inspection, testing, and maintenance procedures applicable to their assigned work~~
- ~~Normal process procedures as well as emergency procedures and changes to procedures~~
- ~~Emergency response plans, including safe and proper evacuation of their work area and the permissible methods for fighting incipient fires in their work area~~
- ~~The necessity for proper functioning of related fire and explosion protection systems~~
- ~~Safe handling, use, storage, and disposal of hazardous materials used in the employees' work areas~~
- ~~The location and operation of fire protection equipment, manual pull stations and alarms, emergency phones, first-aid supplies, and safety equipment~~
- ~~Equipment operation, safe start-up and shutdown, and response to upset conditions~~

8.8.2.2

Employees shall be trained before taking on job-related responsibilities.

8.8.2.3*

Where explosion protection systems or emergency shutdown systems are installed, training of affected personnel shall include the operations and potential hazards presented by such systems.

Supplemental Information

File Name	Description	Approved
660_SR_76_8.8.1_-_8.8.3.docx		
660_SR_76_8.8.1_-_8.8.3.docx	For prod use	

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 16:39:14 EST 2024

Committee Statement

Committee Statement: Training requirements that were contained in multiple industry- or commodity-specific chapters were deemed fundamental and consolidated here.

Response Message: SR-76-NFPA 660-2024

Public Comment No. 54-NFPA 660-2023 [Section No. 8.8]

Second Revision No. 35-NFPA 660-2024 [Section No. 8.8.4]

8.8.3

Refresher training shall be provided at least every three years after initial training or as required by the applicable industry- or commodity-specific chapters of this standard, whichever is shorter .

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 15:55:10 EST 2024

Committee Statement

Committee Statement: A minimum frequency of refresher training needs to be established as a fundamental. Many of the commodity specific chapters still do not presently address a minimum frequency for refresher training. The other chapters can then establish a shorter minimum frequency in accordance with the Conflict language in 1.6.

Response Message: SR-35-NFPA 660-2024

Public Comment No. 204-NFPA 660-2024 [Section No. 8.8.4]

Second Revision No. 36-NFPA 660-2024 [Sections 8.9.3.3, 8.9.3.4, 8.9.3.5, 8.9.3.6]

8.9.3.3*

Contractors working on or near a given process shall be made aware of the potential hazards from and exposures to fires, flash fires, and explosions.

8.9.3.4

Contractors shall be trained and required to comply with the facility's safe work practices and policies in accordance with 8.3.4.

8.9.3.5

Contractors shall be trained on the facility's emergency response and evacuation plan, including, but not limited to, emergency reporting procedures, safe egress points, and evacuation area.

8.9.3.6

Contractors shall receive refresher training annually.

8.9.3.7

Contractor training shall be documented.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 16:07:48 EST 2024

Committee Statement

Committee Statement: The statement for refresher training was previously included in an industry-specific chapter and has been deemed fundamental.

The other statements have been reordered so that the requirement for documentation comes at the end of the training content requirements.

Response Message: SR-36-NFPA 660-2024

Public Comment No. 55-NFPA 660-2023 [Section No. 8.9]

Second Revision No. 70-NFPA 660-2024 [Section No. 8.10]

10.1 Emergency ~~Planning and~~ Response Plan .

10.1.1*

A written emergency response plan shall be developed for preparing for and responding to work-related emergencies including, but not limited to, fires, flash fires, and explosions.

10.1.1.1

The emergency response plan shall be available on-site or electronically.

Detail SR-68

10.1.1.2

The emergency response plan shall include, but not be limited to, the following:

(1)* A means of notification for occupants in the event of fire and explosion

(2) A preplanned evacuation assembly area

(3) A person(s) designated to notify emergency responders, including the fire department

(4) A facility layout drawing(s) showing egress routes, hazardous chemical locations, and fire protection equipment

(5) Location of a safety data sheet(s) for hazardous chemicals

(6) An emergency telephone number(s)

(7) Emergency response duties for occupants

(8) A person(s) designated to meet the offsite emergency responder(s) to coordinate the incident

10.1.2

The emergency response plan and procedures shall be reviewed and validated at least annually and as required by process changes.

10.1.3

The emergency response plan shall be shared with relevant local community officials and emergency response agencies.

10.2 Reserved.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 12:52:23 EST 2024

Committee Statement

Committee Statement: Requirements are being relocated from 8.10 to Chapter 10, and additional provisions will eventually be relocated from other chapters to create a consolidated chapter.

Response Message: SR-70-NFPA 660-2024

Second Revision No. 39-NFPA 660-2024 [Sections 8.11.2, 8.11.3, 8.11.4, 8.11.5]

8.10.2*

Events that could have resulted in fires, flash fires, or explosions under different circumstances but where property losses or injuries were not experienced shall be investigated.

A.8.10.2

In addition to investigation of fires, flash fires, and explosions, it is also a good practice to investigate near misses (events that could have resulted in fires, flash fires, or explosions under different circumstances) and all activations of active fire and explosion mitigation systems. It is important to educate facility personnel on the concept of what a near miss is and to clearly communicate their responsibility for reporting both incidents and near misses.

Near-miss events often indicate an underlying problem that should be corrected. ~~See Chapter 15 for additional information.~~ Barriers to reporting should be removed, as described in ANSI/AIHA Z10, *Occupational Health and Safety Management Systems*. Investigations should include workers and their representatives, as appropriate.

8.10.3

Once the scene has been released to the owner/operator, incident investigations shall be promptly initiated by management personnel or by a designee who has a working knowledge of the facility and processes.

8.10.4*

~~The investigation shall be documented and include findings and recommendations.~~ A written report of the investigation shall be prepared that describes the incident, lists what has been learned from the investigation, and makes recommendations to prevent reoccurrence of that or similar incidents.

A.8.10.4

Incident reports should include the following information:

(1) Date of the incident

(2) Location of the incident and equipment/process involved

(3) Description of the incident, contributing factors, and the suspected cause

(4) Operation of automatic/manual fire protection systems and emergency response

(5) Any recommendations and corrective actions taken or to be taken to prevent a reoccurrence

8.10.5

A system shall be established to address and resolve the findings and recommendations.

8.10.6*

The investigation findings and recommendations shall be reviewed with affected personnel.

A.8.10.6

The term *affected personnel* is intended to include members of employee organizations such as safety committees and employee representatives of various types.

The incident report should also be reviewed with appropriate management personnel and retained on file for future reference. Incident reports are useful in support of the periodic DHA required by 7.1.4 . The owner/operator should consider retaining the incident investigation reports for at least 5 years to be consistent with the DHA review schedule.

The owner/operator should consider sharing relevant learnings with other facilities within the company.

Supplemental Information

File Name	Description	Approved
660_SR_39_8.11.2-8.11.5.docx		
660_SR_39_8.11.2-8.11.5.docx	For prod use	

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 16:45:27 EST 2024

Committee Statement

Committee Statement: This was previously included in an industry-specific chapter and has been deemed fundamental.

Response Message: SR-39-NFPA 660-2024

Public Comment No. 56-NFPA 660-2023 [New Section after 8.11.3]

Second Revision No. 41-NFPA 660-2024 [Section No. 8.13]

8.12* ~~Pre-Startup Safety~~ Operational Readiness Review (ORR) .

A.8.12

An ORR is intended to ensure that, before start-up, a facility is mechanically ready, related management systems (e.g., procedures, training, and inspection, testing, and preventive maintenance programs) have been updated, and personnel are prepared to safely start-up and operate the facility.

8.12.1*

The owner/operator shall perform ~~a pre-startup safety~~ an operational readiness review ~~for new facilities and for modified facilities when the modification is significant enough to require change in the process and technology information required by 8.14.1(5)~~ . before the start-up of the following:

(1) New facilities

(2) Modified facilities when the modification is significant enough to require change in the process and technology information required by 8.13.1(5)

(3) Facilities that have been shut down for minor maintenance activities

(4) Facilities that are periodically shut down as part of normal operations

(5)* Facilities that have been shut down for extended periods of time

A.8.12.1(5)

An example of such a shutdown would be a facility that has been idled for an extended period (e.g., months or longer) for business reasons. Such a facility might be returned to service with little or no modification. However, changes in associated facilities, changes in feed specifications, changes in risk control requirements, potential degradation of equipment, and so forth, might warrant a detailed review, including a DHA update, before the facility is returned to service. Another example would be facilities that have been shut down for major maintenance activities.

A.8.12.1

The owner/operator should consider extending the coverage of the ORR program to include other types of shutdowns such as, but not limited to, emergency shutdowns and precautionary shutdowns in anticipation of external events such as severe storms. The intent of the ORR program is that any facility that has been shut down will receive a review, the scope of which is commensurate with the nature and duration of the shutdown, before the facility is returned to service. See the CCPS *Guidelines for Risk Based Process Safety* .

~~**8.12.2**~~

~~The pre-startup safety review shall confirm the following prior to the operation of a process:~~

~~Construction and equipment are in accordance with design specifications.~~

~~Safety, operating, maintenance, and emergency procedures are in place and are adequate.~~

~~For new facilities, a DHA has been performed and action items have been resolved or implemented before startup.~~

~~Modified facilities meet the requirements contained in Section~~ 8.12 ~~.~~

8.12.2*

The scope and detail of the operational readiness review shall consider the nature and duration of the shutdown and shall confirm the following prior to start-up of the facility:

(1) For new facilities:

(a) Construction and equipment are in accordance with design specifications.

(b) A DHA has been performed in conformance with Chapter 7, and action items have been resolved or implemented before startup.

(c) Accurate, up-to-date safety, operating (including startup), maintenance, and emergency procedures are in place.

(d) Affected personnel have been trained on relevant procedures.

(e) Inspection and testing of safety systems and equipment have been conducted.

(2) For modified facilities:

(a) A management of change review has been conducted in conformance with Section 8.11 , and action items have been resolved or implemented before startup.

(b) Construction and equipment are in accordance with design specifications.

(c) Accurate, up-to-date safety, operating (including startup), maintenance, and emergency procedures are in place.

(d) Affected personnel have been trained on relevant procedures.

(e) Inspection and testing of safety systems and equipment have been conducted.

(3) For facilities that have been shut down for minor maintenance:

(a) Construction and equipment are in accordance with design specifications.

(b) A joint inspection by maintenance and operations personnel has verified that the maintenance has been correctly completed.

(c) Accurate, up-to-date startup procedures are in place.

(4) For facilities that have been shut down as part of normal operations:

(a) A walk-through inspection has verified that the facility is ready for start-up.

(b) Accurate, up-to-date startup procedures are in place.

(5) For facilities that have been shut down for extended periods of time:

(a) A DHA has been performed or updated in conformance with Chapter 7, and action items have been resolved or implemented before startup.

(b) Construction and equipment are in accordance with design specifications.

(c) Accurate, up-to-date safety, operating (including startup), maintenance, and emergency procedures are in place.

(d) Affected personnel have been trained on relevant procedures.

(e) Inspection and testing of safety systems and equipment have been conducted.

A.8.12.2

The lists in 8.12.2 provide the basic requirements for the ORR for the various types of changes. Additional factors could be relevant to particular start-ups. The owner/operator should carefully assess the nature and duration of the shutdown and determine if additional confirmations are warranted for a safe start-up. Table A.8.12.2 provides a graphical representation of the lists.

Table A.8.12.2 Operational Readiness Review Requirements for Types of Shutdowns

Required Review Confirmations	For Shutdowns Described In				
	8.12.2(1)	8.12.2(2)	8.12.2(3)	8.12.2(4)	8.12.2(5)
Construction and equipment are in accordance with design specifications.	X	X	X		X
A DHA has been performed in conformance with Chapter 7, and action items have been resolved or implemented before startup.	X				X
Accurate, up-to-date safety, operating (including startup), maintenance, and emergency procedures are in place.	X	X			X
Accurate, up-to-date startup procedures are in place.			X	X	
Affected personnel have been trained on relevant procedures.	X	X			X
A management of change review has been conducted in conformance with Section 8.11, and action items have been resolved or implemented before startup.		X			
A joint inspection by maintenance and operations personnel has verified that the maintenance has been correctly completed.			X		
A walk-through inspection has verified that the facility is ready for start-up.				X	
Inspection and testing of safety systems and equipment have been conducted.	X	X			X

8.12.3*

The operational readiness review shall be documented and the documentation retained in conformance with 8.13.1(7) .

A.8.12.3

The extent of the ORR documentation should consider the nature and duration of the shutdown. For a maintenance shutdown the documentation could be signatures on the work order after a joint inspection by maintenance and operations. For a routine start-up of a facility that has been shut down as part of normal operations the documentation could be a completed start-up procedure. For new facilities, modified facilities, and facilities that are to start up after an extended outage, the documentation would likely be more extensive, incorporating one or more detailed checklists. To avoid making the documentation task burdensome, 8.13.1(7) only requires retention of documentation for these more detailed ORRs.

Supplemental Information

File Name	Description	Approved
660_SR_41_8.13.docx		
660_SR_41_8.13.docx	For prod use	

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 17:33:57 EST 2024

Committee Statement

Committee Statement: New, modified, or formerly idled facilities require a review prior to startup to verify that all required conditions exist and required safety tasks have been completed. This revision aligns the pre-startup safety review with the concept of an operational readiness review.

Response Message: SR-41-NFPA 660-2024

Public Comment No. 276-NFPA 660-2024 [Section No. 8.13]

Second Revision No. 43-NFPA 660-2024 [Section No. 8.14.1]

8.13.1

The owner/operator shall establish a program and implement a process to manage the retention of documentation, including, but not limited to, the following:

(1) Training records

(2) Equipment inspection, testing, and maintenance records

(3)* Incident investigation reports

(4)* Dust hazards analyses and resolution of DHA recommendations

(5)* Process and technology information

(6)* Management of change documents

(7) Operational readiness review documents for start-up associated with 8.12.2(1) , 8.12.2(2) , and 8.12.2(5) .

(8) Emergency response plan documents

(9)* Contractor records

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 18:04:24 EST 2024

Committee Statement

Committee Statement: The changes made to 8.13 create additional documentation that needs to be added to the list in 8.14.1. This is important documentation that needs to be retained.

Response Message: SR-43-NFPA 660-2024

Public Comment No. 288-NFPA 660-2024 [Section No. 8.14.1]

Second Revision No. 44-NFPA 660-2024 [Section No. 9.3.5.3.2]

9.3.5.3.2*

The required separation distance between the dust or particulate solid fire, flash fire, or explosion hazard area and surrounding exposures shall be determined by an engineering evaluation that addresses the following:

(1) Properties of the materials

(2) Type of operation

(3) Amount of material likely to be present outside the process equipment, including during abnormal or transient operations

(4) Building and equipment design

(5) Nature of surrounding exposures

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 18:17:53 EST 2024

Committee Statement

Committee Statement: The DHA sections that are referred to by section 9.3.5 do not limit the review of hazards to only normal operations. Further, the determination of separation distance should consider the potential for unexpected accumulations of combustible dust. As discussed in section 7.3.4.2.2, threshold housekeeping accumulation limit includes non-routine dust accumulations, which would come from upset or transient conditions. Furthermore, appendix A.8.4.6.3 states, "One example of a transient release of dust is a temporary loss of containment..." which would indicate that facilities need to account for transient or upset conditions when designing separation distances rather than design for an assumption of all operations will only function in a normal state.

Response Message: SR-44-NFPA 660-2024

Public Comment No. 206-NFPA 660-2024 [Section No. 9.3.5.3.2]

Second Revision No. 45-NFPA 660-2024 [Section No. 9.3.5.4.2]

9.3.5.4.2*

The required detachment distance between the dust flash fire or explosion hazard area and surrounding exposures shall be determined by a documented evaluation that addresses the following:

(1) Properties of the materials

(2) Type of operation

(3) Amount of material likely to be present outside the process equipment, including during abnormal or transient operations

(4) Building and equipment design

(5) Nature of surrounding exposures

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 18:19:35 EST 2024

Committee Statement

Committee Statement: The DHA sections that are referred to by section 9.3.5 do not limit the review of hazards to only normal operations. Further, the determination of separation distance should consider the potential for unexpected accumulations of combustible dust. As discussed in section 7.3.4.2.2, threshold housekeeping accumulation limit includes non-routine dust accumulations, which would come from upset or transient conditions. Furthermore, appendix A.8.4.6.3 states, "One example of a transient release of dust is a temporary loss of containment..." which would indicate that facilities need to account for transient or upset conditions when designing separation distances rather than design for an assumption of all operations will only function in a normal state.

Response Message: SR-45-NFPA 660-2024

Public Comment No. 207-NFPA 660-2024 [Section No. 9.3.5.4.2]

Second Revision No. 73-NFPA 660-2024 [Section No. 9.4.3.1.5]

9.4.3.1.3 Systems That Convey Hybrid Mixtures.

~~The~~ Where the combined percentage of the lower flammable limit (LFL) of flammable vapors and the percentage of the minimum explosible concentration (MEC) of combustible dusts~~, when combined, shall not~~ exceeds 25 percent within the airstream, ~~except for systems protected~~ protection shall be provided in accordance with 9.8.2.2(1) through 9.8.2.2(6).

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 15:40:28 EST 2024

Committee Statement

Committee Statement: The changes clarify requirements for conveying hybrid mixtures.

Response Message: SR-73-NFPA 660-2024

Second Revision No. 47-NFPA 660-2024 [Section No. 9.4.4.1.1]

9.4.4.1.1 ~~Collected Material Discharge.~~

The discharge conveying system shall be designed to handle the maximum material flow separated from the air stream.

9.4.4.1.2*

Controls shall be provided to prevent accumulation in the AMS that could interfere with the operation of the AMS or associated explosion protection systems.

A.9.4.4.1.2

The AMS should not be used as a combustible dust storage device due to the potential of bridging filling the unit to the point it will not function, possible inhibiting of the material discharge due to bridging and plugging of the discharge, and possible self-heating of some type of dusts. In addition, overfilling can interfere with the function of explosion prevention/ protection equipment. A rotary airlock valve or a rotary airlock valve and screw conveyor combination can be used to provide for continuous discharge of the separated dusts; alternatively, a slide valve can be used where dust loadings are light, provided that the material is removed frequently enough to prevent bridging and plugging. The container below the rotary valve or other continuous discharge device should be designed for the type of material collected and the typical rates of material collected and to minimize the creation of aerated dusts during the discharge of the material from the AMS into the container. It is also important to maintain regular emptying or replacement of the collected material container to minimize the risk of overfilling.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 18:43:05 EST 2024

Committee Statement

Committee Statement: This was previously included in an industry-specific chapter and has been deemed fundamental.

Response Message: SR-47-NFPA 660-2024

Public Comment No. 61-NFPA 660-2023 [Section No. 9.4.4.1]

Second Revision No. 48-NFPA 660-2024 [Section No. 9.4.4.7.2]

9.4.4.7.2*

Air/gas from AMSs shall be permitted to be recirculated directly back to the pneumatic conveying system.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 18:47:59 EST 2024

Committee Statement

Committee Statement: "Air/gas" is the terminology used elsewhere in the standard.

Response Message: SR-48-NFPA 660-2024

Public Comment No. 62-NFPA 660-2023 [Section No. 9.4.4.7.2]

Second Revision No. 3-NFPA 660-2024 [Section No. 9.4.4.7.3]

Detail SR-49

9.4.4.7.3*

Recycling of AMS exhaust to buildings or building compartments shall be permitted when all the following conditions are met:

(1) Gases or vapors are not present in either the intake or the recycled air in concentrations above applicable industrial hygiene exposure limits or 1 percent of the lower flammable limit (LFL), whichever is lower.

(2)* Combustible particulate solids are not present in the recycled air in concentrations above applicable industrial hygiene exposure limits ~~or 1 percent of the minimum explosible concentration (MEC), whichever is lower~~ .

(3)* The oxygen concentration of the recycled air stream is between 19.5 percent and 23.5 percent by volume.

(4) Provisions are incorporated to prevent transmission of flame and pressure effects from a deflagration in an AMS back to the facility unless a ~~DHA~~ risk assessment indicates that those effects do not pose a threat to the facility or the occupants.

(5) Provisions are incorporated to prevent transmission of smoke and flame from a fire in an AMS back to the facility unless a ~~DHA~~ risk assessment indicates that those effects do not pose a threat to the facility or the occupants.

(6) The system includes a method for detecting AMS malfunctions that would reduce collection efficiency and allow increases in the amount of combustible particulate solids returned to the building.

(7) The building or building compartment to which the recycled air is returned meets the housekeeping requirements of 8.4.6.

(8) Recycled-air ducts are inspected at least annually and cleaned if dust accumulations are present.

A.9.4.4.7.3

Recommended design, maintenance, and operating guidelines for recirculation of industrial exhaust systems, as described in ~~Section 11.8 of the ACGIH~~ the ACGIH publication, *Industrial Ventilation: A Manual of Recommended Practice*, should be followed.

When “clean air” is being returned to the facility interior, it is important to understand that the return air might contain some residual dust depending on the particulate capture effectiveness of AMS. Note also the need for evaluation of required oxygen level in return gas stream as well as possibility of toxicity of gas to personnel. Usually the filter media in a dust collector traps the large particles, but there might be very fine material that manages to get through the filter media and accumulates downstream within the clean air plenum and return air duct. A routine maintenance program is necessary to ensure that the clean air side of the dust collection system remains sufficiently clean to achieve the safety objectives of the standard. The use of HEPA secondary filters or particulate monitors can often reduce the frequency of inspection but should not be expected to eliminate it.

Supplemental Information

File Name	Description	Approved
660_SR-3_9.4.4.7.3.docx		

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Tue Feb 20 11:10:54 EST 2024

Committee Statement

Committee Statement: These changes will create more uniform and consistent language across the document where reference to recycling exhaust air occurs. The revised language moves away from a particular “filter media” and instead guides readers to reference the specific applicable industrial hygiene exposure limits related to their unique indoor environmental conditions.

Note: This SR-3 deletes "or 1 percent of the minimum explosible concentration (MEC), whichever is lower." and "Section 11.8 of". A separate Second Revision, SR-49, changes "DHA" to "risk assessment", and these are balloted separately.

Response Message: SR-3-NFPA 660-2024

Second Revision No. 50-NFPA 660-2024 [Sections 9.4.9.3.1, 9.4.9.3.2]

9.4.9.3.1

Where an explosion hazard exists ~~as determined by a DHA~~ , fixed bulk storage enclosures shall be located outside of buildings.

9.4.9.3.2

Fixed bulk storage enclosures with explosion hazards ~~as determined by a DHA~~ shall be permitted to be located inside buildings where one of the following applies:

(1) Fixed bulk storage enclosures are protected in accordance with 9.8.2.

(2)* Fixed bulk storage enclosures are less than 8 ft^3 (0.2 m^3).

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 18:54:18 EST 2024

Committee Statement

Committee Statement: The phrase "a DHA has determined" is unnecessary for the specified requirements and is somewhat redundant. This phrase is not needed since a hazard either exists or does not and the phrase does not add anything to the requirements.

Response Message: SR-50-NFPA 660-2024

Public Comment No. 145-NFPA 660-2024 [Sections 9.4.9.3.1, 9.4.9.3.2]

Second Revision No. 4-NFPA 660-2024 [Section No. 9.4.17.1.1.1]

Detail SR-51

9.4.17.1.1.1*

Recycling of exhaust from a dryer system to buildings or building compartments shall be permitted when all the following conditions are met:

(1) Gases or vapors are not present in either the intake or the recycled air in concentrations above applicable industrial hygiene exposure limits or 1 percent of the LFL, whichever is lower.

(2)* Combustible particulate solids are not present in the recycled air in concentrations above applicable industrial hygiene exposure limits ~~or 1 percent of the MEC, whichever is lower~~.

(3)* The oxygen concentration of the recycled air stream is between 19.5 percent and 23.5 percent by volume.

(4) Provisions are incorporated to prevent transmission of flame and pressure effects from a deflagration in a dryer system back to the facility unless a ~~DHA~~risk assessment indicates that those effects do not pose a threat to the facility or the occupants.

(5) Provisions are incorporated to prevent transmission of smoke and flame from a fire in a dryer system back to the facility unless a ~~DHA~~risk assessment indicates that those effects do not pose a threat to the facility or the occupants.

(6) The system includes a method for detecting and mitigating dryer system malfunctions that would allow increases in the amount of combustible particulate solids returned to the building.

(7) The building or building compartment to which the recycled air is returned meets the housekeeping requirements of 8.4.6.

(8) Recycled-air ducts are inspected at least annually and cleaned if dust accumulations are present.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Tue Feb 20 11:18:51 EST 2024

Committee Statement

Committee Statement: These changes will create more uniform and consistent language across the document where reference to recycling exhaust air occurs. The revised language moves away from a particular “filter media” and instead guides readers to reference the specific applicable industrial hygiene exposure limits related to their unique indoor environmental conditions.

Note: This SR-4 deletes "or 1 percent of the MEC, whichever is lower." A separate Second Revision, SR-51, changes "DHA" to "risk assessment", and these are balloted separately.

Response Message: SR-4-NFPA 660-2024

Second Revision No. 52-NFPA 660-2024 [Section No. 9.4.17.1.2]

9.4.17.1.2*

Where a ~~DHA has determined a~~ combustible dust hazard exists in the dryer or recycled air stream during the drying process, those hazards shall be controlled.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 18:57:17 EST 2024

Committee Statement

Committee Statement: The phrase "a DHA has determined" is unnecessary for the specified requirements and is somewhat redundant. This phrase is not needed since a hazard either exists or does not and the phrase does not add anything to the requirements.

Response Message: SR-52-NFPA 660-2024

Public Comment No. 147-NFPA 660-2024 [Section No. 9.4.17.1.2]

Second Revision No. 53-NFPA 660-2024 [Section No. 9.4.17.1.4.1]

9.4.17.1.4.1*

Dryer cleaning methods, frequency, and the required level of cleanliness ~~as determined by the DHA~~ shall be documented.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 18:59:46 EST 2024

Committee Statement

Committee Statement: The phrase "a DHA has determined" is unnecessary for the specified requirements and is somewhat redundant. This phrase is not needed since a hazard either exists or does not and the phrase does not add anything to the requirements.

Response Message: SR-53-NFPA 660-2024

Public Comment No. 148-NFPA 660-2024 [Section No. 9.4.17.1.4.1]

Second Revision No. 54-NFPA 660-2024 [Section No. 9.6.3.2]

9.6.3.2*

In areas where a dust explosion hazard or dust flash fire hazard exists, the temperature of ~~external surfaces, such as compressors; steam, water, or process piping; ducts; and process equipment~~ exposed surfaces shall be maintained below 80 percent (in degrees Celsius) of the lower of the dust ~~surface~~ layer ignition temperature or the dust-cloud ignition temperature.

A.9.6.3.2

This section does not apply to electrical systems.

Examples of exposed surfaces include compressors; steam, water, or process piping; ducts; and process equipment.

Fire losses have occurred where steam piping was identified as the ignition source. For example, for wood dust deposits, it is possible that prolonged exposure to elevated temperatures could produce cellulose pyrolysis products that can have lower ignition temperatures than those normally associated with wood. Therefore, in permitting maximum surface temperatures above 100°C (212°F) (the minimum steam temperature), it is assumed that appropriate personnel safety measures are in place and that a rigid housekeeping program exists to keep dust accumulations under control. Equipment surfaces in hard-to-access locations that will collect dust and are likely to be cleaned less frequently should be insulated to keep the maximum surface temperature below 100°C (212°F).

Similarly, the ignition temperature of a layer of dust on hot surfaces could decrease over time if the dust dehydrates or carbonizes. For organic dusts that can dehydrate or carbonize, the temperature should not exceed the lower of the ignition temperature or 329°F (165°C). The ignition temperatures for many materials are shown in NFPA 499 .

~~Consensus standard hot surface dust layer ignition temperature tests include~~ Dust layer and dust cloud ignition temperatures should be determined by ASTM E2021, *Standard Test Method for Hot-Surface Ignition Temperature of Dust Layers*, ASTM E1491, *Standard Test Method for Minimum Autoignition Temperature of Dust Clouds* , ~~and~~ ISO/IEC/UL 80079-20-2~~-1~~ , *Explosive atmospheres — Part 20-2: Material characteristics — Combustible dusts test methods*, or other recognized test methods .

The dust layer thickness used in ~~these tests~~ ASTM E2021 is nominally 0.5 in. (1.27 cm). ~~Thicker dust layers produce lower hot surface ignition temperatures.~~ The minimum ignition temperature typically decreases with increasing layer thickness, and testing up to maximum layer thickness to be expected on external surfaces is recommended.

Normally the minimum ignition temperature of a layer of a specific dust is lower than the minimum ignition temperature of a cloud of that dust; however, this is not universally true (see NFPA 499).

Supplemental Information

File Name	Description	Approved
660_SR_54_9.6.3.2.docx		

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 19:33:22 EST 2024

Committee Statement

Committee Statement: Text from Chapter 14 and Chapter 15 was incorporated with the existing text as it has been deemed fundamental.

Response Message: SR-54-NFPA 660-2024

Public Comment No. 64-NFPA 660-2023 [Section No. 9.6.3.2]

Public Comment No. 63-NFPA 660-2023 [Section No. 9.6.3.2]

Second Revision No. 55-NFPA 660-2024 [Section No. 9.6.7.6]

9.6.7.6

In facility locations that have been identified ~~in the DHA~~ as being dust flash fire or explosion hazard areas or hazardous (classified) locations, heating units shall be provided with a source of combustion air ducted directly from the building exterior or from an unclassified location.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 19:40:21 EST 2024

Committee Statement

Committee Statement: The phrase "in the DHA" is unnecessary for the specified requirements and is redundant.

Response Message: SR-55-NFPA 660-2024

Public Comment No. 150-NFPA 660-2024 [Section No. 9.6.7.6]

Second Revision No. 57-NFPA 660-2024 [Section No. 9.6.9.1]

9.6.9.1*

Heated process equipment containing combustible dust shall have operating controls arranged to maintain the temperature of equipment interiors within the prescribed limits as ~~determined~~ documented by the DHA.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 10:06:55 EST 2024

Committee Statement

Committee Statement: "Determined" should be changed to "documented" by the DHA for better clarity and application of the phrase. The word "documented" also still allows for the determination of hazards, but does not control the design and limits specified in the requirements.

Response Message: SR-57-NFPA 660-2024

Public Comment No. 152-NFPA 660-2024 [Section No. 9.6.9.1]

Second Revision No. 58-NFPA 660-2024 [Section No. 9.6.13]

9.6.13* Smoking and Vaping.

Where smoking and vaping is permitted in the facility, it shall be restricted to designated nonhazardous areas equipped with devices for smoking material disposal and free of combustible/flammable hazards or storage.

A.9.6.13

Signage should be posted to designate where smoking or vaping is or is not permitted.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 10:08:40 EST 2024

Committee Statement

Committee Statement: A statement about "NO SMOKING" signs was previously included in an industry-specific chapter and has been deemed fundamental. This has been reworded for clarity.

Response Message: SR-58-NFPA 660-2024

Public Comment No. 66-NFPA 660-2023 [Section No. 9.6.13]

Second Revision No. 59-NFPA 660-2024 [Section No. 9.8.2]

9.8.2 Equipment Protection.

9.8.2.1* ~~General.~~

Where an explosion hazard exists within any operating equipment greater than 8 ft^3 (0.2 m^3) of containing volume, the equipment shall be protected from the effects of an explosion.

9.8.2.2*

Explosion protection systems shall incorporate one or more of the following methods of protection:

(1) Oxidant concentration reduction in accordance with NFPA 69

(2) Deflagration venting in accordance with NFPA 68

(3) Deflagration venting through listed flame-arresting devices in accordance with NFPA 68

(4) Deflagration pressure containment in accordance with NFPA 69

(5) Deflagration suppression system in accordance with NFPA 69

(6) Dilution with a noncombustible dust to render the mixture noncombustible

9.8.2.3

Enclosures and all interconnections protected in accordance with 9.8.2.2 shall be designed to withstand the resultant pressures produced during the deflagration event.

9.8.2.4

Where both an explosion hazard and a fire hazard exist in an AMS, protection for each type of hazard shall be provided.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 10:16:07 EST 2024

Committee Statement

Committee Statement: This was previously included in an industry-specific chapter and has been deemed fundamental.

Response Message: SR-59-NFPA 660-2024

Public Comment No. 67-NFPA 660-2023 [Section No. 9.8.2]

Second Revision No. 60-NFPA 660-2024 [Section No. 9.9.5.2]

9.9.5.2*

Automatic sprinkler protection shall not be permitted in areas where water-reactive combustible metals or water-reactive materials are produced or handled unless permitted by a risk assessment ~~as part of the DHA~~ .

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 10:19:15 EST 2024

Committee Statement

Committee Statement: The phrase "as part of a DHA" is unnecessary and adds confusion since a risk assessment and DHA are two distinct processes.

Response Message: SR-60-NFPA 660-2024

Public Comment No. 153-NFPA 660-2024 [Section No. 9.9.5.2]

Second Revision No. 69-NFPA 660-2024 [Chapter 10 [Title Only]]

~~Reserved~~ Emergency Planning and Response

Submitter Information Verification

Committee: CMD-FUN
Submittal Date: Thu Feb 22 12:38:07 EST 2024

Committee Statement

Committee Statement: Requirements are being relocated here from 8.10 and additional provisions will eventually be relocated from other chapters to create a consolidated chapter.
Response Message: SR-69-NFPA 660-2024

Second Revision No. 62-NFPA 660-2024 [Section No. A.3.3.14]

A.3.3.14 Combustible Dust.

The term *combustible dust* when used in this standard includes powders, fines, fibers, flyings, etc. Combustible fibers/flyings are specifically mentioned because, while the hazard is the same, *NFPA 70* and NFPA 499 treat combustible dust and combustible fibers/flyings separately in regards to establishing hazardous (classified) locations and specifying the electrical installation. ~~Ignitible fibers/flyings, as defined in~~ *NFPA 70* and NFPA 499~~,~~ do not ~~present~~ consider ignitible fibers/flyings to be a flash fire or explosion hazard, and they are not specifically included in the definition of *combustible dust* in this standard. The difference between ignitible fibers/flyings and combustible fibers/flyings is the condition of being deposited in a layer that is not readily entrainable. A given material might be a combustible fiber/flying when suspended but become an ignitible fiber/flying when deposited in a layer. Ignitible fibers/flyings normally present a fire hazard, so locations are classified differently, and the electrical installation includes additional restrictions compared to combustible fibers/flyings. However, some ignitible fibers/flyings could present a flash fire or explosion hazard if suspended and could pose similar hazards as combustible dust.

This definition also includes consideration of a process-specific oxidizing medium other than air. A larger particle size material might not present a hazard in air, yet could present a hazard in an atmosphere with increased oxygen concentration. Similarly, a combustible metal might still present a hazard in an atmosphere typically considered inert, such as CO_2 or nitrogen.

Dusts traditionally were defined as material 420 µm or smaller (i.e., capable of passing through a ~~U.S.~~ US No. 40 standard sieve). For consistency with other standards, 500 µm (i.e., capable of passing through a ~~U.S.~~ US No. 35 standard sieve) is now considered an appropriate size criterion. Particle surface area-to-volume ratio is a key factor in determining the rate of combustion. Combustible particulate solids with the smallest dimension more than 500 µm generally have a surface-to-volume ratio that is too small to pose a flash fire or explosion hazard. Fibers/flyings with lengths that are large compared to their diameter or thickness usually do not pass through a 500 µm sieve, yet could still pose a flash fire or explosion hazard. Many particulates accumulate electrostatic charge in handling, causing them to attract each other, forming agglomerates. Often, agglomerates behave as if they were larger particles, yet when they are dispersed they present a significant hazard. Therefore, it can be inferred that any combustible particulate solid that has the smallest dimension less than or equal to 500 µm could behave as a combustible dust if suspended in air or the process-specific oxidizer. If the smallest dimension of the particulate is greater than 500 µm, it is unlikely that the material would be a combustible dust, as determined by test. The determination of whether a sample of combustible material presents a flash fire or explosion hazard could be based on a screening test methodology such as provided in ASTM E1226, *Standard Test Method for Explosibility of Dust Clouds*. Alternatively, a standardized test method such as ASTM E1515, *Standard Test Method for Minimum Explosible Concentration of Combustible Dusts*, could be used to determine dust explosibility. Chapter 5 has additional information on testing requirements.

There is some possibility that a sample will result in a false positive in the 20 L (5.3 gal) sphere when tested by the ASTM E1226 screening test or the ASTM E1515 test. This is due to the high energy ignition source overdriving the test. When the lowest ignition energy allowed by either method still results in a positive result, the owner/operator can elect to determine whether the sample is a combustible dust with screening tests performed in a larger scale ~~{~~ [≥1 m^3 (≥35.3 ft^3) ~~}~~] enclosure, which is less susceptible to overdriving and thus will provide more realistic results.

This possibility for false positives has been known for quite some time and is attributed to “overdriven” conditions that exist in the 20 L (5.3 gal) chamber due to the use of strong pyrotechnic igniters. The activation of the pyrotechnic igniters increases both the initial pressure and temperature in the 20 L (5.3 gal) sphere by significant amount prior to the combustion of the dust itself [Taveau, J., et al]. These new pre-existing conditions might or might not physically alter the dust being tested, depending on its physical properties. For material with low flash point, the conjectured mechanism is that the pyrotechnic igniters are able to induce sufficient sublimation and vapor formation to change the combustion mechanism scenario from combustion of solid particles (i.e., dust) to combustion of a mixture of particles and a flammable gas (or vapor). Authors of “Igniter-induced hybrids in the 20-L sphere,” in the *Journal of Loss Prevention in the Process Industries* [Taveau, J., et al.] proposed to call this phenomenon an *igniter-induced hybrid*. Whereas in a 1 m^3 (35.3 ft^3)

chamber the effect disappears after the initial kernel propagates, in a 20 L (5.3 gal) sphere these effects persist throughout the flame propagation, leading to an increased reactivity of the tested material. Authors of Taveau, J., et al expect that the probability of an igniter-induced hybrid increases as the flash point and/or the MAIT of the powder in question decreases. For that reason, the reference method for explosibility testing is based on a 1 m^3 (35.3 ft^3) chamber, and the 20 L chamber test method is calibrated to produce results comparable to those from the 1 m^3 (35.3 ft^3) chamber for most dusts.

NFPA 68 also recognizes this problem and addresses it stating that “the 20 L test apparatus is designed to simulate results of the 1 m^3 chamber; however, the igniter discharge makes it problematic to determine K_{St} values less than 50 bar-m/sec. Where the material is expected to yield K_{St} values less than 50 bar-m/sec, testing in a 1 m^3 chamber might yield lower values.”

Any time a combustible dust is processed or handled, a potential for a flash fire or explosion exists. The degree of flash fire or explosion hazard varies, depending on the type of combustible dust and the processing methods used.

Refer to A.7.2.1 for a description of the conditions required for a combustible dust flash fire or explosion to occur.

Evaluation of the hazard of a combustible dust should be determined by the means of actual test data. Each situation should be evaluated and applicable tests selected. The following list represents the factors that are sometimes used in determining the flash fire and explosion hazards of a dust:

(1) MEC

(2) MIE

(3) Particle size distribution

(4) Moisture content as received and as tested

(5) Maximum explosion pressure at optimum concentration

(6) Maximum rate of pressure rise at optimum concentration

(7) K_{St} (normalized rate of pressure rise) as defined in ASTM E1226, ~~*Standard Test Method for Explosibility of Dust Clouds*~~

(8) Layer ignition temperature

(9) Dust cloud ignition temperature

(10) Limiting oxidant concentration (LOC) to prevent ignition

(11) Electrical volume resistivity

(12) Charge relaxation time

(13) Chargeability

It is important to keep in mind that as a particulate is processed, handled, or transported, the particle size generally decreases due to particle attrition. Therefore, it is often necessary to evaluate the characteristics of the particulate at multiple points along the process. Where process conditions dictate the use of oxidizing media other than air, which is nominally taken as 21 percent oxygen and 79 percent nitrogen, the applicable tests should be conducted in the appropriate process-specific medium.

The definition of *combustible dust* focuses on flash fire and explosion hazards, but fires in piles or layers of combustible particulate solids are also a concern that is addressed in this standard. A combustible dust that poses a flash fire or explosion hazard could also pose a fire hazard when in the form of a settled accumulation. This can also be the case for combustible particulate solids with a minimum dimension greater than 500 µm. (CMD-FUN)

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 10:44:12 EST 2024

Committee Statement

Committee Statement: Identifying that some ignitible fibers/flyings may present a flash fire and explosion hazard if suspended by a catastrophic event or if intentionally suspended by a process, and highlighting the difference between combustible and ignitible fibers/ flyings.

Response Message: SR-62-NFPA 660-2024

Public Comment No. 217-NFPA 660-2024 [Section No. A.3.3.14]

Second Revision No. 11-NFPA 660-2024 [Section No. A.3.3.37]

A.3.3.34 Dust Explosion Hazard.

A dust explosion hazard requires that a dust ~~flash fire~~ deflagration be confined within an enclosure providing for the accumulation of a damaging level of pressure. An explosion hazard can exist in an enclosure of any type, including but not limited to silos, dust collectors, enclosed conveyors, bins, bunkers, rooms, and buildings. (CMD-FUN)

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Tue Feb 20 18:12:54 EST 2024

Committee Statement

Committee Statement: This was previously included in an industry-specific chapter and has been deemed fundamental.

Response Message: SR-11-NFPA 660-2024

Public Comment No. 37-NFPA 660-2023 [Section No. 3.3.37]

Public Comment No. 36-NFPA 660-2023 [Section No. 3.3.37]

Second Revision No. 20-NFPA 660-2024 [Section No. A.7.1]

A.7.1

This chapter provides the minimum requirements for performing a hazard assessment to identify and analyze the hazards presented by the presence of combustible particulate solids for the purpose of identifying relevant management strategies necessary to provide a reasonable degree of protection to life and property.

The intent of this chapter is to establish a requirement to analyze the potential hazards of an operation regardless of size. The dust hazards analysis methodology is not necessarily the same as that in the OSHA process safety management (PSM) regulation and is not intended to trigger such a requirement. Annex B provides an example of how one might perform a DHA.

The term *DHA* should not be construed to mean that the hazards to be assessed are limited to those posed by combustible dusts. The intent of the DHA is to evaluate fire, flash fire, and explosion hazards, which includes the consideration of combustible particulate solids with particle sizes greater than that associated with dusts.

See the CCPS *Guidelines for Combustible Dust Hazard Analysis* for additional guidance on analyzing combustible dust hazards.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 11:20:57 EST 2024

Committee Statement

Committee Statement: Analyzing the hazards associated with combustible dust processes is a complicated topic requiring implementation guidance. The existing annex language provides an excellent base level of information but does not cover the breadth of information necessary to ensure effective hazard analysis. The CCPS publication listed is an excellent voluntary resource for the user community in search of further guidance.

Response Message: SR-20-NFPA 660-2024

Public Comment No. 216-NFPA 660-2024 [Section No. 7.1]

Second Revision No. 63-NFPA 660-2024 [Section No. A.7.2.2]

A.7.2.2

The qualified person who is leading or performing the DHA should be familiar with conducting a DHA. The qualified person should also be familiar with the hazards of combustible dusts. Typically, a team performs a DHA. For some processes this team might be as little as two persons, or for larger and more complex processes, the team might require many more than two persons. This team is made of a variety of persons whose background and expertise can include the following:

(1) Familiarity with the process

(2) Operations and maintenance

(3) Process equipment

(4) Safety systems

(5) History of operation

(6) The properties of the material

(7) Emergency procedures

The individuals involved in the DHA could include facility operators, engineers, owners, equipment manufacturers, or consultants.

Someone who is qualified to perform or lead a DHA has performed all the aspects of several DHAs associated with the affected industry or type of combustible dust(s). This individual has a working understanding of the intent of the numerous combustible dust standards and can recognize safe and cost-effective solutions that fit each facility's needs. This specialized knowledge and experience that comprise an individual's qualifications are gained from months to years of work assessing and mitigating complex combustible dust fire and explosion scenarios. However, this expertise cannot be gained by merely observing a DHA, reading standards, or attending a training course. Simply being a certified environmental, safety, and health (EHS) professional (e.g., CIH, CSP) or licensed professional engineer (PE) in and of itself also does not mean an individual possess the necessary skills and required knowledge to perform a DHA. The complexities associated with analyzing the combustible dust hazards in processes, equipment, and building compartments demand specialized expertise beyond just certifications and licenses. Because the characteristics of being qualified and unqualified are dependent on the type of combustible dust, an individual might also only be qualified to perform a DHA for a specific type of combustible dust. Failure to acknowledge one’s qualifications or lack thereof could cause fire and explosion hazards to be misidentified, incorrectly mitigated, or worse, both.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 11:09:00 EST 2024

Committee Statement

Committee Statement: This additional annex material clarifies who may or may not be qualified to perform a DHA.

Response Message: SR-63-NFPA 660-2024

Public Comment No. 137-NFPA 660-2024 [New Section after A.3.3.105]

Second Revision No. 75-NFPA 660-2024 [Section No. A.7.3.4.2]

A.7.3.4.2

Each and every facility compartment containing combustible particulate solids should be evaluated. The complete contents of the compartment should be considered, including hidden areas. Each area in the compartment should be described, and hazards at each point should be identified. Remedial measures for each hazard should be identified and documented. The means by which the hazard should be managed is then determined. Usually the relevant industry- or commodity-specific NFPA standard will provide options. *(See Annex C.)*

The DHA for building compartments should distinguish between localized flash fire hazards and conditions that present a hazard of a propagating deflagration through a suspended dust accumulation throughout a building compartment or portion thereof. The DHA should document where each hazard exists in the building compartment as this information is needed in order to comply with 8.6.1 .

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 15:49:37 EST 2024

Committee Statement

Committee Statement: The additional language is necessary to comply with the requirements of 8.6.1.

Response Message: SR-75-NFPA 660-2024

Second Revision No. 29-NFPA 660-2024 [Section No. A.8.4.6.1]

A.8.4.6.1

Surfaces on which dust can accumulate can include walls, floors, and horizontal surfaces, such as equipment, ducts, pipes, hoods, ledges, beams, and above suspended ceilings and other concealed surfaces such as the interior of electrical enclosures.

Factory Mutual recommends that surfaces should be cleaned frequently enough to prevent hazardous accumulations (FM Data Sheet 7-76, *Prevention and Mitigation of Combustible Dust ~~Explosives~~ Explosion and Fire*, 2.3.5). Housekeeping for fugitive dusts is most important where the operational intent is that the dust accumulations are not normally present in the occupancy and the building has no explosion protection features, such as damage limiting/ deflagration venting construction or classified electrical equipment, and additional personal protection from dust flash fire or explosion hazards is also not provided. Factors that should be considered in establishing the housekeeping frequency include the following:

(1) Variability of fugitive dust emissions

(2) Impact of process changes and non-routine activities

(3) Variability of accumulations on different surfaces within the room (i.e., walls, floors, overheads)

Ideally, upward-facing surfaces within the facility are painted a contrasting color to the dust that is being handled. This facilitates recognizing when and where accumulations occur. This information then serves to prioritize and schedule cleaning. It is clearly not recommended that the interior surfaces be the same color as the dust that is apt to escape the process and accumulate within the facility.

One method that has proved useful is to print self-adhesive paper or plastic labels with the words “Clean Enough” in bold black type along with a serial number. These labels are installed at representative locations throughout the facility with the locations recorded on a floor-plan drawing. This allows facility staff to survey the labels at scheduled frequencies and record which labels were “clean enough” to be read, and which were not. This facilitates focusing the housekeeping efforts where the dust accumulations are developing most rapidly.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 13:18:44 EST 2024

Committee Statement

Committee Statement: This was previously included in an industry-specific chapter and has been deemed fundamental.

Response Message: SR-29-NFPA 660-2024

Public Comment No. 50-NFPA 660-2023 [Section No. 8.4.6.1]

Second Revision No. 38-NFPA 660-2024 [Section No. A.8.11]

A.8.10

The retroactivity of Chapter 8 is not intended to require investigation of incidents that occurred prior to the adoption of this standard.

To thoroughly assess the risks, analyze the incident, and take any corrective steps necessary, investigations should be conducted promptly based on the nature of the incident and in coordination with the AHJ (as applicable).

The investigation should include root cause analysis and should include a review of existing control measures and underlying systemic factors. Appropriate corrective action should be taken to prevent recurrence and to assess and monitor the effectiveness of actions taken.

Such investigations should be carried out by trained persons (internal or external) and include participation of workers. All investigations should conclude with a report on the action taken to prevent recurrence.

Investigation reports should be reviewed with all affected personnel and their representatives (including contract employees where applicable) whose job tasks are relevant to the incident findings, and with the health and safety committee, to make any appropriate recommendations. Any recommendations from the safety and health committee should be communicated to the appropriate persons for corrective action, included in the management review, and considered for continual improvement activities.

A system should be established to promptly address and resolve the incident report findings and recommendations.

Corrective actions resulting from investigations should be implemented in all areas where there is a risk of similar incidents and subsequently checked to avoid repetition of injuries and incidents that gave rise to the investigation.

Reports produced by external investigation agencies should be acted upon in the same manner as internal investigations.

Incident investigation reports should be made available to affected employees and their representatives at no cost.

See the CCPS *Guidelines for Investigating Process Safety Incidents* for additional guidance on incident investigation .

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Wed Feb 21 16:25:26 EST 2024

Committee Statement

Committee Statement: Investigating incidents and near misses is a complicated topic requiring implementation guidance. The existing annex language provides an excellent base level of information but does not provide the breadth of information necessary to ensure effective incident investigation. The CCPS publication listed is an excellent voluntary resource for the user community in search of further guidance.

Response Message: SR-38-NFPA 660-2024

Public Comment No. 215-NFPA 660-2024 [Section No. 8.11]

Second Revision No. 66-NFPA 660-2024 [Section No. A.9.6.12]

A.9.6.12

Particular attention should be paid to the potential for a lightning strike on ~~roof-mounted~~ buildings, tanks, silos, bucket elevators, dust collectors, cyclones, and ductwork. The electromagnetic pulse from a lightning strike to these pieces of equipment can cause severe damage to any electronic equipment, including spark detection and extinguishing systems, installed on such equipment. The impulse current from a direct lightning strike ~~on roof-mounted dust collectors, cyclones, and ductwork~~ can ignite ~~wood waste~~ combustible material within ~~this~~ exposed equipment that can subsequently be conveyed to other locations in the facility.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 11:26:52 EST 2024

Committee Statement

Committee Statement: This revision replaces the reference to "wood waste" with "combustible material" to make this fundamental. Also references general lightning protection of buildings, tanks, and silos along with the equipment already mentioned.

Response Message: SR-66-NFPA 660-2024

Public Comment No. 109-NFPA 660-2023 [Section No. A.9.6.12]

Second Revision No. 67-NFPA 660-2024 [Section No. A.9.8.2.1]

A.9.8.2.1

A dust explosion hazard can exist in small ~~containers~~ enclosures ; however, deflagration venting or suppression measures for these units are not always possible. Consideration should be given to explosion hazards when electing to omit protection; 8 ft^3 (0.2 m^3) is roughly the size of a 55 gal (208.2 L) drum. Explosion prevention using inerting or pressure containment can be an effective means of managing the hazard. See also A.4.2.1.1.

While flame-resistant garments (FRG) can provide some protection for personnel from thermal exposure associated with these events, it will not provide protection against overpressure effects and projectiles.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 11:33:39 EST 2024

Committee Statement

Committee Statement: Changes were made to highlight the fact that FRG may provide protection from some of the hazards but not all.

Response Message: SR-67-NFPA 660-2024

Public Comment No. 110-NFPA 660-2023 [Section No. A.9.8.2.1]

Second Revision No. 64-NFPA 660-2024 [Chapter V]

Annex V ~~Reserved~~ Guide for Computing Thermal Dose to Personnel from Flash Fires and Building Compartment Deflagrations

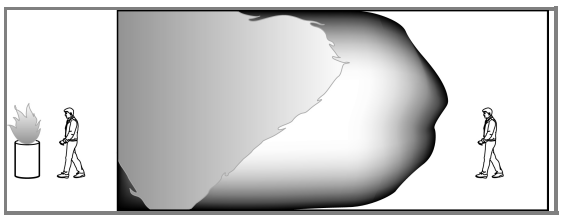
V.1 Introduction.

NFPA 660 uses the determination of the existence of a *flash fire hazard* as the trigger for the requirement for the use of flame-resistant garments (FRG) to protect personnel from that hazard. Section 8.6.1.1 states: “Flame-resistant garments designed in accordance with NFPA 2112 shall be permitted to be used as part of the personnel protection strategy against flash fire exposures, only.” This implies that there can be situations where the protective capabilities of FRG will not be capable of achieving the personnel protection objective. Section 8.6.1.2 states: “Flame-resistant garments shall not be permitted to be the sole safeguard against a propagating deflagration through suspended dust accumulations throughout a building compartment.” This language effectively establishes those events that cannot yield a thermal dose greater that 252 kJ/m^2, resulting from a radiant flux of 84 kW/m^2 for a duration of 3 seconds, as a *flash fire* and those that can yield more than 252 kJ/m^2 as a *building compartment deflagration*.

V.1.1 Range of Scenarios.

To illustrate this distinction, consider these two fire scenarios. First is an ignition of a 2.0 m^3 vapor cloud consisting of cyclohexane (a common organic solvent) that has been pushed out of the ullage space (the space above the settled material in a container) of a 2.0 m diameter mixer, when polymeric resin was added. This has been customarily referred to as a *flash fire* since the 1970s. Second is the propagation of a dust deflagration involving wood dust, from a dust suspension (cloud) that extends from floor to ceiling at one end of the building compartment that is 20 m wide, 50 m long and 5 m high, referred to as a building compartment deflagration (BCD). These are illustrated in Figure V.1.1.

Figure V.1.1 The Two Scenarios of Flash Fire and Building Compartment Deflagration.



V.1.2 Computational Methods.

There are a number of computational methods for predicting the radiant flux impinging on a target as a function of a given fire geometry. [1]

These calculations have been developed primarily for hydrocarbon pool fires and for flammable gas and vapor cloud fires. Where commonly encountered particulates like agricultural, forest, animal-derived, and plastic products are concerned, the combustion chemistries are sufficiently similar to allow the use of those calculations to model a dust deflagration also. Metallic particulates burn with sufficiently different chemistries that corrections should be made to the computational models before use.

To calculate the incident radiant flux rigorously, we must quantify a number of parameters including the emissivity of the flame, the emissivity of the target occupant, the exact distances between the fire and the target, and transmittance of the atmosphere, to name just a few.

The calculation can be simplified by assuming that the flames of both fire events are optically dense radiators. In reality they are. This allows us to base the calculations on the radiating area of the flame rather than on the actual flame volume and then making a second correction to subtract the emissions that are not directed towards the target. We can also use a point-source equivalence to simplify the geometry. But when we do so we lose the geometric continuity between the two cases. As long as we make the same simplifications to both scenarios, the relative radiant intensity ratio will stay constant.

For a hypothetical point-source radiator, the incident radiant flux, q , impinging on a target can be predicted using the relation: [2]

$$q = \tau X_r \left(\frac{Q}{4\Pi L^2} \right) \cos\theta \qquad \textbf{[V.1.2]}$$

where:

τ = atmospheric transmittance (unitless)

X_r = radiative fraction of the heat release, %

Q = Heat release rate, kW

L = Distance from center of fire ball to target, m

The radiant flux has units of kW/m^2 . The ($4\pi L^2$) term is just the surface area of a sphere that is L meters from the central radiating point.

V.1.3 Localized or Limited Deflagration Scenario.

For the vapor deflagration above a mixer scenario, the point-source model does not introduce an error and we have a deflagration fire ball that is a 2 m diameter sphere. Since the person is 1.0 m from the edge of the mixer and the mixer is 2 m in diameter, the person is 2 m from the center of the deflagration but only 1.0 m from the flame surface. The flame volume is 4.2 m^3. At a density of 1.225 kg/m^3, a 4.2 m^3 volume of air has a mass of 5.13 kg. At 21 percent oxygen by weight there is a mass of 1.08 kg of oxygen available for combustion. At 13.1 kJ/gO_2 the heat release in the vapor cloud will be limited to approximately 14.12 MJ. This is a bounding value as it provides the maximum amount of energy that can be derived from the available oxygen in the air. In real deflagrations the value will be somewhat smaller due to incomplete combustion.

If this deflagration propagates across the cloud in 1.0 seconds, the power dissipation will be approximately 14.12 MW. The value for the distance term, L, is the distance from the center of the deflagration to the target, the operator, approximately 2 m. When we use a transmittance coefficient, τ, of 1, radiant fraction, X_r, of 0.35, and incidence angle, Θ, of 90 degrees, we get an estimated radiant flux of 0.0983 MW/m^2 or 98.3 kW/m^2. This incident flux intensity is integrated over the exposure time to obtain the energy dose. In this scenario we assumed a 1.0 second long, momentary constant magnitude radiant flux. The thermal dose would be 98.3 kJ/m^2. There is no persisting radiant flux subsequent to the initial deflagration such as that which would occur if the upper half of the building compartment were filled with hot combustion product gases. The thermal dose is approximately 100 kJ. If the operator was 1.5 m from the center of the deflagration, the thermal dose would be 174 kW/m^2.

The acceptance criterion in NFPA 2112 is 84 kW/m^2 for 3 seconds.[3] This equates to a thermal dose of 252 kJ. The values calculated from the mixer scenario are of the same order of magnitude as the value used by NFPA 2112. Thus, it appears that this fire scenario is close to that which the Technical Committee on Flash Fire Protective Garments was contemplating when it wrote NFPA 2112 and NFPA 2113.[4,5] Consequently, we can conclude that flame-resistant garments complying with NFPA 2112 would provide the desired level of protection from injury, except to the hands and head, from the deflagration event in the first scenario.

V.1.4 Building Compartment Deflagration Scenario.

For the second scenario we must use the large-scale radiant flux data because the radiator is much larger in surface area than the target. This introduces an error of increasing magnitude as the flame gets closer to the target. For large-scale radiation flames the value of 350 kW/m^2 for the radiant flux is often used.[6] This value has been experimentally derived.

Let's compare the radiant flux on the occupant in this scenario. To do this we need to redraw the sketch. It is shown in Figure V.1.4(a). A dust suspension occurs at the left end of the building compartment. The building compartment is 20 m wide, 50 m long and 5 m high. The occupant is 5 m from the right end. And we put two 12 ft by 12 ft roll-up doors at the right end that are open at the time of the event to prevent the rupture of the room walls.

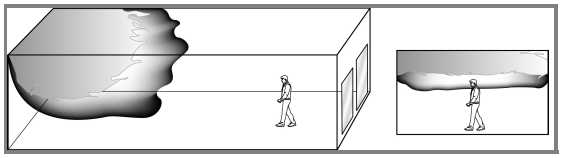
Figure V.1.4(a) The Building Compartment Deflagration Scenario.



At the instant of ignition, the deflagration flame front begins expanding through the fuel/air suspension. The velocity of the flame front expansion through the suspension can be computed from the numerical value of the K_{St} of the dust. But the combustion product gas also expands, pushing the flame front from behind. The actual velocity of the flame front is the sum of these two components.

The left image in Figure V.1.4(b) depicts the initial expansion of the deflagration across the building compartment. The right image in Figure V.1.4(b) depicts the radiating area. We use the simplified point-source, optically dense radiator model used in the first scenario and a uniform radiant intensity per unit area, and the average distance from the front surface of the flame to the occupant in the calculation.

Figure V.1.4(b) The Deflagration Flame 0.5 Seconds after Ignition.



The radiating area is 20 m by about 2.0 m high for a radiating area of 40 m^2. Using the radiant flux per unit area of 350 kW/m^2, this yields an estimated radiant power of 14 MW. Initially the front surface of the deflagration flame front is 5 m from the left wall while the occupant is 5 m from the right wall, putting 40 m between them.

The resulting radiant intensity at the occupant can be calculated with the Inverse Square Law.

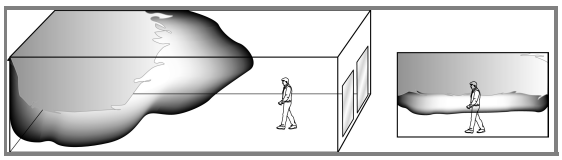
$$q = \frac{Q}{d^2} \qquad \textbf{[V.1.4]}$$

Using the value of 14 MW for Q and 40 m for the distance, d, in the Inverse Square Law for radiant flux intensity yields a calculated incident radiant flux, q, of 8.75 kW/m^2 on the target occupant. This is less than the radiant intensity criterion in NFPA 2112 of 84 kW/m^2.

Thermal dose is the product of radiant intensity multiplied by exposure duration time. Using a simple step-wise summation instead of an integration, we can estimate at the end of the first 1½ second time interval the thermal dose for the occupant is 4.4 kJ/m^2. If the deflagration was limited to this size and 3 seconds in duration, one could expect the injury to the occupant equipped with FRG in accordance with NFPA 2113 to be limited to second degree burns except for the hands and head.

Unfortunately, in a propagating building compartment deflagration the radiating surface is moving across the building compartment as it consumes the suspended fuel. As the deflagration flame front propagates through the dust cloud towards the occupant, the front surface of the flame front is traveling at a rate that is the sum of the flame speed, S_u , and the velocity induced by the expansion of the combustion product gases pushing the whole dust cloud towards the occupant. For sake of simplicity in this this hypothetical example we assign an expansion velocity of 10 m/sec. At 1.0 seconds after ignition, the flame front has moved 5 meters closer to the occupant and the flame has expanded to an area of 20 m by 4 m. The radiating area is now 80 m^2 . Using the radiant flux per unit area of 350 kW/m^2 , the total radiant power is approximately 28 MW. See Figure V.1.4(c) .

Figure V.1.4(c) The Building Compartment Deflagration Scenario 1.0 Seconds after Ignition.

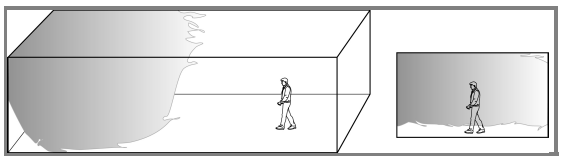


Since the front surface of the flame now averages 10 m from the left wall, the separation has decreased to 35 m and the radiant intensity on the occupant is now 22.9 kW/m^2 .

For this hypothetical example we use a simple step-wise summation in lieu of an integration. (This leads to an over-estimation of the accumulated dose in the initial stages of the event, but the error diminishes in importance as the deflagration propagates across the room.) We can estimate at the end of the second ½ -second time interval the accumulated thermal dose for the occupant is approximately 15.85 kJ/m^2 .

Another 0.5 seconds later, the flame front has advanced another 5 m, reducing the distance between the emitter and the target to 30 m and the radiating surface now extends from floor to ceiling. Now the radiating area is 100 m^2 for a total radiant power of 35 MW. Since the distance has decreased to 30 m the radiant intensity on the occupant is now 38.9 kW/m^2 . At the end of the third ½ -second interval the accumulated thermal dose for the occupant is now approximately 35.3 kJ/m^2 . See Figure V.1.4(d) .

Figure V.1.4(d) The Building Compartment Deflagration Scenario 1.5 Seconds after Ignition.



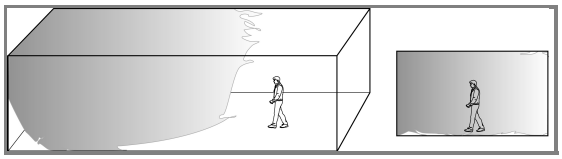
After another 0.5 seconds. 2.0 seconds after ignition, the radiant intensity of the deflagration flame front has not increased as it is limited to the cross-sectional area of the room. But the flame surface is another 5 m closer, now 25 m from the occupant. The radiant intensity impinging upon on the occupant target is now 56 kW/m^2 . At the end of the fourth ½ -second time interval, 2.0 seconds after ignition, the accumulated thermal dose for the occupant is approximately 63.3 kJ/m^2 .

At 2.5 seconds after ignition, the deflagration flame front has moved 5 m closer to the occupant for a separation distance of 20 m. The radiant intensity impinging upon the occupant is now 87.5 kW/m^2 . At the end of the fifth ½ -second time interval, 2.5 seconds after ignition, the accumulated thermal dose for the occupant is approximately 107.1 kJ/m^2 .

If the deflagration flame front continues to advance at the rate of 10 m/sec, at 3 seconds after ignition it has advanced an additional 5 m and the separation distance between the front of the deflagration flame front and the occupant is 15 m. Due to the smaller separation distance the Inverse Square Law predicts the radiant intensity on the occupant will now be

155.6 kW/m^2. At 3.0 seconds after ignition the simple step-wise summation yields an accumulated thermal dose to the occupant of 184.9 kJ/m^2. See Figure V.1.4(e).

Figure V.1.4(e) The Building Compartment Deflagration Scenario 3.0 Seconds after Ignition.



In another 0.5 seconds, 3.5 seconds after ignition, the separation distance has diminished to 10 m while the total radiant power is still 350 kW/m^2 and has remained limited by the room cross-sectional area. Since the front surface of the flame is now only 10 m from the occupant, the radiant intensity on the occupant will now be 350 kW/m^2. This intensity multiplied by the ½ second exposure time adds another 175 KJ/m^2 to the accumulated dose, bringing the total to 359.9 kJ/m^2 for the accumulated thermal dose to the occupant. This accumulated dose exceeds the performance criteria in NFPA 2112, yet the flame front is still advancing towards the occupant. These calculations are summarized in Table V.1.4.

Table V.1.4 Summary of Calculated Thermal Dose for the Building Compartment Deflagration Scenario

t (sec)	*A* (m^2)	*Q* (MW)	*D* (m)	*Q* (kW/m^2)	Accumulated Thermal Dose (kJ/m^2)
0.5	40	14	40	8.75	4.4
1.0	89	28	35	22.8	15.9
1.5	100	35	30	38.9	35.3
2.0	100	35	25	5.6	63.3
2.5	100	35	20	87.5	107.1
3.0	100	35	15	155.6	184.9
3.5	100	35	10	350	359.9

The deflagration flame front has not yet reached the occupant, yet the occupant's thermal dose has exceeded the performance criterion established by NFPA 2112. If there is sufficient accumulated fugitive dust in the building compartment to continue the deflagration propagation, the flame will soon engulf the occupant. Once flame impingement occurs, the heat transfer from the flame gases to a target becomes dominated by convective heat transfer. The influx rate of heat increases enormously. The occupant is subject to catastrophic injury and quite probably death.

Furthermore, if the building compartment does not rupture, once the deflagration flame has run its course, the hot combustion product gas, some of which is carbon monoxide, will be trapped beneath the ceiling. This creates a persisting radiant heat source, as well as a potentially toxic atmosphere.

V.2 Assessing Thermal Dose for Selection of Personnel Protection Strategy.

The hazard assessment necessitates quantifying the reasonable worst-case deflagration size and the reasonable worst-case personnel proximity to the deflagration in order to calculate the probable worst-case thermal dose. The probable worst-case thermal dose is compared to the criteria in NFPA 2112 of 252 kJ/m^2. If the probable worst-cast thermal dose to employees in the hazard area exceeds the NFPA 2112 criteria, FRG cannot be relied upon as the sole consequence-management strategy.

Thermal dose is proportional to the total radiant intensity multiplied by the exposure time. Most of the time the radiant intensity varies as a function of time. Either the deflagration is expanding or decaying. When evaluating deflagration scenarios, the duration of the flame is usually limited to periods of 1 to 5 seconds and the intensity is assumed to be constant over that time period.

The incident radiant intensity is also dependent upon the distance between the radiator and the target. As shown in the second scenario in V.1.4 , when the flame front advances towards the occupant the incident radiant intensity increases proportional to the inverse-square of the distance. A hazard assessment is based upon the minimum separation distance between the radiator (flame) and the target (occupant). A thermal dose in excess of the 252 kJ/m^2 (84 kW/m^2 for 3.0 seconds) criterion can be the result of a large radiator at large separation distance, a small radiator at a small separation distance or a combination between those two extremes.

Finally, the thermal dose is dependent upon the fuel. While ignitable gases, vapors, and nonmetallic dusts yield roughly equivalent deflagration flame temperatures, combustible metal particulates burn at much higher temperatures, necessitating much greater separation distances.

V.2.1 Thermal Dose Estimates for Deflagrations Involving Ignitable Gases, Vapors, and Nonmetallic Particulate Solids.

The first step in determining the personnel protection strategy is to establish the design deflagration. Deflagration flames usually take on a spherical form until constrained by enclosure interior surfaces such as process equipment, walls, ceilings, and floors. Since flames are optically dense radiators, the radiating area has an approximately circular shape with diameter equal to the diameter for the spherical flame volume. Table V.2.1 provides estimated deflagration radiant flux using the 350 kW/m^2 factor for ignitable gases, vapors, and combustible particulate solids used for estimating design deflagration.

Table V.2.1 Estimated Radiant Flux from Deflagrations of Given Volumes

Volume (m^3)	Diameter (m)	Radiating Area (m^3)	Radiant Flux (kW)
1.0	1.24	1.21	424
2.0	1.56	1.92	672
3.0	1.79	2.52	880
4.0	1.97	3.05	1066
5.0	2.14	3.53	1237
7.5	2.42	4.63	1621
10	2.68	5.61	1963
15	3.06	7.35	2572
20	3.36	8.90	3115
25	3.64	10.32	3614
30	3.84	11.66	4080

The next step is to compute the radiant intensity at the target for the computed radiant flux as a function of distance between the front surface of the deflagration flame volume and the target (occupant). This is a simple inverse-square calculation from Equation V.2.1.

$$q = \frac{Q}{d^2} \qquad \textbf{[V.2.1]}$$

where:

q = incident radiant intensity, kW/m^2

Q = emitted radiant flux, kW

d = distance, m

The incident radiant intensity, kW/m^2, is then multiplied by the exposure time, in seconds, to obtain the thermal dose in kJ/m^2. Where the computed thermal dose exceeds the NFPA 2112 criterion of 252 kJ/m^2 (84 kW/m^2 for 3 seconds duration) personnel protection in excess of that provided by FRG designed in accordance with NFPA 2112 is necessary. Lines have been superimposed on Figure V.2.1(a), Figure V.2.1(b), and Figure V.2.1(c), dividing the 1.0 second, 2.0 second, and 3.0 second exposure time boundaries.

Incident radiant intensities are calculated for separation distances incrementing in 1.0 m steps up to 10 m separation distance. For distances between steps, Equation V.2.1 is used to solve for incident radiant intensity, q.

Figure V.2.1(a) Fire Size Versus Separation Distance for 1.0 Second Exposure.

Flame Volume (m^3)	Emitted Radiant Flux (kW/m^2)	Incident Radiant Intensity (kW/m^2) at Distance (m)											
		1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10	15	20
1.0	434	434	108	48.2	27.1	17.4	12.1	8.86	6.78	5.36	4.34	1.93	1.09
2.0	672	672	168	74.7	42.0	26.9	18.7	13.7	10.5	8.30	6.72	2.99	1.68
3.0	880	880	220	97.8	55.0	35.2	24.4	18.0	13.8	10.9	8.80	3.91	2.20
4.0	1066	1066	267	118	66.6	42.6	29.6	21.8	16.7	13.2	10.6	4.73	2.67
5.0	1237	1237	309	137	77.3	49.5	34.4	25.2	19.3	15.3	12.4	5.50	3.09
7.5	1621	1621	405	180	101	64.8	45.0	33.1	25.3	20.0	16.2	7.2	4.05
10	1963	1963	491	218	123	78.5	54.5	40.1	30.7	24.2	19.6	8.72	4.91
15	2572	2572	643	285	160	103	71.4	52.5	40.2	31.8	25.7	11.4	6.43
20	3115	3115	779	346	194	125	86.5	63.6	48.7	38.5	31.2	13.8	7.79
25	3614	3614	904	402	226	145	100	73.8	56.6	44.6	36.1	16.1	9.04
30	4080	4080	1020	453	255	163	113	83.3	63.8	50.4	40.8	18.1	10.2

Thermal Dose Exceeds Capabilities of FRG

Thermal Dose within the Capability Limit for FRG

Figure V.2.1(b) Fire Size Versus Separation Distance for 2.0 Second Exposure.

Flame Volume (m^3)	Emitted Radiant Flux (kW/m^2)	Incident Radiant Intensity (kW/m^2) at Distance (m)											
		1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10	15	20
1.0	434	434	108	48.2	27.1	17.4	12.1	8.86	6.78	5.36	4.34	1.93	1.09
2.0	672	672	168	74.7	42.0	26.9	18.7	13.7	10.5	8.30	6.72	2.99	1.68
3.0	880	880	220	97.8	55.0	35.2	24.4	18.0	13.8	10.9	8.80	3.91	2.20
4.0	1066	1066	267	118	66.6	42.6	29.6	21.8	16.7	13.2	10.6	4.73	2.67
5.0	1237	1237	309	137	77.3	49.5	34.4	25.2	19.3	15.3	12.4	5.50	3.09
7.5	1621	1621	405	180	101	64.8	45.0	33.1	25.3	20.0	16.2	7.2	4.05
10	1963	1963	491	218	123	78.5	54.5	40.1	30.7	24.2	19.6	8.72	4.91
15	2572	2572	643	285	160	103	71.4	52.5	40.2	31.8	25.7	11.4	6.43
20	3115	3115	779	346	194	125	86.5	63.6	48.7	38.5	31.2	13.8	7.79
25	3614	3614	904	402	226	145	100	73.8	56.6	44.6	36.1	16.1	9.04
30	4080	4080	1020	453	255	163	113	83.3	63.8	50.4	40.8	18.1	10.2

Thermal Dose Exceeds Capabilities of FRG

Thermal Dose within the Capability Limit for FRG

Figure V.2.1(c) Fire Size Versus Separation Distance for 3.0 Second Exposure.

Flame Volume (m^3)	Emitted Radiant Flux (kW/m^2)	Incident Radiant Intensity (kW/m^2) at Distance (m)											
		1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10	15	20
1.0	434	434	108	48.2	27.1	17.4	12.1	8.86	6.78	5.36	4.34	1.93	1.09
2.0	672	672	168	74.7	42.0	26.9	18.7	13.7	10.5	8.30	6.72	2.99	1.68
3.0	880	880	220	97.8	55.0	35.2	24.4	18.0	13.8	10.9	8.80	3.91	2.20
4.0	1066	1066	267	118	66.6	42.6	29.6	21.8	16.7	13.2	10.6	4.73	2.67
5.0	1237	1237	309	137	77.3	49.5	34.4	25.2	19.3	15.3	12.4	5.50	3.09
7.5	1621	1621	405	180	101	64.8	45.0	33.1	25.3	20.0	16.2	7.2	4.05
10	1963	1963	491	218	123	78.5	54.5	40.1	30.7	24.2	19.6	8.72	4.91
15	2572	2572	643	285	160	103	71.4	52.5	40.2	31.8	25.7	11.4	6.43
20	3115	3115	779	346	194	125	86.5	63.6	48.7	38.5	31.2	13.8	7.79
25	3614	3614	904	402	226	145	100	73.8	56.6	44.6	36.1	16.1	9.04
30	4080	4080	1020	453	255	163	113	83.3	63.8	50.4	40.8	18.1	10.2

Thermal Dose Exceeds Capabilities of FRG

Thermal Dose within the Capability Limit for FRG

Where the deflagration flame is expected to persist for no more than 1.0 second, such as in a flash fire incident at the fill port of a mixer, FRG designed in accordance with NFPA 2112 can be relied upon to achieve the prevention of occupant injury for fire size and separation distance conditions to the right and above the 1.0 second exposure limit line on Table V.2.1 . Note, at a 1.0 second exposure time, an occupant equipped with FRG located 1.0 m from a 1.0 m^3 deflagration/flash fire is expected to sustain burn injury. The separation distance must be increased to 2 m if injury is to be prevented. At a separation distance of 2.0 m, the employee equipped with FRG could escape injury in the event of a fire up to 3.0 m^3 in flame volume.

If the deflagration flame is expected to persist for longer than 1.0 seconds but not longer than 2.0 seconds, the protection provided by FRG predicted by Figure V.2.1(a) will not achieve the injury limitation objectives at the separation distance contemplated. For the amount the separation distance between the deflagration and the target occupant must be increased, Figure V.2.1(b) should be used.

Where the deflagration flame is expected to persist for no more than 2.0 seconds, FRG designed in accordance with NFPA 2112 can be relied upon to achieve the prevention of occupant injury for fire size and separation distance conditions to the right and above the 2.0 second exposure limit line in Figure V.2.1(b) .

Where the deflagration flame is expected to persist for no more than 3.0 seconds, FRG designed in accordance with NFPA 2112 can be relied upon to achieve the prevention of occupant injury for fire size and separation distance conditions to the right and above the 3.0 second exposure limit line in Figure V.2.1(c) .

V.2.2 Thermal Dose Estimates for Deflagrations Involving Combustible Metal Particulates.

The design of a personnel protection strategy for areas containing combustible metal particulates must address the much higher heats of combustion exhibited by the combustible metal particulates. The 350 kW/m^2 effective radiant flux criterion used for combustible liquids, gases, and nonmetallic particulates was experimentally derived from large-scale diffusion flames. The flame temperatures for diffusion flames involving hydrocarbon fuels are generally on the order of 1,400°K to 1,600°K (1,100°C to 1,900°C).[7] Combustible metal particulates burn at much higher temperatures. The flame temperatures for combustible metal particulates in air suspension are shown in Table V.2.2 .[8,9] (The data for metal dust deflagration flame temperature was not directly measured but rather was computed from pressure data obtained using the U.S.B.O.M 20 L hemispherical test apparatus. The data for heat of combustion was derived from oxygen consumption cone calorimetry.)

Table V.2.2 Flame Temperatures and Net Heat of Combustion for Combustible Metal Particulates

Element	Flame Temperature (°K)	Heat of Combustion MJ/kg
Aluminum	2800–4000	31.06
Boron	1700	58.83
Carbon	1700–2600	-
Chromium	1850–3170	10.78
Hafnium	2400–4850	-
Magnesium	2850–3600	24.73
Molybdenum	2600	-
Nickel	2400	-
Niobium	2100–3540	-
Tantalum	2350–3750	-
Tin	1550–2250	-
Titanium	2850–3990	19.6
Tungsten	1550–3100	4.59
Zinc	1750–2070	5.37

Published data does not exist for the radiant flux from combustible metal deflagrations.

V.3 Implications for the Consideration of Hazard Management Strategy Options.

Where the deflagration flame is expected to be fueled and propagated by the suspension of accumulated fugitive dust already existing within the building compartment, neither the flame volume nor the separation distance can be reliably predicted. The source of the combustible dust suspension is the dust accumulation that exists in the building compartment interior, and it cannot be predicted how much of that accumulated dust will become suspended either by some initiating event or by the pressure front resulting from the deflagration. Furthermore, the deflagration flame front is expected to be moving across the compartment interior. With changing distance comes changing radiant exposure. If the flame front propagates towards the occupant, the radiant exposure rapidly increases and flame impingement upon the occupant is a distinct possibility. Once flame impingement occurs, the heat transfer mechanism from the fire to the target (occupant) becomes dominated by convective and conductive heat transfer. The rate of heat flow into the target (occupant) is much greater than the 82 kW/m^2 used as the benchmark radiant flux in NFPA 2112. Under these conditions, FRG cannot be relied upon to achieve a personnel injury limitation objective. Consequently, reliance on FRG is not an acceptable personnel protection strategy for building compartment deflagration hazards.

Since FRG cannot be relied upon to limit personnel injury in a building compartment deflagration scenario, other hazard management strategies must be employed. The first, and most obvious, is to change the conditions within the building compartment that make a building compartment deflagration possible. This means to reduce the quantity of accumulated dust within the building compartment to a level that will not propagate a building compartment deflagration.

Each of the commodity chapters, Chapters 11 through 15, has accumulated dust layer thickness criteria in the hazard assessment sections that are used to distinguish building compartments that are expected to pose a deflagration hazard from those that are not. The dust layer thickness criteria are derived from historical experience.

An alternative hazard management strategy is to preclude personnel from the dusty building compartments when ignition scenarios are credible. This usually includes during normal operation.

1 Hurley, Morgan, P.E., FSFPE, Editor-in-Chief, SFPE *Handbook of Fire Protection Engineering*, 5th edition, Chapters 66 and 67, Springer Science+Business Media, New York, 2016.

2 Hurley, Morgan, P.E., FSFPE, Editor-in-Chief, SFPE *Handbook of Fire Protection Engineering*, 5th edition, p. 2654, Springer Science+Business Media, New York, 2016.

3 NFPA 2112, *Standard on Flame-Resistant Clothing for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire*, Section B.1, 2018 edition, National Fire Protection Association, Quincy, MA 02169.

4 NFPA 2112, *Standard on Flame-Resistant Clothing for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire*, 2018 edition, National Fire Protection Association, Quincy, MA 02169.

5 NFPA 2113, *Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire*, 2020 edition, National Fire Protection Association, Quincy, MA 02169.

6 Hurley, Morgan, P.E., FSFPE, Editor-in-Chief, SFPE *Handbook of Fire Protection Engineering*, 5th edition, p. 2655, Springer Science+Business Media, New York, 2016.

7 Drysdale, Dougal, *Introduction to Fire Dynamics*, 2nd edition, pp. 77, 129, 148–149, John Wiley & Sons, New York, NY, 2011.

8 https://stacks.cdc.go>cdc>cdc_8762_DS1.

9 Hurley, Morgan, P.E., FSFPE, Editor-in-Chief, SFPE *Handbook of Fire Protection Engineering*, 5th edition, Table A.33, p. 3449, Springer Science+Business Media, New York, 2016.

Supplemental Information

File Name	Description	Approved
660_SR_64_Annex_V.docx		
660_SR_64_Annex_V.docx	For editorial use	

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Thu Feb 22 11:17:31 EST 2024

Committee Statement

Committee Statement: 8.6.1 establishes a requirement to protect employees from the effects of a deflagration. While FRG is available for protection from flash-fires of limited size and duration, no means has been provided by the proposed standard for distinguishing between flash fires for which protection is available, from building compartment deflagrations for which the thermal dose exceeds the capabilities of FRG designed per NFPA 2112. The new annex provides one means by which the operator can determine if FRG is sufficient to achieve the personnel safety objectives for the facility.

Response Message: SR-64-NFPA 660-2024

Public Comment No. 197-NFPA 660-2024 [New Section after A.8.6.2.1]

Second Revision No. 80-NFPA 660-2024 [Sections Z.1, Z.2]

Z.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.

Z.1.1 NFPA Publications.

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

NFPA 1, *Fire Code,* 2024 edition.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2022 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems,* 2025 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems,* 2025 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2025 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* 2024 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* 2022 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection,* 2025 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* 2025 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2023 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2024 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2024 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* 2023 edition.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities,* 2013 edition.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities,* 2017 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2023 edition.

NFPA 69, *Standard on Explosion Prevention Systems,* 2024 edition.

NFPA 70®, *National Electrical Code®,* 2023 edition.

NFPA 70B, *Standard for Electrical Equipment Maintenance,* 2023 edition.

NFPA *70E®*, *Standard for Electrical Safety in the Workplace®,* 2024 edition.

NFPA 72®, *National Fire Alarm and Signaling Code®,* 2025 edition.

NFPA 77, *Recommended Practice on Static Electricity,* 2024 edition.

NFPA 79, *Electrical Standard for Industrial Machinery,* 2024 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2025 edition.

NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures,* 2022 edition.

NFPA 85, *Boiler and Combustion Systems Hazard Code,* 2023 edition.

NFPA 86, *Standard for Ovens and Furnaces,* 2023 edition.

NFPA 87, *Standard for Fluid Heaters,* 2024 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids,* 2020 edition.

NFPA *101®*, *Life Safety Code®,* 2024 edition.

NFPA 220, *Standard on Types of Building Construction,* 2024 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* 2024 edition.

NFPA 252, *Standard Methods of Fire Tests of Door Assemblies,* 2022 edition.

NFPA 400, *Hazardous Materials Code,* 2025 edition.

NFPA 484, *Standard for Combustible Metals,* 2022 edition.

~~NFPA 495, *Explosive Materials Code,* 2023 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,* 2024 edition.

NFPA 499, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas,* 2024 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks, Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations,* 2024 edition.

NFPA 600, *Standard on Facility Fire Brigades,* 2025 edition.

NFPA 601, *Standard for Security Services in Fire Loss Prevention,* 2025 edition.

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Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Mon Feb 26 09:04:23 EST 2024

Committee Statement

Committee Statement: Updating references to their most recent editions.

Response Message: SR-80-NFPA 660-2024

Second Revision No. 81-NFPA 660-2024 [Section No. Z.3]

Z.3 References for Extracts in Informational Sections.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2023 edition.

NFPA 70®, National Electrical Code®, 2023 edition.

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NFPA 2113, *Standard on the Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire,* ~~2020~~ 2025 edition.

Submitter Information Verification

Committee: CMD-FUN

Submittal Date: Mon Feb 26 09:06:35 EST 2024

Committee Statement

Committee Statement: This revision updates extracted text in accordance with the Extract Policy.

Response Message: SR-81-NFPA 660-2024