Second Revision No. 11-NFPA 654-2018 [Global Comment]

The following changes are part of this Global Revision:

1) Change “nano-powder” to “ultrafine particle” throughout the document

2) Change the definition of nano-powder (3.3.30) to:

3.3.30 Ultrafine particle. Individual particles that have a median size, in two or three dimensions, less than 500 nanometer (0.5 microns).

3) Add annex material to the definition:

A.3.3.30 Ultrafine particle. It is important for the user of this standard to be aware that ultrafine particles can present additional hazards that should be considered. Examples of additional hazards are the possible lowering of the MIE and/or MEC levels, the potential for particulates passing through filtration devices used in dust collection, pneumatic conveying, etc. The committee recognizes that the definition for ultrafine particles is wider than the definition in ASTM E2456-06 but has adopted this increased range because of the additional potential hazards associated with ultrafine particles. When the median size is <500 nm it is more likely that part of the size distribution will be lower than 100 nm and therefore a more detailed characterization and hazard assessment specific to ultrafine particles will be necessary.

Nanopowders/nanoparticles, which fall under this definition, are becoming more prevalent as specific-use materials in such industries as Additive Manufacturing.

Submitter Information Verification

Submitter Full Name: Laura Moreno

Committee:

Submittal Date: Thu May 31 11:04:59 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: This definition is roughly consistent with ASTM for ultrafine particles, and also consistent with the European Scientific Committee on Emerging and Newly Identified Health Risks.

Response Message: SR-11-NFPA 654-2018

Committee Notes:

Date	Submitted By	
May 31, 2018	Laura Moreno	Add ASTM E2456-06 to references. Title: Standard Terminology Relating to Nanotechnology. Edition: 2006 reapproved 2012

Public Comment No. 2-NFPA 654-2018 [Section No. 3.3.30]

Second Revision No. 12-NFPA 654-2018 [Global Comment]

Delete A.9.3.4.2.2:

~~A.9.3.4.2.2 For this application, conductive particulate solids typically are those materials having bulk resistivity <10^6 ohm-m.~~

Add a sub-definition to 3.3.X Conductive:

3.3.X.1 Conductive Particulate Solids. Particulate Solids with a volume resistivity of less than 10^6 ohm-m.

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Thu May 31 11:15:53 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: There was confusion as to why conductive particulate solids were not allowed to be used with Type D FIBCs. Moving this section from the annex to a definition, similar to the definition of conductive dust in NFPA 652, will help alleviate this confusion. The Technical Committee recognizes the difference between “less than 10^5 ohm-m” for conductive material and” less than 10^6 ohm-m” for conductive dusts or particulate solids, and asks the NFPA 652 Technical Committee to clarify this difference.

Response Message: SR-12-NFPA 654-2018

Committee Notes:

Date	Submitted By	
May 31, 2018	Laura Moreno	This needs to ballot separately from the new definition for conductive.

Second Revision No. 16-NFPA 654-2018 [Global Comment]

See attached Word document for the reorganized layout of the document, including language to clarify retroactivity.

Supplemental Information

File Name	Description	Approved
654_SR_16_Global_Reorg.docx	New order of the document, with the section number changes shown in tracked changes	
Road_Map.xlsx	For Staff Use	

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Thu May 31 15:55:47 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: The document is being reorganized to align with NFPA 652 to comply with the Correlating Committee guidance and to assist the user in recognizing similar requirements. The requirements which are to be applied retroactively have also been clarified.

Response Message: SR-16-NFPA 654-2018

Committee Notes:

Date	Submitted By	
Jun 1, 2018	Laura Moreno	See word file for the new layout and section numbers shown in tracked changes. The excel file shows where the old sections went. All annex material should move with the body sections.

Public Comment No. 3-NFPA 654-2018 [Global Input]

NOTE: CROSS REFERENCES HAVE NOT BEEN UPDATED IN THIS FILE

Chapter 4 General Requirements

4.1~~.3~~ Owner's Obligation.

The facility owner/operator shall be responsible for ensuring that the facility and the systems handling combustible particulate solids are designed, installed, and maintained in accordance with the requirements of this standard and NFPA 652.

4.~~6~~ 2 Objectives.

The objectives stated in this section shall be interpreted as intended outcomes of this standard and not as prescriptive requirements. [**652:**4.2]

4.~~6~~2.1 Life Safety.

4.~~6~~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 for the time needed to evacuate, relocate, or take refuge. [**652:**4.2.1.1]

4.~~6~~2.1.1.1

The facility, processes, and equipment shall be designed, constructed, equipped, and maintained and management systems shall be implemented to reasonably prevent serious injury from flash fires. [**652:**4.2.1.2]

4.~~6~~2.1.1.2

The facility, processes, and equipment shall be designed, constructed, equipped, and maintained and management systems shall be implemented to reasonably prevent serious injury from explosions. [**652:**4.2.1.3]

4.~~6~~2.1.2

The structure shall be located, designed, constructed, and maintained to reasonably protect adjacent properties and the public from the effects of fire, flash fire, or explosion. [**652:**4.2.1.4]

4.~~6~~2.2 Structural Integrity.

The facility shall be designed, constructed, and equipped to maintain its structural integrity in spite of the effects of fire or explosion for the time necessary to evacuate, relocate, or defend in place occupants not in the immediate proximity of the ignition.

4.~~6~~2.3* Mission Continuity.

The facility, processes, and equipment, shall be designed, constructed, equipped, and maintained and management systems shall be implemented to limit damage to levels that ensure the ongoing mission, production, or operating capability of the facility to a degree acceptable to the owner/operator. [**652:**4.2.2]

4.~~6~~2.4 Mitigation of Fire Spread and Explosions.

The facility and processes shall be designed to prevent fires and explosions that can cause failure of adjacent buildings or building compartments or other enclosures, emergency life safety systems, adjacent properties, adjacent storage, or the facility's structural elements.

4.~~6~~2.4.1*

The structure shall be designed, constructed, and maintained to prevent fire or explosions from causing failure of load-bearing structural members, from propagating into adjacent interior compartments, and from incapacitating fire protective and emergency life safety systems in adjacent compartments.

4.~~6~~2.4.2

The structure shall be located, designed, constructed, equipped, and maintained to prevent the propagation of fire or explosion to or from adjacent storage or structures.

4.~~7~~3* Compliance Options.

The goal in Section 1.3 and the objectives in Section 4.6 shall be achieved by either of the following means:

(1) The prescriptive provisions in accordance with Chapters 6 through 12 of this standard

(2) The performance-based provisions in accordance with Chapters 5, 8, 9, 11, and 12 of this standard

Chapter 5 Hazard Identification

5.1 The materials handled in the facility shall be evaluated for their hazard in accordance with Chapter 5 of NFPA 652.

Chapter 6 Performance-Based Design Option

~~5~~6.1 General Requirements.

~~5~~6.1.1 Approved Qualifications.

The performance-based design shall be prepared by a person knowledgeable about the affected systems and their associated hazards and with qualifications acceptable to the owner/operator.

~~5~~6.1.2* Independent Review.

The AHJ shall be permitted to obtain an independent third party review of the proposed design.

~~5~~6.1.3*

Performance-based designs shall be documented with all calculations, references, assumptions, and sources from which material characteristics and other data have been obtained or on which the designer has relied for some material aspect of the design in accordance with Section 5.8 of NFPA *101*. The documentation requirements of 5.8.6 shall be supplemented to include documentation of flash fire and explosion scenarios.

~~5~~6.1.3.1

A sensitivity analysis shall be performed for each assumption that is not provided in an authoritative reference acceptable to the AHJ to show that variation of said assumption does not result in a failure to meet design criteria.

~~5~~6.1.3.2

The source of all calculation methods and models shall be documented with their limits of applicability.

~~5~~6.1.4*

Performance-based designs and documentation shall be updated and subject to re-approval if any of the assumptions on which the original design was based are changed.

~~5~~6.1.5* Sources of Data.

~~5~~6.1.5.1

Data sources shall be identified and documented for each input data requirement that must be met using a source other than a design fire scenario, an assumption, or a building design specification.

~~5~~6.1.5.2

The degree of conservatism reflected in such data shall be specified, and a justification for the sources shall be provided.

~~5~~6.2 Performance Criteria.

A system and facility design shall be deemed to meet the objectives specified in Section 4.6 if its performance meets the criteria in 5.2.1 through 5.2.5.

~~5~~6.2.1 Occupant Life Safety.

~~5~~6.2.1.1

The life safety objectives of 4.6.1 with respect to a fire hazard shall be achieved if either of the following criteria is met:

(1) Ignition has been prevented.

(2) Under all fire scenarios, no person, other than those in the immediate proximity of the ignition, is exposed to untenable conditions due to the fire, and no critical structural

element of the building is damaged to the extent that it can no longer support its design load during the period of time necessary to effect complete evacuation of the occupants.

~~5~~6.2.1.2

The life safety objectives of 4.6.1 with respect to an explosion hazard shall be achieved if either of the following criteria is met:

(1) Ignition has been prevented.

(2) Under all explosion scenarios, no person, other than those in the immediate proximity of the ignition, is exposed to untenable conditions, including missile impact or overpressure, due to the occurrence of an explosion, and no critical structural element of the building is damaged to the extent that it can no longer support its design load during the period of time necessary to effect complete evacuation of the occupants.

~~5~~6.2.2* Structural Integrity.

The structural integrity objective of 4.6.2 with respect to fire and explosion shall be achieved when no critical structural element of the building is damaged to the extent that it can no longer support its design load under all fire and explosion scenarios.

~~5~~6.2.3 Mission Continuity.

The mission continuity objectives of 4.6.3 shall be achieved when damage to equipment and the facility has been limited to a level of damage acceptable to the owner/operator.

~~5~~6.2.4 Mitigation of Fire Spread and Explosions.

When limitation of fire 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 or explosion from propagating from one process system to an adjacent process system or to the building interior.

~~5~~6.2.5 Effects of Explosions.

Where the prevention of damage due to explosion is to be achieved, deflagrations shall not produce any of the following conditions:

(1) Internal pressures in the room or equipment sufficient to threaten its structural integrity

(2) Extension of the flame front outside the compartment or equipment of origin except where intentionally vented to a safe location

(3) *Rupture of the compartment or equipment of origin and the ejection of fragments that can constitute missile hazards

~~5~~6.3* Design Scenarios.
~~5~~6.3.1 Fire Scenarios.
~~5~~6.3.1.1

Each fuel object in the compartment shall be considered for inclusion as a fire scenario.

~~5~~6.3.1.2

The fuel object that produces the most rapidly developing fire during startup, normal operating conditions, or shutdown shall be included as a fire scenario.

~~5~~6.3.1.3

The fuel object that produces the most rapidly developing fire under conditions of a production upset or single equipment failure shall be included as a fire scenario.

~~5~~6.3.1.4

The fuel object that produces the greatest total heat release during startup, normal operating conditions, or shutdown shall be included as a fire scenario.

~~5~~6.3.1.5

The fuel object that produces the greatest total heat release under conditions of a production upset or single equipment failure shall be included as a fire scenario.

~~5~~6.3.1.6

The fuel object that can produce a deep-seated fire during startup, normal operating conditions, or shutdown shall be included as a fire scenario.

~~5~~6.3.1.7

The fuel object that can produce a deep-seated fire under conditions of a production upset or single equipment failure shall be included as a fire scenario.

~~5~~6.3.2 Explosion Scenarios.
~~5~~6.3.2.1

Each duct, enclosed conveyor, silo, bunker, AMS, or other vessel containing a combustible dust in sufficient quantity or conditions to support the propagation of a flame front during startup, normal operating conditions, or shutdown shall be included as an explosion scenario.

~~5~~6.3.2.2

Each duct, enclosed conveyor, silo, bunker, AMS, or other vessel containing a combustible dust in sufficient quantity or conditions to support the propagation of a flame front under conditions of production upset or single equipment failure shall be included as an explosion scenario.

~~5~~6.3.2.3

Each building or building compartment containing a combustible dust in sufficient quantity or conditions to support the propagation of a flame front during startup, normal operating conditions, or shutdown shall be included as an explosion scenario.

~~5~~6.3.2.4

Each building or building compartment containing a combustible dust in sufficient quantity or conditions to support the propagation of a flame front under conditions of production upset or single equipment failure shall be included as an explosion scenario.

~~5~~6.4 Evaluation of Proposed Design.
~~5~~6.4.1* General.

A proposed design's performance shall be assessed relative to each performance objective in Section 4.6 and each applicable scenario in Section 5.3, with the assessment conducted through the use of appropriate calculation methods acceptable to the AHJ.

~~5~~6.4.2

The design professional shall establish numerical performance criteria for each of the objectives in Section 4.6.

~~5~~6.4.3

The design professional shall use the assessment methods to demonstrate that the proposed design will achieve the goals and objectives, as measured by the performance criteria in light of the safety margins and uncertainty analysis, for each scenario, given the assumptions.

~~Chapter 6 Facility and Systems Design~~
Chapter 7 Dust Hazards Analysis (DHA)
~~4.2~~7.1 ~~Dust Hazards Analysis (DHA)~~General Requirements.
~~4.2~~7.1.1
The requirements of Section 4.2 shall apply retroactively in accordance with 4.2.1.1 through 4.2.1.3. [**652:**7.1.1]
~~4.2~~7.1.1.1*
A DHA shall be completed for all new processes and facility compartments. [**652:**7.1.1.1]
~~4.2~~7.1.1.2
For existing processes and facility compartments a DHA shall be completed by September 7, 2020.[**652:**7.1.1.2]
~~4.2~~7.1.1.3

The owner/operator shall demonstrate reasonable progress each year in completing DHAs prior to the deadline set in 4.2.1.2. [**652:**7.1.1.3]

~~4.2~~7.1.2

The owner/operator of a facility where materials determined to be combustible or explosible in accordance with Chapter 5 of NFPA 652 are present in an enclosure shall be responsible to ensure a DHA is completed in accordance with the requirements of Chapter 7 of NFPA 652. [**652:**7.1.2]

~~4.2~~7.1.3

The absence of previous incidents shall not be used as the basis for not performing a DHA. [**652:**7.1.3]

~~4.2~~7.1.4

The DHA shall be reviewed and updated at least every 5 years. [**652:**7.1.4]

~~**6.1 General.**~~

~~The facility and process shall be designed and operated in accordance with this chapter.~~

~~6.1.1~~7.2 Hazard Assessment.

7.2.1

The facility and process equipment shall be evaluated for dust flash-fire and dust explosion hazards in accordance with this chapter. The hazard assessment shall be conducted in accordance with the retroactivity provisions in Section 4.2.

~~6.1~~7.2.1.1

Those portions of the process and facility interior where dust accumulations exist external to equipment in sufficient depth to prevent discerning the underlying contrasting surface color shall be evaluated to determine if a dust explosion hazard or flash-fire hazard exists.

~~6.1~~7.2.1.2

Areas where dust clouds of a hazardous concentration exist shall be deemed to be dust flash-fire and dust explosion hazard areas.

~~6.1~~7.2.1.3*

Dust flash-fire or dust explosion hazard areas shall additionally be determined in accordance with any one of the following four methods:

(1) Layer depth criterion method in 6.1.3

(2) Mass method A in 6.1.4

(3) Mass method B in 6.1.5

(4) Risk assessment method in 6.1.6

7.2~~6.1~~.1.4

Each of the methods in 6.1.3, 6.1.4, 6.1.5, and 6.1.6 shall be deemed to provide equivalent levels of safety.

7.2~~6.1~~.1.5*

It shall be permitted to determine the accumulated mass and bulk density on a dry weight basis by drying the sample to less than or equal to 5 percent moisture by weight.

7.2~~6.1~~.1.6

Dust accumulations are deemed nonseparated unless segregation, separation, or detachment is used to limit the hazard area in accordance with Section 6.2.

7.2~~6.1~~.1.7

All dust accumulated on structures above the lowest footprint shall be evaluated as if accumulated on the lowest footprint.

7.2~~6.1~~.1.8

Dust accumulation amounts shall reflect the conditions that exist just prior to routinely scheduled cleaning and shall not include short-term accumulations cleaned in accordance with Chapter 8.

7.2~~6.1~~.1.9

The process equipment shall be assessed in accordance with 6.1.7.

7.2~~6.1~~.1.10

Personnel exposed to a dust flash-fire hazard shall be protected in accordance with 11.2.2.

~~6.1~~7.2.2

Those portions of the facility and process where a dust explosion hazard or flash-fire hazard exists shall be protected from the effects of those hazards in accordance with this section as well as Sections 6.2, 6.3, and 6.4 and Chapter 7.

7.2~~6.1~~.3* Layer Depth Criterion Method.

A dust flash-fire or dust explosion hazard area exists when the average dust layer thickness measured external to process equipment over the compartment area exceeds the quantity determined in 6.1.3.1 and 6.1.3.2.

7.2~~6.1~~.3.1

The layer depth criterion, which is 1/32 in. (0.8 mm), shall be permitted to be increased according to the following equation for materials with bulk density less than 75 lb/ft^3 (1200 kg/m^3):

 **[6.1.3.1]**

where:

LD = layer depth (in.)

BD = Bulk density (lb/ft^3)

7.2~~6.1~~.3.2*

A dust explosion hazard and dust flash-fire hazard shall be deemed to exist in any building or room where any of the following conditions exists:

(1) The total area of nonseparated dust accumulations exceeding the layer depth criterion is greater than 5 percent of the footprint area

(2) The area of any single nonseparated dust accumulation exceeding the layer depth criterion is greater than 1000 ft^2 (92.9 m^2)

(3) The total volume of nonseparated dust accumulations is greater than the layer depth criterion multiplied by 5 percent of the footprint area

(4) The total volume of any single nonseparated dust accumulation is greater than the layer depth criterion multiplied by 1000 ft^2 (92.9 m^2)

7.2~~6.1~~.4* Mass Method A.

A dust flash-fire or dust explosion hazard area exists when the total accumulated dust external to process equipment exceeds the quantities determined from the equations in 6.1.4.1 and 6.1.4.2.

7.2~~6.1~~.4.1

The threshold dust mass establishing a building or room as a dust explosion hazard area, $M_{basic\text{-}exp}$, shall be determined by the following equation:

 **[6.1.4.1]**

where:

$M_{basic\text{-}exp}$ = threshold dust mass (kg) based on building damage criterion

A_{floor} = lesser of enclosure floor area (m^2) or 2000 m^2

H = lesser of enclosure ceiling height (m) or 12 m

7.2~~6.1~~.4.2

The threshold dust mass establishing a building or room as a dust flash-fire hazard area, $M_{basic\text{-}fire}$, shall be determined by the following equation:

 **[6.1.4.2]**

where:

$M_{basic\text{-}fire}$ = threshold dust mass (kg) based on personnel fire exposure criterion

A_{floor} = lesser of enclosure floor area (m^2) or 2000 m^2

7.2~~6.1~~.5* Mass Method B.

A dust flash-fire or dust explosion hazard area exists when the total accumulated dust external to process equipment exceeds the quantities determined from the equations in 6.1.5.1 and 6.1.5.2.

7.2~~6.1~~.5.1*

The threshold dust mass establishing a building or room as a dust explosion hazard area, M_{exp}, shall be determined by the following equation:

[6.1.5.1]

where:

M_{exp} = threshold dust mass (kg) based on building damage criterion,

P_{es} = enclosure strength evaluated based on static pressure calculations for the weakest building structural element not intended to vent or fail (bar g) per NFPA 68

DLF = dynamic load factor, the ratio of maximum dynamic deflection to static deflection per NFPA 68

C_w = worst-case dust concentration (kg/m^3) at which the maximum rate-of-pressure-rise results in tests conducted per ASTM E1226

P_{max} = maximum pressure (bar g) developed in ASTM E1226 tests with the accumulated dust sample

A_{floor} = enclosure floor area (m^2)

H = enclosure ceiling height (m)

η_D = entrainment fraction = 0.25

7.2~~6.1~~.5.1.1

In the absence of detailed structural response analysis, it shall be permitted to assume a worst-case value of DLF = 1.5 and design based on the weakest structural element of the enclosure.

7.2~~6.1~~.5.1.2*

It shall be permitted to use an alternative value of η_D based on a risk assessment that is acceptable to the AHJ.

7.2~~6.1~~.5.2*

The threshold dust mass establishing a building or room as a dust flash-fire hazard area, M_{fire}, shall be determined by the following equation:

[6.1.5.2]

where:

M_{fire} = threshold dust mass (kg) based on personnel fire exposure criterion

ρ = probability of flame impingement on a person, not to exceed 0.05 (5 percent probability)

C_w = worst-case dust concentration (kg/m^3) at which the maximum rate-of-pressure-rise results in tests conducted per ASTM E1226

$P_{initial}$ = 1 bar absolute

P_{max} = maximum pressure (bar g) developed in ASTM E1226 tests with the accumulated dust sample

A_{floor} = enclosure floor area (m^2)

D = nominal height of a person (2 m)

η_D = entrainment fraction = 0.25

7.2~~6.1~~.5.2.1*

It shall be permitted to use an alternative value of η_D, based on a risk assessment that is acceptable to the AHJ.

7.2~~6.1~~.6* Risk Assessment Method.

A documented risk assessment acceptable to the AHJ shall be permitted to be conducted to determine whether or where a dust explosion hazard or dust flash-fire hazard area exists.

7.2~~6.1~~.7

An explosion hazard shall be deemed to exist in enclosed process equipment where both of the following conditions are possible:

(1) Combustible dust is present in sufficient quantity to cause enclosure rupture if suspended and ignited.

(2) A means of suspending the dust is present.

Chapter 8 Management Systems

8.1 Retroactivity.

This chapter shall be applied retroactively to new and existing facilities and processes.

8.2 General (Reserved)

8.3 Operating Procedures. *(See 8.8.2)*

8.~~2~~ 4 Housekeeping Procedures and Portable Vacuum Cleaners.

~~All requirements of 8.2.1 through 8.2.3 shall be applied retroactively.~~

8.~~2~~4.1 Cleaning Frequency.

8.~~2~~4.1.1*

Where the facility is intended to be operated with less than the dust accumulation defined by the owner/operator's chosen criterion in Section 6.1, the housekeeping frequency shall be established to ensure that the accumulated dust levels on 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, does not exceed the threshold dust mass/accumulation.

8.~~2~~4.1.2

Where the facility is intended to be operated with less than the dust accumulation defined by the owner/operator's chosen criterion in Section 6.1, a planned inspection process shall be implemented to evaluate dust accumulation rates and the housekeeping frequency required to maintain dust accumulations below the threshold dust mass/accumulation.

8.~~2~~4.1.3*

Where the facility is intended to be operated with less than the dust accumulation defined by the owner/operator's chosen criterion in Section 6.1, the housekeeping procedure shall include specific requirements establishing time to clean local spills or short-term accumulation to allow the elimination of the spilled mass or accumulation from the calculations in Section 6.1.

8.~~2~~4.1.4*

Where the facility is intended to be operated with more than the dust accumulation defined by the owner/operator's chosen criterion in Section 6.1, a documented risk assessment acceptable to the AHJ shall be permitted to be conducted to determine the level of housekeeping consistent with any dust explosion and dust flash-fire protection measures provided in accordance with Section 6.4 and 11.2.2.

8.~~2~~4.2 Cleaning Methods.

8.~~2~~4.2.1

Surfaces shall be cleaned in a manner that minimizes the risk of generating a fire or explosion hazard.

8.~~2~~4.2.2

Vacuuming shall be the preferred method of cleaning.

8.~~2~~4.2.3

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

8.~~2~~4.2.4*

Blowdowns using compressed air or steam shall be permitted to be used for cleaning inaccessible surfaces or surfaces where other methods of cleaning result in greater personal safety risk. Where blowdown using compressed air is used, the following precautions shall be followed:

(1) Vacuuming, sweeping, or water washdown methods are first used to clean surfaces that can be safely accessed prior to using compressed air.

(2) Dust accumulations in the area after vacuuming, sweeping, or water washdown do not exceed the threshold dust accumulation.

(3) Compressed air hoses are equipped with pressure relief nozzles limiting the discharge gauge pressure to 30 psi (207 kPa)in accordance with the OSHA requirements in 29 CFR 1910.242(b), "Hand and Portable Powered Tools and Equipment, General."

(4) All electrical equipment potentially exposed to airborne dust in the area meets, as a minimum, the requirements of *NFPA 70*; NEMA 12 as defined by NEMA 250, *Enclosures for Electrical Equipment*; or the equivalent.

(5) All ignition sources and hot surfaces capable of igniting a dust cloud or dust layer are shut down or removed from the area.

8.~~2~~4.2.5*
Housekeeping procedures shall be documented in accordance with the requirements of Sections 4.2 and 4.3.

8.~~2~~4.3* Portable Vacuum Cleaners.

8.~~2~~4.3.1
Portable vacuum cleaners with a dirty side volume greater than 8 ft^3 shall comply with 7.1.4 and 7.1.6. [**652:**9.4.2.2.1.1]

8.~~2~~4.3.2*
When metal particles, dusts, or powders are being cleaned NFPA 484 shall be the reference source for proper use and limitations of both dry and wet portable vacuum cleaners. [**652:**9.4.2.2.1.2]

8.~~2~~4.3.3*
The operation of portable vacuum cleaning devices shall be subject to a dust hazard analysis to ensure that the risk to personnel and facility operations from deflagrations is minimized. [**652:**9.4.2.2.1.3]

8.~~2~~4.3.4
Hoses and vacuum tools shall be appropriate for use and be static dissipative or conductive. [**652:** 9.4.2.2.1.4]

8.~~2~~4.3.5
Portable vacuum cleaners shall not be used on processes generating hot embers or sparks. [**652:**9.4.2.2.1.5]

8.~~2~~4.3.6*
For portable vacuum cleaners used with combustible dusts having a minimum ignition energy less than 30 mJ, the path to ground shall be verified prior to use after each movement or new connection, or both. [**652:**9.4.2.2.1.6]

8.~~2~~4.3.7*
Portable vacuum cleaners that meet the following minimum requirements shall be permitted to be used to collect combustible particulate solids in unclassified (general purpose) areas:

(1) Materials of construction shall comply with 7.13.2 and 9.3.2.

(2) Hoses shall be conductive or static dissipative.

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

(4) Dust-laden air shall not pass through the fan or blower.

(5) Electrical motors shall not be in the dust-laden air stream unless listed for Class II, Division 1, locations.

(6) *When liquids or wet material are picked up by the vacuum cleaner, paper filter elements shall not be used.

(7) Vacuum cleaners used for metal dusts shall meet the requirements of NFPA 484.

8.~~2~~4.3.8*
In Class II electrically classified (hazardous) locations, vacuum cleaners shall be listed for the purpose and location or shall be a fixed-pipe suction system with remotely located exhauster and AMS installed in conformance with Section 7.13 and shall be suitable for the dust being collected.

8.~~2~~4.3.9
Where flammable vapors or gases are present, vacuum cleaners shall be listed for Class I and Class II hazardous locations.

~~9~~8.5 Open Flames and Sparks (Hot Work).

~~The requirements of 9.5.1 through 9.5.3 shall be applied retroactively.~~

~~9~~8.5.1

Cutting and welding shall comply with the applicable requirements of NFPA 51B.

~~9~~8.5.2

Grinding, chipping, and other operations that produce either sparks or open-flame ignition sources shall be controlled by a hot work permit system in accordance with NFPA 51B.

~~9~~8.5.3

Smoking shall be permitted only in designated areas.

8.6 Personal Protective Equipment (PPE). *(See 8.8.2)*

~~Chapter 12~~8.7 Inspection and Maintenance

~~12~~8.7.1 General Requirements.

~~The requirements of 12.1.1 through 12.1.3 shall be applied retroactively.~~

~~12~~8.7.1.1

An inspection, testing, and maintenance program shall be developed and implemented to ensure that the fire and explosion protection systems and related process controls and equipment perform as designed.

~~12~~8.7.1.2

The inspection, testing, and maintenance program shall include the following:

(1) Fire and explosion protection and prevention equipment in accordance with the applicable NFPA standards

(2) Dust control equipment

(3) Housekeeping

(4) Potential ignition sources

(5) *Electrical, process, and mechanical equipment, including process interlocks

(6) Process changes

(7) Lubrication of bearings

~~12~~8.7.1.3

Records shall be kept of maintenance and repairs performed.

8.7~~12~~.2 Specific Requirements.

8.7~~12~~.2.1 Maintenance of Material Feeding Devices.

8.7~~12~~.2.1.1

Bearings shall be lubricated and checked for excessive wear on a periodic basis.

8.7~~12~~.2.1.2

If the material has a tendency to adhere to the feeder or housing, the components shall be cleaned periodically to maintain good balance and minimize the probability of ignition.

8.7~~12~~.2.2 Maintenance of Air-Moving Devices.

8.7~~12~~.2.2.1

Fans and blowers shall be checked periodically for excessive heat and vibration.

8.7~~12~~.2.2.2

Maintenance, other than the lubrication of external bearings, shall not be performed on fans or blowers while the unit is operating.

8.7~~12~~.2.2.3

Bearings shall be lubricated and checked periodically for excessive wear.

8.7~~12~~.2.2.4*

If the material has a tendency to adhere to the rotor or housing, the components shall be cleaned periodically to maintain good balance and minimize the probability of ignition.

8.7~~12~~.2.2.5*

The surfaces of fan housings and other interior components shall be maintained free of rust.

8.7~~12~~.2.2.6

Aluminum paint shall not be used on interior steel surfaces.

8.7~~12~~.2.3 Maintenance of Air-Material Separators.

8.7~~12~~.2.3.1 Means to Dislodge.

8.7~~12~~.2.3.1.1

Air-material separation devices that are equipped with a means to dislodge particulates from the surface of filter media shall be inspected periodically as recommended in the manufacturers' instructions for signs of wear, friction, or clogging.

8.7~~12~~.2.3.1.2

These devices shall be adjusted and lubricated as recommended in the manufacturers' instructions.

8.7~~12~~.2.3.2

AMSs that recycle air (i.e., cyclones and filter media dust collectors) shall be maintained to comply with 7.13.1.6.3.

8.7~~12~~.2.3.3

Filter media shall not be replaced with an alternative type unless a thorough evaluation of the fire hazards has been performed, documented, and reviewed by management.

8.7~~12~~.2.4 Maintenance of Abort Gates and Abort Dampers.

Abort gates and abort dampers shall be adjusted and lubricated as recommended in the manufacturers' instructions.

8.7~~12~~.2.5 Maintenance of Fire and Explosion Protection Systems.

8.7~~12~~.2.5.1

All fire detection equipment monitoring systems shall be maintained in accordance with the requirements of *NFPA 72*.

8.7~~12~~.2.5.2

All fire-extinguishing systems shall be maintained pursuant to the requirements established in the standard that governs the design and installation of the system.

8.7~~12~~.2.5.3*

All vents for the relief of pressure caused by deflagrations shall be maintained.

8.7~~12~~.2.5.4

All explosion prevention systems and inerting systems shall be maintained pursuant to the requirements of NFPA 69.

~~10.9~~8.7.3 Impairments of Fire Protection and Explosion Prevention Systems.

8.7.3~~10.9~~.1*

Impairments shall include anything that interrupts the normal intended operation of the fire protection or explosion prevention system.

8.7.3~~10.9~~.2*

A written impairment procedure shall be followed for every impairment to the fire protection or explosion prevention system.

8.7.3~~10.9~~.3*

Impairments shall be limited in size and scope to the system or portion thereof being repaired, maintained, or modified.

8.7.3~~10.9~~.4*

Impairment notification procedures shall be implemented by management to notify plant personnel and the AHJ of existing impairments and their restoration.

~~Chapter 11~~8.8 Training and Procedures

~~11~~8.8.1 Employee Training.

~~The requirements of this chapter shall be applied retroactively.~~

8.8~~11~~.2 Plan.

8.8~~11~~.2.1

Operating and maintenance procedures shall be developed.

8.8~~11~~.2.2*

Operating and maintenance procedures shall address personal protective equipment (PPE), including flame-resistant garments, in accordance with the workplace hazard assessment required by NFPA 2113.

8.8~~11~~.2.~~4~~ 3

The plans and procedures shall be reviewed annually and as required by process changes.

8.8~~11~~.3 Initial and Refresher Training.

8.8~~11~~.3.1

Initial and refresher training shall be provided to employees who are involved in operating, maintaining, and supervising facilities that handle combustible particulate solids.

8.8~~11~~.3.2

Initial and refresher training shall ensure that all employees are knowledgeable about the following:

(1) Hazards of their workplace

(2) General orientation, including plant safety rules

(3) Process description

(4) Equipment operation, safe startup and shutdown, and response to upset conditions

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

(6) Equipment maintenance requirements and practices

(7) Housekeeping requirements

(8) *Emergency response plans

8.8~~11~~.4 Certification.
The employer shall certify annually that the training and review required by Sections 11.2 and 11.3 have been completed.
8.9~~11.5~~ Contractors and Subcontractors.
8.9~~11.5~~.1
Owner/operators shall ensure that the requirements of 11.5.1.1 through 11.5.5 are met.
8.9~~11.5~~.1.1*
Only qualified contractors possessing the requisite craft skills shall be employed for work involving the installation, repair, or modification of buildings (interior and exterior), machinery, and fire protection equipment.
8.9~~11.5~~.1.2
Contractors involved in the commissioning, repair, or modification of explosion protection equipment shall be qualified as specified in Chapter 15 of NFPA 69.
8.9~~11.5~~.2 Contractor Training.
8.9~~11.5~~.2.1
Contractors operating owner/operator equipment shall be trained and qualified to operate the equipment and perform the work.
8.9~~11.5~~.2.2

Written documentation shall be maintained detailing the training that was provided and who received it.

8.9~~11.5~~.3

Contractors working on or near a given process shall be made aware of the potential hazards from and exposures to fire, explosion, or toxic releases.

8.9~~11.5~~.4*

Contractors shall be trained and required to comply with the facility's safe work practices and policies, including but not limited to equipment lockout/tagout permitting, hot work permitting, fire system impairment handling, smoking, housekeeping, and use of PPE.

8.9~~11.5~~.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 areas.

8.10 Emergency Planning and Response
8.10.1~~11.2.3~~
A written emergency response plan shall be developed for preventing, preparing for, and responding to work-related emergencies including but not limited to fire and explosion.
8.10.2
The plans and procedures shall be reviewed annually and as required by process changes.

~~4.4~~8.11 Incident Investigation.
~~4.4.1~~
~~The requirements of 4.4.2 through 4.4.5 shall be applied to all facilities covered under the scope of this document.~~
~~4.4~~8.11.2*
Incidents that result in a fire or explosion of a magnitude that causes property damage, production shutdown time, or injury shall be investigated.
A.~~4.4~~8.11.2
Events where there are injuries, equipment damage, or significant business interruption are subject to investigation. [652:A.9.11.1]
In addition to investigation of fires and explosions, it is also a good practice to investigate near misses (i.e., events that could have resulted in 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. [652:A.9.11.1]
The retroactivity of this chapter is not intended to require investigation of incidents that occurred prior to the adoption of this standard.
~~4.4~~8.11.3

Commented [ML1]: Note: annex material changing. This is to cover the intent of the old 4.4.1.

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

~~4.4~~8.11.4*

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 recurrence of that or similar incidents.

~~4.4~~8.11.5*

A summary of the incident investigation report shall be shared with affected personnel operating, maintaining, and supervising the facility.

~~4.3~~8.12* Management of Change.

Written procedures shall be established and implemented to manage proposed changes to process materials, staffing, job tasks, technology, equipment, procedures, and facilities. [**652:**9.9.1]

~~4.3.1~~

~~The requirements of 4.3.1.1 through 4.3.1.3 shall be applied retroactively.~~

~~4.3~~8.12.1~~.1~~

The management-of-change procedures shall ensure that the following issues are addressed prior to any change:

(1) *The technical basis for the proposed change

(2) *The safety and health implications

(3) Whether the change is permanent or temporary, including the authorized duration of the temporary change

(4) Modifications to operating and maintenance procedures

(5) Employee training requirements

(6) Authorization requirements for the proposed change

(7) Results of characterization tests used to assess the hazard, if conducted

~~4.3~~8.12~~.1~~.2

Implementation of the management-of-change procedures shall not be required for replacements-in-kind. [**652:**9.9.3]

~~4.3~~8.12~~.1~~.3

Design documentation, as required by 4.1.2 and procedures shall be updated to incorporate the change.

8.13 Document Retention (Reserved)

8.14 Management Systems Review (Reserved)

8.15 Employee Participation (Reserved)

Chapter 9 Hazard Management: Mitigation and Prevention

~~4~~9.1 Process and Facility Design.

~~4~~9.1.1

The design of processes and facilities that handle combustible particulate solids shall consider the physical and chemical properties that establish the hazardous characteristics of the materials.

~~4~~9.1.2*

The design and its basis shall be documented and maintained for the life of the process.

9.2 Building Design

~~6~~9.2.2 Segregation, Separation, or Detachment of Combustible Dust Handling and Processing Areas.

9.2~~6~~.2.1 General.

Areas in which combustible dusts are produced, processed, handled, or collected such that combustible dust accumulation on exposed or concealed surfaces, external to equipment or containers, exceeds the threshold as determined in Section 6.1, shall be detached, segregated, or separated from other occupancies to minimize damage from a fire or explosion.

9.2~~6~~.2.2 Use of Segregation.

9.2~~6~~.2.2.1*

Physical barriers that are erected to segregate dust flash-fire hazards areas, including seals at all penetrations of floors, walls, ceilings, or partitions, shall have a minimum 1-hour fire resistance rating.

9.2~~6~~.2.2

Physical barriers that are erected to segregate dust explosion hazard areas shall be designed to preclude failure of those barriers during a dust explosion per NFPA 68.

9.2~~6~~.2.3

Doors and openings shall not be permitted in physical barriers unless they are normally are closed and have at least the strength and fire resistance rating required of the physical barrier. These doors shall be installed according to NFPA 80.

9.2~~6~~.2.3 Use of Separation.

9.2~~6~~.2.3.1*

Separation shall be permitted to be used to limit the dust explosion hazard or dust flash-fire hazard area where supported by a documented engineering evaluation acceptable to the AHJ.

9.2~~6~~.2.3.1.1

The required separation distance between the dust explosion hazard or flash-fire hazard area identified in Section 6.1 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 external to process equipment

(4) Building and equipment design

(5) Nature of surrounding exposures

9.2~~6~~.2.3.1.2

The separation area either shall be free of dust or, where dust accumulations exist on any surface, the surface colors below shall be readily discernible.

9.2~~6~~.2.3.1.3

Where separation is used to limit the dust flash-fire or dust explosion hazard area determined in Section 6.1, the minimum separation distance shall not be less than 35 ft (11 m), consistent with NFPA 51B.

9.2~~6~~.2.3.2*

Where separation is used, housekeeping, fixed dust collection systems employed at points of release, and compartmentation shall be permitted to be used to limit the extent of the dust explosion hazard or flash-fire hazard area.

9.2~~6~~.2.3.3

Where separation is used to limit a dust explosion hazard or dust flash-fire hazard area, dust thresholds in Section 6.1 shall be determined for this limited area such that the parameter A_{floor} in the equations in Section 6.1 is consistent with the limited area under consideration.

9.2~~6~~.3 Building Construction.

9.2~~6~~.3.1

All buildings shall be of Type I or Type II construction, as defined in NFPA 220.

9.2~~6~~.3.2

Where local, state, or national building codes are more restrictive, modifications shall be permitted for conformance to those codes.

9.2~~6~~.3.3*

Interior surfaces where dust accumulations can occur shall be designed and constructed so as to facilitate cleaning and to minimize combustible dust accumulations.

9.2~~6~~.3.4

Spaces inaccessible to housekeeping shall be sealed to prevent dust accumulation.

9.2~~6~~.3.5

Interior walls erected for the purpose of limiting fire spread shall be designed in accordance with NFPA 221 and have a minimum 1-hour fire resistance rating.

9.2~~6~~.3.6 Fire Doors.
9.2~~6~~.3.6.1

Openings in fire walls and in fire barrier walls shall be protected by self-closing fire doors that have a fire protection rating, when tested in accordance with NFPA 252, equivalent to the wall design.

9.2~~6~~.3.6.2

Fire doors shall be installed according to NFPA 80 and shall normally be in the closed position.

9.2~~6~~.3.7 Egress.

Means of egress shall comply with NFPA *101*.

9.2~~6~~.3.7.1*

Means of egress for buildings or building compartments that contain a deflagration hazard area shall be designed in accordance with Section 7.11 of NFPA *101*.

9.2~~6~~.3.8 Penetrations.

Where floors, walls, ceilings, and other partitions have been erected to control the spread of fire or deflagrations, penetrations in these structures shall be sealed to maintain their fire resistance rating and their physical integrity in a deflagration. *(See 7.6.7.)*

9.2~~6~~.3.9 Fire Resistance Rating.
9.2~~6~~.3.9.1*

Interior stairs and elevators shall be enclosed in shafts designed to prevent the migration of dust and that have a minimum fire resistance rating of in accordance with Section 8.6 of NFPA *101*.

9.2~~6~~.3.9.2*

Doors that are the automatic-closing or self-closing type and that have a minimum fire protection rating of 1 hour shall be provided at each landing.

9.2~~6~~.3.9.3

Stairs, elevators, and manlifts that serve only open-deck floors, mezzanines, and platforms shall not be required to be enclosed.

9.2~~6~~.3.10*

Floors and load-bearing walls that are exposed to dust explosion hazards shall be designed to preclude failure during an explosion.

9.2~~6~~.4* Deflagration Venting of Buildings or Building Compartments.
9.2~~6~~.4.1*

If a building or building compartment contains a dust explosion hazard area external to protected equipment as specified in 6.1.1.2 or 6.1.1.3, the building or building compartment shall be provided with deflagration venting in accordance with NFPA 68.

9.2~~6~~.4.2* Vent Closures.
9.2~~6~~.4.2.1

Vent closures shall be directed toward a restricted area.

9.2~~6~~.4.2.2

The vent closure shall not be a missile hazard.

9.2~~6~~.4.2.3

The fireball and the blast pressure that are created by the venting process shall not impinge on unrestricted personnel pathways.

9.3 Equipment Design ~~Chapter 7 Process Equipment~~
~~7~~9.3.1* General.
~~7~~9.3.1.1
Equipment shall be maintained and operated in a manner that minimizes the escape of dust.
~~7~~9.3.1.2

Methods of fire and explosion protection for specific equipment shall be in accordance with this section.

~~7~~9.3.1.3* Risk Assessment.

A documented risk assessment acceptable to the AHJ shall be permitted to be conducted to determine the level of protection to be provided per this chapter.

~~7.1.7~~9.3.1.4*

Systems for the pre-deflagration detection and control of ignition sources, installed in accordance with NFPA 69 shall be permitted to be used to reduce the probability of occurrence of a deflagration in the following:

(1) In ductwork supplying AMS

(2) In recycled air from AMS to a building

(3) In ductwork between process equipment

~~7~~9.3.2 Bulk Storage Enclosures.

9.3~~7~~.2.1 General.

9.3~~7~~.2.1.1

For the purposes of this section, bulk storage shall include items such as bins, tanks, hoppers, and silos.

9.3~~7~~.2.1.2*

The requirements of this section shall not apply to containers that are used for transportation of the material.

9.3~~7~~.2.2* Construction.

Bulk storage containers, whether located inside or outside of buildings, shall be constructed so as not to represent an increase in the fire load beyond the capabilities of the existing fire protection.

9.3~~7~~.2.3 Explosion Hazards.

9.3~~7~~.2.3.1

Where an explosion hazard exists, intertank or interbin venting shall not be permitted.

9.3~~7~~.2.3.2 Fixed Bulk Storage Location.

9.3~~7~~.2.3.2.1

Where an explosion hazard exists, fixed bulk storage containers shall be located outside of buildings.

9.3~~7~~.2.3.2.2

Fixed bulk storage containers shall be permitted to be located inside buildings where one of the following applies:

(1) Fixed bulk storage containers are protected in accordance with 7.1.4.

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

9.3~~7~~.2.3.3 Fixed Bulk Storage Protection.

9.3~~7~~.2.3.3.1

Where an explosion hazard exists, fixed bulk storage containers shall be protected in accordance with 7.1.4.

9.3~~7~~.2.3.3.2*

The explosion protection requirements of 7.1.4 shall not be required provided that the volume of the fixed bulk storage container is less than 8 ft^3 (0.2 m^3).

9.3~~7~~.2.3.3.3

The requirements of 7.2.3.3 shall not apply to storage and receiving containers that are used for transportation of the material.

9.3~~7~~.2.4* Interior Surfaces.

Interior surfaces shall be designed and constructed to facilitate cleaning and to minimize combustible dust accumulation.

9.3~~7~~.2.5* Access Doors and Openings.

9.3~~7~~.2.5.1

Access doors or openings shall be provided to allow inspection, cleaning, and maintenance.

9.37.2.5.2

Access doors or openings shall be designed to prevent dust leaks.

9.37.2.5.3

Access doors or openings that are not specifically designed for deflagration venting shall not be considered as providing that function.

9.37.2.5.4

Access doors shall be bonded and grounded.

9.37.2.5.5

Access doors not designed to be used as deflagration vents shall be designed to withstand the vented explosion pressure (P_{red}).

9.37.3 Material Transfer System.
9.37.3.1 General.
9.37.3.1.1*

Where more than one material is to be handled by a system, compatibility tests shall be run.

9.37.3.1.2

Where incompatibility is found, provisions shall be made for cleaning the system prior to transporting a new material.

9.37.3.1.3

Where the materials being conveyed are corrosive, the system shall be constructed of corrosion-resistant materials.

9.37.3.1.4

Where the atmosphere surrounding the conveying system is corrosive, the conveying system shall be constructed of corrosion-resistant materials.

~~4.5~~9.3.3.1.5* **~~Pneumatic Conveying, Dust Collection, and Centralized Vacuum Cleaning System Design.~~**
Systems that handle combustible particulate solids shall be designed by and installed under the supervision of qualified engineers who are knowledgeable about these systems and their associated hazards.

9.37.3.2* Pneumatic Conveying, Dust Collection, and Centralized Vacuum Cleaning Systems.
9.37.3.2.1

The design of the system shall be documented, and the documentation shall include the following information:

(1) Data on the range of particulate size

(2) Concentration of combustible dust in the conveyance air stream

(3) Potential for reaction between the transported particulates and the extinguishing media used to protect process equipment

(4) Conductivity of the particulates

(5) Other physical and chemical properties that could affect the fire protection of the process

9.37.3.2.2*

Existing systems shall not be modified without considering the effects of those changes on the system performance, including the redesign of the system to incorporate the proposed changes.

9.37.3.2.3

All system components that handle combustible particulate solids shall be designed to be dusttight, except for openings designed for intake and discharge of air and material.

9.37.3.2.4*

The system shall be designed and maintained to ensure that the air/gas velocity during operation shall at all times meet or exceed the minimum required to keep the interior surfaces of all piping free of particulate accumulations.

9.37.3.2.5* Pneumatic Conveying Systems.

Where a pneumatic conveying system operates at a gauge pressure of 15 psi (103 kPa) or greater, the components exposed to that pressure under normal or upset conditions shall be designed in accordance with Section VIII of the ASME *Boiler and Pressure Vessel Code* or ASME B31.3, *Process Piping*.

9.37.3.2.5.1*

Where a pneumatic conveying system or any part of such a system operates as a positive pressure–type system and the AMD's gauge discharge pressure is 15 psi (103 kPa) or greater, the system shall be designed in accordance with Section VIII of the ASME *Boiler and Pressure Vessel Code*; ASME B31.3, *Process Piping* or an international equivalent.

9.3.7.3.2.6 Dust Collection Systems.
9.37.3.2.6.1*
At each collection point, the system shall be designed to achieve the minimum required face velocity for dust capture over the entire opening of the hood or pickup point.
9.37.3.2.6.2*
The volumetric flow rate for each collection point shall be included in the system design documentation.
9.37.3.2.6.3*
The rate of airflow at each hood or pickup point for each dust source shall be designed so as to convey and control the collected dust.
9.37.3.2.6.4*
Branch lines shall not be disconnected and unused portions of the system shall not be blanked off without providing a means to maintain required and balanced airflow.
9.37.3.2.6.5*
Branch lines shall not be added to an existing system without reviewing the design of the entire system.
9.37.3.2.6.6*
All ductwork shall be sized to provide the air volume and air velocity necessary to keep the duct interior clean and free of residual material.
9.37.3.2.6.7
Dust collection systems that remove material from operations that generate flames, sparks, or hot material shall not be interconnected with dust collection systems that transport combustible particulate solids or hybrid mixtures.
9.37.3.2.6.8*
Heating, ventilation, and air conditioning (HVAC) systems shall not be used as the means to collect dusts from localized sources.
9.37.3.2.7* Centralized Vacuum Cleaning Systems.
9.37.3.2.7.1*
The system shall be designed to ensure minimum transport velocities at all times.
9.37.3.2.7.2*
The system shall be operated only with the hoses and tools that have been designated in the design documentation for the specific hose connection station.
9.37.3.2.7.3*
Vacuum hose, couplings, and tools shall be made of conductive or static-dissipative materials that are bonded and grounded in accordance with 9.3.2.3.
9.37.3.2.7.4*
Controls shall be provided to prevent overfilling the AMS, which could disable the system.
9.37.3.2.7.5
The maximum number of hose connection stations that can be simultaneously used shall be included in the system documentation.

9.37.3.3* Operations.
9.37.3.3.1 Sequence of Operation.

Pneumatic conveying, dust collection, and centralized vacuum cleaning systems shall be designed with the operating logic, sequencing, and timing outlined in 7.3.3.2 and 7.3.3.3.

9.37.3.3.2* Startup.

Pneumatic conveying, dust collection, and centralized vacuum cleaning systems shall be designed such that, on startup, the system achieves and maintains design air velocity prior to the admission of material to the system.

9.37.3.3.3 Shutdown.
9.37.3.3.3.1

Pneumatic conveying, dust collection, and centralized vacuum cleaning systems shall be designed such that, on normal shutdown of the process, the system maintains design air velocity until material is purged from the system.

9.37.3.3.2

The requirements of 7.3.3.3.1 shall not apply during emergency shutdown of the process, such as by activation of an emergency stop button or by activation of an automatic safety interlocking device.

9.37.3.3.3

Dilute phase pneumatic conveying systems shall be designed such that, upon restart after an emergency shutdown, residual materials can be cleared and design air velocity can be achieved prior to admission of new material to the system.

9.37.4 Specific Requirements for Systems that Convey Metal Particulates.
9.37.4.1 General.

This section shall apply to facilities that operate pneumatic conveying, dust collection, and centralized vacuum cleaning systems for metal particulates.

9.37.4.2

Systems handling metal particulates shall be designed in accordance with NFPA 484 in addition to the requirements of this section.

9.37.4.3* Water Reactivity.
9.37.4.3.1

Unless otherwise determined, metal particulates shall be deemed water-reactive, and water-based extinguishing agents shall not be used.

9.37.4.3.2

Specially engineered high-density water spray systems approved by the AHJ shall be permitted to be used.

9.37.4.3.3

The requirement of 7.4.3.1 shall not apply to the collection of iron dusts from shot blasting.

9.37.4.4

Systems that convey alloys that exhibit fire or explosion characteristics similar to those of the base metal shall be provided with the same protection as systems that convey the base metal.

9.37.4.5 Iron, Nickel, Copper, and Other Transition Metal Particulates.

Transition metal combustible particulates shall be classified as water-compatible, water-incompatible, or water-reactive based on the available chemical and physical data and in conjunction with the AHJ.

9.37.5 Systems That Convey Hybrid Mixtures.

The 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 exceed 25 percent within the airstream, except for systems protected in accordance with 7.1.4.1(1) through 7.1.4.1(4).

9.37.6 Duct Systems.
9.37.6.1

Ducts that handle combustible particulate solids shall conform to the requirements of NFPA 91 except as amended by the requirements of this chapter.

9.37.6.2

Ductwork shall be constructed of metal or noncombustible, conductive material in accordance with 9.3.2.

9.37.6.4*

Flexible hose and connections shall be permitted to be used for material pickup and vibration isolation in accordance with 9.3.2.

~~**7.6.5**~~

~~Bellows shall be permitted to be used for the free movement of weigh bins if the bellows are conductive and the equipment is bonded and grounded.~~

Commented [ML2]: This deletion is done by SR 22

9.37.6.6*

Changes in duct sizes shall be designed to prevent the accumulation of material by utilizing a tapered transformation piece with the included angle of the taper not more than 30 degrees.

9.37.6.7*

When ducts pass through a physical barrier that is erected to segregate dust deflagration hazards, physical isolation protection shall be provided to prevent propagation of deflagrations between segregated spaces.

9.37.7 Sight Glasses.
9.37.7.1

Sight glasses shall be of a material that is impact and erosion resistant.

9.37.7.2

Sight glass assemblies shall have a pressure rating equal to or greater than that of the ductwork.

9.37.7.3

Ductwork shall be supported on each side of the sight glass so that the sight glass does not carry any of the system weight and is not subject to stress or strain.

9.37.7.4

The mechanical strength of the sight glass–mounting mechanism shall be equal to the adjoining ductwork.

9.37.7.5

The inside diameter of a sight glass shall not cause a restriction of flow.

9.37.7.6

The connections between the sight glass and the ductwork shall be squarely butted and sealed so as to be both airtight and dusttight.

9.37.7.7

The electrical bonding across the length of the sight glass shall be continuous and have a resistance of no more than 1 ohm.

9.37.8 Pressure Protection Systems.
9.37.8.1 Vacuum Breakers.

Vacuum breakers shall be installed on negative-pressure systems if the pressure system is not designed for the maximum vacuum attainable.

9.37.8.2* Pressure Relief Devices.
9.37.8.2.1

Pressure relief devices for relief of pneumatic overpressure shall be installed on positive-pressure systems.

9.37.8.2.2

The requirement of 7.8.2.1 shall not apply to systems that are designed for a gauge pressure of less than 15 psi (103 kPa) and are provided with safety interlocks designed to prevent overpressure in accordance with ISA 84.00.01, *Functional Safety: Application of Safety Instrumented Systems for the Process Industry Sector*.

9.37.8.2.3

The requirement of 7.8.2.1 shall not apply to systems that are designed for a gauge pressure of less than 15 psi (103 kPa) and are capable of containing the maximum pressure attainable.

9.37.8.2.4*

Pressure relief devices shall not be vented to an area where a dust explosion hazard or dust flash-fire hazard exists, as specified by Section 6.1.

9.37.8.3 Airflow Control Valves.
9.37.8.3.1

Airflow control valves that are installed in pneumatic conveying, dust collection, or centralized vacuum cleaning systems shall be of both airtight and dusttight construction.

9.37.8.3.2

Airflow control valves shall be sized to allow passage of the total airflow of the system when the damper is fully open.

9.37.8.3.3

The position of airflow control valves shall be visually indicated.

9.37.8.3.4

Manually adjusted airflow control valves, dampers, gates, or orifice plates shall have a means of securing them to prevent subsequent adjustment or manipulation once the system is balanced.

9.37.8.3.5

Diverter valves shall effect a positive diversion of the material and shall mechanically seal all other directions from air or material leakage.

9.37.9 Material Feeding Devices.
9.37.9.1 Mechanical Feeding Devices.
9.37.9.1.1

Mechanical feeding devices shall be equipped with a shear pin or overload detection device and alarm.

9.37.9.1.2

The alarm shall sound at the operator control station.

9.37.9.2 Drives.
9.37.9.2.1

All drives used in conjunction with feeders, air locks, and other material feeding devices shall be directly connected.

9.37.9.2.2

Belt, chain and sprocket, or other indirect drives that are designed to stall the driving forces without slipping and to provide for the removal of static electric charges shall be permitted to be used.

9.37.10* Bucket Elevators.
9.37.10.1 Deflagration Protection.
9.37.10.1.1

Where an explosion hazard exists, bucket elevators shall be protected in accordance with 7.1.4.

9.37.10.2

Elevator casings, head and boot sections, and connecting ducts shall be dusttight and shall be constructed of noncombustible materials.

9.37.10.3

Where provided, inlet and discharge hoppers shall be designed to be accessible for cleaning and inspection.

9.37.10.4 Power Cutoff.
9.37.10.4.1*

Belt-driven bucket elevators shall be provided with a detector that cuts off the power to the drive motor if the motor speed drops below 80 percent of normal operating speed.

9.37.10.4.2

Feed to the elevator leg shall be stopped or diverted when the power to the motor is stopped.

9.37.10.5 Belts.
9.37.10.5.1

Belt-driven bucket elevators shall have a nonslip material (lagging) installed on the head pulley to minimize slippage.

9.37.10.5.2*

Belts and lagging shall be fire and oil resistant.

9.37.10.6

No bearings shall be located in the bucket elevator casing.

9.37.10.7*

Head and boot sections shall be provided with openings to allow for cleanout, inspection, and alignment of the pulley and belt.

9.37.10.8 Drive.
9.37.10.8.1*

The bucket elevator shall be driven by a motor and drive train that is capable of handling the full-rated capacity of the elevator without overloading.

9.37.10.8.2

The drive shall be capable of starting the unchoked elevator under full (100 percent) load.

9.37.10.9 Monitors.

9.37.10.9.1

Elevators shall have monitors at head and tail pulleys that indicate high bearing temperature and belt alignment.

9.37.10.9.2

Abnormal conditions shall actuate an alarm requiring corrective action.

9.37.10.9.3

The alarm shall sound at the operator control station.

9.37.10.10 Emergency Controls.
9.37.10.10.1

All bins into which material is directly discharged from the bucket elevator and that are not designed with automatic overflow systems shall be equipped with devices to shut down equipment or with high-level indicating devices with visual or audible alarms.

9.37.10.10.2

The audible alarm specified in 7.10.10.1 shall sound at the operator control station.

9.37.11* Enclosed Conveyors.
9.37.11.1 Housing and Coverings.
9.37.11.1.1

Where an explosion hazard exists within enclosed conveyors, they shall be protected in accordance with 7.1.4.

9.37.11.1.2

Housings for enclosed conveyors (e.g., screw conveyors and drag conveyors) shall be of metal construction and shall be designed so as to prevent escape of combustible dusts.

9.37.11.1.2.1

Flexible screw conveyors utilizing nonmetal housing shall be permitted to be used provided the requirements of 9.3.2.2 are met.

9.37.11.1.3

Coverings on cleanout, inspection, and other openings shall be fastened to prevent the escape of combustible dusts.

9.37.11.2 Power Shutoff.
9.37.11.2.1*

All conveyors shall be equipped with a device that shuts off the power to the drive motor and sounds an alarm in the event the conveyor plugs.

9.37.11.2.2

The alarm shall sound at the operator control station, and feed to the conveyor shall be stopped or diverted.

9.37.12 Air-Moving Devices (Fans and Blowers).
9.37.12.1

Air-moving devices (AMDs) shall conform to the requirements of NFPA 91 except as amended by the requirements of this chapter.

9.37.12.2 Combustible Particulate Solids.
9.37.12.2.1*

Where an explosion hazard exists, systems shall be designed in such a manner that combustible particulate solids do not pass through an AMD.

9.37.12.2.2*

The requirement of 7.12.2.1 shall not apply to systems designed to operate at a combustible particulate solids concentration or hybrid mixture concentration of less than 10 percent of the MEC or for a hybrid mixture, the lower of 10 percent of the MEC of the dust, or 10 percent of the LFL of the vapor.

9.37.12.2.3*

The requirement of 7.12.2.1 shall not apply to systems protected by an approved explosion prevention or isolation system to prevent the propagation of the flame front from the fan to other equipment in accordance with 7.1.4.1(1), 7.1.4.1(4), 7.1.4.1(5), or 7.1.6.1.

9.37.12.2.4

Where the MEC value is unknown, a value of 0.03 oz/ft^3 (30 g/m^3) shall be permitted to be assumed.

9.37.12.2.5*

Where an AMD is located in the dirty air stream and the dust/air stream concentration is higher than 10 percent of the MEC, fans and blowers shall be of Type A or Type B spark-resistant construction per AMCA 99, *Standards Handbook*, or Type C spark-resistant construction protected with spark detection and extinguishment located downstream of the fan.

9.37.12.3

Where a fire hazard exists and where combustible particulate solids pass through an AMD, provisions shall be made to prevent ignited material from entering processes downstream, in accordance with Chapter 10.

9.37.13 Air-Material Separators (Air Separation Devices).
9.37.13.1 General.
9.37.13.1.1 Location.
9.37.13.1.1.1

Where an explosion hazard exists, AMSs with a dirty-side volume of 8 ft^3 (0.2 m^3) or greater shall be located outside of buildings.

9.37.13.1.1.2*

The requirement of 7.13.1.1.1 shall not apply to the following:

(1) AMSs that are protected in accordance with 7.1.4

(2) AMSs that have a dirty-side volume of less than 8 ft^3 (0.2 m^3)

(3) Wet AMSs that meet all the following criteria:

(a) Interlocks are provided to shut down the system if the flow rate of the scrubbing medium is less than the designed minimum flow rate.

(b) The scrubbing medium is not a flammable or combustible liquid.

(c) The separator is designed to prevent the formation of a combustible dust cloud within the AMS.

(4) *Enclosureless AMSs meeting all the following criteria shall be permitted to be used:

(a) The filter medium is not shaken or pressure-pulsed to dislodge dust during operation.

(b) The AMS is not used to vent or serve metal grinders, hot work processes, or machinery that can produce sparks.

(c) The AMS is not used to vent or serve sanders, abrasive planers, or similar sanding process equipment.

(d) *Each collector system has a maximum air flow–handling capacity of 5000 cfm (2.8 m^3/sec).

(e) *The fan motor is suitable for Class II, Division 2, or Class III, as appropriate.

(f) The collected dust is removed daily or at a frequency sufficient to ensure efficient operation and to limit the collected dust to less than 22 lb (10 kg).

(g) The collector is located at least 20 ft (6.1 m) from any means of egress or area routinely occupied by personnel.

(h) *Multiple collectors in the same room are separated from each other by at least 20 ft (6.1 m).

(i) *The minimum ignition energy (MIE) of the collected materials is greater than 500 mJ.

(j) The fan construction is spark resistant and meets the criteria in 7.12.2.5.

(k) The filter medium is not located within 35 ft (10.7 m) of any open flame or hot surface capable of igniting a dust cloud of the material it contains.

9.3~~7~~.13.1.2 Protection.
9.3~~7~~.13.1.2.1

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

9.3~~7~~.13.1.2.2

Where an explosion hazard exists, AMSs with a dirty-side volume of 8 ft^3 (0.23 m^3) or greater shall be protected in accordance with 7.1.4.

9.3~~7~~.13.1.2.3

Where a fire hazard exists, see Chapter 10.

9.3~~7~~.13.1.3 Manifolding of Dust Collection Ducts.
9.3~~7~~.13.1.3.1

Manifolding of dust collection ducts to AMSs shall not be permitted.

9.3~~7~~.13.1.3.2

Dust collection ducts from a single piece of equipment or from multiple pieces of equipment interconnected on the same process stream shall be permitted to be manifolded.

9.3~~7~~.13.1.3.3

Dust collection ducts from nonassociated pieces of equipment shall be permitted to be manifolded provided that each duct is equipped with an isolation device prior to manifolding in accordance with 7.1.6.

9.3~~7~~.13.1.3.4

Dust collection ducts for centralized vacuum cleaning systems shall be permitted to be manifolded.

9.3~~7~~.13.1.4*

Isolation devices shall be provided for AMSs in accordance with 7.1.6.

9.3~~7~~.13.1.5

Where lightning protection is provided, it shall be installed in accordance with NFPA 780.

9.3~~7~~.13.1.6 Exhaust Air.
9.3~~7~~.13.1.6.1

Exhaust air from the final AMS shall be discharged outside to a restricted area and away from air intakes.

9.37.13.1.6.2

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

9.37.13.1.6.3*

Recycling of AMS exhaust to buildings or rooms shall be permitted when all of the following requirements are met:

(1) Combustible or flammable gases or vapors are not present either in 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) Deflagration isolation is incorporated to prevent transmission of flame and pressure effects from a deflagration in an AMS back to the facility in accordance with 7.1.6, unless a DHA 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 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 room to which the recycled air is returned meets the fugitive dust control and housekeeping requirements of this standard (Chapter 8).

(8) Recycled-air ducts are inspected and cleaned at least annually.

9.37.13.1.7

Where more than one material is to be handled by a system and is known to be incompatible, provisions shall be made for cleaning the system prior to the handling of a new material.

9.37.13.1.8

Operator controls for AMSs associated with pneumatic conveying, dust collection, or centralized vacuum cleaning systems shall be installed in a location that is safe from the effects of a vented deflagration in the AMS.

9.37.13.2 Construction.
9.37.13.2.1 Noncombustible Material.
9.37.13.2.1.1

AMSs shall be constructed of noncombustible materials.

9.37.13.2.1.2

Filter media and filter media support frames shall be permitted to be constructed of combustible material.

9.37.13.2.1.3

Portable containers intended to receive materials discharged from an AMS, where isolated from the AMS by a valve, shall be permitted to be constructed of combustible material.

9.37.13.2.2 Maximum Material Flow.
9.37.13.2.2.1

AMSs shall be constructed to minimize internal ledges or other points of dust accumulation.

9.37.13.2.2.2

Hopper bottoms shall be sloped, and the discharge conveying system shall be designed to handle the maximum material flow attainable from the system.

9.37.13.2.3 Access Doors.
9.37.13.2.3.1

Access doors or openings shall be provided to permit inspection, cleaning, and maintenance.

9.37.13.2.3.2

Access doors or openings shall be designed to prevent dust leaks.

9.37.13.2.3.3

Access doors shall be permitted to be used as deflagration vents if they are specifically designed for both purposes.

9.37.13.2.3.4

Access doors shall be bonded and grounded.

9.37.13.2.3.5*

Access doors not designed to be used as deflagration vents shall be designed to withstand the vented explosion pressure (P_{red}).

9.37.14* Size Reduction.
9.37.14.1

Before material is processed by size reduction equipment, foreign materials shall be excluded or removed as required by 9.1.2.

9.37.14.2

Where an explosion hazard exists, protection shall be provided as specified in 7.1.4.

9.37.14.3

Where a fire hazard exists, protection shall be provided in accordance with Chapter 10.

9.37.15* Particle Size Separation.
9.37.15.1

Particle separation devices shall be in dusttight enclosures.

9.37.15.2

Connection ducts shall be in conformance with Section 7.6.

9.37.15.3* Explosion Protection.
9.37.15.3.1

Where an explosion hazard exists, protection shall be provided as specified in 7.1.4.

9.37.15.3.2*

Screens and sieves shall not be required to have explosion protection.

9.37.15.4

Where a fire hazard exists, protection shall be in accordance with Chapter 10.

9.37.16 Mixers and Blenders.
9.37.16.1

Mixers and blenders shall be designed to control the release of dust.

9.37.16.2

Foreign materials shall be excluded or removed as required by 9.1.2.

9.37.16.3

Where an explosion hazard exists, protection shall be provided as specified in 7.1.4.

9.37.16.4

Where a fire hazard exists, protection shall be in accordance with Chapter 10.

9.37.16.5

Mixers and blenders shall be made of metal, other noncombustible material, or a material that does not represent an increased fire load beyond the capabilities of the existing fire protection.

9.37.17* Dryers.
9.37.17.1

Heating systems shall be in accordance with Section 9.6.

9.37.17.2 Drying Media.
9.37.17.2.1

Drying media that come into contact with material being processed shall not be recycled to rooms or buildings.

9.37.17.2.2

Drying media shall be permitted to be recycled to the drying process provided the following conditions are met:

(1) The media passes through a filter, dust separator, or equivalent means of dust removal.

(2) The vapor flammability of the drying media in the dryer is controlled by either oxidant concentration reduction or combustible concentration reduction in accordance with NFPA 69.

9.37.17.3

Dryers shall be constructed of noncombustible materials.

9.37.17.4

Interior surfaces of dryers shall be designed so that accumulations of material are minimized and cleaning is facilitated.

9.37.17.5

Access doors or openings shall be provided in all parts of the dryer and connecting conveyors to permit inspection, cleaning, maintenance, and the effective use of portable extinguishers or hose streams.

9.37.17.6

Where an explosion hazard exists, protection shall be provided as specified in 7.1.4.

9.37.17.7

Where a fire hazard exists, protection shall be in accordance with Chapter 10.

9.37.17.8

Heated dryers shall comply with NFPA 86.

9.37.17.9*

Heated dryers shall have operating controls arranged to maintain the temperature of the drying chamber within the prescribed limits.

9.37.17.10

Heated dryers and their auxiliary equipment shall be equipped with separate excess-temperature-limit controls, independent of the operating controls, that are arranged to supervise the following:

(1) Heated air supply to the drying chamber

(2) Airstream at the discharge of the drying chamber

9.37.18 Nano-Powders.
9.37.18.1* General.

The processing, handling, and storage of nano-powders shall also follow the requirements of this section.

9.37.18.2

If testing of a mixture or particle size distribution that includes nano-powders shows that the explosibility characteristics are similar to the micrometer particles the requirements of this section shall not apply.

9.37.18.3*

The DHA performed for processes or facilities that handle nano-powders shall include an assessment of the hazards associated with the difficulty of containing and controlling nano-powders in the equipment and processes involved in addition to the fire and deflagration hazards customarily addressed.

9.3~~7~~.18.4

The DHA shall include a determination of the appropriate effective fire and explosion protection measures for combustible nano-powder processes and equipment.

9.3~~7~~.18.5 Nano-Powder Production Processes.
9.3~~7~~.18.5.1*

Fire, flash-fire, and explosion hazards associated with production of nano-powders shall be assessed and documented.

9.3~~7~~.18.5.2

Any process that involves metal nano-powders shall refer to NFPA 484.

9.3~~7~~.18.6 Housekeeping.
9.3~~7~~.18.6.1

A documented housekeeping program shall be established based on the hazards described in the DHA for all nano-powders and shall include special provisions for preventing personnel exposure to nano-powders during the cleaning process.

9.3~~7~~.18.6.2

Personal protective equipment (PPE) provided for personnel during the cleaning process shall consider the hazards associated with the nano-powders involved.

9.3~~7~~.19 Additive Manufacturing. (Reserved)

~~Chapter 9~~9.4 Ignition Source~~s~~ Control

9.4.1 Heat from Mechanical Sparks and Friction.
9.4.1.1 Risk Assessment.
A documented risk assessment acceptable to the AHJ shall be permitted to be conducted to determine the level of protection to be provided according to this chapter.
9.4.1.2 Foreign Materials.
9.4.1.2.1
Means shall be provided to prevent foreign material from entering the system when such foreign material presents an ignition hazard.
9.4.1.2.2
Floor sweepings shall not be returned to any machine.
9.4.1.2.3*
Foreign materials, such as tramp metal, that are capable of igniting combustible material being processed shall be removed from the process stream by one of the following methods:

(1) Permanent magnetic separators or electromagnetic separators that indicate loss of power to the separators

(2) Pneumatic separators

(3) Grates or other separation devices

9.4.1.3* Inherently Ignitible Process Streams.
9.4.1.3.1
Where the process is configured such that the pneumatic conveying, dust collection, or centralized vacuum cleaning system conveys materials that can act as an ignition source, means shall be provided to minimize the hazard.
9.4.1.3.2
The means used to minimize the ignition source hazard specified in 9.1.3.1 shall be permitted to include protection measures identified in 7.1.3 and Section 10.1, as appropriate.
9.4.1.4* Belt Drives.
Belt drives shall be designed to stall without belt slippage, or a safety device shall be provided to shut down the equipment if slippage occurs.
9.4.1.5* Bearings.
9.4.1.5.1
Roller or ball bearings shall be used on all processing and transfer equipment.
9.4.1.5.2
Bushings shall be permitted to be used when a documented engineering evaluation shows that mechanical loads and speeds preclude ignition due to frictional heating.
9.4.1.5.3
Lubrication shall be performed in accordance with the manufacturer's recommendations.

9.4.1.5.4*
Bearings that are directly exposed to a combustible dust atmosphere or that are subject to dust accumulation, either of which poses a dust ignition hazard, shall be monitored for overheating. [**652:**8.4.5.2]

9.4.1.5.5
The owner/operator shall establish frequencies for monitoring bearings in 9.1.5.4. [**652:**8.4.5.3]

9.4.1.5.6*
It shall be permitted to eliminate bearing monitoring based on a risk assessment acceptable to the AHJ. [**652:**8.4.5.4]

9.4.1.6 Equipment.
Equipment with moving parts shall be installed and maintained so that true alignment is maintained and clearance is provided to minimize friction.

~~**9.2 Electrical Equipment.**~~

~~All electrical equipment and installations shall comply with the requirements of Section 6.5.~~

~~**6.5**~~**9.4.2 Electrical Equipment.**

9.4.2~~**6.5**~~**.1**

All electrical equipment and installations shall comply with the requirements of *NFPA 70*.

9.4.2~~**6.5**~~**.2***

In local areas of a plant where a hazardous quantity of dust accumulates or is suspended in air, the area shall be classified and all electrical equipment and installations in those local areas shall comply with Article 502 or Article 503 of *NFPA 70*, as applicable.

9.4.2~~**6.5**~~**.3**

Hazardous (classified) areas that are identified in accordance with 6.5.2 shall be documented, and such documentation shall be permanently maintained on file for the life of the facility.

9.4.3* Static Electricity.

Commented [ML3]: This title is being changed to "Electrostatic Discharges" by SR 23

The requirements of 9.3.2 through 9.3.4 shall be applied retroactively.

9.4.3.1

For electrostatic hazard assessment purposes, MIE determination of dust clouds shall be based on a purely capacitive discharge circuit in accordance with ASTM E2019, *Standard Test Method for Minimum Ignition Energy of a Dust Cloud in Air*.

9.4.3.2* Conductive Components.

9.4.3.2.1*

All system components shall be conductive.

9.4.3.2.2

Nonconductive system components shall be permitted where all of the following conditions are met:

(1) Hybrid mixtures are not present.

(2) Conductive dusts are not handled.

(3) The MIE of the material being handled is greater than 3 mJ.

(4) The nonconductive components do not result in isolation of conductive components from ground.

(5) *The breakdown strength across nonconductive sheets, coatings, or membranes does not exceed 4 kV when used in high surface charging processes.

9.4.3.2.3*

Bonding and grounding with a resistance of less than 1.0×10^6 ohms to ground shall be provided for conductive components.

9.4.3.3

Where belt drives are used, the belts shall be electrically conductive and have a resistance of less than 1.0×10^6 ohms to ground.

9.4.3.4~~7.6.3~~*
Where flexible hose is used to connect conductive components, the resistance between the conductive components shall be less than 1×10^6 ohms.

9.4.3.~~X~~5* Flexible Connectors

9.4.3.~~X~~5.1 Retroactivity.

This section shall not be required to be applied retroactively. [652:9.4.7.1.4.1]

9.4.3.~~X~~5.2

Flexible connectors longer than 6.6 ft (2 m) shall have an end-to-end resistance of less than 1.0 × 108 ohms to ground even where an internal or external bonding wire connects the equipment to which the flexible connector is attached. [652:9.4.7.1.4.2]

9.4.3.~~X~~5.3*

Where flammable vapors are not present, flexible connectors with a resistance equal to or greater than 1.0 × 108 ohms shall be permitted under either of the following conditions:

(1) The dust has an MIE greater than 2000 mJ.

(2) The maximum powder transfer velocity is less than 2000 fpm (10 m/sec).

[652:9.4.7.1.4.3]

Commented [ML4]: This is a new section created by SR 21 (before the reorg it is located after 9.3.3)

9.4.3.~~4~~6* Flexible Intermediate Bulk Containers (FIBCs).

FIBCs shall be permitted to be used for the handling and storage of combustible particulate solids in accordance with the requirements in 9.3.4.1 through 9.3.4.7. [**652:**8.4.7.4]

9.4.3.4.1*

Electrostatic ignition hazards associated with the particulate and objects surrounding or inside the FIBC shall be included in the DHA required by Section 4.2. [**652:**8.4.7.4.1]

9.4.3.4.2*

Type A FIBCs shall be limited to use with noncombustible particulate solids or combustible particulate solids having an MIE greater than 1000 mJ. [**652:**8.4.7.4.2]

9.4.3.4.2.1

Type A FIBCs shall not be used in locations where flammable vapors are present. [**652:**8.4.7.4.2.1]

9.4.3.4.2.2*

Type A FIBCs shall not be used with conductive dusts. [**652:**8.4.7.4.2.2]

9.4.3.4.3*

Type B FIBCs shall be permitted to be used where combustible dusts having an MIE greater than 3 mJ are present. [**652:**8.4.7.4.3]

9.4.3.4.3.1

Type B FIBCs shall not be used in locations where flammable vapors are present. [**652:**8.4.7.4.3.1]

9.4.3.4.3.2

Type B FIBCs shall not be used for conductive dusts.*(See A.9.3.4.2.2.)* [**652:**8.4.7.4.3.2]

9.4.3.4.4*

Type C FIBCs shall be permitted to be used with combustible particulate solids and in locations where Class I Division Group C/D or Zone Group IIA/IIB flammable vapors or gases, as defined by *NFPA 70*, are present. [**652:**8.4.7.4.4]

9.4.3.4.4.1

Conductive FIBC elements shall terminate in a grounding tab, and resistance from these elements to the tab shall be less than or equal to 10^7 ohms. [**652:**8.4.7.4.4.1]

9.4.3.4.4.2

Type C FIBCs shall be grounded during filling and emptying operations with a resistance to ground of less than 25 ohms. [**652:**8.4.7.4.4.2]

9.4.3.4.4.3

Type C FIBCs shall be permitted to be used for conductive dusts where a means for grounding the conductive dusts is present. [**652:**8.4.7.4.4.3]

9.4.3.4.5*

Type D FIBCs shall be permitted to be used with combustible particulate solids and in locations where Class I Division Group C/D or Zone Group IIA/IIB flammable vapors or gases, as defined by *NFPA 70*, having an MIE greater than 0.14 mJ are present. [**652:**8.4.7.4.5]

9.4.3.4.5.1*

Type D FIBCs shall not be permitted to be used for conductive particulate solids. [**652:**8.4.7.4.5.1]

9.4.3.4.6*

Type B, Type C, and Type D FIBCs shall be tested and verified as safe for their intended use by a recognized testing organization in accordance with the requirements and test procedures specified in IEC 61340-4-4, *Electrostatics — Part 4-4: Standard Test Methods for Specific Applications — Electrostatic Classification of Flexible Intermediate Bulk Containers (FIBC)*, before being used in hazardous environments. [**652:**8.4.7.4.6]

9.4.3.4.6.1

Intended use shall include both the product being handled and the environment in which the FIBC will be used. [**652:**8.4.7.4.6.1]

9.4.3.4.6.2

Materials used to construct inner baffles, other than mesh or net baffles, shall meet the requirements for the bag type in which they are to be used. [**652:**8.4.7.4.6.2]

9.4.3.4.6.3*

Inner liners shall be suitable to maintain the electrostatic characteristics of the bag types in which they are used.

9.4.3.4.6.4

Documentation of test results shall be made available to the AHJ. **[652:**8.4.7.4.6.3]

9.4.3.4.6.5

FIBCs that have not been tested and verified for type in accordance with IEC 61340-4-4, *Electrostatics — Part 4 4: Standard Test Methods for Specific Applications — Electrostatic Classification of Flexible Intermediate Bulk Containers (FIBC)*, shall not be used for combustible dusts or in flammable vapor atmospheres. [**652:**8.4.7.4.6.4]

9.4.3.4.7*

Deviations from the requirements in 9.3.4.1 through 9.3.4.6 for safe use of FIBCs shall be permitted based on a documented risk assessment acceptable to the AHJ. [**652:**8.4.7.4.7]

9.4.3.5 Rigid Intermediate Bulk Containers (RIBCs).
9.4.3.5.1*

Conductive RIBCs shall be permitted to be used for dispensing into any flammable vapor, gas, dust, or hybrid atmospheres provided that the RIBCs are electrically grounded. [**652:**8.4.7.4.5.1]

9.4.3.5.2*

Nonconductive RIBCs shall not be permitted to be used for applications, processes, or operations involving combustible particulate solids or where flammable vapors or gases are present unless a documented risk assessment assessing the electrostatic hazards is acceptable to the AHJ. [**652:**8.4.7.5.2]

9.4.3.6

Particulate solids shall not be manually dumped directly into vessels containing flammable atmospheres (gases at a flammable concentration with an oxidant) or where displacement could cause a flammable atmosphere external to the vessel.

9.4.3.7*

Manual additions of solids through an open port or a manway into a vessel containing flammable atmospheres shall be permitted to be done in 50 lb (25 kg) batches or smaller, provided the requirements of 9.3.7.1 through 9.3.7.7 are satisfied.

9.4.3.7.1*

Conductive or static-dissipative components of the container shall be grounded.

9.4.3.7.2

Direct emptying of powders from nonconductive plastic bags into a vessel that contains a flammable atmosphere shall be strictly prohibited.

9.4.3.7.3

The use of nonconductive liners in grounded conductive or static-dissipative outer packaging shall be permitted, provided that the liner thickness is less than 0.08 in. (2 mm) and the liner cannot become detached during emptying.

9.4.3.7.4*

Loading chutes, receiving vessels, and auxiliary devices used for addition of bulk material shall be conductive and grounded.

9.4.3.7.5*

Personnel in the vicinity of openings of vessels that contain flammable atmospheres shall be grounded.

9.4.3.7.6

Operators shall wear flame-resistant garments as specified in NFPA 2113 and any other personal protective equipment (PPE) required for protection against flash-fire hazards during charging operations.

9.4.3.7.7*

A documented risk assessment acceptable to the AHJ shall be conducted to determine additional engineering and administrative controls necessary to protect against ignition of the flammable atmosphere.

9.4.3.8 Grounding of Personnel.

9.4.3.8.1*

Where an explosive atmosphere exists and is subject to ignition from an electrostatic spark discharge from ungrounded personnel, personnel involved in manually filling or emptying particulate containers or vessels shall be grounded during such operations. [652:9.4.7.3.1]

9.4.3.8.2

Personnel grounding shall not be required where both of the following conditions are met:

(1) Flammable gases, vapors, and hybrid mixtures are not present.

(2)* The minimum ignition energy of the dust cloud is greater than 30 mJ.

[652:9.4.7.3.2]

Commented [ML5]: This is a new section created by SR 20 (before the reorg it is located at 9.3.4)

9.4.4 Cartridge-Actuated Tools.

The requirements of 9.4.1 through 9.4.3 shall be applied retroactively.

9.4.4.1

Cartridge-actuated tools shall not be used in areas where combustible material is produced, processed, or present unless all machinery is shut down and the area is cleaned and inspected to ensure the removal of all accumulations of combustible material.

9.4.4.2

Accepted lockout/tagout procedures shall be followed for the shutdown of machinery.

9.4.4.3

The use of cartridge-actuated tools shall be in accordance with 9.5.2.

9.4.4.4

An inspection shall be made after the work is completed to ensure that no cartridges or charges are left in the area where they can enter equipment or be accidentally discharged after operation of the dust-producing or handling machinery is resumed.

9.4.5
Hot work shall be managed in accordance with 8.5.

9.4.6 Process and Comfort Heating Systems.
9.4.6.1*

In areas processing combustible dust, process and comfort heating shall be provided by indirect means.

9.4.6.2

Fired equipment shall be located outdoors or in a separate dust-free room or building.

9.4.6.3

Air for combustion shall be taken from a clean outside source.

9.4.6.4

Comfort air systems for processing areas containing combustible dust shall not be recirculated.

9.4.6.5

Recirculating systems shall be permitted to be used provided that all of the following criteria are met:

(1) Only fresh makeup air is heated.

(2) The return air is filtered to prevent accumulations of dust in the recirculating system.

(3) The exhaust flow is balanced with fresh air intake.

9.4.6.6

Comfort air shall not be permitted to flow from hazardous to nonhazardous areas.

9.4.7* Hot Surfaces.

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 shall be maintained below 80 percent (in degrees Celsius) of the lower of the dust surface ignition temperature or the dust-cloud ignition temperature.

9.4.8 Industrial Trucks.
9.4.8.1

Where used, industrial trucks shall be listed or approved for the electrical classification of the area, as determined by Section 6.5, and shall be used in accordance with NFPA 505.

9.4.8.2*

Where industrial trucks, in accordance with NFPA 505 are not commercially available, a documented risk assessment acceptable to the AHJ shall be permitted to be used to specify the fire and explosion prevention features for the equipment used.

9.4.9 Other Vehicles.

Risk management controls shall be implemented to ensure the safe operation of vehicles not covered under NFPA 505, which could introduce ignition sources into classified areas. Such risk management controls include the application of hot work controls under NFPA 51B.

9.5 Pyrophoric Dusts (Reserved)

9.6 Dust Control

~~Chapter 8 Fugitive Dust Control and Housekeeping~~
~~8.1 Fugitive Dust Control.~~
~~8.1~~9.6.1
Continuous suction to minimize the escape of dust shall be provided for processes where combustible dust is liberated in normal operation.
~~8.1~~9.6.2
The dust shall be conveyed to AMSs.
9.6.3
Housekeeping procedures shall be in accordance with 8.4.
9.6.4
Dust collection and centralized vacuum systems shall be designed in accordance with 9.3.3.2.

9.7 Explosion Prevention / Protection

~~7.1.4~~9.7.1 **Explosion Protection for Equipment.**
9.7.1~~7.1.4~~.1
The design of explosion protection for equipment shall incorporate one or more of the following methods of protection:

(1) Oxidant concentration reduction in accordance with NFPA 69

(a) Where oxygen monitoring is used, it shall be installed in accordance with ISA 84.00.01, *Functional Safety*: *Application of Safety Instrumented Systems for the Process Industry Sector*.

(b) *Where the chemical properties of the material being conveyed require a minimum concentration of oxygen to control pyrophoricity, that level of concentration shall be maintained.

(2) *Deflagration venting in accordance with NFPA 68
(3) Deflagration pressure containment in accordance with NFPA 69
(4) Deflagration suppression systems in accordance with NFPA 69
(5) *Dilution with a noncombustible dust to render the mixture noncombustible *(See 7.1.4.2.)*
(6) *Deflagration venting through a listed dust retention and flame-arresting device

9.7.1~~7.1.4~~.2
If the method in 7.1.4.1(5) is used, test data for specific dust and diluent combinations shall be provided and shall be acceptable to the AHJ.
~~7.1.6~~9.7.2* **Isolation of Equipment and Work Areas.**
9.7.2~~7.1.6~~.1*
Where an explosion hazard exists, isolation devices shall be provided to prevent deflagration propagation between connected equipment and/or work areas in accordance with NFPA 69.
9.7.2~~7.1.6~~.2
Isolation devices shall not be required where oxidant concentration has been reduced or where the dust has been rendered noncombustible in accordance with 7.1.4.1(1) or 7.1.4.1(5).

9.8 Fire Protection

~~7.1.5~~9.8.1 **Fire Protection for Equipment.**
Equipment fire protection shall be designed in accordance with Chapter 10.
~~7.1.8~~9.8.2 **Fire Protection for Facility.**
Where a fire propagation hazard exists, the requirements of Chapter 10 shall apply.

~~Chapter 10~~9.8.3 **Fire Protection**
~~10~~9.8.3.1 **General.**
Fire protection systems, where installed, shall be specifically designed to address building protection, process equipment, and the chemical and physical properties of the materials being processed.
9.8.3~~10~~.2 **System Requirements.**
Fire protection systems required by this standard shall comply with 10.2.1 through 10.2.10.3.
9.8.3~~10~~.2.1*
Fire-extinguishing agents shall be compatible with the conveyed materials.
9.8.3~~10~~.2.2
Where fire detection systems are incorporated into pneumatic conveying, dust collection, or centralized vacuum cleaning systems, an analysis shall be conducted to identify safe interlocking requirements for AMDs and process operations.
9.8.3~~10~~.2.3

Where fire-fighting water or wet product can accumulate in the system, vessel and pipe supports shall be designed to support the additional water weight.

9.8.3~~10~~.2.4 Detection Systems.

9.8.3~~10~~.2.4.1

Where fire detection systems are incorporated into the pneumatic conveying, dust collection, or centralized vacuum cleaning system, the fire detection systems shall be interlocked to shut down any active device feeding materials to the pneumatic conveying, dust collection, or centralized vacuum cleaning system, on actuation of the detection system.

9.8.3~~10~~.2.4.2

Where spark or infrared detection and extinguishing systems are provided, the process shall be permitted to continue operating on activation of the detection system.

9.8.3~~10~~.2.4.3

Where a spark or infrared detection system actuates a diverter valve that sends potentially burning material to a safe location, the process shall be permitted to continue operating on activation of the detection system.

9.8.3~~10~~.2.5

Where the actuation of fire-extinguishing systems is achieved by means of electronic fire detection, the fire detection system, including control panels, detectors, and notification appliances, shall be designed, installed, and maintained in accordance with *NFPA 72*.

9.8.3~~10~~.2.6

All fire detection initiating devices shall be connected to the fire detection control panel via Class A or B circuits as described in *NFPA 72*.

9.8.3~~10~~.2.7

All fire detection notification appliances shall be connected to the fire detection control panel via Class A or B circuits as described in *NFPA 72*.

9.8.3~~10~~.2.8 System Releasing Devices.

9.8.3~~10~~.2.8.1

All fire-extinguishing system releasing devices, solenoids, or actuators shall be connected to the fire detection control panel via Class A or B circuits as described in *NFPA 72*.

9.8.3~~10~~.2.8.2

The supervision shall include the continuity of the extinguishing system releasing device, whether that device is a solenoid coil, a detonator (explosive device) filament, or other such device.

9.8.3~~10~~.2.9

All supervisory devices that monitor critical elements or functions in the fire detection and extinguishing system shall be connected to the fire detection control panel via Class A or B circuits as described in *NFPA 72*.

9.8.3~~10~~.2.10* Abort Gates/Abort Dampers.

9.8.3~~10~~.2.10.1 Construction.

9.8.3~~10~~.2.10.1.1

Abort gates and abort dampers shall be constructed of noncombustible materials.

9.8.3~~10~~.2.10.1.2

Abort gates shall be actuated by spark detection in the duct or pipe upstream of the device.

9.8.3~~10~~.2.10.1.3*

The detection system and abort gate shall respond to prevent sparks, glowing embers, or burning materials from passing beyond the abort gate.

9.8.3~~10~~.2.10.2 Operation.

9.8.3~~10~~.2.10.2.1

The abort gate or abort damper shall be installed so that it diverts airflow to a restricted area to safely discharge combustion gases, flames, burning solids, or process gases or fumes.

9.8.3~~10~~.2.10.2.2 Manual Reset.

9.8.3~~10~~.2.10.2.2.1*

An abort gate or abort damper shall be provided with a manually activated reset located proximate to the device such that, subsequent to operation, it can be returned to the normal operating position only at the damper (gate).

9.8.3~~10~~.2.10.2.2.2

Automatic or remote reset provisions shall not be permitted.

9.8.3~~10~~.2.10.3 Fire Protection.

9.8.3~~10~~.2.10.3.1

All fire protection abort gates or abort dampers shall be connected to the fire detection control panel via Class A or D circuits as described in *NFPA 72*.

9.8.3~~10~~.2.10.3.2

When the abort gate is connected via a Class A circuit, the supervision shall include the continuity of the abort gate or abort damper releasing device, whether that device is a solenoid coil, a detonator (explosive device) filament, or other such device.

9.8.3~~10~~.3 Fire Extinguishers.
9.8.3~~10~~.3.1

Portable fire extinguishers shall be provided throughout all buildings in accordance with the requirements of NFPA 10.

9.8.3~~10~~.3.2*

Personnel shall be trained to use portable fire extinguishers in a manner that minimizes the generation of dust clouds during discharge.

9.8.3~~10~~.4 Hose, Standpipes, and Hydrants.
9.8.3~~10~~.4.1

Standpipes and hose, where provided, shall comply with NFPA 14.

9.8.3~~10~~.4.2 Nozzles.
9.8.3~~10~~.4.2.1*

Portable spray hose nozzles that are listed or approved for use on Class C fires shall be provided in areas that contain dust, to limit the potential for generating unnecessary airborne dust during fire-fighting operations.

9.8.3~~10~~.4.2.2*

Straight-stream nozzles shall not be used on fires in areas where dust clouds can be generated.

9.8.3~~10~~.4.2.3

Straight-stream nozzles or combination nozzles shall be permitted to be used to reach fires in locations that are otherwise inaccessible with the nozzles specified in 10.4.2.1.

9.8.3~~10~~.4.3

Private outside protection, including outside hydrants and hoses, where provided, shall comply with NFPA 13.

9.8.3~~10~~.5* Automatic Sprinklers.
9.8.3~~10~~.5.1*

Where a process that handles combustible particulate solids uses flammable or combustible liquids, a documented risk assessment that is acceptable to the AHJ shall be used to determine the need for automatic sprinkler protection in the enclosure in which the process is located.

9.8.3~~10~~.5.2

Automatic sprinklers, where provided, shall be installed in accordance with NFPA 13.

9.8.3~~10~~.5.3

Where automatic sprinklers are installed, dust accumulation on overhead surfaces shall be minimized to prevent an excessive number of sprinkler heads from opening in the event of a fire.

9.8.3~~10~~.6 Spark/Ember Detection and Extinguishing Systems.

Spark/ember detection and extinguishing systems shall be designed, installed, and maintained in accordance with NFPA 69 and *NFPA 72*.

9.8.3~~10~~.7 Special Fire Protection Systems.
9.8.3~~10~~.7.1

Automatic extinguishing systems or special hazard extinguishing systems, where provided, shall be designed, installed, and maintained in accordance with the following standards, as applicable:

(1) NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*

(2) NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*

(3) NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*

(4) NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*

(5) NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*

(6) NFPA 17, *Standard for Dry Chemical Extinguishing Systems*

(7) NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*

(8) NFPA 750, *Standard on Water Mist Fire Protection Systems*

(9) NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*

9.8.3~~10~~.7.2

The extinguishing systems shall be designed and used in a manner that minimizes the generation of dust clouds during their discharge.

9.8.3~~10~~.8 Fire **Alarm Service.**

Fire Alarm service, if provided, shall comply with *NFPA 72*.

Second Revision No. 24-NFPA 654-2018 [Global Comment]

Update NFPA 652 extracts as shown in the attached Word document.

Supplemental Information

File Name	Description	Approved
654_SR_24_Extract_update_Body.docx		
654_SR_24_Extract_update_Annex.docx		

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Mon Jun 04 11:31:43 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: NFPA 652 has made some changes to the layout since the NFPA 654 First Draft, primarily switching chapters 8 and 9.

Response Message: SR-24-NFPA 654-2018

Committee Notes:

Date	Submitted By	
Jun 4, 2018	Laura Moreno	These word files are based on the pre-reorganization order of the document.

4.2 Dust Hazards Analysis (DHA).
4.2.1

The requirements of ~~Section 4.2~~this chapter shall ~~apply~~ be applied retroactively in accordance with 4.2.1.1 through 4.2.1.3. [**652:**7.1.1]

4.3* Management of Change.

Written procedures shall be established and implemented to manage proposed changes to process materials, staffing, job tasks, technology, equipment, procedures, and facilities. [**652:**~~9.9~~8.12.1]

4.3.1.2

Implementation of the management-of-change procedures shall not be required for replacements-in-kind. [**652:**~~9.9~~8.12.3]

8.2.3* Portable Vacuum Cleaners.
8.2.3.1

Portable vacuum cleaners with a dirty side volume greater than 8 ft^3 shall comply with 7.1.4 and 7.1.6. [**652:**~~9~~8.4.2.2.1.1]

8.2.3.2*

When metal particles, dusts, or powders are being cleaned NFPA 484 shall be the reference source for proper use and limitations of both dry and wet portable vacuum cleaners. [**652:**~~9~~8.4.2.2.1.2]

8.2.3.3*

The operation of portable vacuum cleaning devices shall be subject to a dust hazard analysis to ensure that the risk to personnel and facility operations from deflagrations is minimized. [**652:**~~9~~8.4.2.2.1.3]

8.2.3.4

Hoses and vacuum tools shall be appropriate for use and be static dissipative or conductive. [**652:** ~~9~~8.4.2.2.1.4]

8.2.3.5

Portable vacuum cleaners shall not be used on processes generating hot embers or sparks. [**652:**~~9~~8.4.2.2.1.5]

8.2.3.6*

For portable vacuum cleaners used with combustible dusts having a minimum ignition energy less than 30 mJ, the path to ground shall be verified prior to use after each movement or new connection, or both. [**652:**~~9~~8.4.2.2.1.6]

9.1.5.4*

Bearings that are directly exposed to a combustible dust atmosphere or that are subject to dust accumulation, either of which poses a dust ignition hazard, shall be monitored for overheating. [**652:**~~8~~9.4.5.2]

9.1.5.5

The owner/operator shall establish frequencies for monitoring bearings in 9.1.5.4. [**652:**~~8~~9.4.5.3]

9.1.5.6*

It shall be permitted to eliminate bearing monitoring based on a risk assessment acceptable to the AHJ. [**652:**~~8~~9.4.5.4]

9.3.4* Flexible Intermediate Bulk Containers (FIBCs).

FIBCs shall be permitted to be used for the handling and storage of combustible particulate solids in accordance with the requirements in 9.3.4.1 through 9.3.4.7. [**652:**~~8~~9.4.7.4]

9.3.4.1*

Electrostatic ignition hazards associated with the particulate and objects surrounding or inside the FIBC shall be included in the DHA required by Section 4.2. [**652:**~~8~~9.4.7.4.1]

9.3.4.2*

Type A FIBCs shall be limited to use with noncombustible particulate solids or combustible particulate solids having an MIE greater than 1000 mJ. [**652:**~~8~~9.4.7.4.2]

9.3.4.2.1

Type A FIBCs shall not be used in locations where flammable vapors are present. [**652:**~~8~~9.4.7.4.2.1]

9.3.4.2.2*

Type A FIBCs shall not be used with conductive dusts. [**652:**~~8~~9.4.7.4.2.2]

9.3.4.3*

Type B FIBCs shall be permitted to be used where combustible dusts having an MIE greater than 3 mJ are present. [**652:**~~8~~9.4.7.4.3]

9.3.4.3.1

Type B FIBCs shall not be used in locations where flammable vapors are present. [**652:**~~8~~9.4.7.4.3.1]

9.3.4.3.2

Type B FIBCs shall not be used for conductive dusts.*(See A.9.3.4.2.2.)* [**652:**~~8~~9.4.7.4.3.2]

9.3.4.4.1

Conductive FIBC elements shall terminate in a grounding tab, and resistance from these elements to the tab shall be less than or equal to 10^7 ohms. [**652:**~~8~~9.4.7.4.4.1]

9.3.4.4.2

Type C FIBCs shall be grounded during filling and emptying operations with a resistance to ground of less than 25 ohms. [**652:**~~8~~9.4.7.4.4.2]

9.3.4.4.3

Type C FIBCs shall be permitted to be used for conductive dusts where a means for grounding the conductive dusts is present. [**652:**~~8~~9.4.7.4.4.3]

9.3.4.5.1*

Type D FIBCs shall not be permitted to be used for conductive particulate solids. [**652:**~~8~~9.4.7.4.5.1]

9.3.4.6*

Type B, Type C, and Type D FIBCs shall be tested and verified as safe for their intended use by a recognized testing organization in accordance with the requirements and test procedures specified in IEC 61340-4-4, *Electrostatics — Part 4-4: Standard Test Methods for Specific Applications — Electrostatic Classification of Flexible Intermediate Bulk Containers (FIBC)*, before being used in hazardous environments. [**652:**~~8~~9.4.7.4.6]

9.3.4.6.1

Intended use shall include both the product being handled and the environment in which the FIBC will be used. [**652:**~~8~~9.4.7.4.6.1]

9.3.4.6.2

Materials used to construct inner baffles, other than mesh or net baffles, shall meet the requirements for the bag type in which they are to be used. [**652:**~~8~~9.4.7.4.6.2]

9.3.4.6.4

Documentation of test results shall be made available to the AHJ. **[652:**~~8~~9.4.7.4.6.3]

9.3.4.6.5

FIBCs that have not been tested and verified for type in accordance with IEC 61340-4-4, *Electrostatics — Part 4 4: Standard Test Methods for Specific Applications — Electrostatic Classification of Flexible Intermediate Bulk Containers (FIBC)*, shall not be used for combustible dusts or in flammable vapor atmospheres. [**652:**~~8~~9.4.7.4.6.4]

9.3.4.7*

Deviations from the requirements in 9.3.4.1 through 9.3.4.6 for safe use of FIBCs shall be permitted based on a documented risk assessment acceptable to the AHJ. [**652:**~~8~~9.4.7.4.7]

9.3.5 Rigid Intermediate Bulk Containers (RIBCs).

9.3.5.1*

Conductive RIBCs shall be permitted to be used for dispensing into any flammable vapor, gas, dust, or hybrid atmospheres provided that the RIBCs are electrically grounded. [**652:**~~8~~9.4.7.4.5.1]

9.3.5.2*

Nonconductive RIBCs shall not be permitted to be used for applications, processes, or operations involving combustible particulate solids or where flammable vapors or gases are present unless a documented risk assessment assessing the electrostatic hazards is acceptable to the AHJ. [**652:**~~8~~9.4.7.5.2]

Annex A Explanatory Material
A.4.3

It is essential to have thorough written documentation, as the slightest changes to procedures, processes, resources, staffing, and equipment, including equipment from suppliers, can have a dramatic impact on the overall hazard analysis. Change includes something as benign as process materials sourcing from a different manufacturer, the same raw material manufacturer using new methods to produce the product, or changes in formulation. These changes from a supplier's end can impact the characteristics of the processes and materials. Individuals involved should include those involved in the process such as maintenance, engineering, and purchasing personnel, and all others as deemed necessary. Staffing and job tasks are not intended for shift changes, but for overall staff and their representative tasks. For reference, see the documentation form in ANSI/AIHA Z10, *Occupational Health and Safety Management Systems*. [**652:**A.~~9~~8.12.1]

The following changes in material or process should warrant a management-of-change review per Section 4.3, and new samples should be collected and analyzed:

(1) New process equipment is installed that presents new hazards.

(2) New operating conditions for existing equipment create a new hazard.

(3) A new material is used in the process.

[**652:**A.~~9~~8.12.1]

A.4.3.1.1(1)

The proposed change and why it is needed should be described. It should include sufficient technical information to facilitate review by the approvers, address adverse effects that could occur, and describe how such effects would be mitigated by the proposed change.[**652:**A.~~9~~8.12.2(1)]

A.4.3.1.1(2)

Some fire and explosion protection systems introduce additional hazards into the process environment. These hazards can include, but are not limited to, energy in suppression canisters, asphyxiation hazards from inert gases, and mechanical laceration/amputation hazards from explosion isolation systems. While these are not fire or explosion hazards, they should be addressed as part of the management-of-change review per this document so that appropriate controls can be applied.[**652:**A.~~9~~8.12.2(2)]

A.4.4.2

Events where there are injuries, equipment damage, or significant business interruption are subject to investigation. **[652:**A.~~9~~8.11.1]

In addition to investigation of fires and explosions, it is also a good practice to investigate near misses (i.e., events that could have resulted in 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. [**652:**A.~~9~~8.11.1]

A.8.2.3

Portable vacuum cleaners are self-contained units that typically utilize either an electrically or compressed air powered (with venturi) vacuum source (AMD) and an air-material separator (AMS) that is either wet (i.e., liquid) or dry (i.e., filter media). A single hose connection is normally provided, but larger semiportable units (either on trucks or moved by forklifts) can allow use of more than one simultaneous operator. Typically, when dry filter media is used there is no automatic filter cleaning method; however, with the larger semiportable units automatic filter cleaning is usually provided due to the higher air flows and material/dust loading. [**652:**A.~~9~~8.4.2.2.1]

A.8.2.3.2

Using a portable vacuum cleaner with metal dusts and particles can have risks that are not adequately covered in NFPA 652. However, NFPA 484 has specific sections for use of wet and dry portable vacuum cleaning equipment and on their use with the more exotic metals and alloys such as titanium, aluminum, and so forth. [**652:**A.~~9~~8.4.2.2.1.2]

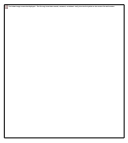
A.8.2.3.3

Use of portable vacuum cleaning equipment for housekeeping of combustible dusts is subject to the same dust hazards analysis (DHA) as would be a centralized vacuum cleaning system. The combustible dust

characteristics, hazards, and risks should be analyzed to determine the best type of portable unit to use and the restrictions on their use. This should also consider the classification of the area of use, personnel protective equipment, and so forth. [**652:** A.~~9~~8.4.2.2.1.3]

A.8.2.3.6

Verification of the path to ground can be visual. [**652:**A.~~9~~8.4.2.2.1.6]

A.9.1.5.4 

The intent of this requirement is to address bearings that can have accumulations of dust on them or be in a suspended dust cloud. The concern is that if the bearing overheats it can present an ignition source to the dust cloud or the dust layer.

Such equipment can include, but is not limited to, the following:

(1) Bucket elevator head and boot areas

(2) Particulate size-reduction equipment

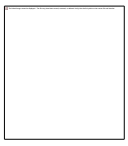
(3) Blenders

(4) Belt-driven fans where combustible dust is present

In addition to monitoring bearing temperatures directly, precursors to bearing or shaft overheating can also provide early warnings of bearing or shaft deterioration. These precursors include excessive shaft vibration or speed reduction. Monitoring can consist of periodic manual checks, installed devices, or automated monitoring. [**652:**A.~~8~~9.4.5.2]

A.9.1.5.6

The risk assessment should include the potential for propagation of an explosion from an unmonitored unit. [**652:**A.~~8~~9.4.5.4]

A.9.3.4 

A more detailed description of FIBC ignition hazards can be found in IEC 61340-4-4, *Electrostatics — Part 4-4: Standard Test Methods for Specific Applications — Electrostatic Classification of Flexible Intermediate Bulk Containers (FIBC)*. [**652:**A.~~8~~9.4.7.4]

A.9.3.4.1

Induction charging of ungrounded conductive objects, including personnel, should be addressed as part of the dust hazards analysis. The DHA should also consider that higher rates of transfer into and out of the FIBC increase the rate of charge generation. Consideration should also be given to the possibility of surface (cone) discharges while the FIBC is being filled, regardless of FIBC type. [**652:**A.~~8~~9.4.7.4.1]

For additional information on these phenomena, refer to NFPA 77. The use of internal liners in FIBCs can introduce additional electrostatic ignition hazards and should be subject to expert review prior to use. [**652:**A.~~8~~9.4.7.4.1]

A.9.3.4.2

Type A FIBCs are capable of producing propagating brush discharges that are capable of igniting combustible dusts and flammable vapors/gases. Type A bags are capable of producing brush discharges that are capable of igniting flammable vapors/gases. Type A FIBCs can allow conductive particulate solids to become isolated conductors, leading to capacitive spark discharges. [**652:**A.~~8~~9.4.7.4.2]

A.9.3.4.2.2

For this application, conductive particulate solids typically are those materials having bulk resistivity less than 10^6 ohm-m. [**652:**A.~~8~~9.4.7.4.2.2]

A.9.3.4.3

Type B FIBCs are capable of producing cone (bulking brush) discharges across the full width of the FIBC with maximum discharge energies of ~3 mJ. These discharges are capable of igniting flammable vapors/gases and combustible dusts with MIE less than 3 mJ. Type B bags are capable of producing brush discharges that are capable of igniting flammable vapors/gases. Type B FIBCs can allow conductive particulate solids to become isolated conductors, leading to capacitive spark discharges. [**652:**A.~~8~~9.4.7.4.3]

A.9.3.4.4

Type C FIBCs are capable of producing capacitive spark discharges if the grounding tab is not connected. Type C FIBCs are not capable of producing brush or propagating brush discharges, but could be capable of producing cone discharges across the half-width of the bag. Some Type C FIBCs have an internal coating that can isolate conductive particulate solids from ground, producing the potential for capacitive spark discharges from the conductive material to the grounded conductive elements of the bag. Per IEC 61340-4-4, *Electrostatics — Part 4-4: Standard Test Methods for Specific Applications — Electrostatic Classification of Flexible Intermediate Bulk Containers (FIBC)*, Type C FIBCs are permitted to be used for Zone Group IIA and IIB gases but not Group IIC. [**652:**A.~~8~~9.4.7.4.4]

A.9.3.4.5

Type D FIBCs use low energy corona discharges to dissipate static charges from the bag surface. Corona discharges are capable of igniting flammable gases or vapors with MIE less than 0.14 mJ. Type D FIBCs are not capable of producing brush or propagating brush discharges, but could be capable of producing cone discharges across the half-width of the bag. Per IEC 61340-4-4, *Electrostatics — Part 4-4: Standard Test Methods for Specific Applications — Electrostatic Classification of Flexible Intermediate Bulk Containers (FIBC)*, Type C FIBCs are permitted to be used for Zone Group IIA and IIB gases but not Group IIC. [**652:**A.~~8~~9.4.7.4.5]

A.9.3.4.5.1

Type D bags function by corona discharge. Metals or other conductive particulate solids could require additional precautions because, if the particulate is isolated and becomes charged, incendiary sparks could occur during rapid filling and emptying operations. IEC TS 60079-32-1 gives guidance on additional precautions that could be necessary. A risk assessment referencing IEC TS 60079-32-1 could be performed to support the use of Type D FIBCs for conductive particulate solids. [**652:**A.~~8~~9.4.7.4.5.1]

A.9.3.4.6

Table A.9.3.4.6 and Figure A.9.3.4.6 provide guides for the selection and use of FIBCs based on the MIE of product contained in the FIBC and the nature of the atmosphere surrounding it.

Table A.9.3.4.6 Use of Different Types of FIBCs

Bulk Product in FIBC	**Surroundings**		
MIE of Solids[a]	**Nonflammable Atmosphere**	**Class II, Divisions 1 and 2 (1,000 mJ ≥ MIE >3 mJ)[a]**	**Class I, Divisions 1 and 2 (Gas Group C and D) or Class II, Divisions 1 and 2 (MIE ≤ 3 mJ)[a]**
MIE > 1000 mJ	A, B, C, D	B, C, D	C, D[b]
1000 mJ ≥ MIE > 3 mJ	B, C, D	B, C, D	C, D[b]
MIE ≤ 3 mJ	C, D	C, D	C, D[b]

Notes:

(1) Additional precautions usually are necessary when a flammable gas or vapor atmosphere is present inside the FIBC, for example, in the case of solvent wet solids.

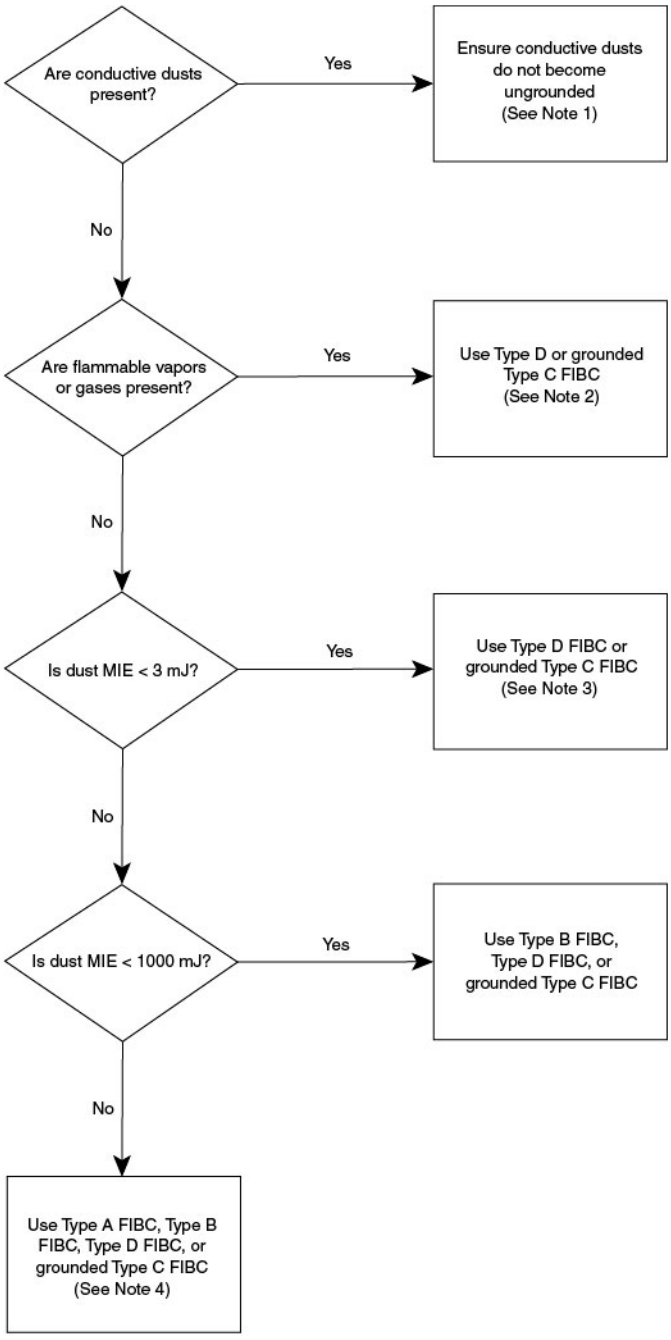
(2) Nonflammable atmosphere includes combustible particulate solids having a MIE greater than 1000 mJ.

(3) FIBC Types A, B, and D are not suitable for use with conductive combustible particulate solids.

[a]Measured in accordance with ASTM E2019, capacitive discharge circuit (no added inductance).

[b]Use of Type C and D is limited to Gas Groups C and D with MIE greater than or equal to 0.14 mJ. [**652:**A.~~8~~9.4.7.4.6]

Figure A.9.3.4.6 FIBC Selection Decision Tree. [652:Figure A.~~8~~9.4.7.4.6]



Note 1: Conductive dusts can produce spark discharges if allowed to be isolated from ground. Grounded Type C FIBCs can provide adequate grounding, but some Type C FIBCs have internal coatings or liners that can allow conductive dusts to remain isolated. A risk assessment is recommended prior to handling conductive dusts in FIBCs.

Note 2: Do not use Type D FIBCs for flammable vapors/gases with MIE < 0.14 mJ.

Note 3: Type A or B FIBCs can allow cone discharges to occur across the full width of the FIBC, with an effective energy up to 3 mJ.

Note 4: Type A FIBCs have the potential to produce propagating brush discharges with effective energy of ~1000 mJ.

A.9.3.4.7

In special cases it might be necessary to use a type of FIBC that is not permitted for the intended application based on the requirements of 9.3.4. For such cases, it might be determined that the FIBC is

safe to use provided that filling or emptying rates are restricted to limit electrostatic charging. In the case of conductive combustible particulate solids, the use of a Type A FIBC might be acceptable provided that the maximum ignition energy from the FIBC or charged product within it is less than the MIE of the combustible particulate solids. [**652:**A.~~8~~9.4.7.4.7]

A.9.3.5.1

Conductive containers are generally made from either metal or carbon-filled plastic having a volume resistivity less than 10^6 ohm-m. [**652:**A.~~8~~9.4.7.5.1]

A.9.3.5.2

Induction charging of ungrounded conductive objects, including personnel, should be addressed as part of the risk assessment and dust hazards analysis when the use of nonconductive RIBCs is being considered. The risk assessment should also consider that higher rates of transfer into and out of the RIBC increase the rate of charge generation, which could result in the brush discharges, propagating brush discharges, or surface (cone) discharges while the RIBC is being filled. For additional information on these phenomena, refer to NFPA 77. [**652:**A.~~8~~9.4.7.~~4.~~5.2]

Second Revision No. 26-NFPA 654-2018 [Global Comment]

New Chapter:

Chapter 5 **Hazard Identification**

5.1 **Hazard Identification.**

The materials handled in the facility shall be evaluated for their hazard in accordance with Chapter 5 of NFPA 652.

Submitter Information Verification

Committee:

Submittal Date: Wed Jul 25 12:49:39 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: This chapter is being added as part of the reorganization effort to align with NFPA 652.

Response Message: SR-26-NFPA 654-2018

Second Revision No. 33-NFPA 654-2018 [Global Comment]

~~4.4~~ 8.11 Incident Investigation.

~~4.4.1~~

~~The requirements of 4.4.2 through 4.4.5 shall be applied to all facilities covered under the scope of this document.~~

A.~~4.4~~ 8.11 .2

Events where there are injuries, equipment damage, or significant business interruption are subject to investigation. [652:A.9.11.1]

In addition to investigation of fires and explosions, it is also a good practice to investigate near misses (i.e., events that could have resulted in 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. [652:A.9.11.1]

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

Submitter Information Verification

Committee:

Submittal Date: Wed Jul 25 15:24:58 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Retroactivity is now covered by 8.1, which says the entire chapter will apply retroactively. Annex material has been added to clarify how retroactivity applies to incident investigations.

Response Message: SR-33-NFPA 654-2018

Second Revision No. 23-NFPA 654-2018 [Detail]

Changes to section 9.3 (which will become 9.4.3 after the reorganization).

9.4.3* ~~**Static Electricity.**~~ **Electrostatic Discharges.**
The requirements of 9.4.3.2 through 9.4.3.6 shall be applied retroactively.

A.9.4.3
See NFPA 77 for information on this subject.
Several types of electrostatic discharges are capable of igniting combustible dusts and hybrid mixtures. The requirements in 9.4.3 are intended to protect against the following four types of discharge: Brush, cone (or bulking brush), propagating brush, and capacitive spark. [**652:** A.9.4.7]
Brush discharges occur when electrostatic charge accumulates on a nonconductive surface and is discharged to nearby conductor. These discharges have a maximum theoretical discharge energy of 3 mJ–5 mJ, which is sufficient to ignite most flammable vapors and gases. There are no records of brush discharges igniting combustible dusts outside of laboratory settings. In the first edition of this standard, a 3 mJ MIE limit was applied as a minimum criterion for the use of nonconductive system components. The intent of this criterion was to ensure that brush discharges were prevented when the MIE was less than the theoretical upper limit of brush discharge energy. However, even where combustible dusts have MIE values less than 3 mJ, the diffuse nature of a brush discharge makes it a less effective ignition source than the capacitive spark used for determining the MIE value. [**652:** A.9.4.7]
Cone or bulking brush discharges occur when resistive solids are transferred into containers where the charge accumulates in the bulk material. The compaction of the charges by gravity creates a strong electric field across the top surface of the material. When the field strength exceeds the breakdown voltage of air, a cone discharge occurs across the surface of the pile terminating at a conductive object (typically the vessel wall.) The energy of a cone discharge is dependent on the size of the container (among other parameters), and discharges up to 20 mJ can occur in process equipment. One particular situation in which cone discharges can occur is in filling FIBCs. For nonconductive containers and vessels such as FIBCs, discharges can occur across the full width (as opposed to the radius or half-width for conductive vessels). For a typical nonconductive FIBC, discharges up to 3 mJ can occur. [**652:** A.9.4.7]
Propagating brush discharges occur when the rapid flow of particulate material generates a high surface charge on a thin nonconductive surface. The presence of this charge on one side of the material induces an opposite charge on the other side, essentially forming a capacitor. If the voltage difference across the material exceeds the material's breakdown voltage, then a pinhole channel is created at a weak spot in the material and the charges on the opposite surfaces are discharged through the channel. Propagating brush discharge energy can be on the order of 1000 mJ. Propagating brush discharges cannot occur if the material is sufficiently thick (greater than 8 mm) or has a sufficiently low breakdown voltage (less than 4 kV for films or sheets or less than 6 kV for woven materials). The presence of an external grounding wire on a nonconductive object will not prevent a propagating brush discharge. [**652:** A.9.4.7]
Capacitive spark discharges occur when the voltage difference between two conductive objects exceeds the breakdown voltage of the medium between them (typically air). Capacitive sparks can ignite both flammable vapors/gases and combustible dusts. [**652:** A.9.4.7]
For more information on electrostatic discharges, refer to NFPA 77 and IEC TS 60079-32-1, *Explosive atmospheres — Part 32-1: Electrostatic hazards, guidance* . [**652:** A.9.4.7]

9.4.3.1
For electrostatic hazard assessment purposes, MIE determination of dust clouds shall be based on a purely capacitive discharge circuit in accordance with ASTM E2019, *Standard Test Method for Minimum Ignition Energy of a Dust Cloud in Air*.
9.4.3.2* Conductive Components.
9.4.3.2.1*
All system components shall be conductive.
9.4.3.2.2
Nonconductive system components shall be permitted where all of the following conditions are met:

(1)* Hybrid mixtures _ and flammable gas/vapor atmospheres are not present.

(2)* Conductive ~~dusts~~ particulate solids are not handled.

(3) ~~The MIE of the material being handled is greater than 3 mJ.~~

(3)* The nonconductive components do not result in isolation of conductive components

from ground.

(4)* The breakdown strength across nonconductive sheets, coatings, ~~or~~ membranes, or pipe/vessel wall with thickness less than 8 mm does not exceed 4 kV, and the breakdown strength across nonconductive woven materials does not exceed 6 kV, when used in high surface charging processes~~.~~ (e.g., pneumatic conveying, milling).

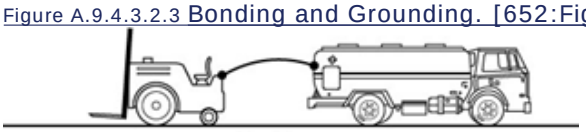
A.9.4.3.2.2(1)
This requirement is intended to prevent ignition of hybrid mixtures or flammable gas/vapor atmospheres by brush discharges from nonconductive surfaces. [**652:** A.9.4.7.1.2(1)]
A.9.4.3.2.2(2)
This requirement is intended to prevent ignition of combustible dusts by the isolation of conductive particulate solids where they can accumulate charge and create capacitive spark discharges to grounded conductive objects. [**652:** 9.4.7.1.2(2)]
A.9.4.3.2.2(3)
This requirement is intended to prevent ignition of combustible dusts by capacitive sparks from isolated process equipment. [**652:** 9.4.7.1.2(3)]

A.9.4.3.2.2(4)
~~The potential for propagating brush discharges exists where nonconductive materials with breakdown voltages exceeding 4 kV are exposed to processes that generate strong surface charges such as pneumatic conveying. Such discharges do not occur where the breakdown voltage is less than 4 kV.~~ This requirement is intended to prevent ignition of combustible dusts by propagating brush discharges. Pneumatic conveying is an example of a process operation that can generate high surface charging. [**652:** A.9.4.7.1.2(4)]

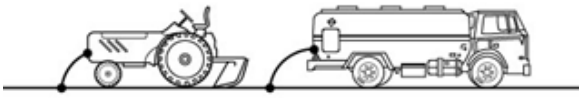
9.4.3.2.3*

Bonding and grounding with a resistance of less than 1.0×10^6 ohms to ground shall be provided for conductive components.[**652:** 9.4.7.1.3]

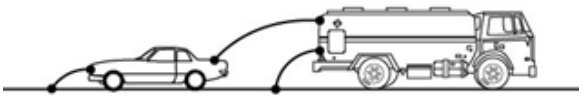
A.9.4.3.2.3
This requirement is intended to prevent ignition of combustible dusts, flammable gas/vapor atmospheres, or hybrid mixtures by capacitive sparks from isolated process equipment. Where the bonding~~/~~ and grounding system is all metal, resistance in continuous ground paths ~~is~~ typically is less than 10 ohms. Such systems include those having multiple components. Greater resistance usually indicates that the metal path is not continuous, usually because of loose connections or corrosion. ~~A~~ A permanent or fixed grounding system that is acceptable for power circuits or for lightning protection is more than adequate for a static electricity grounding system.[**652:** A.9.4.7.1.3]
See Figure A.9.4.3.2.3 for illustrations of bonding and grounding principles. [**652:** A.9.4.7.1.3]
Figure A.9.4.3.2.3 Bonding and Grounding. [652:Figure A.9.4.7.1.3]



Bonding



Grounding



Bonding and grounding

Supplemental Information

File Name	Description	Approved
654_SR_23_9.3.docx	For staff use	

Submitter Information Verification

Submitter Full Name: Laura Moreno

Committee:

Submittal Date: Fri Jun 01 11:06:54 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Clarity is being added to NFPA 654 by aligning with the static requirements in NFPA 652 and helping the user understand the hazards involved.

Section 9.4.3.2.2(4) (formerly 9.3.2.2(5)) is not directly extracted from NFPA 652. Modifications were made to clarify that the 4 kV restriction applies to more than just liners, etc. The former language was not meant to allow application of a section of PVC piping to a pneumatic conveyance system, for example.

Response Message: SR-23-NFPA 654-2018

Committee Notes:

Date	Submitted By	
Jun 1, 2018	Laura Moreno	There are already separate FR's on other subsections of 9.3.

Second Revision No. 27-NFPA 654-2018 [Detail]

Chapter 8 ~~**Fugitive Dust Control and Housekeeping**~~ **Management Systems**

8.1 **Retroactivity.**

This chapter shall be applied retroactively to new and existing facilities and processes.

8.2 **General. (Reserved)**

8.3 **Operating Procedures.**

See 8.8.1 .

Submitter Information Verification

Committee:

Submittal Date: Wed Jul 25 15:09:40 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Headings and requirement are being added as part of the reorganization effort to align with NFPA 652 and to clarify which requirements are to be applied retroactively.

Response Message: SR-27-NFPA 654-2018

Second Revision No. 28-NFPA 654-2018 [Detail]

8.2~~.~~4 Housekeeping**Procedures and Portable Vacuum Cleaners** .
~~All requirements of 8.4.1 through 8.4.3 shall be applied retroactively.~~

Submitter Information Verification

Committee:

Submittal Date: Wed Jul 25 15:12:00 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Retroactivity is now covered by 8.1, which says the entire chapter will apply retroactively. The title of the section is changing to reflect the new contents after reorganization.

Response Message: SR-28-NFPA 654-2018

Second Revision No. 29-NFPA 654-2018 [Detail]

9 8 .5 Open Flames and Sparks **(Hot Work)** .

~~The requirements of 8.5.1 through 8.5.3 shall be applied retroactively.~~

Submitter Information Verification

Committee:

Submittal Date: Wed Jul 25 15:15:21 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Retroactivity is now covered by 8.1, which says the entire chapter will apply retroactively. The title of the section is changing to reflect the contents after reorganization.

Response Message: SR-29-NFPA 654-2018

Second Revision No. 32-NFPA 654-2018 [Detail]

8.10.2
The plans and procedures shall be reviewed annually and as required by process changes.

Submitter Information Verification

Committee:

Submittal Date: Wed Jul 25 15:22:43 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: After the reorganization, emergency planning and employee training have been separated into two different sections. In the previous draft, this requirement applied to both so it is being copied here to apply to emergency planning.

Response Message: SR-32-NFPA 654-2018

Second Revision No. 34-NFPA 654-2018 [Detail]

9.2 6 .4* Deflagration Venting **of Buildings or Building Compartments** .

Submitter Information Verification

Committee:
Submittal Date: Wed Jul 25 15:31:02 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: The title is being revised to reflect the contents of this section.
Response Message: SR-34-NFPA 654-2018

Second Revision No. 35-NFPA 654-2018 [Detail]

9.4.5 **Hot Work.**
Hot work shall be managed in accordance with Section 8.5 .

Submitter Information Verification

Committee:

Submittal Date: Wed Jul 25 15:32:50 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: This directs the user to the hot work requirements which are an ignition source but are located in Chapter 8 with management systems.

Response Message: SR-35-NFPA 654-2018

Second Revision No. 36-NFPA 654-2018 [Detail]

9.6.3
Housekeeping procedures shall be in accordance with Section 8.4 .
9.6.4
Dust collection and centralized vacuum systems shall be designed in accordance with 9.3.3.2 .

Submitter Information Verification

Committee:
Submittal Date: Wed Jul 25 15:34:55 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: These refer the user to other sections applicable to dust control.
Response Message: SR-36-NFPA 654-2018

Second Revision No. 38-NFPA 654-2018 [Detail]

8.6 **Personal Protective Equipment (PPE).**
See 8.8.1 .

Submitter Information Verification

Committee:

Submittal Date: Fri Jul 27 08:00:14 EDT 2018

Committee Statement and Meeting Notes

Committee Statement:	This directs the user to the requirements to develop operating and maintenance procedures that address PPE.
Response Message:	SR-38-NFPA 654-2018

Second Revision No. 42-NFPA 654-2018 [Detail]

Add new reserved sections in Chapter 8:

8.13 Document Retention. (Reserved)
8.14 Management Systems Review. (Reserved)
8.15 Employee Participation. (Reserved)

Submitter Information Verification

Committee: CMD-HAP
Submittal Date: Fri Sep 07 09:52:39 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: New section headings are added as part of the reorganization effort to align with NFPA 652.
Response Message: SR-42-NFPA 654-2018

Second Revision No. 14-NFPA 654-2018 [New Section after 1.1.1]

1.1.2

This standard includes specific requirements for additive manufacturing.

Submitter Information Verification

Submitter Full Name: Laura Moreno

Committee:

Submittal Date: Thu May 31 11:27:50 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: This revision is one of three revisions related to additive manufacturing, to edit the document scope, add a new definition for additive manufacturing, and provide specific requirements. The change to the scope section signifies to users who may not be aware that the requirements of this standard apply to their additive process. In addition to the general requirements in the standard, some additive manufacturing specific requirements have been added to Chapter 9 (which was section 7.19 before the reorganization).

Response Message: SR-14-NFPA 654-2018

Committee Notes:

Date	Submitted By	
Jun 25, 2018	Barbosa	Renumber rest of section

Second Revision No. 39-NFPA 654-2018 [New Section after 1.7]

1.8 Units and Formulas.

Where extracted text contains values expressed in only one system of units, the values in the extracted text have been retained without conversion to preserve the values established by the responsible technical committee in the source document.

Submitter Information Verification

Committee:

Submittal Date: Fri Aug 10 10:09:07 EDT 2018

Committee Statement and Meeting Notes

Committee Statement:	This boiler plate language is added because of the text extracted from NFPA 652 8.4.2.2.1.1, which is only expressed in one system of units.
Response Message:	SR-39-NFPA 654-2018

Second Revision No. 25-NFPA 654-2018 [Section No. 2.4]

2.4 References for Extracts in Mandatory Sections.

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

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

NFPA 77, *Recommended Practice on Static Electricity,* 2019 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* 2018 edition.

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

NFPA 484, *Standard for Combustible Metals,* 2019 edition.

NFPA 652, *Standard on the Fundamentals of Combustible Dust,* 2019 edition.

NFPA 921, *Guide for Fire and Explosion Investigations,* 2017 edition.

NFPA 1250, *Recommended Practice in Fire and Emergency Services Organization Risk Management,* 2015 edition.

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

Submitter Information Verification

Committee:

Submittal Date: Mon Jun 25 13:56:25 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: The definition for pyrophoric material was previously extracted from NFPA 400 and is now extracted from NFPA 484. The definition of dissipative is now extracted from NFPA 77.

Response Message: SR-25-NFPA 654-2018

Second Revision No. 15-NFPA 654-2018 [New Section after 3.3.1]

3.3.2* Additive Manufacturing.

A process of joining materials to make objects from 3D model data, usually layer upon layer.

A.3.3.2 Additive Manufacturing.

Additive manufacturing is sometimes referred to as 3D printing; however, this is only one part of the process.

Submitter Information Verification

Submitter Full Name: Laura Moreno

Committee:

Submittal Date: Thu May 31 11:29:03 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: This revision is one of three revisions related to additive manufacturing, to edit the document scope, add a new definition for additive manufacturing, and provide specific requirements. The change to the scope section signifies to users who may not be aware that the requirements of this standard apply to their additive process. In addition to the general requirements in the standard, some additive manufacturing specific requirements have been added to Chapter 9 (which was section 7.19 before the reorganization).

Response Message: SR-15-NFPA 654-2018

Committee Notes:

Date	Submitted By	
Jun 25, 2018	Barbosa	Add definition after Abort Gate/Abort Damper.

Second Revision No. 17-NFPA 654-2018 [New Section after 3.3.8]

3.3.10* Conductive.

Possessing the ability to allow the flow of an electric charge. [**652,** 2019]

A.3.3.10 Conductive.

A typical threshold for solid materials of construction would be a volume resistivity less than 10^5 ohm-m. [**652,** 2019]

Global SR-12

3.3.10.1 Conductive Particulate Solids.

Particulate solids with a volume resistivity of less than 10^6 ohm-m.

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Thu May 31 16:44:05 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Clarity is being added to NFPA 654 by aligning with the static requirements in NFPA 652 and helping the user understand the hazards involved.

Also see definition of dissipative, definition of nonconductive, and revisions to NFPA 652 extracts in Chapter 9.

Response Message: SR-17-NFPA 654-2018

Committee Notes:

Date	Submitted By	
Jun 25, 2018	Barbosa	Add definition after Compartmentation.

Second Revision No. 18-NFPA 654-2018 [New Section after 3.3.11]

3.3.14* Dissipative.

A material or a construction that will reduce static charge to acceptable levels. [**77,** 2019]

A.3.3.14 Dissipative.

Typically, a dissipative material is one having a surface resistivity between 10^5 ohms per square and 10^9 ohms per square or a volume resistivity between 10^5 ohm-m and 10^9 ohm-m. The intent is to limit the voltage achieved by electrostatic charge accumulation to a potential that is less than the threshold voltage for incendive discharge. Some applications might require different resistivities to accommodate different charging rates or desired relaxation times. [**652,** 2019]

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Thu May 31 16:46:59 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Clarity is being added to NFPA 654 by aligning with the static requirements in NFPA 652 and helping the user understand the hazards involved.

Also see definition of conductive, definition of nonconductive, and revisions to NFPA 652 extracts in Chapter 9.

Response Message: SR-18-NFPA 654-2018

Committee Notes:

Date	Submitted By	
Jun 25, 2018	Barbosa	Add definition after Detachment.

Second Revision No. 7-NFPA 654-2018 [Section No. 3.3.29]

3.3.32* Minimum Ignition Energy (MIE).

The lowest capacitive spark energy capable of igniting the most ignition-sensitive concentration of a flammable vapor-air mixture or a combustible dust-air mixture as determined by a standard test procedure. [**652,** 2019]

A.3.3.32 Minimum Ignition Energy (MIE).

The standard test procedure for MIE of combustible particulate solids is ASTM E2019, *Standard Test Method for Minimum Ignition Energy of a Dust Cloud in Air,* and the standard test procedure for MIE of flammable vapors is ASTM E582, *Standard Test Method for Minimum Ignition Energy and Quenching Distance in Gaseous Mixtures.* [**652,** 2019]

To characterize electrostatic discharge ignition hazards, it is recommended that the ASTM E2019 test be conducted without added inductance, which is equivalent to a capacitive spark discharge.

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Tue May 15 18:04:17 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: This revision adds clarity and makes the user aware that there are variances in tests for MIE.
Response Message: SR-7-NFPA 654-2018

Second Revision No. 19-NFPA 654-2018 [New Section after 3.3.31]

3.3.34* Nonconductive.

A material or a construction that has the ability to accumulate charge, even when in contact with ground. [**652,** 2019]

A.3.3.34 Nonconductive.

Typically, a nonconductive material is one having a surface resistivity greater than 10^9 ohms per square or a volume resistivity greater than 10^9 ohm-m. [**652,** 2019]

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Thu May 31 16:52:07 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Clarity is being added to NFPA 654 by aligning with the static requirements in NFPA 652 and helping the user understand the hazards involved.

Also see definition of dissipative, definition of conductive, and revisions to NFPA 652 extracts in Chapter 9.

Response Message: SR-19-NFPA 654-2018

Committee Notes:

Date	Submitted By	
Jun 25, 2018	Barbosa	Add definition after Noncombustible Material.

Second Revision No. 2-NFPA 654-2018 [Section No. 3.3.35]

3.3.38 Pyrophoric Material.

A ~~chemical with an autoignition temperature in~~ material that ignites upon exposure to air at or below 130°F (54.4°C). [**~~400~~ 484** , 2019]

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Tue May 15 11:33:58 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: This definition is being extracted from NFPA 484 instead of NFPA 400 to add clarity.
Response Message: SR-2-NFPA 654-2018

Public Comment No. 4-NFPA 654-2018 [Section No. 3.3.35]

Second Revision No. 43-NFPA 654-2018 [Section No. 4.3]

4.3* Compliance Options.

The goal in Section 1.3 and the objectives in Section 4.2 shall be achieved by either of the following means:

(1) The prescriptive provisions in accordance with Chapters ~~6 through 12~~ 7 , 8 , and 9 of this standard

(2) The performance-based provisions in accordance with Chapters 6 , 7 , and 8, and Sections 9.4 and 9.6 ~~9, 11, and 12~~ of this standard

Submitter Information Verification

Committee: CMD-HAP

Submittal Date: Mon Sep 10 14:29:42 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Updating the references based on the road map for reorganization done by Global SR 16.

Response Message: SR-43-NFPA 654-2018

Second Revision No. 22-NFPA 654-2018 [Sections 7.6.4, 7.6.5]

9.3.6.3*

Flexible hose and connections shall be permitted ~~to be used for material pickup and vibration isolation~~ in the minimum length necessary to achieve functions such as but not limited to material pickup, material transfer, vibration isolation, weigh bin isolation, or equipment movement in accordance with ~~9.4.3.2~~ 9.4.3 .

A.9.3.6.3

Where flexible hoses are used, they should be of the minimum length to accommodate the intended function. Most flexible hoses produce large pressure drops per unit of length, reducing efficiency.

~~**7.6.5**~~

~~Bellows shall be permitted to be used for the free movement of weigh bins if the bellows are conductive and the equipment is bonded and grounded.~~

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Fri Jun 01 09:51:51 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Flexible components are now covered in 9.4.3. This revision clarifies the intent and points the user to the electrostatic discharges section. The section that was previously 7.6.5 is deleted as it is now covered by this rewording and the electrostatic discharges section.

Response Message: SR-22-NFPA 654-2018

Second Revision No. 3-NFPA 654-2018 [Section No. 7.10.9.1]

9.3.10.9.1

~~Elevators shall have monitors at~~ Elevator head and tail pulleys ~~that indicate~~ shall be monitored for high bearing temperature, pulley alignment, and belt alignment.

Submitter Information Verification

Submitter Full Name: Laura Moreno

Committee:

Submittal Date: Tue May 15 12:23:20 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: This section has been revised in NFPA 652 to include pulley alignment. The pulley alignment requirement was previously thought to have been linked to belt alignment but based on feedback from users, it is important to maintain this separate requirement.

The wording was revised to clarify that the monitoring does not need to be continuous.

Response Message: SR-3-NFPA 654-2018

Public Comment No. 5-NFPA 654-2018 [Section No. 7.10.9.1]

Second Revision No. 9-NFPA 654-2018 [Section No. 7.13.1.1.2]

9.3.13.1.1.2*

The requirement of 9.3.13.1.1.1 shall not apply to the following:

(1) AMSs that are protected in accordance with 9.7.1

(2) AMSs that have a dirty-side volume of less than 8 ft^3 (0.2 m^3)

(3) Wet AMSs that meet all the following criteria:

(a) Interlocks are provided to shut down the system if the flow rate of the scrubbing medium is less than the designed minimum flow rate.

(b) The scrubbing medium is not a flammable or combustible liquid.

(c) The separator is designed to prevent the formation of a combustible dust cloud within the AMS.

(4)* Enclosureless AMSs meeting all the following criteria shall be permitted to be used:

(a) The filter medium is not shaken or pressure-pulsed to dislodge dust during operation.

(b) The AMS is not used to vent or serve metal grinders, hot work processes, or machinery that can produce sparks.

(c) The AMS is not used to vent or serve sanders, abrasive planers, or similar sanding process equipment.

(d)* Each collector system has a maximum air flow–handling capacity of 5000 cfm (~~2.8~~ 2.4 m^3/sec).

(e)* The fan motor is suitable for Class II, Division 2, or Class III, as appropriate.

(f) The collected dust is removed daily or at a frequency sufficient to ensure efficient operation and to limit the collected dust to less than 22 lb (10 kg).

(g) The collector is located at least 20 ft (6.1 m) from any means of egress or area routinely occupied by personnel.

(h)* Multiple collectors in the same room are separated from each other by at least 20 ft (6.1 m).

(i) * The minimum ignition energy (MIE) of the collected materials is greater than 500 mJ.

(j) The fan construction is spark resistant and meets the criteria in 9.3.12.2.5.

(k) The filter medium is not located within 35 ft (10.7 m) of any open flame or hot surface capable of igniting a dust cloud of the material it contains.

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Wed May 16 16:16:32 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Fixing a conversion error.
Response Message: SR-9-NFPA 654-2018

Committee Notes:

Date	Submitted By	
Jun 25, 2018	Laura Moreno	The only thing that is changing is 2.8 to 2.4 in (4)(d)- rest should not be underlined

Second Revision No. 4-NFPA 654-2018 [New Section after 7.13.1.6.3]

9.3.13.1.6.4*

A flame-arresting and particulate-retention device that is designed for use on explosion vent discharge shall not be used as an explosion isolation device in a return air line.

A.9.3.13.1.6.4

Presently a standard test method does not exist to provide listing or certification for this type of device for this purpose. The prohibition is being retained until there is listing by a nationally recognized testing laboratory or proof this type of device can be used successfully for this purpose.

Currently there are strong concerns regarding the differential pressure effects, material accumulation effects, and so forth, which could lead to problems that represent additional, uncontrolled or unmitigated hazards.

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Tue May 15 14:12:50 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: There is currently no available method to determine if this type of device is viable, and there are other parameters which should be considered and have not been, thus the Committee has decided to retain the previous prohibition but include explanatory annex information. The Technical Committee is aware that the NFPA 69 Technical Committee may receive a TIA on this subject. If that TIA is successful, then the NFPA 654 Technical Committee will reconsider this prohibition.

Response Message: SR-4-NFPA 654-2018

Public Comment No. 7-NFPA 654-2018 [Section No. 7.13.1.6.3]

Second Revision No. 13-NFPA 654-2018 [Section No. 7.19]

9.3.19 Additive Manufacturing. ~~(Reserved)~~

9.3.19.1 General Requirements.

9.3.19.1.1

Additive manufacturing shall comply with the additional requirements of this chapter.

9.3.19.1.2

Additive manufacturing involving metal powders shall be covered by NFPA 484 .

9.3.19.1.3

Verification of the grounding and bonding of portable equipment shall be done before each use.

9.3.19.1.4

Containers used for conductive particulate solids shall be conductive or static dissipative.

9.3.19.1.4.1

Conductive and static-dissipative powder containers shall be bonded to the equipment prior to the transfer of powder to and from such equipment.

9.3.19.1.5

Control measures shall be provided to avoid the creation of suspended dust clouds during transfer of powder to and from equipment.

9.3.19.1.6

Portable vacuum cleaning units and portable dust collection equipment shall be listed for use in a Class II atmosphere.

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Thu May 31 11:23:03 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: This revision is one of three revisions related to additive manufacturing, to edit the document scope, add a new definition for additive manufacturing, and provide specific requirements. The change to the scope section signifies to users who may not be aware that the requirements of this standard apply to their additive process. In addition to the general requirements in the standard, some additive manufacturing specific requirements have been added to Chapter 9 (which was section 7.19 before the reorganization).

Response Message: SR-13-NFPA 654-2018

Second Revision No. 21-NFPA 654-2018 [New Section after 9.3.3]

9.4.3.5* Flexible Connectors.

A.9.4.3.5

In order to properly specify a flexible connector for combustible dust service, it is necessary to know the end-to-end resistance. The end-to-end resistance is typically not specified by the suppliers of flexible connectors. This makes it necessary for the user to measure it. ISO 8031, *Rubber and plastics hoses and hose assemblies — Determination of electrical resistance and conductivity* , provides methods to determine the end-to-end resistance. For convenience, the following is a brief description of a similar procedure:

(1) It is preferred to measure the actual flexible connector to be used, but if it is too long for this to be practical, a shorter length (for example, 6 in. to 24 in.) can be used. The measured end-to-end resistance per unit length can then be multiplied by the total flexible connector length to get the overall flexible connector end-to-end resistance.

(2) The flexible connector should be placed on a nonconductive surface, such as a rigid sheet of PTFE, polyethylene, or polypropylene. It is important that neither the flexible connector or megohm meter metal connections are touched by the operator's bare skin during the measurement as this will short the circuit. In addition, the rigid polymer sheet and flexible connector should be dry during the measurement.

(3) The leads on a megohm meter should be contacted on the inside surface of the flexible connector at each end. This should be done at several points on the inside surface to ensure that a consistent reading is obtained. Care should be taken to make measurements at the greatest distance from any supporting wires in the flexible connector to avoid measuring the resistance across the wire. The readings should be taken at approximately 500 V.

[**652:** A.9.4.7.1.4]

9.4.3.5.1* Retroactivity.

This section shall not be required to be applied retroactively. [**652:** 9.4.7.1.4.1]

A.9.4.3.5.1

Flexible connectors wear out over time. The intent of this statement is that existing connectors would be replaced with compliant flexible connectors at the end of their service life. [**652:** A.9.4.7.1.4.1]

9.4.3.5.2

Flexible connectors longer than 6.6 ft (2 m) shall have an end-to-end resistance of less than 1.0×10^8 ohms to ground even where an internal or external bonding wire connects the equipment to which the flexible connector is attached. [**652:** 9.4.7.1.4.2]

9.4.3.5.3*

Where flammable vapors are not present, flexible connectors with a resistance equal to or greater than 1.0×10^8 ohms shall be permitted under either of the following conditions:

(1) The dust has an MIE greater than 2000 mJ.

(2) The maximum powder transfer velocity is less than 2000 fpm (10 m/sec).

[**652:** 9.4.7.1.4.3]

A.9.4.3.5.3

Propagating brush discharges, which are generally considered to be the most energetic type of electrostatic discharge, are usually taken to be on the order of 1000 mJ. 2000 mJ provides a margin of safety.

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Fri Jun 01 08:29:20 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Clarity is being added to NFPA 654 by aligning with the static requirements in NFPA 652 and helping the user understand the hazards involved.

Response Message: SR-21-NFPA 654-2018

Committee Notes:

Date	Submitted By	
Jun 1, 2018	Laura Moreno	This will be relocating to 9.4.3.5. It is staying in the "static electricity" section below conductive components.

Second Revision No. 10-NFPA 654-2018 [Section No. 9.3.3]

9.4.3.3*

Where belt drives are used in areas where combustible dust clouds or ignitible vapor or gas atmospheres might be present , the belts shall ~~be electrically conductive and~~ have a resistance of less than 1.0×10^6 ohms to ground.

A.9.4.3.3

Electrostatic charge generation on power transmission belts occurs due to contact and separation between the belt and pulleys and is dependent on the width of the belt, speed of rotation, and belt tension. IEC 60079-32-1, *Explosive Atmospheres — Part 32-1: Electrostatic Hazards, Guidance* , provides detailed requirements based on belt speed and hazard area classification. It does not require static-dissipative belts in Zone 2 (Class I Division 2) or Zone 22 (Class II Division 2) areas, unless experience shows that incendive discharges occur frequently. The resistance is measured at the inner side of the mounted transmission belt, between an electrode halfway between the two pulleys and ground.

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Wed May 16 17:37:20 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: The elimination of this requirement as done in NFPA 652 was not appropriate for this document, however, a relaxation of the requirement is appropriate and consistent with NFPA 77 and IEC 60079-32-1.
Response Message: SR-10-NFPA 654-2018

Second Revision No. 5-NFPA 654-2018 [Sections 9.3.4.4, 9.3.4.5]

9.4.3.6.4*

Type C FIBCs shall be permitted to be used with combustible particulate solids and in locations where Class I ~~Division~~ Group C/D or Zone Group IIA/IIB flammable vapors or gases, as defined by *NFPA 70*, are present. [**652:** ~~8.4.7.4.4~~]

A.9.4.3.6.4

Type C FIBCs are capable of producing capacitive spark discharges if the grounding tab is not connected. Type C FIBCs are not capable of producing brush or propagating brush discharges, but could be capable of producing cone discharges across the half-width of the bag. Some Type C FIBCs have an internal coating that can isolate conductive particulate solids from ground, producing the potential for capacitive spark discharges from the conductive material to the grounded conductive elements of the bag. Per IEC 61340-4-4, *Electrostatics — Part 4-4: Standard Test Methods for Specific Applications — Electrostatic Classification of Flexible Intermediate Bulk Containers (FIBC)*, Type C FIBCs are permitted to be used for Zone Group IIA and IIB gases but not Group IIC. [**652:**~~A.8.4.7.4.4~~ A.9.4.7.4.4]

9.4.3.6.4.1

Conductive FIBC elements shall terminate in a grounding tab, and resistance from these elements to the tab shall be less than or equal to 10^7 ohms. [**652:**~~8.4.7.4.4.1~~ 9.4.7.4.4.1]

9.4.3.6.4.2

Type C FIBCs shall be grounded during filling and emptying operations with a resistance to ground of less than 25 ohms. [**652:**~~8.4.7.4.4.2~~ 9.4.7.4.4.2]

9.4.3.6.4.3

Type C FIBCs shall be permitted to be used for conductive dusts where a means for grounding the conductive dusts is present. [**652:**~~8.4.7.4.4.3~~ 9.4.7.4.4.3]

9.4.3.6.5*

Type D FIBCs shall be permitted to be used with combustible particulate solids and in locations where Class I ~~Division~~ Group C/D or Zone Group IIA/IIB flammable vapors or gases, as defined by *NFPA 70*, having an MIE greater than 0.14 mJ are present. [**652:** ~~8.4.7.4.5~~]

A.9.4.3.6.5

Type D FIBCs use low energy corona discharges to dissipate static charges from the bag surface. Corona discharges are capable of igniting flammable gases or vapors with MIE less than 0.14 mJ. Type D FIBCs are not capable of producing brush or propagating brush discharges, but could be capable of producing cone discharges across the half-width of the bag. Per IEC 61340-4-4, *Electrostatics — Part 4-4: Standard Test Methods for Specific Applications — Electrostatic Classification of Flexible Intermediate Bulk Containers (FIBC)*, Type ~~C~~ D FIBCs are permitted to be used for Zone Group IIA and IIB gases but not Group IIC. [**652:**~~A.8.4.7.4.5~~ A.9.4.7.4.5]

9.4.3.6.5.1*

Type D FIBCs shall not be permitted to be used for conductive particulate solids. [**652:**~~8.4.7.4.5.1~~ 9.4.7.4.5.1]

A.9.4.3.6.5.1

Type D bags function by corona discharge. Metals or other conductive particulate solids could require additional precautions because, if the particulate is isolated and becomes charged, incendiary sparks could occur during rapid filling and emptying operations. IEC TS 60079-32-1 gives guidance on additional precautions that could be necessary. A risk assessment referencing IEC TS 60079-32-1 could be performed to support the use of Type D FIBCs for conductive particulate solids. [**652:**~~A.8.4.7.4.5.1~~ A.9.4.7.4.5.1]

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Tue May 15 15:17:50 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: The terminology for "Class I Group C/D" has been corrected to align with NFPA 70, and an error in referencing Type C FIBCs in the annex for Type D has been fixed.
Response Message: SR-5-NFPA 654-2018

Public Comment No. 8-NFPA 654-2018 [Section No. 9.3.4]

Second Revision No. 20-NFPA 654-2018 [New Section after 9.3.7]

9.4.3.10* Grounding of Personnel.

A.9.4.3.10

NFPA 77 provides guidance on how to ground personnel. The most common methods of personnel grounding are through conductive flooring and footwear or through dedicated personnel-grounding devices such as wrist straps. Grounding devices should provide a resistance to ground between 10^6 and 10^8 ohms. The lower resistance limit (10^6 ohms) is specified to protect personnel from electrocution due to inadvertent contact with energized electrical equipment, while the upper resistance limit (10^8 ohms) is specified to ensure adequate charge dissipation. Grounding devices should be tested regularly, and cleaning should be performed to ensure that accumulations of noncombustible residues do not interfere with continuity. [**652:** A.9.4.7.3]

9.4.3.10.1*

Where an explosive atmosphere exists and is subject to ignition from an electrostatic spark discharge from ungrounded personnel, personnel involved in manually filling or emptying particulate containers or vessels shall be grounded during such operations. [**652:** 9.4.7.3.1]

A.9.4.3.10.1

The user should expect that activities such as pouring, unloading, and transferring dusts can lead to the development of an ignitible atmosphere above the settled material in the receiving vessel. [**652:** A.9.4.7.3.1]

Refer to NFPA 77 for recommendations for how to safely ground personnel. [**652:** A.9.4.7.3.1]

9.4.3.10.2

Personnel grounding shall not be required where both of the following conditions are met:

(1) Flammable gases, vapors, and hybrid mixtures are not present.

(2)* The minimum ignition energy of the dust cloud is greater than 30 mJ.

A.9.4.3.10.2(2)

Based on information in Britton, *Avoiding Static Ignition Hazards in Chemical Operations* , the maximum reasonable discharge energy from a person is estimated to be approximately 25 mJ. Where the MIE of the dust cloud is greater than 30 mJ, personnel grounding provides no risk reduction. MIE is dependent on particle size, so it is important to determine the MIE value on the particle size distribution that is likely to remain airborne during the operation. Since large particles will quickly fall out of suspension, the sub-75 µ fraction of the material (or material passing through a 200-mesh sieve) is typically tested for this purpose. Where a bulk material includes larger particles, the sub-75 µ MIE might be significantly lower than the bulk material MIE. ASTM E2019, *Standard Test Method for Minimum Ignition Energy of a Dust Cloud in Air* , is the test method for determining particulate and dust MIE. [**652:** A.9.4.7.3.2(2)]

[**652:** 9.4.7.3.2]

Submitter Information Verification

Submitter Full Name: Laura Moreno

Committee:

Submittal Date: Fri Jun 01 08:03:33 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Clarity is being added to NFPA 654 by aligning with the static requirements in NFPA 652 and helping the user understand the hazards involved.

Response Message: SR-20-NFPA 654-2018

Committee Notes:

Date	Submitted By	
Jun 1, 2018	Laura Moreno	This is going to be section 9.4.3.8 after the reorg, following the section "a documented risk assessment acceptable to the AHJ shall be conducted..."

Second Revision No. 37-NFPA 654-2018 [Section No. 10.8]

9.8.3.8 Fire Alarm Service.

~~Alarm~~ Fire alarm service, if provided, shall comply with *NFPA 72*.

Submitter Information Verification

Committee:

Submittal Date: Wed Jul 25 15:36:57 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: This revision clarifies the application of the requirement.

Response Message: SR-37-NFPA 654-2018

Second Revision No. 31-NFPA 654-2018 [Section No. 11.1]

~~**8.8.1** Employee Training.~~

~~The requirements of this chapter shall be applied retroactively.~~

Submitter Information Verification

Committee:

Submittal Date: Wed Jul 25 15:17:29 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Retroactivity is now covered by 8.1, which says the entire chapter will apply retroactively.

Response Message: SR-31-NFPA 654-2018

Committee Notes:

Date	Submitted By	
Aug 15, 2018	Barbosa	PROD: change 8.8 title to Employee Training and Procedures per reorg.

Second Revision No. 30-NFPA 654-2018 [Section No. 12.1 [Excluding any Sub-Sections]]

~~The requirements of 8.7.1.1 through 8.7.1.3 shall be applied retroactively.~~

Submitter Information Verification

Committee:
Submittal Date: Wed Jul 25 15:16:51 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Retroactivity is now covered by 8.1, which says the entire chapter will apply retroactively.
Response Message: SR-30-NFPA 654-2018

Second Revision No. 6-NFPA 654-2018 [Section No. A.7.13.1.6.3]

A.9.3.13.1.6.3

Recommended design, maintenance, and operating guidelines for recirculation of industrial exhaust systems, as described in Chapter 7 of ACGIH *Industrial Ventilation: A Manual of Recommended Practice for Design* 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 type of AMS. Usually the filter media in a dust collector trap 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 can often reduce the frequency of inspection but should not be expected to eliminate it.

~~Flame-arresting/particulate retention devices have been proposed for use as a deflagration isolation means for return air ducts. The use of such devices is the subject of considerable debate, and NFPA 69 has not yet established the criteria for the application and limitations of these devices for this purpose.~~

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Tue May 15 15:46:48 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: The Technical Committee has retained the prohibition of these types of devices in 7.13.1.6.4 and has added annex material to that section, so this language is now unnecessary.
Response Message: SR-6-NFPA 654-2018

Public Comment No. 1-NFPA 654-2018 [Section No. A.7.13.1.6.3]

Second Revision No. 41-NFPA 654-2018 [Section No. A.8.4.1.3]

A.8.4.1.3

Unscheduled housekeeping should be performed in accordance with Table A.8.4.1.3(a) to limit the time that a local spill or short-term accumulation of dust is allowed to remain before the local area is cleaned to less than the threshold dust mass/accumulation.

Table A.8.4.1.3(a) Unscheduled Housekeeping

Accumulation on the Worst Single Square Meter of Surface	Longest Time to Complete Unscheduled Local Cleaning of Floor-Accessible Surfaces	Longest Time to Complete Unscheduled Local Cleaning of Remote Surfaces
> 1 to 2 times threshold dust mass/accumulation	8 hours	24 hours
>2 to 4 times threshold dust mass/accumulation	4 hours	12 hours
>4 times threshold dust mass/accumulation	1 hour	3 hours

Table A.8.4.1.3(a) shows approximate equivalent depths for the accumulation values in Table A.8.4.1.3(b) when the threshold dust mass/accumulation is 0.2 lb/ft^2 (1 kg/m^2). The owner/operator can use an approximate depth to facilitate communication of housekeeping needs.

Table A.8.4.1.3(b) Unscheduled Housekeeping Accumulations

Accumulation on the Worst Single Square Meter of Surface	Average Depth at 75 lb/ft^3 (1200 kg/m^3)	Average Depth at 30 lb/ft^3 (481 kg/m^3)
>0.2–0.4 lb/ft^2(>1 to 2 kg/m^2)	>1/32–1/16 in.(0.8-1.7 mm)	>5/64–5/32 in. (2.1–4.2 mm)
>0.4–0.8 lb ft^2(>2 to 4 kg/m^2)	>1/16–1/8 in.(1.7–3.3 mm)	>5/32 - 5/16 in. (4.2–8.3 mm)
>0.8 lb/ft^2(> 4 kg/m^2)	>1/8 in.(>3.3 mm)	> 5/16 in. (>8.3 mm)

Submitter Information Verification

Committee: CMD-HAP
Submittal Date: Thu Sep 06 08:49:31 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Editorial revision to the table title to differentiate between Table A.8.4.1.3(a) and A.8.4.1.3(b).
Response Message: SR-41-NFPA 654-2018

Second Revision No. 8-NFPA 654-2018 [Section No. A.9.3.4.6.3]

A.9.4.3.6.6.3

Inner liners for FIBCs are separated into three types. Note that the selection of the type of liner is critical to maintaining classification of the FIBC. Appropriate inner liner selection, where applicable, is addressed in IEC 61340-4-4, *Electrostatics — Part 4-4: Standard Test Methods for Specific Applications —Electrostatic Classification of Flexible Intermediate Bulk Containers (FIBC)* , and Table 20 of IEC 60079-32-1, *Explosive Atmospheres — Part 32-1: Electrostatic Hazards, Guidance* .

Type L1 liners are made from materials with surface resistivity on at least 1 surface of less than 10^{7} ohms and, where necessary, a breakdown voltage through the material less than 4 kV. They should be used only with Type C FIBCs, and the liner should be electrically bonded to the conductive elements of the FIBCs.

Type L2 liners are made from materials with surface resistivity on at least 1 surface between 10^{9} ohms and 10^{12} ohms and a breakdown voltage through the material less than 4 kV. They should be used with Type B, C, or D FIBCs. When used with Type D FIBCs, the combination of FIBCs and liner should be tested together.

Type L3 liners are made from materials with surface resistivity of greater than 10^{12} ohms and a breakdown voltage through the material less than 4 kV. They should be used only with Type B FIBCs.

Type A FIBCs have no specific requirements for liners, because Type A FIBCs are not appropriate for use in hazardous atmospheres regardless of liner type.

Users should consult an expert or the latest edition of IEC 60079-32-1 to validate proper liner selection.

Submitter Information Verification

Submitter Full Name: Laura Moreno
Committee:
Submittal Date: Wed May 16 11:45:58 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Additional information from these references has been added to assist the user in selecting the correct liner type.
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G.1.2.2 AIChE Publications.

American Institute of Chemical Engineers, 120 Wall Street, FL 23, New York, NY 10005-4020.

~~AIChE G-18,~~ AIChE Center for Chemical Process Safety, *Guidelines for Hazard Evaluation Procedures*, 3rd edition, 2008.

AIChE Center for Chemical Process Safety, *Guidelines for Safe Automation of Chemical Processes*, 1993.

Submitter Information Verification

Committee: CMD-HAP
Submittal Date: Mon Aug 13 15:09:45 EDT 2018

Committee Statement and Meeting Notes

Committee Statement: Reference update
Response Message: SR-40-NFPA 654-2018