

NFPA®

652

**Standard on
the Fundamentals of
Combustible Dust**

2019



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NFPA® 652

Standard on

the Fundamentals of Combustible Dust

2019 Edition

This edition of NFPA 652, *Standard on the Fundamentals of Combustible Dust*, was prepared by the Technical Committee on Fundamentals of Combustible Dusts and released by the Correlating Committee on Combustible Dusts. It was issued by the Standards Council on May 4, 2018, with an effective date of May 24, 2018, and supersedes all previous editions.

This edition of NFPA 652 was approved as an American National Standard on May 24, 2018.

Origin and Development of NFPA 652

NFPA 652, *Standard on the Fundamentals of Combustible Dust*, provides the general requirements for management of combustible dust fire and explosion hazards and directs the user to NFPA's industry- or commodity-specific standards, as appropriate: NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*; NFPA 484, *Standard for Combustible Metals*; NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*; NFPA 655, *Standard for Prevention of Sulfur Fires and Explosions*; and NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*. This new standard establishes the relationship and hierarchy between it and any of the industry- or commodity-specific standards, ensuring that fundamental requirements are addressed consistently across industries, processes, and dust types.

While NFPA has addressed combustible dust hazards and safeguards for flour and pulverized fuels, such as coal, as far back as 1920, it was not until 2003 that users from all sectors comprehensively examined the specific requirements contained in the five commodity-specific NFPA standards. Those documents apply broadly to varied facilities, processes, equipment types, and dust types to protect against the hazards from combustible dust fires and explosions.

A basis for safety embedded in each of those standards requires the fuel — in this case dust — to be managed, ignition sources to be controlled, and impact from an explosion to be limited through construction, protection, isolation, and housekeeping.

Some users of the NFPA commodity-specific standards believed that the requirements were inconsistent between the various industry sectors and the dust types, leading to confusion in determining which standard applied and how to protect similar hazards within a given process.

In response to that perceived challenge to the longstanding NFPA combustible dust standards, NFPA staff addressed the question of whether there was a better way to structure the committees and standards. Working through the direction of the NFPA Standards Council, a task group chaired by a member of the council explored options for restructuring the combustible dust project. The task group consisted of the chairs of the technical committees for the four existing commodity-specific standards, an additional member from each committee, and NFPA staff liaisons. A report presented to the Standards Council at its March 2011 meeting contained two key recommendations: the establishment of a correlating committee to oversee the work of the four existing combustible dust committees, as well as the work of a proposed new Technical Committee on Fundamentals of Combustible Dusts, and the establishment of a new committee whose scope would permit it to develop documents on the management of hazards from combustible dusts and combustible particulate solids.

The Technical Committee on Fundamentals of Combustible Dusts began its work in earnest in early 2012, using task groups to develop draft chapters based on a straw-man outline proposed by the committee. A preliminary draft was developed and approved by the committee to serve as the basis for requesting approval from the NFPA Standards Council to establish a specific revision cycle. The council initially approved the development of NFPA 652 for the Fall 2014 cycle; during the second



draft stage of the process, however, the committee requested more time to review and process the extensive public comments received. That request was approved, and the standard was moved to the Annual 2015 cycle.

Hazard awareness appears prominently in the standard through the inclusion of chapters on hazard identification, hazard analysis or evaluation, and hazard management involving hazard prevention or mitigation. The committee made some of the requirements in NFPA 652 apply retroactively, including dust hazards analysis (DHA). For existing facilities, a DHA is permitted to be phased in and completed no later than 3 years from the effective date of the standard. Because so many of the investigation findings conclude that owners/operators appear to be unaware of the hazards posed by combustible particulate solids that have the potential to form combustible dusts when processed, stored, or handled, the committee believed it essential to establish the DHA as a fundamental step in creating a plan for safeguarding such facilities.

Together with NFPA 652, the combustible dust standards speak directly to such critical factors as dust containment and collection, hazard analysis, testing, ventilation, air flow, housekeeping, and fire suppression. The provisions of this standard incorporate many of the lessons learned and recommendations issued as part of the combustible dust incident investigation findings reported by the Chemical Safety Board. In addition, this standard complements the efforts of the Occupational Safety and Health Administration and its National Emphasis Program on combustible dust.

The first edition of NFPA 652 was dedicated to the memory of workers who suffered and lost their lives from the hazards of combustible dusts in the hope that it helps prevent such tragedies in the future.

The 2019 edition of NFPA 652 contains the following changes:

- (1) NFPA 652 is intended to be the fundamentals document for combustible dust. As such, definitions that are considered fundamental to the topic of combustible dust reside in NFPA 652 and be extracted into the industry and commodity-specific standards. This ensures consistency in documents dealing with dust. Changes to this edition reflect this, and several definitions are added from industry and commodity-specific documents that also are considered fundamental to combustible dust.
- (2) Provisions designate the requirements that are meant to be retroactive. Management system requirements, such as housekeeping, personal protective equipment (PPE), and hot work are now in Chapter 8, Management Systems.
- (3) Material is added to Chapter 5 that helps the user evaluate the requirements for mixtures of types of combustible dust, such as a mixture containing metal dust and agricultural dust.
- (4) Changes to the deadlines are included for the completion of dust hazard analysis (DHA) for existing processes and facility compartments. The deadline for completion of a DHA is now September 7, 2020. This aligns with industry and commodity-specific dust standards. NFPA 652 now also requires that the DHA be reviewed and updated every 5 years.
- (5) Chapter 9, Hazard Management: Mitigation and Prevention, is expanded to include requirements on equipment design and operation. This includes air material separators (AMS), air moving devices (AMDs), duct systems, sight glasses, abort gates and dampers, bulk storage enclosures, size reduction equipment, pressure protection systems, material feeding devices, bucket elevators, enclosed conveyors, mixers and blenders, and dryers. Requirements for fans for continuous dust control are also added. Changes are made to the requirements for equipment isolation to remove the exemption for small diameter ductwork. Note that this is consistent with the current requirements in NFPA 654.
- (6) The committee modified the material on electrostatic discharges to provide clarity to the user regarding conductive equipment, bonding and grounding, flexible connectors, particulate transport rates, grounding of personnel, flexible intermediate bulk containers (FIBCs), and rigid intermediate bulk containers (RIBCs).

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Committee Scope: This Committee shall have primary responsibility for documents on the hazard identification, prevention, control, and extinguishment of fires and explosions in the design, construction, installation, operation, and maintenance of facilities and systems used in manufacturing, processing, recycling, handling, conveying, or storing combustible particulate solids, combustible metals, or hybrid mixtures.

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Information on referenced publications can be found in Chapter 2 and Annex D.

Chapter 1 Administration

1.1* Scope. This standard shall provide the basic principles of and requirements for identifying and managing the fire and explosion hazards of combustible dusts and particulate solids.

1.2 Purpose. This standard shall provide the minimum general requirements necessary to manage the fire, flash fire, and explosion hazards posed by combustible dusts and directs the user to other NFPA standards for industry- and commodity-specific requirements.

1.3 Application.

1.3.1 The user shall be permitted to use Figure 1.3.1 for guidance when using this standard. See Figure 1.3.1.

1.3.2 This standard shall apply to all facilities and operations that manufacture, process, blend, convey, repackage, generate, or handle combustible dusts or combustible particulate solids.

1.3.3 This standard shall not apply to the following:

- (1) Storage or use of consumer quantities of such materials on the premises of residential or office occupancies
- (2) Storage or use of commercially packaged materials at retail facilities
- (3) Such materials displayed in original packaging in mercantile occupancies and intended for personal or household use or as building materials
- (4)* Warehousing of sealed containers of such materials when not associated with an operation that handles or generates combustible dust
- (5) Such materials stored or used in farm buildings or similar occupancies for on-premises agricultural purposes

1.3.4 Where an industry- or commodity-specific NFPA standard exists, its requirements shall be applied in addition to those in this standard.

1.4 Conflicts.

1.4.1* For the purposes of this standard, the industry- or commodity-specific NFPA standards shall include the following:

- (1) NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*
- (2) NFPA 484, *Standard for Combustible Metals*
- (3) NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*
- (4) NFPA 655, *Standard for Prevention of Sulfur Fires and Explosions*
- (5) NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*

1.4.2 Where a requirement in an industry- or commodity-specific NFPA standard differs from the requirement specified in this standard, the requirement in the industry- or commodity-specific NFPA standard shall be permitted to be used.

1.4.3 Where an industry- or commodity-specific NFPA standard specifically prohibits a requirement specified in this standard, the prohibition in the industry- or commodity-specific NFPA standard shall be applied.

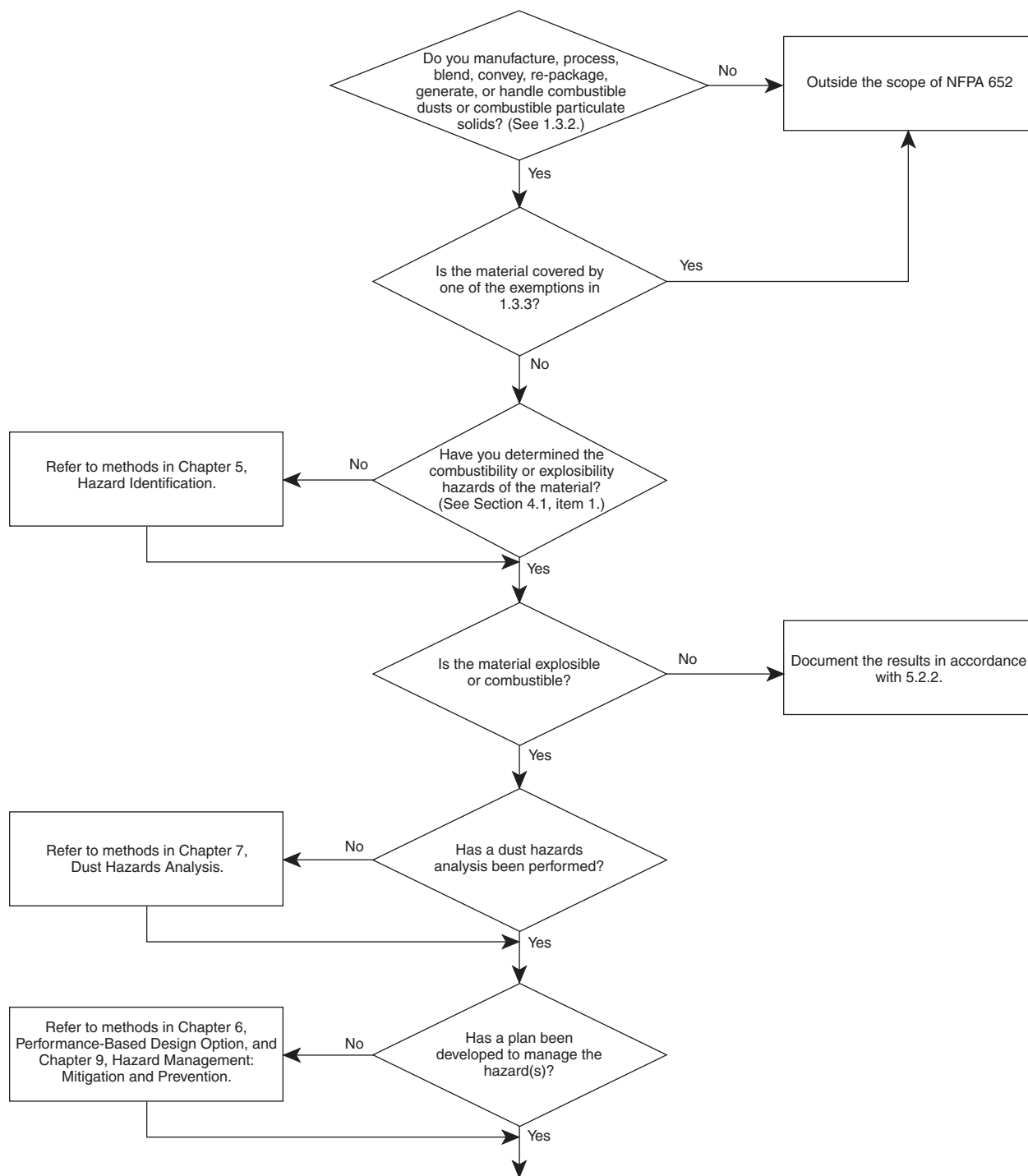
1.4.4 Where an industry- or commodity-specific NFPA standard neither prohibits nor provides a requirement, the requirement in this standard shall be applied.

1.4.5 Where a conflict between a general requirement of this standard and a specific requirement of this standard exists, the specific requirement shall apply.

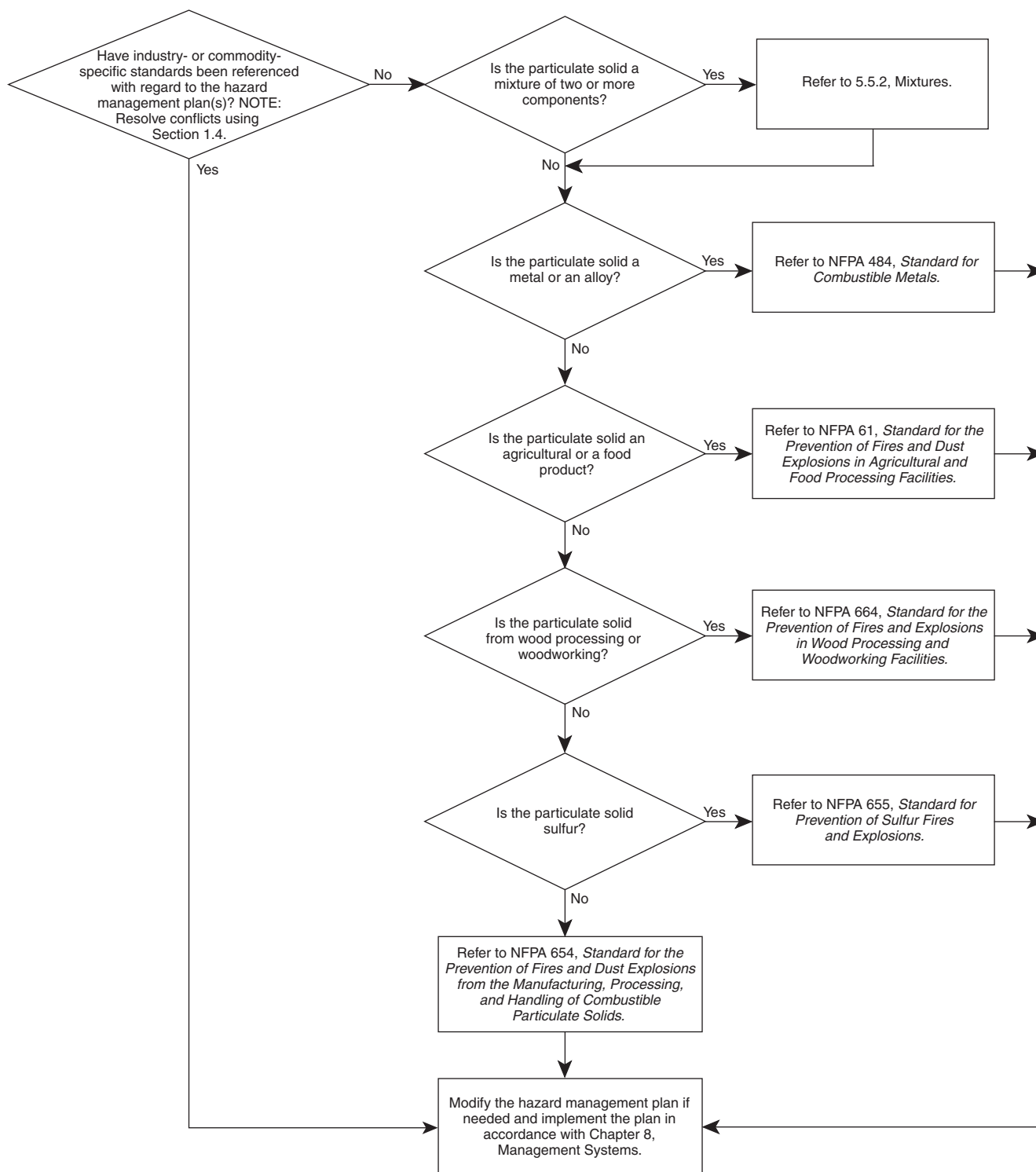
1.5 Retroactivity.

1.5.1 The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.5.2 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.



▲ FIGURE 1.3.1 Document Flow Diagram for Combustible Dust Hazard Evaluation.



▲ FIGURE 1.3.1 Continued

1.5.3 In those cases where the authority having jurisdiction (AHJ) determines that the existing situation presents an unacceptable degree of risk, the AHJ shall be permitted to apply retroactively any portions of this standard that, based on the application of clear criteria derived from the objectives in this standard, the AHJ determines to be necessary to achieve an acceptable degree of risk.

1.5.4 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that the modification does not result in an unacceptable degree of risk.

1.6 Equivalency.

1.6.1 Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.6.2 Technical documentation shall be made available to the authority having jurisdiction to demonstrate equivalency.

1.6.3 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.7 Units and Formulas.

1.7.1 SI Units. Metric units of measurement in this standard shall be in accordance with the modernized metric system known as the International System of Units (SI).

1.7.2* Primary and Equivalent Values. If a value for a measurement as given in this standard is followed by an equivalent value in other units, the first stated value shall be regarded as the requirement.

1.7.3 Conversion Procedure. SI units shall be converted by multiplying the quantity by the conversion factor and then rounding the result to the appropriate number of significant digits.

Chapter 2 Referenced Publications

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

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

NFPA 10, *Standard for Portable Fire Extinguishers*, 2018 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2016 edition.

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

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2018 edition.

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

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2016 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2017 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, 2015 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2017 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2019 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2018 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2019 edition.

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

NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, 2016 edition.

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

NFPA 54, *National Fuel Gas Code*, 2018 edition.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, 2017 edition.

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

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

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

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

NFPA 85, *Boiler and Combustion Systems Hazards Code*, 2015 edition.

NFPA 86, *Standard for Ovens and Furnaces*, 2019 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids*, 2015 edition.

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

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

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*, 2018 edition.

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2017 edition.

NFPA 655, *Standard for Prevention of Sulfur Fires and Explosions*, 2017 edition.

NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, 2017 edition.

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

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

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

NFPA 2113, *Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire*, 2015 edition.

2.3 Other Publications.

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

AMCA 99-0401-86, *Classification for Spark Resistant Construction*, 1986.

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

ASME B31.3, *Process Piping*, 2016.

Boiler and Pressure Vessel Code, 2017.

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

ASTM E1226, *Standard Test Method for Explosibility of Dust Clouds*, 2012a.

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

2.3.4 IEC Publications. International Electrotechnical Commission, 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland.

IEC 61340-4-4, *Electrostatics — Part 4-4: Standard Test Methods for Specific Applications — Electrostatic Classification of Flexible Intermediate Bulk Containers (FIBC)*, 2014.

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

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

2.3.6 UN Publications. United Nations Publications, Room DC2-853, 2 UN Plaza, New York, NY 10017.

UN Recommendations on the Transport of Dangerous Goods: Model Regulations — Manual of Tests and Criteria, 2011.

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

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

2.3.8 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

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

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

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

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

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

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

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

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

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

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

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster’s Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase “standards development process” or “standards development activities,” the term “standards” includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Abort Gate/Damper. A device for the quick diversion of material or air to the exterior of a building or other safe location in the event of a fire.

3.3.2* Air-Material Separator (AMS). A device designed to separate the conveying air from the material being conveyed.

3.3.2.1 Enclosureless AMS. An air-material separator designed to separate the conveying air from the material

being conveyed where the filter media are not enclosed or in a container.

3.3.3* Air-Moving Device (AMD). A power-driven fan, blower, or other device that establishes an airflow by moving a given volume of air per unit time.

3.3.4 Bonding. For the purpose of controlling static electric hazards, the process of connecting two or more conductive objects by means of a conductor so that they are at the same electrical potential but not necessarily at the same potential as the earth.

3.3.5* Centralized Vacuum Cleaning System. A fixed-pipe system utilizing variable-volume negative-pressure (i.e., vacuum) air flows from remotely located hose connection stations to allow the removal of dust accumulations from surfaces and conveying those dusts to an air-material separator (AMS).

3.3.6* Combustible Dust. A finely divided combustible particulate solid that presents a flash-fire hazard or explosion hazard when suspended in air or the process-specific oxidizing medium over a range of concentrations.

3.3.7* Combustible Metal. Any metal composed of distinct particles or pieces, regardless of size, shape, or chemical composition, that will burn.

3.3.8* Combustible Particulate Solid. Any solid material composed of distinct particles or pieces, regardless of size, shape, or chemical composition, that, when processed, stored, or handled in the facility, has the potential to produce a combustible dust.

3.3.9 Compartment. A subdivision of an enclosure.

3.3.10* Conductive. Possessing the ability to allow the flow of an electric charge.

3.3.10.1 Conductive Dusts. Dusts with a volume resistivity of less than 10^6 ohm-m.

3.3.11* Deflagration. Propagation of a combustion zone at a velocity that is less than the speed of sound in the unreacted medium. [68, 2018]

3.3.12 Detachment. Location in a separate building or an outside area removed from other structures to be protected by a distance as required by this standard.

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

3.3.14 Duct. Pipes, tubes, or other enclosures used to convey materials pneumatically or by gravity.

3.3.15* Dust Collection System. A combination of equipment designed to capture, contain, and pneumatically convey fugitive dust to an air-material separator (AMS) in order to remove the dust from the process equipment or surrounding area.

3.3.16 Dust Deflagration Hazard. A condition that presents the potential for harm or damage to people, property, or the environment due to the combustion of a sufficient quantity of combustible dust suspended in air or another oxidizing medium.

3.3.17 Dust Explosion Hazard. A dust deflagration hazard in an enclosure that is capable of bursting or rupturing the enclosure due to the development of internal pressure from the deflagration.

sure due to the development of internal pressure from the deflagration.

3.3.18* Dust Hazards Analysis (DHA). A systematic review to identify and evaluate the potential fire, flash fire, or explosion hazards associated with the presence of one or more combustible particulate solids in a process or facility.

3.3.19* Enclosure. A confined or partially confined volume. [68, 2018]

3.3.20* Explosible. Capable of propagating a deflagration when dispersed in air or the process-specific oxidizing media.

3.3.21 Explosion. The bursting or rupture of an enclosure or container due to the development of internal pressure from a deflagration. [69, 2014]

3.3.22 Fire Hazard. Any situation, process, material, or condition that can cause a fire or provide a ready fuel supply to augment the spread or intensity of a fire and poses a threat to life or property.

3.3.23* Flash Fire. A fire that spreads by means of a flame front rapidly through a diffuse fuel, such as dust, gas, or the vapors of an ignitable liquid, without the production of damaging pressure. [921, 2017]

3.3.24 Fuel Object. A combustible object or mass of particulate that can serve as a source of fuel for a fire or deflagration; sometimes referred to as a *fuel package*.

3.3.25 Fugitive Dusts. Dust that escapes from equipment and containers.

3.3.26 Grounding. The process of bonding one or more conductive objects to the ground so that all objects are at zero electrical potential; also referred to as *earthing*.

3.3.27 Hot Work. Work involving burning, welding, or a similar operation that is capable of initiating fires or explosions. [51B, 2019]

3.3.28* Hybrid Mixture. An explosible heterogeneous mixture, comprising gas with suspended solid or liquid particulates, in which the total flammable gas concentration is ≥ 10 percent of the lower flammable limit (LFL) and the total suspended particulate concentration is ≥ 10 percent of the minimum explosible concentration (MEC). [68, 2018]

3.3.29* Industry- or Commodity-Specific NFPA Standard. An NFPA code or standard whose intent as documented within its purpose or scope is to address fire and explosion hazards of a combustible particulate solid.

3.3.30 Intermediate Bulk Containers.

3.3.30.1* Flexible Intermediate Bulk Container (FIBC). Large bags typically made from nonconductive woven fabric that are used for storage and handling of bulk solids.

3.3.30.1.1 Type A FIBC. An FIBC made from nonconductive fabric with no special design features for control of electrostatic discharge hazards.

3.3.30.1.2 Type B FIBC. An FIBC made from nonconductive fabric where the fabric or the combination of the fabric shell, coating, and any loose liner has a breakdown voltage of less than 6000 volts.

- △ **3.3.30.1.3 Type C FIBC.** An FIBC made from conductive material or nonconductive woven fabric incorporating interconnected conductive threads of specified spacing with all conductive components connected to a grounding tab.
- △ **3.3.30.1.4 Type D FIBC.** An FIBC made from fabric and/or threads with special static properties designed to control electrostatic discharge energy without a requirement for grounding the FIBC.
- △ **3.3.30.2* Rigid Intermediate Bulk Container (RIBC).** An intermediate bulk container (IBC) that can be enclosed in or encased by an outer structure consisting of a steel cage, a single-wall metal or plastic enclosure, or a double wall of foamed or solid plastic.
- △ **3.3.30.2.1 Insulating RIBC.** An RIBC constructed entirely of solid plastic or solid plastic and foam composite that cannot be electrically grounded.
- N **3.3.31 K_{st} .** The deflagration index of a dust cloud. [68, 2018]
- △ **3.3.32* Minimum Explosible Concentration (MEC).** The minimum concentration of a combustible dust suspended in air, measured in mass per unit volume, that will support a deflagration.
- △ **3.3.33* 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.
- N **3.3.34* Mixture.** A combination of particulates incorporating more than one material.
- N **3.3.35* Nonconductive.** A material or a construction that has the ability to accumulate charge, even when in contact with ground.
- 3.3.36* Pneumatic Conveying System.** An equipment system that transfers a controlled flow of solid particulate material from one location to another using air or other gases as the conveying medium, and that is comprised of the following components: a material feeding device; an enclosed ductwork, piping, or tubing network; an air–material separator; and an air-moving device.
- N **3.3.37 Portable Vacuum Cleaner.** A movable assembly consisting basically of a vacuum source [air-moving device (AMD)], an air-material separator (AMS) using either liquid or filter media within an enclosure, and a vacuum hose, used to remove dusts and particles from surfaces.
- △ **3.3.38 Pyrophoric Material.** A material that ignites upon exposure to air at or below 54.4°C (130°F). [484, 2019]
- 3.3.39 Qualified Person.** A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to deal with problems related to the subject matter, the work, or the project. [1451, 2018]
- 3.3.40 Replacement-in-Kind.** A replacement that satisfies the design specifications of the replaced item.
- 3.3.41* Risk Assessment.** An assessment of the likelihood, vulnerability, and magnitude of the incidents that could result from exposure to hazards. [1250, 2015]

3.3.42 Segregation. A hazard management strategy in which a physical barrier is established between the hazard area and an area to be protected.

3.3.43 Separation. A hazard management strategy achieved by the establishment of a distance as required by the standard between the combustible particulate solid process and other operations that are in the same room.

3.3.44* Spark. A localized source of thermal or electrical energy capable of igniting combustible material.

N **3.3.44.1* Capacitive Spark.** A short-duration electric discharge due to a sudden breakdown of air or some other insulating material separating two conductors at different electric potentials, accompanied by a momentary flash of light; also known as electric spark, spark discharge, and sparkover.

N **3.3.44.2* Thermal Spark.** A moving particle of solid material that emits radiant energy sufficient to act as an ignition source due to either its temperature or the process of combustion on its surface.

3.3.45 Threshold Housekeeping Dust Accumulations. The maximum quantity of dust permitted to be present before cleanup is required.

3.3.46 Transient Releases. (Reserved)

3.3.47 Ullage Space. The open space above the surface of the stored solids in a storage vessel.

3.3.48 Wall.

3.3.48.1 Fire Barrier Wall. A wall, other than a fire wall, having a fire resistance rating. [221, 2018]

3.3.48.2 Fire Wall. A wall separating buildings or subdividing a building to prevent the spread of fire and having a fire resistance rating and structural stability. [221, 2018]

N **3.3.49 Wet Air-Material Separator.** An air-material separator (AMS) that uses liquid for the separation of the pneumatically conveyed solid from the air/gas.

Chapter 4 General Requirements

4.1* General. The owner/operator of a facility with potentially combustible dust shall be responsible for the following activities:

- (1) Determining the combustibility and explosibility hazards of materials in accordance with Chapter 5
- (2) Identifying and assessing any fire, flash fire, and explosion hazards in accordance with Chapter 7
- (3) Managing the identified fire, flash fire, and explosion hazards in accordance with 4.2.3
- (4) Communicating the hazards to affected personnel in accordance with Section 8.8

4.2 Objectives. The objectives stated in this section shall be interpreted as intended outcomes of this standard and not as prescriptive requirements.

4.2.1 Life Safety.

4.2.1.1* The facility, processes, and equipment shall be designed, constructed, equipped, and maintained and management systems shall be implemented to reasonably protect occu-

pants not in the immediate proximity of the ignition from the effects of fire for the time needed to evacuate, relocate, or take refuge.

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

4.2.1.3 The facility, processes, and equipment shall be designed, constructed, equipped, and maintained and management systems shall be implemented to reasonably prevent injury from explosions.

4.2.1.4 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.

4.2.2* 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.

4.2.3* Mitigation of Fire Spread and Explosions. The facility and processes shall be designed to prevent or mitigate 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.

4.2.4* Compliance Options. The objectives in Section 4.2 shall be deemed to have been met by implementing either of the following:

- (1) A prescriptive approach in accordance with Chapters 5, 7, 9, and 8 in conjunction with any prescriptive provisions of applicable commodity-specific NFPA standards
- (2) A performance-based approach in accordance with Chapter 6

4.2.5 Where a dust fire, deflagration, or explosion hazard exists within a process system, the hazards shall be managed in accordance with this standard.

4.2.6 Where a dust fire, deflagration, or explosion hazard exists within a building or building compartment, the effects of the fire, deflagration, or explosion shall be managed in accordance with this standard.

Chapter 5 Hazard Identification

5.1 Responsibility. The owner/operator of a facility with potentially combustible dusts shall be responsible for determining whether the materials are combustible or explosible, and, if so, for characterizing their properties as required to support the DHA.

5.1.1 Where dusts are determined to be combustible or explosible, the hazards associated with the dusts shall be assessed in accordance with Chapter 7.

5.1.2 Where dusts are determined to be combustible or explosible, controls to address the hazards associated with the dusts shall be identified and implemented in accordance with 4.2.4.

5.2* Screening for Combustibility or Explosibility.

5.2.1 The determination of combustibility or explosibility shall be permitted to be based upon either of the following:

- (1) Historical facility data or published data that are deemed to be representative of current materials and process conditions
- (2) Analysis of representative samples in accordance with the requirements of 5.4.1 and 5.4.3

5.2.2* Test results, historical data, and published data shall be documented and, when requested, provided to the authority having jurisdiction (AHJ).

5.2.3 The absence of previous incidents shall not be used as the basis for deeming a particulate to not be combustible or explosible.

5.2.4 Where dusts are determined to not be combustible or explosible, the owner/operator shall maintain documentation to demonstrate that the dusts are not combustible or explosible.

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

5.4 Combustibility and Explosibility Tests. Where combustibility or explosibility screening tests are required, they shall be conducted on representative samples obtained in accordance with Section 5.5.

5.4.1 Determination of Combustibility.

5.4.1.1 Where the combustibility is not known, determination of combustibility shall be determined by one of the following tests:

- (1) A screening test based on the *UN Recommendations on the Transport of Dangerous Goods: Model Regulations — Manual of Tests and Criteria*, Part III, Subsection 33.2.1, Test N¹, “Test Method for Readily Combustible Solids”
- (2) Other equivalent fire exposure test methods

5.4.1.2* For the purposes of determining combustibility, if the dust in the form tested ignites and propagates combustion or ejects sparks from the heated zone after the heat source is removed, the material shall be considered combustible.

5.4.1.3 If the dust is known to be explosible, it shall be permitted to assume that the dust is combustible and the requirements of 5.4.1.1 shall not apply.

5.4.2* Determination of Flash-Fire Potential. (Reserved)

5.4.3 Determination of Explosibility.

5.4.3.1 Where the explosibility is not known, determination of explosibility of dusts shall be determined according to one of the following tests:

- (1) The “Go/No-Go” screening test methodology described in ASTM E1226, *Standard Test Method for Explosibility of Dust Clouds*
- (2) ASTM E1515, *Standard Test Method for Minimum Explosible Concentration of Combustible Dusts*
- (3) An equivalent test methodology

5.4.3.2* When determining explosibility, it shall be permitted to test a sample sieved to less than 200 mesh (75 µm).

5.4.3.3* When determining explosibility, it shall be permitted to test the as-received sample.

5.4.3.4 It shall be permitted to assume a material is explosible, forgoing the requirements of 5.4.3.1.

5.4.3.5* When the representative sample has a characteristic particle size smaller than 0.5 µm, the explosibility screening test method shall account for possible ignitions in the sample injection apparatus.

5.4.4 Quantification of Combustibility and Explosibility Characteristics.

5.4.4.1* Where dusts are determined to be combustible or explosible, additional testing shall be performed, as required, to acquire the data necessary to support the performance-based design method described in Chapter 6; the DHA described in Chapter 7; the risk assessments described in Chapter 9; or specification of the hazard mitigation and prevention described in Chapter 9.

5.4.4.2 The owner/operator shall be permitted to use the worst-case characteristics of the various materials being handled as a basis for design.

N 5.4.4.3 When quantifying combustibility and explosibility characteristics, it shall be permitted to test the as-received sample only for those locations where the particulate remains homogeneously mixed.

N 5.4.4.4* Where the material does not remain homogeneously mixed, a representative fine fraction shall be tested.

5.5 Sampling.

5.5.1 Sampling Plan.

5.5.1.1 A sampling plan shall be developed and documented to provide data as needed to comply with the requirements of this chapter.

5.5.1.2 Representative samples of dusts shall be identified and collected for testing according to the sampling plan.

5.5.1.3 The sampling plan shall include the following:

- (1) Identification of locations where fine particulates and dust are present
- (2) Identification of representative samples
- (3) Collection of representative samples
- (4)* Preservation of sample integrity
- (5) Communication with the test laboratory regarding sample handling
- (6) Documentation of samples taken
- (7) Safe sample collection practices

5.5.2* Mixtures. If the combustible particulate solid sample is a mixture, the approximate proportions of each general category of particulate solid shall be determined and documented on the basis of available information and shall be used to assist in determining representative samples.

N 5.5.2.1 Mixtures comprised of more than 10 percent by mass of metallic particulate shall be treated as a metallic combustible dust in accordance with the relevant sections of NFPA 484.

N 5.5.2.1.1 It shall be permitted to evaluate metal mixtures per the requirements in 1.1.6.2 of NFPA 484.

N 5.5.2.1.1.1 Mixtures containing metals identified as legacy metals (aluminum, magnesium, niobium, tantalum, titanium, zirconium, and hafnium) shall be evaluated per the requirements in 1.1.6.2 of NFPA 484.

N 5.5.2.2 Mixtures consisting of more than 50 percent by mass wood or wood-based particulate but less than 10 percent metallic particulate shall be treated as a wood dust in accordance with the relevant sections of NFPA 664.

N 5.5.2.3 Mixtures consisting of more than 50 percent by mass agricultural particulate to be used in foodstuffs but less than 10 percent metallic particulate shall be treated as an agricultural dust in accordance with the relevant sections of NFPA 61.

N 5.5.2.4 Any mixture that does not fall under 5.5.2.1 through 5.5.2.3 shall be treated as a chemical dust in accordance with NFPA 654.

N 5.5.2.5 Where the mixture contains both combustible and noncombustible materials, the combustible components shall be used as the basis for the mixture classification.

N 5.5.2.6* Where components with different chemical compositions do not remain homogeneously mixed, the properties of the individual constituents shall be considered separately.

5.5.3* Representative Samples.

N 5.5.3.1 Samples collected from each location shall be representative of material used in the process or equipment or found on surfaces at that location.

N 5.5.3.2 Samples that could oxidize or degrade in the presence of air shall be maintained in suitable inert gas or vacuum packaging until tested.

5.5.4 Sample Collection. Dust samples shall be collected in a safe manner without introducing an ignition source, dispersing dust, or creating or increasing the risk of injury to workers.

5.5.4.1* Samples shall be uniquely identified using identifiers such as lot, origin, composition (pure, mixture), process, age, location, and date collected.

Chapter 6 Performance-Based Design Option

6.1 General Requirements.

6.1.1 Retained Prescriptive Requirements. Portions of a facility designed in accordance with this chapter as an alternative for particular prescriptive requirements shall meet all other relevant prescriptive requirements in this standard.

6.1.2* It shall be permitted to use performance-based alternative designs for a process or part of a process, specific material, or piece of equipment in lieu of the prescriptive requirements found in Chapter 9.

6.1.3 Approved Qualifications. The performance-based design shall be prepared by a person with qualifications acceptable to the owner/operator.

6.1.3.1* General. All applicable aspects of the design, including those described in 6.1.4.1 through 6.1.4.13, shall be documented in a format and content acceptable to the AHJ.

6.1.4* Document Requirements. Performance-based designs shall be documented to include 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 6.1.4.

6.1.4.1* Technical References and Resources. When requested by the AHJ, the AHJ shall be provided with sufficient documentation to support the validity, accuracy, relevance, and precision of the proposed methods. The engineering standards, calculation methods, and other forms of scientific information provided shall be appropriate for the particular application and methodologies used.

6.1.4.2 Building Design Specifications. All details of the proposed building, facilities, equipment, and process designs that affect the ability of the facility to meet the stated goals and objectives shall be documented.

6.1.4.3 Performance Criteria. Performance criteria, with sources, shall be documented.

6.1.4.4 Occupant Characteristics. Assumptions about occupant characteristics shall be documented.

6.1.4.5 Design Fire and Explosion Scenarios. Descriptions of combustible dust fire and explosion design scenarios shall be documented.

6.1.4.6 Input Data. Input data to models and assessment methods, including sensitivity analyses, shall be documented.

6.1.4.7 Output Data. Output data from models and assessment methods, including sensitivity analyses, shall be documented.

6.1.4.8 Safety Factors. The safety factors utilized shall be documented.

6.1.4.9 Prescriptive Requirements. Retained prescriptive requirements shall be documented.

6.1.4.10 Modeling Features.

6.1.4.10.1 Assumptions made by the model user and descriptions of models and methods used, including known limitations, shall be documented.

6.1.4.10.2 Documentation shall be provided to verify that the assessment methods have been used validly and appropriately to address the design specifications, assumptions, and scenarios.

6.1.4.11 Evidence of Modeler Capability. The design team's relevant experience with the models, test methods, databases, and other assessment methods used in the performance-based design proposal shall be documented.

6.1.4.12 Performance Evaluation. The performance evaluation summary shall be documented.

6.1.4.13 Use of Performance-Based Design Option. Design proposals shall include documentation that provides anyone involved in the ownership or management of the building with notification of the following:

- (1) Approval of the building, facilities, equipment or processes, in whole or in part, as a performance-based design with certain specified design criteria and assumptions
- (2) Need for required re-evaluation and reapproval in cases of remodeling, modification, renovation, change in use, or change in established assumptions

6.1.5* 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.

6.1.6 Sources of Data.

6.1.6.1 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.

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

6.1.7* Maintenance of the Design Features. To continue meeting the performance goals and objectives of this standard, the design features required for each hazard area shall be maintained for the life of the facility subject to the management of change provisions of Section 8.12.

6.1.7.1* This shall include complying with originally documented design assumptions and specifications.

6.1.7.2* Any variation from the design shall be acceptable to the AHJ.

6.2 Risk Component and Acceptability. The specified performance criteria of Section 6.3 and the specified fire and explosion scenarios of Section 6.4 shall be permitted to be modified by a documented risk assessment acceptable to the AHJ. The final performance criteria, fire scenarios, and explosion scenarios established for the performance-based design shall be documented.

6.3 Performance Criteria. A system and facility design shall be deemed to meet the objectives specified in Section 4.2 if its performance meets the criteria in 6.3.1 through 6.3.5.

6.3.1 Life Safety.

6.3.1.1* The life safety objectives of 4.2.1 with respect to a fire hazard shall be achieved if either of the following conditions 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 time necessary to effect complete evacuation.

6.3.1.2 The life safety objectives of 4.2.1 with respect to an explosion hazard shall be achieved if either of the following conditions 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 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 time necessary to effect complete evacuation.

6.3.2 Structural Integrity. The structural integrity objectives embodied in 4.2.1 and 4.2.2 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.

6.3.3 Mission Continuity. The mission continuity objectives of 4.2.2 shall be achieved when damage to equipment and the

facility has been limited to a level of damage acceptable to the owner/operator.

6.3.4 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.

6.3.5 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 building or building compartment or equipment sufficient to threaten its structural integrity
- (2) Extension of the flame front outside the building or building compartment or equipment of origin except where intentionally vented to a safe location
- (3) Rupture of the building or building compartment or equipment of origin and the ejection of fragments that can constitute missile hazards

6.4* Design Scenarios.

6.4.1 Fire Scenarios.

6.4.1.1* Each fuel object in the building or building compartment or equipment of origin shall be considered for inclusion as a fire scenario.

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

6.4.1.3 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.

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

6.4.1.5 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.

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

6.4.1.7 Each 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.

6.4.2 Explosion Scenarios.

6.4.2.1 Each duct, enclosed conveyor, silo, bunker, cyclone, dust collector, 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.

6.4.2.2 Each duct, enclosed conveyor, silo, bunker, cyclone, dust collector, 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.

6.4.2.3 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.

6.4.2.4 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.

6.4.2.5* Where combustible dust can cause other explosion hazards, such as generation of hydrogen or other flammable gases, those hazards shall be included as explosion scenarios.

6.5 Evaluation of Proposed Design.

6.5.1* A proposed design's performance shall be assessed relative to each documented performance criterion as established in Section 6.2 or in Section 6.3 and in each documented fire and explosion scenario established for the design, with the assessment conducted through the use of appropriate calculation methods acceptable to the AHJ.

6.5.2 The designer shall establish numerical performance criteria for each of the documented performance objectives established for the design.

6.5.3 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 7 Dust Hazards Analysis (DHA)

7.1* General Requirements.

7.1.1 Retroactivity. The requirements of this chapter shall be applied retroactively in accordance with 7.1.1.1 and 7.1.1.2.

7.1.1.1* A DHA shall be completed for all new processes and facility compartments.

7.1.1.2* For existing processes and facility compartments, a DHA shall be completed by September 7, 2020.

7.1.1.3 The owner/operator shall demonstrate reasonable progress each year in completing DHAs prior to the deadline set in 7.1.1.2.

7.1.2 The owner/operator of a facility where materials determined to be combustible or explosible in accordance with Chapter 5 are present in an enclosure shall be responsible to ensure a DHA is completed in accordance with the requirements of this chapter.

7.1.3 The absence of previous incidents shall not be used as the basis for not performing a DHA.

7.1.4 The DHA shall be reviewed and updated at least every 5 years.

7.2 Criteria.

7.2.1* Overview. The DHA shall evaluate the fire, deflagration, and explosion hazards and provide recommendations to manage the hazards in accordance with Section 4.2.

7.2.2* Qualifications. The DHA shall be performed or led by a qualified person.

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

7.3 Methodology.

7.3.1 General. The DHA shall include the following:

- (1) Identification and evaluation of the process or facility areas where fire, flash fire, and explosion hazards exist
- (2) Where such a hazard exists, identification and evaluation of specific fire and deflagration scenarios shall include the following:
 - (a) Identification of safe operating ranges
 - (b)* Identification of the safeguards that are in place to manage fire, deflagration, and explosion events
 - (c) Recommendation of additional safeguards where warranted, including a plan for implementation

7.3.2 Material Evaluation.

7.3.2.1 The DHA shall be based on data obtained in accordance with Chapter 5 for material that is representative of the dust present.

7.3.3 Process Systems.

7.3.3.1* Each part of the process system where combustible dust is present or where combustible particulate solids could cause combustible dust to be present shall be evaluated, and the evaluation shall address the following:

- (1) Potential intended and unintended combustible dust transport between parts of the process system
- (2) Potential fugitive combustible dust emissions into a building or building compartments
- (3) Potential deflagration propagation between parts of the process system

7.3.3.2 Each part of the process that contains a combustible particulate solid and that can potentially include both of the following conditions shall be considered a fire hazard and shall be documented as such:

- (1) Oxidizing atmosphere
- (2) Credible ignition source

7.3.3.3* Each part of the process that contains a sufficient quantity of combustible dust to propagate a deflagration and that can potentially include all the following conditions shall be considered a dust deflagration hazard and shall be documented as such:

- (1) Oxidizing atmosphere
- (2) Credible ignition source
- (3) Credible suspension mechanism

7.3.4 Building or Building Compartments.

7.3.4.1 Each building or building compartment where combustible dust is present shall be evaluated.

7.3.4.1.1 Where multiple buildings or building compartments present essentially the same hazard, a single evaluation shall be permitted to be conducted as representative of all similar buildings or building compartments.

7.3.4.1.2 The evaluation shall address potential combustible dust migration between buildings or building compartments.

7.3.4.1.3 The evaluation shall address potential deflagration propagation between buildings or building compartments.

7.3.4.2* Each building or building compartment that contains a combustible particulate solid and that can potentially include both of the following conditions shall be considered a fire hazard and shall be documented as such:

- (1) Oxidizing atmosphere
- (2) Credible ignition source

7.3.4.2.1* The evaluation of dust deflagration hazard in a building or building compartment shall include a comparison of actual or intended dust accumulation to the threshold housekeeping dust accumulation that would present a potential for flash-fire exposure to personnel or compartment failure due to explosive overpressure.

7.3.4.2.2 Threshold housekeeping dust accumulation levels and nonroutine dust accumulation levels (e.g., from a process upset) shall be in accordance with relevant industry- or commodity-specific NFPA standards.

7.3.4.3 Each building or building compartment that contains a sufficient quantity of combustible dust to propagate a deflagration and that can potentially include all of the following conditions shall be considered a dust deflagration hazard and shall be documented as such:

- (1) Oxidizing atmosphere
- (2) Credible ignition source
- (3) Credible suspension mechanism

Chapter 8 Management Systems

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

8.2* General. The procedures and training in this chapter shall be delivered in a language that the participants can understand.

8.3 Operating Procedures and Practices.

8.3.1* The owner/operator shall establish written procedures for operating its facility and equipment to prevent or mitigate fires, deflagrations, and explosions from combustible particulate solids.

8.3.2* The owner/operator shall establish safe work practices to address hazards associated with maintenance and servicing operations.

8.3.2.1 The safe work practices shall apply to employees and contractors.

8.3.3 A periodic walk-through review of operating areas shall be conducted, on a schedule established by the owner/operator per the requirement in 8.7.3, to verify that operating procedures and safe work practices are being followed.

N 8.4 Housekeeping.**N 8.4.1 General.****N 8.4.2* Methodology.****N 8.4.2.1 Procedure.****N 8.4.2.1.1* Housekeeping procedures shall be documented.**

N 8.4.2.1.2* The methods used for cleaning surfaces shall be selected on the basis of reducing the potential for creating a combustible dust cloud.

N 8.4.2.1.3 Cleaning methods to be used shall be based on the characteristics of the material and quantity of material present.

N 8.4.2.2 Vacuum Cleaning Method.**N 8.4.2.2.1* Portable Vacuum Cleaners.**

N 8.4.2.2.1.1 Portable vacuum cleaners with a dirty side volume greater than 8 ft³ shall comply with 9.7.3 and 9.7.4.

N 8.4.2.2.1.2* 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.

N 8.4.2.2.1.3* 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.

N 8.4.2.2.1.4 Hoses and vacuum tools shall be appropriate for use and be static dissipative or conductive.

N 8.4.2.2.1.5 Portable vacuum cleaners shall not be used on processes generating hot embers or sparks.

N 8.4.2.2.1.6* 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.

N 8.4.2.2.1.7* Portable vacuum cleaners that meet the following minimum requirements shall be permitted to be used to collect combustible particulate solids in unclassified (nonhazardous) areas:

- (1) Materials of construction shall comply with 9.4.7.1.
- (2) Hoses shall be conductive or static dissipative.
- (3) All conductive components, including wands and attachments, shall be bonded and grounded.
- (4) The fan or blower shall be on the clean side of the primary filtration media or wet separation chamber.
- (5) Electrical motors shall not be located on the dirty side of the primary filtration media or wet separation chamber unless listed for Class II, Division 1 locations.
- (6)* Where liquids or wet materials 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.

N 8.4.2.2.2* In Class II electrically classified (hazardous) locations, electrically powered vacuum cleaners shall be listed for the purpose and location or shall be a fixed-pipe suction system with a remotely located exhaustor and an AMS installed in conformance with Section 9.3, and they shall be suitable for the dust being collected.

N 8.4.2.2.3 Where flammable vapors or gases are present in Class II areas, vacuum cleaners shall be listed for both Class I and Class II hazardous locations.

N 8.4.2.3* Sweeping, Shoveling, Scoop, and Brush Cleaning Method. The use of scoops, brooms, and brushes for sweeping and shoveling shall be a permitted cleaning method.

N 8.4.2.4* Water Washdown Cleaning Method.

N 8.4.2.4.1 The use of water washdown shall be a permitted cleaning method.

N 8.4.2.4.2 Where the combustible dust being removed is metal or metal-containing dust or powder within the scope of NFPA 484, the requirements of NFPA 484 shall be followed.

N 8.4.2.4.3* Where the combustible dust being removed is a water-reactive material, additional precautions shall be taken to control the associated hazards.

N 8.4.2.5 Water Foam Washdown Systems. (Reserved)**N 8.4.2.6 Compressed Air Blowdown Method.**

N 8.4.2.6.1* Blowdowns using compressed air shall be permitted to be used as a cleaning method in accordance with the provisions of 8.4.2.6.2.

N 8.4.2.6.2* Where blowdown using compressed air is used, the following precautions shall be followed:

- (1) Prior to using compressed air, vacuum cleaning, sweeping, or water washdown methods are used to clean surfaces that can be safely accessed.
- (2) Dust accumulations in the area after vacuum cleaning, sweeping, or water washdown do not exceed the threshold housekeeping dust accumulation.
- (3) Compressed air hoses are equipped with pressure relief nozzles limiting the discharge pressure to 30 psi (207 kPa) in accordance with OSHA requirements in 29 CFR 1910.242(b), "Hand and Portable Powered Tools and Equipment, General."
- (4) All electrical equipment, including lighting, potentially exposed to airborne dust in the area during cleaning is suitable for use in a Class II, Division 2, hazardous (classified) location in accordance with NFPA 70.
- (5) All ignition sources and hot surfaces capable of igniting a dust cloud or dust layer are shut down or removed from the area.
- (6) After blowdown is complete, residual dust on lower surfaces is cleaned prior to re-introduction of potential ignition sources.
- (7) Where metal or metal-containing dust or powder under the scope of NFPA 484 is present, the requirements of NFPA 484 apply.

N 8.4.2.7 Steam Blow Down Method. (Reserved)

N 8.4.3 Training. Employee and contractor training shall include housekeeping procedures, required personal protective equipment (PPE) during housekeeping, and proper use of equipment.

N 8.4.4 Equipment. (Reserved)**N 8.4.5 Vacuum Trucks.**

N 8.4.5.1 Vacuum trucks shall be grounded and bonded.

N 8.4.5.2 Vacuum truck hoses and couplings shall be static dissipative or conductive and grounded.

N 8.4.6 Frequency and Goal.

N 8.4.6.1* Housekeeping frequency and accumulation goals shall be established to ensure that the accumulated fugitive dust levels on surfaces do not exceed the threshold housekeeping dust accumulation limits.

N 8.4.6.2 The threshold housekeeping dust accumulation limits shall be in accordance with the industry- or commodity-specific NFPA standard. (See 1.3.1.)

N 8.4.6.3* Provisions for unscheduled housekeeping shall include specific requirements establishing time to clean local dust spills or transient releases.

N 8.4.7 Auditing and Documentation.

N 8.4.7.1* Housekeeping effectiveness shall be assessed based on the results of routine scheduled cleaning and inspection, not including transient releases.

N 8.4.7.2 The owner/operator shall retain documentation that routine scheduled cleaning occurs in accordance with the frequency and accumulation goals established in 8.4.6.1.

N 8.5 Hot Work.

N 8.5.1* In addition to the requirements of NFPA 51B, all hot work activities shall comply with the requirements in 8.5.2 through 8.5.5.

N 8.5.2* The area affected by hot work shall be thoroughly cleaned of combustible dust prior to commencing any hot work.

N 8.5.3 Equipment that contains combustible dust and is located within the hot work area shall be shut down, shielded, or both.

N 8.5.4 When the hot work poses an ignition risk to the combustible dust within equipment, the equipment shall be shut down and cleaned prior to commencing such hot work.

N 8.5.5 Floor and wall openings within the hot work area shall be covered or sealed.

N 8.5.6 Use of portable electrical equipment that does not comply with the electrical classification of the area where it is to be used shall be authorized and controlled in accordance with the hot work procedure as outlined in Section 8.5.

N 8.6 Personal Protective Equipment.

N 8.6.1 Workplace Hazard Assessment.

N 8.6.1.1* An assessment of workplace hazards shall be conducted as described in NFPA 2113.

N 8.6.1.2 When the assessment in 8.6.1.1 has determined that flame-resistant garments are needed, personnel shall be provided with and wear flame-resistant garments.

N 8.6.1.3* When flame-resistant clothing is required for protecting personnel from flash fires, it shall comply with the requirements of NFPA 2112.

N 8.6.1.4* Consideration shall be given to the following:

- (1) Thermal protective characteristics of the fabric over a range of thermal exposures
- (2) Physical characteristics of the fabric

- (3) Garment construction and components
- (4) Avoidance of static charge buildup
- (5) Design of garment
- (6) Conditions under which garment will be worn
- (7) Garment fit
- (8) Garment durability/wear life
- (9) Recommended laundering procedures
- (10) Conditions/features affecting wearer comfort

N 8.6.1.5 Flame-resistant garments shall be selected, procured, inspected, worn, and maintained in accordance with NFPA 2113.

N 8.6.1.6* The employer shall implement a policy regarding care, cleaning, and maintenance for flame-resistant garments.

N 8.6.2 Limitations of PPE Application. (Flame-Resistant Garments)

N 8.6.2.1* When required by 8.6.1.2, flame-resistant or non-melting undergarments shall be used.

N 8.6.2.2* When determined by 8.6.1.1 that flame-resistant garments are needed, only flame-resistant outerwear shall be worn over flame-resistant daily wear.

N 8.6.3 Limitations of PPE to Combustible Dust Flash Fires. (Reserved)

N 8.6.4 Face, Hands, and Footwear Protection. (Reserved)

8.7 Inspection, Testing, and Maintenance.

8.7.1* Equipment affecting the prevention, control, and mitigation of combustible dust fires, deflagrations, and explosions shall be inspected and tested in accordance with the applicable NFPA standard and the manufacturers' recommendations.

8.7.2 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

8.7.3 The owner/operator shall establish procedures and schedules for maintaining safe operating conditions for its facility and equipment in regard to the prevention, control, and mitigation of combustible dust fires and explosions.

8.7.4* Where equipment deficiencies that affect the prevention, control, and mitigation of dust fires, deflagrations, and explosions are identified or become known, the owner/operator shall establish and implement a corrective action plan with an explicit deadline.

8.7.5* Inspections and testing activities that affect the prevention, control, and mitigation of dust fires, deflagrations, and explosions shall be documented.

Δ 8.7.6 A periodic walk-through review of operating areas shall be conducted, on a schedule established by the owner/operator per the requirement in 8.7.3, to verify that the equipment is in safe operating condition.

8.8 Training and Hazard Awareness.

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

8.8.2* General safety training and hazard awareness training for combustible dusts and solids shall be provided to all affected employees.

8.8.2.1* Job-specific training shall ensure that employees are knowledgeable about fire and explosion hazards of combustible dusts and particulate solids in their work environment.

8.8.2.2 Employees shall be trained before taking responsibility for a task.

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

8.8.3 Refresher training shall be provided as required by the AHJ and as required by other relevant industry- or commodity-specific NFPA standards.

8.8.4 The training shall be documented.

8.9 Contractors.

8.9.1 Owner/operators shall ensure the requirements of Section 8.9 are met.

8.9.2* Only qualified contractors shall be employed for work involving the installation, repair, or modification of buildings (interior and exterior), machinery, and fire and explosion protection equipment that could adversely affect the prevention, control, or mitigation of fires and explosions.

8.9.3* Contractor Training.

8.9.3.1 Contractors operating owner/operator equipment shall be trained and qualified to operate the equipment and perform the work.

8.9.3.2 Contractor training shall be documented.

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

8.9.3.4 Contractors shall be trained and required to comply with the facility's safe work practices and policies in accordance with 8.3.2.

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

8.10 Emergency Planning and Response.

8.10.1* A written emergency response plan shall be developed for preparing for and responding to work-related emergencies including, but not limited to, fire and explosion.

8.10.2 The emergency response plan shall be reviewed and validated at least annually.

8.11* Incident Investigation.

8.11.1* The owner/operator shall have a system to ensure that incidents that result in a fire, deflagration, or explosion are reported and investigated in a timely manner.

8.11.2 The investigation shall be documented and include findings and recommendations.

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

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

8.12 Management of Change.

8.12.1* Written procedures shall be established and implemented to manage proposed changes to process materials, staffing, job tasks, technology, equipment, procedures, and facilities.

8.12.2 The procedures shall ensure that the following are addressed prior to any change:

- (1)* The basis for the proposed change
- (2)* Safety and health implications
- (3) Whether the change is permanent or temporary, including the authorized duration of temporary changes
- (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

8.12.3* Implementation of the management of change procedure shall not be required for replacements-in-kind.

8.12.4 Design and procedures documentation shall be updated to incorporate the change.

8.13* Documentation Retention.

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

- (1) Training records
- (2) Equipment inspection, testing, and maintenance records
- (3)* Incident investigation reports
- (4) Dust hazards analyses
- (5)* Process and technology information
- (6)* Management of change documents
- (7) Emergency response plan documents
- (8)* Contractor records

8.14 Management Systems Review.

8.14.1 The owner/operator shall evaluate the effectiveness of the management systems presented in this standard by conducting a periodic review of each management system.

8.14.2 The owner/operator shall be responsible for maintaining and evaluating the ongoing effectiveness of the management systems presented in this standard.

8.15* Employee Participation. Owner/operators shall establish and implement a system to consult with and actively involve affected personnel and their representatives in the implementation of this standard.

Chapter 9 Hazard Management: Mitigation and Prevention

9.1* Inherently Safer Designs.

9.2 Building Design.

9.2.1 Risk Assessment. A documented risk assessment acceptable to the AHJ shall be permitted to be conducted to determine the level of building design and protection features to be provided, including, but not limited to, the measures addressed in Section 9.2.

9.2.2* Construction. The type of construction shall be in accordance with the building code adopted by the AHJ.

9.2.3 Building or Building Compartment Protection.

9.2.3.1* Each building or building compartment where a dust deflagration hazard exists shall be protected from the consequence of deflagration.

9.2.3.2* If a building or building compartment contains a dust explosion hazard outside of equipment, such areas shall be provided with deflagration venting to a safe area in accordance with NFPA 68.

9.2.3.2.1 Venting to relieve pressure shall be located through an outside wall or roof.

9.2.3.2.2 The fireball, blast hazards, and missile hazards that are created by deflagration venting shall not expose additional personnel or property assets.

9.2.4 Life Safety. Building configuration and appurtenances shall comply with the life safety requirements of the building and fire prevention codes adopted by the AHJ.

9.2.4.1 Where a dust deflagration hazard exists in a building or building compartment outside of equipment, building configuration and appurtenances shall comply with the life safety requirements of the building and fire prevention codes for a hazardous occupancy adopted by the AHJ.

9.2.4.2 Where a dust explosion hazard exists in a building or building compartment and an enclosed means of egress is provided, it shall be designed to withstand potential external overpressure from building deflagration.

9.2.5 Construction Features to Limit Accumulation.

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

9.2.5.2 Enclosed building spaces inaccessible to routine housekeeping shall be sealed to prevent dust accumulation.

9.2.5.3* Enclosed building spaces that are difficult to access for routine housekeeping shall be designed to facilitate routine inspection for the purpose of determining the need for periodic cleaning.

9.2.6 Separation of Hazard Areas from Other Hazard Areas and from Other Occupancies.

9.2.6.1 Areas where a dust deflagration hazard exists in a building or building compartment (excluding hazard within equipment) shall be segregated, separated, or detached from other occupancies to minimize damage from a fire or an explosion.

9.2.6.2 Use of Segregation.

9.2.6.2.1 Physical barriers erected for the purpose of limiting fire spread shall be designed in accordance with NFPA 221.

9.2.6.2.2 Physical barriers erected to segregate fire hazard areas, including all penetrations and openings of floors, walls, ceilings, or partitions, shall have a minimum fire resistance rating based on the anticipated fire duration.

9.2.6.2.3 Physical barriers, including all penetrations and openings of floors, walls, ceilings, or partitions, that are erected to segregate dust explosion hazard areas shall be designed to preclude failure of those barriers during a dust explosion in accordance with NFPA 68.

9.2.6.3 Use of Separation.

9.2.6.3.1* Separation shall be permitted to be used to limit the dust explosion hazard or deflagration hazard area within a building when it is supported by a documented engineering evaluation acceptable to the AHJ.

9.2.6.3.2* The required separation distance between the dust explosion hazard or deflagration hazard area and surrounding exposures shall be determined by an engineering evaluation that addresses the following:

- (1) Properties of the materials
- (2) Type of operation
- (3) Amount of material likely to be present outside the process equipment
- (4) Building and equipment design
- (5) Nature of surrounding exposures

9.2.6.3.3 Either the separation area shall be free of dust or where dust accumulations exist on any surface, the color of the surface on which the dust has accumulated shall be readily discernible.

9.2.6.3.4 Where separation is used to limit the dust explosion or deflagration hazard area determined in Chapter 7, the minimum separation distance shall not be less than 35 ft (11 m).

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

9.2.6.4 Use of Detachment.

9.2.6.4.1 Detachment shall be permitted to be used to limit the dust hazard area to a physically separated adjacent building.

9.2.6.4.2* The required detachment distance between the dust explosion hazard area or the deflagration hazard area and surrounding exposures shall be determined by an engineering evaluation that addresses the following:

- (1) Properties of the materials
- (2) Type of operation
- (3) Amount of material likely to be present outside the process equipment
- (4) Building and equipment design
- (5) Nature of surrounding exposures

9.3 Equipment Design.

9.3.1* 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, including, but not limited to, protection measures addressed in Section 9.3.

9.3.2 Design for Dust Containment.

9.3.2.1 All components of enclosed systems that handle combustible particulate solids shall be designed to prevent the escape of dust, except for openings intended for intake and discharge of air and material.

9.3.2.2 Where the equipment cannot be designed for dust containment, dust collection shall be provided. (See also 9.3.3.)

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

9.3.3.1 General Requirements.

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

9.3.3.1.2* Where it is necessary to make changes to an existing system, all changes shall be managed in accordance with the management of change requirements in Section 8.12.

9.3.3.1.3* The system shall be designed and maintained to ensure that the air-gas velocity used shall meet or exceed the minimum required to keep the interior surfaces of all piping or ducting free of accumulations under all normal operating modes.

N 9.3.3.1.4 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 9.7.3.2(1) through 9.7.3.2(6).

9.3.3.1.5* Operations.

9.3.3.1.5.1 Sequence of Operation. Pneumatic conveying, dust collection, and centralized vacuum cleaning systems shall be designed with the operating logic, sequencing, and timing outlined in 9.3.3.1.5.2 and 9.3.3.1.5.3.

9.3.3.1.5.2* 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.

9.3.3.1.5.3 Shutdown.

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

(B) The requirements of 9.3.3.1.5.3(A) 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.

(C) 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.

9.3.3.2* Specific Requirements for Pneumatic Conveying Systems.

9.3.3.2.1* The design of the pneumatic conveying system shall address required performance parameters and properties of the materials being conveyed.

9.3.3.2.2* Where a pneumatic conveying system or any part of such a system operates as a positive-pressure-type system and the air-moving device'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*, or ASME B31.3, *Process Piping*, or international equivalents.

9.3.3.2.3* Pneumatic conveying systems conveying combustible particulate solids and posing an explosion hazard shall be protected in accordance with Section 9.7.

9.3.3.3* Specific Requirements for Dust Collection Systems.

9.3.3.3.1* At each collection point, the system shall be designed to achieve the minimum velocity required for capture, control, and containment of the dust source.

9.3.3.3.2* The hood or pickup point for each dust source shall have a documented minimum air volume flow based upon the system design.

9.3.3.3.3* 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.

9.3.3.3.4* The addition of branch lines shall not be made to an existing system without first confirming that the entire system will maintain the required and balanced airflow.

9.3.3.3.5* Dust collection systems that remove material from operations that generate flames, sparks, or hot material under normal operating conditions shall not be interconnected with dust collection systems that transport combustible particulate solids or hybrid mixtures. (See 9.7.4.)

9.3.3.3.6* The air-material separator (AMS) selected for the system shall be designed to allow for the characteristics of the combustible dust being separated from the air or gas flow.

9.3.3.3.7* Air-moving devices (AMDs) shall be of appropriate type and sufficient capacity to maintain the required rate of air flow in all parts of the system.

9.3.3.3.8* Control equipment controlling the operation of the AMS shall be installed in a location that is safe from the effects of a deflagration in the AMS.

9.3.3.4* Specific Requirements for Centralized Vacuum Cleaning Systems.

9.3.3.4.1* The system shall be designed to assure minimum conveying velocities at all times whether the system is used with a single or multiple simultaneous operators.

9.3.3.4.2* The hose length and diameter shall be sized for the application and operation.

9.3.3.4.3* Where ignition-sensitive materials are collected, vacuum tools shall be constructed of metal or static dissipative materials and provide proper grounding to the hose.

9.3.3.4.4* Vacuum cleaning hose shall be static dissipative or conductive and grounded.

9.3.4 AMS.**9.3.4.1 AMS Indoor Locations.****9.3.4.1.1* Dry AMS.**

9.3.4.1.1.1 If the dirty side volume of the air-material separator is greater than 8 ft³ (0.2 m³), it shall be protected in accordance with Section 9.7.

9.3.4.1.1.2 Enclosureless AMS shall not be permitted to be located indoors unless specifically allowed by an industry- or commodity-specific NFPA standard.

9.3.4.1.2 Wet AMS.

9.3.4.1.2.1 Wet air-material separators shall be permitted to be located inside when all of the following criteria are met:

- (1) Interlocks are provided to shutdown the system if the flow rate of the scrubbing medium is less than the designed minimum flow rate.
- (2) The scrubbing medium is not a flammable or combustible liquid.
- (3) The separator is designed to prevent the formation of a combustible dust cloud within the air-material separator.
- (4) The design of the separator addresses any reaction between the separated material and the scrubbing medium.

9.3.4.2 AMS Outdoor Locations. (Reserved)**9.3.4.3 AMS Clean Air Exhaust.**

9.3.4.3.1 Exhaust air from the final AMS shall be discharged outside of buildings to a restricted area separated from clean air intakes for the building.

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

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

- (1) Combustible or flammable gases or vapors are not present in either the intake or the recycled air in concentrations above applicable industrial hygiene exposure limits or 1 percent of the lower flammable limit (LFL), whichever is lower.
- (2)* Combustible particulate solids are not present in the recycled air in concentrations above applicable industrial hygiene exposure limits or 1 percent of the minimum explosible concentration (MEC), whichever is lower.
- (3)* The oxygen concentration of the recycled air stream is between 19.5 percent and 23.5 percent by volume.
- (4) Provisions are incorporated to prevent transmission of flame and pressure effects from a deflagration in an AMS back to the facility unless a DHA 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 building compartment to which the recycled air is returned meets the requirements of Section 8.4.
- (8) Recycled-air ducts are inspected and cleaned at least annually.

N 9.3.4.4 AMS Construction.

N 9.3.4.4.1 AMSs shall be constructed of noncombustible materials.

N 9.3.4.4.2 Filter media and filter media support frames shall be permitted to be constructed of combustible material.

N 9.3.4.4.3 Where isolated from an AMS by a valve, portable containers intended to receive materials discharged from the AMS shall be permitted to be constructed of combustible material.

N 9.3.4.4.4 AMSs shall be constructed to minimize internal ledges or other points of dust accumulation.

N 9.3.4.4.5 Hopper bottoms shall be sloped and the discharge conveying system shall be designed to handle the maximum material flow attainable from the system.

N 9.3.4.4.6 Where provided to permit inspection, cleaning, and maintenance, access doors and access openings shall meet the following requirements:

- (1) They shall be designed to prevent dust leaks.
- (2) They shall be permitted to be used as deflagration vents if they are specifically designed for both purposes.
- (3) They shall be bonded and grounded.
- (4)* If not designed to be used as deflagration vents, they shall be designed to the same strength as the AMS.

N 9.3.5 Air-Moving Devices (Fans and Blowers).

N 9.3.5.1 Air-moving devices (AMDs) shall conform to the requirements of NFPA 91, except as amended by the requirements of this chapter.

N 9.3.5.2 Where an explosion hazard exists, systems shall be designed in such a manner that combustible particulate solids do not pass through an AMD.

N 9.3.5.3* The requirement of 9.3.5.2 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 9.7.3.2(1), 9.7.3.2(5), 9.7.3.2(6), or 9.7.4.

N 9.3.5.4* 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 99-0401-86, *Classification for Spark Resistant Construction*, or Type C spark-resistant construction protected with spark detection and extinguishment located downstream of the fan.

N 9.3.6 Duct Systems.

N 9.3.6.1 Ducts that handle combustible particulate solids shall conform to the requirements of NFPA 91, except as amended by the requirements of this chapter.

N 9.3.6.2* 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.

N 9.3.6.3* When ducts pass through a physical barrier erected to segregate dust deflagration hazards, physical isolation protection shall be provided to prevent propagation of deflagrations between segregated spaces.

N 9.3.6.3.1 Access doors, openings, or removable sections of ductwork shall be provided to allow inspection, cleaning, maintenance, and fire department access.

N 9.3.6.3.2 Access doors, openings, or removable sections of ductwork shall be designed and maintained to prevent dust leaks and preserve the integrity of the duct.

N 9.3.6.3.3 Access doors, openings, or removable sections of ductwork that are not specifically designed for deflagration venting shall not be considered as providing that function.

N 9.3.6.3.4 Access doors, openings, or removable sections of ductwork shall be bonded and grounded.

N 9.3.7 Sight Glasses.

N 9.3.7.1 Sight glasses shall be of a material that is impact and erosion-resistant.

N 9.3.7.2 Sight glass assemblies shall have a pressure rating equal to or greater than that of the ductwork.

N 9.3.7.3 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.

N 9.3.7.4 The mechanical strength of the sight glass-mounting mechanism shall be equal to the adjoining ductwork.

N 9.3.7.5 The inside diameter of a sight glass shall not cause a restriction of flow.

N 9.3.7.6 The connections between the sight glass and the ductwork shall be squarely butted and sealed so as to be both airtight and dusttight.

N 9.3.7.7 The electrical bonding across the length of the sight glass shall be continuous and have a resistance of no more than 1 ohm.

N 9.3.8 Abort Gates/Dampers.

N 9.3.8.1 Construction.

N 9.3.8.1.1 Abort gates and abort dampers shall be constructed of noncombustible materials.

N 9.3.8.1.2 Abort gates and abort dampers shall be actuated by spark detection or equivalent automatic detection in the duct or pipe upstream of the device.

N 9.3.8.1.3 The detection system and abort gate shall respond to prevent sparks, glowing embers, or burning materials from passing beyond the abort gate.

N 9.3.8.1.4 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.

N 9.3.8.2 Manual Reset.

N 9.3.8.2.1 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 at the damper/gate.

N 9.3.8.2.2 Automatic or remote reset provisions shall not be permitted.

N 9.3.8.3 Integrity of Actuation Circuits.

N 9.3.8.3.1 All fire protection abort gates or abort dampers shall be connected to the fire detection control panel via Class A or Class D circuits as described in *NFPA 72*.

N 9.3.8.3.2 When the abort gate is connected via a Class A circuit, 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.

N 9.3.9 Bulk Storage Enclosures.

N 9.3.9.1 General.

N 9.3.9.1.1 For the purposes of this section, bulk storage enclosures shall include items such as bins, tanks, hoppers, and silos.

N 9.3.9.1.2* The requirements of this section shall not apply to containers that are used for transportation of the material.

N 9.3.9.2* Construction. Bulk storage enclosures, 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.

N 9.3.9.3 Fixed Bulk Storage Location.

N 9.3.9.3.1 Where an explosion hazard exists, fixed bulk storage enclosures shall be located outside of buildings.

N 9.3.9.3.2 Fixed bulk storage enclosures shall be permitted to be located inside buildings where one of the following applies:

- (1) Fixed bulk storage enclosures are protected in accordance with 9.7.3.
- (2)* Fixed bulk storage enclosures are less than 8 ft³ (0.2 m³).

N 9.3.9.4* Interior Surfaces. Interior surfaces shall be designed and constructed to facilitate cleaning and to minimize combustible dust accumulation.

N 9.3.9.5 Access Doors and Access Openings. Where provided to permit inspection, cleaning, and maintenance, access doors and access openings shall meet the following requirements:

- (1) They shall be designed to prevent dust leaks.
- (2) They shall be permitted to be used as deflagration vents if they are specifically designed for both purposes.
- (3) They shall be bonded and grounded.
- (4) If not designed to be used as deflagration vents, they shall be designed to the same strength as the AMS.

N 9.3.10* Size Reduction. Before material is processed by size reduction equipment, foreign materials shall be excluded or removed as required by 9.4.12.

N 9.3.11* Particle Size Separation.

N 9.3.11.1 Particle separation devices shall be designed to control fugitive dust emissions per Section 9.6.

N 9.3.11.2 Flexible connectors shall be in conformance with 9.3.6.