

NFPA®

61

Standard for the
Prevention of Fires and
Dust Explosions in Agricultural
and Food Processing Facilities

2020



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NFPA® 61

Standard for the

Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities

2020 Edition

This edition of NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, was prepared by the Technical Committee on Agricultural Dusts and released by the Correlating Committee on Combustible Dusts. It was issued by the Standards Council on November 4, 2019, with an effective date of November 24, 2019, and supersedes all previous editions.

This edition of NFPA 61 was approved as an American National Standard on November 24, 2019.

Origin and Development of NFPA 61

The NFPA 61 standard originated in 1923, when standards were first being developed to prevent dust explosions in grain terminals and flour mills. There were four standards associated with agricultural dusts. In 1969, NFPA 61B was adopted by the Association as a tentative standard to replace three former standards: NFPA 61B, *Code for the Prevention of Dust Explosions in Terminal Grain Elevators*; NFPA 64, *Code for the Prevention of Dust Ignitions in Country Grain Elevators*; and NFPA 661, *Suction and Venting in Grain Elevators*. In addition, NFPA 93, *Standard for Dehydrators and Dryers for Agricultural Products*, was withdrawn in 1968 and its text was incorporated as a chapter in NFPA 61B. The 1969 tentative edition of NFPA 61B was officially adopted at the 1970 NFPA Annual Meeting.

In 1995, the following four agricultural dust standards were combined into a single standard: NFPA 61A, *Standard for the Prevention of Fire and Dust Explosions in Facilities Manufacturing and Handling Starch*; NFPA 61B, *Standard for the Prevention of Fires and Explosions in Grain Elevators and Facilities Handling Bulk Raw Agricultural Commodities*; NFPA 61C, *Standard for the Prevention of Fire and Dust Explosions in Feed Mills*; and NFPA 61D, *Standard for the Prevention of Fire and Dust Explosions in the Milling of Agricultural Commodities for Human Consumption*. The Technical Committee on Agricultural Dusts determined that the four standards were largely duplicative, and it therefore created one comprehensive standard, NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, covering the full range of requirements for good design, operating practice, and protective features.

In the 2002 edition, the second revised edition after the combination of the four documents, requirements were clarified and additional advisory material was added. The document was also modified to comply with the updated NFPA *Manual of Style* for technical committee documents.

In the 2008 edition, requirements for life safety and construction were clarified. A requirement for safety devices on belt conveyors was added. Requirements for proper head section venting were added, as well as a requirement for all filters to be located outdoors. Clarification on training requirements were provided.

In the 2013 edition, the Committee updated definitions related to agricultural products handling, conveying, and dust collection. The requirements in Chapter 7 affecting bucket elevators were revised to reflect current industry practice. The requirements in Chapter 10 affecting dust control systems were revised to include a written housekeeping program. Requirements for pneumatic conveying system design were added into Chapter 11. In Chapter 12, the requirement related to standpipes was revised.

The 2017 edition underwent substantial revision to better align with the newly issued NFPA 652, *Standard on the Fundamentals of Combustible Dust*. The document was reorganized to match, where possible, the organization of NFPA 652. New requirements for dust hazards analysis (Chapter 7) were added, as well as a new Chapter 6 on performance-based design. Objectives were added to the

general requirements in Chapter 4. A new Chapter 5 on hazard identification also was added to the document. In addition, the table on agricultural dust test data was reviewed and updated.

In the 2020 edition, additional changes have been made to align the organization of NFPA 61 with NFPA 652 where possible, and the deadline for completing a dust hazard analysis (DHA) for existing processes and facility compartments has been specified as January 1, 2022. Surface resistivity requirements for conveyor belts, lag belts, and lagging have been revised, and a new statement has been added to exclude air-material separators with a dirty side volume of less than 0.2 m³ (8 ft³) from explosion protection requirements. This edition contains new sections on spray dryer systems, mixers and blenders, and work activities that present an ignition source. The section on management of change has been revised to clarify what is required to be addressed versus what is recommended. Annex material has been added to provide information about the methods that can be used to complete a DHA; determining filtering efficiency of dust collectors; and protection methods for bins, silos, and tunnels where explosion venting is not practical. The table on agricultural dust test data has been updated and expanded to include additional dusts, and the example checklist for completing a DHA has been replaced with a more detailed, comprehensive example.

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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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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the prevention, control, and extinguishment of fire and explosions resulting from dusts produced by the processing, handling, and storage of grain, starch, food, animal feed, flour, and other agricultural products. The Technical Committee shall also be responsible for requirements relating to the protection of life and property from fire and explosion hazards at agricultural and food products facilities.

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NFPA 61

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Agricultural and Food Processing Facilities

2020 Edition

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

Chapter 1 Administration

1.1 Scope. This standard provides requirements applicable to agricultural and/or food processing facilities for managing or mitigating fire and explosion hazards of combustible agricultural or food processing dusts or related particulate solids.

1.2* Purpose. This standard shall provide the minimum requirements necessary for safety to life and property from fire, flash fire, and explosion posed by agricultural and food processing combustible dust and represents the industry and commodity-specific requirements for agricultural and food processing.

1.3 Application.

1.3.1* This standard shall apply to all of the following:

- (1) All facilities that receive, handle, process, dry, blend, use, mill, package, store, or ship dry agricultural bulk materials, their by-products, or dusts that include grains, oilseeds, agricultural seeds, legumes, sugar, flour, spices,

feeds, dry dairy/food powders, and other related materials

- (2) All facilities designed for manufacturing and handling starch, including drying, grinding, conveying, processing, packaging, and storing dry or modified starch, and dry products and dusts generated from these processes
- (3) Those seed preparation and meal-handling systems of oilseed processing plants not covered by NFPA 36

1.3.2 This standard shall not apply to oilseed extraction processes that are covered by NFPA 36.

1.4* Conflicts.

1.4.1 Where a requirement specified in this industry-specific standard differs from a requirement specified in NFPA 652, the requirement in this standard shall be permitted to be used instead.

1.4.2 Where a requirement specified in this standard specifically prohibits a requirement specified in NFPA 652, the prohibition in this standard shall be permitted.

1.4.3 The requirements of this standard shall be applied or construed so as not to create an unreasonable risk to public food safety.

1.5 Retroactivity. 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.

1.5.1 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.

1.5.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.5.3 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 a reasonable degree of safety is provided.

1.5.4 When renovating an existing facility, equipment, or process, the provisions of this standard shall apply to that portion of the facility, equipment, or process.

1.6* Equivalency. 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. Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency. 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). [652:1.7.1]

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. [652:1.7.2]

Chapter 2 Referenced Publications

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

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

NFPA 10, *Standard for Portable Fire Extinguishers*, 2018 edition.
NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2019 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2019 edition.

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

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2020 edition.

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

NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, 2020 edition.

NFPA 36, *Standard for Solvent Extraction Plants*, 2017 edition.

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

NFPA 54/ANSI Z223.1, *National Fuel Gas Code*, 2018 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2020 edition.

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

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

NFPA 70®, *National Electrical Code®*, 2020 edition.

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

NFPA 86, *Standard for Ovens and Furnaces*, 2018 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids*, 2020 edition.

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

NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, 2017 edition.

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

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

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2020 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2020 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*, 2020 edition.

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

2.3 Other Publications.

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

ANSI/AMCA Standard 99, *Standards Handbook, Classifications for Spark Resistant Construction*, 2010.

2.3.2 ASME Publications. ASME Technical Publishing Office, Two Park Avenue, New York, NY 10016-5990.

Boiler and Pressure Vessel Code, Section VIII, Division I, "Rules for Construction of Pressure Vessels," 2015.

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

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

ASTM 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 ISA Publications. International Society of Automation, 67 T.W. Alexander Drive, Research Triangle Park, NC 27709.

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

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

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

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

UN Recommendations on the Transport of Dangerous Goods: Model Regulations — Manual of Tests and Criteria, 13th edition.

2.3.7 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*, 2019 edition.

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

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

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

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2020 edition.

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

NFPA 1451, *Standard for a Fire and Emergency Services Vehicle Operations Training Program*, 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* Agricultural Combustible Dust. Any finely divided solid agricultural material that presents a flash fire hazard or explosion hazard when suspended and ignited in air.

▲ **3.3.2* Air-Material Separator (AMS).** A device designed to separate the conveying air from the material being conveyed. [652, 2019]

▲ **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. [652, 2019]

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. [652, 2019]

3.3.5 Bucket Elevator. An enclosed vertical conveyor using a belt with buckets or cups attached, with a head pulley, a tail pulley, and a knee pulley.

3.3.6* Bulk Raw Grain. Grain materials, such as cereal grains, oilseeds, and legumes, that have not undergone processing or size reduction.

3.3.7* Centralized Vacuum Cleaning System. A fixed-pipe pneumatic conveying system using remotely located hose connection stations to allow the vacuuming of combustible dust accumulations from surfaces and conveying those dusts to an air-material separator (AMS).

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. [652, 2019]

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

3.3.10 Duct. Pipes, tubes, or other enclosures used to convey materials pneumatically or by gravity. [652, 2019]

3.3.11* 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. [652, 2019]

3.3.12* Dust Hazard 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. [652, 2019]

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

3.3.14* Explosion. The bursting or rupture of an enclosure or container due to the development of internal pressure from a deflagration. [654, 2020]

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

▲ **3.3.16 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. [652, 2019]

▲ **3.3.17* Flexible Intermediate Bulk Container (FIBC).** Large bags typically made from nonconductive woven fabric that are used for storage and handling of bulk solids. [652, 2019]

3.3.18 Food. According to the United States FDA, (1) articles used for food or drink for man or other animals, (2) chewing gum, and (3) articles used for components of any such article.

3.3.19 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*. [652, 2019]

3.3.20 Headhouse. The building or enclosure where grain-handling equipment (e.g., conveyors, legs, scales, cleaners) is located and where grain is lifted by one or more elevator legs and discharged into a bin or grain-handling equipment.

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

3.3.22 Ingredient Transport System. A pneumatic system and AMS dedicated to the transport of clean food ingredients or mixtures from one storage location inside a facility to another location in the facility.

3.3.23 Marine Tower. Stationary or movable tower used for supporting equipment to load or unload grain.

▲ **3.3.24* 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. [652, 2019]

▲ **3.3.25* Minimum Ignition Energy (MIE).** The lowest capacitive spark energy capable of igniting the most ignition-sensitive concentration of a flammable vapor–air mixture or a combustible dust–air mixture as determined by a standard test procedure. [652, 2019]

3.3.26 Ohms per Square. The term used to define electrical surface resistivity of a material.

3.3.27 Outside Bucket Elevator (Leg). A bucket elevator that has less than 20 percent of the abovegrade leg height inside any enclosed structure.

3.3.28* Pneumatic Conveying System. A material feeder, an air-material separator, an enclosed ductwork system, or an air-moving device in which a combustible particulate solid is conveyed from one location to another with a stream of air or other gases. Pneumatic conveying for product transfer is distinguished from dust collection systems that are designed to handle dust.

3.3.29 Point-of-Use Dust Collector. A bin vent–type of dust collector with an integral AMD used to create negative pressure on enclosed conveying equipment.

3.3.30 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]

3.3.31 Replacement-in-Kind. A replacement that satisfies the design specifications of the replaced item. [652, 2019]

▲ **3.3.32* Risk Assessment.** An assessment of the likelihood, vulnerability, and magnitude of incidents that could result from exposure to hazards. [1250, 2020]

▲ **3.3.33 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. [652, 2019]

Chapter 4 General Requirements

4.1* General. The owner/operator shall be permitted to consider dust generated from bulk raw grain and other organically-derived materials as agricultural combustible dusts unless available data and/or specific testing shows that the dust is not combustible.

4.1.1 Where necessary, testing protocols in Chapter 5 shall be used to identify noncombustible dusts or provide specific information on a given uncharacterized dust.

4.1.2 The owner/operator of a facility with agricultural combustible dust shall be responsible for the following activities:

- (1) Identify credible fire, flash fire, and explosion hazards associated with their facility
- (2) Assess consequences of credible fire, flash fire, and explosion hazards
- (3) Manage credible fire, flash fire, and explosion hazards
- (4) Communicate the hazards to affected personnel

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

4.2 Objectives.

4.2.1 The design of the facility, processes, and equipment shall be based upon the goal of providing a reasonable level of safety and protection of property by meeting the following objectives:

- (1) Life safety
- (2) Mission continuity
- (3) Mitigation of fire spread and explosions

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

4.2.1.2 The objectives stated in Section 4.2 shall be deemed to be met when, consistent with the goal in 4.2.1 and the provisions in Sections 1.4 and 1.5, the following has been achieved:

- (1) The facility, processes, and equipment are designed, constructed, and maintained in accordance with the prescriptive criteria set forth in this standard.
- (2) The management systems set forth in this standard are implemented.

4.2.1.3 Where a performance-based alternative design is used, it shall be documented to meet the same objectives as the prescriptive design it replaces, in accordance with Chapter 6 of this standard.

4.2.1.4* Nothing in these objectives shall allow the AHJ to require changes to Good Manufacturing Practices (GMP), sanitation, or Hazard Analysis Critical Control Points (HACCP).

4.2.2 Life Safety. The life safety objective shall be deemed to have been met when, consistent with the goal in 4.2.1 and the provisions in Sections 1.4 and 1.5, the occupants not in the immediate proximity of the ignition are protected from the effects of fires, flash fires, and explosions for the time needed to evacuate, relocate, or take refuge in order to prevent serious injury.

4.2.3* Mission Continuity. The mission continuity objective shall be deemed to have been met when, consistent with the goal in 4.2.1 and the provisions in Sections 1.4 and 1.5, the protection features for the facility, processes, and equipment limit damage to levels that ensure the ongoing mission, production, or operating capability of the facility to a degree acceptable to the owner/operator.

4.2.4* Mitigation of Fire Spread and Explosions. The mitigation of fire spread and explosions shall be deemed to have been met when, consistent with the goal in 4.2.1 and the provisions in Sections 1.4 and 1.5, the prescribed or performance-based alternative design features are incorporated into the facility and processes to prevent or mitigate fires and explosions that can cause failure of adjacent buildings, emergency life safety systems, adjacent properties, or the facility's structural elements.

4.2.5* Compliance Options. The objectives in Section 4.2 shall be achieved by either of the following means:

- (1) A prescriptive approach in accordance with Chapters 5, 7, 9, and 8.
- (2) A performance-based approach in accordance with Chapter 6.

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. [652:5.1]

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. [652:5.1.1]

5.1.1.1 The owner/operator shall be permitted to either assume the dust is combustible or determine its combustibility or noncombustibility in accordance with Sections 5.2 through 5.5.

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 4.2.5. [652:5.1.2]

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

[652:5.2.1]

5.2.2* Test results, historical data, and published data shall be documented and, when requested, provided to the authority having jurisdiction (AHJ). [652:5.2.2]

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. [652:5.2.3]

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. [652:5.2.4]

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. [652:5.4]

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 N.1, “Test Method for Readily Combustible Solids”
- (2) Other equivalent fire exposure test methods [652:5.4.1.1]

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. [652:5.4.1.2]

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. [652:5.4.1.3]

5.4.2 Determination of Flash-Fire Potential. (Reserved)

5.4.3 Determination of Explosibility.

5.4.3.1 It shall be permitted to assume a material is explosible, forgoing the requirements of 5.4.3.2. [652:5.4.3.4]

5.4.3.2 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 [652:5.4.3.1]

5.4.3.3* When determining explosibility, it shall be permitted to test a sample sieved to less than 200 mesh (75 µm). [652:5.4.3.2]

5.4.3.4* When determining explosibility, it shall be permitted to test the as-received sample. [652:5.4.3.3]

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. [652:5.4.3.5]

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. [652:5.4.4.1]

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. [652:5.4.4.2]

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. [652:5.4.4.3]

N 5.4.4.4* Where there is a potential for fines to segregate from the sample, 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. [652:5.5.1.1]

5.5.1.2* Representative samples of dusts shall be identified and collected for testing according to the sampling plan. [652:5.5.1.2]

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. [652:5.5.2]

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. [652:6.1.1]

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. [652:6.1.2]

6.1.3 Approved Qualifications. The performance-based design shall be prepared by a person with qualifications acceptable to the owner/operator. [652:6.1.3]

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. [652:6.1.3.1]

Δ 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. [652:6.1.4]

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 stand-

ards, calculation methods, and other forms of scientific information provided shall be appropriate for the particular application and methodologies used. [652:6.1.4.1]

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. [652:6.1.4.2]

6.1.4.3 Performance Criteria. Performance criteria, with sources, shall be documented. [652:6.1.4.3]

6.1.4.4 Occupant Characteristics. Assumptions about occupant characteristics shall be documented. [652:6.1.4.4]

6.1.4.5 Design Fire and Explosion Scenarios. Descriptions of combustible dust fire and explosion design scenarios shall be documented. [652:6.1.4.5]

6.1.4.6 Input Data. Input data to models and assessment methods, including sensitivity analyses, shall be documented. [652:6.1.4.6]

6.1.4.7 Output Data. Output data from models and assessment methods, including sensitivity analyses, shall be documented. [652:6.1.4.7]

6.1.4.8 Safety Factors. The safety factors utilized shall be documented. [652:6.1.4.8]

6.1.4.9 Prescriptive Requirements. Retained prescriptive requirements shall be documented. [652:6.1.4.9]

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. [652:6.1.4.10.1]

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. [652:6.1.4.10.2]

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. [652:6.1.4.11]

6.1.4.12 Performance Evaluation. The performance evaluation summary shall be documented. [652:6.1.4.12]

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 re-approval in cases of remodeling, modification, renovation, change in use, or change in established assumptions
- [652:6.1.4.13]

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. [652:6.1.5]

▲ 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. [652:6.1.6.1]

6.1.6.2 The degree of conservatism reflected in such data shall be specified, and a justification for the sources shall be provided. [652:6.1.6.2]

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. [652:6.1.7]

6.1.7.1* This shall include complying with originally documented design assumptions and specifications. [652:6.1.7.1]

N 6.1.7.2* Any variation from the design shall be acceptable to the AHJ. [652:6.1.7.2]

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. [652:6.2]

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. [652:6.3]

6.3.1 Life Safety.

6.3.1.1* The life safety objectives of 4.2.2 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.

[652:6.3.1.1]

6.3.1.2 The life safety objectives of 4.2.2 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.

[652:6.3.1.2]

6.3.2 Structural Integrity. The structural integrity objectives embodied in 4.2.2 and 4.2.3 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. [652:6.3.2]

6.3.3 Mission Continuity. The mission continuity objectives of 4.2.3 shall be achieved when damage to equipment and the facility has been limited to a level of damage acceptable to the owner/operator. [652:6.3.3]

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.

[652:6.3.4]

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.

[652:6.3.5]

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. [652:6.4.1.1]

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. [652:6.4.1.2]

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. [652:6.4.1.3]

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. [652:6.4.1.4]

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. [652:6.4.1.5]

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. [652:6.4.1.6]

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. [652:6.4.1.7]

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. [652:6.4.2.1]

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. [652:6.4.2.2]

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. [652:6.4.2.3]

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. [652:6.4.2.4]

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. [652:6.4.2.5]

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. [652:6.5.1]

6.5.2 The designer shall establish numerical performance criteria for each of the documented performance objectives established for the design. [652:6.5.2]

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. [652:6.5.3]

Chapter 7 Dust Hazard Analysis (DHA)

7.1* General Requirements.

Δ 7.1.1 Retroactivity. The requirements of Chapter 7 shall apply retroactively in accordance with 7.1.2.1 through 7.1.2.3.

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. [652:7.1.2]

7.1.2.1 For new processes that will be constructed and facility processes that are undergoing significant modification, the owner/operator shall complete DHAs as part of the project.

7.1.2.2* For existing processes and facility compartments that are not undergoing significant modification, the owner/operator shall schedule and complete DHAs of bucket elevators, conveyors, grinding equipment, spray dryer systems, and dust collection systems by January 1, 2022.

7.1.2.3 For the purposes of applying the provisions of 7.1.2, significant modification shall include modifications that exceed 25 percent of the replacement cost of the equipment system.

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. [652:7.2.1]

7.2.2* Qualifications. The DHA shall be performed or led by a qualified person. [652:7.2.2]

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. [652:7.2.3]

7.3* Methodology.

Δ 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

[652:7.3.1]

- (3) It shall be permitted to use a checklist to complete a DHA on an agricultural combustible dust. (See Annex F for a sample checklist.)

7.3.2 Material Evaluation.

Δ 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. [652:7.3.2.1]

Chapter 8 Management Systems

8.1* Retroactivity. This chapter shall be applied retroactively to new and existing facilities and processes. [652:8.1]

8.2* General. The procedures and training in this chapter shall be delivered in a language that the participants can understand. [652:8.2]

8.3 Operating Procedures and Practices.

8.3.1* The owner/operator shall have written procedures that include operating its facility and equipment for the prevention of fires, deflagrations, and explosions from combustible particulate solids. [652:8.3.1]

8.3.2* The owner/operator shall establish safe work practices to address hazards associated with maintenance and servicing operations. [652:8.3.2]

8.3.2.1 The safe work practices shall apply to employees and contractors. [652:8.3.2.1]

N 8.4 Housekeeping.

N 8.4.1 General. (Reserved)

N 8.4.2 Methodology.

N 8.4.2.1* The facility shall develop and implement a written housekeeping program that establishes the frequency and method(s) determined best to reduce accumulations of fugitive agricultural dust on ledges, floors, equipment, and other inside exposed surfaces. Unless a greater threshold for housekeeping dust accumulation is prescribed in writing and justified by a documented risk assessment, the threshold housekeeping dust accumulation limit shall be 3.2 mm (1/8 in.) over 5 percent of the footprint area.

N 8.4.2.1.1* Dust on floors, structural members, and other surfaces shall be removed concurrently with operations.

N 8.4.2.1.2* Provisions for unscheduled housekeeping shall include specific requirements establishing time to clean local dust spills or transient releases. [652:8.4.6.3]

N 8.4.2.2 Vacuum Cleaning Method.

N 8.4.2.2.1* Portable Vacuum Cleaners. Portable electric vacuum cleaners, if used, shall be listed for use in Class II, Group G, Division 1 atmospheres as defined in *NFPA 70*.

N 8.4.2.2.2 Vacuum systems shall be grounded and bonded. Vacuum system hoses and couplings shall be static dissipative or conductive and grounded.

N 8.4.2.3 Sweeping, Shovel, Scoop, and Brush Cleaning Method. (Reserved)

N 8.4.2.4 Water Washdown Cleaning Method. (Reserved)

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 The use of compressed air or other means that cause dust to be suspended in air during removal from ledges, walls, and other surfaces shall be permitted only after all machinery in the area has been shut down and all sources of ignition controlled.

N 8.4.2.6.2 Areas in processing facilities shall be permitted to be cleaned with compressed air, provided that both of the following conditions are met:

- (1) Airborne material will not envelop adjacent operating equipment.
- (2) Prior to blowdown, areas and adjacent equipment are checked to ensure that no ignition sources are present.

N 8.4.2.7 Steam Blowdown Method. (Reserved)

N 8.4.3 Training. (Reserved)

N 8.4.4 Equipment. (Reserved)

N 8.4.5 Vacuum Trucks. (Reserved)

N 8.4.6 Reserved.

N 8.4.7 Auditing and Documentation. (Reserved)

8.5 Hot Work.

8.5.1* Hot work in facilities covered by this standard shall comply with the requirements of NFPA 51B, except as modified in this section.

8.5.2 Hot work performed outside of safe, designated areas shall follow 8.5.2.1 through 8.5.2.3.

8.5.2.1* A documented hot work permit system shall be used.

8.5.2.2 The hot work permit system shall include the following conditions:

- (1) The area within 11 m (35 ft) of the work shall be cleaned of combustible dust.
- (2) Other combustibles within 11 m (35 ft) of the work shall be moved or protected with covers, guards, or shields.
- (3) Combustible floors or equipment in or below the work area shall be wet down or covered with damp sand, metal shields, or fire-retardant blankets or tarps.
- (4) Equipment being worked on shall be thoroughly cleaned of combustible material and oil residues, and any exposed combustible linings shall be removed.
- (5) Combustible dust or flammable vapor-producing machinery or operations in the area shall not be permitted to be operating during the work.
- (6)* Fire protection or detection systems, if provided, shall be in operation during the work unless the work is being performed on the system. In the cases where fire or explosion protection systems present a life safety hazard, an active fire watch shall be permitted to be used while the fire protection system is impaired.
- (7) Floor, wall ducts, and other openings within 11 m (35 ft) of the work shall be covered or closed, and all open spouts in the work area shall be sealed or plugged.
- (8) A fire watch supplied with suitable portable extinguishers or a water hose shall be maintained during the work and for at least 60 minutes after the work is completed. In certain circumstances, the permit-authorizing individual shall be permitted to assess and document an extension of the fire watch or an alternative to active fire watch, such as a thorough wet down of the area after the work is complete.
- (9) The duration of the permit system shall not exceed one shift.
- (10)* Regular inspections of the work area shall be made to ensure that no smoldering fires develop, including a final inspection performed prior to closing the area for the day or weekend.
- (11) Hot work shall not be permitted on equipment that is operating.

8.5.2.3 The person responsible for the hot work operations shall perform the following duties:

- (1) Inspect the proposed work area to determine that the conditions of the permit system have been met
- (2) Designate additional precautions as deemed necessary
- (3) Sign the permit to authorize the work to begin

8.5.3 The hot work operations shall be stopped if the conditions of the permit change.

8.5.4 Upon completion of the work and after time has been allowed for cooling hot surfaces, the areas shall be restored to normal operation.

8.5.5 Fire protection or detection systems shall not be disabled unless the hot work could activate them. If so, such systems shall be restored to service promptly after the hot work task is completed.

N 8.5.6 Use of Portable Equipment.

N 8.5.6.1* Work activities that could present an ignition source but do not fit the definition of hot work, such as drilling, sawing, or use of hand-operated portable electrical equipment that does not comply with the electrical classification of the area where it is to be used, shall be permitted in accordance with 8.5.6.1.1 through 8.5.6.1.6.

N 8.5.6.1.1 The area affected by the work shall be thoroughly cleaned of combustible dust prior to commencing the work.

N 8.5.6.1.2 The area affected by the work shall be free from airborne combustible dust.

N 8.5.6.1.3 Equipment that contains combustible dust and is located near the work area shall be protected from the work.

N 8.5.6.1.4 When the work poses an ignition risk to the combustible dust within equipment, the equipment shall be shut down and cleaned prior to commencing such work.

N 8.5.6.1.5 Floor and wall openings within the work area shall be covered or sealed.

N 8.5.6.1.6 The work shall be performed on surfaces and equipment not directly handling combustible dusts.

8.5.6.2 Spark-producing portable power tools and propellant-actuated tools shall not be used where combustible dust is present.

8.5.6.3 When the use of spark-producing or propellant-actuated tools becomes necessary, the following procedures shall be performed:

- (1) All dust-producing machinery in the area shall be shut down.
- (2) The use of spark-producing or propellant-actuated tools shall be authorized by the use of a hot work permit.

8.5.6.4 After completion of the work requiring the use of propellant actuated tools, a check shall be made to be sure that no cartridges or powder charges are left on the premises where they could enter equipment or otherwise be accidentally discharged.

N 8.6 Personal Protective Equipment.

N 8.6.1* When flame-resistant clothing is used for protecting personnel from flash fires, it shall comply with the requirements of NFPA 2112. [652:8.6.1.3]

N 8.6.2 Flame-resistant garments shall be selected, procured, inspected, worn, and maintained in accordance with NFPA 2113. [652:8.6.1.5]

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 fires, deflagrations, and explosions shall be inspected,

tested, and maintained in accordance with the applicable NFPA standard.

8.7.1.1 Where there is no applicable NFPA standard, equipment shall be inspected, tested, and maintained in accordance with manufacturers' recommendations, as modified by operational experience.

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

- (1) Fire and explosion protection and prevention equipment
- (2) Dust control equipment
- (3) Safety devices
- (4)* Electrical, process, and mechanical equipment, including process interlocks associated with fire and explosion protection and prevention
- (5) Lubrication of bearings

8.7.3 The owner/operator shall have 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. [652:8.7.3]

8.7.4* Where equipment maintenance 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 a documented deadline.

8.7.5 Inspections and testing activities that affect the prevention, control, and mitigation of dust fires, deflagrations, and explosions shall be documented. [652:8.7.5]

8.7.6 An inspection of the operating area shall take place on an established schedule to help ensure that the equipment is in safe operating condition and that proper work practices are being followed.

8.8 Training and Hazard Awareness.

8.8.1* General safety training and hazard awareness training for combustible dusts and solids shall be provided to all affected employees. [652:8.8.2]

8.8.2* 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. [652:8.8.1]

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

8.8.4* Where explosion protection systems are installed, training of affected personnel shall include the operations and potential hazards presented by such systems. [652:8.8.2.3]

8.8.5 Refresher training shall be provided annually.

8.8.6 The training shall be documented. [652:8.8.4]

8.9 Contractors.

8.9.1 Only knowledgeable 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. [652:8.9.2]

8.9.2* Contractor Training.

8.9.2.1 Contractors operating owner/operator equipment shall be trained and qualified to operate the equipment and perform the work. [652:8.9.3.1]

8.9.2.2 Contractor training shall be documented. [652:8.9.3.2]

8.9.2.3* Contractors working on or near a given process shall be made aware of the potential hazards from and exposures to fires and explosions. [652:8.9.3.3]

8.9.2.4 Contractors shall be trained and required to comply with the facility's safe work practices and policies in accordance with 8.3.2. [652:8.9.3.4]

8.9.2.5 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. [652:8.9.3.5]

8.9.2.6 Contractors shall receive refresher training annually.

8.10 Emergency Planning and Response. Each facility shall have a written emergency action plan on-site or electronically available that includes, but is not limited to, the following:

- (1) A means of notification for occupants in the event of fire and explosion
- (2) A preplanned evacuation assembly area
- (3) A person(s) designated to notify emergency responders, including the fire department
- (4) A facility layout drawing(s) showing egress routes, hazardous chemical locations, and fire protection equipment
- (5) Location of a safety data sheet(s) for hazardous chemicals
- (6) An emergency telephone number(s)
- (7) Emergency response duties for occupants
- (8) A person(s) designated to meet the offsite emergency responder(s) to coordinate the incident

8.10.1 Annual training regarding the emergency action plan shall be provided for all affected personnel.

8.10.2 The emergency action plan shall be coordinated with local emergency responders and include fire department pre-fire plans.

8.10.3* Fire-Fighting Operation.

8.10.3.1 Fires, when discovered, shall be reported promptly to facility management and emergency responders, including the fire department.

8.10.3.2 Burning material shall not be transferred into legs.

8.10.3.3 If a fire cannot be controlled promptly in its incipient stage, the endangered structure(s) shall be evacuated.

8.10.3.4 Bearing fires shall be extinguished with a gentle application of water fog onto the bearing for cooling.

8.10.3.4.1 If water is not available, other means of extinguishment shall be permitted to be used on the bearing fire, provided caution is taken to avoid the suspension of combustible dust.

8.10.3.4.2 If the bearing is located inside equipment, material flow shall be stopped, equipment shall be shut down, and extreme caution shall be used when equipment is opened.

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

8.10.3.5.1* Portable spray hoses located in areas with combustible dust shall be provided with nozzles that are listed or approved for use on Class C fires to limit the potential for generating unnecessary airborne dust during fire-fighting operations.

8.10.3.5.2 Straight stream nozzles or combination nozzles shall be permitted to be used to reach fires in locations that are otherwise inaccessible with the nozzles specified in 8.10.3.5.

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. [652:8.11.1]

8.11.2 The investigation shall be documented and include findings and recommendations. [652:8.11.2]

8.11.3 A system shall be established to address and resolve the findings and recommendations. [652:8.11.3]

8.11.4* The investigation findings and recommendations shall be reviewed with affected personnel. [652:8.11.4]

8.12 Management of Change.

N 8.12.1* Documented procedures shall be established and implemented to manage proposed changes to process materials, combustible dust handling equipment, facilities, and fire and explosion protection devices that affect dust, fire, or explosion hazards.

8.12.1.1 The owner/operator shall require that a qualified person knowledgeable in the fire and deflagration hazards of agricultural or food dust review the proposed changes.

8.12.1.2 The qualified person shall consider whether or not the change would comply with NFPA 61 and if the change does not comply, then a method of compliance shall be determined.

N 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) Authorization requirements for the proposed change

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

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 hazard analysis
- (5)* Process and technology information
- (6) Management of change documents
- (7)* 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. [652:8.14.1]

8.14.2 The owner/operator shall be responsible for maintaining and evaluating the ongoing effectiveness of the management systems presented in this standard. [652:8.14.2]

8.15* Employee Participation. Owner/operators shall include affected personnel in the control and mitigation of fire and explosion risk.

8.16 Storage of Oils, Flammable Liquids, and Liquefied Petroleum Gas (LP-Gas).

8.16.1 Flammable and combustible liquids shall be stored in closed containers, safety cans, flammable liquid cabinets, storage rooms, and so forth, as permitted in NFPA 30.

8.16.2 Portable LP-Gas containers located inside the facility shall be stored, used, and handled in accordance with NFPA 58.

8.17 Warning Signs.

8.17.1 Where personnel are exposed to bodily risk from installed fire or explosion prevention systems, such as inert gas systems used to reduce oxygen concentration or explosion suppression systems, equipment and buildings having such systems shall be provided with warning signs.

8.17.2 Warning signs shall indicate the potential dangers, shall state adequate precautions, and shall be posted at all entrances to the building or equipment.

8.18 Miscellaneous Storage in Grain-Handling Facilities.

8.18.1 Sacks, nonessential uninstalled machinery or parts, or other supplies shall not be stored in areas where the only other combustible material is the agricultural commodity that is being stored.

8.18.2 Miscellaneous storage shall not impede facility house-keeping or fire fighting.

Chapter 9 Hazard Management: Mitigation and Prevention

9.1 Reserved.

9.2 Building Design.

9.2.1 Risk Assessment. A documented risk assessment 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.

N 9.2.2 Construction.

9.2.2.1 The construction, renovation, modification, reconstruction, alteration, repair, addition, change of use or change of occupancy classification, demolition, and relocation of all buildings and structures shall comply with the governing building code, except as modified herein.

9.2.2.2* Enclosures built to segregate dust explosion hazard areas from other areas shall be designed such that they will not fail before the explosion pressure is vented to a safe outside location.

9.2.2.3 Electrical wiring and power equipment shall meet all applicable requirements of NFPA 70.

9.2.3 Building or Building Compartment Protection.

9.2.3.1 Masonry shall not be used for the construction of exterior walls or roofs of areas classified as Class II, Group G, Division 1 in NFPA 70.

9.2.3.1.1* The requirement in 9.2.3.1 shall not apply to masonry walls that are designed for explosion resistance to preclude failure of these walls so the explosion pressure can be vented safely to the outside.

9.2.3.2 Facilities that are designed for receiving, shipping, handling, and storing of bulk raw agricultural commodities and are located in a separate structure from grain processing or manufacturing areas and their associated raw material, ingredient, production, and finished product bins shall be located and constructed in accordance with the requirements of 9.2.3.2.1 through 9.2.3.2.4.

9.2.3.2.1 Structures housing personnel-intensive areas not directly involved in operations such as, but not limited to, those involved exclusively in administrative or clerical personnel groups, grain inspection and weighing supervision, or operations from control rooms shall be constructed in a location remote from storage silos and headhouse structures as specified in 9.2.3.2.2 through 9.2.3.2.4.

9.2.3.2.1.1 The requirement in 9.2.3.2.1 shall not apply to small control rooms contiguous to specific operations such as railcar and truck discharging or loading or to control rooms such as those used in feed mills for mixing operations.

9.2.3.2.2 Structures housing personnel-intensive areas shall not be constructed directly over subterranean tunnels through which grain-handling equipment or dust control system ductwork passes or over other tunnels that have direct openings into grain-handling areas.

9.2.3.2.2.1 The requirement in 9.2.3.2.2 shall not apply to small control room structures contiguous to specific operations such as railcar and truck discharging or loading.

9.2.3.2.3 Where reinforced concrete is used in silos and headhouses, the separation distance from personnel-intensive areas shall be at least 30 m (100 ft).

9.2.3.2.3.1 Distances less than 30 m (100 ft) but in no case less than 15 m (50 ft) shall be permitted where any of the following conditions exist:

- (1) The property boundaries or other permanent constraints preclude 30 m (100 ft).
- (2) Structures do not have inside legs.
- (3) Structures have inside legs that are equipped with explosion protection equipment in accordance with 9.3.14.

9.2.3.2.4 Where the headhouse is constructed of structural steel or reinforced concrete framework with lightweight, explosion-relieving wall panels or does not contain inside or unprotected bucket elevators, the separation distance from personnel-intensive areas shall be at least 15 m (50 ft).

9.2.3.2.4.1 Distances less than 15 m (50 ft) shall be permitted if the property boundaries or other permanent constraints preclude 15 m (50 ft), but in no case shall distances less than 9 m (30 ft) be permitted.

9.2.3.3* Where provided, a lightning protection system shall be designed and installed in accordance with NFPA 780.

N 9.2.4 Life Safety. (Reserved)**9.2.5 Interior Wall Construction.**

9.2.5.1 Storage areas larger than 465 m² (5000 ft²) and containing packaging, bagging, palletizing, and pelleting equipment shall be cut off from all other areas with fire barrier walls designed for a minimum fire resistance of 2 hours and designed in accordance with Chapter 8 of *NFPA 5000*.

9.2.5.2 Warehouse areas shall be designed in accordance with *NFPA 5000*.

9.2.5.3 Necessary openings in fire walls and fire barrier walls shall be kept to a minimum and be as small as practicable. Such openings shall be protected with listed self-closing fire doors, fire shutters, fire dampers, or penetration seals installed in accordance with Chapter 8 of *NFPA 5000*.

9.2.5.3.1 Fire doors, fire shutters, fire dampers, and fire penetration seals shall be listed and shall have a fire protection rating complying with *NFPA 101*.

9.2.5.3.2 Hold-open devices, if used, shall be listed and shall activate and allow the door to close upon sensing at least one of the following:

- (1) Heat
- (2) Smoke
- (3) Flames
- (4) Products of combustion

9.2.5.4* **Interior Surfaces.** Horizontal surfaces shall be minimized to prevent accumulations of dust in all interior structural areas where significant dust accumulations could occur.

N 9.2.6 Separation of Hazard Areas from Other Hazard Areas and from Other Occupancies.**N 9.2.6.1 Reserved.****N 9.2.6.2 Use of Segregation.**

N 9.2.6.2.1 Physical barriers erected for the purpose of limiting fire spread shall be designed in accordance with local code.

N 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. [652:9.2.6.2.2]

N 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*. [652:9.2.6.2.3]

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 if the separation is supported by a documented evaluation.

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
- [652:9.2.6.3.2]

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. [652:9.2.6.3.3]

9.2.6.3.4 Where separation is used to limit the dust explosion or deflagration hazard area, the minimum separation distance shall not be less than 35 ft (11 m). [652:9.2.6.3.4]

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. [652:9.2.6.3.5]

9.2.7 Means of Egress.

9.2.7.1 Means of egress shall be in accordance with *NFPA 101*.

9.2.7.2 Where the horizontal travel distance to the means of egress is less than 15 m (50 ft) in normally unoccupied spaces, a single means of egress shall be permitted.

9.2.7.3 Bin decks shall have two means of egress that are remote from each other such that a single fire or explosion event will not likely block both means of egress.

9.2.7.3.1 One means of egress shall be required for bin deck areas where travel distance to the means of egress is less than 15 m (50 ft).

9.2.8 Marine Towers.

9.2.8.1 Marine towers shall be constructed of noncombustible materials.

9.2.8.2 Movable marine towers shall be provided with automatic or manually operated brakes.

9.2.8.2.1 Movable marine towers shall be provided with automatic or manual rail clamps.

9.2.8.2.2 Equipment to monitor wind velocity shall be installed on movable marine towers.

9.2.8.2.3 Rail clamps shall operate or be activated when the wind velocity is great enough to cause movement of the tower, even when brakes or gear drives are preventing the rail wheels from turning.

9.2.8.3 Movable marine towers shall have provisions for emergency tie-downs.

9.2.8.4 Marine vessel loading equipment, such as conveyors, spouts, or drags, shall have safety devices to prevent the equipment from falling if the operating cable(s) breaks.

9.3 Equipment Design.

Δ 9.3.1* Risk Assessment. A documented risk assessment 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.

N 9.3.2 Design for Dust Containment. (Reserved)**9.3.3 Pneumatic Conveying, Dust Collection, and Centralized Vacuum Cleaning Systems.****9.3.3.1* General.**

9.3.3.1.1 Pneumatic conveying, dust collection, and centralized vacuum cleaning systems shall be installed in accordance with 9.3.3 and 9.3.5 through 9.3.9 of NFPA 654.

N 9.3.3.1.2 The systems shall be designed and maintained to ensure that the air-gas velocity used meets or exceeds the minimum required to keep the interior surfaces of all piping or ducting free of accumulations under all normal operating modes.

9.3.3.1.3 Pneumatic Conveying System Design. Systems that handle combustible dusts shall be designed by and installed under the supervision of qualified persons who are knowledgeable about these systems and their associated hazards.

9.3.3.2 General Design.

9.3.3.2.1* All system components shall be electrically conductive.

9.3.3.2.2 Bonding and grounding shall be provided for all components, including sight glasses and couplings.

9.3.3.2.3 Electrical wiring and power equipment shall meet all applicable requirements of *NFPA 70*.

9.3.3.2.4* Ingredient transport system installations whose sole function is to transfer ingredients shall be permitted to be installed inside of a building without explosion protection where all of the following requirements are met:

- (1) The system is a negative or positive pressure pneumatic conveying system.
- (2) The system, through its design, is isolated from the addition of mechanical or electrical energy and process activities, such as cooking or drying, by positive means, such as rotary valves, filters, normally closed valves, or sealed hoppers, from outside events that could trigger an event such as a flash fire or deflagration.
- (3) The system is not a bulk raw grain transportation pneumatic system or dust collection system.

9.3.3.3 Piping, Valves, and Blowers.

9.3.3.3.1 Positive- and negative-type pressure systems shall be permitted. Where the blower discharge pressure and its conveying system are designed to operate at gauge pressures exceeding 103 kPa (15 psi), the system shall be designed in accordance with Section VIII of ASME *Boiler and Pressure Vessel Code*.

9.3.3.3.2 All piping and tubing systems shall be as follows:

- (1) Supported to include the weight of material in a full or choked position
- (2) Airtight and dusttight
- (3) Assembled in such a manner as to provide convenient disassembly for cleaning

9.3.3.3.3 Pressure- and vacuum-relief valves shall be located, designed, and set to relieve pressure to protect the system components.

9.3.3.3.4 Multiple-direction valves shall be of airtight and dusttight construction and sized to effect a positive diversion of the

product with a full cross-sectional open area. Diversion in one direction shall seal all other directions from air, dust, or product leakage.

9.3.3.4 Receiving and Shipping Conveyances.

9.3.3.4.1* All transport modes such as railcars (hopper cars, boxcars, or tank cars) and trucks (both receiving and shipping in bulk), into which or from which commodities or products are pneumatically conveyed, shall be electrically bonded to the plant ground system or earth grounded.

9.3.3.4.1.1 The requirement in 9.3.3.4.1 shall not apply to materials of processes involving inert materials, such as limestone at feed mills.

9.3.3.4.2 Flexible connections shall be electrically conductive, having a resistance not greater than 1 megohm.

9.3.3.4.3 All connections between the transport vehicles and the plant system shall be made on the outside of the building or in a dedicated shipping/receiving area that is separated from process areas and warehouses by walls or detachment.

9.3.3.5 Dust Collection Systems.

9.3.3.5.1 Fans and Blowers. Fans and blowers designed to convey combustible dusts through them shall be of spark-resistant construction Type A or B as described in ANSI/AMCA Standard 99, *Standards Handbook, Classifications for Spark Resistant Construction*.

9.3.3.5.2 Construction. All components of the dust collection system shall be constructed of noncombustible materials.

9.3.3.5.2.1 The requirement in 9.3.3.5.2 shall not apply to filter bags, filter media, liners, drive belts, wear parts, and flexible connector ducts.

9.3.3.5.3 Manifolding. Dust collection systems for one or more hammer mills or pulverizer mills shall not be manifolded with other types of machinery.

9.3.3.5.3.1 Conveyors, sifters, and hammer mills used for the sizing of oilseed meals and hulls shall be permitted to have a common dust collection system.

9.3.3.5.4 Separate Collection Systems. Each department in starch manufacturing and handling (i.e., starch drying, grinding, dextrine cooking) shall have a separate dust collection system.

9.3.3.5.5* Dust Liberation. Liberation of dust into the ambient air within a shed or structure from open pits or hoppers, such as truck or railcar dump pits, shall be reduced as much as practical by dust control.

9.3.3.5.6 Machinery Startup and Shutdown. Dust collection systems shall be in operation before startup of related machinery.

9.3.3.5.6.1 Shutdown of a dust collection system collecting only combustible dusts shall actuate an audible or visual signal that can be either seen or heard by the attendant.

9.3.3.5.6.2 Procedures shall be established, or an automatic sequence provided, to shut down related machinery if the dust collection system shuts down during operations.

9.3.3.5.6.3 Dust collection systems equipped with explosion venting or explosion suppression systems shall include a

method of shutting down the system automatically when a deflagration event occurs within the air-material separator (AMS).

9.3.3.5.7 Filter Media Dust Collectors.

9.3.3.5.7.1 Filter media dust collectors shall have a monitoring device (such as a differential pressure gauge) to indicate pressure drop across the filter media.

9.3.3.5.7.2 Manufacturer's recommendations and specifications shall be followed concerning actions to be taken based on the indicated pressure drop across the filter media.

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

9.3.3.5.8* Dust Bins and Tanks.

9.3.3.5.8.1 Bins and tanks for the storage of grain dust shall be dusttight, constructed of noncombustible materials, and located outside the buildings or structures.

9.3.3.5.8.2 The dust bins and tanks shall have transfer systems that are separated from the upstream operations by rotary valves or choke seals, or through the use of other methods to reduce the likelihood of propagation of an explosion in accordance with NFPA 69.

9.3.3.5.9 Floor Sweeps. If provided, floor sweeps shall be on a separate, dedicated vacuum or dust collection system, provided the fan is located downstream of the filter.

9.3.3.6 Duct Systems.

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

9.3.3.6.1.1 Plastic or fiberglass ducts or pipes shall not be used.

9.3.3.6.1.2* Ductwork utilizing a combustible lining shall be permitted only in high impact areas.

9.3.3.6.2 Flexible Hose. Flexible hose shall conform to the following provisions:

- (1) It shall be permitted for use with combustible materials only if it is made of static dissipative construction and properly grounded.
- (2) It shall be permitted for connections and isolation purposes only properly grounded and less than 457 mm (18 in.) in length.

9.3.3.7 Centralized Vacuum Cleaning System.

9.3.3.7.1 Only static-conductive vacuum cleaning tools shall be used and shall be properly grounded to the hose end.

9.3.3.7.2 Only static-dissipative hoses shall be used and shall be properly grounded.

9.3.3.7.3 The air-material separator (AMS) used with this system shall comply with the requirements of 9.3.4.1 and comply with 9.7.3.1.

9.3.3.7.4* The AMS shall include filtration for the separation of the conveyed combustible dust from the conveying air stream.

9.3.3.7.5 The air-moving device shall be downstream of the AMS.

9.3.3.7.6 Cyclones used as primary AMS units shall be permitted only in combination with a filtered secondary AMS.

9.3.3.7.7 The system shall be designed to provide the conveying airflow velocity required to keep the conveyed material airborne in the ducting/piping at all times whether a single user or multiple active users are connected to the system.

9.3.3.7.8* The hose length and diameter shall be sized for the application and operation. [652:9.3.3.4.2]

9.3.3.7.9* Where ignition-sensitive materials are collected, vacuum tools shall be constructed of metal or static dissipative materials and provide proper grounding to the hose. [652:9.3.3.4.3]

9.3.4 AMS Locations.

9.3.4.1 Air-Material Separators.

9.3.4.1.1 Air-material separators connected to processes that are potential sources of ignition, such as hammer mills, ovens, and direct-fired dryers, and other similar equipment placed inside or outside of buildings shall be protected in accordance with 9.7.3.1.

9.3.4.1.1.1 Indoor air-material separators protected by explosion venting shall be located adjacent to an exterior wall and vented to the outside through straight ducts not exceeding 6 m (20 ft) in length.

9.3.4.1.1.2 Indoor air-material separators protected by explosion venting shall be designed so that the explosion pressures will not rupture the ductwork or the separator.

N 9.3.4.1.1.3* The requirements in 9.7.3.1 shall not apply to an AMS with a dirty side volume of less than 0.2 m³ (8 ft³).

Δ 9.3.4.1.2 Cyclones with a 0.76 m (30 in.) diameter or less used as air-material separators shall be allowed to be placed inside buildings without explosion protection when the following conditions are present:

- (1) The room, building, or other enclosure is not a Class I, Division 1 or 2 or Class II, Division 1 area as defined by Article 500 of NFPA 70.
- (2) The material being processed has a minimum ignition energy of more than 10 mJ.
- (3) The system is a closed process, excluding cleaning vacuum systems.
- (4) The material being processed has a K_{St} of less than 200 bar-m/sec.

9.3.4.1.3* Filtered Air.

9.3.4.1.3.1* Recycling of air from air-material separators to buildings shall be permitted if the system is designed to prevent transmission of energy from a fire or explosion to the building.

9.3.4.1.3.2 Air that is returned inside the building or to air makeup systems shall be filtered to the efficiency of 0.02 g per dry standard cubic meter of airflow (0.008 grain per dry standard cubic foot of airflow).

9.3.4.1.3.3* Air from multiple pneumatic filters shall be permitted to be returned to the air makeup system.

9.3.4.1.3.4* Air from hammer mill filters shall not be returned to the air makeup system.

9.3.4.1.3.5* Air from filters used for classifying food products (purifiers) shall be permitted to be returned to the air makeup system.

9.3.4.1.4 Air from a multiple pneumatic conveying system, negative or positive, shall be permitted to be returned to the air makeup system.

9.3.4.2* Dust Collector Location. Dust collectors shall be located outside of buildings and shall be protected in accordance with **9.7.3.1**.

9.3.4.2.1 Dust collectors shall be permitted inside of buildings if any of the following apply:

- (1) Deflagration venting is provided in accordance with the requirements of NFPA 68.
- (2) Dust collectors are equipped with an explosion suppression system designed according to NFPA 69.

9.3.4.2.2 If the dust collector is a centrifugal separator without bags, used for removing moisture from coolers that handle pelleted, extruded, or flaked grain and feed products, it shall be permitted inside or outside of buildings without explosion protection.

9.3.4.2.3 Bin vent dust collectors directly mounted without a hopper on a tank or bin, whose primary function is to filter air displaced during filling or blending operations and return dust directly to the bin, shall be permitted inside or outside of buildings without explosion protection. Filters that return air to inside of buildings shall be capable of a minimum efficiency of 0.02 g per dry standard cubic meter of airflow (0.008 grains per dry standard cubic foot of airflow).

9.3.4.2.4 Filters used for classifying food products with air (product purifiers) shall be permitted to be located inside or outside of buildings without explosion protection.

9.3.5 Recycle of AMS Clean Air Exhaust.

9.3.5.1* Pneumatic Conveyor Filtered Air.

9.3.5.1.1* Recycling of air from air-material separators to buildings shall be permitted if the system is designed to prevent transmission of energy from a fire or explosion to the building.

9.3.5.1.2 Air that is returned inside the building or to air makeup systems shall be filtered to the efficiency of 0.02 g per dry standard cubic meter of airflow (0.008 grain per dry standard cubic foot of airflow).

9.3.5.1.3* Air from multiple pneumatic filters shall be permitted to be returned to the air makeup system.

9.3.5.1.4* Air from hammer mill filters shall not be returned to the air makeup system.

9.3.5.1.5* Air from filters used for classifying food products (purifiers) shall be permitted to be returned to the air makeup system.

9.3.5.1.6 Air from a multiple pneumatic conveying system, negative or positive, shall be permitted to be returned to the air makeup system.

9.3.5.2* Dust Collector Filtered Air.

9.3.5.2.1* Recycling of air from collectors to buildings shall be permitted if the system is designed in accordance with methods found in NFPA 69, Chapter 11 and Chapter 12, to prevent a

return of dust, combustion products, flammable vapors, heat, and flames into the building.

9.3.5.2.2 Filters that return air to the inside of buildings shall be capable of a minimum efficiency of 0.02 g per dry standard cubic meter of airflow (0.008 grains per dry standard cubic foot of airflow).

9.3.6 Duct Systems. (Reserved)

N 9.3.7 Sight Glasses. (Reserved)

N 9.3.8 Abort Gates/Dampers. (Reserved)

9.3.9 Bins, Tanks, and Silos.

9.3.9.1 Construction of bins, tanks, and silos shall conform to applicable local, state, or national codes.

9.3.9.2* Where explosion relief vents are provided on silos, bins, and tanks, they shall operate due to overpressure before the container walls fail.

9.3.9.3 Access doors or openings shall meet the following requirements:

- (1) They shall be provided to permit inspection, cleaning, and maintenance and to allow effective use of fire-fighting techniques in the event of fire within the bin, tank, or silo.
- (2) They shall be designed to prevent dust leaks.

9.3.9.4 Where a bin, tank, or silo has a personnel access opening provided in the roof or cover, the smallest dimension of the opening shall be at least 610 mm (24 in.).

N 9.3.10 Size Reduction. (Reserved)

N 9.3.11 Particle Size Separation. (Reserved)

N 9.3.12 Pressure Protection Systems. (Reserved)

N 9.3.13 Material Feeding Devices. (Reserved)

9.3.14 Bucket Elevator Legs.

9.3.14.1 All Legs.

9.3.14.1.1 Casing, head and boot sections, access openings, and connecting spouts shall be as dusttight as practicable and shall be constructed of noncombustible materials.

9.3.14.1.2* Inspection openings shall be provided in the boot section to allow clean-out of the boot and inspection of the alignment of the boot pulley and belt.

9.3.14.1.3 Inspection openings shall be provided in the head section to allow complete inspection of the head pulley lagging, the belt and pulley alignment, and the discharge throat of the leg.

9.3.14.1.4* Each leg shall be independently driven by motor(s) and drive train(s) capable of handling the full-rated capacity of the elevator leg without overloading.

9.3.14.1.4.1 Line shaft drives shall be acceptable for legs used in the milling industry as long as they are capable of handling the full-rated capacity of all connected equipment without overloading.

9.3.14.1.4.2 Multiple motor drives shall be interlocked to prevent operation of the leg upon failure of any single motor.

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

9.3.14.1.5* Each leg shall be provided with a speed sensor device that will cut off the power to the drive motor and actuate an alarm in the event the leg belt slows to 80 percent of normal operating speed. Feed to the elevator leg by mechanical means shall be stopped or diverted.

9.3.14.1.6 The use of plastic, rubber, and other combustible linings shall be limited to high-impact areas and wear surfaces.

9.3.14.1.7 The leg head section between the up and down casings shall be sloped at an angle of not less than 45 degrees.

9.3.14.1.8 All spouts intended to receive grain or dry ingredients directly from any leg shall be designed and installed to handle the full-rated elevating capacity of the largest leg feeding such spouts.

9.3.14.1.9 Legs shall have lagging installed on the head pulley to minimize slippage.

9.3.14.1.10* Leg belts and lagging shall have a surface resistivity not greater than 300 megohms per square.

9.3.14.1.11 Leg belts and lagging shall be fire resistant and oil resistant.

9.3.14.1.11.1 Oil-resistant lagging or belting shall not be required for bucket elevators used in flour mills or for handling inert materials.

9.3.14.1.11.2 Oil-resistant lagging or belting shall not be required for line shaft drives as used in the milling industry.

9.3.14.1.11.3 Belts shall be fire resistant by complying with the requirements of the Mine Safety and Health Administration (MSHA) 2G flame test for conveyor belting in 30 CFR 18, Section 18.65 (July 2006), or the flame test for belting in Part 13.2 of ASTM D378, *Standard Test Methods for Rubber (Elastic) Conveyor Belting, Flat Type*.

9.3.14.1.12* Monitors.

9.3.14.1.12.1* Inside legs shall have monitors at head, tail, and knee pulley bearings that indicate high bearing temperature or vibration detection.

9.3.14.1.12.2 Inside legs shall have monitors for head, tail, and knee pulley alignment and belt alignment.

9.3.14.1.12.3 Abnormal conditions shall actuate a visual or an audible and visual alarm requiring corrective action.

9.3.14.1.13 All garners, bins, or other receptacles into which material is spouted directly from legs, and which are not designed with automatic overflow systems, shall be equipped either with devices to shut down equipment or with high-level indicating devices with visual or audible alarms.

▲ 9.3.14.2* Legs Handling Bulk Raw Grain.

▲ 9.3.14.2.1* Legs handling bulk raw grain shall be installed either as an outside leg or as an inside leg with compliance with one of the following cases:

- (1) Legs are located within 3 m (10 ft) of an exterior wall and are vented as outlined in 9.3.14.2.2 to the outside of the building and designed so that the explosion pressures will not rupture the ductwork or the leg.
- (2) Legs are vented in accordance with NFPA 68.

(3) Legs are protected in accordance with NFPA 69.

9.3.14.2.2* All newly installed outside legs shall be provided with explosion relief panels located at intervals no greater than 6 m (20 ft) along the casings as shown in Figure 9.3.14.2.2(a) and Figure 9.3.14.2.2(b).

9.3.14.2.2.1 To minimize personnel exposure, explosion venting for outside legs shall start between 2.5 m to 3.5 m (8 ft to 12 ft) above grade, or the bottom of the explosion vent shall be within 0.3 m to 1 m (1 ft to 4 ft) after the leg penetrates the building roof.

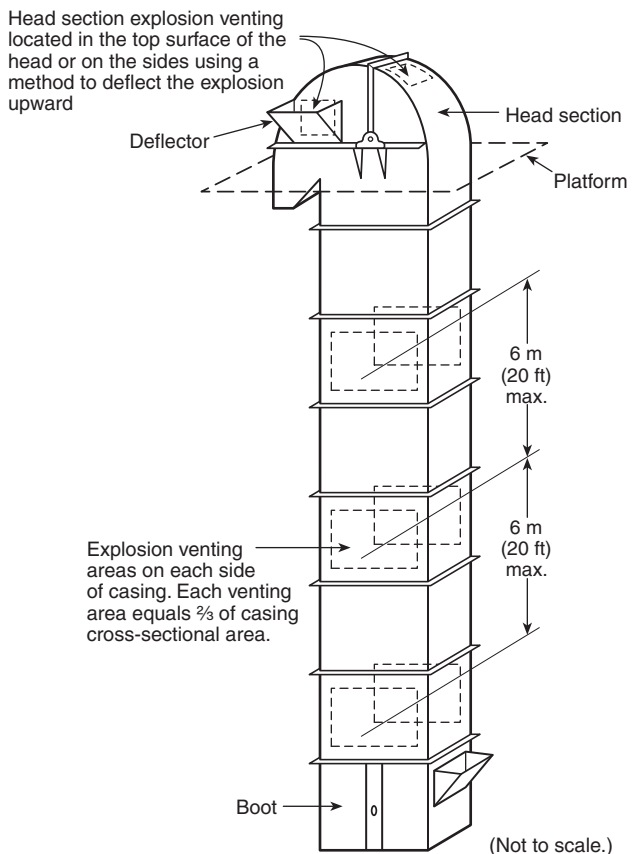
9.3.14.2.2.2 Venting shall not be required on portions of outside legs located below grade or passing through ground-level buildings.

9.3.14.2.2.3 Each side vent shall have a minimum area equivalent to two-thirds of the cross-sectional area of the leg casing.

9.3.14.2.2.4 A single face vent shall be permitted to replace a pair of opposing side vents in those portions of a double-casing leg where either of the following situations exists:

- (1) Side venting could expose personnel on access ladders or platforms.
- (2) Structural interferences are present that would interfere with vent operation.

9.3.14.2.2.5 Single face vents shall be equal to the area of two side vents [four-thirds of the cross-sectional area of the leg casing as indicated in Figure 9.3.14.2.2(b)].



▲ FIGURE 9.3.14.2.2(a) Typical Elevator Explosion Venting for a Single Casing Leg.