# NFPA® 61

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

## 2013 Edition

NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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**NFPA® 61**

**Standard for the**

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

**2013 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 acted on by NFPA at its June Association Technical Meeting held June 11–14, 2012, in Las Vegas, NV. It was issued by the Standards Council on August 9, 2012, with an effective date of August 29, 2012, and supersedes all previous editions.

This edition of NFPA 61 was approved as an American National Standard on August 29, 2012.

## Origin and Development of NFPA 61

The NFPA 61 standard originated in 1923, when standards were 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 In addition, NFPA 93, *Standard for Dehydrators and Dryers for Agricultural Products*, was withdrawn in 1968 and its text was incorporated as a chapter in NFPA 61B.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 *Manual of Style for NFPA 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 has updated definitions related to agricultural products handling, conveying, and dust collection. The requirements in Chapter 7 affecting bucket elevators have been revised to reflect current industry practice. The requirements in Chapter 10 affecting dust control systems have been revised to include a written housekeeping program. Requirements for pneumatic conveying system design have been added into Chapter 11. In Chapter 12, the requirement related to standpipes has been revised.

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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.

## Contents

**NFPA 61**

**Standard for the**

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

**2013 Edition**



NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex F. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

## Chapter 1 Administration

**1.1 Scope.**

**1.1.1*** 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, 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, *Standard for Solvent Extraction Plants*

**1.1.2** This standard shall not apply to oilseed extraction plants that are covered by NFPA 36, *Standard for Solvent Extraction Plants.*

**1.2* Purpose.** The purpose of this standard shall be to prescribe requirements for safety to life and property from fire and explosion and to minimize the resulting damage if a fire or explosion occurs.

**1.3 Application.** The requirements of Chapter 13 shall apply to all facilities, both new and existing.

**1.4 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.

**1.4.1** 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.

**1.4.2** 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.

**1.4.3** 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* 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.

## 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,* 2010 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2013 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* 2010 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2011 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2012 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment,* 2011 edition.

NFPA 36, *Standard for Solvent Extraction Plants,* 2009 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2009 edition.

NFPA 54, *National Fuel Gas Code,* 2012 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2011 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2007 edition.

NFPA 69, *Standard on Explosion Prevention Systems,* 2008 edition.

*NFPA 70®, National Electrical Code®,* 2011 edition.

*NFPA 72®, National Fire Alarm and Signaling Code,* 2013 edition.

NFPA 86, *Standard for Ovens and Furnaces,* 2011 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids,* 2010 edition.

NFPA *101®, Life Safety Code®,* 2012 edition.

NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment,* 2008 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations,* 2011 edition.

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids,* 2013 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2011 edition.

*NFPA 5000®, Building Construction and Safety Code®,* 2012 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.

AMCA Standards Handbook, Standard 99-0401-86, *Classifications for Spark Resistant Construction,* 2010.

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

ASME *Unfired Pressure Vessel Code,* Section VIII, "Rules for Construction of Pressure Vessels," 2010.

**2.3.3 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,* 2009 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2007 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids,* 2010 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* 2012 edition.

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids,* 2013 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.** A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which 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 *Manual of Style for NFPA Technical Committee Documents.*

**3.3 General Definitions.**

**3.3.1* Agricultural Dust.** Any finely divided solid agricultural material 420 microns or smaller in diameter (material passing a U.S. No. 40 Standard Sieve) that presents a fire or explosion hazard when dispersed and ignited in air.

**3.3.2* Air-Material Separator (AMS).** A device designed to separate the conveying air from the material being conveyed. [**654,** 2013]

**3.3.3* Air-Moving Device (AMD).** A fan, blower, or other device that establishes an airflow by moving a volume of air per unit time. [**91,** 2010]

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

**3.3.5* 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).

**3.3.6* Deflagration.** Propagation of a combustion zone at a velocity that is less than the speed of sound in the unreacted medium. [**68,** 2007]

**3.3.7* Dust Collection System.** A combination of equipment designed to contain, capture, collect, and filter airborne dusts.

**3.3.8* Explosion.** The bursting or rupture of an enclosure or container due to the development of internal pressure from a deflagration.

**3.3.9 Fire Barrier Wall.** A wall, other than a fire wall, having a fire resistance rating. [**221,** 2012]

**3.3.10 Fire-Resistant Belting Materials.** Belts that meet Mine Safety and Health Administration (MSHA) 2G flame test for conveyor belting.

**3.3.11 Hot Work.** Work involving burning, welding, or a similar operation that is capable of initiating fires or explosions. [**51B,** 2009]

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

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

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

**3.3.15* 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 point 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.

## Chapter 4 Construction Requirements

### 4.1 General Requirements.

**4.1.1** 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.

**4.1.2*** 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.

**4.1.3** Electrical wiring and power equipment shall meet all applicable requirements of *NFPA 70, National Electrical Code.*

**4.1.4*** 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, National Electrical Code.*

*Exception: Masonry walls that are designed for explosion resistance to preclude failure of these walls before the explosion pressure can be vented safely to the outside.*

**4.1.5** 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 4.1.5.1 through 4.1.5.4.

**4.1.5.1** 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 4.1.5.2 through 4.1.5.4.

*Exception: 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.*

**4.1.5.2** 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.

*Exception: Small control room structures contiguous to specific operations such as railcar and truck discharging or loading.*

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

*Exception: Distances less than 30 m (100 ft) but in no case less than 15 m (50 ft) shall be permitted if 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 suppression systems in accordance with NFPA 69, Standard on Explosion Prevention Systems.*

**4.1.5.4** 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).

*Exception: 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.*

**4.1.6*** Where provided, a lightning protection system shall be designed and installed in accordance with NFPA 780, *Standard for the Installation of Lightning Protection Systems.*

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

### 4.3 Interior Wall Construction.

**4.3.1** Storage areas larger than 465 $m^2$ (5000 $ft^2$) 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 *NFPA 5000, Building Construction and Safety Code,* Chapter 8, Fire-Resistive Materials and Construction.

**4.3.2** Warehouse areas shall be designed in accordance with *NFPA 5000, Building Construction and Safety Code.*

**4.3.3** 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 *NFPA 5000, Building Construction and Safety Code,* Chapter 8, Fire-Resistive Materials and Construction.

**4.3.3.1** Fire doors, fire shutters, fire dampers, and fire penetration seals shall be listed and shall have a fire resistance rating complying with NFPA *101*, *Life Safety Code*.

**4.3.3.2** 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

**4.4 Means of Egress.**

**4.4.1** Means of egress shall be in accordance with NFPA *101*, *Life Safety Code*.

**4.4.2** 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.

**4.4.3** 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.

*Exception: Only 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).*

**4.5 Bins, Tanks, and Silos.**

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

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

**4.5.3** 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.

**4.5.4** 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.).

**4.6 Marine Towers.**

**4.6.1** Marine towers shall be constructed of noncombustible materials.

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

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

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

**4.6.2.3** 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.

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

**4.6.4** 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.

## Chapter 5 Ventilation and Venting

**5.1 General.**

**5.1.1** In this chapter, ventilation shall refer to natural or mechanical movement of air necessary for normal operation and personnel comfort and safety.

**5.1.2** Recirculating or recycling exhaust air ventilation systems for dust explosion hazard areas, if used, shall be equipped with filter systems capable of removing dust from the air.

**5.1.3** Dust collection systems used in conjunction with ventilation systems shall comply with the provisions of Chapter 10 of this standard.

**5.2 Venting of Bins, Tanks, and Silos.**

**5.2.1** The requirements for air displacement shall be as follows:

(1) Each bin, tank, or silo shall be provided with means for air displacement during filling or emptying.
(2) Displaced air shall not be discharged to the building atmosphere unless it is cleaned with a filter having a minimum efficiency of 0.02 g per dry standard cubic meter of airflow (0.008 grains per dry standard cubic foot of airflow).

**5.2.2*** Vents shall be designed to prevent plugging due to accumulations of dust.

**5.2.3** Inclined vent stacks shall have clean-out doors or panels.

**5.2.4** All vents shall be fitted with weather hoods.

**5.2.5** Bin vents shall be sized to handle the air displaced by either filling or emptying.

## Chapter 6 Explosion Prevention, Relief, and Venting

**6.1* General.** Explosion prevention, relief, and venting, as used in this standard, shall encompass the design and installation of devices and systems to vent the gases and overpressure resulting from a combustion explosion occurring in equipment, rooms, buildings, or other enclosures so that damage is minimized.

**6.2* Enclosure Requirements.**

**6.2.1*** If a dust explosion hazard exists in rooms, buildings, or other enclosures under normal operating conditions, such areas shall be provided with explosion relief venting distributed over the exterior walls (and roof, if applicable) in accordance with NFPA 68, *Standard on Explosion Protection by Deflagration Venting*.

**6.2.1.1** The design of such explosion relief venting shall consider the limitations imposed by the structural design of the area.

**6.2.1.2** The design shall offer the least possible resistance to explosion pressures.

*Exception No. 1: Tunnels and pits where explosion venting is not practical due to confinement by soil, building constraints, or both.*

*Exception No. 2: Bins and silos where explosion venting is not practical due to bin or silo geometry, building constraints, or both.*

**6.2.2*** Explosion relief panels, windows, or other venting devices shall be designed to prevent reclosing after relieving the explosion pressure and shall be attached to retention cables or restrained by equivalent means such that they will not become a hazardous projectile upon relief.

**6.3 Equipment Requirements.**

**6.3.1** Equipment requiring explosion prevention shall be protected by containment, suppression, inerting, or explosion venting.

**6.3.2** Suppression, containment, or inerting systems shall be designed according to NFPA 69, *Standard on Explosion Prevention Systems.*

**6.3.3*** Explosion venting shall be designed in accordance with NFPA 68, *Standard on Explosion Protection by Deflagration Venting.*

**6.3.3.1** Explosion venting shall be directed to a safe, outside location away from platforms, means of egress, or other potentially occupied areas or directed through a listed flame arresting and particulate retention device.

## Chapter 7 Equipment

**7.1 Bearings.**

**7.1.1** Antifriction bearings shall be used on all machinery, conveyors, legs, and processing equipment.

*Exception: Sleeve and friction-type bearings, plastic bearings, or oil-impregnated wood bearings shall be permitted for equipment operating at 150 rpm or less.*

**7.1.2** All bearings shall be maintained per manufacturers' recommendations and shall be kept free of dust, product, and excessive lubricant.

**7.1.3*** All bearings on legs and conveyors shall be located outside of machinery enclosures and isolated from the product stream to minimize exposure to dust and to be more accessible for inspection and service.

*Exception: Antifriction support bearings on screw conveyors and similar equipment requiring bearings to be within the product stream shall be of the sealed type. Sleeve and friction-type bearings shall be permitted for equipment operating at 150 rpm or less.*

**7.2 Drive Belts.**

**7.2.1** Where drive assemblies involve the use of belts, such as V-belts, timing belts, flat belts, and so forth, they shall be electrically conductive at 1 megohm or less and shall be fire resistant and oil resistant.

**7.2.2** Where a drive belt is used, the drive train shall be designed with a minimum service factor of 1.5 or higher if the manufacturer of the drive components recommends a higher service factor for continuous service for the type of equipment to be driven.

*Exception: Line shaft drives as used in the milling industry.*

**7.3* Conveyors, Spouts, and Throws of Material.**

**7.3.1*** Bulk material conveyor belts shall be designed to either relieve or stop if the discharge end becomes plugged.

**7.3.2** Bulk material conveyor belts shall have belt alignment and hot bearing sensors at the head and tail.

**7.3.3** Screw, drag, or en-masse conveyors shall be fully enclosed in metal housings and shall be designed to either relieve or stop if the discharge end becomes plugged.

**7.3.4*** Bulk material conveyor belts and lagging shall have a surface resistivity not greater than 100 megohms (MΩ) per square and shall be fire resistant and oil resistant.

**7.3.5** Fixed spouts shall be dusttight.

**7.3.6*** Use of combustible lining shall be permitted in spouts and other handling equipment at impact points and on wear surfaces.

**7.3.7** Portable, automatic distributing, and movable spouts shall be permitted in work areas, bin areas, and distribution areas and shall be as dusttight as practicable when in use.

**7.3.8*** Spouts that direct material into bins, tanks, or silos shall be designed and installed so that any foreign objects, such as metal or stones, in the material stream do not strike the walls of the container, as far as is practicable.

**7.4 Bucket Elevator Legs.**

**7.4.1 All Legs.**

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

**7.4.1.2*** 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.

**7.4.1.3** 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.

**7.4.1.4*** 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.

*Exception: 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.*

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

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

**7.4.1.5*** Each leg shall be provided with a motion detector 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.

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

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

**7.4.1.8** 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.

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

**7.4.1.9.1*** Leg belts and lagging shall have a surface resistivity not greater than 100 megohms per square.

**7.4.1.9.2** Leg belts and lagging shall be fire resistant and oil resistant.

*Exception No. 1: Oil-resistant lagging or belting shall not be required for bucket elevators used in flour mills or for handling inert materials.*

*Exception No. 2: Line shaft drives as used in the milling industry shall be exempt from the lagging requirement.*

**7.4.1.10*** Inside legs shall have bearing temperature or vibration detection, head pulley alignment, and belt alignment monitors at head and tail pulleys.

*Exception: Legs that have capacities less than 106 $m^3$/hr (3750 $ft^3$/hr).*

**7.4.1.11** 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.

**7.4.2 Legs Handling Bulk Raw Grain.**

**7.4.2.1*** 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 7.4.2.2 to the outside of the building and designed so that the explosion pressures will not rupture the ductwork or the leg. Explosion relief panels shall be provided on the leg housing so the ducts will not be a collection point for dust during normal operations.
(2) Legs are vented in accordance with NFPA 68, *Standard on Explosion Protection by Deflagration Venting.*
(3) Legs are provided with explosion suppression in accordance with NFPA 69, *Standard on Explosion Prevention Systems.*
(4)*Legs that have capacities less than 106 $m^3$/hr (3750 $ft^3$/hr).

**7.4.2.2*** 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 7.4.2.2(a) and Figure 7.4.2.2(b). 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. Head section explosion venting shall be located in the top surface of the head or on the sides using a method to deflect the explosion upward.

*Exception No. 1: Legs that have capacities less than 106 $m^3$/hr (3750 $ft^3$/hr).*

*Exception No. 2: Those portions of outside legs, as defined in this standard, below grade or passing through ground-level buildings.*

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

**7.4.2.2.2** 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:

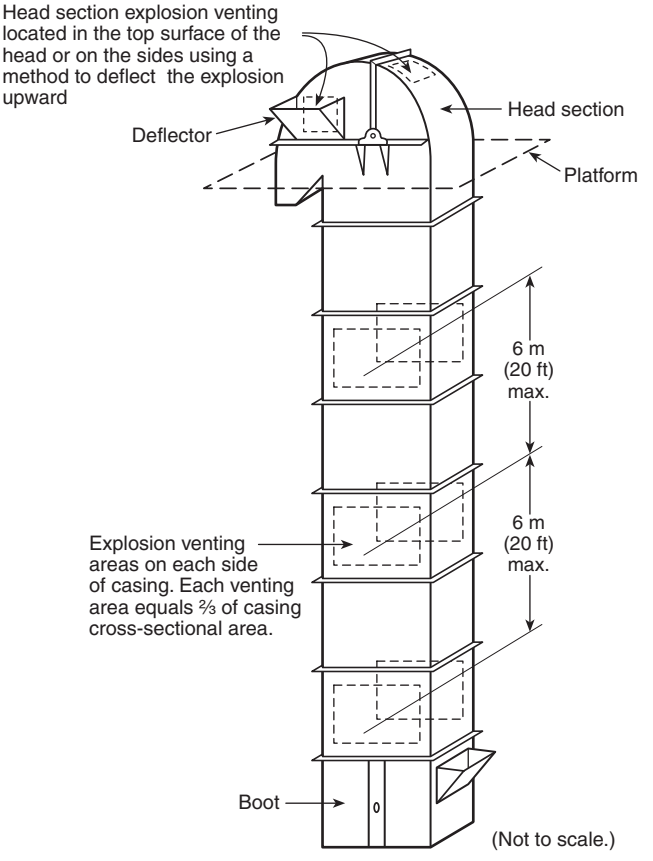


**FIGURE 7.4.2.2(a) Typical Elevator Explosion Venting for a Single Casing Leg.**

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

**7.4.2.2.3** Single face vents shall be equal to the area of two side vents [4/3 of the cross-sectional area of the leg casing as indicated in Figure 7.4.2.2(b)].

**7.4.2.2.4** The head section of bucket elevators shall be provided with explosion vents in the top surface or on the sides using a method to deflect the explosion upward. The vent area shall be a minimum of 0.14 $m^2$ (5 $ft^2$) of vent area per 2.9 $m^3$ (100 $ft^3$) of head section volume. The largest vent area as practicable shall be used in the head section to help minimize the development of explosive pressure. Vents shall deploy when an internal pressure of 3.5 kPa to 6.9 kPa (0.5 psi to 1.0 psi) occurs.

**7.4.3 Legs Handling Materials Other Than Bulk Raw Grain That Present an Explosion Hazard.**

**7.4.3.1** Explosion venting of legs into buildings shall not be permitted.

**7.4.3.2*** Newly installed outside legs shall be equipped with explosion venting in accordance with 7.4.2.2.

*Exception: Those portions of outside legs, as defined in this standard, below grade or passing through ground-level buildings.*

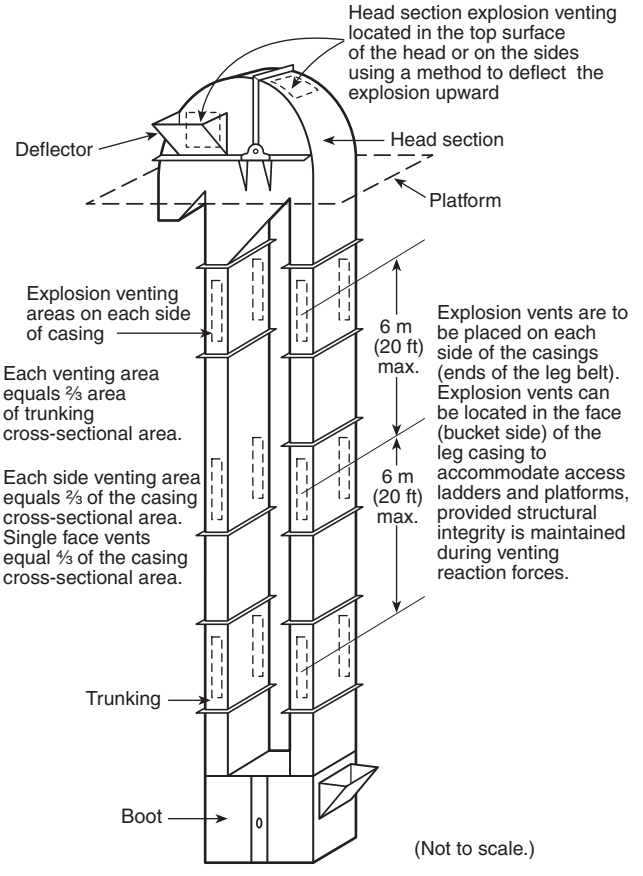


**FIGURE 7.4.2.2(b) Typical Elevator Explosion Venting for a Double Casing Leg.**

**7.4.3.3*** Legs or portions of legs that are located inside shall have the maximum practicable explosion relief area through the roof directly to the outside.

*Exception: Legs that have capacities less than 106 $m^3$/hr (3750 $ft^3$/hr).*

**7.5 Processing Machinery and Equipment.**

**7.5.1* General.**

**7.5.1.1** Receiving systems prior to the leg shall be equipped with one or more devices such as grating, wire mesh screens, permanent magnets, listed electromagnets, pneumatic separators, or specific gravity separators, to minimize or eliminate tramp material from the product stream.

*Exception: Barge and ship receiving systems using legs as the primary reclaiming systems shall be allowed to have the tramp material protection after the unloading leg but prior to being handled in another leg or processing equipment.*

**7.5.1.2*** Where tributary spouts or conveyors feed whole grain or grain products for size reduction into grinders, pulverizers, or rolling mills, they shall be equipped with properly installed permanent magnets or listed electromagnets, pneumatic separators, specific gravity separators, scalpers, or screens to exclude metal or foreign matter of a size larger than the grain being processed as far as practicable.

**7.5.1.3*** Equipment shall be bonded and grounded to dissipate static electricity.

**7.5.1.4** All processing machinery and components, such as magnets, shall be mounted to facilitate access for cleaning.

*Exception: Where processing machinery is mounted on a tight-fitting base that prevents material from reaching inaccessible places beneath the machine.*

**7.5.1.5** Screw, drag, or en-masse conveyors shall be fully enclosed in metal housings and shall be designed to either relieve or stop if the discharge end becomes plugged.

**7.5.2 Starch Processing Machinery and Equipment.**

**7.5.2.1** Carbon steel shall be avoided in the grinding chambers and moving parts of grinding mills in favor of brass, bronze, stainless steel, and other metals with lower sparking potential.

**7.5.2.2** The reels or sieves of screens, scalpers, and similar devices shall be in dusttight enclosures.

**7.5.2.3** Connecting ducts shall be metal.

*Exception No. 1: Electrically conductive nonmetallic flexible connecting ducts having an electrical resistance not greater than 1 megohm.*

*Exception No. 2: Plastic tubing used for sample delivery systems.*

**7.5.2.4** Where more than one material source is connected to a common conveyor, air-material separator, or similar device, each source that is connected shall be equipped with a method to prevent propagation of a deflagration in accordance with NFPA 69, *Standard on Explosion Prevention Systems.*

**7.5.2.5** Dry milling or grinding of starch shall be performed in a separate building with explosion relief or in a separate room isolated from other areas by interior walls designed according to 4.1.2.

*Exception No. 1: This requirement shall not apply if the equipment can be designed to be protected in accordance with NFPA 69, Standard on Explosion Prevention Systems, by deflagration containment, by explosion suppression, or by inerting the volume to reduce oxygen such that combustion is not supported.*

*Exception No. 2: This requirement shall not apply if mills are provided with explosion venting to a safe outside location. If explosion vent ducts longer than 3 m (10 ft) are to be used, the milling equipment and explosion vent duct shall be designed to withstand the increased vented explosion pressure.*

## Chapter 8 Dryers

**8.1* General Requirements.** This chapter shall apply to grain dryers, commodity product dryers, and starch dryers.

**8.1.1** Dryers, within the scope of this standard, shall function to process materials that are subjected to heated air for the purpose of reducing their moisture content.

**8.1.2*** Other dryers used in further processing of agricultural commodities shall be outside the scope of this standard.

**8.1.3*** Dryers and auxiliary equipment shall be designed, operated, cleaned, and maintained to minimize combustible accumulations on those inside surfaces intended to be free of grain or product during drying.

**8.2* Grain Dryers.**

**8.2.1* Location.**

**8.2.1.1** Dryers shall be located so as to minimize fire exposure to adjacent buildings and structures, including other dryers,

to minimize ignition potential to operating and storage areas, and to provide access for fire fighting.

**8.2.1.2** Dryers shall not be located inside grain-handling or grain storage structures.

**8.2.2 Construction.**

**8.2.2.1** Dryers shall be constructed of noncombustible materials.

**8.2.2.2** Dryers and related equipment shall be designed so that the fire hazard inherent in equipment operating at elevated temperatures is minimized.

**8.2.2.3** Interior surfaces of dryers shall be designed to minimize the accumulation of material and to facilitate cleaning.

**8.2.2.4** Dryers designed to recirculate a portion of the exhaust air shall have a means to minimize entrained particles from being reintroduced into the drying chamber.

**8.2.2.5** Outward opening doors or openings shall be provided to allow access to all parts of the dryer and connecting spouts, inlet or outlet hoppers, and conveyors to permit inspection, cleaning, maintenance, and the effective use of portable extinguishers or hose streams.

**8.2.2.6** In case of fire, dryers shall be designed with means for unloading (emergency dumping) of the dryer contents to a safe outside location in which the location and the manner does not cause fire exposure to adjacent buildings, structures, or equipment.

**8.2.2.7** A method shall be provided for the safe handling of burning material and for the extinguishment of the burning material as it is emptied from the dryer.

**8.2.3 Air Heating Systems.**

**8.2.3.1*** Air heating systems shall include the heat source and associated piping or wiring and the circulating fan and associated ductwork used to convey the heated air to the dryer.

**8.2.3.2*** The air heater and its components shall be selected for the intended application, shall be compatible with the types of fuels to be used, and shall be designed for the temperatures to which they will be subjected.

**8.2.3.3** Direct-fired air heating systems shall have a means to minimize airborne combustible material from entering the drying chamber.

**8.2.3.4** Burner systems and their controls for dryers fired by fuel oil, natural gas, mixed gas, manufactured gas, or liquefied petroleum gas, as well as mixing components, shall comply with NFPA 86, *Standard for Ovens and Furnaces*.

**8.2.3.5** Liquefied petroleum gas vaporizing burner installations shall comply with NFPA 58, *Liquefied Petroleum Gas Code*.

**8.2.3.6** Fuel systems, up to the point of connection to the burner, shall comply with the following as applicable:

(1) NFPA 30, *Flammable and Combustible Liquids Code*
(2) NFPA 31, *Standard for the Installation of Oil-Burning Equipment*
(3) NFPA 54, *National Fuel Gas Code*
(4) NFPA 58, *Liquefied Petroleum Gas Code*

**8.2.4 Safety Controls.**

**8.2.4.1** Safety controls shall be designed, constructed, and installed such that required conditions of safety for operation of the air heater, the dryer, and the ventilation equipment are maintained.

**8.2.4.2** The dryer and its auxiliary equipment shall be equipped with excess temperature limit controls arranged to supervise both of the following:

(1) Airstream between the fuel burner and the drying chamber air inlet
(2) Airstream at the discharge of the cooling and heating sections

**8.2.4.3** Excessive temperatures detected by devices required by 8.2.4.2 shall initiate an automatic shutdown.

**8.2.4.3.1** The automatic shutdown shall accomplish all of the following:

(1) Shut off the fuel or heat to the burners.
(2) Stop the flow of product out of the dryer.
(3) Stop all airflow from fans into the dryer.
(4) Sound an alarm at a constantly attended location or for the operator, or both, to prompt an emergency response.

**8.2.4.3.2** An emergency stop shall be provided that will enable manual initiation of the automatic shutdown.

**8.2.4.4** All safety control equipment shall be nonrecycling and shall require manual reset before the dryer can be returned to operation.

**8.2.5 Dryer Operation.**

**8.2.5.1** Operating controls shall be designed, constructed, and installed so that required conditions of safety for operation of the air heater, the dryer, and the ventilation equipment are maintained.

**8.2.5.2** The drying chamber shall have an operating control that maintains the temperature within prescribed limits.

**8.2.5.3** Extraneous material that is not normally part of the grain as it is received from the farm and that would contribute to a fire hazard shall be removed before it enters the dryer.

**8.2.6 Fire Detection and Protection.**

**8.2.6.1** A fire detection system shall be provided for the dryer when the operation is intermittent during the drying season and the dryer is shut down full or partially full of grain.

**8.2.6.1.1** The fire detection system shall sound an alarm in a constantly attended location.

**8.2.6.1.2** The fire detection system shall be permitted to be deactivated when the dryer has been thoroughly emptied and cleaned or when the dryer has been emptied, cleaned, and secured at the end of the drying season.

**8.2.6.2** When operating practices prohibit the retention of any grain in the dryer during intermittent unattended shutdowns, a fire detection system shall not be required.

**8.2.6.3*** Means shall be provided for extinguishing fires within the drying chamber.

**8.3 Product Dryers.**

**8.3.1** Drying units shall be equipped with remote power cutoff switches.

**8.3.2** On direct-fired dryers, the air supply shall be filtered of all particles that could be a combustion hazard.

**8.3.3** Fuel systems, up to the point of connection to the dryer burner, shall comply with the following as applicable:

(1) NFPA 30, *Flammable and Combustible Liquids Code*
(2) NFPA 31, *Standard for the Installation of Oil-Burning Equipment*
(3) NFPA 54, *National Fuel Gas Code*
(4) NFPA 58, *Liquefied Petroleum Gas Code*

**8.3.4** Direct-fired dryers with an explosion hazard located within buildings shall be protected in accordance with Section 6.3.

**8.3.5** The combustion and burner system and controls shall be designed, operated, and tested as required in NFPA 86, *Standard for Ovens and Furnaces*.

**8.4 Starch Dryers.**

**8.4.1 General.** Starch dryers shall be designed and located in accordance with the requirements of 8.2.1 through 8.2.2.7.

**8.4.2 Ignition Sources.**

**8.4.2.1*** The interior heated surface of a starch dryer shall be designed and maintained to prevent the accumulation of starch that can attain a thickness or depth of 13 mm (½ in.) or more.

**8.4.2.2*** Inspection and clean-out doors shall be located at points in the system where spontaneous ignition is likely to occur, specifically where starch can build up and where starch is subject to continuous heat.

**8.4.2.3** Inspection and cleaning of the areas in 8.4.2.1 and 8.4.2.2 shall be performed to minimize starch accumulations.

**8.4.2.4** The combustion and burner systems and controls shall be designed, operated, and tested as required in NFPA 86, *Standard for Ovens and Furnaces*.

**8.4.3 Fire Detection, Alarm, and Interlocking Systems.**

**8.4.3.1** Every dryer shall have the means for detecting abnormal conditions that indicate the presence or potential of a fire.

**8.4.3.1.1** The detection of these conditions shall activate an alarm and automatically shut down the equipment and activate the extinguishing system.

**8.4.3.1.2** The design of an automatically operated extinguishing system shall include provisions for the necessary personnel protective features required for inspection and cleaning of the dryers.

**8.4.3.2** The dryer system, including auxiliary ducts, fans, and conveyors, shall be interlocked to provide a safe and orderly shutdown in the event of mechanical failure or abnormal operating conditions.

**8.4.4 Suppression and Extinguishing Systems.**

**8.4.4.1*** Each dryer located inside a building shall be protected by a permanently installed fire protection system, explosion suppression system, or both, in accordance with applicable NFPA standards.

**8.4.4.1.1** The system shall be actuated by fire or explosion detection devices that will sound an alarm and sequentially shut down the dryer.

**8.4.4.1.2** The fire extinguishing system shall be capable of manual actuation from locations that will be accessible during a fire in the dryer.

**8.4.4.1.3** The dryer shall not be returned to production until the fire protection or explosion suppression system has been restored.

**8.4.4.2** Piping for extinguishing systems shall be located to minimize the possibility of destruction in case of an explosion.

**8.4.4.3** The water supply for fire protection to buildings subject to explosion hazards shall be sectionalized in such a way that a water line break from an explosion can be readily isolated.

**8.5* Inspection and Tests.**

**8.5.1** All fire detection equipment shall be tested and maintained in accordance with *NFPA 72, National Fire Alarm and Signaling Code*.

**8.5.2** All fire extinguishing systems shall be tested and maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

**8.5.3** A manufacturer's test and maintenance procedure shall be provided to the owner for testing and maintenance of explosion suppression systems in accordance with NFPA 69, *Standard on Explosion Prevention Systems*. This procedure shall provide for the initial testing of the equipment as well as for periodic inspection and maintenance.

## Chapter 9 Heat Transfer Operations

**9.1 Heat Transfer Systems.**

**9.1.1** Heat transfer devices utilizing air, steam, or vapors of heat transfer fluids shall be provided with pressure-relief valves where necessary. Relief valves on systems employing combustible heat transfer media shall be vented to a safe outside location.

**9.1.2** Heaters and pumps for combustible heat transfer fluids shall be located in a separate, dustfree room or building of noncombustible construction and shall be protected by automatic sprinklers designed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, to control a fire involving the combustible heat transfer fluid. Air for combustion shall be taken from a clean outside source.

**9.1.2.1*** Buildings or rooms that contain heat transfer equipment and boilers that use combustible heat transfer fluids shall be located in separate areas such that they do not communicate directly with areas that contain a dust explosion hazard.

**9.1.2.2** Where combustible heat transfer fluids are used, doorways shall be curbed or ramped and floor drains shall be provided to direct spills of the heat transfer fluid to a safe location. Automatic sprinkler protection designed to control these fluid fires shall be provided in areas containing equipment that uses these fluids and in areas containing storage tanks for these fluids.

**9.1.3** Enclosures for heat exchangers shall be constructed of noncombustible materials and shall have access openings for cleaning and maintenance.

**9.1.4*** Heat exchangers shall be located and arranged in a manner that does not allow combustible dust to accumulate on coils, fins, or other heated surfaces.

**9.1.5** Heaters for heat transfer systems shall be provided with operating controls in accordance with NFPA 86, *Standard for Ovens and Furnaces*.

**9.2 Comfort Heating.**

**9.2.1** In areas containing combustible dust, comfort heating, if provided, shall be appropriately rated for the area as defined in *NFPA 70, National Electrical Code*.

**9.2.2** Boilers used to provide hot water or low-pressure steam for comfort heating shall be located in a nonhazardous area and shall be installed in accordance with the requirements of 9.1.2.

**9.2.3** Steam or hot water supply pipes and hot air supply ducts to comfort areas shall be fitted with insulation having a continuous, nonporous covering and an insulation quality sufficient to keep the temperatures of the outer surface below 60°C (140°F) for personnel safety purposes and less than 121°C (250°F) for prevention of dust ignition.

## Chapter 10 Dust Control

**10.1* General.** Dust control as used in this chapter shall be the control of emission of airborne combustible dusts from process and conveying equipment or material transfer points.

**10.2 Removal of Layered Agricultural Dust.**

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

**10.2.1.1*** 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 exposed surfaces.

**10.2.2** 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.

*Exception: 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.*

**10.2.3*** Portable electric vacuum cleaners, if used, shall be listed for use in Class II, Group G, Division 1 atmospheres as defined in *NFPA 70, National Electrical Code*.

**10.3 Dust Emissions.**

**10.3.1*** A method shall be used to prevent the escape of dust from process equipment into the surrounding environment.

**10.3.1.1** Suppressants shall be permitted to be used for dust control.

**10.3.1.2** In grain elevators, a method to prevent the escape of dust into surrounding areas shall be provided at leg boot sections, belt loaders, belt discharge or transfer points, trippers, turnheads, or distributors, and on unfiltered vents from which dust could be emitted into interior areas with displaced air.

**10.3.1.3** Packaging and weighing systems, including fixed-scale hoppers and upper and lower bins and garners, shall be enclosed and equipped with a venting system or air aspiration to collect the dust normally emitted by rapid air displacement during filling and emptying, if necessary.

**10.3.1.4** All machinery such as cleaners, scalpers, and similar devices normally used inside structures but not designed to be dusttight shall be provided with a means of controlling combustible dusts, if present.

**10.3.2*** Collected grain dust shall be permitted to be returned to the grain stream prior to or after being handled in a leg. Dust alone shall not be added directly to the leg and handled by itself. However, dust shall be permitted to be handled in an outside located leg that is used as part of a dust loadout system.

**10.3.3** Dust returned to handling equipment other than a leg, storage, or process shall be returned downstream of the collection point in such a manner that it will not create dust emissions.

**10.4 Dust Collection Systems.**

**10.4.1 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 AMCA Standards Handbook, Standard 99-0401-86, *Classifications for Spark Resistant Construction*.

**10.4.2** Dust collectors and filters used for grinders or hammermills shall be located outside of buildings and shall be protected in accordance with Section 6.3.

**10.4.3* Location.** Dust collectors shall be located outside of buildings and shall be protected in accordance with Section 6.3.

*Exception No. 1: Dust collectors shall be permitted inside of buildings if deflagration venting is provided in accordance with the requirements of NFPA 68.*

*Exception No. 2: Dust collectors shall be permitted to be located inside of buildings if equipped with an explosion suppression system designed according to NFPA 69, Standard on Explosion Prevention Systems.*

*Exception No. 3: Centrifugal separators, without bags, used for removing moisture from coolers that handle pelleted, extruded, or flaked grain and feed products shall be permitted inside or outside of buildings without explosion protection.*

*Exception No. 4: 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 feet of airflow).*

*Exception No. 5: Filters used for classifying food products with air (product purifiers) shall be permitted to be located inside or outside of buildings without explosion protection.*

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

*Exception: Filter bags, filter media, liners, drive belts, wear parts, and flexible connector ducts.*

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

*Exception: Conveyors, sifters, and hammermills used for the sizing of oilseed meals and hulls shall be permitted to have a common dust collection system.*

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

**10.4.7* 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.

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

**10.4.8.1** 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.

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

**10.4.8.3** 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).

**10.4.9 Filter Media Dust Collectors.**

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

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

**10.4.9.3** Where lightning protection is provided, it shall be installed in accordance with NFPA 780, *Standard for the Installation of Lightning Protection Systems.*

**10.4.10* Dust Bins and Tanks.**

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

**10.4.10.2** 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, *Standard on Explosion Prevention Systems.*

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

**10.4.12* Filtered Air.**

**10.4.12.1*** Recycling of air from collectors to buildings shall be permitted if the system is designed in accordance with NFPA 69, *Standard on Explosion Prevention Systems,* using methods found in Chapters 11 and 12 to prevent a return of dust, combined products, flammable vapors, heat, and flames into the building.

**10.4.12.2** 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).

**10.5 Duct Systems.**

**10.5.1*** Ducts that handle combustible dust particulate solids shall conform to the requirements of NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids,* except as amended by the requirements of this chapter.

**10.5.1.1** Plastic or fiberglass ducts or pipes shall not be used.

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

**10.5.2 Flexible Hose.** Flexible hose shall conform with 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.

**10.6 Centralized Vacuum Cleaning System.**

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

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

**10.6.3** The air-material separator (AMS) used with this system shall comply with the requirements of Chapter 11 and comply with Section 6.3.

**10.6.4** The AMS shall include filtration for the separation of the conveyed combustible dust from the conveying air stream. Wet or dry filtration are both acceptable methods.

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

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

**10.6.7** 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.

## Chapter 11 Pneumatic Conveying

**11.1* General.**

**11.1.1** Pneumatic conveying systems shall be installed in accordance with Section 7.3 and Sections 7.5 through 7.9 of NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids.*

**11.1.2 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.

**11.2 General Design.**

**11.2.1*** All system components shall be electrically conductive.

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

**11.2.3** Electrical wiring and power equipment shall meet all applicable requirements of *NFPA 70, National Electrical Code*.

**11.3 Piping, Valves, and Blowers.**

**11.3.1** 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 *Unfired Pressure Vessel Code*.

**11.3.2** 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

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

**11.3.4** 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.

**11.4 Air-Material Separators.**

**11.4.1** Air-material separators connected to processes that are potential sources of ignition, such as hammermills, ovens, and direct-fired dryers, and other similar equipment placed inside or outside of buildings shall be protected in accordance with Section 6.3.

**11.4.1.1** 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.

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

**11.4.2** 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, National Electrical Code*.
(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.

**11.4.3* Filtered Air.**

**11.4.3.1*** 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.

**11.4.3.2** 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).

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

**11.4.3.4*** Air from hammermill filters shall not be returned to the air makeup system.

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

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

**11.5 Receiving and Shipping Conveyances.**

**11.5.1*** 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.

*Exception: Materials of processes involving inert materials, such as limestone at feed mills.*

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

**11.5.3** 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.

## Chapter 12 Building Fire Protection

**12.1* Portable Fire Extinguishers.** Portable fire extinguishers shall comply with NFPA 10, *Standard for Portable Fire Extinguishers*.

**12.2 Automatic Sprinklers.** Where installed, automatic sprinklers shall comply with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

**12.3 Supervisory Services.** Where installed, supervisory services shall comply with *NFPA 72, National Fire Alarm and Signaling Code*.

**12.4 Standpipe and Hose.**

**12.4.1** Standpipes and hoses, where installed, shall comply with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*.

**12.4.2*** Wet or dry standpipes shall be provided to all operating areas of head houses, processing structures with operating areas, and grain bin galleries located over 15 m (50 ft) above grade.

**12.4.3*** Wet or dry standpipes shall be installed in warehouses and packing areas with combustible contents.

*Exception: Bulk storage warehouses or warehouses used for other than agricultural or food product storage.*

**12.5 Emergency Preplanning.**

**12.5.1** 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 material safety data sheet(s) for hazardous chemicals
(6) An emergency telephone number(s)
(7) Emergency response duties for occupants

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

**12.5.3** The emergency action plan shall be coordinated with local emergency responders and shall include fire department prefire plans.

**12.6 Fire-Fighting Operations.**

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

**12.6.2*** If possible, incipient fires shall be manually extinguished or burning materials removed. Burning materials shall not be transferred into legs.

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

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

**12.6.4.1** 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.

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

**12.7 Maintenance.** Water-based extinguishing systems shall be maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

## Chapter 13 Supplemental Requirements

**13.1 Applicability.** The requirements of Chapter 13 shall apply to all facilities, both new and existing.

**13.2 Electrical Wiring and Equipment.**

**13.2.1** Electrical wiring and equipment shall comply with *NFPA 70, National Electrical Code.*

**13.2.2*** Electrical wiring and equipment in areas meeting the definition of Class II, Group G, Division 1 or 2 according to Article 500 of *NFPA 70, National Electrical Code,* shall comply with Article 502 of that code.

*Exception No. 1: Electrical equipment that has been listed and installed as intrinsically safe according to Article 504 of NFPA 70.*

*Exception No. 2: Electrical equipment that is housed in an enclosure that meets the applicable requirements of NFPA 496, Standard for Purged and Pressurized Enclosures for Electrical Equipment.*

**13.3 Hot Work.**

**13.3.1*** Hot work operations in facilities covered by this standard shall comply with the requirements of NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* except as modified in this section.

**13.3.2** Hot work shall be permitted only in safe, designated areas and shall not be permitted on equipment that is operating.

**13.3.3** If it is necessary to cut or weld outside of safe, designated areas, the precautions in 13.3.3.1 through 13.3.3.3 shall be followed.

**13.3.3.1*** A hot work permit system shall be used.

**13.3.3.2** 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) All equipment 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.
(7) Floor and wall 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.
(9) The duration of the permit system shall not exceed one shift.
(10) Hot work shall not be permitted on equipment that is operating.

**13.3.3.3** The person responsible for authorizing 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 such additional precautions as are deemed necessary.
(3) Sign the permit to authorize the work.

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

**13.3.5** Upon completion of the work and after a time suitable for cooling hot surfaces, the areas shall be restored to normal operation.

**13.3.6** 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.

**13.3.7** Regular inspections of the work area shall be made to determine that no smoldering fires develop, and an additional

inspection shall be performed prior to closing the area for the day or weekend.

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

**13.3.9** When the use of the spark-producing tools becomes necessary, the following procedures shall be performed:

(1) All dust-producing machinery in the area shall be shut down.
(2) All equipment, floors, and walls shall be carefully cleaned and all dust accumulations in the area removed.

**13.3.10** 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.

**13.4* Static Electricity.** Static electricity shall be dissipated by using bonding and grounding.

**13.5 Engine- and Motor-Driven Equipment.**

**13.5.1** Engine- and motor-driven equipment used in confined Class II, Group G, Division 2 operating areas shall be equipped with safety devices designed to reduce the potential fire hazard and electrical shock hazard.

**13.5.2*** Engine- and motor-driven equipment shall meet the requirements of NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations.*

*Exception: Front-end loaders or similar equipment used in flat storage areas or marine vessels to handle grain, meal, hulls, or other agricultural commodities.*

**13.5.3** Spark arresters shall be used on the exhaust stacks of all diesel-powered units.

*Exception No. 1: Engines equipped with turbo-chargers.*

*Exception No. 2: Road vehicles, such as grain delivery vehicles, locomotives, and other vehicles that do not operate in combustible dust-producing areas.*

**13.5.4*** Refueling shall be conducted outdoors.

**13.5.5*** Surface dust shall be removed from engine- and motor-driven equipment at regular intervals during operation.

**13.5.5.1** Cleaning of front-end loaders or other motor-driven equipment with compressed air shall not be conducted in hazardous locations.

**13.5.5.2** Spark arresters shall be cleaned or replaced according to the manufacturer's recommendation.

**13.5.6** Maintenance procedures shall comply with the manufacturer's instructions regarding replacement of insulation, covers, electrical enclosures, and parts of the electrical system designed to reduce chafing of insulation or termination failure.

**13.6* Smoking.** Smoking shall be permitted only in designated areas.

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

**13.7.1** 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, *Flammable and Combustible Liquids Code.*

**13.7.2** Portable LP-Gas containers located inside the facility shall be stored, used, and handled in accordance with NFPA 58, *Liquefied Petroleum Gas Code.*

**13.8* Outside Contractors.**

**13.8.1** Outside contractors performing work within the confines of the facility shall be instructed in applicable safety policies and procedures, which shall include, but are not limited to, the following:

(1) Hot work permits
(2) Prohibition of smoking in hazardous areas

**13.8.2** The local facility manager shall establish a procedure for daily follow-up to ensure that the contractors are complying with established requirements.

**13.9 Warning Signs.**

**13.9.1** 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.

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

**13.10 Miscellaneous Storage in Grain-Handling Facilities.**

**13.10.1** 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.

**13.10.2** Miscellaneous storage shall not impede facility housekeeping or fire fighting.

**13.11 Maintenance.** All equipment provided in accordance with the requirements of this standard shall be maintained in a safe operable condition in accordance with manufacturer's specifications and recommendations.

## Annex A Explanatory Material

*Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.*

**A.1.1.1** Examples of facilities covered by this standard include, but are not limited to, bakeries, grain elevators, feed mills, flour mills, milling, corn milling (dry and wet), rice milling, dry milk products, mix plants, soybean and other oilseed preparation operations, cereal processing, snack food processing, tortilla plants, chocolate processing, pet food processing, cake mix processing, sugar refining and processing, and seed plants.

**A.1.2** This standard is voluntary and follows the accredited NFPA practices. Public authorities with lawmaking or rule-making powers who are considering adoption of this standard should do so in a manner consistent with NFPA licensing provisions and should undertake an appropriate rule-making process consistent with the jurisdiction.

**A.1.5** This standard permits the use of performance-based design options. Guidelines on performance-based design options for combustible dust hazards can be found in NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids.*

**A.3.2.1 Approved.** The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

**A.3.2.2 Authority Having Jurisdiction (AHJ).** The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

**A.3.2.4 Listed.** The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

**A.3.3.1 Agricultural Dust.** Dusts traditionally have been defined as a material 420 µm or smaller (capable of passing through a U.S. No. 40 standard sieve). Other standards have adopted the 500 µm (capable of passing through a U.S. No. 35 standard sieve) as the appropriate size criterion. For the purposes of this standard, the Committee believes that 420 µm should be retained because of the historical data that exist. In some cases, material smaller than 420 µm might not be explosible, and in some cases material larger 420 µm might be explosible. Explosibility can ultimately be determined by testing such as using the go/no-go explosibility screening test described in ASTM E 1226, *Standard Test Method for Explosibility of Dust Clouds.*

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

A dust explosion has the following five conditions, all of which must be met:

(1) The dust is combustible.
(2) The dust particles are in suspension.
(3) The dust particles exceed the minimum explosive concentration in air.
(4) The dust is confined within a piece of equipment, a building, or a structure.
(5) A source of ignition is present.

Evaluation of a combustible dust explosion hazard and the prevention techniques employed should be determined by means of actual test data. All combustible dusts that can produce a dust explosion should be tested so as to determine the following data:

(1) Particle size distribution
(2) Moisture content as received and dried
(3) Minimum dust concentration to ignite
(4) Minimum energy required for ignition (joules)
(5) Maximum rate of pressure rise at various concentrations
(6) Layer ignition temperature
(7) Maximum explosion pressure at optimum concentration

Optional testing includes the following:

(1) Dust cloud ignition temperature
(2) Maximum permissible oxygen content to prevent ignition
(3) Electrical resistivity measurement

**A.3.3.2 Air-Material Separator (AMS).** Examples include the following:

(1) Cyclonic separator (cyclone) — a device utilizing centrifugal forces and geometry to separate the conveying air/gas from the majority of the conveyed material. The efficiency of this separation is based upon many factors such as geometry of the cyclone, material particle size and density, and air/gas mass flow. Generally, this unit is considered only an initial or primary separator, and additional separation devices are applied to meet air pollution control requirements.
(2) Dust collector — a device utilizing filter media to separate fine dust particles from the conveying air/gas stream. Such devices often have automatic methods for continuous filter cleaning in order to maintain the operational efficiency of the device. Typically the filter medium is either cartridges or bags. The operating pressure of this device is usually limited by its shape and physical construction.
(3) Filter receiver — similar to a dust collector but designed for higher differential pressure applications.
(4) Scrubber — a device utilizing geometry, physical barriers, and/or absorption methods, along with a fluid (e.g., sprays, streams) to separate and collect gases and/or dusts.
(5) Electrostatic precipitator — a device utilizing differences in electrical charges to remove fine particulates from the air stream.
(6) Final filter — a high-efficiency device commonly utilizing a pre-filter and secondary filter within an enclosure to provide the last particulate removal step before the air is discharged from the system. Such devices are commonly used when recirculating the air stream to occupied areas. This device can provide protection against the failure of a dust collector or filter receiver upstream of the device. A high efficiency particulate air (HEPA) filter is an example.

[**654:** A.3.3.2]

**A.3.3.3 Air-Moving Device (AMD).** Air-moving devices include fans, centrifugal fans, or mixed-flow fans. These devices have previously been called blowers or exhausters. Air-moving devices also include steam ejectors and similar devices. [**91:** A.3.3.2]

**A.3.3.4 Bulk Raw Grain.** Cleaning or drying does not constitute processing.

**A.3.3.5 Centralized Vacuum Cleaning System.** This system normally consists of multiple locations, known as hose connection stations, hard-piped to an air-material separator, using an air-moving device to provide the vacuum and induced air flow. The hoses and vacuum cleaning tools utilized with the system are designed to be static conductive and dissipative in order to minimize any risk of generating an ignition source. Low minimum ignition energy (MIE) materials will require special consideration in the system design and use. A primary separator can also be used if large quantities of materials are involved. However, most secondary AMS units are capable of handling the dusts without the addition of a primary cyclone.

**A.3.3.6 Deflagration.** The primary concern of this document is a deflagration that produces a propagating flame front or pressure increase that can cause personnel injuries or the rupture of process equipment or buildings. Usually these deflagrations are produced when the fuel is suspended in the oxidizing medium. [**654:** A.3.3.8]

**A.3.3.7 Dust Collection System.** A typical dust collection system consists of the following:

(1) Hoods — devices designed to contain, capture, and control the airborne dusts by directing the induced air flow through the fugitive dust.
(2) Ducting — piping, tubing, fabricated duct, and so forth, used to provide the controlled pathway from the hoods to the dust collector (i.e., air-material separator). Maintaining proper duct velocity is a key factor in proper functioning of the system.
(3) Dust collector — an AMS designed to filter the conveyed dusts from the conveying air stream. Typically these devices have automatic methods for cleaning the filters to allow extended use without blinding. In some systems, a scrubber or similar device is used in place of the filter unit.
(4) Fan package — an air-moving device designed to induce air flow through the entire system.

**A.3.3.8 Explosion.** For the purposes of this standard, the term *explosion* is equivalent to the term *deflagration* as identified in NFPA 68, *Standard on Explosion Protection by Deflagration Venting*.

**A.3.3.15 Pneumatic Conveying System.** Generically, pneumatic conveying systems include a wide range of equipment systems utilizing air or other gases to transport solid particles from one point to another. Pneumatic conveying systems typically require a device to meter the material into the conveying system which is significantly different from the function of a dust collection system or central vacuum cleaning system. Pneumatic systems can also convey comparatively large masses of materials when compared to a dust collection system, where the mass of the dust (and resulting energy loss) is not normally considered in the design of the system.

Pneumatic conveying systems present a lower hazard than fugitive dust collectors and centralized vacuum systems. Pneumatic conveying systems allow greater control of the risk factors associated with combustible dusts, such as ignition sources. For this reason, the prescriptive requirements of this standard are different for pneumatic conveying systems.

**A.4.1.2** For information on designing to relieve explosion pressure, see NFPA 68, *Standard on Explosion Protection by Deflagration Venting*.

**A.4.1.4** For the purpose of this standard, masonry construction refers to stone, brick, gypsum, hollow tile, concrete block, and cinder block building units, or other similar building units or materials laid up unit by unit and set in mortar.

**A.4.1.6** Guidance is provided in NFPA 780, *Standard for the Installation of Lightning Protection Systems*, for determining the need for lightning protection.

**A.4.2** The suggested minimum angle of repose of dust is 60 degrees. Vertical surfaces should be smooth to facilitate cleaning. Horizontal surfaces should be minimized to prevent accumulation of dust.

**A.4.5.2** See NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, for information on the design of explosion venting. Situations can occur in which it is not possible to provide calculated deflagration venting as described in NFPA 68, *Standard on Explosion Protection by Deflagration Venting*. Such situations do not justify the exclusion of all venting. The maximum practical amount of venting should be provided, since some venting should reduce the damage potential. In addition, consideration should be given to other protection and prevention methods.

**A.5.2.2** If a vertical vent stack cannot be installed because of structural conditions, the vent should be permitted to be located in the side of the bin, below its top, or should be permitted to be installed at an angle of up to 30 degrees from vertical.

**A.6.1** To better understand the hazards of the operations and how to apply the provisions of this standard to a facility and operations, a hazard analysis can be conducted regarding the deflagration properties of the materials being handled, the equipment used, and the operations. See Table A.6.2.1 or use equivalent test data for deflagration properties of agricultural or food dusts.

It should be noted that the protections described in Chapter 6 might not, in themselves, eliminate explosion or deflagration propagation. Other means, when practicable, such as rotary valves, fast-closing valves, conveyor seals, or chokes can minimize propagation potential. Ultimately, if adequate explosion venting is provided or equipment fails, explosion propagation could still be possible. Additional information on deflagration isolation can be found in NFPA 69, *Standard on Explosion Prevention Systems*, and in the annex material of NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*.

**A.6.2** See NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, for information on the design of explosion venting.

**A.6.2.1** These are locations in which combustible dust is in the air under normal operating conditions in quantities sufficient to produce explosive or ignitible mixtures; or where mechanical failure or abnormal operation of machinery or equipment could cause explosive or ignitible mixtures to be produced, and could also provide a source of ignition through simultaneous failure of electrical equipment, operation of protection devices, or other causes.

Situations can occur in which it is not possible to provide calculated deflagration venting as described in NFPA 68, *Standard on Explosion Protection by Deflagration Venting*. Such situations do not justify the exclusion of all venting. The maximum practical amount of venting should be provided, since some venting should reduce the damage potential. In addition, consideration should be given to other protection and prevention methods.

Table A.6.2.1 contains 20-L sphere test data for selected agricultural dusts with known explosion data parameters to aid in the determination of the potential for a dust explosion hazard to be present in the enclosure.

**Table A.6.2.1 20-L Sphere Test Data — Agricultural Dusts**

| Dust Name | $P_{max}$ (bar g) | (1) $K_{St}$ (bar m/sec) | Percent Moisture | Particle Size (µm) | Minimum Explosive Concentration ($g/m^3$) | Percent Greater Than 200 Mesh |
|---|---|---|---|---|---|---|
| Alfalfa | 6.7 | 94 | 2.1 | 36 | | |
| Apple | 6.7 | 34 | | 155 | 125 | |
| Beet root | 6.1 | 30 | | 108 | 125 | |
| Carrageen | 8.5 | 140 | 3.8 | | | 98 |
| Carrot | 6.9 | 65 | | 29 | | |
| Cocoa bean dust | 7.5 | 152 | | | | |
| Cocoa powder | 7.3 | 128 | | | | |
| Coconut shell dust | 6.8 | 111 | 6.5 | | | 51 |
| Coffee dust | 6.9 | 55 | 4.8 | 321 | | |
| Corn meal | 6.2 | 47 | 8.2 | 403 | | |
| Cornstarch | 7.8 | 163 | 11.2 | | | |
| Cotton | 7.2 | 24 | | 44 | 100 | |
| Cottonseed | 7.7 | 35 | | 245 | 125 | |
| Garlic powder | 8.6 | 164 | | | | |
| Gluten | 7.7 | 110 | | 150 | 125 | |
| Grass dust | 8.0 | 47 | | 200 | 125 | |
| Green coffee | 7.8 | 116 | 5.0 | 45 | | |
| Hops (malted) | 8.2 | 90 | | 490 | | |
| Lemon peel dust | 6.8 | 125 | 9.5 | 38 | | |
| Lemon pulp | 6.7 | 74 | 2.8 | 180 | | |
| Linseed | 6.0 | 17 | | 300 | | |
| Locust bean gum | 7.8 | 78 | 1.7 | | | 53 |
| Malt | 7.5 | 170 | 10.5 | 72 | | |
| Oat flour | 6.4 | 81 | 8.6 | | | |
| Oat grain dust | 6.0 | 14 | | 295 | 750 | |
| Olive pellets | 10.4 | 74 | | | 125 | |
| Onion powder | 9.0 | 157 | | | | |
| Parlsey (dehydrated) | 7.5 | 110 | 5.4 | | 26 | |
| Peach | 8.4 | 81 | | 140 | 60 | |
| Peanut meal and skins | 6.4 | 45 | 3.8 | | | |
| Peat | 8.3 | 51 | | 74 | 125 | |
| Potato | 6.0 | 20 | | 82 | 250 | |
| Potato flour | 9.1 | 69 | | 65 | 125 | |
| Potato starch | 9.4 | 89 | | 32 | | |
| Raw yucca seed dust | 6.2 | 65 | 12.7 | 403 | | |
| Rice dust | 7.7 | 118 | 2.5 | | | 4 |
| Rice flour | 7.4 | 57 | | | 60 | |
| Rice starch | 10.0 | 190 | | 18 | | 90 |
| Rye flour | 8.9 | 79 | | 29 | | |
| Semolina | 7.6 | 79 | | | | 9 |
| Soybean dust | 7.5 | 125 | 2.1 | | | 59 |
| Spice dust | 6.9 | 65 | 10.0 | | | |
| Spice powder | 7.8 | 172 | 10.0 | | | |
| Sugar (10×) | 8.4 | 154 | | | | |
| Sunflower | 7.9 | 44 | | 420 | 125 | |
| Tea | 7.6 | 102 | 6.3 | 77 | 125 | |
| Tobacco blend | 8.8 | 124 | 1.0 | 120 | | |
| Tomato | | | | 200 | 100 | |
| Walnut dust | 8.4 | 174 | 6.0 | | | 31 |
| Wheat flour | 8.3 | 87 | 12.9 | 57 | 60 | 6 |
| Wheat grain dust | 9.3 | 112 | | 80 | 60 | |
| Wheat starch | 9.8 | 132 | | 20 | 60 | |
| Xanthan gum | 7.5 | 61 | 8.6 | 45 | | |

Notes:

(1) Normalized to 1 $m^3$ test vessel pressures, per ASTM E 1226, *Standard Test Method for Explosibility of Dust Clouds.*

(2) See also Table F.1(a) in NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, for additional information on agricultural dusts with known explosion hazards.

(3) For those agricultural dusts without known explosion data, the dust should be tested in accordance with ASTM E 1226, *Standard Test Method for Explosibility of Dust Clouds.*

**A.6.2.2** If an explosion vent recloses after relieving an explosion pressure wave, an implosion can occur.

**A.6.3.3** See NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, for information on determining the appropriate explosion venting area and arrangement. For information on venting bucket elevators, see the National Grain and Feed Association Research report, *Emergency Preplanning and Fire Fighting Manual — A Guide for Grain Elevator Operators and Fire Department Officials*.

**A.7.1.3** Pillow block bearings are preferred for head, tail, and bend pulleys.

**A.7.3** Throwing of grain for a considerable distance (i.e., not confined in spouts) should not be permitted unless absolutely necessary in open or semiconfined spaces, such as in barge and ship loading or in large bulk grain storage areas.

When using enclosed conveying equipment, an evaluation should be conducted to determine if ignition sources might be present and contained by the proposed enclosure. Dust collection should be considered with proper design to assure constant airflow and collection of the dust generated inside the enclosed area or device.

**A.7.3.1** Each bulk material conveyor should be provided with a motion detector device that will cut off the power to the drive motor and actuate an alarm in the event of any slowdown equivalent to, or exceeding, 20 percent. Feed to the bulk material conveyors should be stopped or diverted.

**A.7.3.4** CFR 1910.272(b)(2)(p)(2) requires that belting have a surface electrical resistance not greater than 300 MΩ. Subsection 7.3.4 requires that belting have a surface resistivity not greater than 100 MΩ per square. Surface resistance in ohms and surface resistivity in ohms per square are two different specifications. Surface resistance is a point-to-point measurement. Surface resistivity is a measurement of resistance of a square unit of area and is the same regardless of the size of a material.

There is still much debate on the correct test method to use for each measurement, since it is dependent on a number of variables, including the type of material and its resistivity (how conductive or insulative the material is). This topic needs to be reviewed in much greater detail. Surface resistance and surface resistivity are not the only factors to consider. Volume resistivity should also be considered, along with the conductivity of the pulleys and the total resistance from the belt to ground.

**A.7.3.6** For equipment lined with combustible material (other than spouts), a means should be provided to have access for fire fighting. The use of noncombustible ceramic or steel linings is preferred. If combustible linings are used extensively, it is suggested that a firebreak of noncombustible lining material be used at a grain stream direction change point.

**A.7.3.8** Spout openings in distributors and turnheads should be closed when not in use, to reduce the likelihood of propagation of flame through idle spouts.

**A.7.4.1.2** Access doors should be dusttight. Pits should be lighted and accessible and should provide ample room for cleaning, lubrication, repairs, and replacement of parts. Elevator boot sections and the spouts feeding them should be constructed so as to minimize choking of the boot.

**A.7.4.1.4** Any motor or combination of motors utilized should be no larger than the smallest standard motor(s) capable of meeting this requirement.

**A.7.4.1.5** Belt alignment monitoring devices are recommended for all elevator legs. Bearing monitoring systems are recommended for head, tail, and bend (knee) pulley bearings on elevator legs.

**A.7.4.1.9.1** CFR 1910.272(b)(2)(p)(2) requires that belting have a surface electrical resistance not greater than 300 MΩ. Subsection 7.3.4 requires that belting have a surface resistivity not greater than 100 MΩ per square. Surface resistance in ohms and surface resistivity in ohms per square are two different specifications. Surface resistance is a point-to-point measurement. Surface resistivity is a measurement of resistance of a square unit of area and is the same regardless of the size of the material.

There is still much debate on the correct test method to use for each measurement, since it is dependent on a number of variables, including the type of material and its resistivity (how conductive or insulative the material is). This topic needs to be reviewed in much greater detail. Surface resistance and surface resistivity are not the only factors to consider. Volume resistivity should also be considered, along with the conductivity of the pulleys and the total resistance from the belt to ground.

**A.7.4.1.10** This requirement is also desirable for outside legs. The exemption for 106 $m^3$/hr (3750 $ft^3$/hr) represents a processing rate of 3000 bushels/hr. This exemption is based on reports that low belt speeds with large buckets substantially reduce dust concentrations.

**A.7.4.2.1** Inside legs located in concrete leg wells should be avoided. Where venting is provided for an inside bucket elevator, explosion vents should be directed to outside areas following the guidelines of NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, and distributing leg vents along the leg as recommended. Vents should never be directed to the inside of a structure. It is preferable to locate inside legs that are to be vented next to outside walls, to minimize the length of explosion relief ducts.

Explosion suppression devices can be used in conjunction with leg feed and discharge points to limit flame propagation into structures or other grain-handling equipment.

**A.7.4.2.1(4)** The exemption for 106 $m^3$/hr (3750 $ft^3$/hr) represents a processing rate of 3000 bushels/hr. This exemption is based on reports that low belt speeds with large buckets substantially reduce dust concentrations.

**A.7.4.2.2** Explosion venting is recommended for all outside legs handling grain or grain products, regardless of size or use. All legs handling grain and other combustible materials, not just whole grain legs, are subject to an explosion. The leg is the most frequent location for a primary explosion to occur.

**A.7.4.3.2** For guidance on explosion venting design guidelines, see A.7.4.2.2.

**A.7.4.3.3** The exemption for 106 $m^3$/hr (3750 $ft^3$/hr) represents a processing rate of 3000 bushels/hr. This exemption is based on reports that low belt speeds with large buckets substantially reduce dust concentrations.

**A.7.5.1** Openings of 64 mm × 64 mm (2½ in. × 2½ in.) should be used on grating for receiving pits, to limit entry of foreign objects. Larger openings could be needed to accommodate some materials, such as whole corncobs and hay cubes.

**A.7.5.1.2** Such devices should be installed on hoppers, conveyors, or spouts that handle grain from truck dump pits, railcar dump pits, and barge or ship unloading systems prior to

entry of the grain into subsequent conveyors, elevators, or processing machinery, to minimize the entry of tramp metal and other foreign objects.

**A.7.5.1.3** NFPA 77, *Recommended Practice on Static Electricity*, provides information on this subject.

**A.8.1** Static deposits of combustible dust on heated surfaces are subject to ignition due to carbonization of the dust. Understanding of the mechanism involved is lacking, but it does appear that there is no direct relationship between the temperature necessary to ignite a dust cloud and that necessary to ignite a dust layer. Rather, a time-versus-energy (temperature) relationship appears to be involved. The higher the temperature, the shorter the time needed for carbonization and subsequent ignition.

The energy necessary to ignite a dust cloud has to be great enough to raise the dust particles to their ignition temperature and overcome heat losses to the surrounding air. The energy has to be of sufficient duration to ignite enough adjacent dust particles to sustain propagation of the flame front. A static dust deposit has none of the dynamic motion and heat losses of a dust cloud. Also, the insulating characteristics of organic dusts act to retard the heat loss from particles of dust in intimate contact with the heated surface. Thus, a lower temperature is necessary to establish the time–energy relationship leading to ignition. This behavior, combined with the fact that the ignition temperature of an organic dust is lowered by prolonged heat exposure, gives cause for concern over dust deposits on heated surfaces. The ignition of a dust layer and the subsequent quiescent burning can provide the pilot flame necessary to ignite a dust cloud.

**A.8.1.2** For information on other dryers, see NFPA 86, *Standard for Ovens and Furnaces*.

**A.8.1.3** Spontaneous ignition is a primary cause of dryer fires and explosions. The requisites of this phenomenon are a heated surface or a hot airstream, a layer of product exposed to this heat, and time.

**A.8.2** Typically, a grain dryer is a self-contained unit that processes bulk quantities of an agricultural commodity either by continuous flow or in batch quantities. The dryer is usually located on the plant property, adjacent to the elevator, storage building, or tank. The commodity, either directly from harvest or from interim storage, contains extraneous materials, partly as a result of harvesting, that have a tendency to interfere with the drying process and to contribute to fires within the dryer itself.

**A.8.2.1** Particular attention is needed when adjacent buildings or structures are of combustible construction or have walls with vents, windows, or spout or conveyor openings.

**A.8.2.3.1** The dryer can be direct fuel-fired (i.e., the products of combustion enter the drying chamber) or indirect fuel-fired (i.e., the products of combustion do not enter the drying chamber).

**A.8.2.3.2** Typically, the firing rates of grain dryers are on a demand basis created by a temperature-measuring device located in the heated airstream prior to its contact with grain. The demand set point is chosen to produce the desired degree of dryness or moisture removal.

This control arrangement maintains the air temperature within the upper and lower temperature ranges of the measuring device. If the temperature range is exceeded, the burner firing rate is reduced and, when the temperature drops below the lower range, the burner firing rate is increased.

This control arrangement is satisfactory for most operating conditions, grain moisture content, and ambient temperature conditions. Operators usually recognize that, if the grain is unusually wet, they need to increase the dryer temperature setting and possibly slow down the rate of grain flow through the dryer. It has to be recognized that the burner needs to operate at abnormally high firing rates when the outside temperatures are unusually cold.

**A.8.2.6.3** One or a combination of the following methods, depending on local conditions, should be used:

(1) Fixed water spray or automatic sprinkler systems with adequate water supplies (see NFPA 13, *Standard for the Installation of Sprinkler Systems*, and NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*)
(2) Hose lines, 38 mm (1½ in.), of sufficient length to reach all access openings on the dryer, connected to a 51 mm (2 in.) or larger water supply line (see NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*)
(3) Small-diameter hose lines of sufficient length to reach all access openings on the dryer and supplied by the domestic water system
(4) Fixed water spray or automatic sprinkler systems supplied by a dry standpipe
(5) An adequately designed steam-smothering system
(6) Class A portable fire extinguishers

**A.8.4.2.1** Spontaneous ignition is a primary cause of dryer fires and explosions. The requisites of this phenomenon are a heated surface or a hot airstream, a layer of product exposed to this heat, and time. In the case of starch, a catalyst appears to be water from leaks or condensation. Fires have occurred in such accumulations at normal operating temperatures of 177°C (350°F). Thus, the control of these elements through design, operation, cleaning, and maintenance will prevent explosions from this ignition source.

**A.8.4.2.2** Typical points where spontaneous ignition is likely to occur include the following:

(1) Adjacent to steam coils that are subject to starch accumulation
(2) In tubes or ducts of dryers where starch can accumulate (e.g., in elbows below a vertical run where entrained dust will fall when the fan is shut off, where there is a sharp change of direction from vertical to horizontal, and where there is a marked change to a lower velocity, such as a duct leading into a cyclone)
(3) Near burners to detect carbon buildup

**A.8.4.4.1** Where an outside dryer is provided with adequate explosion venting, fire protection or explosion suppression systems are not always necessary.

**A.8.5** The entire fire-extinguishing system should be completely inspected at least annually. More frequent general inspections are recommended. Regular service contracts with the manufacturer or installing company are recommended.

In the annual inspection, particular attention should be given to the detection and actuation system, containers, piping and nozzles, and auxiliary equipment.

The inspection of detection and actuation system should include the following:

(1) The detectors should be checked (and cleaned if necessary) to ensure that they are free of foreign substances.

(2) If the detection system is supervised, the supervisory features should be checked to determine that the detection system is in satisfactory condition. The methods and procedures for this inspection should be according to the manufacturers' recommendations.

The inspection of containers should include the following:

(1) Containers should be examined for evidence of corrosion or mechanical damage.
(2) Container bracketing, supports, and so forth, should be checked to determine that their condition is satisfactory.

The inspection of piping and nozzles should include the following.

(1) Piping should be examined for any evidence of corrosion.
(2) Pipe hangers or straps, or both, should be examined to see that the piping is securely supported.
(3) Nozzles should be checked to determine that the orifices are clear and unobstructed.
(4) Where nozzle seals are provided, they should be checked for signs of deterioration and replaced if necessary.
(5) Nozzles should be checked for proper position and alignment.

The inspection of auxiliary equipment should include the following:

(1) All auxiliary and supplementary components such as switches, releases, interconnected valves, supplementary alarms, and so forth, should be manually operated (where possible) to ensure that they are in proper operating condition.
(2) All devices should be returned to normal standby condition after testing.

**A.9.1.2.1** Communication between hazardous and heat-producing areas should be arranged so that a fire partition, fire wall, and so forth, with all openings closed is always between the hazard and the heat-producing area. The firebreak could be a nonhazardous room, entryway, airlock, and so forth, arranged so that the communicating opening between the room and the hazardous area will not be open when the communicating opening between the room and heat-producing area is open, and vice versa.

A communicating opening such as machinery doors is permitted, provided that these doors are kept locked and are only opened when either the hazardous area or the heat-producing area is shut down and will not cause a fire or explosion with the machinery door open.

**A.9.1.4** See A.8.1.

**A.10.1** Dust collection systems are designed to handle airborne dust as distinguished from pneumatic conveying for product transport that is covered in Chapter 11.

**A.10.2.1** A relatively small initial dust deflagration can disturb and suspend in air dust that has been allowed to accumulate on the horizontal and vertical surfaces of a building or equipment. This dust cloud provides fuel for the secondary deflagration, which can cause damage. The reduction of significant additional dust accumulations is, therefore, a major factor in reducing the hazard in areas where a dust hazard can exist.

For further information, see NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*. Note that grain and agricultural dusts have a much lower bulk density than the 1201 kg/m$^3$ (75 lb/ft$^3$) used as an example.

**A.10.2.1.1** The housekeeping program should address fugitive agricultural dust accumulations at priority housekeeping areas. Priority housekeeping areas should include at least the following:

(1) Floor areas within 10.7 m (35 ft) of inside bucket elevators
(2) Floors of enclosed areas containing grinding equipment
(3) Floors of enclosed areas containing equipment used to heat, toast, or dry located inside the facility

The facility should immediately remove any fugitive agricultural dust accumulations whenever they exceed 3.2 mm (⅛ in.) at priority housekeeping areas, pursuant to the housekeeping program, or should demonstrate and ensure, through the development and implementation of the housekeeping program, that equivalent protection is provided.

**A.10.2.3** Vacuum cleaning systems are preferred for removal of static dust on surfaces in order to prevent resuspension of the dust in ambient air, as is often caused by brushing down with brooms or using compressed air. Where the surfaces are inaccessible or create a hazard to employees working from stepladders or in hazardous positions while handling vacuum hoses and tools, alternative means should be followed under the conditions specified in 10.2.3. *(See also 10.3.1.)*

**A.10.3.1** Techniques to prevent or reduce dust generation and dispersal are vital to any dust control program. These techniques include the use of reduced handling speeds, dead boxes, choked feeding, snorkel loaders, dusttight enclosures, short vertical runs, cleaning, and dust suppressant, as well as many others. Preventive dust control is encouraged, since it can effectively reduce total dust control costs as well as the demands placed on the performance of subsequent dust control techniques outlined in Sections 10.2 and 10.3.

Various oils and other liquids have been used as a dust suppressant. Each dust suppressant has its limitations and should be used with regard to applicable grain and food standards and regulations. Oil dust suppressants should not be applied directly into the leg, as there have been cases of belt slippage using oil. Application should be made in the transition spout between the receiving pit and the receiving leg. If this is not feasible, application can be made at a transfer point or discharge of a conveying system, or directly on a conveyor belt or into a screw auger. The idea is to apply the dust suppressant where there is grain turbulence, thereby allowing the dust suppressant to mix thoroughly.

**A.10.3.2** Legs are the most frequent location of known primary dust explosions and can experience malfunctions, which can result in ignition of the returned dust.

**A.10.4.3** NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, provides information on this subject.

**A.10.4.7** Dust control in grain or product-receiving areas consists of air aspiration or dust containment during vessel or vehicle unloading. Dust control can be achieved by baffles or enclosures with air aspiration, dust suppression, choked feeding, special belt designs, slowdown techniques, or other methods.

**A.10.4.10** NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, contains guidance on designing explosion vents to relieve deflagrations of combustible dusts in vessels having length-to-diameter ($L/D$) ratios of 3 or less.

Separate storage of dusts within a facility is a greater hazard due to concerns with secondary explosions. The magnitude of an explosion in a dust bin is much greater than that in a grain bin.

The storage of grain dust as an ingredient in feed mill or other processes should be in separate outside bins or in bins that have external walls that are equipped with explosion venting.

**A.10.4.11** Floor sweeps, if used, should be designed and operated according to the provisions of Section 8.2 in NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*.

**A.10.4.12** If the return air duct air–material separator fails, a control system should be provided to direct the return air to an auxiliary filter capable of effectively entraining the dust particles, or to produce an alarm and shut down the system.

**A.10.4.12.1** For bin vents, see 10.4.3, Exception No. 4. Return air ducts should have a method to prevent excessive dust from returning to the plant in the case of filter failure. Methods include, but are not limited to, use of a diverter valve that exhausts return air outside, or a series of secondary filters in the return air line designed to collect the material if part of the filter medium fails.

**A.10.5.1** NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*, is referenced in order to avoid extracting large amounts of text related to basic duct design. The amendments required by this chapter make the ducts acceptable for combustible dust applications.

**A.10.5.1.2** High-impact areas can include elbows and joints where changes of direction occur. The use of noncombustible ceramic or steel linings is preferred.

**A.11.1** Pneumatic conveying for product transport is to be distinguished from dust collection systems that are designed to handle airborne dust. Such airborne dust systems can be used in conjunction with pneumatic conveying and are covered in Chapter 10. Other gases used in this process include carbon dioxide and nitrogen. See Annex E for installation schematics depicting typical pneumatic conveying installation concepts.

**A.11.2.1** For guidance on static electricity, see NFPA 77, *Recommended Practice on Static Electricity*.

**A.11.4.3** If the return air duct air–material separator fails, a control system should be provided to direct the return air to an auxiliary filter capable of effectively entraining the dust particles, or to produce an alarm and shut down the system.

**A.11.4.3.1** For bin vents, see 10.4.3, Exception No. 4.

**A.11.4.3.3** Filters used for air from negative mill pneumatics using cyclones for product separation should be permitted to be located inside of buildings without explosion venting. Clean air should be partially returned to the air makeup system. See the flow diagram in Figure A.11.4.3.3.

**A.11.4.3.4** Filters used for hammermills should be equipped with explosion venting. Clean air should not be returned to the air makeup system. See the flow diagram in Figure A.11.4.3.4.

**A.11.4.3.5** Filters used for product purifiers should be permitted to be located inside of buildings without explosion venting. All clean air should be returned to the air makeup system. See the flow diagram in Figure A.11.4.3.5.

**A.11.5.1** See NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*.

**A.12.1** Caution should be exercised in the selection of extinguishers for use on dusts; extinguishers with a high-pressure

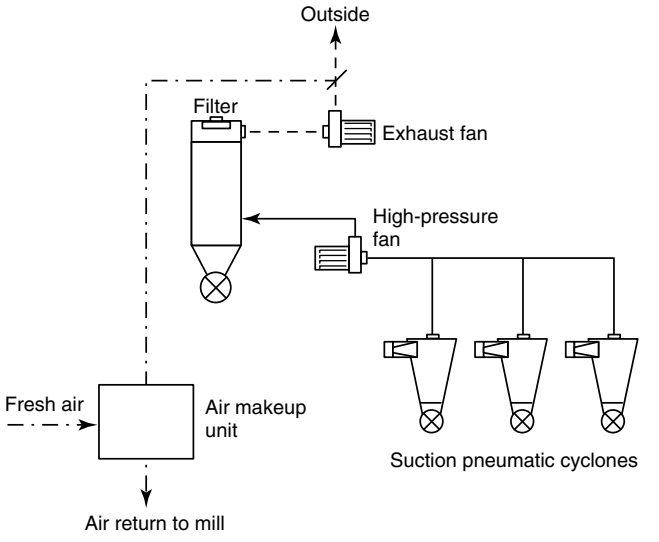


**FIGURE A.11.4.3.3 Flow Diagram of Typical Pneumatic Filter Cyclone.**

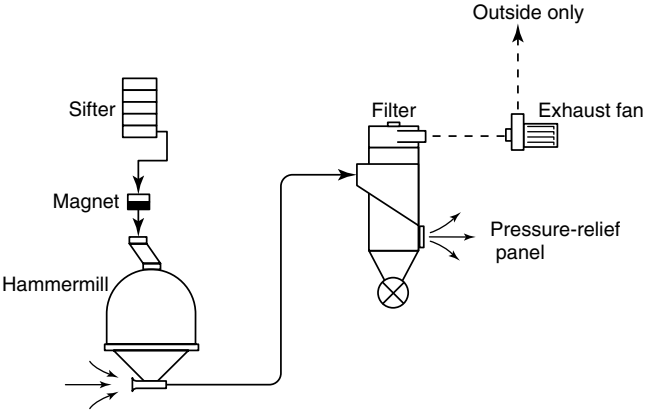


**FIGURE A.11.4.3.4 Flow Diagram of Typical Hammermill Filter.**

discharge could raise additional dust, resulting in further combustion or an explosion. See Annex B for supplementary information on fire protection.

**A.12.4.2** An operating area is an area where personnel can be present to perform operational or maintenance tasks.

**A.12.4.3** Examples of combustible contents are finished products and raw material in paper or cloth bags, cardboard boxes or containers, wood pallet storage, and packing material storage.

**A.12.6.2** The following are incipient fire-fighting techniques for agricultural dust fires:

(1) *Leg Fires.* Material flow into a leg should be stopped and the leg should be shut down. Leg fires should be extinguished by water fog or gentle application of water. Fires should be located by feeling the leg casing for heat or observing discoloration of metal. If the location is unknown, water should be applied first in the boot section, then in the bin-pulley access door, and last in the head section.

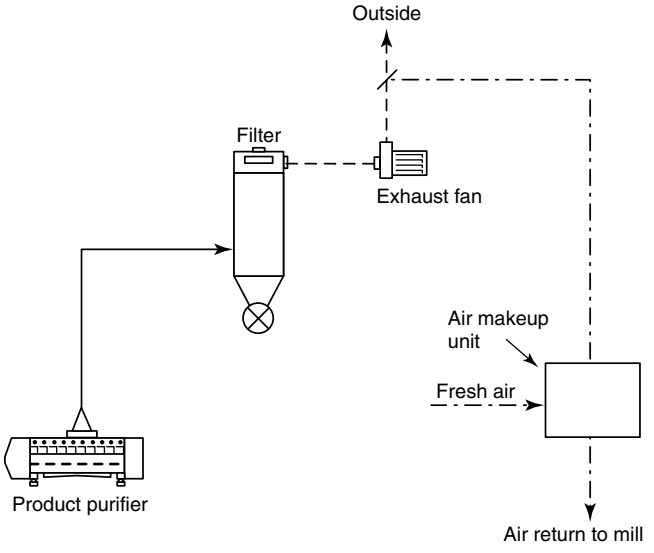


**FIGURE A.11.4.3.5 Flow Diagram of Typical Product Purifier.**

(2) *Conveyor Belt Fires.* Conveyor belt fires should be extinguished by application of water. Material flow to the conveyor belt should be stopped. If necessary, the belt should be cut to isolate the fire.
(3) *Dryer Fires.* Dryer fires should be extinguished by removing burning material from the dryer or gentle application of water. Fuel to burners, fans, and material flow into the dryer and from the facility should be stopped. If necessary, emergency dump should be used to remove material from the dryer.
(4) *Concrete Bin or Silo and Steel Tank Fires.* Concrete bin or silo fires should be extinguished by removing burning material from the bin or silo directly to the outside after wetting the top surface of the material with gentle application of water at a low flow rate directly to the burning materials. Water fog should be applied to walls and to the underside of the roof to reduce airborne dust. Fire should be located by thermometer probes, thermographic photography, or feeling heat on bin or silo surfaces. Openings to the bin or silo should be sealed to limit oxygen entry. Material flow to and from the bin or silo should be stopped. Fire-fighting operations should be done from outside the bin or silo. Fires should be isolated by selective unloading of material near the fire in a steel tank.
(5) *Fumigant or Chemical Fires.* Fires involving fumigants containing phosphine should be extinguished by inert material or nonaqueous agent used for Class B fires. Water should not be used for phosphine fires to avoid exothermic reaction and development of explosive gases.
(6) *Water Gas Reaction.* Application of small amounts of water on glowing grain in a partially confined space, such as a grain silo, and in the presence of air can generate a water gas reaction. The glowing grain must be at temperatures of at least 700°C to 800°C (1290°F to 1470°F), and initial water contact may not cool the mass of glowing grain below 600°C (1110°F).

The partial oxidation reduction between carbon and water forms carbon monoxide and hydrogen as follows:

$$C + H_2O \rightarrow CO + H_2$$

In the presence of oxygen (air), the carbon monoxide and hydrogen burn, immediately releasing heat as follows:

$$C + H_2O + O_2 \rightarrow CO_2 + H_2O + 19{,}440\ J/g\ (8350\ Btu/lb)$$

In a partially confined space, the combustion energy will rapidly pressurize the space beyond what the silo walls or tops can withstand, causing destruction of the silo.

**A.13.2.2** NFPA 499, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, contains guidelines for determining whether an area should be categorized as a Class II area.

**A.13.3.1** OSHA 29 CFR 1910.272 also establishes requirements for hot work in grain-handling operations.

**A.13.3.3.1** See the permit form example in Appendix A of NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work.*

**A.13.4** NFPA 77, *Recommended Practice on Static Electricity*, provides information on this subject. For information about using flexible intermediate bulk containers, see Section 9.3.4 of NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids.*

**A.13.5.2** Refer to the following publications for further information:

(1) ANSI/UL 558, *Standard for Internal Combustion Engine-Powered Industrial Trucks*
(2) ANSI/UL 583, *Standard for Electric-Battery-Powered Industrial Trucks*
(3) ANSI B56.1, *Safety Standard for Low Lift and High Lift Trucks*

**A.13.5.4** Exterior docks should open at least on one side, and exterior platform areas should be considered to meet the "outdoor" provision.

**A.13.5.5** Cleaning should be done at 4-hour intervals during periods of steady operation and at the end of each workday.

**A.13.6** "NO SMOKING" signs should be posted.

**A.13.8** Topics on the outside contractor checklist should include, but should not be limited to, the following:

(1) Hot work permits
(2) Facility smoking regulations
(3) Restriction of alcohol, drugs, weapons, and so forth, on the premises
(4) Vehicle traffic control in plant (i.e., restricted areas, plant traffic pattern, railroad traffic), railroad car switching procedure, warning system, and restrictions on crossing tracks
(5) Restricted access to nonworking areas and areas where additional safety instruction should be received before contractor is authorized to enter
(6) Authorization before the cutting of any processing lines or the opening or closing of any valve
(7) Shutdown of operating equipment by contractor
(8) Replacement of guards before restarting the equipment
(9) Housekeeping and sanitation responsibilities and requirements for end-of-day cleanup by contractor
(10) Accident reporting requirements (personnel injury and property damage)

(11) Use and restrictions of passenger elevators and lifts
(12) Familiarization with plant emergency organization and actions to be taken by contractor in an emergency situation
(13) Familiarization and instruction in use of all pertinent procedures
(14) Restricted use of tools and equipment by contractor
(15) Use of protective equipment by contractor personnel
(16) Use and storage of hazardous or flammable materials
(17) Use and storage of acetylene and oxygen cylinders

## Annex B Supplementary Information on Fire Protection

*This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.*

**B.1 Automatic Sprinklers.** All areas containing combustible materials, except bulk storage tanks and bins, should be protected by suitable automatic sprinkler systems installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems,* and NFPA 1, *Fire Code.*

**B.2 Supervisory Services.** For prompt detection of fires, either security service, an automatic fire detection system, or sprinkler waterflow and supervisory service should be provided. If security service is provided, routing and recording apparatus should meet the requirements of NFPA 601, *Standard for Security Services in Fire Loss Prevention.* Automatic fire detection systems to actuate local alarms or other suitable arrangements for automatically notifying the fire department should meet the applicable requirements of *NFPA 72, National Fire Alarm and Signaling Code.*

**B.3 Hydrants.** Either public or private hydrants should be provided for fire-fighting use. Hydrants should be fed by an adequate water supply.

**B.4 Explosion Suppression.** Explosion suppression systems designed for instantaneous detection and suppression of explosions are available for use in confined areas such as bins, tanks, dust collectors, and so forth. The use of such systems should be considered in unusually hazardous areas where other means of hazard control are not suitable. Such systems should meet the requirements of NFPA 69, *Standard on Explosion Prevention Systems.*

**B.5 Fire-Fighting Operations.** Hose streams should be used with great care to avoid creating dust clouds or causing structural damage to bins. Fog nozzles should be used.

**B.6 Manual Fire Suppression.** Those individuals responsible for manual fire suppression at these types of facilities should have a fire protection plan. This plan should meet the recommendations contained in the National Grain and Feed Association Research Report, *Emergency Preplanning and Fire Fighting Manual — A Guide for Grain Elevator Operators and Fire Department Officials.*

## Annex C Supplementary Information on Fumigation

*This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.*

**C.1 Definitions.**

**C.1.1** Fumigants as used in this annex are substances or mixtures that rapidly or progressively produce gases or vapors to control identified insects or other pests. Carbon dioxide and heat treatment and the use of diatomaceous earth are not included in this definition.

**C.1.2** Pesticides, herbicides, and rodenticides are not considered to be fumigants. See NFPA 400, *Hazardous Materials Code,* for information on storage of pesticides.

**C.1.3** Fumigation is a process whereby commodities stored in a space, or the space itself, are subjected to the vapors, fumes, or gases produced by or from fumigants.

**C.2 Regulatory Usage.**

**C.2.1** Fumigants should not be used in any manner inconsistent with the registered label or labeling.

**C.2.2** The manner in which fumigants are sold, used, applied, stored, shipped, or otherwise handled, including disposal procedures, and the manner in which fumigations are conducted, are governed directly by the language of the label or labeling under which a fumigant is registered with the U.S. Environmental Protection Agency's Pesticide Registration Division, located in Washington, DC. It is a violation of federal law for any pesticide, including those registered as fumigants, to be used in any manner inconsistent with the registered label or labeling.

**C.3 Fire and Explosion Prevention and Protection.**

**C.3.1** A thorough cleanup should be made, and all refuse, oily waste, and other combustible material, except that needing fumigation, should be removed from the area to be fumigated prior to the sealing of the premises.

**C.3.2** All fire protection equipment such as sprinklers, alarms, and fire pumps should remain in operating condition during fumigation.

**C.3.3** While the space is being sealed and during the fumigation and ventilation period, the use of matches, smoking materials, fires, and open flames, including flame-powered fumigant gas detection devices and any similar source of ignition, should be prohibited.

**C.3.4** If it is necessary to heat the enclosure being fumigated during the fumigation, only enclosed steam or hot water systems should be used. The boiler thermostats should be effectively sealed off from the area being fumigated.

**C.3.5** When buildings or other enclosures in which electric-powered equipment is located are being fumigated, all switches controlling electric power to the portion of the building being fumigated should be locked in the open position or all current-carrying conductors disconnected prior to fumigation. Electrical equipment that is explosionproof or rated for the area need not be locked out prior to and during fumigation.

**C.3.6** Temporary remote control power leads with control switches located outside the fumigated space should be installed for powering circulating fans in the fumigated space. Such fans should be approved for the intended use.

**C.3.7** Control valves for gas, oil, or other fuel systems, if in the area of fumigation, should be closed prior to the beginning of the fumigation operation.

**C.4 Storage and Handling.**

**C.4.1** Fumigants, whether packaged in cartons, drums, bulk tanks, or other containers, should be stored in locked, dry, well-ventilated, enclosed areas.

**C.4.2** Fire hazards as well as life and health hazards are caused by the misuse of fumigants. Direct contact of metal

phosphide fumigants with water, acids, or many other liquids can cause rapid generation of hydrogen phosphide and a fire. Piling of tablets, pellets, prepacked ropes, or dust from their fragmentation can cause a temperature increase and confine the release of gas so that ignition could occur.

**C.4.3** Fumigant storage areas should be properly posted to indicate the hazardous nature of the material being stored.

**C.4.4** When fumigants are being handled, smoking, matches, open flames, or other sources of ignition should be prohibited in the vicinity of such handling. Metal phosphide fumigant containers should be opened outside or near well-ventilated areas and should be protected from water exposure. These containers should not be opened in a hazardous atmosphere.

**C.4.5** Metal phosphide fumigants can react with water. Therefore, fumigation using metal phosphides should be avoided in wet grain. Containers of metal phosphide fumigants should be opened in open air because, under certain conditions, they can flash upon opening.

**C.4.6** When fumigants are transferred from storage areas to the area of application, to commodities, or for space fumigation, only a quantity sufficient for a reasonable period of need should be moved. Unused fumigants should be returned to storage or disposed of as directed on the label.

**C.5 Hazard Warning.**

**C.5.1** All areas where fumigants are stored should be posted, utilizing warning placards in accordance with NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*.

**C.5.2** It is preferable that fumigant storage areas be located in a secured, detached outside building of noncombustible construction.

**C.5.3** All areas where fumigants are in use should be placarded according to the fumigant label.

## Annex D Employee Health and Safety

*This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.*

**D.1 Recognition.** Employee health and safety in operations depends on the recognition of actual or potential hazards, controlling or eliminating these hazards, and training employees to work safely.

**D.2 Guidelines.** The following guidelines are recommended for the recognition, evaluation, and control of actual or potential hazards.

**D.2.1** Training programs should be instituted to properly inform employees about the hazards involved in starch plants, with emphasis on the following areas:

(1) Fire and dust explosion hazards
(2) Sources of ignition and their control
(3) Confined spaces and bin entry and cleaning
(4) Fumigation
(5) Housekeeping
(6) Fire protection equipment

**D.2.2** Emergency procedures to be followed in case of fire or explosion should be established. All employees should be thoroughly indoctrinated in these procedures.

**D.2.3** Procedures should be established for the recognition and control of employee exposure to air contaminants.

**D.2.4** Procedures should be established for locking out equipment under any conditions where startup of such equipment could subject employees to a hazardous situation.

**D.2.5** The work area should be maintained in as clean, orderly, and sanitary a manner as working conditions allow.

**D.2.6** Personal protective equipment should be required for each employee wherever bodily injury or health hazard is a possibility.

## Annex E Schematics of Typical Pneumatic Conveying Installations

*This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.*

**E.1 Installation Schematics.** Figure E.1(a) through Figure E.1(i) show typical transfer systems.

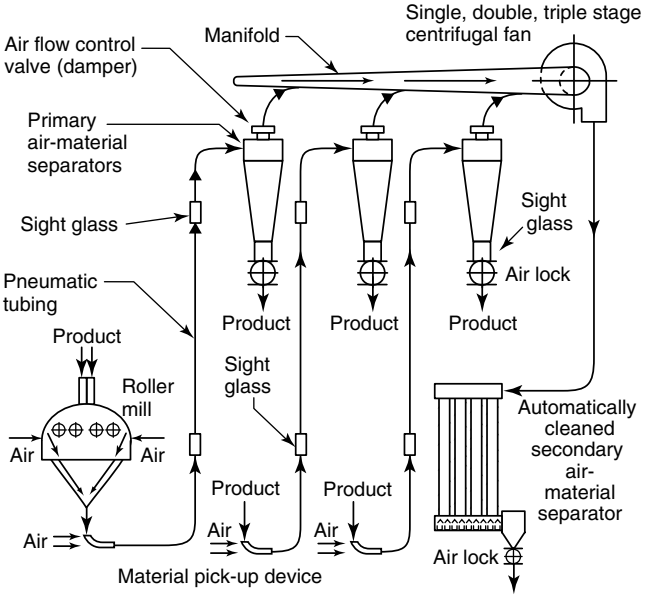


**FIGURE E.1(a) Multiple Strand System, Negative Pressure Type, Typical for Cereal Mills.**