

NFPA®

664

Standard for the
Prevention of Fires
and Explosions in Wood Processing
and Woodworking Facilities

2020



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NFPA® 664

Standard for the

Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities

2020 Edition

This edition of NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, was prepared by the Technical Committee on Wood and Cellulosic Materials Processing and released by the Correlating Committee on Combustible Dusts. It was issued by the Standards Council on November 4, 2019, with an effective date of November 24, 2019, and supersedes all previous editions.

This edition of NFPA 664 was approved as an American National Standard on November 24, 2019.

Origin and Development of NFPA 664

NFPA activity in the field of wood dust explosion hazards dates back to 1930, when work on *Code on Wood Flour Manufacturing* (No. 662) was initiated. The first edition was adopted in 1931, and subsequent editions were issued in 1940, 1942, 1946, and 1949. A separate code on *Woodworking Plants* (No. 663) was added in 1934 and reissued in 1952 and 1959. In 1960, the two codes were combined into a new one, *Code for the Prevention of Dust Explosions in Woodworking and Wood Flour Manufacturing Plants* (No. 664), and revised editions were adopted in 1962, 1971, 1981, 1987, 1993, and 1998.

In the 2002 edition, NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, was expanded to include all the fire hazards associated with wood processing facilities (the occupancy), not just the dust (the commodity). The scope was modified to exclude very small facilities that represented substantially smaller perceived risk based on explicit facility area and flow rate criteria. The standard was also revised to allow a performance-based design approach as an alternative to the prescriptive design criteria itemized in the standard. The section on dust collectors was revised to permit the use of enclosureless dust collectors, based upon specific design criteria. The standard was also modified to comply with the updated *Manual of Style for NFPA Technical Committee Documents*.

The 2007 edition was modified to include requirements for a formal documented hazard analysis as the basis for the applicability of the prescriptive design criteria in the standard. Additional requirements were added for what is required of a designer who elects to use performance-based design methods and to bring these requirements into conformance with the performance-based design requirements in NFPA 101®, *Life Safety Code*®. Advisory material was added regarding choices for placement of an abort gate with respect to the dust collector.

The 2012 edition was modified to include a new definition of *deflagration hazard* in Chapter 3. A new methodology for the determination of a deflagration hazard using settled bulk density to determine an allowable thickness for combustible wood dust accumulations was added to Chapter 4. Detailed instructions on how to collect the dust sample for the new methodology were added to Annex A. In addition, the existing definition of *enclosureless dust collector* was revised, along with the definitions for *deflagrable wood dust*, *dry nondeflagrable wood dust*, and *floor sweep* to coincide with the requirements in the standards that use those terms.

A new section containing requirements for hazard determination was added to Chapter 8, including the use of access doors for inspection of and fire department access to ductwork. Existing requirements for use of explosion protection systems and deflagration venting on metal ducts located both indoors and outdoors were revised in Chapter 8.

The existing maximum explosible concentration (MEC) percentage for wood dust was revised from 75 percent to 25 percent for fans, blowers, and air-moving devices, to be consistent with NFPA 69, *Standard on Explosion Prevention Systems*. In addition, the requirements for dust collectors with deflagration hazards to be equipped with a deflagration suppression system were revised to be consistent with NFPA 69, and the requirements for deflagration relief vents on dust collectors were revised to be consistent with NFPA 68, *Standard on Explosion Protection by Deflagration Venting*. The requirements for recycling of air-material separator exhaust into buildings were revised. New material on control system design for solid fueled burners was added to Annex A.

The 2017 edition contained changes designed to begin alignment with the newly issued NFPA 652, *Standard on the Fundamentals of Combustible Dust*. Definitions used within the standard were aligned with those in NFPA 652. The objectives in Chapter 4 were updated to align with those of the other industry and commodity-specific combustible dust standards, including NFPA 652. The scope of the standard was clarified to indicate that it includes carpentry shops that exceed certain size thresholds in addition to other types of woodworking and wood processing facilities. Exemption language was modified to meet *Manual of Style for NFPA Technical Committee Documents* requirements.

The 2020 edition continues the work to align NFPA 664 with NFPA 652. All of the chapters have been reorganized to match the layout of NFPA 652. The definitions for deflagrable wood dust and dry nondeflagrable wood dust were revised along with the requirements for assessing hazards based on particle size and moisture content. Conducting a documented risk assessment has been added to the standard as a compliance option, and requirements for damage-limiting construction have been revised to refer to resources where a complete treatment is specified. Surface temperature requirements now depend on the dust surface ignition temperature or the dust-cloud ignition temperature of the material present, rather than having one maximum temperature for all processes. A revision to requirements for blowdown align with NFPA 652 and Occupational Safety and Health Administration (OSHA) requirements for personnel safety.

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

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Committee Scope: This Committee shall have primary responsibility for documents on the prevention, control, and extinguishment of fires and explosions in wood processing, woodworking facilities, and facilities that use other cellulosic materials as a substitute or additive for wood.

Contents

Chapter 1 Administration	664- 6	8.11 Incident Investigation.	664- 16
1.1 Scope.	664- 6	8.12 Management of Change.	664- 16
1.2 Purpose.	664- 6	8.13 Record Retention.	664- 16
1.3 Application.	664- 6		
1.4 Conflicts.	664- 6	Chapter 9 Hazard Management: Mitigation and Prevention	664- 16
1.5 Retroactivity.	664- 6	9.1 Inherently Safe Designs. (Reserved)	664- 16
1.6 Equivalency.	664- 6	9.2 Building Design.	664- 16
1.7 Units and Formulas.	664- 6	9.3 Equipment Design.	664- 18
		9.4 Ignition Source Control.	664- 22
Chapter 2 Referenced Publications	664- 7	9.5 Reserved.	664- 24
2.1 General.	664- 7	9.6 Dust Control.	664- 24
2.2 NFPA Publications.	664- 7	9.7 Explosion Prevention/Protection.	664- 24
2.3 Other Publications.	664- 7	9.8 Fire Protection.	664- 25
2.4 References for Extracts in Mandatory Sections.	664- 8		
		Chapter 10 Thermal Oil Heating Systems	664- 25
Chapter 3 Definitions	664- 8	10.1 Hazard Determination and Design Criteria.	664- 25
3.1 General.	664- 8	10.2 General Criteria.	664- 26
3.2 NFPA Official Definitions.	664- 8	10.3 Location and Construction.	664- 26
3.3 General Definitions.	664- 8	10.4 Heaters.	664- 26
		10.5 Piping.	664- 26
Chapter 4 General Requirements	664- 9	10.6 Expansion Tank.	664- 27
4.1 General.	664- 9	10.7 Storage Tanks.	664- 27
4.2 Objectives.	664- 10	10.8 Safety Controls and Interlocks.	664- 27
4.3 Compliance Options.	664- 10	10.9 Fuel Burner Controls and Interlocks.	664- 27
		10.10 Operational Considerations.	664- 28
Chapter 5 Hazard Identification	664- 10	10.11 Fire Protection.	664- 28
5.1 Hazard Identification.	664- 10		
		Chapter 11 Storage	664- 28
Chapter 6 Performance-Based Design Option	664- 11	11.1 General.	664- 28
6.1 General Requirements.	664- 11	11.2 Indoor Dry, Fine Particulate Storage.	664- 28
6.2 Risk Component and Acceptability. (Reserved)	664- 11	11.3 Wood Scrap or Wood Waste Processing and Disposal.	664- 28
6.3 Performance Criteria.	664- 11		
6.4 Design Scenarios.	664- 12	Chapter 12 Special Considerations (Reserved)	664- 28
6.5 Evaluation of Proposed Design.	664- 12		
6.6 Safety Factors.	664- 13	Annex A Explanatory Material	664- 29
		Annex B Explosion Protection	664- 57
Chapter 7 Hazards Analysis	664- 13	Annex C Informational Primer on Spark Detection and Extinguishing Systems	664- 61
7.1 Hazards Analysis.	664- 13	Annex D Conveying System Isolation	664- 64
		Annex E Automatic Water Spray Deluge Protection for Dryer Systems	664- 69
Chapter 8 Management Systems	664- 13	Annex F Informational References	664- 73
8.1 Retroactivity.	664- 13	Index	664- 75
8.2 General. (Reserved)	664- 13		
8.3 Operating Procedures and Practices.	664- 13		
8.4 Housekeeping.	664- 13		
8.5 Hot Work.	664- 14		
8.6 Personal Protective Equipment.	664- 14		
8.7 Inspection, Testing, and Maintenance.	664- 14		
8.8 Training and Hazard Awareness.	664- 15		
8.9 Contractors.	664- 15		
8.10 Emergency Planning and Response.	664- 16		

NFPA 664

Standard for the

Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities

2020 Edition

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

Chapter 1 Administration

1.1 Scope. This standard provides the minimum requirements for fire and explosion prevention and protection of industrial, commercial, or institutional facilities that process wood or manufacture wood products using wood or other cellulosic fiber as a substitute for or an additive to wood fiber, and facilities that process wood, creating wood chips, particles, or dust.

1.1.1 Woodworking and wood processing facilities shall include, but are not limited to, wood flour plants, industrial woodworking plants, furniture plants, plywood plants, composite board plants, lumber mills, production-type woodworking shops, and carpentry shops.

1.1.2* The requirements contained in Chapters 4, 5, 6, and 7; Sections 8.1 through 8.3; Chapter 9, with the exception of 9.3.11, 9.4.16, and Section 9.6; and Chapters 10 and 11 shall not apply to woodworking operations that occupy areas smaller

than 465 m² (5000 ft²), and where dust-producing equipment requires an aggregate dust collection flow rate less than 2549 m³/hr (1500 ft³/min).

1.2 Purpose. The purpose of this standard shall be to provide minimum requirements, with due function, for the design, operation, and maintenance of woodworking and wood processing facilities for the safety to life, property protection, and mission continuity from fire and explosion.

1.3 Application.

1.3.1 This standard shall be applied to new facilities and to new processes within existing facilities.

1.3.2 This standard shall be used to supplement the requirements established by NFPA 652.

1.4 Conflicts.

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

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

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

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

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

1.5.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

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

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

1.6.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

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

1.7 Units and Formulas.

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

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

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

Chapter 2 Referenced Publications

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

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

- NFPA 10, *Standard for Portable Fire Extinguishers*, 2018 edition.
- NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2016 edition.
- NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2018 edition.
- NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2019 edition.
- NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2019 edition.
- NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2017 edition.
- NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2017 edition.
- NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2019 edition.
- NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2018 edition.
- NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2019 edition.
- NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2020 edition.
- NFPA 30, *Flammable and Combustible Liquids Code*, 2018 edition.
- NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, 2020 edition.
- NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, 2018 edition.
- NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids*, 2018 edition.
- NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2019 edition.
- NFPA 54, *National Fuel Gas Code*, 2018 edition.
- NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2018 edition.
- NFPA 69, *Standard on Explosion Prevention Systems*, 2019 edition.
- NFPA 70®, *National Electrical Code®*, 2020 edition.
- NFPA 72®, *National Fire Alarm and Signaling Code®*, 2019 edition.
- NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2019 edition.
- NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment*, 2019 edition.

NFPA 85, *Boiler and Combustion Systems Hazards Code*, 2019 edition.

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

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

NFPA 204, *Standard for Smoke and Heat Venting*, 2018 edition.

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

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

NFPA 600, *Standard on Facility Fire Brigades*, 2020 edition.

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

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

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

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

NFPA 1600®, *Standard on Continuity, Emergency, and Crisis Management*, 2019 edition.

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

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

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

2.3 Other Publications.

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

ANSI/ASME B31.1, *Power Piping*, 2016.

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

Boiler and Pressure Vessel Code, 2017.

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

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

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

ASTM E1591, *Standard Guide for Obtaining Data for Deterministic Fire Models*, 2013.

2.3.3 US Government Publications. US Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

Title 29, Code of Federal Regulations, 1910.242(b), "Compressed Air Used for Cleaning."

2.3.4 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

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

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

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

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

3.3 General Definitions.

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

3.3.2 Combustion Chamber. Enclosure where the combustion takes place and the fuel energy is liberated in the form of heat.

3.3.3 Compartment. A subdivision of an enclosure. [652, 2019]

3.3.4 Cyclone. See 3.3.12.1.

3.3.5* Damage-Limiting Construction. A building construction method that incorporates exterior wall or roof sections, or both, designed to relieve deflagration pressures without jeopardizing the structural integrity of the building and without allowing the deflagration to propagate into adjacent interior spaces.

3.3.6 Deflagrable Wood Dust. See 3.3.32.1.

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

3.3.8* Deflagration Hazard. A hazard determined to exist where either of the two following conditions is present: (1) deflagrable wood dust is present as a layer on upward facing surfaces at a depth greater than that permitted in Section 4.1.3 or (2) deflagrable wood dust is suspended in the air at a concentration in excess of 25 percent of the MEC under normal operating conditions.

3.3.9 Detachment. Location in a separate building or an outside area removed from other structures to be protected by a distance as required by this standard. [652, 2019]

3.3.10 Dry Nondeflagrable Wood Dust. See 3.3.32.2.

3.3.11* Dust Collection Systems. A pneumatic conveying system that is specifically designed to capture dust and wood particulates at the point of generation, usually from multiple sources, and to convey the particulates to a point of consolidation.

3.3.12 Dust Collector An AMS used to separate the material from the air stream, including, but not limited to, cyclones, filter media type (baghouse), and enclosureless units.

3.3.12.1* Cyclone. A cylindrical type of dust collector used to separate particulates from the air stream by centrifugal force, having an enclosure of circular cross-section, a tangential air and material inlet, an air exhaust outlet, and a material discharge.

3.3.12.2 Enclosureless AMS. An AMS designed to separate the conveying air from the material being conveyed where the filter media is not enclosed or in a container.

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

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

3.3.15 Explosion Hazard. An enclosure of any type, including but not limited to silos, dust collectors, enclosed conveyors,

bins, bunkers, rooms, and buildings where a deflagration hazard exists.

3.3.16 Floor Sweep. A suction hood located on the floor with an opening to allow floor sweepings to enter the dust collection system.

3.3.17 Green Material. Wood particulate that has an average moisture content equal to or greater than 25 percent by weight (wet basis).

3.3.18 Hog (Wood Hog). A machine used to grind or reduce the size of wood, other feed stock, or scrap wood.

3.3.19 Kiln Dryers. Large heated rooms or enclosures intended to reduce or control the moisture content of lumber and hardboard products.

Δ **3.3.20* Minimum Explosible Concentration (MEC).** The minimum concentration of a combustible dust suspended in air, measured in mass per unit volume, that will support a deflagration. [652, 2019]

3.3.21* Moisture Content (Wet Basis). The maximum percentage of water that can be driven off a sample through drying as a percentage of the original sample weight.

3.3.22 Nonvaporizing Thermal Oil Heating System. See 3.3.27.1.

Δ **3.3.23 Pneumatic Conveying System.** An equipment system that transfers a controlled flow of solid particulate material from one location to another using air or other gases as the conveying medium, and that is comprised of the following components: a material feeding device; an enclosed ductwork, piping, or tubing network; an air-material separator; and an air-moving device [652, 2019]

3.3.24 Segregation. A hazard management strategy in which a physical barrier is established between the hazard area and an area to be protected. [652, 2019]

3.3.25 Separation. A hazard management strategy achieved by the establishment of a distance as required by the standard between the combustible particulate solid process and other operations that are in the same room. [652, 2019]

3.3.26 Stuck Lumber. Lumber storage piles with 2.5 cm (1 in.) runners perpendicular to the storage at every level.

3.3.27 Thermal Oil Heating System. A thermal oil heating system is a closed loop circulating system that heats a flammable or combustible fluid and transports it to utilization equipment for the purpose of transferring its heat to the equipment.

3.3.27.1 Nonvaporizing Thermal Oil Heating System. A thermal oil heating system that is designed to operate with the heated oil below its atmospheric boiling point.

3.3.27.2 Vaporizing Thermal Oil Heating System. A thermal oil heating system that is designed to heat the oil above its atmospheric boiling point as it passes through the heater.

3.3.28 Thermal Oil Used as Heat Transfer Fluid. An organic or synthetic fluid that is flammable or combustible and that is used as a medium to transfer heat energy from a heater or vaporizer to a remote heat consumer.

3.3.29 Vaporizing Thermal Oil Heating System. See 3.3.27.2.

3.3.30 Wood. The cellulosic material derived from trees, and other cellulosic materials including, but not limited to, wheat straw, flax, bagasse, coconut shells, corn stalks, hemp, rice hulls, and paper or other cellulosic fiber used as a substitute or additive to wood.

3.3.31 Wood-Derived Materials. These materials include but are not limited to sawdust, sanderdust, planer shavings, hoggings, wood flour, and moulder waste.

3.3.32 Wood Dust.

Δ **3.3.32.1* Deflagrable Wood Dust.** Wood particulate that will propagate a deflagration flame front, when suspended in air, or the process-specific oxidizing medium, in sufficient concentration, thus presenting a deflagration hazard.

Δ **3.3.32.2 Dry Nondeflagrable Wood Dust.** Wood particulate having a moisture content of less than 25 percent (wet basis) and a particle size that will not propagate deflagration.

Chapter 4 General Requirements

4.1 General.

4.1.1 Goal. The goal of this standard shall be to provide for a woodworking and wood processing facility that is reasonably protected from fire or deflagration in a cost-effective manner.

4.1.2 Owner's Obligation. The facility owner/operator shall be responsible for implementing the requirements of this standard.

4.1.3 Building Compartment Deflagration Hazard.

Δ **4.1.3.1*** A deflagration hazard shall be deemed to exist in a building compartment when the layer of accumulated fugitive deflagrable wood dust averaged over all upward-facing surfaces in the building compartment exceeds 3.2 mm (1/8 in.) in thickness.

• **4.1.3.2** A deflagration hazard shall be determined to exist unless otherwise determined by a dust hazard analysis, as described in Chapter 7. For additional information, see Chapter 7 of NFPA 652.

4.1.3.3* The layer thickness criterion in 4.1.3.1 shall be permitted to be corrected for dusts having a settled bulk density other than 320 kg/m³ (20 lb/ft³) using the following formula:

For SI units:

[4.1.3.3a]

$$T = \frac{(3.2 \text{ mm})(320 \text{ kg/m}^3)}{(\text{Settled Bulk Density, kg/m}^3)}$$

where:

T = The allowable thickness (mm)

For US customary units:

$$\Delta \quad [4.1.3.3b] \quad T = \frac{(0.125 \text{ in.})(20 \text{ lb/ft}^3)}{(\text{Settled Bulk Density, lb/ft}^3)}$$

where:

T = The allowable thickness (in.)

• **4.1.4 Designer and Installer Qualifications.** Systems that handle combustible wood particulates shall be designed by and installed under the supervision of qualified engineers who are knowledgeable of these systems and their associated hazards.

4.2 Objectives.

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

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

Δ **4.2.1.1** The objectives stated in 4.2.1 shall be interpreted as intended outcomes of this standard and not as prescriptive requirements.

Δ **4.2.1.2** The objectives stated in Section 4.2 shall be deemed to be met when the facility, processes, and equipment are designed, constructed, and maintained in accordance with the prescriptive criteria set forth in this standard, and the management systems set forth in this standard are implemented.

Δ **4.2.1.3** Where a performance-based alternative design is used, it shall be documented to meet the same objectives as the prescriptive design it replaces in accordance with Chapter 5.

Δ **4.2.2 Life Safety.** The life safety objective shall be deemed to have been met when the occupants not in the immediate proximity of the ignition are protected from the effects of fires, flash-fires, and explosions for the time needed to evacuate, relocate, or take refuge to prevent serious injury.

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

Δ **4.2.4* Mitigation of Fire Spread and Explosions.** The mitigation of fire spread and explosions shall be deemed to have been met when the prescribed or performance-based alternative design features are incorporated into the facility and processes to prevent or mitigate fires and explosions that can cause failure of adjacent buildings or building compartments, or other enclosures, emergency life safety systems, adjacent properties, adjacent storage, or the facility's structural elements.

Δ **4.2.4.1** Where a fire, deflagration, or explosion hazard exists within a process system, the hazards shall be managed in accordance with this standard.

Δ **4.2.4.2** Where a fire, deflagration, or explosion hazard exists with a facility compartment, the effects of the fire, deflagration,

or explosion shall be managed in accordance with this standard.

4.2.5 Structural Integrity. The facility shall be designed, constructed, and equipped to maintain its structural integrity despite the effects of fire or deflagration for the time necessary to evacuate, relocate, or defend in-place occupants who are not intimate with ignition.

4.3 Compliance Options.

Δ **4.3.1 Options.** Life safety, property protection, and mission continuity shall be provided in accordance with either of the following:

- (1) Performance-based provisions per 4.3.2
- (2) Prescriptive provisions per 4.3.3

Δ **4.3.2 Performance-Based Design.**

N **4.3.2.1** A performance-based design shall be in accordance with Chapter 6.

4.3.2.2* Performance-based designs shall be documented with all calculations, references, and sources from which material characteristics and other data have been obtained or upon which the designer has relied for some material aspect of the design per Chapter 6 of this standard and Chapter 5 of NFPA 101.

• **4.3.3 Prescriptive Design.** A prescriptive design shall be in accordance with Chapter 5 and Chapters 7 through 11.

N **4.3.4 Risk Assessment.** A documented risk assessment acceptable to the AHJ shall be permitted to be conducted to determine the building design, process design, and the level of protection features to be provided.

N Chapter 5 Hazard Identification

N **5.1* Hazard Identification.** Wood particulates in a facility shall be assessed for their hazards in accordance with Chapter 5 of NFPA 652.

N **5.1.1** A wood particulate having a moisture content of less than 25 percent (wet basis) and a mass median particle size of less than 500 micron shall be deemed to be a deflagrable wood dust unless testing shows it not to be capable of propagating deflagration.

N **5.1.2** A wood particulate having a moisture content of less than 25 percent, wet basis, and having a mass median particle size greater than 5.0 mm (0.2 in.) (3.5 mesh sieve) shall be permitted to be considered nondeflagrable wood dust on the basis of particle size.

N **5.1.3*** The assessment of hazard on the basis of mass median particle size shall be limited to those locations in the process and facility where the wood particulate remains a uniform mixture.

N **5.1.4*** When the testing laboratory reports that a sample cannot be tested in accordance with ASTM E1226, *Standard Test Method for Explosibility of Dust Clouds*, or ASTM E1515, *Standard Test Method for Minimum Explosible Concentration of Combustible Dusts*, or an equivalent protocol, based on particle size only, it shall be permitted to consider the particulate to be nondeflagrable.

Chapter 6 Performance-Based Design Option

6.1 General Requirements.

N 6.1.1 Retained Prescriptive Requirements. Portions of a facility designed in accordance with this chapter as an alternative for particular prescriptive requirements shall meet all other relevant prescriptive requirements in this standard. [652:6.1.1]

N 6.1.2* It shall be permitted to use performance-based alternative designs for a process or part of a process, specific material, or piece of equipment in lieu of the prescriptive requirements found in Chapter 9. [652:6.1.2]

6.1.3* Independent Review. The authority having jurisdiction shall be permitted to require an approved, independent third party to review the proposed design and provide an evaluation of the design to the authority having jurisdiction.

6.1.4 Approved Qualifications. The performance-based design shall be prepared by a person with qualifications acceptable to the authority having jurisdiction.

6.1.5* Documentation Requirements.

6.1.5.1 All aspects of the design shall be documented.

Δ 6.1.5.2 The content and format of the documentation shall comply with NFPA 101 and be acceptable to the authority having jurisdiction.

N 6.1.6* Re-evaluation. Performance-based designs shall be subject to a complete, documented re-evaluation and reapproval if and when any of the assumptions upon which the original design is based are changed or when other aspects of the facility's operations are changed.

6.1.7 Sources of Data.

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

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

6.1.8 Maintenance of the Design Features. To continue meeting the performance goals and objectives of this standard, the design features required for each hazard area shall be maintained for the life of the facility. This shall include complying with originally documented design assumptions and specifications. Any variation from the design shall require approval of the authority having jurisdiction prior to actual change.

N 6.2 Risk Component and Acceptability. (Reserved)

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

6.3.1 Occupant Life Safety.

6.3.1.1 The life safety objectives of 4.2.2 with respect to a fire hazard shall be deemed to have been achieved when the following conditions are met:

- (1) Ignition has been prevented.
- (2) Extension of the fire beyond the locus of ignition has been prevented.

- (3) Under all fire scenarios, no person, other than those intimate with the ignition, is exposed to untenable conditions due to the fire.
- (4) Under all fire scenarios, no structural element of the building is damaged, during the period of time necessary to effect complete evacuation of the occupants, to the extent that it can no longer support its design load.

6.3.1.2 The life safety objectives of 4.2.2 with respect to a deflagration hazard shall be deemed to have been achieved when the following conditions are met:

- (1) Ignition has been prevented.
- (2) Under all deflagration scenarios, no person, other than those intimate with the ignition, is exposed to untenable conditions due to the occurrence of a deflagration.
- (3) Under all deflagration scenarios, no person, other than those intimate with the ignition, is subject to missile impact due to the occurrence of a deflagration or explosion.
- (4) Under all deflagration scenarios, no structural element of the building is damaged, during the period of time necessary to effect complete evacuation of the occupants, to the extent that it can no longer support its design load.

6.3.2* Structural Integrity.

6.3.2.1 The structural integrity objective of 4.2.5 with respect to fire shall be deemed to have been achieved when no structural element of the building is damaged to the extent that it can no longer support its design load under all fire scenarios.

6.3.2.2 The structural integrity objective of 4.2.5 with respect to deflagrations shall be deemed to have been achieved when no structural element of the building is damaged to the extent that it can no longer support its design load under all deflagration scenarios.

6.3.2.3 The structural integrity objective of 4.2.5 with respect to deflagrations shall be deemed to have been achieved when the pressure resulting from a deflagration within a building, vessel, enclosure, duct, or compartment during deflagration is limited to that pressure the containment can withstand, by design, without release of flame, burning fuel, hot combustion product gases, or missiles.

6.3.3 Mission Continuity. The mission continuity objectives of 4.2.3 shall be deemed to have been achieved when damage to equipment and the facility has been limited to a level of damage acceptable to the owner or operator.

Δ 6.3.4 Prevention of Ignition.

Δ 6.3.4.1* Prevention of ignition shall be deemed to be achieved when the temperature of the combustible materials present in the facility is maintained at a temperature lower than the following:

- (1) Lowest reported dust layer ignition temperature for the dusts
- (2) Lowest temperature at which pyrolysis has been reported
- (3) The ignition temperature of the combustible materials present

6.3.4.2 For performance evaluation for prevention of ignition, the power (energy per unit time) criterion used shall be based upon the median particle mass, specific heat, coefficient of thermal conductivity, and emissivity. No credit shall be allowed for radiant or convective heat losses from the target particle.

6.3.5 Prevention of Fire Extension.

6.3.5.1 When limitation of fire spread is to be achieved, the following criteria shall be demonstrated:

- (1) Radiant flux to adjacent combustibles shall not exceed 20 kW/m².
- (2) Combustibles outside the compartment of fire origin shall not attain their ignition temperature.
- (3) Particulate processing systems shall be designed, constructed, equipped, and maintained to prevent fire or deflagration from propagating from the process equipment to the building interior.
- (4) Particulate processing systems shall be designed, constructed, equipped, and maintained to prevent fire or deflagration from propagating from one process system to an adjacent process system.
- (5) The surface area, smoothness, and inclination of all interior surfaces shall be such that the aggregate dust accumulations of these surfaces will not propagate a deflagration if half the dust were suspended in a cloud and ignited.

6.3.5.2 Where the prevention of fire extension to adjacent buildings is to be achieved, the following criteria shall be demonstrated:

- (1) Radiant flux to adjacent combustibles shall not exceed 20 kW/m².
- (2) Combustibles outside the compartment of fire origin shall not attain their ignition temperature.
- (3) The pressure within a building, vessel, enclosure, duct, or compartment during deflagration shall be limited to that pressure the containment can withstand, by design, without release of flame, burning fuel, hot gases, or missiles due to the internal deflagration pressure to an adjacent building.

6.3.6 Effects of Deflagrations. Where the prevention of damage due to deflagration is to be achieved, the criteria in 6.3.6.1 through 6.3.6.4 shall be demonstrated.

6.3.6.1 Deflagrations shall not produce any of the following conditions:

- (1) Internal pressures in the containment vessel, room, or equipment sufficient to threaten the structural integrity of the equipment or the building
- (2) Exposure of occupants to untenable conditions
- (3) Damage in excess of the permissible loss

6.3.6.2 Deflagrations shall not result in the extension of the deflagration flame front outside the compartment or equipment of origin except where intentionally vented to a safe location.

6.3.6.3 Deflagrations shall not result in the rupture of the compartment or equipment of origin and the ejection of fragments that can constitute missile hazards.

6.3.6.4 The pressure within a vessel, enclosure, duct, or compartment during deflagration shall be limited to a pressure lower than the yield strength of the vessel, enclosure, duct, or compartment, without release of flame, burning fuel, hot gases, or missiles due to the internal deflagration pressure to an unsafe location.

6.4 Design Scenarios.

6.4.1 Fire Scenarios.

6.4.1.1 Each fuel object in association with a credible ignition mechanism in the compartment shall be considered for inclusion as a fire scenario.

6.4.1.2 The fuel object that produces the most rapidly developing fire under normal operating conditions shall be included as one fire scenario.

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

6.4.1.4 The fuel object that produces the greatest total heat release under normal operating conditions shall be included as one fire scenario.

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

6.4.1.6 The fuel object that can produce a deep-seated fire under normal operating conditions shall be included as a fire scenario.

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

6.4.2 Deflagration Scenarios.

6.4.2.1 Each duct, enclosed conveyor, silo, bunker, cyclone, dust collector, or other vessel containing a combustible dust in sufficient quantity or conditions to support the propagation of a deflagration flame and a credible igniter front under normal operating conditions shall be included as a deflagration scenario.

6.4.2.2 Each duct, enclosed conveyor, silo, bunker, cyclone, dust collector, or other vessel containing a combustible dust in sufficient quantity or conditions to support the propagation of a deflagration flame front and a credible igniter under conditions of production upset or single equipment failure shall be included as a deflagration scenario.

6.4.2.3 Each building or building compartment containing a combustible dust in sufficient quantity or conditions to support the propagation of a deflagration flame and a credible igniter front under normal operating conditions shall be included as a deflagration scenario.

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

6.5 Evaluation of Proposed Design.

6.5.1* General. A proposed design's performance shall be assessed relative to each performance objective in Section 4.2 and each applicable scenario in Section 6.4, with the assessment conducted through the use of appropriate calculation methods. The authority having jurisdiction shall approve the choice of assessment methods.

6.5.2 Use. For each scenario, the design professional shall use the assessment methods to demonstrate that the proposed

design will achieve the goals and objectives, as measured by the performance criteria in light of the safety margins and uncertainty analysis, given the assumptions.

6.5.3 Input Data.

6.5.3.1 Data. Input data for computer fire models shall be obtained in accordance with ASTM E1591, *Standard Guide for Obtaining Data for Deterministic Fire Models*. Data for use in analytical models that are not computer-based fire models shall be obtained using appropriate measurement, recording, and storage techniques to ensure the applicability of the data to the analytical method being used.

6.5.3.2 Data Requirements. A complete listing of input data requirements for all models, engineering methods, and other calculation or verification methods required or proposed as part of the performance-based design shall be provided.

6.5.3.3* Uncertainty and Conservatism of Data. Uncertainty in input data shall be analyzed and, as determined appropriate by the authority having jurisdiction, addressed through the use of conservative values.

6.5.4* Output Data. The assessment methods used shall accurately and appropriately produce the required output data from input data based on the design specifications, assumptions, and scenarios.

6.5.5 Validity. Evidence shall be provided confirming that the assessment methods are valid and appropriate for the proposed building, use, and conditions.

6.6 Safety Factors. A safety factor, acceptable to the authority having jurisdiction, shall be applied to the results of the design calculations as appropriate for the design method used to reflect uncertainty in the assumptions, data, and other factors associated with the performance-based design.

N Chapter 7 Hazards Analysis

N 7.1* Hazards Analysis.

N 7.1.1 The design of the fire and deflagration safety provisions of the facility shall be based upon an analysis of the facility, the process, and the fire or deflagration hazards encompassed by the facility and process.

N 7.1.2 The design of systems and facilities that handle combustible particulate solids shall address the physical and chemical properties and hazardous characteristics of the materials in the hazard area.

N 7.1.3 The results of the facility and process analysis shall be permanently documented.

N 7.1.4 The facility and process analysis shall be reviewed and the documented results revised when the process is changed in accordance with the management-of-change criteria in Section 8.12 of this standard.

N 7.1.5 The results of the process analysis shall be maintained for the life of the facility and process.

N 7.1.6 The process analysis shall include a dust hazards analysis performed in accordance with Chapter 7 of NFPA 652.

Δ Chapter 8 Management Systems

8.1 Retroactivity. The provisions of this chapter shall be applied retroactively.

N 8.2 General. (Reserved)

N 8.3 Operating Procedures and Practices.

N 8.3.1* The owner/operator shall establish written procedures for operating its facility and equipment to prevent or mitigate fires, deflagrations, and explosions from combustible particulate solids. [652:8.3.1]

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

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

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

N 8.4 Housekeeping.

N 8.4.1 General Requirements.

N 8.4.1.1* This section shall apply to the monitoring and removal of combustible waste materials in order to prevent these materials from accumulating outside, on, or around operating equipment or otherwise within the facility in sufficient quantity to create an undue fire hazard.

N 8.4.1.2* Documented housekeeping and inspection programs shall be developed and maintained.

N 8.4.1.3* Any waste material or debris found in large enough quantity that the material is heavily coated or is in any way impeding the operation of energized or moving equipment shall be collected and removed immediately.

N 8.4.1.4 Combustible waste that cannot be reintroduced to the production process or utilized as fuel shall be placed in covered metal receptacles until removed to a safe place for daily disposal.

N 8.4.1.5 Any metal collected through the cleanup process shall be separated from wood debris or combustible waste to prevent entry into the wood-handling or processing equipment, the dust-collecting system, or the scrap wood hog.

N 8.4.1.6* Production equipment shall be maintained and operated in a manner that minimizes the escape of debris or dust in accordance with Chapter 9.

N 8.4.1.7 Spaces inaccessible to housekeeping shall be sealed to prevent dust accumulation.

N 8.4.1.8* Combustible or flammable liquid spills or leaks from any source shall be cleaned up without delay.

N 8.4.1.9 Residue from condensation of oil and resin volatiles shall be removed from areas within, around, and over curing ovens, dryers, fume extraction systems, or ventilation systems.

N 8.4.1.10 Oil-soaked cloths or waste material shall be stored in approved metal receptacles with self-closing covers.

N 8.4.1.11 Oily clothing, if stored between shifts, shall be kept in metal lockers.

N 8.4.1.12 Flammable liquids shall be handled and stored in accordance with NFPA 30.

N 8.4.2 Cleanup Methods.

N 8.4.2.1 Removal of Dust.

N 8.4.2.1.1 Surfaces shall be cleaned in a manner that minimizes the generation of dust clouds.

N 8.4.2.1.2* Blowing down with steam or compressed air or vigorous sweeping shall be permitted only if the following conditions are met:

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

N 8.4.2.1.3* A documented risk assessment shall be permitted to be used to determine which precautions in 8.4.2.1.2 are required for the specific conditions under which compressed air is being used.

N 8.4.2.1.4* Unless the conditions stipulated in 8.4.2.1.5 are met, portable vacuum cleaners shall be listed for use in Class II hazardous locations or shall be a fixed-pipe suction system with remotely located exhaust and air-material separator dust collector installed in conformance with Section 8.4 of this standard and 8.4.2.2 of NFPA 652.

N 8.4.2.1.5 When used in Class II areas, as determined in accordance with 9.4.2.2, portable vacuum cleaners shall be listed for use in Class II hazardous locations or shall be a fixed-pipe suction system with remotely located exhaust and dust collector installed in conformance with Section 8.4.

N 8.5* Hot Work. Hot work, including the use of propellant-actuated tools outside of areas specifically designated for this activity, shall be performed only under a hot work permit program and in accordance with NFPA 51B.

8.5.1* Hot work shall be performed in accordance with NFPA 51B.

8.5.2 Facilities shall ensure that outside contractors operate pursuant to NFPA 51B.

8.6 Personal Protective Equipment.

8.6.1 Workplace Hazard Assessment.

8.6.1.1* An assessment of workplace hazards shall be conducted as described in NFPA 2113. [652:8.6.1.1]

8.6.1.2 When the assessment in 8.6.1.1 has determined that flame-resistant garments are needed, personnel shall be provided with and wear flame-resistant garments. [652:8.6.1.2]

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

8.6.1.4* Consideration shall be given to the following:

- (1) Thermal protective characteristics of the fabric over a range of thermal exposures
- (2) Physical characteristics of the fabric
- (3) Garment construction and components
- (4) Avoidance of static charge buildup
- (5) Design of garment
- (6) Conditions under which garment will be worn
- (7) Garment fit
- (8) Garment durability/wear life
- (9) Recommended laundering procedures
- (10) Conditions/features affecting wearer comfort

[652:8.6.1.4]

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

8.6.1.6* The employer shall implement a policy regarding care, cleaning, and maintenance for flame-resistant garments. [652:8.6.1.6]

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

8.6.2.1* When required by 8.6.1.2, flame-resistant or non-melting undergarments shall be used. [652:8.6.2.1]

8.6.2.2* When determined by 8.6.1.1 that flame-resistant garments are needed, only flame-resistant outerwear shall be worn over flame-resistant daily wear. [652:8.6.2.2]

8.6.3 Limitations of PPE to Combustible Dust Flash-Fires. (Reserved) [652:8.6.3]

8.6.4 Face, Hands, and Footwear Protection. (Reserved) [652:8.6.4]

8.7 Inspection, Testing, and Maintenance.

8.7.1 An inspection, testing, and maintenance program shall be developed to ensure that fire and explosion protection systems are in accordance with Chapter 9.

8.7.2 The inspection, testing, and maintenance program shall be a documented program detailing the equipment inspected, testing performed, test results formulated, and maintenance or repair requirements.

8.7.3* Process controls, equipment, and machinery shall be inspected, tested, and maintained in accordance with the manufacturer's recommended guidelines and safe practices.

8.7.4 Dust Collection Systems.

8.7.4.1* The entire system, including each fan, motor, blower unit, operating control panels, fume scrubbers, flexible connections, and dampers, shall be inspected and maintained in accordance with the manufacturer's recommended guidelines and safe practices.

8.7.4.2* Aluminum paint shall not be used on interior steel surfaces.

8.7.4.3 Filters shall be cleaned or replaced when their resistance to airflow exceeds the manufacturer's specifications.

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

8.7.4.5 Where ducts are protected with sprinklers, sprinklers covered with deposits or corrosion shall be replaced or sent to a recognized testing lab for evaluation of suitability for continued service.

8.7.4.6 All vents for the relief of pressure caused by deflagrations shall be maintained free and clear of all obstructions and pursuant to the manufacturer's recommendations.

8.7.4.7 Maintenance shall not be performed on fans, blowers, or other equipment while the unit(s) is operating.

8.7.5 Impairments of Fire Protection and Explosion Prevention Systems.

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

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

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

8.7.5.4* Impairment notification procedures shall be implemented by management to notify plant personnel and the authority having jurisdiction of existing impairments and their restoration.

N 8.8 Training and Hazard Awareness.

8.8.1* Employee Training. Employee training shall include general safety training and job-specific training.

8.8.1.1 General safety training shall ensure that all employees are knowledgeable about the following:

- (1) General plant safety rules
- (2) Emergency procedures
- (3) Procedure for reporting an accident or unsafe conditions
- (4) Housekeeping policy and practices
- (5) Basic personal protective equipment requirements
- (6) Location of safety office, medical center, and first-aid stations
- (7) Emergency routes, exits, and safe shelters
- (8) Location of fire protection equipment
- (9) Hazardous areas

8.8.1.2 Job-specific training shall ensure that all employees are knowledgeable about the following:

- (1)* The hazards of their working environment and their behavior and procedures in case of emergencies, including fires, explosions, and hazardous materials releases
- (2) Emergency response plans, including safe and proper evacuation of their work area and the permissible methods for fighting incipient fires in their work area
- (3) The necessity for proper functioning of related fire and explosion protection systems that are under their responsibility
- (4) Equipment maintenance requirements and practices, including lockout/tagout procedures
- (5) Safe handling, use, storage, and disposal of hazardous materials used in the employees' work areas
- (6) The location and operation of fire protection equipment, manual pull stations and alarms, emergency phones, first-aid supplies, and safety equipment
- (7) Equipment operation, safe startup and shutdown, and response to upset conditions
- (8) The decision-making process necessary to determine the degree and extent of the hazard and the personal protective equipment and job planning necessary to perform the task safely

8.8.1.3* A qualified person shall be trained and knowledgeable of the construction and operation of equipment or a specific work method, and shall be trained to recognize and avoid potential hazards present with respect to that equipment or work method.

8.8.1.4 Training programs and procedures shall be reviewed and updated at least annually and whenever workplace conditions (i.e., equipment, process, chemical, material storage) change.

8.8.1.5* Emergency awareness training shall be given to all employees when emergency plans are initially implemented, revised, or updated and at least annually.

Δ 8.9 Contractors.

8.9.1* Contractors performing work involving the installation, repair, or modification of buildings (interior and exterior), machinery, fire protection equipment, and so forth, shall be trained (to the level of the employee), and only qualified contractors shall be employed.

8.9.2 Companies that hire contractors to operate their equipment shall ensure that those contractors are properly trained and qualified to operate the equipment and perform the work. Written documentation shall be maintained detailing the training that was provided and who received it.

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

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

8.9.5 Contractors shall be made aware of the facility's emergency response and evacuation plan.

8.9.6 Contractors shall be informed of whom to report emergencies to and be advised of safe egress points and evacuation areas in the event of an emergency such as fire, explosion, or toxic release.

8.10 Emergency Planning and Response.

8.10.1 Emergency planning and response shall be in accordance with NFPA 600 and NFPA 1600.

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

8.11 Incident Investigation.

8.11.1* Every incident that results in a fire or explosion shall be investigated and recorded.

8.11.2* Once the scene has been released by the authority having jurisdiction, incident investigations shall be promptly initiated by management personnel or their designee who has a good working knowledge of the facility and processes.

8.12* Management of Change. Management shall implement and maintain a system to evaluate proposed changes to the facility and processes, both physical and human, for the impact on safety, loss prevention, and control.

8.12.1 Management of change shall include review by all relevant authorities having jurisdiction.

8.12.2* Management of change shall include review of all projects involving the following:

- (1)* Occupancy and process changes involving storage configurations and heights, process equipment and materials, or rates of production
- (2)* Changes to all fire protection and alarm systems
- (3)* Exposure changes
- (4) Human element changes involving key members of loss prevention programs
- (5) New construction or modification to an existing structure

N 8.12.3 Written procedures to manage change to process materials, technology, equipment, procedures, and facilities shall be established and implemented. The requirements of 8.12.3.1 and 8.12.3.2 shall be applied retroactively.

N 8.12.3.1 The management-of-change procedures shall ensure that the following issues are addressed prior to any change:

- (1) Technical basis for the proposed change
- (2) Safety and health implications
- (3) Whether the change is permanent or temporary
- (4) Modifications to operating and maintenance procedures
- (5) Employee training requirements
- (6) Authorization requirements for the proposed change

N 8.12.3.2 Implementation of the management-of-change procedures shall not be required for replacements-in-kind.

N 8.12.3.3 Design documentation, as required by Chapter 7, shall be updated to incorporate the change.

8.13 Record Retention.

8.13.1* Records requiring retention shall include, but are not limited to, drawings and supporting documents relating to initial installation/purchase of equipment, routine equipment inspections, testing and repair history, fire and safety inspection or audit reports, service records, and manufacturer's data sheets.

8.13.2* Records of inspections, tests, and maintenance of fire protection equipment and components shall be retained and

made available to the authority having jurisdiction upon request.

8.13.3* All records required to be kept shall be retained until their usefulness has been served or until no longer required by the applicable standard or authority having jurisdiction.

8.13.4* Records shall be maintained on-site by the owner.

8.13.5* Retained records shall indicate the procedure performed (e.g., installation, inspection, testing, training, or maintenance), the organization that performed the work, the results, and the date the work was performed.

Chapter 9 Hazard Management: Mitigation and Prevention

N 9.1 Inherently Safe Designs. (Reserved)

N 9.2 Building Design.

N 9.2.1* Construction. The type of construction shall be in accordance with the building code adopted by the authority having jurisdiction.

N 9.2.2 Building or Building Compartment Protection.

N 9.2.2.1* Compartmentation. Where required by other sections of this standard, passive fire protection features shall be utilized to prevent the spread of fires or deflagrations to adjacent compartments or occupancies. Passive fire protection features shall include, but not be limited to, space separation, fire walls, fire partitions, or draft curtains.

N 9.2.2.2 Fire Walls, Fire Partitions, and Fire Barrier Walls.

N 9.2.2.2.1 Walls erected as fire walls and fire barrier walls shall comply with NFPA 221.

N 9.2.2.2.2 Fire barrier walls separating different occupancies shall have the minimum fire resistance rating required by code. Where no building code exists, fire barrier walls shall have a minimum fire resistance rating of 1 hour.

N 9.2.2.3 Protection of Openings and Penetrations.

N 9.2.2.3.1 Penetrations of walls, floors, or ceilings that provide a required fire separation shall be protected by listed systems or approved materials that have a fire resistance rating equal to that of the wall, floor, or ceiling and shall conform to the relevant requirements of NFPA 221.

N 9.2.2.3.2 Penetrations in barriers erected to segregate dust hazards shall be dusttight.

N 9.2.2.3.3* Conveyor and chute openings in fire walls shall be protected by listed or approved, automatic-closing fire doors or fire dampers that have a fire resistance rating equivalent to the fire wall.

N 9.2.2.3.4 Fire doors shall be designed, installed, tested, and maintained in accordance with NFPA 80.

N 9.2.2.3.5 Openings in walls designed to be explosion resistant shall be protected by doors that provide the same degree of explosion resistance protection as the walls.

N 9.2.2.3.5.1 Such doors shall be kept closed at all times when not actually being used.

N 9.2.2.3.5.2* Such doors shall not be considered as part of a required means of egress to satisfy the requirements of NFPA 101.

N 9.2.3 Occupant Life Safety Systems Means of Egress.

N 9.2.3.1 Occupant life safety systems shall be designed, constructed, installed, and maintained in accordance with NFPA 101.

N 9.2.3.2 The means of egress shall comply with NFPA 101.

N 9.2.3.2.1* Means of egress for building or building compartments that contain a deflagration hazard area shall be designed according to Section 7.11 in NFPA 101.

N 9.2.3.3 The design and construction of the building, mechanical and electrical systems, and systems and equipment necessary to the wood utilization occupancy shall be such that the occupants are able to recognize hazards and egress safely from the building in the event of one of the anticipated hazards.

N 9.2.3.4 The building design shall be such that the means of egress is clearly identifiable and usable for occupancy.

N 9.2.4 Separation of Hazard Areas from Other Hazard Areas and from Other Occupancies.

N 9.2.4.1 Areas where a dust deflagration hazard exists in a building or building compartment (excluding hazard within equipment) shall be segregated, separated, or detached from other occupancies to minimize damage from a fire or an explosion. [652:9.2.6.1]

N 9.2.4.2 Use of Segregation.

N 9.2.4.2.1 Physical barriers erected for the purpose of limiting fire spread shall be designed in accordance with NFPA 221. [652:9.2.6.2.1]

N 9.2.4.2.2 Physical barriers erected to segregate fire hazard areas, including all penetrations and openings of floors, walls, ceilings, or partitions, shall have a minimum fire resistance rating based on the anticipated fire duration. [652:9.2.6.2.2]

N 9.2.4.2.3 Physical barriers, including all penetrations and openings of floors, walls, ceilings, or partitions, that are erected to segregate dust explosion hazard areas shall be designed to preclude failure of those barriers during a dust explosion in accordance with NFPA 68. [652:9.2.6.2.3]

N 9.2.4.3 Use of Separation.

N 9.2.4.3.1* Separation shall be permitted to be used to limit the dust explosion hazard or deflagration hazard area within a building when it is supported by a documented engineering evaluation acceptable to the AHJ. [652:9.2.6.3.1]

N 9.2.4.3.2* The required separation distance between the dust explosion hazard or deflagration hazard area and surrounding exposures shall be determined by an engineering evaluation that addresses the following:

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

[652:9.2.6.3.2]

N 9.2.4.3.3* Either the separation area shall be free of dust, or where dust accumulations exist on any surface, the color of the surface on which the dust has accumulated shall be readily discernible. [652:9.2.6.3.3]

N 9.2.4.3.4 Where separation is used to limit the dust explosion or deflagration hazard area determined in Chapter 7, the minimum separation distance shall not be less than 11 m (35 ft). [652:9.2.6.3.4]

N 9.2.4.3.5* Where separation is used, housekeeping, fixed dust collection systems employed at points of release, and the use of physical barriers shall be permitted to be used to limit the extent of the dust explosion hazard or flash-fire hazard area. [652:9.2.6.3.5]

N 9.2.4.4 Use of Detachment.

N 9.2.4.4.1 Detachment shall be permitted to be used to limit the dust hazard area to a physically separated adjacent building. [652:9.2.6.4.1]

N 9.2.4.4.2* The required detachment distance between the dust explosion hazard or deflagration hazard area and surrounding exposures shall be determined by an engineering evaluation that addresses the following:

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

[652:9.2.6.4.2]

N 9.2.5 Special Requirements.

N 9.2.5.1* Surfaces and Ledges in Dusty Areas. Interior surfaces and ledges not readily accessible for cleaning shall be designed to minimize dust accumulation.

N 9.2.5.2* Damage-Limiting Construction.

N 9.2.5.2.1 Dust deflagration hazard areas shall be separated or segregated from all other areas.

N 9.2.5.2.2* Where a deflagration hazard is known to exist in a room or building, exterior walls shall be designed, constructed, and maintained such that they relieve the pressure from a dust deflagration without damage to the load-bearing capacity of the structure.

N 9.2.5.2.3* Interior walls erected to isolate dust explosion hazards shall be designed for sufficient explosion resistance to preclude damage to these walls before the explosion pressure can be safely vented to the outside.

N 9.2.5.3 Draft Curtains.

N 9.2.5.3.1 Where required, draft curtains shall be constructed and installed in accordance with Chapter 7 in NFPA 204.

N 9.2.5.3.1.1 Minimum 26 gauge steel sheeting [0.455 mm (0.018 in.)] shall be used.

N 9.2.5.3.1.2 Where automatic sprinkler protection is provided, draft curtains shall be permitted to be constructed of wood panels 12.7 mm (½ in.) thick or greater.

N 9.2.5.3.1.3 Aluminum sheeting, fiberglass reinforced plastic (FRP), or other plastic materials shall not be used.

N 9.2.5.3.2 Solid beams, purlins, and other solid structural members extending down from the roof deck or ceiling shall be deemed equivalent to draft curtains if the depth criteria in Chapter 7 of NFPA 204 is met.

N 9.3 Equipment Design.

N 9.3.1* Applicability. Section 9.3 shall apply to storage, all pneumatic systems, dust control systems, mechanical conveyors, and mechanical equipment of all types used to convey, resize, pulverize, dry, or otherwise process wood and wood-derived particulate and other cellulosic materials used as a substitute or supplement for wood.

N 9.3.2 Fire Protection and Explosion Suppression Systems. Where required, fire protection and explosion suppression systems shall be provided in accordance with Sections 9.7 and 9.8.

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

N 9.3.3.1* Hazard Determination. The hazard associated with the particulate conveying system shall be determined through a hazard analysis.

N 9.3.3.1.1 The analysis of the fire and deflagration hazard shall address the moisture content and particle size distribution of the particulate at each point of material entry into the duct system to determine whether the material is green, dry nondeflagrable, or deflagrable.

N 9.3.3.1.2 The analysis of the fire and deflagration hazard shall identify the minimum explosible concentration (MEC) for all deflagrable material.

N 9.3.3.1.3 Fire and deflagration hazards shall be permitted to be deemed nonexistent where only green material is collected or conveyed and construction of the equipment handling and storing the material is all noncombustible.

N 9.3.3.1.4* A fire hazard shall be deemed to exist in the system wherever dry wood particulate is collected or conveyed or wherever components of the conveying system are constructed of combustible materials.

N 9.3.3.1.5* In addition to the fire hazard, a deflagration hazard shall also be deemed to exist where deflagrable wood dust is, or could be, suspended in air during operation at a maximum concentration above 25 percent of the MEC.

N 9.3.3.2 Pneumatic Conveying and Dust Collection Systems.

N 9.3.3.2.1 General Requirements.

N 9.3.3.2.1.1 Pneumatic conveying systems shall be designed in accordance with NFPA 654 except as modified by this standard.

N 9.3.3.2.1.2* Woodworking pneumatic conveying systems shall be restricted to handling wood residues; under no circumstances shall another operation that generates sparks, such as from grinding wheels, or flammable vapors, such as from a finishing operation, be connected to a woodworking pneumatic conveying system.

N 9.3.3.2.1.3 Once a system airflow has been properly balanced, additional pickup points, duct modifications, and modification of balancing damper settings shall not be made without ensuring that the remaining portions of the system still have sufficient capture and conveying air velocities for their intended function.

N 9.3.3.2.1.4* Every section of the collection system shall be sized for not less than the minimum air velocity and volume required to collect and transport the material through the ducting and into the collection equipment.

N 9.3.3.2.2* Operations.

N 9.3.3.2.2.1 Sequence of Operation. Pneumatic conveying, dust collection, and centralized vacuum cleaning systems shall be designed with the operating logic, sequencing, and timing outlined in 9.3.3.2.2.2 and 9.3.3.2.2.3. [654:9.3.3.3.1]

N 9.3.3.2.2.2* Startup. Pneumatic conveying, dust collection, and centralized vacuum cleaning systems shall be designed such that, on startup, the system achieves and maintains design air velocity prior to the admission of material to the system. [654:9.3.3.3.2]

N 9.3.3.2.2.3 Shutdown. The shutdown of pneumatic conveying, dust collection, and centralized vacuum cleaning systems shall be in accordance with 9.3.3.2.2.3(A) through 9.3.3.2.2.3(C).

N (A) Pneumatic conveying, dust collection, and centralized vacuum cleaning systems shall be designed such that, on normal shutdown of the process, the system maintains design air velocity until material is purged from the system. [654:9.3.3.3.3.1]

N (B) The requirements of 9.3.3.2.2.3(A) shall not apply during emergency shutdown of the process, such as by activation of an emergency stop button or by activation of an automatic safety interlocking device. [654:9.3.3.3.3.2]

N (C) Dilute phase pneumatic conveying systems shall be designed such that, upon restart after an emergency shutdown, residual materials can be cleared and design air velocity can be achieved prior to admission of new material to the system. [654:9.3.3.3.3.3]

N 9.3.3.2.3 Duct System.

N 9.3.3.2.3.1 Ductwork shall be metallic.

N (A) Flexible ducting shall be permitted for final machine connection in a length not exceeding the minimum required for machine operation.

N 9.3.3.2.3.2* Nonconductive ducts such as PVC pipes shall not be permitted.

N 9.3.3.2.3.3 Where extinguishing is present, horizontal ductwork subject to water accumulation shall be capable of supporting the weight of the duct system plus the weight of the duct half-filled with water.

N 9.3.3.2.3.4 Ductwork shall be protected from corrosion.

N 9.3.3.2.3.5 Dust collection air velocity and volume shall be calculated according to 9.3.3.2.3.5(A) and 9.3.3.2.3.5(B).

N (A) The capacity of the system shall be calculated on the basis of all hoods and other openings connected to the system being open or equipped with means to ensure minimum conveying velocity of 9.3.3.2.1.4 in all sections of the system.

N (B) Floor sweeps, which are normally closed and are only opened on an occasional basis to facilitate housekeeping, shall be permitted to be excluded from the air flow calculations for the system.

- N 9.3.3.2.3.6*** Where dampers or gates are used for individual equipment, the volume and velocity resulting from the operation of such dampers or gates shall not reduce the system velocity below the design minimum.
- N 9.3.3.2.3.7** Ducts used to convey particulate shall have a circular cross-section unless a non-circular cross-section of equal area is needed where the duct connects to other equipment or where external obstructions necessitate a non-circular cross-section be used.
- N 9.3.3.2.3.8** Ductwork shall be bonded and grounded in accordance with 9.4.8.2(1).
- N 9.3.3.2.3.9* Hazard Determination.** The dust accumulation hazard associated with the duct system shall be determined by means of a hazard analysis.
- N (A)** Access doors, openings, or removable sections of ductwork shall be provided to allow inspection, cleaning, maintenance, and fire department access.
- N (B)** Access doors, openings, or removable sections of ductwork shall be designed and maintained to prevent dust leaks and maintain the integrity of the duct.
- N (C)** Access doors, openings, or removable sections of ductwork that are not specifically designed for deflagration venting shall not be considered as providing that function.
- N (D)** Access doors, openings, or removable sections of ductwork shall be bonded and grounded.
- N 9.3.3.2.3.10* Duct Access** For duct systems subject to dust accumulation, access doors, openings, or removable sections of ductwork shall be provided in accordance with 9.3.3.2.3.9(A) through 9.3.3.2.3.9(D).
- N 9.3.3.2.4 Hoods and Enclosures.**
- N 9.3.3.2.4.1** Hoods or enclosures shall be designed and located such that the wood dust or particulate generated will fall, be projected, or be drawn into the hoods or enclosures so as to minimize fugitive dust emissions without interfering with the safe and satisfactory operation of the machine.
- N 9.3.3.2.4.2*** At each collection point, the system shall be designed to achieve the minimum velocity required for capture, control, and containment of the dust source. [652:A.9.3.3.1]
- N 9.3.3.2.4.3*** The hood or pickup point for each dust source shall have a documented minimum air volume flow based upon the system design. [652:9.3.3.2]
- N 9.3.3.2.4.4** All hoods and enclosures shall be of noncombustible construction unless protected with automatic sprinklers installed in accordance with NFPA 13.
- N 9.3.3.2.5 Fans or Blowers (Air-Moving Devices).**
- N 9.3.3.2.5.1*** Fans or blowers shall be of appropriate type and sufficient capacity to maintain the required rate of airflow in all parts of the system.
- N 9.3.3.2.5.2** Fans and blowers shall be permitted to be located in accordance with 9.3.3.2.5.2(1) through 9.3.3.2.5.2(6):
- (1)* On the clean air side of dust collectors, regardless of the moisture content or particle size of the material being conveyed
 - (2)* Upstream of the dust collector when the material being conveyed has a moisture content in excess of 25 percent (wet basis)
 - (3) Upstream of the dust collector when the material being conveyed has a moisture content of less than 25 percent (wet basis) and the concentration of sub-500 micron particulate is less than 25 percent of the MEC, and the duct downstream of the fan is equipped with a listed spark detection extinguishing system and/or abort system
 - (4) Upstream of the dust collector when the material being conveyed has a moisture content of less than 25 percent (wet basis) and the concentration of sub-500 micron particulate is in excess of 25 percent of the MEC, and the duct and dust collector are equipped with either deflagration relief venting or deflagration suppression systems
 - (5) Upstream of enclosureless dust collectors, in accordance with 9.3.3.2.5
 - (6) Upstream of outdoor cyclone collectors receiving knife planer shavings when the fan and the cyclone are located outdoors and exhaust to outdoor atmosphere
- N 9.3.3.2.5.3*** When fans with a deflagration hazard are arranged as material-handling fans on ducts, the fan housing shall meet the same design strength criteria required of the duct in 9.7.1.1.
- N 9.3.3.2.6 Air-Material Separators.**
- N 9.3.3.2.6.1** The system shall be provided with collection equipment of sufficient size and capacity to maintain the required airflow and efficiently separate the wood dust from the air before the air is exhausted.
- N 9.3.3.2.6.2*** Operator controls for AMSs associated with pneumatic conveying, dust collection, or centralized vacuum cleaning systems shall be installed in a location that is safe from the effects of a vented deflagration in the AMS. [654:9.3.13.1.8]
- N 9.3.3.2.6.3** The enclosures of collection equipment shall be designed and constructed entirely of noncombustible material suitable for the use intended.
- N 9.3.3.2.6.4*** The requirements in this section allowing the use of enclosureless AMS shall be limited to enclosureless AMS that meet all of the following criteria:
- (1) The filtration is accomplished by passing dust-laden air through filter media, collecting the dust on the inside of the filter media, and allowing cleaned air to exit to the surrounding area.
 - (2) The filter media are not enclosed or in a container.
 - (3) There is no means to mechanically shake or pressure-pulse the filter media while the fan is on.
 - (4) The filter media are under positive pressure.
 - (5) Removal of the collected dust is not automatic, continuous, or mechanical.
- N 9.3.3.2.6.5*** Dust collectors shall have independent supporting structures capable of supporting the weight of the following:
- (1) Collector
 - (2) Material being collected
 - (3) Any water from fire-extinguishing systems that will not readily drain from the system

N 9.3.4* AMS Locations. Dust collectors shall be located in accordance with one of the following:

- (1) Outside of buildings
- (2) Indoors when deemed to have no fire or deflagration hazard
- (3) Indoors for dust collectors with only a fire hazard when protected in accordance with this standard
- (4) Indoors when equipped with listed deflagration suppression system
- (5) Indoors when equipped with deflagration relief vents with relief pipes extending to safe areas outside the building and the collector meets the strength requirement of this standard
- (6) Indoors when equipped with deflagration relief vents exhausting through listed flame-quenching devices and the collector meets the strength requirement of this standard
- (7)* Indoors for enclosureless dust collectors meeting all of the following criteria:
 - (a) The collector is used only for dust pickup from wood processing machinery (i.e., no metal grinders and so forth).
 - (b) The collector is not used on sanders, molders, or abrasive planers having mechanical material feeds through the machine.
 - (c) Each collector has a maximum air-handling capacity of 2.36 m³/sec (5000 cfm).
 - (d) The fan motor is of a totally enclosed, fan-cooled design.
 - (e) The collected dust is removed daily or more frequently if necessary to ensure efficient operation.
 - (f) The collector is located at least 6.1 m (20 ft) from any means of egress or area routinely occupied by personnel.
 - (g) Multiple collectors in the same room are separated from each other by at least 6.1 m (20 ft).

N 9.3.5 Recycling of AMS Clean Air Exhaust. Recycling of AMS exhaust to buildings shall be permitted if the provisions of 9.3.5.1 through 9.3.5.4 are met.

N 9.3.5.1* The system shall be designed to prevent return of dust with a minimum efficiency of 99.9 percent at 10 µm.

N 9.3.5.2 Recycling of air-material separator exhaust to the building shall not be permitted under any circumstances where combustible gases, vapors, or hybrid mixtures are involved.

N 9.3.5.3 Recycling of air-material separator exhaust to the building shall not be permitted when the recycled stream reduces the concentration of oxygen below 19.5 percent by volume in the work area.

N 9.3.5.4* Air from air-material separators or dust collectors deemed to have a fire hazard shall meet the provisions of 9.3.5.4.1, 9.3.5.4.2, 9.3.5.4.3, or 9.3.5.4.4.

N 9.3.5.4.1* For dust collection systems of capacity less than or equal to 2.36 m³/sec (5000 cfm), one of the following shall apply:

- (1) The system shall be equipped with listed spark detection, designed and installed in conformance with the relevant sections of *NFPA 72* located on the duct upstream from the dust collector and downstream from the last material entry point, connected directly to a listed spark extin-

guishing system, designed and installed in conformance with *NFPA 15* or

- (2) The system shall be protected in accordance with 9.3.5.4.2.

N 9.3.5.4.2* For dust collection systems of capacity greater than 2.36 m³/sec (5000 cfm), the following shall apply:

- (1) The system shall be equipped with a listed spark detection system, designed and installed in conformance with the relevant sections of *NFPA 72* located on the duct upstream from the dust collector and downstream from the last material entry point, or on the exhaust side of the dust collector, to detect fire entering or occurring within the dust collector, respectively, and
- (2) The exhaust air duct conveying the recycled air back to the building shall be equipped with a high-speed abort gate activated by the spark detector in 9.3.5.4.2(1), and the abort gate shall be sufficiently fast to intercept and divert any burning material to atmosphere before it can enter the plant.
- (3)* The abort gate is provided with a manual reset so that, after it has aborted, it can be reset to the normal position only by manual interaction at the damper; automatic or remote reset shall not be allowed. A powered reset is acceptable if it can be activated only by manual interaction at the damper location.

N 9.3.5.4.3 Air from enclosureless dust collectors meeting the requirements of 9.3.4(7) shall be permitted to be exhausted into the building.

N 9.3.5.4.4 Air from cyclone pre-cleaners, located outside the building and having a capacity of 2.36 m³/sec (5000 cfm) or less shall be permitted to be ducted directly to enclosureless dust collectors located within the building.

N 9.3.6 Mechanical Conveying Systems.

N 9.3.6.1 General Requirements.

N 9.3.6.1.1 All equipment shall be designed, installed, and operated to maintain alignment and lubrication to avoid excessive heat buildup from friction, hot bearings, and so forth.

N 9.3.6.1.2* All equipment shall be designed to minimize fugitive dust emissions from the equipment.

N 9.3.6.1.3 Dusttight ball or roller bearings shall be used wherever practicable.

N 9.3.6.1.4 All bearings and bushings shall be dusttight.

N 9.3.6.1.5* Bearings and bushings shall be located outside the equipment unless equipment design makes it impractical.

N 9.3.6.1.6 Shaft seals shall be provided where rotating shafts penetrate equipment walls.

N 9.3.6.1.7* Access hatches and removable equipment covers shall be tight fitting and securely fastened for dusttight operation.

N 9.3.7* Particulate Size Reduction Equipment.

N 9.3.7.1 Hazard Analysis and Design Criteria.

N 9.3.7.1.1* Unless the particulate size reduction equipment is strictly dedicated to handling green material or is pressurized with steam, it shall be considered a high-frequency ignition source.

N 9.3.7.2 Size Reduction Equipment.

N 9.3.7.2.1 Hazard Analysis. The fire and deflagration potential of each piece of particulate size reduction machinery shall be determined by a hazard analysis as outlined in 9.3.7.1.

N 9.3.7.2.2 General Requirements.

N 9.3.7.2.2.1* All equipment shall be designed in accordance with 9.3.6.1.

N 9.3.7.2.2.2* Foreign material shall be removed from the process material feed into all particulate size reduction equipment by permanent magnet or self-cleaning electromagnet-type magnetic separators, or by pneumatic separators, or by both.

N 9.3.8 Panel Product Manufacturing Machinery.

N 9.3.8.1 Panel formers utilizing dry wood or other cellulosic materials, consisting of particles or fiber of various sizes, shall be provided with dust control to minimize dust clouds within the enclosure.

N 9.3.8.2 Bearings, rollers, and bushings shall be in accordance with 9.3.6.1.

N 9.3.8.3 Foreign material shall be removed from the process material feed into all particulate size reduction equipment by permanent magnet or self-cleaning electromagnet-type magnetic separators, or by pneumatic separators, or by both.

N 9.3.8.4 All dust-producing equipment shall be designed for dusttight operation, or the equipment and dust-producing operations shall be provided with dusttight hoods or enclosures that comply with the requirements of 9.3.3.

N 9.3.9 Dryer Systems.**N 9.3.9.1* Veneer and Fiberboard Dryers.**

N 9.3.9.1.1* Automatic water spray deluge protection shall be provided for horizontal tray dryers, air plenums, and air exhaust stacks.

N 9.3.9.1.1.1 Protection shall not be required for the following:

- (1) Portions of the dryer where the material has a moisture content greater than 40 percent (wet basis), there are no thermal oil heat exchangers in the dryer, and combustible debris or deposits do not accumulate inside the dryer.
- (2) Portions of the dryer that have two or fewer trays, there are no thermal oil heat exchangers in the dryer, and combustible debris or deposits do not accumulate inside the dryer.

N 9.3.9.1.2 Where two or more deluge systems are provided in the same dryer, the water demand shall be designed for two systems operating at one time. (See Annex E.)

N 9.3.9.1.3* The interior of the dryer shall be regularly inspected and cleaned, if necessary, to keep dust and resin deposits to less than 3.2 mm (1/8 in.) thick.

N 9.3.9.1.4* The ceiling areas above these dryers shall receive regular cleaning, especially around roof exhaust fan openings, to keep dust and resin deposits to less than 3.2 mm (1/8 in.) thick.

N 9.3.9.1.5 Ceiling areas above veneer and fiberboard dryers shall have draft curtains to contain dust and resin deposits locally to each dryer.

N 9.3.9.1.6 Where automatic sprinkler protection is provided within the draft curtained area, the sprinkler design operating area shall be based on all heads flowing within the curtained area if this area is greater than the normal design area.

N 9.3.9.2* Rotary Dryers.

N 9.3.9.2.1 Rotary dryers having a deflagration hazard shall be located in one of the following places:

- (1) Outdoors
- (2) In a separate detached building
- (3) In a separate cutoff room with damage-limiting construction

N 9.3.9.2.2* Rotary dryers shall have automatic spark detection and extinguishing systems installed between the dryer drum and downstream material-handling equipment, such as cyclones or wind boxes.

N 9.3.9.2.3* The interior of the dryer shall be regularly inspected and cleaned, if necessary, to keep combustible deposits to a minimum.

N 9.3.9.3* Conveyor Dryers.

N 9.3.9.3.1* Conveyor dryers shall be protected with water spray deluge systems, activated by spark, flame, and/or heat detectors.

N 9.3.9.3.2 Dust collection systems used to capture dust emissions in or between individual conveyor dryers shall be designed in accordance with 9.3.3.2.

N 9.3.9.3.3* The interior of the dryer shall be regularly inspected and cleaned, if necessary, to keep dust and resin deposits to a minimum.

N 9.3.9.4* Flash Tube Dryers.

N 9.3.9.4.1 The location of the flash dryers shall comply with one of the following:

- (1) Flash dryers shall be located outdoors.
- (2) Flash dryers shall be located in a building physically detached from the main production building.
- (3) Flash dryers shall be permitted to be installed such that the head-end portion of a flash dryer, in which the moisture content of the material being dried is greater than 40 percent (dry basis), is located inside the main production building.
- (4) Flash dryers shall be permitted to be installed such that any portion of a flash dryer, in which the moisture content of the material being dried is less than 40 percent (dry basis), is located inside the main production building if it has explosion protection designed in accordance with NFPA 69.

N 9.3.9.4.2* Flash tube dryers shall be protected by a combination of spark detection and extinguishing systems, water spray deluge, deflagration relief venting, and process isolation devices and interlocks.

N 9.3.9.4.3* The dryer duct shall be regularly inspected and cleaned to minimize fiber accumulations.

N 9.3.9.5* Kiln Dryers.

N 9.3.9.5.1* Automatic sprinkler protection shall be provided within dry kilns and ovens with a rating over 150,000 Btu/hr.

- N 9.3.9.5.2** Sprinklers below the fan decks of dry kilns shall be based on the storage height of product within the kiln, with the operating area being the entire area.
- N 9.3.9.5.3** Sprinklers above the fan decks of dry kilns shall be designed to provide 6.1 L/min/m² (0.15 gpm/ft²) density over the entire area.
- N 9.3.9.5.4** If the dry kiln is heated by a thermal oil system with hot oil piping inside the kiln that is not all welded (e.g., bolted connections), the minimum sprinkler design density shall be per the requirements in NFPA 13 for Extra Hazard Group 1 occupancies over the entire kiln area.
- N 9.3.9.5.5** Hydraulic calculations shall be balanced for the simultaneous operation of all sprinklers above and below the fan deck.
- N 9.3.9.5.6*** The interior of the dryer shall be regularly inspected and cleaned, if necessary, to keep dust and resin deposits to a minimum.
- N 9.3.9.5.7** Fuel burner combustion controls and interlocks shall conform to Chapter 10.
- N 9.3.9.6 Finishing Room Dryers.** Sprinkler protection provided in finishing room dryers (flammable and combustible solvents) shall be protected as an Extra Hazard Group 2 occupancy as outlined in NFPA 13.
- N 9.3.10 Hot Presses.**
- N 9.3.10.1 Continuous Presses.**
- N 9.3.10.1.1*** Continuous presses shall be protected in a manner acceptable to the authority having jurisdiction.
- N 9.3.10.1.2** Pits beneath continuous presses shall be protected in accordance with 9.3.10.2.
- N 9.3.10.2 Multiopening Batch-Type Presses.**
- N 9.3.10.2.1** For press pit installations that do not utilize thermal oil heating, automatic sprinkler protection shall be provided with a minimum density of 8.15 L/min/m² (0.20 gpm/ft²) over the entire pit area, with a hose stream allowance of 1893 L/min (500 gpm) included in the hydraulic calculations.
- N 9.3.10.2.2*** For press pit installations where thermal oil heating is used, automatic sprinkler protection shall be designed to provide a minimum density of 10.2 L/min/m² (0.25 gpm/ft²) over the entire pit area, with a hose stream allowance of 1893 L/min (500 gpm) included in the hydraulic calculations.
- N 9.3.10.2.3** Where presses are supported on steel columns and thermal oil heating is used, automatic sprinkler protection for steel support columns shall be provided unless the columns are protected with a 2-hour fire-rated material.
- N 9.3.11 Portable Appliances.**
- N 9.3.11.1*** A written policy shall be established to regulate the use of portable appliances.
- N 9.3.11.2*** The policy shall identify locations where specific portable appliances are permitted or prohibited.
- N 9.3.11.3*** The policy shall provide for inspections conducted periodically to ensure compliance with this standard.
- N 9.3.12 Spray Finishing.** Spray finishing operations shall be in accordance with NFPA 33.
- N 9.3.13 Dipping and Coating.** Dipping and coating operations shall be in accordance with NFPA 34.
- N 9.3.14* Pollution Control Equipment.**
- N 9.3.14.1** The pollution control exhaust system shall be designed and maintained in accordance with NFPA 91.
- N 9.3.14.2** Pollution control bag filters shall be designed in accordance with 9.3.3.2.6.
- N 9.3.14.3** Where an extinguishing system is provided in pollution control equipment, the system shall be designed to operate simultaneously with any extinguishing system in the process equipment.
- N 9.4 Ignition Source Control.**
- N 9.4.1 Hot Work.** See Section 8.5.
- N 9.4.2 Electrical Systems.**
- N 9.4.2.1** All electrical systems and system components shall be installed in accordance with *NFPA 70*.
- N 9.4.2.2*** Portions of the facility where dust accumulations occur or where suspensions of wood dust in air could occur shall be equipped with electrical systems and equipment per Article 502 or 503 of *NFPA 70*.
- N 9.4.3 Hot Surfaces.**
- N 9.4.3.1*** In areas where a dust explosion hazard or dust flash-fire hazard exists, the temperature of external surfaces shall be maintained below 80 percent (in degrees Celsius) of the lower of the dust surface ignition temperature or the dust-cloud ignition temperature.
- N 9.4.3.2*** Bearings shall be dusttight ball or roller type and shall be monitored for adequate lubrication and excessive wear in accordance with 9.3.6.1.
- N 9.4.4* Industrial Trucks.** In areas with a deflagration hazard, only trucks listed or approved for the electrical classification of the area, where commercially available, shall be used in accordance with NFPA 505.
- N 9.4.5* Lighting.** Lighting system fixtures shall be designed, installed, and maintained such that they do not pose a potential ignition hazard due to the heat evolved from normal operation or as a result of catastrophic failure or damage.
- N 9.4.6 Fuel-Fired Equipment.**
- N 9.4.6.1** Fuel-fired heating units shall be designed, installed, and maintained in accordance with the relevant NFPA codes and standards, including, but not limited to, the following:
- (1) NFPA 31
 - (2) NFPA 54
 - (3) NFPA 85
- N 9.4.6.2** Wood-fired burners and boilers shall be designed, installed, and operated in a manner that prevents the unintentional ignition of wood or other cellulosic material outside the combustion zone.
- N 9.4.6.3*** Provisions shall be made to prevent the accumulation of wood and cellulosic dust on the heated surfaces of heating units operating at temperatures exceeding 180°C (356°F).
- N 9.4.6.4** In facility locations where airborne dust or dust accumulations on horizontal surfaces are apt to occur, heating units

shall be provided with a source of combustion air ducted directly from the building exterior.

N 9.4.6.5 An emergency shutoff valve, readily accessible during a fire, shall be provided for flammable fuel lines.

N 9.4.7* Lightning Protection. Lightning protection, where provided, shall be designed, installed, and maintained in accordance with NFPA 780.

N 9.4.8* Static Electricity.

N 9.4.8.1 Air hoses and other dust-removal equipment pursuant to this section shall be conductive to prevent static electric charge generation by the airflow.

N 9.4.8.2 Where equipment is subject to the accumulation of static electric charge, the accumulation of static electric charge shall be controlled by one of the following:

- (1) Permanent grounding and bonding of production equipment
- (2) Grounded metal combs to provide discharge paths
- (3) Other means shown to be effective and acceptable to the authority having jurisdiction

N 9.4.9* Machines and Processing Equipment.

N 9.4.9.1* Feed-Rate Controls. Feed rates and machine adjustments for the stock being processed on wood cutting, shaping, planing, and sanding operations shall be controlled to prevent ignition (hot cuts).

N 9.4.9.2 Cutter and Abrasive Maintenance.

N 9.4.9.2.1* Wood cutting, shaping, and planing equipment shall be maintained at a level of sharpness to minimize the heat generated from woodworking operations.

N 9.4.9.2.2* Abrasive cutting belts, disc surfaces, and devices shall not be used beyond their design lifetime and shall be replaced or cleaned in the manner specified by the manufacturer when showing signs of loading of the grit.

N 9.4.10 Machinery Setup and Maintenance.

N 9.4.10.1 Provisions shall be made to ensure that machine setup, including but not limited to depth of cut and feed rate, is properly fixed and secure from unintentional change during the production run, consistent with the manufacturer's operation manual.

N 9.4.10.2* Woodworking machines shall be maintained as required in the manufacturer's operation and maintenance manual.

N 9.4.11 Foreign Material.

N 9.4.11.1 Wood stock shall be inspected for foreign materials, such as nails, sugar taps, fencing wire, and so forth, prior to being processed.

N 9.4.11.2* Foreign materials, such as tramp metal, capable of igniting wood waste and wood dust shall be prevented from entering the wood and dust process equipment.

N 9.4.11.3 Prevention of foreign materials in dust collection systems shall be in accordance with 9.3.3.2.

N 9.4.11.4 Prevention of foreign materials in particulate size reduction equipment shall be in accordance with 9.3.7.

N 9.4.12 Friction.

N 9.4.12.1 All equipment shall be designed, installed, and operated to maintain alignment and lubrication to avoid ignition from frictional heating.

N 9.4.12.2* Roller or ball bearings shall be used on all processing and transfer equipment in accordance with 9.3.6.1.

N 9.4.12.3 Bushings shall be permitted to be used where an engineering analysis has shown that the mechanical loads and speeds preclude attainment of temperatures sufficient to ignite wood particulates in the environment of the machines in question.

N 9.4.13 Fans.

N 9.4.13.1 Requirements for fans and blowers used in pneumatic conveying systems shall be in accordance with 9.3.3.2.5.

N 9.4.13.2* Fans that are subject to combustible residue buildup on the fan, fan shroud, and drive mechanism shall be kept clean to prevent overheating and ignition of the deposits.

N 9.4.14 Spontaneous Ignition and Chemical Action.

N 9.4.14.1* When storage of wood or wood substitute particulates is employed, the wood or wood substitute particulates shall be evaluated for the potential for spontaneous ignition from chemical reactions during storage.

N 9.4.14.2 Wood or wood substitute particulates that are determined to have a spontaneous ignition potential shall be stored in one of the following locations:

- (1) Outside
- (2) Inside in accordance with Chapter 11
- (3) In separate buildings
- (4) In bins designed such that the particulate flow occurs in a first-in/first-out basis

N 9.4.14.3* Rags, cloths, filter media, or other similar material containing finishing oils that have been determined to have a spontaneous ignition potential shall be disposed of pursuant to 8.4.1.10.

N 9.4.15 Propellant-Actuated Tools.

N 9.4.15.1 Propellant-actuated tools shall not be used in areas where combustible dust or dust clouds are present.

N 9.4.15.2 When the use of propellant-actuated tools becomes necessary, the following procedures shall be performed prior to their use:

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

N 9.4.15.3 A check shall be made after the work is completed to ensure that no cartridges of charges are left in the premises where they could enter equipment or be accidentally discharged after operation of the dust-producing or -handling machinery is resumed.

N 9.4.16 Smoking. Smoking shall be permitted only in designated areas equipped with ample devices for smoking material disposal and free of combustible/flammable hazards or storage.