

NFPA 664

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

2007 Edition



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

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Standard for the

Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities

2007 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. It was issued by the Standards Council on July 28, 2006, with an effective date of August 17, 2006, and supersedes all previous editions.

This edition of NFPA 664 was approved as an American National Standard on August 17, 2006.

Origin and Development of NFPA 664

NFPA activity in the field of wood dust explosion hazards dates from 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 was reissued in 1952 and 1959. In 1960, these two codes were combined in 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 document 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, conditioned upon specific design criteria. The document was also modified to comply with the updated *Manual of Style for NFPA Technical Committee Documents*.

This 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 this section 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.

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

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



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

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex F. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

Chapter 1 Administration

1.1 Scope. This standard shall establish 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 additive to wood fiber, and 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 wood-working plants, furniture plants, plywood plants, composite board plants, lumber mills, and production-type woodworking shops and carpentry shops that are incidental to facilities that would not otherwise fall within the purview of this standard.

1.1.2* This standard shall apply to woodworking operations that occupy areas of more than 465 m² (5000 ft²) or where dust-producing equipment requires an aggregate dust collection flow rate of more 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. This standard shall be applied to new facilities and to new processes within existing facilities.

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

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

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

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

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

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

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

1.6 Units and Formulas.

1.6.1 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).

1.6.2* 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.

1.6.3 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*, 2007 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2005 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2005 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2007 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2007 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2007 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2002 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2007 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2003 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2007 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2002 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2003 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, 2006 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, 2007 edition.

NFPA 34, *Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids*, 2007 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2003 edition.

NFPA 54, *National Fuel Gas Code*, 2006 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2002 edition.

NFPA 70, *National Electrical Code*®, 2005 edition.

NFPA 72®, *National Fire Alarm Code*®, 2007 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2007 edition.

NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment*, 2004 edition.

NFPA 85, *Boiler and Combustion Systems Hazards Code*, 2004 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*, 2004 edition.

NFPA 101®, *Life Safety Code*®, 2006 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*, 2006 edition.

NFPA 230, *Standard for the Fire Protection of Storage*, 2003 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*, 2006 edition.

NFPA 600, *Standard on Industrial Fire Brigades*, 2005 edition.

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2006 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2006 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2004 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2004 edition.

2.3 Other Publications.

2.3.1 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th floor, New York, NY 10036.

ANSI/ASME B31.1, *Power Piping*, 1998.

ANSI/ASME B31.3, *Chemical Plant and Petroleum Refinery Piping*, 1999.

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

ASME *Boiler and Pressure Vessel Code*, 2001.

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

ASTM E 1226, *Standard Test Method for Pressure and Rate of Pressure Rise for Combustible Dusts*, 2005.

ASTM E 1515, *Standard Test Method for Minimum Explosible Concentration of Combustible Dusts*, 2003.

ASTM E 1591, *Standard Guide for Obtaining Data for Deterministic Fire Models*, 2006.

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 13, *Standard for the Installation of Sprinkler Systems*, 2007 edition.

NFPA 68, *Guide for Venting of Deflagrations*, 2002 edition.

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2006 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. A document, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1 Compartment. A space completely enclosed by walls and a ceiling. The compartment enclosure is permitted to have openings in walls to an adjoining space if the openings have a minimum lintel depth of 8 in. (203 mm) from the ceiling and the openings do not exceed 8 ft (2.44 m) in width. A single opening of 36 in. (914 mm) or less in width without a lintel is permitted when there are no other openings to adjoining spaces. [13, 2007]

3.3.2 Cyclone. See 3.3.9.1.

3.3.3* 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.

3.3.4 Deflagrable Wood Dust. See 3.3.24.1.

3.3.5 Deflagration. Propagation of a combustion zone at a velocity that is less than the speed of sound in the unreacted medium. [68, 2002]

3.3.6 Deflagration Hazard. A situation where deflagrable wood dust is normally in suspension or can be placed in suspension at concentrations at or above the minimum explosible concentration (MEC).

3.3.7 Dry Nondeflagrable Wood Dust. See 3.3.24.2.

3.3.8 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.

3.3.9 Dust Collector. Any device used to separate the material from the air stream, including but not limited to cyclones, filter media-type (baghouse), and enclosureless units.

3.3.9.1* 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.

3.3.9.2* Enclosureless Dust Collector. An air-material separator designed and used to remove dust from the transport air possessing ALL of the following: (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 medium is not enclosed or in a container. (3) The filter medium is not mechanically shaken or pressure-pulsed. (4) The filter medium is under positive pressure. (5) Removal of the collected dust is not continuous or mechanical.

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

3.3.11 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.

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

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

3.3.14* 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. [654, 2006]

3.3.15* 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.

3.3.16 Nonvaporizing Thermal Oil Heating System. See 3.3.19.1.

3.3.17 Pneumatic Conveying System. A material feeder, an air-material separator, an enclosed ductwork system, and an air-moving device in which a combustible particulate solid is conveyed from one point to another with a stream of air or other gases. [654, 2006]

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

3.3.19 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.

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

3.3.19.2 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.

3.3.20 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.

3.3.21 Vaporizing Thermal Oil Heating System. See 3.3.19.2.

3.3.22 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.

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

3.3.24 Wood Dust.

3.3.24.1* Deflagrable Wood Dust. Wood particulate with a median diameter of 420 microns or smaller (i.e., material that will pass through a U.S. No. 40 Standard Sieve), having a moisture content of less than 25 percent (wet basis).

3.3.24.2 Dry Nondeflagrable Wood Dust. Wood particulate with a median diameter greater than 420 microns (i.e., material that will not pass through a U.S. No. 40 Standard Sieve), having a moisture content of less than 25 percent (wet basis).

Chapter 4 General Requirements

4.1 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.

4.2* Process Analysis.

4.2.1 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.

4.2.2 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.

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

4.2.4 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 4.3 of this standard.

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

4.3 Management of Change. Written procedures to manage change to process materials, technology, equipment, procedures, and facilities shall be established and implemented. The requirements of 4.3.1 and 4.3.2 shall be applied retroactively.

4.3.1 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

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

4.3.3 Design documentation, as required by Section 4.2, shall be updated to incorporate the change.

4.4 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.

4.5 Objectives.

4.5.1 Life Safety.

4.5.1.1* The facility, woodworking processes, and human element programs shall be designed, constructed, equipped, and maintained to protect the occupants from the effects of fire, deflagration, and explosion for the time needed to evacuate, relocate, or defend in place occupants who are not intimate with ignition.

4.5.1.2 The structure shall be located, designed, constructed, and maintained to prevent the propagation of fire or deflagration to adjacent properties and to avoid injury to the public at large.

4.5.2 Structural Integrity. The facility shall be designed, constructed, and equipped to maintain its structural integrity in

spite of the effects of fire or deflagration for the time necessary to evacuate, relocate, or defend in place occupants who are not intimate with ignition.

4.5.3* Mission Continuity. The facility, woodworking processes and equipment, and human element program shall be designed, constructed, equipped, and maintained to limit damage to levels that ensure the ongoing mission, production, or operating capability of the facility to a degree acceptable to the relevant authority having jurisdiction.

4.5.4* Mitigation of Fire Spread and Explosions. The facility and processes within the facility shall prevent unintentional deflagrations and other ignitions of combustible materials that can cause failure of adjacent compartments, emergency life safety systems, adjacent properties, adjacent storage, or the facility's structural element.

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

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

4.6 Compliance Options.

4.6.1 Options. Life safety, property protection, and mission continuity meeting the goals and objectives of Section 4.1 and Section 4.5 shall be provided in accordance with either of the following:

- (1) Performance-based provisions per 4.6.2
- (2) Prescriptive-based provisions per 4.6.3

4.6.2 Performance-Based Design. A performance-based design shall be in accordance with Chapter 5.

4.6.2.1* 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 5 of this standard and Chapter 5 of NFPA 101, *Life Safety Code*.

4.6.2.2* 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.

4.6.3 Prescriptive-Based Design. A prescriptive-based design shall be in accordance with Chapter 6 through Chapter 11.

Chapter 5 Performance-Based Design Option

5.1 General Requirements.

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

5.1.2 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.



5.1.3 Sources of Data.

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

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

5.1.4 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.

5.1.5* Documentation Requirements.

5.1.5.1 All aspects of the design shall be documented.

5.1.5.2 The content and format of the documentation shall comply with NFPA 101, *Life Safety Code*, and be acceptable to the authority having jurisdiction.

5.2 Performance Criteria. A system and facility design shall be deemed to meet the objectives specified in Section 4.5 if its performance meets the criteria in this section.

5.2.1 Occupant Life Safety.

5.2.1.1 The life safety objectives of 4.5.1 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.

5.2.1.2 The life safety objectives of 4.5.1 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.

5.2.2 Structural Integrity.

5.2.2.1 The structural integrity objective of 4.5.2 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.

5.2.2.2 The structural integrity objective of 4.5.2 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.

5.2.2.3 The structural integrity objective of 4.5.2 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 shall be limited to that pressure the containment can withstand, by design, without release of flame, burning fuel, hot combustion product gases, or missiles.

5.2.3 Mission Continuity. The mission continuity objectives of 4.5.3 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.

5.2.4 Prevention of Ignition.

5.2.4.1* Prevention of ignition shall be deemed to be achieved when the temperature of the particulates present in the facility is maintained at a temperature lower than either of the following:

- (1) Lowest reported dust layer ignition temperature
- (2) Lowest temperature at which pyrolysis has been reported

5.2.4.2 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.

5.2.5 Prevention of Fire Extension.

5.2.5.1 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.

5.2.5.2 Where the prevention of fire extension to adjacent buildings is to be achieved, the following 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.

5.2.6 Effects of Deflagrations. Where the prevention of damage due to deflagration is to be achieved, the criteria in 5.2.6.1 through 5.2.6.4 shall be demonstrated.

5.2.6.1 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

5.2.6.2 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.

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

5.2.6.4 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.

5.3 Design Fire Scenarios.

5.3.1 Fire Scenarios.

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

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

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

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

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

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

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

5.3.2 Deflagration Scenarios.

5.3.2.1 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.

5.3.2.2 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.

5.3.2.3 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.

5.3.2.4 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.

5.4 Evaluation of Proposed Design.

5.4.1* General. A proposed design's performance shall be assessed relative to each performance objective in Section 1.4 and each applicable scenario in Section 5.3, with the assessment conducted through the use of appropriate calculation methods. The authority having jurisdiction shall approve the choice of assessment methods.

5.4.2 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.

5.4.3 Input Data.

5.4.3.1 Data. Input data for computer fire models shall be obtained in accordance with ASTM E 1591, *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.

5.4.3.2 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.

5.4.3.3* 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.

5.4.4* 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.

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

5.5 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.

Chapter 6 Building Construction

6.1 Prescriptive Requirements.

6.1.1 Facilities that are not designed pursuant to the performance-based design methods outlined in Chapter 5 shall comply with the following deemed to satisfy prescriptive criteria provided by this chapter.



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

6.2* 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.

6.2.1 Fire Walls, Fire Partitions, and Fire Barrier Walls.

6.2.1.1 Walls erected as fire walls and fire barrier walls shall comply with NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*.

6.2.1.2 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.

6.2.2 Protection of Openings and Penetrations.

6.2.2.1 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, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*.

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

6.2.2.3* 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.

6.2.2.4 Fire doors shall be designed, installed, tested, and maintained in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*.

6.2.2.5 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.

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

6.2.2.5.2* Such doors shall not be considered as part of a required means of egress to satisfy the requirements of NFPA 101, *Life Safety Code*.

6.3 Occupant Life Safety Systems Means of Egress.

6.3.1 Occupant life safety systems shall be designed, constructed, installed, and maintained in accordance with NFPA 101, *Life Safety Code*.

6.3.2 The means of egress shall comply with NFPA 101, *Life Safety Code*.

6.3.3 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.

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

6.4 Special Requirements.

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

6.4.2 Damage-Limiting Construction.

6.4.2.1* A dust explosion in one enclosed area shall not damage the building structure, shall not breach any wall dividing this area from an adjacent area in the same building, and shall not propagate to any adjacent indoor area through openings in a dividing wall. The structure areas with a dust hazard shall be so constructed to relieve deflagration pressures and prevent the deflagration from propagating into adjacent interior spaces without losing structural integrity or emergency systems.

6.4.2.2* Where a deflagration hazard is known to exist in a room or building, it shall be considered to have an explosion hazard where dust accumulations exceed 3.2 mm ($\frac{1}{8}$ in.) or where visible dust clouds exist. Rooms or buildings where dust accumulations present an explosion hazard shall be provided with damage-limiting construction, including deflagration venting to a safe outside location.

6.4.2.3* 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.

6.4.3 Draft Curtains.

6.4.3.1 Where required, draft curtains shall be constructed of noncombustible materials.

Exception: Where automatic sprinkler protection has been provided for the building, draft curtains shall be permitted to be constructed of combustible materials other than plastic. Wood panels less than 12.7 mm ($\frac{1}{2}$ in.) thick shall not be used.

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

6.4.3.1.2 Aluminum sheeting shall not be used.

6.4.3.2 Where required, draft curtains shall extend down from the roof deck a minimum depth of 10 percent of the floor-to-ceiling height and shall fit tight against the roof deck.

6.4.3.3 Beams, purlins, and other structural members extending down from the roof deck to a depth equal to or greater than 10 percent of the floor-to-ceiling height shall be deemed equivalent to draft curtains.

Chapter 7 Prevention of Ignition and Control of Ignition Sources

7.1 Prescriptive Requirements. Facilities that are not designed pursuant to the performance-based design methods outlined in Chapter 5 shall comply with the following deemed to satisfy prescriptive criteria provided by this chapter.

7.2 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, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*.

7.3 Electrical Systems.

7.3.1 All electrical systems and system components shall be installed in accordance with NFPA 70, *National Electrical Code*.

7.3.2* 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, *National Electrical Code*.

7.4 Hot Surfaces.

7.4.1* Exterior surfaces of heated process equipment that are or could come in contact with wood shall not exceed a maximum allowable temperature of 260°C (500°F).

Exception: Processes protected in accordance with Chapters 8 and 9.

7.4.2* Bearings shall be dusttight ball or roller type and shall be monitored for adequate lubrication and excessive wear in accordance with 8.2.3.1.

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

7.6 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.

7.7 Fuel-Fired Equipment.

7.7.1 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, *Standard for the Installation of Oil-Burning Equipment*
- (2) NFPA 54, *National Fuel Gas Code*
- (3) NFPA 85, *Boiler and Combustion Systems Hazards Code*

7.7.2 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.

7.7.3* Provisions shall be made to prevent the accumulation of wood and cellulosic dust on the heated surfaces of heating units.

Exception: Where the equipment is operated within the limits of 7.4.1.

7.7.4 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.

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

7.8* Lightning Protection. Lightning protection, where provided, shall be designed, installed, and maintained in accordance with NFPA 780, *Standard for the Installation of Lightning Protection Systems*.

7.9* Static Electricity.

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

7.9.2 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

7.10* Machines and Processing Equipment.

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

7.10.2 Cutter and Abrasive Maintenance.

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

7.10.2.2* 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.

7.11 Machinery Setup and Maintenance.

7.11.1 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.

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

7.12 Foreign Material.

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

7.12.2* 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.

7.12.3 Prevention of foreign materials in dust collection systems shall be in accordance with 8.2.2.

7.12.4 Prevention of foreign materials in particulate size reduction equipment shall be in accordance with Section 8.4.

7.13 Friction.

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

7.13.2* Roller or ball bearings shall be used on all processing and transfer equipment in accordance with 8.2.3.1.

Exception: 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.

7.14 Fans.

7.14.1 Requirements for fans and blowers used in pneumatic conveying systems shall be in accordance with Chapter 8.

7.14.2* 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.

7.15 Spontaneous Ignition and Chemical Action.

7.15.1* 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.

7.15.2 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 Section 8.10
- (3) In separate buildings
- (4) In bins designed such that the particulate flow occurs in a first-in/first-out basis

7.15.3* 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 11.1.10.

7.16 Propellant-Actuated Tools.

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

7.16.2 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.

7.16.3 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.

7.17 Smoking. Smoking shall be restricted in accordance with Section 10.10.

7.18* Portable Electric Equipment and Appliances. Portable electric equipment and appliances used in hazardous areas shall be listed for the area in which they are to be used.

Chapter 8 Processes, Operations, and Special Systems

8.1 General.

8.1.1* Applicability. This chapter shall apply to all pneumatic systems, dust control systems, mechanical conveyors, and mechanical equipment of all types used to convey, re-size, pulverize, dry, or otherwise process wood and wood-derived particulate and other cellulosic materials used as a substitute or supplement for wood.

8.1.2 Prescriptive Requirements. Facilities that are not designed pursuant to the performance-based design methods outlined in Chapter 5 shall comply with the deemed to satisfy prescriptive criteria provided by this chapter.

8.1.3 Fire Protection and Explosion Suppression Systems. Where required, fire protection and explosion suppression systems shall be provided in accordance with Chapter 9.

8.2 Particulate Conveying and Dust Collection Systems.

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

8.2.1.1 The analysis of the fire and deflagration hazard shall address the moisture content and particle size distribution of the particulate comprising the process stream downstream of each point of material entry to determine whether the material is green, dry nondeflagrable, or deflagrable.

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

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

8.2.1.4* 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.

8.2.1.5* In addition to the fire hazard, deflagration conditions shall also be deemed to exist where deflagrable wood dust is, or could be, suspended in air during operation at a maximum concentration above 75 percent of the MEC.

8.2.2 Pneumatic Conveying and Dust Collection Systems.

8.2.2.1 General Requirements.

8.2.2.1.1 Pneumatic conveying systems shall be designed in accordance with NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, except as modified by this standard.

8.2.2.1.2* 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.

8.2.2.1.3 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.

8.2.2.1.4* Dust collection systems shall be in operation whenever equipment connected to the system for the control of fugitive dust is processing wood stock.

8.2.2.1.5* 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.

8.2.2.2 Duct System.

8.2.2.2.1 General Requirements.

8.2.2.2.1.1 Ductwork shall be metallic.

Exception: Flexible ducting shall be permitted for final machine connection in a length not exceeding the minimum required for machine operation.

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

8.2.2.2.1.3 Unless equipped with drainage, horizontal ductwork shall be capable of supporting the weight of the duct half-filled with material. Where sprinkler protection is

provided in the duct, horizontal ductwork shall be capable of supporting the weight of the system plus the weight of the duct half-filled with water or material being conveyed, whichever has the higher density.

8.2.2.2.1.4 Ductwork shall be protected from corrosion.

8.2.2.2.1.5* 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 8.2.2.1.5 in all sections of the system.

8.2.2.2.1.6* Dampers, gates, or orifice plates provided for the specific purpose of balancing the airflow in the system shall be fastened to prevent inadvertent movement.

8.2.2.2.1.7 Ducts with a circular cross-section shall be used.

Exception: Transition to a noncircular cross-section of equal area shall be permitted where ducts connect to other equipment or where external obstructions necessitate a noncircular cross-section.

8.2.2.2.1.8 Ductwork shall be bonded and grounded in accordance with 7.9.2(1).

8.2.2.2.2* Ducts with a Fire Hazard. Ducts conveying dry material released by equipment having a high frequency of generated sparks shall be designed and constructed in accordance with one of the following:

- (1) Equipped with a listed spark detection and extinguishing system installed downstream from the last material entry point and upstream of any collection equipment
- (2)*Equipped with a listed spark detection system actuating a high-speed abort gate, provided the abort gate can operate fast enough to intercept and divert burning embers to atmosphere before they can enter any collection or storage equipment
- (3) If conveying material to locations representing minimal exposure to personnel and the public at large, equipped without spark detection and extinguishing systems but subject to a risk analysis acceptable to the authority having jurisdiction

8.2.2.2.3* Ducts with a Deflagration Hazard. Ducts having a deflagration hazard shall be designed, constructed, and installed pursuant to one of the following:

- (1)*Ducts, including all access hatches, shall be constructed of metal of sufficient strength to withstand the maximum unvented deflagration pressure of the material being conveyed.
- (2)*Metal ducts shall be protected by a listed explosion suppression system that has a design strength exceeding the maximum reduced deflagration pressure.
- (3)*Metal ducts shall be located indoors and equipped with adequate deflagration relief vents that have relief pipes, not exceeding 6 m (20 ft) in length, extending to safe areas outside the building and that have a design strength exceeding the maximum reduced deflagration pressure.
- (4)*Metal ducts shall be located indoors and equipped with adequate deflagration relief vents that exhaust through listed flame-quenching devices and have a design strength exceeding the maximum reduced deflagration pressure.
- (5)*Metal ducts shall be located outdoors and equipped with adequate deflagration vents and shall have a design strength exceeding the maximum reduced deflagration pressure.

- (6)*Metal ducts that are located outdoors and have weaker construction shall be permitted to be used subject to a risk analysis acceptable to the authority having jurisdiction.

8.2.2.3 Hoods and Enclosures.

8.2.2.3.1 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.

8.2.2.3.2 All hoods and enclosures shall be of noncombustible construction unless protected with automatic sprinklers installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

8.2.2.3.3 The rate of airflow into every hood and enclosure shall be sufficient to capture the wood particulate and carry it into the duct system.

8.2.2.4 Fans or Blowers (Air-Moving Devices).

8.2.2.4.1* Fans or blowers shall be of appropriate type and sufficient capacity to maintain the required rate of airflow in all parts of the system.

8.2.2.4.2 Fans and blowers shall be located in one of the following locations:

- (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 a concentration of sub-420 micron particulate, less than 75 percent of the MEC, and the duct downstream of the fan is equipped with a listed spark detection extinguishing system and an abort gate to divert material to a safe location
- (4) Upstream of the dust collector when the material being conveyed has a moisture content of less than 25 percent (wet basis) and a concentration of sub-420 micron particulate, in excess of 75 percent of the MEC, and the duct and dust collector are equipped with either deflagration relief venting or deflagration suppression systems
- (5) Upstream of an enclosureless dust collector, regardless of the moisture content or particulate size of the material being conveyed

8.2.2.4.3* 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 8.2.2.2.3.

8.2.2.5 Dust Collectors.

8.2.2.5.1 General Requirements.

8.2.2.5.1.1 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.

8.2.2.5.1.2 The collection equipment shall be designed and constructed entirely of noncombustible material suitable for the use intended.

Exception: Filter bags and explosion vent diaphragms fabricated from combustible material shall be permitted.



8.2.2.5.1.3* 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

8.2.2.5.1.4* 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 or abrasive planers having mechanical material feeds.
 - (c) Each collector has a maximum air-handling capacity of 2.4 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).

8.2.2.5.2* Dust Collectors with Fire Hazards. Where automatic sprinkler protection is provided in dust collectors, it shall be hydraulically designed to provide a minimum density of 8.15 L/min/m² (0.20 gpm/ft²) over the horizontal projected area of the piece of equipment.

Exception: Enclosureless dust collectors meeting all of the following criteria:

- (1) The collector is used only for dust pickup from wood processing machinery (i.e., no metal grinders and so forth).
- (2) The collector is not used on sanders or abrasive planers having mechanical material feeds.
- (3) Each collector has a maximum air-handling capacity of 2.4 m³/sec (5000 cfm).
- (4) The fan motor is a totally enclosed, fan-cooled design.
- (5) The collected dust is removed from the filter media daily or more frequently if necessary to ensure efficient operation.
- (6) The collector is located at least 6.1 m (20 ft) from any means of egress or area routinely occupied by personnel.
- (7) Multiple collectors in the same room are separated from each other by at least 6.1 m (20 ft).

8.2.2.5.3* Dust Collectors with Deflagration Hazards. Dust collectors with a deflagration hazard shall be designed and constructed in accordance with one of the following options:

- (1)*Dust collectors constructed of welded steel or other non-combustible material of sufficient strength to withstand the maximum unvented deflagration pressure of the material being collected
- (2)*Dust collectors protected by a listed deflagration suppression system with a design strength exceeding the maximum reduced deflagration pressure of the material being collected
- (3)*Dust collectors equipped with adequate deflagration relief vents with a design strength exceeding the maximum reduced deflagration pressure of the material being collected
- (4) Dust collectors located outdoors and representing minimal exposure to personnel and the public at large with weaker construction subject to a risk analysis acceptable to the authority having jurisdiction.

Exception: Enclosureless dust collectors of any strength suitable for the use intended shall be permitted without any additional explosion protection requirements.

8.2.2.6* Recycling Exhaust Air. Air from air-material separators or dust collectors deemed to have either a fire or deflagration hazard shall not be recycled back into the building unless the provisions of 8.2.2.6.1, 8.2.2.6.2, 8.2.2.6.3, or 8.2.2.6.4 are met.

8.2.2.6.1* For dust collection systems of capacity less than or equal to 2.4 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, *National Fire Alarm Code*, located on the duct upstream from the dust collector and downstream from the last material entry point, connected directly to a listed spark extinguishing system, designed and installed in conformance with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, or
- (2) The system shall be protected in accordance with 8.2.2.6.2.

8.2.2.6.2* For dust collection systems of capacity greater than 2.4 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, *National Fire Alarm Code*, 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 8.2.2.6.2(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.

8.2.2.6.3 Air from enclosureless dust collectors meeting the requirements of 8.2.2.5.2 shall be permitted to be exhausted into the building.

8.2.2.6.4 Air from cyclone pre-cleaners, located outside the building and having a capacity of 2.4 m³/sec (5000 cfm) or less shall be permitted to be ducted directly to enclosureless dust collectors located within the building without provisions.

8.2.3 Mechanical Conveying Systems.

8.2.3.1 General Requirements.

8.2.3.1.1 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.

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

8.2.3.1.3 Dusttight ball or roller bearings shall be used wherever practicable.

8.2.3.1.4 All bearings and bushings shall be dusttight.

8.2.3.1.5* Bearings and bushings shall be located outside the equipment.

Exception: Bearings and bushings shall be permitted inside equipment where there is no other practical location.

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

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

8.2.3.2* Mechanical Conveying Equipment with a Fire Hazard. Where provided, sprinkler protection for rubber belt and other conveyors shall be designed, installed, and maintained in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

8.2.3.3 Mechanical Conveying Equipment with a Deflagration Hazard.

8.2.3.3.1 Enclosed conveyors with a deflagration hazard shall comply with the criteria in 8.2.2.2.3.

8.2.3.3.2* Access hatches and removable equipment covers shall be secured with fasteners capable of withstanding design deflagration pressure in accordance with 8.2.2.2.3.

Exception: Where the hatch or cover is designed to also function as a deflagration relief vent.

8.2.4* Conveying System Isolation.

8.2.4.1 Conveying systems with fire and deflagration hazards shall be isolated to prevent propagation of fire and deflagration both upstream and downstream into occupied areas or other critical process equipment. (See Annex D.)

Exception No. 1: Small enclosureless dust collection systems shall be permitted to operate without isolation if they meet all the requirements of 8.2.2.2.3.

Exception No. 2: Conveying systems shall be permitted to operate without isolation subject to a risk analysis acceptable to the authority having jurisdiction.

8.2.4.2* Isolation devices shall be listed for the use intended.

Exception: Where no listed equipment is available for the necessary isolation application, nonlisted equipment that has loss history proving its effectiveness shall be acceptable.

8.2.4.3 Ducts shall be isolated to prevent propagation of deflagration to other vessels.

8.3* Thermal Oil Heating Systems.

8.3.1 Hazard Determination and Design Criteria. Thermal oil heating systems shall be designed, operated, and maintained such that risk of thermal oil spills is minimized, and any fires or

explosions resulting from thermal oil spills are extinguished or controlled in a manner that will not cause unacceptable property damage or interruption of production, or unacceptable risk to operating personnel or the public at large.

8.3.1.1 The hazard posed by the thermal oil system, when the oil is used as heat transfer fluid (HTF), shall be determined on the basis of the largest most credible spill quantity of thermal oil, taking into account the following:

- (1)*Total quantity of thermal oil in the system
- (2)*Flow rate of thermal oil through system loops
- (3)*System instrumentation and alarm features that would detect loss of fluid from the system
- (4)*System automatic controls and interlocks, and/or presence of trained operators, that can reliably shut down pumping and/or isolate portions of the system to limit the amount of thermal oil spilled
- (5)*Spatial orientation of thermal oil piping and system components that would allow isolated portions of the system to drain their trapped quantities of thermal oil by gravity

8.3.1.2* The hazard analysis shall define the location, size, and extent of the maximum most credible thermal oil spill, taking into account the following:

- (1) Diversion of a spill due to floor or ground slope
- (2) Containment of a spill by pits, curbs, and dikes
- (3) Relocation of a spill from the immediate area by drains

8.3.1.3 The hazard analysis shall define the fire intensity and duration of the maximum most credible thermal oil spill defined from the analyses in 8.3.1.1 and 8.3.1.2, taking into account the following:

- (1) Rate at which oil will be spilled
- (2) Rate at which oil will drain away
- (3)*Rate at which oil will be consumed during burning
- (4) Heat release rate of the oil spill fire

8.3.1.4 The hazard analysis shall determine the extent of property damage, loss of production, and risk of injury to operating personnel or the public at large from a fire involving the maximum most credible thermal oil spill, taking into account the following:

- (1) Fire resistance of the exposed equipment or structures
- (2) Presence and adequacy of automatic sprinklers or other special extinguishing systems for the duration of the fire
- (3) Presence of fire alarms and means of egress from the vicinity of the fire

8.3.1.5 For vaporizing thermal oil systems, the risk analysis shall additionally determine the extent of property damage, loss of production, and risk of injury to operating personnel or the public at large from a room explosion involving the sudden release of thermal oil vapor or thermal oil heated above its atmospheric boiling point.

8.3.2 Deemed to Satisfy Prescriptive Criteria. Thermal oil systems that are not designed pursuant to the performance objectives and design criteria in 8.3.1 shall comply with the deemed to satisfy prescriptive criteria of this subsection.

8.3.2.1* General Criteria. Thermal oil shall not be permitted to be pumped throughout a facility to provide building heat except under one of the following conditions:



- (1) All thermal oil piping and points of connection to valves, heat exchangers, or other equipment have welded connections.
- (2) Areas where mechanical joints for thermal oil piping exist are protected with a sprinkler system designed to control a fire in the largest credible thermal oil spill.

8.3.2.2 Location and Construction.

8.3.2.2.1 Thermal oil heaters shall be physically separated from adjacent manufacturing areas by locating them in one of the following areas (in order of preference):

- (1) Outdoors where drainage is certain to be away from a building
- (2) In a detached building
- (3) In a building attached to an outside wall of the manufacturing building with the common wall having a 1-hour fire rating
- (4) In a cutoff room at an outside wall of the main production building with the three interior walls having a 1-hour fire rating

Exception: Nonvaporizing thermal oil heaters with an oil capacity less than 1893 L (500 gal) shall be permitted in manufacturing areas if an oil spill at the heater is controlled pursuant to 8.3.2.2.3.

8.3.2.2.2* Avaporizing thermal oil heater shall be located pursuant to the following:

- (1) In compliance with 8.3.2.2.1
- (2) In a room or building housing having damage-limiting construction to vent an explosion toward a safe area

8.3.2.2.3 Curbs, dikes, or floor slope combined with drainage to a safe location shall be provided around indoor thermal oil system components (e.g., storage tanks and pump heat exchangers).

Exception: Drainage shall not be required when a properly designed automatic sprinkler system is provided over the containment area and the containment area is designed to hold the largest credible oil spill plus 20 minutes of sprinkler discharge.

8.3.2.2.4* Where the utilization of ground slope will not increase hazard, ground slope shall be provided under outdoor thermal oil system components that utilize nonwelded mechanical connections to thermal oil circulation piping to divert oil spills to a safe location away from the thermal oil equipment or adjacent buildings.

8.3.2.2.5* Process control rooms, which are expected to be manned in an emergency, shall be separated from the thermal oil utilization equipment by 1-hour fire-rated construction.

8.3.2.2.6 At least one path of egress from the control room shall be through an area not susceptible to a fire involving thermal oil.

8.3.2.3 Heaters.

8.3.2.3.1 Heaters operating at gauge pressures exceeding 103 kPa (15 psi) shall be designed and operated in conformance with the ASME *Boiler and Pressure Vessel Code*.

8.3.2.3.2* Pressure relief devices, when provided, shall be piped to discharge oil or vapor to a safe location.

8.3.2.3.3 Fire detection systems, fire extinguishing systems, or both for an internal heater fire shall be in accordance with Chapter 9.

8.3.2.4 Piping.

8.3.2.4.1* Piping shall be securely supported to maintain adequate clearance from combustible construction or other combustible materials.

8.3.2.4.2* Welded pipe connections shall be used throughout a thermal oil piping system.

Exception: Bolted mechanical joints shall be permitted to be used at pumps, valves, and equipment connections if both of the following conditions are met:

- (1) Areas where mechanical joints exist are protected with a sprinkler system designed to control a fire involving the largest credible thermal oil spill.
- (2) Mechanical joints are insulated and shielded to prevent a leak from becoming a spray fire, and the shielding has a drip hole at the low point to facilitate detection of leaking joints.

8.3.2.4.3* Where necessary to reduce the largest credible thermal oil spill to an acceptable level, provisions shall be made to isolate the supply and return piping to and from utilization equipment.

8.3.2.4.4 Copper, cast iron, or plastic piping shall not be used.

8.3.2.4.5 For systems operating above gauge pressures of 103 kPa (15 psi), pipe materials and types shall be in accordance with ANSI/ASME B31.1, *Power Piping*, or ANSI/ASME B31.3, *Chemical Plant and Petroleum Refinery Piping*, as applicable.

8.3.2.4.6* Piping that is routed through production areas where airborne wood particulate can collect on thermal oil piping shall be insulated to keep surface temperatures below the maximum permitted by 7.4.1.

8.3.2.5 Expansion Tank.

8.3.2.5.1* Expansion tanks shall be designed in accordance with Section VIII of the ASME *Boiler and Pressure Vessel Code*.

8.3.2.5.2* Expansion tanks that have a breather vent, overflow drain, or pressure relief valve shall have the discharge from these openings piped to a safe location.

8.3.2.5.3* When necessary to reduce the largest credible thermal oil spill to an acceptable level, the expansion tank shall be provided with a remotely operable drain line that allows the expansion tank to be drained to a safe location.

8.3.2.5.4* An automatic expansion tank refill system to maintain the thermal oil level in the expansion tank shall not be permitted.

8.3.2.5.5* Expansion tanks on vaporizing systems or on nonvaporizing systems that heat the oil to within 50 degrees of its atmospheric boiling point shall be provided with an inert gas blanket in the expansion tank vapor space.

8.3.2.5.5.1 The inert gas blanket shall operate at a pressure between 103 kPa and 172 kPa (15 psi and 25 psi) above the vapor pressure of the heated oil.

8.3.2.5.5.2 A low-pressure interlock shall be provided that will shut off the heater fuel source if the inert gas pressure drops to less than 103 kPa (15 psi) above the hot oil vapor pressure.

8.3.2.6* **Storage Tanks.** Both indoor and outdoor above-ground thermal oil storage tanks shall be constructed, located, and arranged in accordance with NFPA 30, *Flammable and Combustible Liquids Code*.

8.3.2.7 Safety Controls and Interlocks.

8.3.2.7.1* All thermal oil system emergency shutdown and isolation devices intended to limit the largest credible thermal oil spill shall be interlocked to actuate when any one of the following conditions exist:

- (1) Automatic sprinkler system water flow in any area containing thermal oil heaters, pumps, utilization equipment, or thermal oil piping that is not fully welded at all connecting joints
- (2) Activation of a fire detection system in any area containing thermal oil heaters, pumps, utilization equipment, or thermal oil piping that is not fully welded at all connecting joints
- (3) Activation of the thermal oil leak detection system

Exception No. 1: If an area has both a fire detection system and an automatic sprinkler system, only one of these shall be required to activate the automatic shutdown and isolation.

Exception No. 2: If the area where the fire detection, sprinkler water flow, or thermal oil loss can be positively identified by the arrangement and/or control system of the detection devices, only those automatic shutdown and isolation devices required to stop thermal oil flow into and out of the affected area shall be required to be interlocked for automatic actuation.

Exception No. 3: If an area subject to a thermal oil spill is under constant observation by operators or personnel who are trained to respond and have access authority to manually activate the required thermal oil system shutdown and isolation, then automatic shutdown by sprinkler water flow shall not be required for that area.

8.3.2.7.2* An accessible, manual, remote emergency shutoff switch shall be provided that is capable of safely shutting down and isolating the heat transfer system in the configuration required to limit the largest credible thermal oil spill.

8.3.2.8 Fuel Burner Controls and Interlocks.

8.3.2.8.1 Oil or gas-fired heaters shall be designed and installed in accordance with the applicable requirements of NFPA 85, *Boiler and Combustion Systems Hazards Code*.

8.3.2.8.2 Wood dust suspension burners shall be designed and installed in accordance with the applicable requirements of NFPA 85, *Boiler and Combustion Systems Hazards Code*.

8.3.2.8.3* Heaters that burn wood waste in a fluidized bed or on a grate shall provide a means to prevent the accumulation of explosible concentrations of combustibles in the heater or in any stack gas utilization equipment, following a shutdown with unburned fuel in the heater.

8.3.2.8.4* If stack gas from the thermal oil heater is recovered to provide auxiliary base load heat for other equipment (e.g., rotary dryers), a means shall be provided to ensure that all equipment is properly purged prior to an attempt being made to ignite a burner on any of the interconnected equipment.

8.3.2.8.5* Instrumentation and interlocks shall be provided to sound an alarm and automatically shut off the fuel source to the thermal oil heater when any of the following conditions are detected:

- (1) Low thermal oil flow or pressure at the heater outlet
- (2) High thermal oil temperature or pressure at the heater outlet
- (3) Low oil level in expansion tank and, if provided, any other signal indicating loss of thermal oil from the system

- (4) Low liquid thermal oil level in heater (vaporizing systems only)
- (5) Activation of a fire detection system, extinguishing system, or both, for the heater heat exchanger, if provided

8.3.2.9 Operational Considerations.

8.3.2.9.1 Any and all system leaks that are discovered shall be promptly corrected with permanent repairs, regardless of the size of the leak.

8.3.2.9.2 Any spilled oil shall be cleaned up promptly.

8.3.2.9.3 Any pipe or equipment insulation that is discovered to be oil-soaked shall be promptly removed and replaced with clean, oil-free insulation.

8.3.2.9.4* If it is suspected that the material being heated is infiltrating into the thermal oil loop, the system shall be immediately shut down to find and repair the leakage.

8.3.2.9.5* Operators shall be trained at least annually in proper operation of the thermal oil system, including recognition and proper response to upset conditions that could lead to dangerous situations.

8.3.2.9.6 Safety interlocks shall be inspected, tested, and calibrated at least annually to keep them in proper operating condition.

8.3.2.9.7* The physical properties of the thermal oil shall be tested and documented annually, with replacement of all oil in the system when recommended by the oil manufacturer.

8.3.2.10* Fire Protection.

8.3.2.10.1 Automatic sprinkler protection meeting the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, for Extra Hazard Group 1 occupancies shall be provided for building areas containing heat transfer system heaters, vaporizers, equipment using thermal oil, plenums, or any other areas where a hot oil spill could accumulate.

8.3.2.10.2* Heaters shall be provided with a means to detect and automatically extinguish a thermal oil spill fire in the fire box or heat exchanger section where spilled oil would collect.

Exception: An automatic extinguishing system shall not be required where one of the following conditions exists:

- (1) Systems contain less than 7571 L (2000 gal) of thermal oil, subject to a risk analysis that is acceptable to the authority having jurisdiction.
- (2) Heaters have a fire detection system interlocked to physically isolate the heater from the external thermal oil piping.
- (3) Instrumentation is present to alert operators of an oil fire in the heater and operators constantly monitor conditions in the heater and are trained to actuate a manual extinguishing system.

8.3.2.10.3* Activation of a heater fire extinguishing system shall automatically stop the primary thermal oil circulation pumps.

Exception: Automatic shutdown of primary circulation pumps shall not be required when both of the following conditions exist:

- (1) The heater contains a bed of wood waste fuel or the refractory inside the heater can retain enough heat to cause thermal oil breakdown and tube fouling if fluid circulation through the unit is stopped.
- (2) The primary loop system has an emergency bypass with an oil cooling heat exchanger to rapidly reduce oil temperature.



8.4* Particulate Size Reduction Equipment.

8.4.1 Hazard Analysis and Design Criteria.

8.4.1.1* 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.

8.4.1.2 The hazard associated with the particle size reduction equipment shall be based on the physical properties of particulate, including the following:

- (1) Minimum explosible concentration
- (2) Minimum ignition energy (MIE)
- (3) Particle size distribution
- (4) Moisture content as received and as tested
- (5) Maximum explosion pressure at optimum concentration
- (6) Maximum rate of pressure rise at optimum concentration
- (7) K_{St} (normalized rate of pressure rise) as defined in ASTM E 1226, *Standard Test Method for Pressure and Rate of Pressure Rise for Combustible Dusts*
- (8) Layer ignition temperature
- (9) Dust cloud ignition temperature
- (10) Limiting oxidant concentration (LOC) to prevent ignition
- (11) Electrical resistivity
- (12) Charge relaxation time
- (13) Chargeability

8.4.2 Deemed to Satisfy Prescriptive Requirements.

8.4.2.1 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 8.4.1.

8.4.2.2 General Requirements.

8.4.2.2.1* All equipment shall be designed in accordance with 8.2.3.1.

8.4.2.2.2* 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.

8.4.2.3* Size Reduction Equipment with a Fire Hazard. Downstream equipment shall be protected against ignitions caused by size reduction equipment in accordance with Section 8.2.

8.4.2.4* Size Reduction Equipment with a Deflagration Hazard.

8.4.2.4.1 Size reduction equipment shall be located outdoors.

Exception: Size reduction equipment shall be permitted indoors if located in a detached building or separated from other production areas by damage-limiting construction.

8.4.2.4.2* Size reduction equipment shall be constructed in accordance with one of the following:

- (1) An enclosure shall be constructed of welded steel or other noncombustible material of sufficient strength to withstand the maximum unvented explosion pressure of the processed material.
- (2) An enclosure shall be constructed of noncombustible material, protected by a listed explosion suppression system with a design strength exceeding the maximum reduced explosion pressure of the processed material.

- (3) An enclosure constructed of noncombustible material, equipped with adequate deflagration relief vents having relief pipes extending outdoors or discharging through listed flame-quenching devices, shall have a design strength exceeding the maximum reduced explosion pressure of the processed material.

8.4.2.4.3 Rooms containing the size reduction equipment shall be considered a Class II, Division 2 hazardous area as defined in Article 500 of NFPA 70, *National Electrical Code*.

Exception: When fugitive dust is not cleaned off building and equipment structures and is allowed to accumulate to depths exceeding 3.2 mm (1/8 in.) thick, the room shall be considered a Class II, Division 1 hazardous area as defined in Article 500 of NFPA 70, National Electrical Code.

8.5 Panel Product Manufacturing Machinery.

8.5.1 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.

8.5.2 Bearings, rollers, and bushings shall be in accordance with 8.2.3.1.

8.5.3 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.

8.5.4 Dust. 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 Section 8.2.

8.6 Dryer Systems.

8.6.1* Veneer and Fiberboard Dryers.

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

Exception: Protection can be omitted from portions of the dryer where the following conditions exist:

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

8.6.1.2 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.)

8.6.1.3* 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.

8.6.1.4* 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.

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

8.6.1.6 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.

8.6.2* Rotary Dryers.

8.6.2.1 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

8.6.2.2* 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.

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

8.6.3* Conveyor Dryers.

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

8.6.3.2 Dust collection systems used to capture dust emissions in or between individual conveyor dryers shall be designed in accordance with 8.2.2.

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

8.6.4* Flash Tube Dryers.

8.6.4.1 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, *Standard on Explosion Prevention Systems*.

8.6.4.2* 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.

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

8.6.5* Kiln Dryers.

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

8.6.5.2 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.

8.6.5.3 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.

8.6.5.4 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, *Standard for the Installation of Sprinkler Systems*, for Extra Hazard Group 1 occupancies over the entire kiln area.

8.6.5.5 Hydraulic calculations shall be balanced for the simultaneous operation of all sprinklers above and below the fan deck.

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

8.6.5.7 Fuel burner combustion controls and interlocks shall conform to Section 8.3.

8.6.6 **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, *Standard for the Installation of Sprinkler Systems*.

8.7 **Spray Finishing.** Spray finishing operations shall be in accordance with NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*.

8.8 **Dipping and Coating.** Dipping and coating operations shall be in accordance with NFPA 34, *Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids*.

8.9* Pollution Control Equipment.

8.9.1 The pollution control exhaust system shall be designed and maintained in accordance with NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Non-combustible Particulate Solids*.

8.9.2 Pollution control bag filters shall be designed in accordance with 8.2.2.5.

8.9.3 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.

8.10 **Storage.** Except as modified in this section, storage shall be in accordance with NFPA 230, *Standard for the Fire Protection of Storage*.

8.10.1 **Dry Lumber.** Where protected, indoor storage of lumber, panelboard, stuck lumber, dense pack lumber, and veneer shall be protected in the same manner as a Class II commodity in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

Exception: Where the moisture content is greater than or equal to 25 percent (wet basis), the stored materials shall be protected in the same manner as a Class I commodity in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems.

8.10.2 **Flammable Liquid Storage.** Design protection for bulk and container storage shall be in accordance with NFPA 30, *Flammable and Combustible Liquids Code*.

8.10.3 Silos and Storage Bins.

8.10.3.1* Where automatic sprinkler protection is provided in bins, hoppers, and silos, the system shall be hydraulically designed to provide a minimum density of 8.15 L/min/m² (0.20 gpm/ft²) over the horizontal projected area of the piece of equipment.

