NFPA 8503
Standard for Pulverized Fuel Systems

1997 Edition

National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

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This edition of NFPA 8503, *Standard for Pulverized Fuel Systems*, was prepared by the Technical Correlating Committee on Boiler Combustion System Hazards and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 19–22, 1997, in Los Angeles, CA. It was issued by the Standards Council on July 24, 1997, with an effective date of August 15, 1997, and supersedes all previous editions.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

This edition of NFPA 8503 was approved as an American National Standard on August 15, 1997.

Origin and Development of NFPA 8503

The initial *Standard for the Installation of Pulverized Fuel Systems* (NFPA 60) was adopted in 1924 during the early development of equipment for burning pulverized fuel in suspension. This standard was continued until 1945, at which time it was superseded by a new code under the separate title, *Code for the Installation and Operation of Pulverized Coal Systems* (NFPA 60A). The earlier code was maintained in effect for equipment that was installed prior to 1945 until January 1957, at which time it was retired from active status by the Committee on Dust Explosion Hazards.

The distinguishing feature of the 1945 standard, which provided greater safety in operation and was made practicable by the evolution and improvement of equipment design, is represented by its requirements that equipment be capable of withstanding internal explosion pressures of 50 psi without dependence on venting facilities in equipment and buildings for relief of explosions as specified by the earlier code.

Following 1973, the standard was transferred from the Committee on Dust Explosion Hazards to the Committee on Boiler-Furnace Explosions, and the number changed from NFPA 60 to NFPA 85F. At the Annual Meeting in 1978, a complete revision to the former NFPA 60 was accepted and the revision was published as NFPA 85F.

Changes to the 1982 edition were made primarily to reorganize and relocate essential material for increased clarity and to more closely comply with the NFPA *Manual of Style*. Numerous other changes were made to provide for proper sequential operation and control of boiler firing.

The 1988 standard consisted of a complete rewrite of the document. These changes ranged from a clarification of the retroactivity policy to limitations on the use of brittle materials. Revised diagrams also were included to clarify certain requirements of these systems.

The 1992 edition was a partial revision and included a variety of changes. Foremost was the renumbering and retitling of the document to NFPA 8503, *Standard for Pulverized Fuel Systems*. This change was consistent with an initiative by the NFPA boiler project to remove the letter designations and use shorter document titles.

This latest edition is a partial revision, and it includes changes to clarify the document's scope. Definitions have been added, and figures and references have been updated.

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Committee Scope: This Committee shall have primary responsibility for documents on the reduction of combustion system hazards in single- and multiple-burner boilers with a heat input rate of 12,500,000 Btu/hr and above. This includes all fuels. This Committee also is responsible for documents on the reduction of hazards in pulverized fuel systems, fluidized-bed boilers, heat recovery steam generators, and stoker-fired boilers, at any heat input rate.

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Committee Scope: This Committee shall have primary responsibility for documents on the operation and design requirements of pulverized fuel systems and reduction of hazards associated with those systems. This includes all carbonaceous solid fuels at any heat input rate.

This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in membership may have occurred. A key to classifications is found at the back of this document.

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.

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

Information on referenced publications can be found in Chapter 6 and Appendix E.

Foreword

Technological advances in recent years, and in particular the pervasiveness of microprocessor-based hardware, make it even more important that only highly trained individuals be employed in the translation of these guidelines into operating systems. Each type of hardware has its own unique features and operational modes. It is vital that the designer of the safety system be completely familiar with the features and foibles of the specific hardware as well as possess a thorough understanding of these standards and their intent.

It is neither possible for these standards to encompass the specific hardware applications nor should these standards be considered a "cookbook" for the design of a safety system.

When applying any type of equipment to a safety system, the designer must carefully consider all of the possible failure modes and the effect that each might have on the integrity of the system and the safety of the unit and personnel. In particular, no single point failure should result in an unsafe or uncontrollable condition, or in a masked failure of a microprocessor-based system that could result in the operator unwittingly taking action that could lead to an unsafe condition.

Chapter 1 Introduction

1-1 Scope.

1-1.1 This standard shall apply to pulverized fuel systems, beginning with the raw fuel bunker, which is ahead of the pulverizer, and the point at which primary air enters the pulverizing system, and terminating at the point where pressure can be relieved by fuel being burned or collected in a device that is built in accordance with this standard. The pulverized fuel system shall be defined to include the primary air ducts, which are upstream of the pulverizer, to a point where pressure can be relieved by application of a suitable vent or other means.

1-1.2 This standard shall cover only those fuels having reactivities greater than that of Pennsylvania anthracite with a volatile content of 8 percent on a dry basis. Reactivity of a fuel, relative to this base, shall be determined by the pulverizer manufacturer utilizing his or her own technique, and applicability of the standard shall be determined and agreed to by the user.

1-1.3 In the case of pulverized fuel–fired boiler furnaces, a related work is NFPA 8502, *Standard for the Prevention of Furnace Explosions/Implosions in Multiple Burner Boilers.* Users of this type of equipment are, therefore, referred to both standards.

1-1.4 This standard shall exclude those systems with an oxygen content that is greater than 21 percent, which require special attention.

1-1.5 Revisions to this document recognize the current state of knowledge and shall not imply that previous editions were inadequate.

1-2 Purpose.

1-2.1 The purpose of this standard is to establish minimum standards for design, installation, operation, maintenance, and personnel safety in connection with pulverized fuel systems. The standard's purpose also includes contributing to operating safety and minimizing the probability of pulverized fuel system explosions and the effects of explosions that do occur.

1-2.2 No standard can be promulgated that will guarantee the elimination of pulverized fuel system explosions. Technology in this area is under constant development, which will be reflected in revisions to this standard. The users of this standard must recognize the complexity of pulverized fuel systems with regard to the type of equipment and the characteristics of the fuel. Therefore, the designer is cautioned that this standard is not a design handbook. The standard does not eliminate the need for the engineer or competent engineering judgment. It is intended that a designer who is capable of applying more complete and rigorous analysis to special or unusual problems shall have latitude in the development of such designs. In such cases, the designer is responsible for the validity of the approach.

1-2.3 This standard shall be applicable to new installations and to major alterations or extensions of existing equipment for the preparation and burning of fuel in pulverized form that was contracted subsequent to June 15, 1992. The standard shall not be retroactive.

1-2.4 The provisions of this standard shall be considered necessary to provide a reasonable level of protection from loss of life and property from fire and explosion. They shall reflect conditions and the state of the art at the time the standard was issued.

The standard shall apply to any retrofit program that involves replacement of the entire pulverized fuel system as defined in 2-5.1 and 2-5.2. For less than total system replacement, the user is encouraged to consider application of this standard.

1-3 Basic Principles.

1-3.1 Functional Requirements.

1-3.1.1 The various types of pulverized fuel systems convert a solid fuel to pulverized fuel and deliver it continuously and at controlled rates to burners, storage bins, or other apparatus.

1-3.1.2 Pulverized fuel systems and their components shall be capable of long-term continuous and proper operation. Unwanted interruptions shall be kept to an absolute minimum because of the general combustible and explosive nature of the pulverized fuels. Experience shows that fires and explosions are most likely to occur during start-up or shutdown or after an emergency shutdown.

1-3.1.3 Pulverized fuel systems shall incorporate all necessary equipment and controls to provide for repeated safe cycles of start-up, operation, and shutdown, whether these cycles are of long or short duration.

1-3.1.4 The pulverized fuel system shall be sized and arranged to meet the demands of the system that it serves over the required range of operation.

1-3.2 Hazards in Pulverized Fuel Systems. The design, operation, and maintenance of a pulverized fuel system shall recognize certain inherent hazards, as outlined in 1-3.2.1 through 1-3.2.17.

1-3.2.1 An uninterrupted, controllable, raw fuel supply is essential to minimize fires and explosions within the system. These interruptions and control problems in the fuel supply can be caused by worn equipment, excessive surface moisture, large or unusual fuel sizing, or foreign substances, including iron, wood, rags, excelsior, or rock. Compositions of certain clays (i.e., Bentonitic or mixed layers), which are contained in some coal seams, can cause interruptions in coal flow, which shall be guarded against.

1-3.2.2 To facilitate the discharge of fuel from the raw fuel bunker at a controlled rate, the bunker shall be designed in accordance with principles that are stated in 2-6.5. These principles require a bunker design that provides for mass flow and self-cleaning flow characteristics. The purchaser or the purchaser's designated representative shall be aware of the wide range in material-handling characteristics of fuel that are related to differences in moisture, size distribution, and consolidation characteristics. The probable range in these characteristics for the fuels to be used and a determination of time consolidation shear values over these ranges are prerequisites for obtaining a bunker design that provides the desired flow characteristics over the range of fuels to be used. If the fuel is of a nature in which spontaneous combustion in the raw fuel bunker is likely to occur even when equipment is in service, the bunker design shall be a mass flow design.

1-3.2.3 A fire that is ahead of or in the pulverizer usually causes an abnormal increase in temperature of the equipment or of the mixture leaving the pulverizer. Fires are caused by feeding burning fuel from the raw fuel bin, by spontaneous combustion of an accumulation of fuel or foreign material in the pulverizer, piping, or burners, or by operating at abnormally high temperatures.

1-3.2.4 Fires in burner pipes or other parts of pulverized fuel systems after the pulverizer will generally not be detected by an abnormal increase in pulverizer outlet temperature. Temperature sensors on pipes or in or on other components of the system can be used to detect these fires.

1-3.2.5 Abnormally hot, smoldering, or burning raw fuel that is ahead of the pulverizer shall be considered serious and shall be dealt with promptly. The procedures outlined in Section 3-5 shall be followed.

1-3.2.6 Transport Air.

1-3.2.6.1 Transport velocities shall be adequate to prevent settling of the fuel particles in the system or flashback from the burners.

1-3.2.6.2 Pulverized fuel is conveyed through pipes from the pulverizer in transport air. Malfunction or maloperation can introduce several hazards. For example, improper removal of a burner from service can introduce the settling out of pulverized fuel in the burner pipes, a leakage of pulverized fuel from the operating pulverizer through the burner valve into an idle burner pipe, or leakage of gas or air through a burner valve, thereby causing a fire in an idle pulverizer. In Chapter 3, necessary precautions are established to avoid such hazards.

1-3.2.7 Pulverizers that are tripped under load will have fuel remaining in the hot pulverizer, burner piping, and burners. These accumulations can cause spontaneous combustion of the fuel or an explosion.

1-3.2.8 Fuel systems are hazardous when fuel escapes into the surrounding atmosphere or when air enters an inerted system.

1-3.2.9 Oxidation can raise a fuel's temperature to a point where auto-combustion or spontaneous combustion can occur. This characteristic can constitute a special hazard with certain fuels and fuel mixtures.

1-3.2.10 Accumulations of fuel in the pulverizer can cause fires. This buildup could be due to design, conditions of wear, or insufficient drying, indicated by too low a pulverizer outlet mixture temperature.

1-3.2.11 Excessive pulverizer outlet mixture temperatures increase the possibility of pulverizer fires and can cause accumulation of fuel on burner parts.

1-3.2.12 Gases can be released from freshly crushed fuel, and accumulations of flammable or explosive mixtures can occur in bins or other enclosed areas.

1-3.2.13 Hot air flowing back into the fuel bunker constitutes a hazard.

1-3.2.14 To ensure compatibility of the equipment and the type of fuel to be pulverized, it is desirable to have a quality definition of the fuel. This definition shall be acceptable to the equipment designer, the agency responsible for procurement of the fuel, and the operating department. Volatility, moisture, ash content, maximum size and distribution, grindability, corrosiveness, abrasiveness, and other characteristics shall be given close attention.

1-3.2.15 A pulverized fuel system is designed for a specific range of fuel characteristics. Fuels that differ widely from the design range can cause serious operating difficulties and can produce a potential safety hazard. Care shall be exercised to make sure that all received fuels are within the specific range of the fuel-handling and fuel-burning equipment.

1-3.2.16 Improperly trained personnel, inadequate maintenance programs, or operation of abnormally worn equipment can cause fires and explosions.

1-3.2.17 Accumulation of pulverized fuel in air ducts or pipes, particularly those shared by a group of pulverizers, is hazardous.

1-3.3 Pulverizing and Fuel System Component Functions.

1-3.3.1 Drying and Conveying of Fuel. Pulverizer air is used to continuously convey the pulverized fuel from the pulverizer. Normally, heated pulverizer air evaporates some of the moisture from the raw fuel while it is being pulverized, and it elevates the air/fuel mixture to the desired temperature. The temperature and quantity of pulverizer air that is used is controlled to obtain the desired degree of dryness and pulverizer outlet temperature, depending on the type of fuel being burned.

1-3.3.2 Classifying the Pulverized Fuel. An essential characteristic of the pulverized product is its fineness. It is desirable that the pulverized fuel system minimizes variation in fineness as pulverizer parts exhibit wear and as fuel properties change over the anticipated range. For this purpose, most pulverizers are equipped with adjustable classifiers or achieve some adjustment of fineness by varying air flow or other means.

1-3.3.3 Transporting and Distributing the Pulverized Fuel. The pulverized fuel shall be transported directly to one or more burners, to one or more air/fuel separation devices, or to one or more bins or lock hoppers for intermediate storage.

1-3.3.4 Refuse Removal. It is desirable that foreign, hard-to-grind material be removed from the fuel before it is fed to the pulverizers; however, it is advisable that the pulverizers reject or tolerate reasonable amounts of such materials so that damage or interruption of service does not result.

1-3.4 Manufacturing, Design, and Engineering.

1-3.4.1 The equipment manufacturer, the designer, and the purchaser or the purchaser's agent shall cooperate in determining requirements for equipment design and operation.

1-3.4.2 An evaluation shall be made to determine the optimum integration of manual and automatic safety features, considering the advantages and disadvantages of each trip function. The results of the evaluation shall be used in the system design.

NOTE: The maximum number of automatic trip features does not necessarily provide for maximum safety. Some trip actions result in additional operations that increase exposure to hazards.

1-3.5 Coordination of Design, Installation, and Operations.

1-3.5.1 The pulverized fuel system shall not be released for operation before the installation and checkout of the required safeguards and instrumentation system.

1-3.5.1.1 The constructor who is responsible for the erection and installation of the equipment shall verify that all pertinent apparatus is installed and connected in accordance with the system design.

1-3.5.1.2 The purchaser, the engineering consultant, the equipment manufacturer, and the operating company shall prohibit pulverized fuel system operation until such safeguards have been tested for proper operation as a system. In some instances, it could be necessary to install temporary interlocks and instrumentation to meet these requirements. Any such temporary system shall be reviewed by the purchaser, the engineering consultant, the equipment manufacturer, and the operating company, and agreement shall be reached on its suitability in advance of start-up.

1-3.5.1.3 Testing and checkout of the safety interlock system and protective devices shall be accomplished jointly by the organization with the system design responsibility and those who operate and maintain such a system and devices. These tests shall be accomplished before initial operation.

1-3.5.2 It is essential that proper coordination of design, installation, operation, maintenance, and training be accomplished.

1-3.6 Operation, Maintenance, and Training.

1-3.6.1 The pulverized fuel system handles erosive materials that can cause rapid rates of wear of system components, thus creating a potential explosion hazard. Special maintenance measures are required to safeguard the system. A preventive maintenance program, using criteria such as tonnage or hours of service, which are based on plant experience, shall be put into effect. The manufacturer's recommendations shall be considered in establishing these maintenance criteria, especially in those plants with little or no experience in handling pulverized fuel.

1-3.6.2 For safe operation, proper coordination of the overall design and functional objectives are important. It cannot be assumed that correctly designed equipment and the manufacturer's operating instructions can be wholly relied upon to ensure a safe operating system without the benefit of a competent technical, operating, and maintenance plant organization.

1-3.6.3 Continued competence can only be achieved by maintenance of technical training and operator proficiency as a continuing activity throughout the life of the plant after initial training.

1-3.6.4 Control equipment, including interlocks and alarms, shall be maintained properly at all times to ensure the proper and reliable operating condition of the system. All control equipment shall operate over a period of time that is consistent with the equipment being controlled without requiring maintenance.

1-4 Definitions. For the purpose of this standard, the following definitions shall apply.

Air.

Auxiliary Air. Air or inert gas that is supplied from an auxiliary source to maintain a minimum fuel mixture velocity in the burner piping.

Primary Air. The air or inert gas that is used to convey the pulverized fuel to the burners.

NOTE: In some direct-fired pulverized fuel systems, the primary air serves the same function as pulverizer air.

Pulverizer Air. Air or inert gas that is introduced into the pulverizer to convey the pulverized fuel from the pulverizer and to dry the fuel if required.

Seal Air. Air or inert gas that is supplied to any device at an adequate pressure for the specific purpose of minimizing contamination.

Tempering Air. Air or inert gas at a lower temperature that is added to hot primary air or gas to modify its temperature.

Transport Air. Air or inert gas that is used to convey pulverized fuel.

Alarm. An audible or visible signal indicating an off-standard or abnormal condition.

Alteration. A change or modification in a pulverized fuel system or subsystem that results in a deviation from the original design specifications or criteria.

Annunciator. A device that indicates an off-standard or abnormal condition by both visual and audible signals.

Approved.* Acceptable to the authority having jurisdiction.

Authority Having Jurisdiction.* The organization, office, or individual responsible for approving equipment, an installation, or a procedure.

Bin. An enclosure to store pulverized fuel.

Bunker. An enclosure to store raw fuel.

Burner. A device or group of devices for the introduction of fuel and air into a furnace at the velocities, turbulences, and concentrations that are necessary to maintain ignition and combustion of the fuel within the furnace.

Classifier. A device to control pulverized fuel particle size distribution.

Confined Space. Any work location or enclosure in which either of the following exist:

(a) The dimensions are such that a person who is 6 ft (1.8 m) tall cannot stand up in the middle of the space or extend his or her arms in all directions without hitting the enclosure.

(b) Access to or from the enclosure is by manhole, hatch, port, or other relatively small opening that limits ingress and egress to one person at a time.

Confined spaces can include but are not limited to the following: pulverizers, ducts, heaters, windboxes, cyclones, coal dust collectors, furnaces, bunkers or bins, and so forth.

Cyclone. A device that separates the pulverized fuel from air or inert gas by centrifugal action.

Damper.

Auxiliary Air Control Damper. A controllable damper for regulating the flow of auxiliary air.

Hot Air Control Damper. A controllable damper for regulating the flow of hot air as required to control pulverizer outlet temperature.

Primary Air Control Damper. A controllable damper for regulating the flow of primary air or pulverizer air.

Primary Air Shutoff Damper. A tight-seating damper, usually located upstream from the primary air control damper, to prevent flow.

Shutoff Damper. A close-fitting damper to minimize air or flue gas passing into any system component.

Tempering Air Control Damper (Cold Air Damper). A controllable damper that is used for controlling the flow of tempering air.

Direct-Fired System (Unit System). A system in which the fuel is pulverized and delivered suspended in the primary air directly to the burner(s).

Distributor/Divider. A device that splits a single fuel and primary air stream into two or more streams.

Dust Collector. An auxiliary separator that is used to separate the fuel dust from the air or inert gas prior to discharge of the latter from the system.

Exhauster. The fan that is used to draw the pulverizer air through the pulverizer and to deliver the air/fuel mixture to the burner(s) or other apparatus.

Feeder, Fuel. A device for supplying a controlled amount of fuel to a system or subsystem.

Flame. The visible or other physical evidence of the chemical process of rapidly converting fuel and air into products of combustion.

Gate, Fuel. A shutoff gate between the fuel bunker or bin and the fuel feeder.

Grindability. The characteristic of solid fuel that represents its relative ease of pulverization. *(See ASTM D 409, Grindability of Coal by the Hardgrove-Machine Method.)*

Igniter. A device that provides adequate ignition energy to immediately light off the main burner. *(See NFPA 8502, Standard for the Prevention of Furnace Explosions/Implosions in Multiple Burner Boilers.)*

Inert Gas. A gas that is noncombustible, nonreactive, and incapable of supporting combustion with the contents of the system being protected.

Inerting. The dilution of the oxygen content of an air/fuel mixture to a point where it is no longer explosive through the addition of an inert gas or vapor.

Interlock. A device or group of devices arranged to sense a limit or off-limit condition or improper sequence of events. Once one of these conditions is detected, the interlock shall shut down the offending or related piece of equipment or prevent proceeding in an improper sequence to avoid a hazardous condition.

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.

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 identified standards or has been tested and found suitable for a specified purpose.

Lock Hopper. A vessel with valves and controls for transferring fuel from a low-pressure containment to a higher one.

Pressure/Air Lock. A device for transferring pulverized fuel between zones of different pressure without permitting appreciable flow of air or gas in either direction.

Primary Air Fan (Pulverizer Air Fan). The fan that is used to supply the pulverizer air to the pulverizer or to supply the air to the burner lines of a storage system.

Pulverized Fuel. Solid fuel that is reduced to a size such that more that 50 percent will pass through a 200-mesh (74-μm) sieve.

Pulverized Fuel Pump. A device or system for transporting fuel mechanically or pneumatically by utilizing minimum air flow.

Pulverizer. A machine to convert solid fuel to pulverized fuel.

Repair. A process that returns the pulverized fuel system or subsystem to its original design specifications or criteria.

Shall. Indicates a mandatory requirement.

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

Valve.

Barrier Valve. A valve, not necessarily dusttight, to impede furnace gases from traveling back into any system component that is opened for inspection or maintenance.

Burner Shutoff Valve. A valve that is installed in the fuel line between the pulverizer and the burner.

Check Valve. A self-operating valve that is used to prevent reverse flow through any portion of the system.

Dusttight Valve. A tight-seating valve that is intended to stop flow.

Flow Control Valve. A device that is capable of regulating quantity of throughput to a controlled range.

Vent Control Valve. A controllable valve for regulating the flow of vented air or gas from the system.

Vent Valve. A valve that is used to permit venting of air or gas from the system.

Vent. An outlet through which air or gas can be discharged from the system to relieve explosion pressures.

Chapter 2 Design

2-1 Introduction. General requirements for pulverized fuel systems are covered in this chapter. Specific requirements for only the more commonly used direct-fired unit systems and storage systems are covered in detail. For other types of systems, refer to Chapter 5 and Appendices B and C.

2-2 System Arrangement Requirements.

2-2.1 The system arrangement shall be such that it provides only one possible direction of flow (i.e., from the points of entrance of fuel and air to the point of discharge), which can be either a furnace or a transport and collection system.

2-2.1.1 Means shall be provided to resist the passage of air or gas from the pulverizer through the feeder into the bunker.

NOTE: A vertical and cylindrical column of fuel of sufficient height is one way to satisfy this requirement.

2-2.1.2 The primary air, or flue gas, supply shall be taken from a source with a pressure that is equal to or higher than that against which fuel will be discharged from the system.

2-2.2 The system shall include indicators and annunciators that provide the operator with adequate information about significant operating conditions, both normal and abnormal, throughout the system.

2-3 Piping Arrangement.

2-3.1 Piping shall be arranged to minimize hazardous accumulation of fuel.

2-3.2 Where the air/fuel stream is directed into multiple pipes, the system shall divide the air/fuel mixture in the proper ratio among the various pipes.

2-3.3 Positive means shall be provided to ensure that all pipe velocities are equal to or above the minimum velocity required for fuel transport. Testing during initial start-up and retesting as appropriate shall be performed to verify that individual pipe velocities are adequate.

2-3.4 All piping system components shall be capable of being cleared of pulverized fuel using transport air.

2-4 Inerting Arrangement. Where an inerting system is required in accordance with 2-6.8, it shall be permanently installed and equipped with suitable connections, which shall be a minimum of 1-in. (2.54-cm) diameter. Injection shall be controlled by readily operable valves or dampers. *(See NFPA 69, Standard on Explosion Prevention Systems.)*

NOTE: It is preferable that operation of these valves be accomplished at a location that is remote from the pulverized fuel system to reduce personnel hazard.

2-5 System Arrangements.

2-5.1 Direct-Fired Systems.

2-5.1.1 This system shall be permitted to have the fan located either following or ahead of the pulverizer. If auxiliary air is used, a damper shall be in this line. The usual direct-firing pulverized fuel system shall be permitted to be comprised of the following components *[see Figures 2-5.1.1(a) through (f)]*:

(a) Raw fuel bunker
(b) Raw fuel gate
(c) Raw fuel feeder
(d) Flow control of raw fuel
(e) Feeder discharge piping
(f) Air-swept pulverizer
(g) Classifier
(h) Foreign material–collecting hopper
(i) Pulverizer air fan or exhauster
(j) Source of hot air
(k) Source of tempering air
(l) Temperature control of air
(m) Flow control of air
(n) Piping and ducts
(o) Valves
(p) Dampers
(q) Burners
(r) Means of inerting
(s) Safety interlocks and alarms

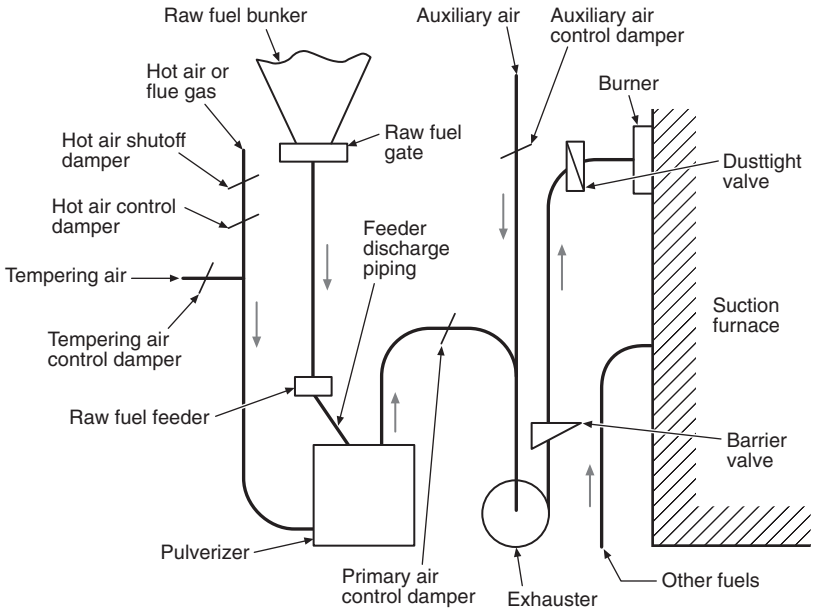


Figure 2-5.1.1(a) Direct-firing pulverized fuel exhauster system for suction furnace.

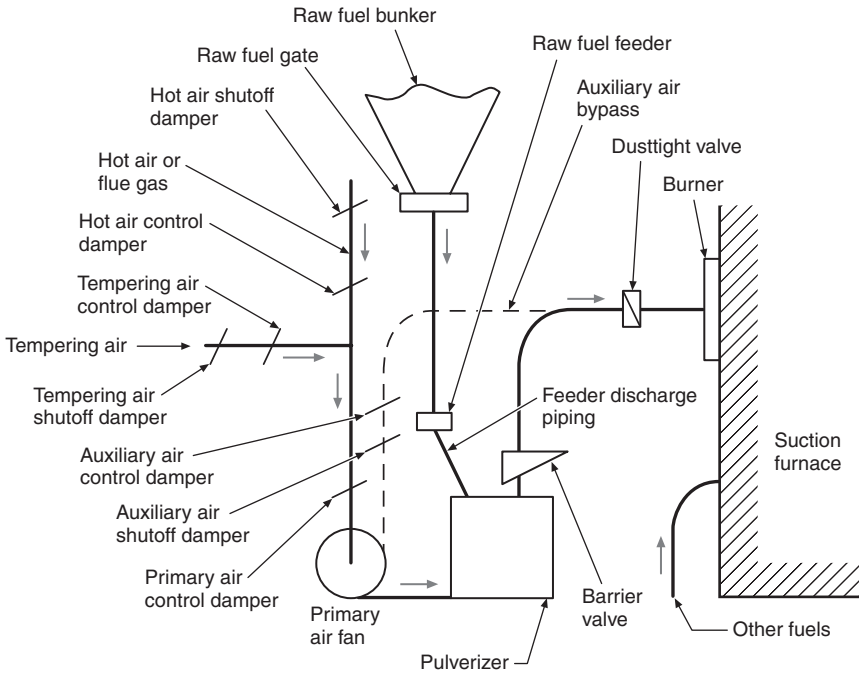


Figure 2-5.1.1(b) Direct-firing pulverized fuel hot primary air fan system for suction furnace.

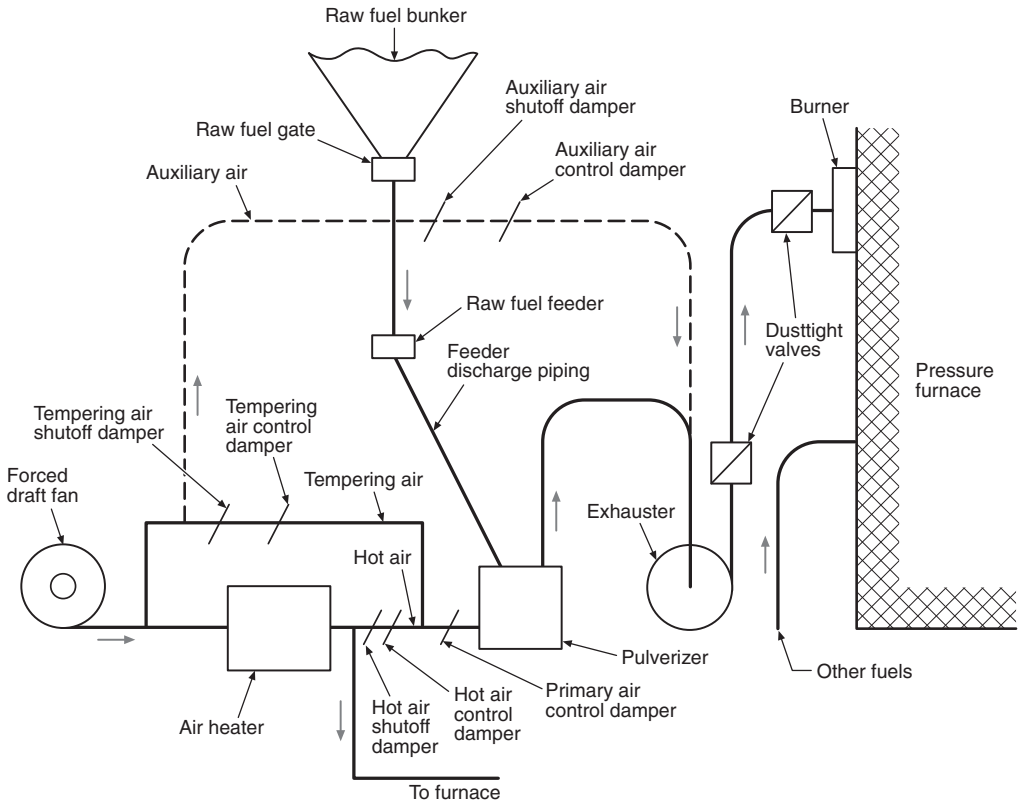


Figure 2-5.1.1(c) Direct-firing pulverized fuel exhauster system for positive pressure furnace.

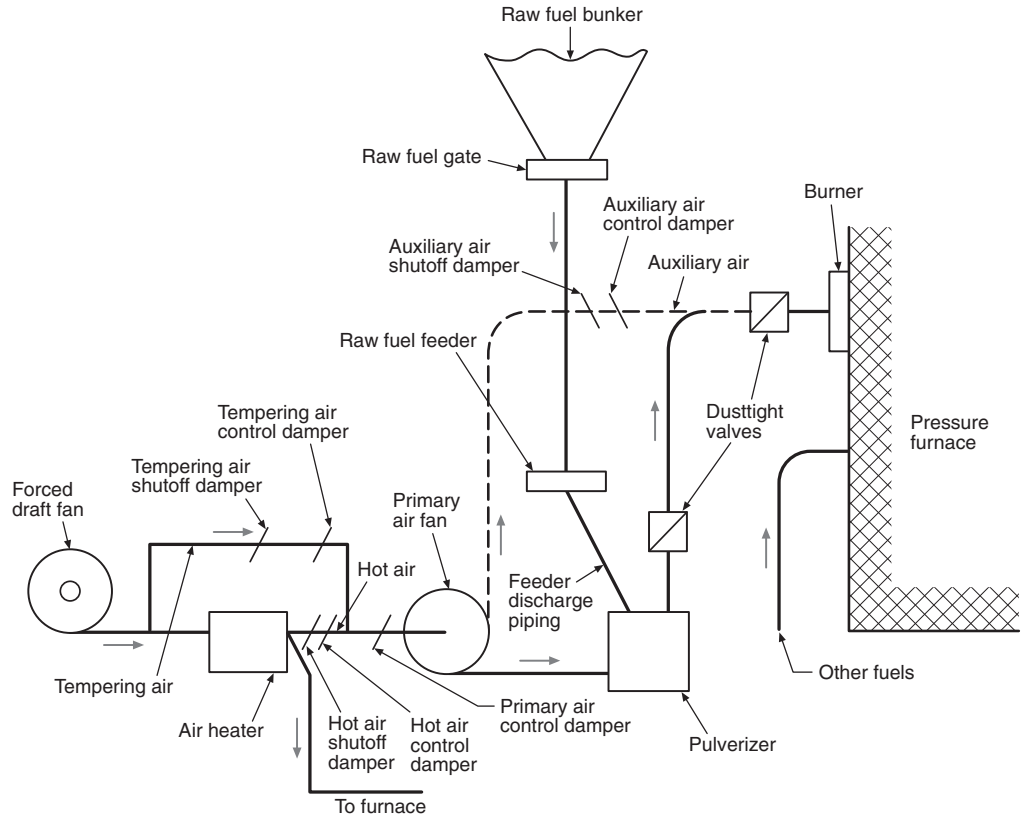


Figure 2-5.1.1(d) Direct-firing pulverized fuel hot primary air fan system for pressure furnace.

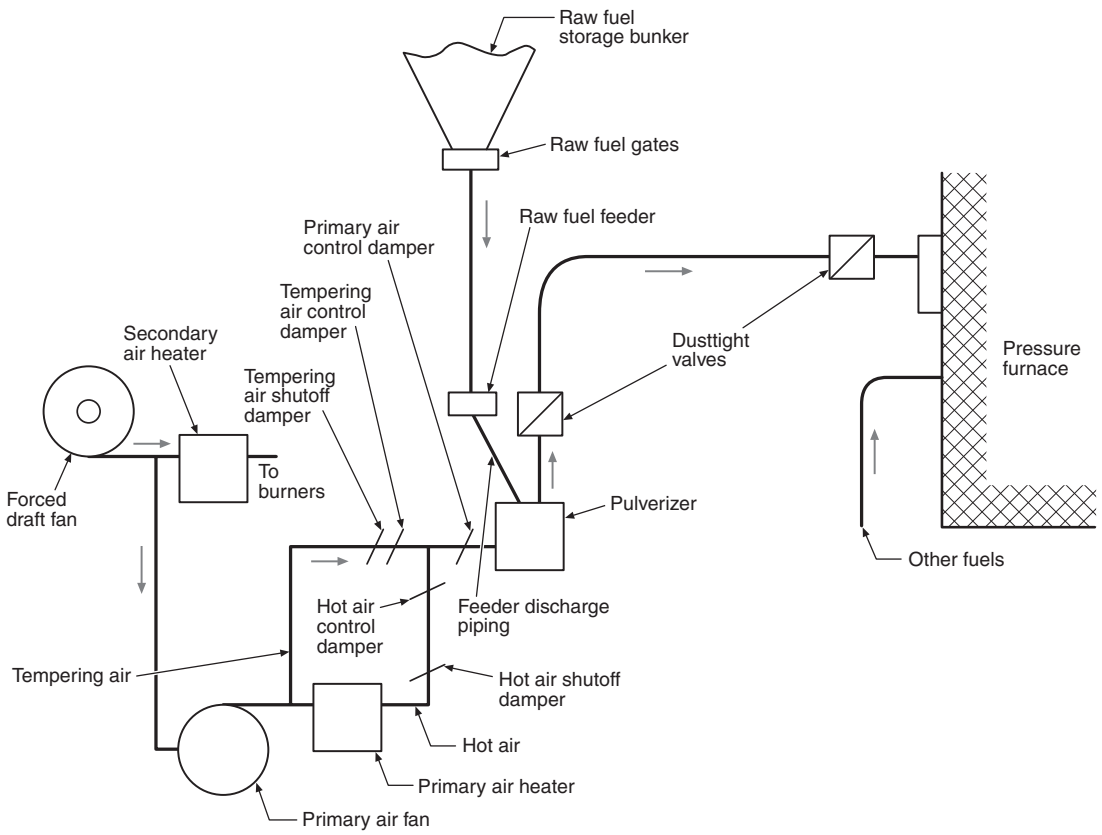


Figure 2-5.1.1(e) Direct-firing pulverized fuel cold primary air fan system for pressure furnace.

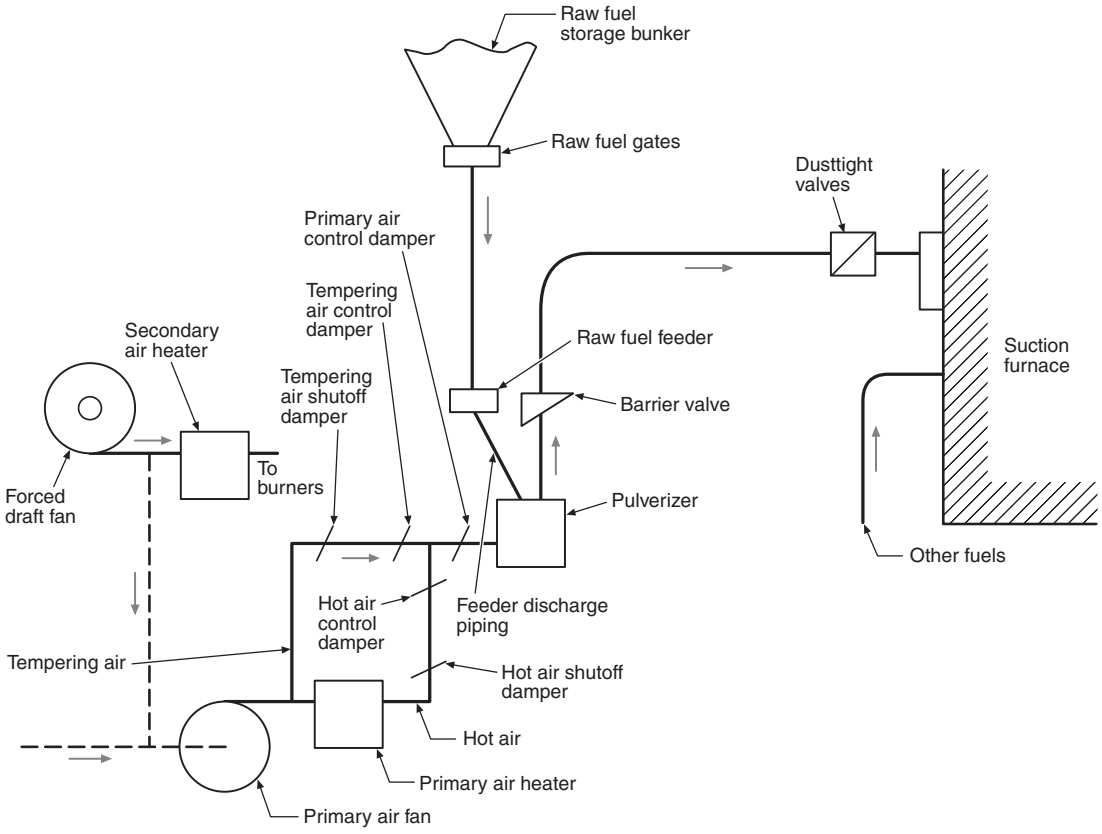


Figure 2-5.1.1(f) Direct-firing pulverized fuel cold primary air fan system for suction furnace.

2-5.1.2 Valve Requirements.

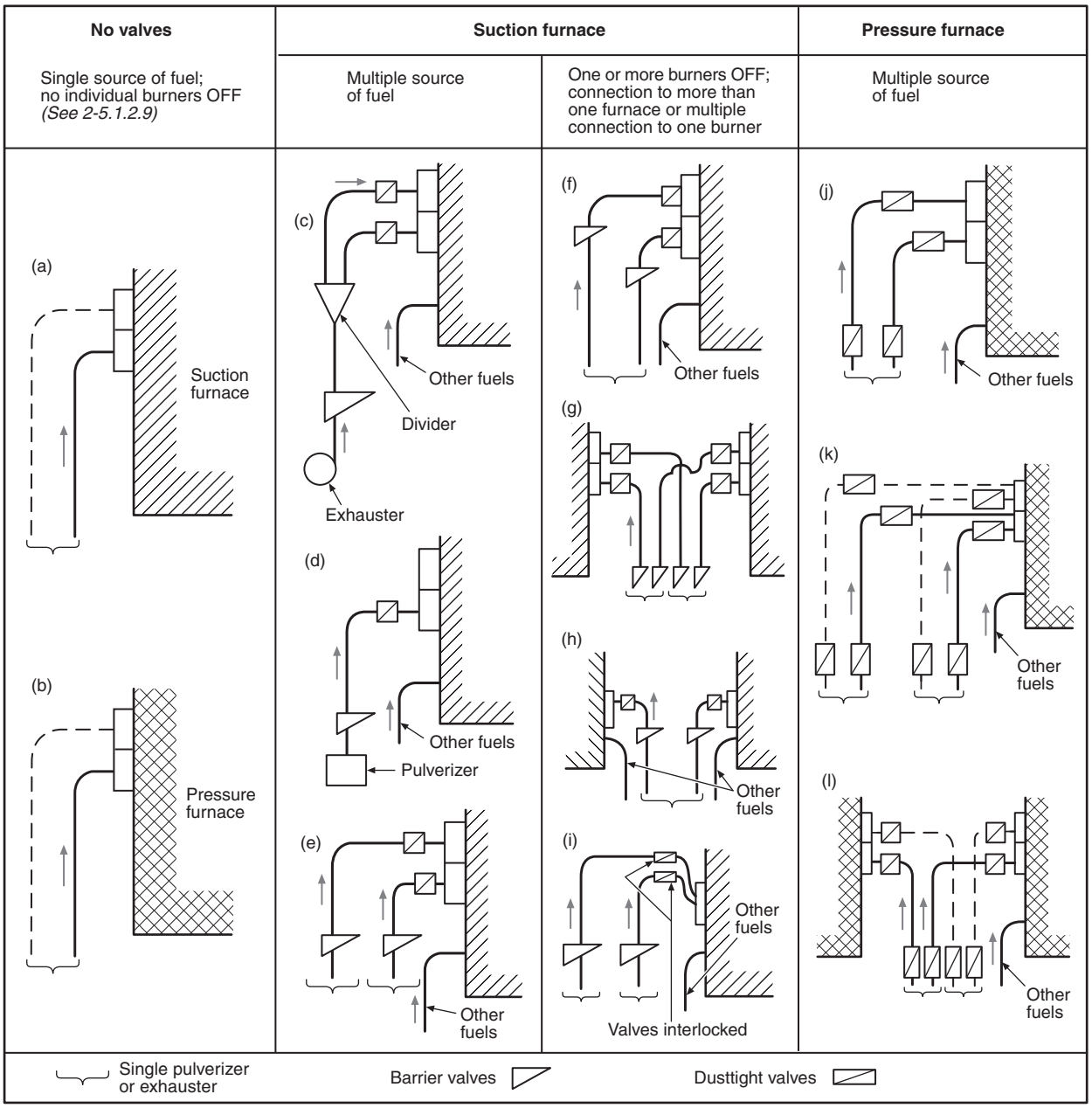


Figure 2-5.1.2 Direct-firing pulverized fuel system's valve requirements in burner piping.

2-5.1.2.1 For a suction furnace that can be fired by other main fuels or is connected to two or more pulverizers or exhausters, valves shall be installed to isolate all burner lines *[see Figures 2-5.1.2, details (c), (d), (e), (f), (g), (h), and (i).]* This requirement shall be permitted to be met with one dusttight and one barrier valve or two dusttight valves. A dusttight valve shall be installed in the burner pipe as close to the furnace as practicable. The second valve shall be installed as close to the pulverizer as practicable. The valves shall be closed prior to entering a pulverizer, exhauster, or fuel piping. *(See also 2-5.1.2.8.)*

2-5.1.2.2 For a pressure furnace that can be fired by other main fuels or is connected to two or more pulverizers or exhausters, a dusttight valve shall be installed to isolate all burner lines *[see Figure 2-5.1.2, details (j), (k), and (l)]*. In addition, a second dusttight valve shall be installed as close to the furnace as practicable. Both valves shall be closed prior to entering a pulverizer, exhauster, or fuel piping.

NOTE: It is recommended that one or both valves, which are described in 2-5.1.2.1 and 2-5.1.2.2, be quick closing.

2-5.1.2.3 If one valve is used to isolate more than one burner line, means shall be provided to prevent circulation between those lines or burners.

2-5.1.2.4 Two dusttight valves or one dusttight valve and one barrier valve shall be provided in each burner pipe if one or more pulverizers is connected to more than one suction furnace at a time. *[See Figure 2-5.1.2, details (g) and (h).]*

2-5.1.2.5 When one or more pulverizer(s) is connected to two or more pressure furnace(s) at the same time, valve requirements of 2-5.1.2.2 shall apply. *[See Figure 2-5.1.2, detail (l).]*

2-5.1.2.6 Two dusttight valves or one dusttight valve and one barrier valve shall be installed in the burner piping when the discharge pipes from separate exhausters or pulverizers are connected to the same burner nozzle of a suction furnace. *[See Figure 2-5.1.2, detail (i).]*

2-5.1.2.7 Two dusttight valves shall be installed in the burner piping when the discharge pipes from separate exhausters or pulverizers are connected to the same burner nozzle of a pressure furnace. *[See Figure 2-5.1.2, detail (k).]*

2-5.1.2.8 The valve that is located nearest to the pulverizer shall be so positioned that pulverized fuel accumulations above the valve will drain into the exhauster or pulverizer when the valve is opened. Other valves shall be located so as to prevent accumulation of pulverized fuel.

2-5.1.2.9 Figures 2-5.1.1(a) through (f), Figure 2-5.1.2, details (a) through (l), and the accompanying text illustrate and specify requirements for the usual combinations of equipment; if other combinations are used, they shall conform to the principles set forth in this standard.

NOTE: No valves are required between the pulverizer and the burners for a single pulverizer or exhauster connected to one or more burners in a furnace that cannot be fired by any other main fuel, provided that the combustion air to individual burners cannot be shut off *[see Figure 2-5.1.2, details (a) and (b)]*. If combustion air can be shut off to individual burners, see 2-5.1.2.1 and 2-5.1.2.2.

2-5.1.3 Air Supply Isolation Requirements.

2-5.1.3.1 For pressurized pulverizers and suction pulverizers with pressurized air supply installations, there shall be a means for tight shutoff of the hot air supply and a means for shutting off the primary air supply to each pulverizer.

NOTE: This means could be the total primary air control damper if tight seating.

2-5.1.3.2 For suction pulverizer installations with an atmospheric tempering air supply, there shall be a means for shutting off the hot air supply.

NOTE: This means could be the hot air control damper if tight seating.

2-5.2 Storage-Firing Systems.

2-5.2.1 This system can be arranged for partial or complete venting of the pulverizer air and water vapor after separating the pulverized fuel in cyclones or other types of dust collectors. The separated fuel usually is transported to storage bins for subsequent supply to the burners. In addition to the components of a direct-fired system as listed under 2-5.1, a typical storage system includes some or all of the following special equipment *[see Figures 2-5.2.1(a) through (g)]*:

(a) Cyclone separator

(b) Dust collector (e.g., cyclone vent collector)

(c) Vent fan

(d) Cyclone pressure lock

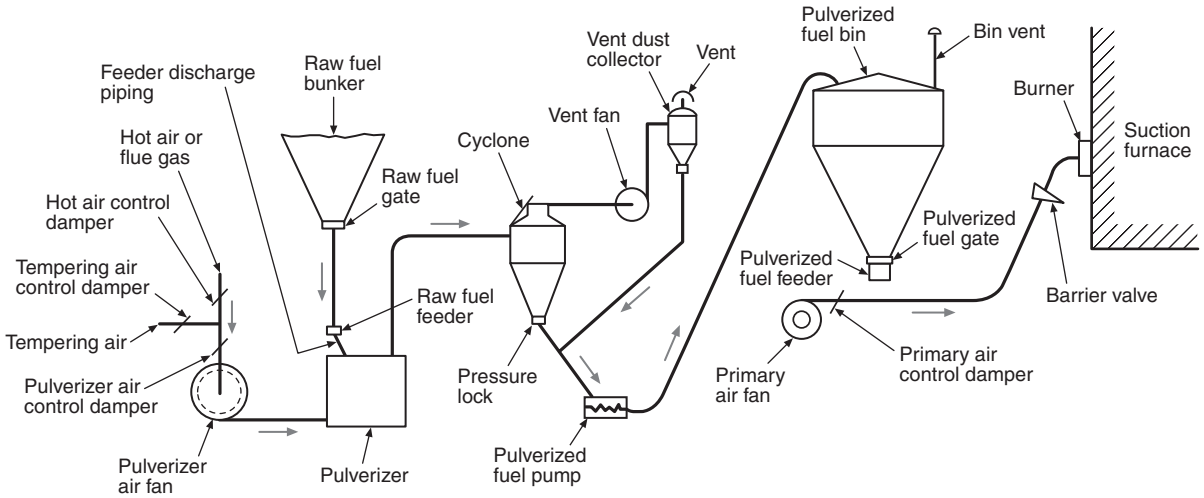
(e) Transport system (e.g., pulverized fuel pump, piping, and valves)

(f) Pulverized fuel bins

(g) Pulverized fuel feeders

(h) Auxiliary air damper

(i) Primary air fan



Note: Pulverizer fan or vent fan might not be required.

Figure 2-5.2.1(a) Pulverized fuel storage firing system.

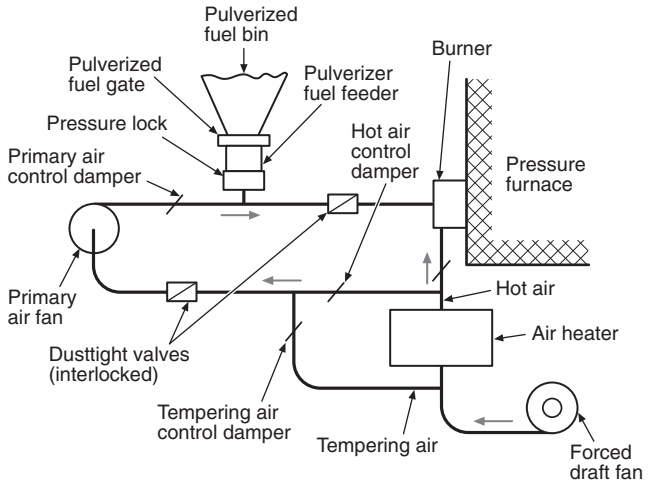


Figure 2-5.2.1(b) Pulverized fuel storage firing system for pressure furnace.

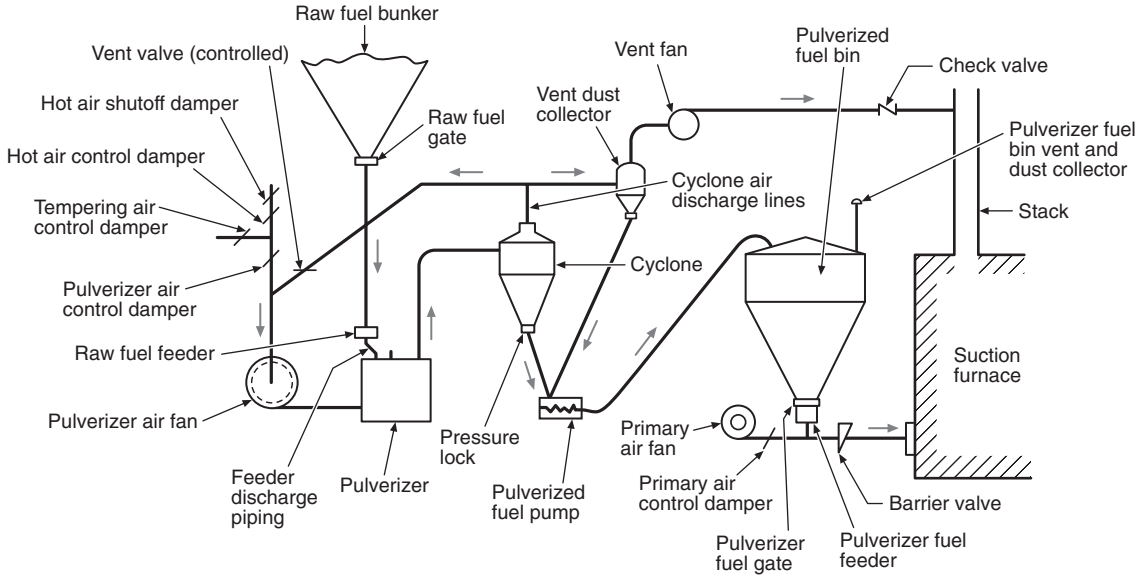


Figure 2-5.2.1(c) Pulverized fuel storage firing system (partial recirculation—vented air to stack).

2-5.2.2 Valve Requirements.

2-5.2.2.1 Barrier valves shall be provided in the piping between pulverized fuel feeders and burners of a storage system that is connected to one or more burners of a suction furnace. *[See Figures 2-5.2.1(a) and (c) through (g).]*

2-5.2.2.2 A check valve shall be installed in each vent pipe connecting the cyclone or dust collector of a storage system to the primary air fan or to any portion of the furnace or stack of a suction furnace. *[See Figures 2-5.2.1(c), (d), (e), and (g).]*

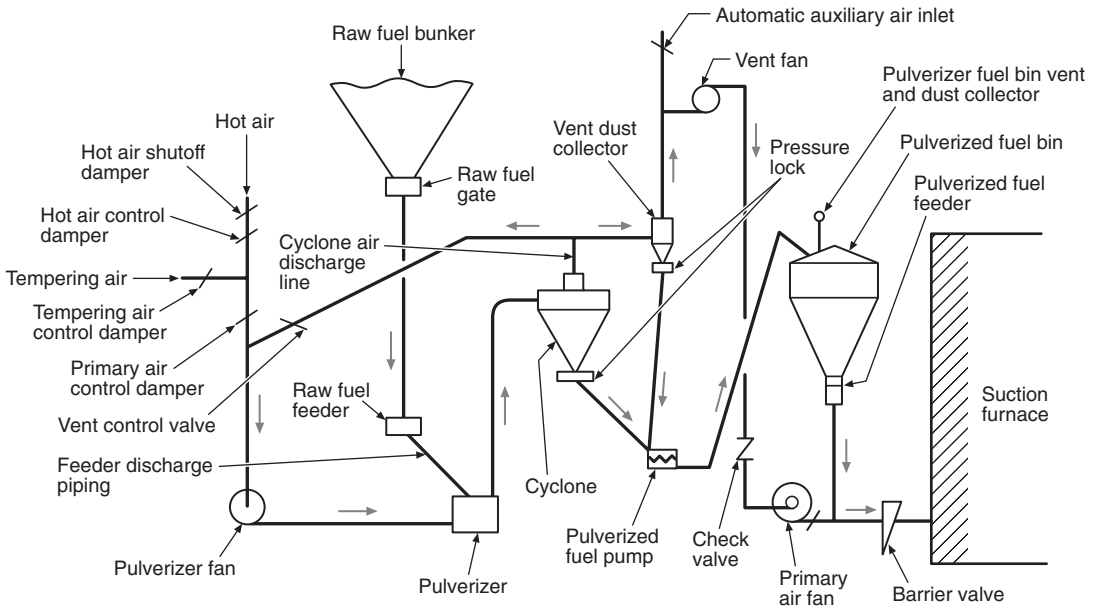
2-5.2.2.3 A dusttight valve shall be installed in each burner pipe between the pulverized fuel feeder and the burner for a storage system that is connected to one or more burners of a pressure furnace *[see 2-5.2.3 and Figure 2-5.2.1(b)]*. These valves shall not be opened until the primary air pressure is established.

2-5.2.2.4 A pressure lock shall be installed at each fuel outlet of a pulverized fuel bin (if required) that is connected to a pressure furnace to permit feeding of fuel into the burner lines at higher pressure and to prevent flow of primary air into the bin. *[See Figure 2-5.2.1(b).]*

2-5.2.2.5 A pressure lock shall be installed at each cyclone outlet if more than one cyclone is connected to a single pulverized fuel pump or if the cyclone is arranged for direct gravity discharge into the pulverized fuel bin. *[See Figures 2-5.2.1(a) and (c) through (g).]*

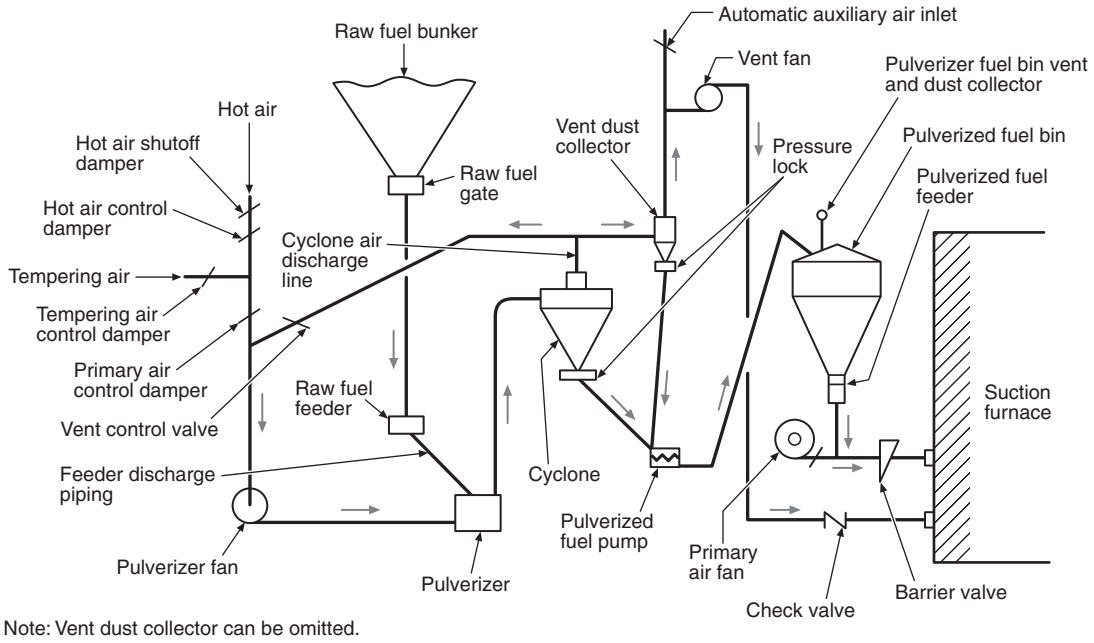
NOTE: A pressure lock is not required at the cyclone outlet if only one cyclone is connected to the pulverized fuel pump.

2-5.2.3 Primary Air Connections of Pressure Furnace Firing. For pressure furnace firing, a dusttight valve shall be installed between the forced draft system and the inlet for the primary air fan *[see Figure 2-5.2.1(d)]*. A minimum stop shall be provided on the primary air control damper to prevent its being completely closed unless the shutoff dampers in the burner pipes are closed.



Note: Vent dust collector can be omitted.

Figure 2-5.2.1(d) Storage firing system (partial recirculation—vented air to primary air fan).



Note: Vent dust collector can be omitted.

Figure 2-5.2.1(e) Storage firing system (partial recirculation—vented air to furnace).

2-5.2.4 Venting.

2-5.2.4.1 Partial venting shall be used to control humidity in the pulverized fuel system, to minimize quantity of vented air or gas, or to conserve heat.

2-5.2.4.2 Total venting shall be used where there is no further use for the transport air or gas.

2-5.2.4.3 Both vent systems shall have the following common requirements:

(a) There shall be no venting to a pressure furnace because of the probability of reverse flow of furnace gases.

(b) Venting to a suction furnace shall be permitted when it is delivered to a zone where combustion is active and injection line velocities are maintained at least 50 percent above the maximum flame propagation rate of the fuel.

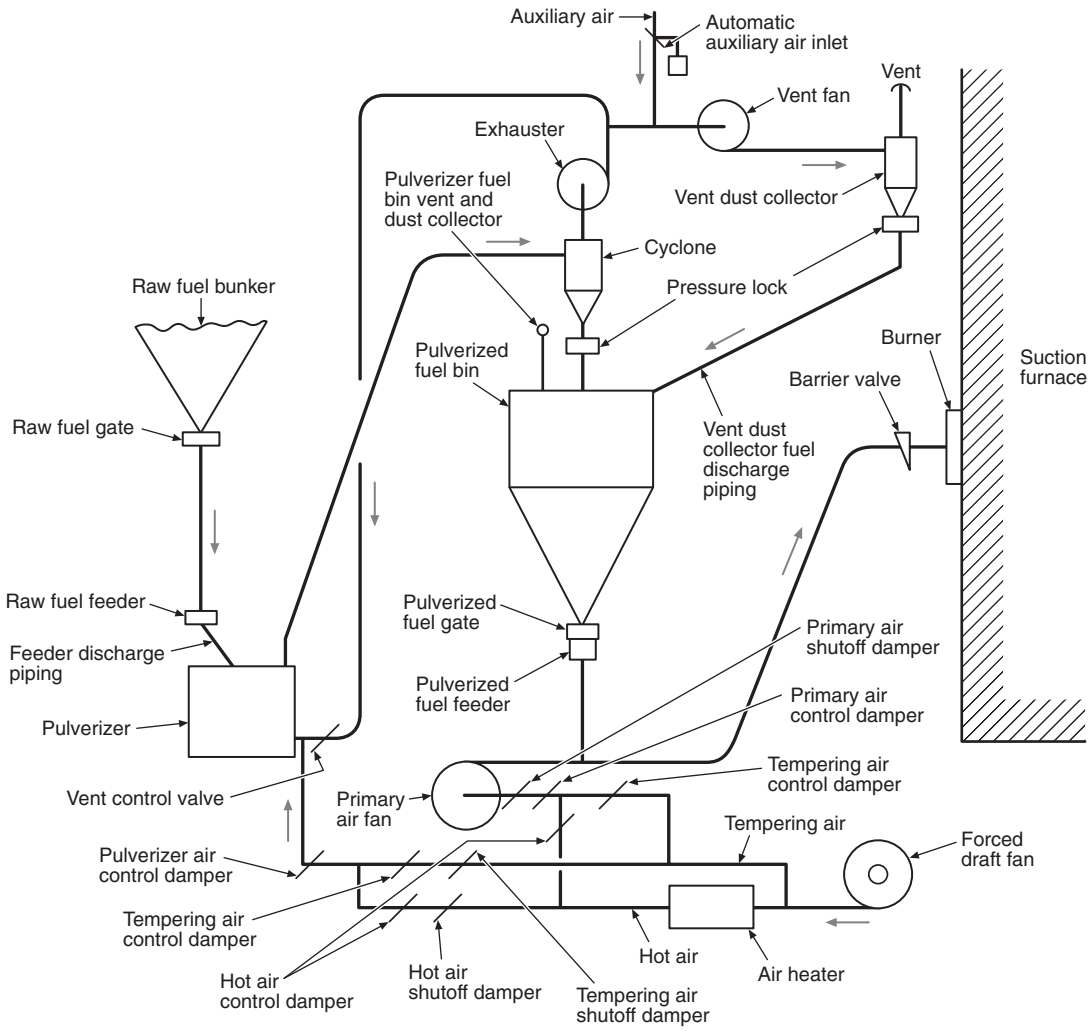


Figure 2-5.2.1(f) Storage firing system (partial recirculation).

(c) Venting to a stack, flue, or breeching shall be permitted when it is done to a zone where the temperature does not exceed two-thirds of the ignition temperature of the fuel in degrees Fahrenheit and the design of the entire vent system is such that there will be no hazardous accumulation of combustible fuel dust.

(d) Venting to the primary air fan shall be permitted when the primary air fan is operating if the following conditions are met:

1. Some means is provided to prevent reverse flow

2. The primary air system can handle the total amount of air

3. The primary air fan is discharging to a zone of active combustion

(e) When venting to the atmosphere, the vented air or gas shall be sufficiently clean of combustible material as to create no fire or explosion hazard. The vented air or gas shall not interfere with the proper operation of other systems within the area.

(f) Check valves, where required, shall be located as near as practicable to the source of possible reverse flow into the system.

2-5.2.4.4 When the vented air from the cyclone is discharged to the atmosphere as in Figure 2-5.2.1(a), the vent shall discharge at an adequate height above the building roof.

2-5.2.4.5 When the vented air is discharged into the stack, flue, or breeching, the connection shall be made at a point where the pressure is less than that of the room in which the pulverizer is located, and each vent line shall have a check valve that opens in the direction of the flow.

2-5.2.4.6 Vent connections shall be located downstream of the recirculated gas inlet connection in such a manner that any combustible dust that is carried by the vented air cannot be entrained in the recirculated gas for possible introduction into a zone of high furnace temperature.

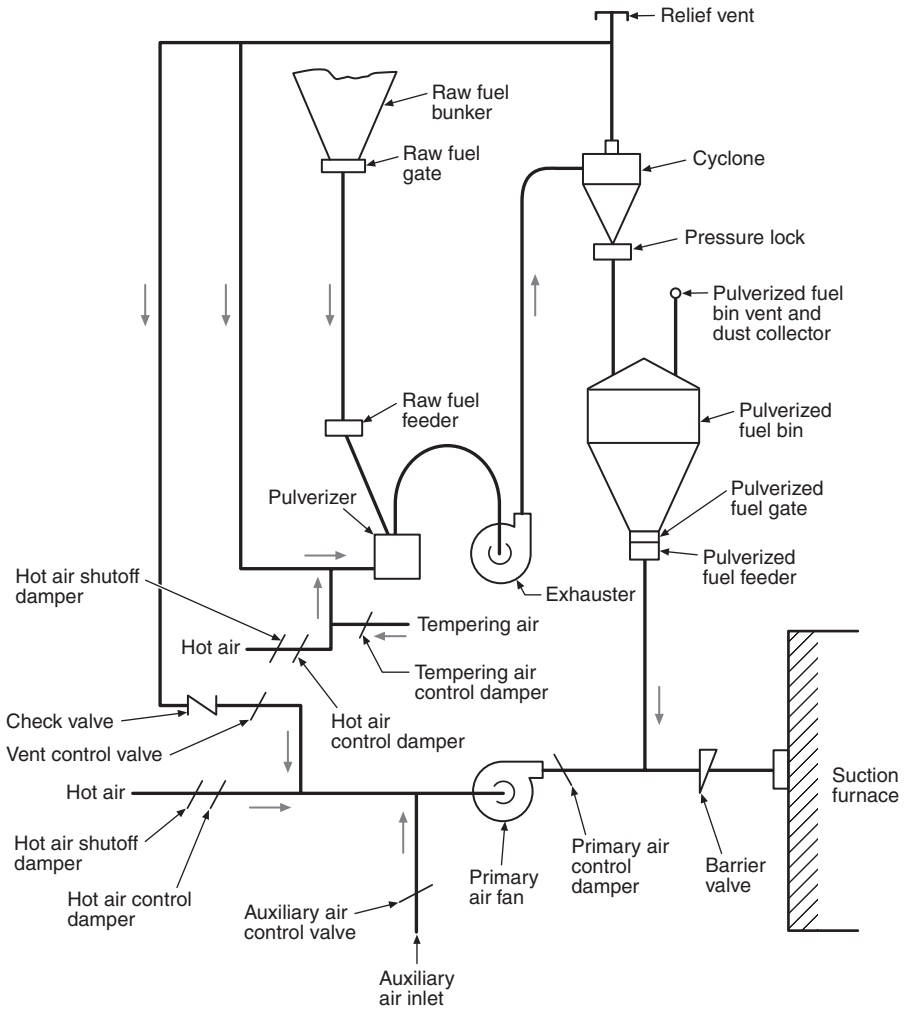


Figure 2-5.2.1(g) Storage firing system (no vent fan, with exhauster).

2-6 Pulverizer System Component Design Requirements.

2-6.1 Strength of Equipment.

2-6.1.1 All components of the pulverized fuel system as described below that are normally operated at no more than gauge pressure of 2 psi (13.8 kPa) shall be designed to withstand an internal explosion gauge pressure of 50 psi (344 kPa) for containment of possible explosion pressures. For operating gauge pressures in excess of 2 psi (13.8 kPa), the equipment as described below shall be designed to withstand an internal explosion pressure of 3.4 times the absolute operating pressure.

2-6.1.2 Equipment design strength shall incorporate the combined stresses from mechanical loading, operating, and explosion pressures plus an allowance for wear, which shall be determined by agreement between the manufacturer and purchaser. Implosion pressures shall also be considered.

2-6.1.3 Some parts of the pulverized fuel system, such as large flat areas, sharp corners, and so forth, can be subjected to shock wave pressures, and special consideration shall be given to their design, based on their locations in the system.

2-6.1.4 The components falling within the requirements of 2-6.1.1, 2-6.1.2, and 2-6.1.3 for a direct-fired system shall begin at a point that is 2 ft (0.61 m) above the inlet of the raw fuel feeder, at the point of connection of ductwork to the pulverizer, and at the seal air connections to the pulverizer system. They shall end at the discharge of the pulverizer, external classifier, or exhauster. These components shall include, but are not limited to, the following:

(a) Raw fuel feeding devices, discharge hoppers, and feed pipes to the pulverizer

(b) All parts of the pulverizer that are required for containment of internal pressure

(c) Exhauster and connecting piping from the pulverizer

(d) External classifiers and connecting piping from the pulverizer

(e) Foreign material–collecting hoppers that are connected to the pulverizer

NOTE: Not included in the scope of these requirements are the raw fuel bunker or mechanical components, such as seals, gears, bearings, shafts, drives, and so forth.

2-6.1.5 Explosion vents shall not be used on any component of the system that is described in 2-6.1.4.

2-6.1.6 All ductwork from the hot and tempering air supply ducts to individual pulverizers, including damper frames, expansion joints, supports, and hot primary air fans, shall be designed to contain the test block capability of the pulverizer air supply fan. Consideration shall be given to the fact that this ductwork can be exposed to explosion pressures from the pulverizer.

2-6.1.7 If a pulverized fuel storage system is started and operated with an inert atmosphere in all parts of the system in accordance with NFPA 69, *Standard on Explosion Prevention Systems,* the strength requirements of 2-6.1.1 shall not apply. Any component of the system that is started and operated with an inert atmosphere need not comply with the strength requirements of 2-6.1.1.

2-6.1.8 A pulverized fuel storage system that is not started and operated with an inert atmosphere in accordance with NFPA 69, *Standard on Explosion Prevention Systems,* shall meet the requirements of 2-6.1.1. The components falling within these requirements are those listed in 2-6.1.4, plus any or all of the following:

(a) Lock hoppers

(b) Circulating fans

(c) Transport systems

(d) Pulverized fuel feeders

(e) Primary air fans handling fuel-laden air

(f) Vent fans if not located downstream of a dust collector that is vented in accordance with 2-6.1.9

2-6.1.9 In a pulverized fuel storage system that is not started and operated with an inert atmosphere in accordance with NFPA 69, *Standard on Explosion Prevention Systems,* the following equipment shall meet the requirements of 2-6.1.1 or shall be equipped with suitable vents as described in NFPA 68, *Guide for Venting of Deflagrations:*

(a) Cyclone

(b) Dust collectors

(c) Pulverized fuel bins

2-6.1.10 Explosion vents shall not be used on the feeder or pulverizer of any system.

2-6.2 Piping. For systems that are normally operated at no more than gauge pressure of 2 psi (13.8 kPa), the pulverized fuel piping from the outlet of the equipment, as defined in 2-6.1.4 and 2-6.1.9, to the pulverized fuel burner or storage bin shall comply with 2-6.1. Systems that are operated at greater than gauge pressure of 2 psi (13.8 kPa) shall be designed to withstand an internal explosion of 3.4 times the absolute operating pressure.

2-6.2.1 There shall be an allowance for wear in excess of the strength requirements of 2-6.2 that shall be determined by agreement between the manufacturer and purchaser.

NOTE: Elbows especially are vulnerable to wear, but all parts of the system need consideration.

2-6.2.2 Pulverized fuel piping shall provide smooth flow and have bend radii of not less than one pipe diameter. Wherever possible, radii in excess of one pipe diameter shall be used.

2-6.2.3 Flexible joints and split clamp couplings shall conform to 2-6.2 except that the junction of two sections shall be permitted to be sealed with flexible material. There shall be no separation of the pipe joint in case of failure of the flexible material. Positive mechanical connections shall be provided between the two sections to prevent serious misalignment or separation.

2-6.2.4 At temperatures that are normally encountered in the service of the equipment, piping materials shall satisfy the strength requirements of 2-6.2 and shall comply with 2-6.6.2 for allowable stresses.

2-6.2.5 This requirement shall apply only to new installations. Brittle materials shall not be used for piping except as abrasion-resistant linings and where no credit is taken for the structural strength of the lining. Brittle materials are those having a plastic elongation of less than 8 percent prior to tensile rupture.

2-6.2.6 Piping support systems shall be designed and installed in accordance with ANSI B31.1, *Power Piping Code,* Chapter 2, Part 5, so that combined stresses will not be in excess of those specified in 2-6.6.2.

2-6.2.7 Pipe that is lined with abrasion-resistant material shall have casing thickness and flange size that is designed for the strength requirements in 2-6.2 with no required allowance for wear.

2-6.2.8 Prior to initial operation or after piping system renovation, an in-service leak test shall be performed in accordance with the following procedure:

(a) The system shall be gradually brought up to normal operating pressure and temperature.

(b) The system shall be continuously held at the conditions that are described in (a) for 10 minutes.

(c) Examination for leakage shall be made of all joints and connections.

(d) The system shall show no visual evidence of weeping or leakage.

2-6.3 Valves. All valves in the pulverized fuel system from a point within 2 ft (0.61 m) above the inlet of raw fuel feeder to the point of consumption of the pulverized fuel shall have construction that is capable of withstanding pressures as defined in 2-6.1.1, 2-6.2, or 2-6.4, depending on the application. These components shall include but not be limited to the following:

(a) Barrier valve

(b) Dusttight valve

(c) Check valve

(d) Pressure/air lock

(e) Raw fuel gate

2-6.4 Interconnections. Valves at points of interconnection between pulverized fuel system components requiring different design pressures shall comply with the strength requirements of the lower pressure of the two.

2-6.5 Bunker and Hopper Designs.

2-6.5.1 The raw fuel bunker structural material shall be made of noncombustible material. It shall be designed to provide the following:

(a) An uninterrupted flow of fuel being handled at a controlled rate

(b) A flow pattern in which arching and ratholing (piping) are avoided.

2-6.5.1.1 The bunker outlet feeder(s) shall be coordinated with the bunker to avoid the probability that improper feeder selection will result in altering the bunker flow characteristics as specified in 2-6.5.1(a) or (b).

2-6.5.1.2 Provisions shall be made to prevent accumulation of flammable mixtures of air, fuel dust, and combustible gases within the bunker.

2-6.5.2 Pulverized fuel bins shall conform to strength requirements as specified in 2-6.1 *(see 2-6.1.7 and 2-6.1.9).* These bins shall be designed to permit fuel discharge at an uninterrupted, controlled rate. Internal construction shall minimize static deposits. Open-top bins shall not be used.

2-6.5.2.1 Provisions shall be made to prevent accumulation of flammable mixtures of air, fuel dust, and combustible gases within the bin.

2-6.5.2.2 Bins shall be equipped with high- and low-level fuel detectors. *(See 2-2.2.)*

2-6.5.3 Pulverized fuel lock hoppers shall be designed for 3.4 times the absolute operating pressure. These hoppers shall be designed to permit fuel discharge at an uninterrupted controlled rate. Internal construction shall minimize accumulations.

2-6.5.4 Lock hoppers shall be equipped with high- and low-level fuel detectors. *(See 2-2.2.)*

2-6.6 Materials of Construction.

2-6.6.1 Materials that are used to meet strength requirements shall be ferrous materials and shall satisfy the strength requirements of 2-6.1 at temperatures that normally are encountered in the service of the equipment.

Exception: Raw coal bunkers of concrete construction are acceptable.

2-6.6.2 If made of steel or other ductile metals, the allowable stress values shall be determined as follows:

(a) *Tension.* The maximum allowable direct (i.e., membrane) stress shall not exceed the lesser of $^1/_4$ of the ultimate strength or $^5/_8$ of the yield strength of the material.

(b) *Combined Bending and Membrane Stress (where bending stresses are not self-limiting).* The maximum allowable value of combined bending and membrane stress shall not exceed the lesser of the yield strength or $^1/_2$ the ultimate strength of the material.

(c) *Combined Bending and Membrane Stress (where bending stresses are self-limiting).* The maximum allowable values of combined self-limiting and non-self-limiting bending stresses plus membrane stress shall not exceed the ultimate strength of the material.

(d) *Compressive Stress.* For components where compressive stresses occur, in addition to the requirements of 2-6.6.2(a), (b), and (c), the critical buckling stress shall be taken into account.

(e) *Fatigue Analysis.* On components subject to cyclic loading, fatigue analysis shall be made to guard against possible fatigue failures. Both mechanical and thermal loading shall be considered.

2-6.6.3 If made of cast iron or other nonductile materials, the allowable stress shall not exceed $^1/_4$ of the ultimate strength of the material for all parts. When cast iron or other nonductile materials are used for flat areas exceeding 1 ft^2 (0.0929 m^2), the surface shall be strengthened by ribbing or other means. The possibility of buckling and fatigue failures also shall be considered.

2-6.6.4 To ensure casting quality, suitable nondestructive examination shall be made to detect significant defects at locations of high stress, at abrupt changes of section, and at sharp angles. The choice of such a quality assurance program shall be the responsibility of the designer.

2-6.6.5 The justification of new materials or improved analytical methods that could be developed shall be the responsibility of the designer. If such materials and methods are used for the design of pulverized fuel system components, they shall meet the requirements of 2-6.1 and 2-6.2. The materials that are used shall be capable of withstanding the conditions that could occur during abnormal incidents, such as pulverized fuel fires.

2-6.7 Electrical Equipment.

2-6.7.1 All electrical equipment and wiring shall conform to NFPA 70, *National Electrical Code®*.

2-6.7.2 Locations where completely dusttight pulverized fuel systems are installed in compliance with this standard shall not be considered a hazardous location for electrical equipment as defined in NFPA 70, *National Electrical Code.*

2-6.8 Inerting System.

2-6.8.1 Pulverizers and pulverized fuel storage systems shall be equipped with an inerting system that is capable of maintaining an inert atmosphere as required to meet the provisions of 3-5.2.1. *(See also NFPA 69, Standard on Explosion Prevention Systems.)*

2-6.8.2 Provisions shall be made for verification of flow of inerting media when the system is activated.

2-6.9 Fire-Extinguishing System.

2-6.9.1 Pulverizers and pulverized fuel collecting systems shall be equipped with suitable connections for fire extinguishing. These connections shall be at least 1 in. (25 mm) in diameter and shall be adequate to pass the amount of required extinguishing material.

2-6.9.2 Provisions shall be made for verification of flow of fire-extinguishing media when the system is activated.

2-7 Safety Interlock Systems.

2-7.1 The safety interlocks that are required by the pulverizer system shall be coordinated with the boiler, furnace, or other related devices.

2-7.1.1 Interlock devices shall be designed for anticipated environmental conditions, such as temperature, humidity, vibration, and corrosive agents.

2-7.1.2 These components shall be installed in a manner that will facilitate testing and maintenance.

2-7.2 Interlocks for direct-fired pulverized fuel systems shall be arranged to trip in the following sequence:

(a) Failure of primary air flow trips the pulverizer and burner shutoff valve or equivalent and feeder. Follow manufacturer's requirements regarding the burner's shutoff valve operation.

(b) Failure of pulverizer trips the feeder and primary air flow.

(c) Closure of all fuel line valves trips the pulverizer, primary air flow, and raw fuel feed.

(d) Failure of feeder shall initiate an alarm; restarting is blocked until feeder start-up conditions are re-established.

NOTE: Several means are available to indicate loss of fuel feed through the pulverizer, loss of fuel feed to the pulverizer, loss of fuel stored within the pulverizer, and loss of fuel input to the burners. At least one means, but preferably a combination of means, should be reliably established and used to actuate loss-of-fuel interlocks.

(e) Primary air flow that is below the manufacturer's recommended minimum trips the pulverizer.

2-7.3 Permissive sequential-starting interlocks for direct-fired systems shall be arranged so that after appropriate furnace interlocks have been satisfied in accordance with NFPA 8502, *Standard for the Prevention of Furnace Explosions/Implosions in Multiple Burner Boilers,* the pulverizer can be started only in the following sequence:

(a) Start ignition system in service in accordance with NFPA 8502, *Standard for the Prevention of Furnace Explosions/ Implosions in Multiple Burner Boilers.*

(b) Start primary air fan or exhauster.

(c) Establish minimum air flow.

(d) Start pulverizer.

(e) Start raw fuel feeder.

Exception: Items (b) and (d) can be simultaneous when dictated by system design.

2-7.4 Interlocks for pulverizers of storage systems shall be arranged to trip as follows:

(a) The full pulverized fuel bin trips the fuel pump or conveyor and raw fuel feeder.

(b) Failure of fuel pump or conveyor trips the vent fan on the cyclone or dust collector and pressure locks upstream of fuel pump or conveyor.

(c) Failure of vent fan trips the pulverizer exhauster or air fan.

(d) Failure of pulverizer exhauster or air fan trips the raw fuel feeder.

(e) Failure of pulverizer trips the raw fuel feeder.

2-7.5 Permissive sequential-starting interlocks for pulverized fuel storage systems shall be arranged so that the system components can be started only in the following sequence:

(a) Start pulverized fuel pump or conveyor.

(b) Start cyclone and dust collector pressure locks.

(c) Start vent fan.

(d) Start pulverizer exhauster or air fan.

(e) Start pulverizer.

(f) Start raw fuel feeder.

Exception: Items (d) and (e) can be simultaneous when dictated by system design.

2-7.6 For pressure furnaces that are firing from storage or semistorage systems, the dusttight valve in the burner pipe that is after the pulverized fuel feeder shall be interlocked so that it cannot be opened unless the dusttight damper in the primary air supply is open.

Chapter 3 Operation

3-1 Introduction.

3-1.1 Operating principles and sequences that are applicable to all pulverized fuel systems are covered in Section 3-2. Sequences for the most common systems are given in Sections 3-3 and 3-4. Other arrangements require different sequences of operating events. Abnormal conditions are covered in Section 3-5.

3-1.2 Since this chapter covers only the operation of the pulverized fuel system as indicated in 1-1.1, the user is referred to the NFPA standard covering the particular application (e.g., NFPA 8502, *Standard for the Prevention of Furnace Explosions/ Implosions in Multiple Burner Boilers*). If the particular application is not covered by NFPA standards, the user is referred to the equipment manufacturer's operating instructions.

3-2 Operation of All Pulverized Fuel Systems.

3-2.1 Functional Requirements.

3-2.1.1 The purchaser's consultant or engineering staff or, preferably, the operating staff shall prepare written operating instructions and checklists to coordinate the operation of the pulverized fuel equipment with the other associated apparatus or systems.

3-2.1.2 Correct sequence of operating events shall be followed regardless of whether the unit is operated manually or certain functions are accomplished by interlocks or automatic controls.

3-2.1.3 Normal practice shall be to operate all parts of the system within the established fuel, air, pressure, and temperature limitations.

3-2.1.4 To permit continuous operation of the pulverized fuel system, every effort shall be made to establish operating procedures for the process or system in which the fuel is consumed.

3-2.1.5 Operation of the pulverizer-burner system with less than the full complement of burners, served by a pulverizer, shall be avoided unless the system is designed specifically for such operation. If not so designed, extra precautions shall be used in isolating out-of-service burners.

3-2.2 Preparation for Starting.

3-2.2.1 Preparation for every start-up shall include checks for the following conditions:

(a) Pulverizer system sealing air, if required, in service

(b) Energy supplied to control system and to safety interlocks

(c) All pulverizer system gates, valves, and dampers in start-up positions

3-2.2.2 After an overhaul or after significant maintenance or outage, the following inspections and checks shall be made:

(a) Pulverizers, ducts, and fuel piping is in good repair and free from foreign material.

(b) Pulverizers, ducts, and fuel piping are evacuated by all personnel, all access and inspection doors are closed, and all personnel protection devices are reinstalled.

(c) All pulverizer air or flue gas dampers are operated through full operating range.

(d) Pulverizers, feeders, controls, and associated equipment are in good condition, adjusted properly, and ready for service.

(e) A complete functional check is made of all safety interlocks.

3-3 Operation of Direct-Fired Systems.

3-3.1 Starting Sequence. The starting sequence shall consist of the following steps. All steps shall be included. The sequence of steps (b) through (i) shall be permitted to vary as recommended by the system designer.

(a) Start all necessary light-off equipment in proper sequence.

(b) Open tempering air damper.

(c) If driven separately from the pulverizer, start primary air fan or exhauster.

(d) Open primary air flow control damper to a predetermined setting that is at least sufficient to provide minimum burner line velocity.

(e) Open burner line valves, if any, on the pulverizer to be started.

(f) Start pulverizer.

(g) Open hot air damper and maintain pulverizer outlet temperature within the normal range.

(h) Start raw fuel feeder.

(i) Place pulverizer outlet temperature control, primary air flow control, and raw fuel feed control on automatic.

3-3.2 Normal Operation.

3-3.2.1 The pulverizer output shall be regulated by increasing or decreasing its fuel and air supplies in accordance with the manufacturer's procedures or as determined by field tests.

3-3.2.2 The individual burner shutoff valves, if provided, shall be wide open or completely closed. They shall never be placed at intermediate settings.

3-3.2.3 For operation at reduced pulverizer loads, the auxiliary air dampers, where provided, shall be used to maintain minimum burner line velocities.

3-3.2.4 A pulverizer shall not be operated below its minimum air or fuel stop setting.

3-3.3 Normal Shutdown. The shutdown sequence shall consist of the following steps. All steps shall be included. The sequence of steps shall be permitted to vary as recommended by the system designer.

(a) Reduce pulverizer output and establish required combustion system conditions for shutdown. *(See NFPA 8502, Standard for the Prevention of Furnace Explosions/Implosions in Multiple Burner Boilers.)*

(b) Shut off the hot air and open up the cold air to cool down the pulverizer.

(c) When the pulverizer is cooled, stop the feeder and continue operation of the pulverizer with sufficient air flow to remove all fuel from the pulverizer and associated burner lines. Continue cooling if required.

(d) Shut the pulverizer down after a predetermined time as required to empty the pulverizer.

(e) Burner line shutoff valves shall be positioned in accordance with the manufacturer's instructions.

(f) Stop primary air flow when desired system conditions are reached.

3-4 Operation of Storage Systems.

3-4.1 Operation of Fuel-Burning Equipment.

NOTE: Operation of the fuel-burning and fuel-pulverizing sections of storage systems are virtually independent of each other.

3-4.1.1 Starting Sequence. The starting sequence shall be as follows:

(a) Coordinate the fuel-burning portion with the furnace. *(See NFPA 8502, Standard for the Prevention of Furnace Explosions/Implosions in Multiple Burner Boilers.)*

(b) Start primary air fan(s).

(c) Open all burner line valves for the burners to be started.

(d) Open pulverized fuel gate, if not already open, and start pulverized fuel feeders for these burners.

3-4.1.2 Normal Operation.

3-4.1.2.1 Individual burner valves shall be wide open or completely closed. They shall never be placed at intermediate settings.

3-4.1.2.2 Fuel flow shall be controlled by adjusting the pulverized fuel feeder speed.

3-4.1.2.3 Primary air flow shall be sufficient at all times to prevent settling of coal dust in burner pipes.

3-4.1.3 Normal Shutdown. The shutdown sequence shall be as follows *(see also NFPA 8502, Standard for the Prevention of Furnace Explosions/Implosions in Multiple Burner Boilers):*

(a) Establish required combustion system conditions for shutdown.

(b) Stop pulverized fuel feeder.

(c) When burner flame is extinguished, close burner and primary air shutoff valves.

(d) Stop primary air fan after last burner that is served by that fan is shut down.

3-4.2 Operation of Pulverizing Equipment of Storage Systems.

3-4.2.1 Starting Sequence. The basic principle to be followed is that of starting equipment in sequence from the storage bin "upstream" toward the point of pulverizer air supply and then finally the raw fuel supply *[see Figures 2-5.2.1(a) through (g)]*. The starting sequence shall be as follows:

(a) Start pulverized fuel pump or conveyor, if provided.

(b) Start cyclone pressure lock, if provided.

(c) Start cyclone or dust collector vent fan or exhauster in accordance with 2-5.2.4.

(d) Start pulverizer exhauster or fan and adjust control dampers to obtain proper air flow and temperature.

(e) Start pulverizer.

(f) Start raw fuel feeder.

(g) Readjust control damper(s) to obtain required pulverizer air/fuel outlet temperature and air flow.

3-4.2.2 Normal Shutdown. The shutdown sequence shall be as follows:

(a) Close hot air damper and open cold air, or flue gas, damper to cool down pulverizer.

(b) Stop raw fuel feeder.

(c) After pulverizer is operated for a predetermined time that is sufficient to empty the pulverizer of fuel and make it cool, shut pulverizer down.

(d) Stop pulverizer exhauster or fan.

(e) Stop cyclone and dust collector vent fan or exhauster.

(f) Stop cyclone pressure lock.

(g) Stop pulverized fuel pump or conveyor.

3-5 Abnormal Pulverizer System Conditions.

3-5.1 When a fire is suspected in the pulverizer system and abnormal operating conditions are encountered, all personnel shall be cleared from the area near the pulverizer, primary air duct, burner pipes, burners and feeder, or other pulverized fuel system components before the operating conditions are changed.

3-5.2 Pulverizer Tripping.

3-5.2.1 Inerting.

3-5.2.1.1 A pulverizer that is tripped under load shall be inerted and maintained under an inert atmosphere until confirmation that no burning/smoldering fuel exists in the pulverizer or the fuel is removed.

3-5.2.1.2 The inerting procedure shall be as prescribed by agreement between the pulverizer equipment manufacturer and the purchaser. They shall consider fuel characteristics, pulverizer temperature, size, and arrangement of the pulverizer.

3-5.2.1.3 Inerting media shall be selected from the following:

(a) Carbon dioxide

(b) Steam

(c) Nitrogen

(d) Other inert media

3-5.2.2 Fuel-Clearing Procedures.

3-5.2.2.1 For pulverizers that are tripped and inerted while containing a charge of fuel in accordance with 3-5.2.1.1, the following procedure shall be used to clear fuel from the pulverizer and sweep the transport lines clean as soon as possible after it has been tripped and there is confirmation that there is no burning or smoldering fuel.

(a) Isolate from the furnace all shutdown or tripped pulverizers.

(b) Start up one pulverizer in accordance with the principles and sequences as listed in 3-3.1(a) through (i).

(c) Continue to operate the pulverizer until empty and in normal condition for shutdown. When the operating pulverizer is empty of fuel, proceed to another pulverizer and repeat the procedure until all are cleared of fuel.

Exception: Furnace conditions permitting, rather than running the pulverizer until empty, restart feeder and return pulverizer to normal operation.

3-5.2.2.2 In the event that there are indications of burning or smoldering fuel in an out-of-service pulverizer, the pulverizer shall not be restarted under the normal procedure. Fire-extinguishing procedures shall be followed or removal of residual fuel shall be accomplished under inert conditions by taking the following steps:

(a) Remove fuel through the pyrites removal system.

(b) Start the pulverizer with inert primary air, using the starting sequences in 3-3.1(a) through (i).

Due to the danger of an explosion when opening and cleaning, pulverizers shall not be cleaned manually until they and their contents have been cooled to ambient temperature. *(See 3-5.3.)*

3-5.3 Pulverized Fuel System Fires.

3-5.3.1 Fire in any part of a pulverized fuel system shall be considered serious and dealt with promptly. Extinguishing media shall be in accordance with 3-5.2.1.3 or water or inert solids.

3-5.3.2 The following procedures for fighting fires shall be considered with modifications for specific systems, specific locations of fire, or requirements of the equipment manufacturer.

(a) If sufficient flow capacity of inerting media is provided (at least 50 percent by volume of the minimum primary air flow for the system), inert the pulverizer air/fuel flow, shut off the fuel feed, empty the pulverizer of fuel, shut down the pulverizer, and isolate it.

(b) Stop the primary air flow, trip the pulverizer and feeder, isolate the system, and inert. Avoid disturbing any accumulation of dust within the pulverizing equipment. Do not open any access doors to the pulverizer until the fire is extinguished and all temperatures have returned to ambient. After isolation of the pulverizer is verified, follow procedures as outlined in 3-5.3.5 and 3-5.3.6.

(c) A fire that is detected in an operating low-storage pulverizer can be extinguished by shutting off the hot air, increasing the raw fuel feed as much as possible without overloading the pulverizer, and continuing to operate with tempering air.

(d) Introduce water into the raw fuel or air-tempering streams, or both. The water must be added in such quantities and at such locations as not to cause hang-up or interruption of raw fuel feed or to stir up any deposit of combustible material. When all evidence of fire has disappeared, shut off the water, trip the pulverizer, isolate, and inert.

3-5.3.3 In the event of fires that are detected in other parts of a direct-fired system, such as burner lines, the appropriate procedures as outlined in 3-5.3.2(a), (b), or (c) shall be followed.

3-5.3.4 In the event of fires that are detected in components, such as cyclones, dust collectors, pulverized fuel bins, and so forth, of pulverized fuel systems other than direct-fired systems, the affected components shall be isolated and inerted.

3-5.3.5 If fire is found in a pulverizer that is out of service, it shall be kept out of service and isolated. All air supply to the pulverizer shall be shut off. Access doors to a pulverizer shall not be opened until the fire is extinguished by water or other extinguishing media and all temperatures have returned to ambient.

3-5.3.6 Following fires in pulverizing systems, the pulverizing equipment shall be inspected internally and all coke formations and other accumulations shall be removed to avoid future fires; if the pulverizer is wet, it shall be dried. In no case shall a compressed air jet be used. All components shall be inspected, and damaged items, such as gaskets, and so forth, shall be replaced.

Chapter 4 Personnel Safety

4-1 Confined Spaces. Specific procedures shall be developed and used for personnel entering confined spaces that shall accomplish the following:

(a) Positively prevent inadvertent introduction of fuel, hot air, steam, gas, or any inerting medium.

(b) Positively prevent inadvertent starting or moving of mechanical equipment or fans.

(c) Prevent accidental closing of access doors or hatches.

(d) Include tags, permits, or locks to cover confined space entry.

(e) Determine need for ventilation or self-contained breathing apparatus where the atmosphere could be stagnant, depleted of oxygen, or contaminated with irritating or combustible gases. Test for an explosive or oxygen-deficient atmosphere.

(f) Provide for a safety attendant. The safety attendant shall remain outside of the confined space with appropriate rescue equipment and shall be in contact, preferably visual contact, with those inside.

(g) Provide for the use of proper safety belts or harnesses that shall be tied off properly when such use is practical.

4-2 Raw Fuel Bunkers.

4-2.1 In addition to the general provisions of Section 4-1, additional specific provisions for entering and working in fuel bunkers or bins as listed in 4-2.2 through 4-2.11 shall be made that recognize the high probability of the presence of combustible or explosive gases and the associated hazards with shifting or sliding coal.

4-2.2 No one shall be permitted to enter fuel bunkers or bins without first notifying the responsible supervisor and obtaining appropriate permits, tags, clearances, and so forth.

4-2.3 The responsible supervisor shall inspect the bunker, see that all necessary safety equipment is on hand, and see that a safety attendant, who will have no other duties during the job, is also on hand. The supervisor shall review with the safety attendant and the workers the scope of the job and safety procedures to be followed.

4-2.4 No smoking, flames, or open lights shall be permitted. All lamps shall be suitable for Class II, Division I location as defined in NFPA 70, *National Electrical Code.*

4-2.5 Tests shall be made for the presence of an explosive and oxygen-deficient atmosphere in a bunker or bin. If such an atmosphere is found, positive ventilation shall be provided and entry shall be prohibited until the atmosphere returns to safe limits. Sufficient retests shall be made during the course of the work to ensure a safe atmosphere, and if it is not maintained, the bunker shall be evacuated.

Exception: A nonexplosive, oxygen-deficient atmosphere shall be permitted to be entered with suitable breathing apparatus.

4-2.6 No person shall enter a bunker containing burning fuel.

4-2.7 No person shall enter a bunker or walk on the fuel unless the safety attendant is present and the person is equipped with a safety belt or harness and lifeline. The lifeline shall be secured to an adequate support above the person and shall have only sufficient slack to permit limited movement for necessary job performance. The lifeline shall be manila rope that is at least $^1/_2$ in. (12.7 mm) in diameter, or equivalent, and in good condition.

4-2.8 The safety attendant shall remain outside or above the bunker and shall keep the workers in full view at all times. An adequate means of communication shall be provided to the safety attendant in case additional help is needed.

4-2.9 Wherever practical, work shall be done from platforms, ladders, scaffolds, and so forth, rather than from the surface of the fuel itself.

4-2.10 To avoid the possibility of being covered by sliding fuel, no one shall walk on or work on a fuel surface that is more than 3 ft (0.9 m) lower than the highest point of the surrounding fuel.

4-2.11 Full-face respirators or respirators and goggles shall be worn when dust conditions require them, as directed by the responsible supervisor or the safety attendant.

4-3 Maintenance Rules.

4-3.1 Housekeeping.

4-3.1.1 Good housekeeping is essential for safe operation and prevention of fires or explosions. Therefore, provisions shall be made for periodic cleaning of horizontal ledges or surfaces of buildings and equipment to prevent the accumulation of appreciable dust deposits.

4-3.1.2 Creation of dust clouds shall be minimized during cleaning. Compressed air shall not be used to dislodge coal dust accumulations; water-washing or vacuum-cleaning methods are preferred.

4-3.2 Cleaning Plugged Equipment. Severe injury and property damage can result from careless handling of unconfined pulverized fuel. Therefore, extreme caution shall be used in cleaning out plugged burners, burner piping, pulverized fuel bins, feeders, or other parts of the system.

NOTE: Pulverized fuel that can flood out or spill from such places can be ignited by a random spark or by the hot surfaces on which it falls, or it could already be smoldering, and it can produce an intensely hot fire or explosion without warning. Since pulverized fuel drifts freely in air, ignition can take place at considerable distance from the point of initial disturbance.

4-3.3 Welding and Flame Cutting. See also NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes,* and NFPA 51B, *Standard for Fire Prevention in Use of Cutting and Welding Processes.*

4-3.3.1 Emphasis shall be placed on the hazards that are associated with welding or flame cutting on pulverized fuel equipment; such operations shall be properly supervised with use of fire-fighting equipment and watches. Written procedures shall be established that specify the precautions and required permits for welding and cutting on or near the pulverized fuel system.

4-3.3.2 Prior to welding or flame cutting, all deposits of pulverized fuel shall be removed by washing down or vacuuming, as far as practical and by approved methods, from exterior and interior surfaces that could be affected. No work shall commence until the area has been ventilated sufficiently to minimize the possibility of fire or explosion. Equipment shall not be returned to service until any area that has been subjected to welding or cutting has been cooled.

4-3.3.3 Fire-resistive blankets or other approved methods shall be used in such manner as to confine weld spatter or cutting sparks.

4-3.3.4 A careful inspection of all areas near where welding or cutting has been done, including the floors above and below, shall be made when the job is finished or interrupted, and such area shall be patrolled for a period long enough to make certain that no smoldering fires have developed.

4-3.4 Explosion-Operated Tools and Forming Techniques. These tools and techniques shall not be used where flammable dust or dust clouds are present. Where these operations become necessary, all equipment, floors, and walls shall be cleaned and all dust accumulation shall be removed by an approved method. A careful check shall be made to be sure that no cartridges or charges are left in the work area.

4-4 Electrical Tools and Lighting.

4-4.1 Where flammable dusts or dust clouds are present, sparking electrical tools shall not be used. All lamps shall be suitable for Class II, Division 1 locations as defined in NFPA 70, *National Electrical Code*.

4-4.2 Either ground-fault protected or specifically approved, low-voltage (6 volts to 12 volts) extension cords or lights shall be used for all confined spaces where moisture can be a hazard.

Chapter 5 Special Systems

5-1 Introduction. Specific requirements of some special systems, as well as operation of these special systems, are covered in this chapter. For general design, operating, and safety requirements of these systems, refer to Chapters 2, 3, and 4.

5-2 Semi-Direct-Firing System.

5-2.1 Description. This system is one in which the fuel is pulverized near the point of use in an air-swept pulverizer. The fuel is separated from the air in a cyclone or other type of dust collector. Fuel discharges from the cyclone through a rotary valve and is picked up by air from a primary air fan and blown into the furnace. The primary air fan can take its suction from the pulverizer air fan or from other sources. If the primary air fan does not utilize all of the pulverizer air, a vent fan is required. *[See Figures 5-2(a) and (b).]*

5-2.2 System Arrangement. This system shall be permitted to include the following special equipment:

(a) Cyclone separator or other type dust collectors

(b) Pressure lock

(c) Primary air fan

(d) Vent fan and dust collector, if required

(e) Pulverized fuel pickup

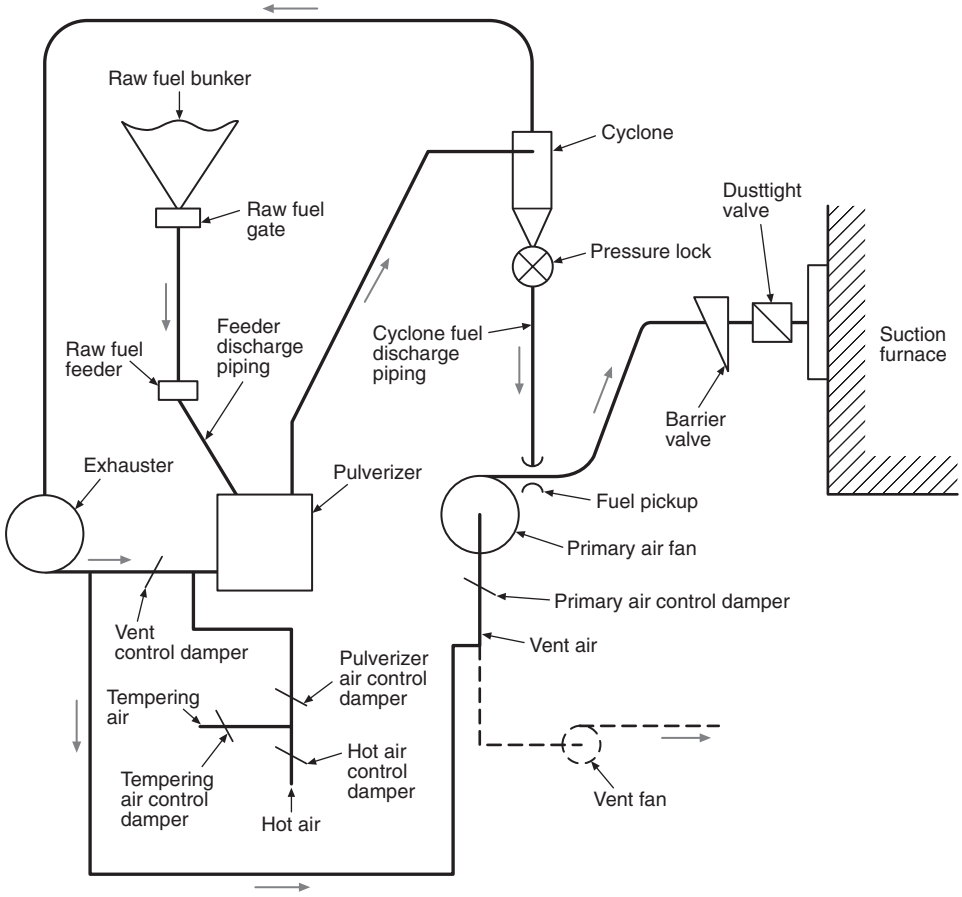


Figure 5-2(a) Semi-direct-firing pulverized fuel system.

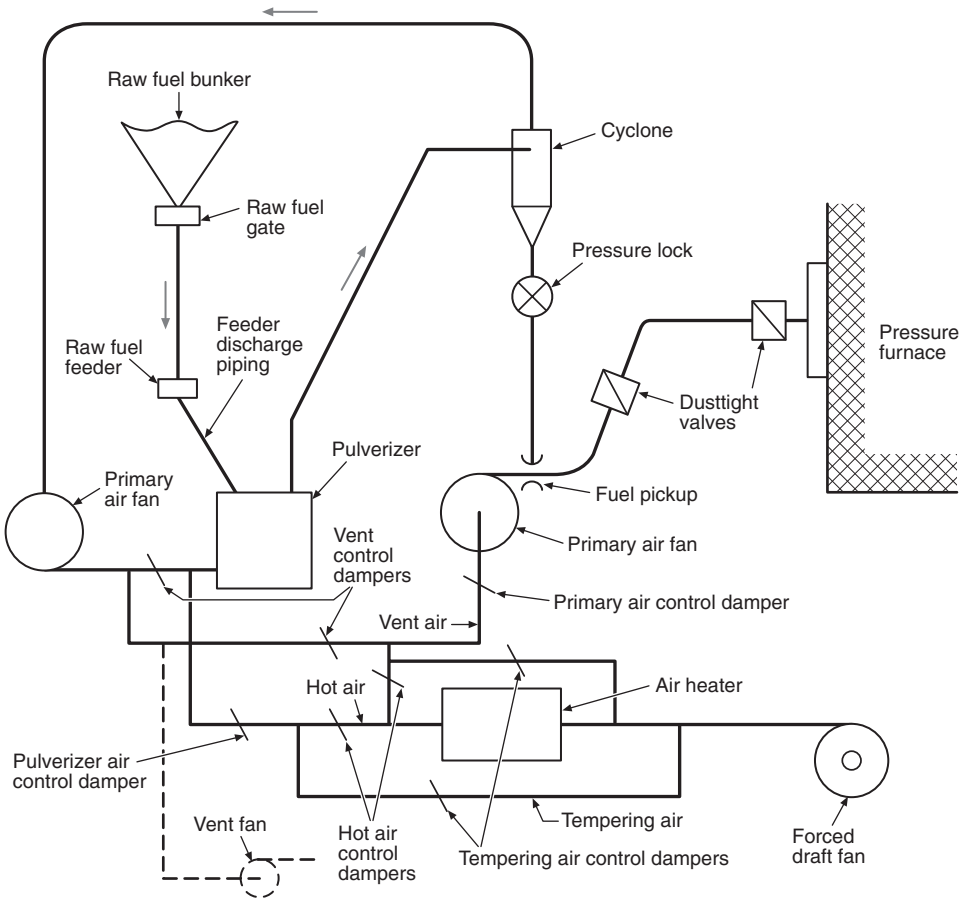


Figure 5-2(b) Semi-direct-firing pulverized fuel system.

5-2.3 Valve Requirements. See 2-5.1.2.

5-2.3.1 A barrier valve and a dusttight valve shall be installed between each fuel pickup point and the burner for a suction furnace that can be fired by other fuels. *(See 2-5.1.2.1.)*

5-2.3.2 Two dusttight valve(s) shall be installed between the fuel pickup point and the burner for a pressurized furnace if the furnace can be fired by other fuels. *(See 2-5.1.2.2.)*

NOTE 1: It is recommended that one or both valve(s) as described in 5-3.3.1 and 5-3.3.2 be quick closing.

NOTE 2: No valves are required between the pulverizer outlet and cyclone.

5-2.4 Isolation Requirements. See 2-5.1.3.

5-2.5 Operation.

5-2.5.1 Starting Sequence. The starting sequence shall be as follows:

(a) Start up all necessary combustion system auxiliaries in the proper sequence. *(See 3-3.1.)*

(b) Start forced draft fan (for pressure furnace only).

(c) Start primary air fan.

(d) Open all valves in lines to burners to be started, including barrier valves and dusttight valves.

(e) Adjust primary air flow to desired value, at least sufficient to provide minimum burner line velocity.

(f) Start pressure locks.

(g) Start pulverizer air fan.

(h) Start pulverizer.

(i) Start vent fan, if required.

(j) Start raw fuel feeder.

(k) Adjust dampers and controls as in 3-3.1(i).

5-2.5.2 Normal Operation. See 3-3.2.

5-2.5.3 Normal Shutdown. The normal shutdown procedure shall be as follows:

(a) Follow the procedures of 3-3.3.

(b) When the pulverizer is empty and cool, stop the pulverizer and pulverizer air fan or exhauster.

(c) Stop pressure locks.

(d) Stop vent fan.

(e) Stop primary air fan.

5-2.5.4 Interlocking. See Section 2-7.

5-3 Pulverized Fuel System for Blast Furnace Injection.

5-3.1 Description. This system is one in which the fuel is pulverized in an air-swept pulverizer, collected, stored, and batch-pressurized to a pressure that is higher than the blast furnace pressure, transported, and distributed to the furnace tuyeres *(see Figure 5-3)*. This system has the following three major subsystems:

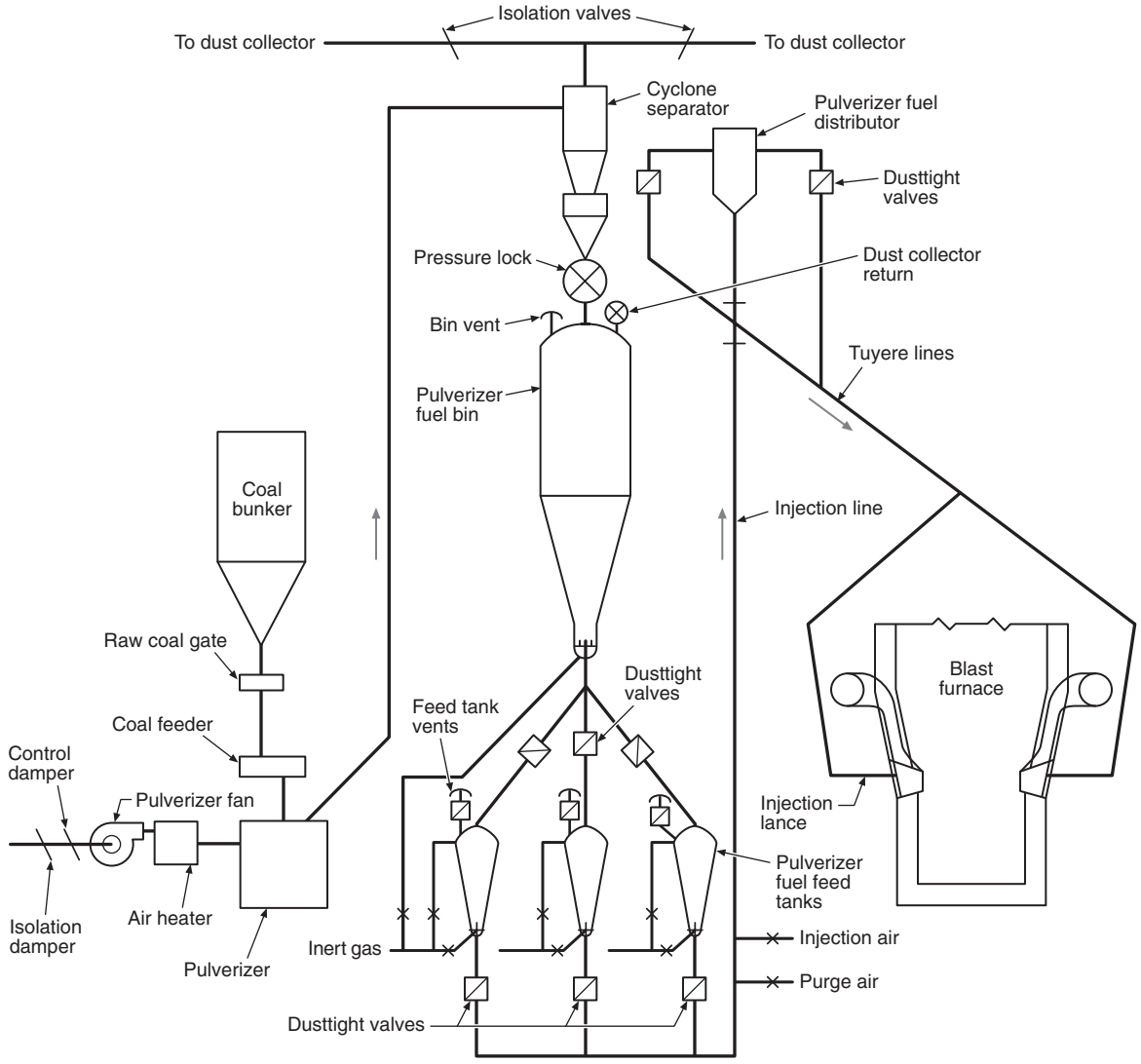


Figure 5-3 Blast furnace pulverized fuel injection system.

(a) A fuel grinding and collecting system

(b) An inert gas, pressurized fuel, storage and feeding system

(c) Pulverized fuel transportation and distribution system

5-3.2 System Arrangement. The pulverizer and pulverized fuel–collecting, –pressurizing, and –feeding equipment can be located remotely from the blast furnace. It is recommended that the distribution system be located close to the blast furnace. The pulverizer fan can be located ahead of the air heater and pulverizer, between the air heater and pulverizer, at the pulverizer outlet, or at the cyclone or dust collector vent.

The special equipment includes the following:

(a) Pulverizer air heater

(b) Cyclone separator or other type of dust collector

(c) Cyclone pressure lock

(d) Pulverized fuel bin

(e) Pulverized fuel feed tanks

(f) Pressure-tight isolation valves

(g) Injection air system

(h) Inert gas system

(i) Fuel injection lances

(j) Flow control of air or flue gas

(k) Vent dust collector

5-3.3 Valve Requirements.

5-3.3.1 Pressure locks shall be installed at the pulverized fuel discharge of the cyclone separator or vent dust collector return lines.

5-3.3.2 Special dusttight valves shall be installed at each fuel outlet of the pulverized fuel bin, at the fuel discharge outlet of each feed tank, and at each fuel outlet of the pulverized fuel distributors. These valves shall be tight at a pressure that is 1.5 times the required pressure in the feed tanks.

5-3.4 Isolation Requirements. Isolation damper(s) shall be provided upstream of the pulverizer and at the discharge of the cyclone separator to permit inerting in this system.

5-3.5 Operation.

NOTE: Pulverized fuel is injected into the blast furnace tuyeres where the blast air carries this fuel into a furnace zone of extremely high temperature. The injection of fuel into an operating blast furnace presents no explosion hazard, but precautions in handling pulverized fuel must be observed to avoid fires and explosions in the pulverizer fuel injection system.

5-3.5.1 Operation of Fuel-Pulverizing Equipment. This is a storage-grinding system, and the principles and procedures in 3-4.2 shall apply.

5-3.5.2 Operation of fuel injection equipment shall be as follows:

(a) Ascertain that the blast furnace is in service before starting the pulverized fuel injection system.

(b) Start inert gas source.

(c) Start injection air system blower or compressor, and pressurize injection line to distributor.

(d) Pressurize the filled pulverized fuel feed tank with inert gas.

(e) Open dusttight valves in lines leaving the distributors.

(f) Establish transport air flow.

(g) Open discharge dusttight valves from the pulverized fuel feed tank.

NOTE: This sequence will start pulverized fuel flow to the blast furnace. This system description uses pulverized fuel feed tank sequencing to maintain the feed; however, other means for doing this can be used. Because of the fire hazard, inert gas is used to fluidize and pressurize the feed tank system. In normal operation, pulverized fuel flow to the furnace is controlled by regulating the pressure drop across the system.

5-3.6 Normal Shutdown.

5-3.6.1 The shutdown sequence shall be as follows:

(a) Empty fuel bin and feed tanks of pulverized fuel.

(b) Purge the injection and distribution system.

(c) Close the distributor dusttight valves.

5-3.6.2 If all pulverized fuel cannot be removed from the system, inert gas shall be provided for the feed hoppers and pulverized fuel bin when the system is idle.

5-3.7 Interlocking. In addition to the interlocking requirements of 2-7.4, the following shall be included:

(a) Failure of pulverizer air flow trips the separately fired air heater.

(b) Failure of the cyclone separator or other type of dust collector pressure lock trips the raw coal feeder.

(c) Power failure closes all valves that are required to isolate the system.

5-4 Firing System for Rotary Kilns.

5-4.1 Description of Direct-Firing System.

5-4.1.1 General. This system is a form of direct firing *[see 2-5.1 and Figures 5-4(a) and 5-4(b)]*. The only special equipment is a dust collector with a pressure lock for cleaning hot air or gas (optional). *[See Figures 5-4(a) and 5-4(b).]*

5-4.1.1.1 Isolation Requirements.

(a) When a bypass air system is used, a bypass control damper shall be installed.

(b) A tempering damper shall be installed near the kiln hood to protect the hot gas duct.

5-4.1.2 Operation.

5-4.1.2.1 Starting Sequence. The starting sequence shall be as follows *(see 3-3.1)*:

(a) Start pressure lock.

(b) Start the primary air fan or exhauster.

(c) Start air heaters, if furnished.

(d) Start the pulverizer.

(e) Start the raw fuel feeder.

(f) Adjust primary air and fuel to desired value.

5-4.1.2.2 Normal Operation. See 3-3.2.

5-4.1.2.3 Normal Shutdown. Normal shutdown procedure shall be as follows:

(a) Shut off hot air.

(b) When pulverizer is cool, stop raw fuel feeder.

(c) When pulverizer is empty, stop pulverizer.

(d) Stop primary air fan or exhauster.

(e) Stop pressure lock.

5-4.1.3 Interlocking. See 2-7.1 and 2-7.2.

5-4.2 Description of Semi-Direct-Firing System. See Section 5-2.

5-4.3 Description of Storage System for Rotary Kiln Firing. See 2-5.2.

Chapter 6 Referenced Publications

6-1 The following documents or portions thereof are referenced within this standard as mandatory requirements and shall be considered part of the requirements of this standard. The edition indicated for each referenced mandatory document is the current edition as of the date of the NFPA issuance of this standard. Some of these mandatory documents might also be referenced in this standard for specific informational purposes and, therefore, are also listed in Appendix E.

6-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 68, *Guide for Venting of Deflagrations,* 1994 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 1997 edition.

NFPA 70, *National Electrical Code,* 1996 edition.

NFPA 8502, *Standard for the Prevention of Furnace Explosions/ Implosions in Multiple Burner Boilers,* 1995 edition.

6-1.2 ANSI Publication. American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

ANSI B31.1, *Power Piping Code,* 1995.

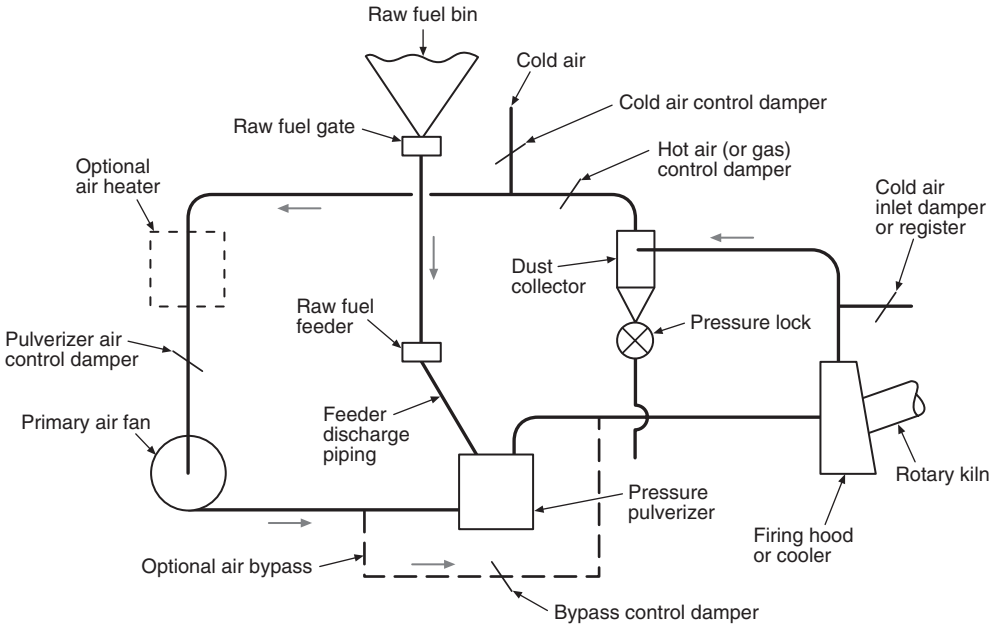


Figure 5-4(a) Direct-fired pulverized fuel systems for rotary kilns.

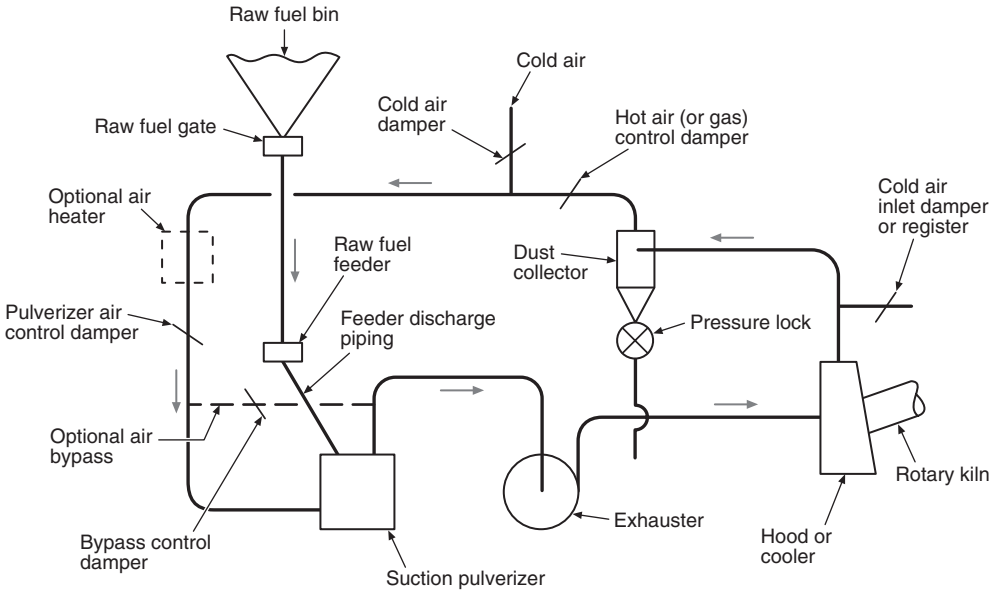


Figure 5-4(b) Direct-fired pulverized fuel systems for rotary kilns.

Appendix A Explanatory Material

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

A-1-4 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A-1-4 Authority Having Jurisdiction. The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the