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NFPA 123
Standard for Fire Prevention and Control in Underground Bituminous Coal Mines
1995 Edition

NFPA

National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101

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Policy Adopted by NFPA Board of Directors on December 3, 1982

The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

Statement on NFPA Procedures

This material has been developed under the published procedures of the National Fire Protection Association, which are designed to assure the appointment of technically competent Committees having balanced representation. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accept any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

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NFPA 123

Standard for

Fire Prevention and Control in Underground Bituminous Coal Mines

1995 Edition

This edition of NFPA 123, *Standard for Fire Prevention and Control in Underground Bituminous Coal Mines*, was prepared by the Technical Committee on Mining Facilities and acted on by the National Fire Protection Association, Inc., at its Fall Meeting held November 14-16, 1994, in Toronto, Ontario, Canada. It was issued by the Standards Council on January 13, 1995, with an effective date of February 7, 1995, and supersedes all previous editions.

The 1995 edition of this document has been approved by the American National Standards Institute.

Origin and Development of NFPA 123

In 1978 the Technical Committee on Mining Facilities, through its membership and current Mine Safety and Health Administration regulations, identified the need for guidance in fire prevention and control in underground coal mines. The first edition of NFPA 123 was developed through several subcommittee and committee meetings and was officially released as the 1987 edition.

A variety of important changes were included in the 1990 edition of NFPA 123. Most important among these were the addition of new criteria that specifically address protective signaling systems and automatic sprinkler systems used in underground bituminous coal mines. his material was developed in conjunction with the NFPA Technical Committees responsible for these fire protection systems, in accordance with the NFPA Standards Council policy on jurisdictional scope issues.

This latest edition incorporates the requirements that were previously included in NFPA 124, *Standard for Fire Protection of Diesel Fuel and Diesel Equipment in Underground Mines,* which was withdrawn. Further changes include editorial corrections and revisions that provide consistency with other NFPA mining related standards.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

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

Committee Scope: This Committee shall have primary responsibility for documents on requirements for safeguarding life and property against fire, explosion, and related hazards associated with underground and surface coal and metal and nonmetal mining facilities and equipment.

Contents

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Standard for

Fire Prevention and Control in Underground Bituminous Coal Mines

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

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

Chapter 1 Introduction

1-1* Scope.

1-1.1* This standard covers minimum requirements for reducing loss of life and property from fire in underground bituminous coal mines.

1-1.2 This standard does not apply to the following:

(a) Diesel fuel that has been modified with additives that reduce the flash point to less than 100°F (37.8°C);

(b) Modified or unmodified diesel fuel used at altitudes where the flash point drops to less than 100°F (37.8°C);

(c) Explosion hazards;

(d) Storage of flammable and combustible liquids produced in underground coal mines;

(e) Methane drainage systems; and

(f) Spontaneous combustion.

1-1.3 This standard is based on the current state of the art. Application to existing installations is not mandatory. Nevertheless, operating mines are urged to adopt those features of this standard that are considered applicable and reasonable for existing installations.

1-1.4 Nothing in this standard is intended to prevent the use of systems, methods, or devices of a quality, reliability, strength, fire resistance, effectiveness, durability, or safety equivalent to those prescribed by this standard. Technical justification or demonstration of equivalency shall be provided to the authority having jurisdiction.

1-2 Purpose. This standard was prepared for the use and guidance of those charged with designing, constructing, installing, examining, approving, operating, or maintaining fire prevention, fire protection, or fire-fighting equipment in underground bituminous coal mines.

1-3 General.

1-3.1 Because of the uniqueness of underground bituminous coal mines, provisions in this standard might differ from commonly accepted fire protection standards and guides devised for other types of occupancies.

1-3.2 Only those skilled in fire protection are competent to design and supervise the installation of mine fire protection systems. It might be necessary for those responsible for the storage of flammable and combustible liquids and the use of diesel-powered equipment within underground bituminous coal mines to consult an experienced fire protection specialist.

1-4 Definitions.

Approved. Acceptable to the authority having jurisdiction.

NOTE: 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 concerned with product evaluations that is in a position to determine compliance with appropriate standards for the current production of listed items.

Atmospheric Tank. A storage tank that has been designed to operate at pressures that range from atmospheric through 0.5 psig (a gauge pressure of 3.5 kPa).

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

NOTE: 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 authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

Boiling Point. The boiling point of liquid at a pressure of 14.7 psia (760 mm). Where an accurate boiling point is unavailable for the material in question, or for mixtures that do not have a constant boiling point, for purposes of this standard, the 10 percent point of a distillation performed in accordance with ASTM D86, *Standard Method of Test for Distillation of Petroleum Products*, shall be permitted to be used as the boiling point of the liquid.

Closed Container. A container sealed by means of a lid or other device so that neither liquid nor vapor can escape from it at ambient temperatures.

Combustible. Capable of undergoing combustion.

Combustible Liquid. Any liquid having a flash point at or above 100°F (37.8°C).

Combustible liquids shall be subdivided as follows:

Class II liquids shall include those having flash points at or above 100°F (37.8°C) and below 140°F (60°C).

Class IIIA liquids shall include those having flash points at or above 140°F (60°C) and below 200°F (94.4°C).

Class IIIB liquids shall include those having flash points at or above 200°F (93.4°C).

Combustible Liquid Storage Area — Portable. An area used for storage of Class II and Class III combustible liquids that is periodically moved, and where the aggregate quantity present shall not exceed 1,000 gal (3,785 L). Handling of liquids incidental to transfer can take place within a storage area.

Combustible Liquid Storage Area — Fixed. An area used for storage of Class II and Class III combustible liquids that is infrequently moved, and where the aggregate quantity present shall not exceed 5,000 gal (18,925 L). Handling of liquids incidental to transfer can take place within a storage area.

Combustible Liquid Storage Area — Mobile. Self-propelled or mobile equipment fitted with suitable containers or tanks and other related fixtures used for the storage, transport, and dispensing of Class II and Class III combustible liquids. The aggregate quantity of combustible liquid carried on such equipment shall not exceed 1,000 gal (3,785 L).

Container. Any vessel of 60 U.S. gal (227 L) or less.

Diesel-Powered Equipment. Any device powered by a diesel engine.

Dry-Pipe Sprinkler System. A system employing automatic sprinklers attached to a piping system containing air or nitrogen under pressure, the release of which (as from the opening of a sprinkler) permits the water pressure to open a dry-pipe valve. The water then flows into the piping system and out the opened sprinklers.

Fire Detector. An automatic device designed to detect the presence of fire and initiate action.

Fire-Resistant Construction. Masonry walls or equivalent having at least a 1-hour fire rating, including compressible materials having an equivalent fire resistance capability.

Fire Risk Assessment. The evaluation of the relative danger of the start and spread of fire; the generation of smoke, gases, or toxic fumes; and the possibility of explosion or other occurrence endangering the lives and safety of personnel or causing significant damage to property.

Fixed Fire-Suppression System. A total flooding or local application system consisting of a fixed supply of extinguishing agent permanently connected for fixed agent distribution to fixed nozzles that are arranged to discharge an extinguishing agent into an enclosure (total flooding), directly onto a hazard (local application), or a combination of both; or an automatic sprinkler system.

Flammable Liquid. A liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 psia (276 kPa) at 100°F (37.8°C) and classified as Class I liquid.

Class I liquids shall be subdivided as follows:

Class IA shall include those liquids having flash points below 73°F (22.8°C) and a boiling point below 100°F (37.8°C).

Class IB shall include those liquids having flash points below 73°F (22.8°C) and a boiling point at or above 100°F (37.8°C).

Class IC shall include those liquids having flash points at or above 73°F (22.8°C) and below 100°F (37.8°C).

Flammable Liquid Storage Area. Area used for storage of Class I liquids.

Flash Point. The minimum temperature at which a liquid emits vapor in sufficient concentration to form an ignitible mixture with air near the surface of the liquid with the container as specified by appropriate test procedures and apparatus as follows:

The flash point of a liquid having a viscosity less than 45 SUS at 100°F (37.8°C) or a flash point of 200°F (93.4°C) or higher shall be determined in accordance with ASTM D56, *Standard Method of Test for Flash Point by the Tag Closed Cup Tester.*

The flash point of a liquid having a viscosity of 45 SUS or more at 100°F (37.8°C) or a flash point of 200°F (93.4°C) or higher shall be determined in accordance with ASTM D93, *Standard Method of Test for Flash Point by the Pensky-Martens Closed Tester.*

As an alternative, ASTM D3243, *Standard Method of Tests for Flash Point of Aviation Turbine Fuels by Setaflash Closed Tester*, shall be permitted to be used for testing aviation turbine fuels within the scope of this procedure.

As an alternative, ASTM D3278, *Standard Method of Tests for Flash Point of Liquids by Setaflash Closed Tester*, shall be permitted to be used for paints, enamels, lacquers, varnishes, and related products and their components having flash points of 32°F to 230°F (0°C to 110°C), and having a viscosity lower than 150 stokes at 77°F (25°C).

Hand Hose Line System. A hose and nozzle assembly connected by fixed piping or connected directly to a supply of extinguishing agent.

Hydrant. A valved hose connection.

Inby. A mining term that means in the direction of the face of the mine or further into the mine.

Intrinsically Safe. Approved equipment incapable of releasing enough electrical or thermal energy under normal or abnormal conditions to cause ignition of a flammable mixture of methane or natural gas and air of the most easily ignitible composition.

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.

Liquid. For the purpose of this document, any material with fluidity greater than that of 300 penetration asphalt when tested in accordance with ASTM D5, *Standard Method of Test for Penetration of Bituminous Materials.*

Listed. Equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

Low Pressure Tank. A storage tank designed to withstand an internal pressure above 0.5 psig (3.5 kPa) but not more than 15 psig (102.4 kPa).

Mine Operator. The highest-ranking person responsible for conduct of work at a mine.

Mobile Equipment. Wheeled, skid-mounted, track-mounted, or rail-mounted equipment capable of moving or being moved.

Noncombustible. Material that, in the form used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. Materials reported as noncombustible when tested in accordance with ASTM E136, *Standard Method of Test for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C*, shall be considered noncombustible materials.

Operating Area. Area where mining of coal is taking place or area where construction is underway.

Outby. A mining term that means in the direction away from the face of the mine or toward the outside of the mine; opposite of inby.

Permissible Equipment. A completely assembled machine or accessory for which formal approval has been issued, allowing operation in a potentially explosive methane and air-mixture environment.

Pipeline System. An arrangement of piping, valves, connections, and allied equipment installed in a mine for the purpose of transporting, transferring, or dispensing flammable or combustible liquids.

Portable Extinguisher. An extinguisher of the hand-held or wheeled type that is capable of being carried or moved about; or a transportable system consisting of a hose reel or rack, hose, and discharge nozzle assembly connected to a supply of suppressant.

Portable Tank. Any closed vessel having a liquid capacity of over 60 gal (227 L), but less than 1,000 gal (3,785 L), and not intended for fixed installation.

Pressure Vessel. Any fired or unfired vessel within the scope of the applicable section of the ASME *Boiler and Pressure Vessel Code*.

Safety Can. An approved container of not more than 5 gal (18.9 L) capacity having a spring-closing lid and spout cover and designed so that it safely relieves internal pressure when subjected to fire exposure.

Self-Closing Door. A door that, when opened and released, returns to the closed position.

Self-Propelled. Equipment that contains a motive power train as an integral part.

Shall. Indicates a mandatory requirement.

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

Suitable. That which is appropriate and has the qualities or qualifications to meet a given purpose, occasion, condition, function, or circumstance.

Tank. A closed vessel having a liquid capacity in excess of 60 U.S. gal (227 L).

Chapter 2 Fire Prevention

2-1 Housekeeping.

2-1.1 Maintenance and operating practices shall minimize leakage and prevent the accidental release of flammable or combustible liquids. Spillage shall not be allowed to accumulate in quantities that could create a fire hazard and shall be cleaned up promptly.

2-1.2 Where flammable or combustible liquids are used or handled, means shall be provided to dispose of leakage or spills safely.

2-1.3 Combustible material shall not be allowed to accumulate in nondesignated areas. Appropriate waste receptacles shall be provided for combustible refuse.

2-1.4 Routes designated for access to fire protection equipment shall be kept clear of obstructions.

2-1.5 Air volume and velocity shall be sufficient to dilute, render harmless, and carry away flammable or explosive concentrations of vapors.

2-1.6 Excessive amounts of coal dust shall be cleaned up, covered, or inerted with rock dust.

2-2 Cutting and Welding.

2-2.1 Cutting and welding shall be performed only by persons instructed in precautions and procedures for safe operation.

2-2.2 Cutting and welding equipment shall be maintained in good operating condition with all necessary safeguards in place and functioning.

2-2.2.1 Flashback and backflow preventers shall be installed at the outlets of all pressure regulators and on the hose connections used in cutting, welding, brazing, and soldering torches.

2-2.2.2 Manifolding of cylinders containing gases used for cutting and welding shall be permitted only in well-ventilated shops. The equipment shall be electrically grounded and maintained in accordance with the safety precautions provided by the manufacturer.

2-2.3 When transporting compressed gas cylinders for cutting or welding, they shall be:

(a) Disconnected from regulators;

Exception: Cylinders, regulators, hoses, and torches that are protected adequately against damage shall not be required to be disconnected during transport to prevent possible contamination of the system by coal dust and air.

(b) Protected with a metal cap or headband (fence-type metal protector around the valve stem);

(c) Secured by devices that will hold the cylinders in place during transit on conveyor belts or mobile or self-propelled equipment;

(d) Placed in electrically insulated, substantial containers designed to hold the cylinders during transit on a trolley wire haulage system; and

(e) Clearly labeled "empty" or "MT" if the gas has been expended.

2-2.4 Valves on unattended compressed gas cylinders shall be closed. Where located in other than underground shops, compressed gas cylinders not in use shall have the regulators removed, and the valves shall be protected by covering with protective metal caps, by tank design, or by other approved equivalent protection.

2-2.5 Compressed gas shall be used only for its intended purpose. Compressed oxygen shall not be used to blow coal dust from clothing or machinery.

2-2.6 Cutting or welding shall not be performed on or within containers or tanks that have stored combustible or flammable materials until such containers or tanks have been purged and cleaned thoroughly or have been inerted.

NOTE: For additional information, see NFPA 327, *Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers Without Entry*, and AWS F4.1, *Recommended Safe Practices for Preparation for Welding and Cutting Containers and Piping That Have Held Hazardous Substances*.

2-2.7 Cutting or welding shall not be performed within 50 ft (15.2 m), measured horizontally, of explosives, blasting agents, or flammable or combustible liquid storage areas unless separated by a suitable noncombustible barrier.

2-2.8 Before cutting and welding operations are undertaken, the following precautions shall be observed:

2-2.8.1 The immediate area shall be suitably cleaned, wetted down with water, or coated with rock dust. Open gear cases and combustible machine components located close to cutting or welding operations shall be covered with noncombustible material.

2-2.8.2 Fire extinguishing equipment, including multipurpose (ABC) dry chemical extinguishers, rock dust, or water hoses shall be immediately available. In the case of a portable fire extinguisher, either a single unit having a nominal capacity of 20 lb (9.1 kg) with a minimum rating of 10-A:60-B:C, or two units, each having a nominal capacity of 10 lb (4.5 kg) with a minimum rating of 4-A:40-B:C, shall be immediately available at the cutting or welding site.

2-2.8.3 Tests for methane gas (CH_4) shall be made before cutting or welding in any area where methane gas is likely to be present. Subsequent tests shall be made to monitor changes in methane concentration during the cutting and welding operation. Cutting or welding shall not be allowed to begin or continue unless the concentration is less than 1 percent by volume.

2-2.8.3.1 Where cutting or welding is necessary inby the last open crosscut, a continuous fire watch shall be maintained.

2-2.8.3.2 Where inby equipment to be modified or repaired can be moved, it shall be moved outby the last open crosscut before cutting or welding.

2-2.8.4 Adequate ventilation shall be established prior to, and maintained during, cutting or welding.

2-2.8.4.1 Cutting or welding on equipment or within enclosed areas of the equipment shall not be performed in the presence of atmospheres containing flammable mixtures of gases, vapors or liquids, or combustible mixtures of dust in suspension.

2-2.8.4.2 Flammable and combustible liquids shall not be dispensed within 50 ft (15.2 m) of cutting or welding operations. Freshly-painted surfaces shall be allowed to dry sufficiently so that ignitible vapor is not present before cutting or welding.

2-2.8.5 Compressed gas cylinders shall be secured in the upright position or angled with the valve end higher for proper and safe operation during cutting and welding.

2-2.9 Compressed gas cylinders stored underground shall meet the requirements of this section.

2-2.9.1 Compressed gas cylinders shall be placed in storage areas designated for the purpose. These areas shall be constructed of noncombustible material or shall be well rock-dusted and free of trash and combustible or flammable liquids.

2-2.9.2 Compressed gas cylinders shall be stored and secured in an upright position or angled with the valve end elevated.

2-2.9.3 Compressed gas cylinders shall be protected against damage from falling material, contact with power lines and energized electrical machinery, and heat from cutting or welding operations.

2-2.9.4 The valves of the compressed gas cylinder shall be closed tightly and protected from physical damage when not in use.

2-2.9.5 Compressed gas cylinders shall not be stored or left unattended inby the last open crosscut.

2-2.10 Upon completion of cutting or welding, a fire watch shall be maintained until all material has cooled sufficiently to allow touching with a bare hand.

2-2.10.1 Fire watchers shall have fire extinguishing equipment readily available and shall be trained in its use.

2-2.10.2 Fire watchers shall be familiar with the facilities and the procedures for sounding an alarm in the event of a fire.

2-3 Flammable Vapors. Precautions shall be taken to prevent the ignition of flammable vapors. Sources of ignition include, but are not limited to:

(a) Open flames;

(b) Smoking;

(c) Cutting and welding;

(d) Hot surfaces;

(e) Frictional heat;

(f) Static, electrical, and mechanical sparks;

(g) Spontaneous ignition, including heat-producing chemical reactions; or

(h) Radiant heat.

2-4 Underground Maintenance Shops.

2-4.1 Underground maintenance shops that are intended for use longer than 6 months shall be enclosed structures of fire-resistant construction, including floor, roof, roof supports, doors, and door frames, or shall be protected with an automatic fire suppression system. (*See Chapter 5 for information on fire suppression systems.*)

NOTE: Automatic-closing doors provide a higher level of fire protection and are therefore recommended.

2-4.2 The shop area shall be ventilated directly to a return.

2-5* Belt Conveyors. Belt conveyors installed in underground coal mines shall, as a minimum, meet all the requirements of this section.

2-5.1 Conveyor belts shall be approved.

2-5.2 Entries in which belt conveyors are installed shall be kept reasonably free of accumulations of coal and coal dust and shall be rock-dusted as needed.

2-5.3 All belt conveyors shall be equipped with an approved slippage switch system designed to shut down the belt if slippage develops between the drive pulley(s) and the belt. On each new installation, the slippage switch system shall be tested before the conveyor is used for the transport of coal. Thereafter, the slippage switch system shall be tested weekly.

2-5.4 All conveyor belts shall be equipped with an approved interlock system that will shut down inby belt conveyors or other coal-feeding equipment if any conveyor in the system should stop or reduce its normal speed.

2-5.5 Fixed combustible material such as posts, cribbing, and roof supports shall be guarded from contact by the belt with noncombustible material or located at least half the width of the belt from any idler or pulley. Guarding for machinery in the drive area and at other points along the belt shall be of noncombustible material.

NOTE: To minimize potential frictional ignition, alignment switches can be permitted to be provided at intervals sufficient to prevent the belt from contacting such materials.

2-5.6 New belt conveyor installations shall use a support structure without a deck between the upper and lower belt flights.

Exception: Belts that carry the load of the belt on a low-friction metal deck without rollers.

2-6 Hydraulic Fluids.

2-6.1 Fire-resistant hydraulic fluid shall be approved.

2-6.2 Unattended hydraulic equipment shall employ fire-resistant hydraulic fluid unless protected by an automatic fire suppression system.

2-6.3 Where fire-resistant fluids are required, samples of in-use fire-resistant fluids of the invert emulsion-type shall be collected quarterly. These samples shall be tested individually to determine if the water content is sufficient to make the fluid fire resistant. When a sample indicates that the water content is insufficient for the fluid to be considered fire resistant, the fluid shall be replaced or water shall be added to raise the water content above the minimum safe level. When water is added to the hydraulic system of any machine, a sample shall be taken and analyzed within 24 hours.

2-7 Risk Management.

2-7.1* Fire Risk Assessment.

2-7.1.1 A fire risk assessment shall be performed on all electrical or diesel-powered fixed, mobile, and self-propelled equipment by the mine operator or the operator's designee. This assessment shall include evaluation of the risk potential for the start and spread of a fire and the generation of smoke, gases, or toxic fumes that could endanger the lives and safety of personnel or cause unacceptable damage to property.

2-7.1.2 A separate fire risk assessment for each piece of equipment shall be required only when variations in design, use, condition, and environment change the fire potential.

2-7.1.3 If the assessment identifies unacceptable risks, further assessment shall include an evaluation of each of the following:

(a) Methods for minimizing or eliminating existing hazardous fire conditions;

(b) Use of detection and early fire-warning devices;

(c) Normal and emergency means of egress from the equipment or areas and evacuation to a safe location;

(d) Compartmentalization of equipment or isolation of areas to prevent or contain the spread of fire;

(e) Availability of fire-fighting personnel and existing fire suppression equipment;

(f) Spread of equipment fire to combustible materials in proximity;

(g) Ventilation control structures to contain or redirect products of combustion to the return; and

(h) Any other devices or procedures necessary to protect life and property.

2-7.2 Fire Risk Reduction. Fire risk-reduction practices shall follow the principles of minimizing ignition sources and reducing exposure of combustible materials to ignition sources. Paragraphs 2-7.2.1 and 2-7.2.2 delineate risk-reduction practices.

2-7.2.1 Equipment Modification.

2-7.2.1.1 All equipment shall be analyzed to determine whether fire risks can be reduced through equipment modification. Some examples include physical barriers between fuel and ignition sources, thermal shields over hot surfaces, hydraulic hose and electrical wiring harness rerouting, and power shutoffs.

NOTE: Modifications can affect the life expectancy and certification of equipment and equipment components. Such a modified machine might not be covered by the manufacturer's warranty or certification. Questions concerning the effect of a proposed modification should be discussed with the equipment manufacturer or the manufacturer's representative.

2-7.2.1.2 Modifications affecting fire risk of equipment shall be analyzed to determine whether such modifications decrease or increase fire risk.

2-7.2.2 Equipment, Inspection, and Maintenance. Hydraulic lines, coolant lines, lubrication lines, fuel lines, and electrical wiring, mechanical components, and fire prevention devices shall be inspected and maintained in proper condition in accordance with the manufacturer's recommendations.

Chapter 3 Flammable Liquids

3-1 General.

3-1.1 Wherever possible, the underground storage of flammable liquids shall be minimized.

3-1.2 Electrical equipment in flammable liquid storage areas shall be Class I, Division 1, as specified in NFPA 70, *National Electrical Code®*, or shall be classified "permissible" electrical equipment.

NOTE: Electrical equipment classified as "permissible" is certified as meeting the requirements of *Code of Federal Regulations*, Title 30, Chapter 1, Part 18.

3-1.3 Flammable liquids in storage shall be kept in closed containers.

3-1.4 Flammable liquids shall be permitted to be used only where there are no open flames or other sources of ignition within the possible path of vapor travel in flammable concentrations.

3-1.5 Flammable liquid containers shall be returned to a flammable liquid storage area after use.

3-1.6 All aerosol cans shall be treated as containing flammable liquids unless otherwise specifically identified.

3-1.7 Individual aerosol cans that are used regularly in normal operations shall be permitted on mobile equipment or in tool cabinets. Such cans shall be protected from mechanical damage.

3-2 Flammable Liquid Containers.

3-2.1 Flammable paints shall be stored only in original containers or cans of not over 5 gal (3.8 L) capacity. All other flammable liquids shall be transferred while on the surface to a listed safety can.

3-2.2 Safety cans containing Class IA flammable liquids shall not exceed 2 gal (7.6 L) capacity.

3-2.3 All flammable liquid containers shall be clearly labeled with the word "flammable."

3-2.4 Flammable liquid containers shall be stored in a stable manner.

3-3 Flammable Liquid Storage Areas.

3-3.1 Flammable liquids shall be stored in noncombustible cabinets or areas specifically designed and constructed for such purpose.

3-3.1.1 Noncombustible storage cabinets shall be listed or approved, or shall meet the requirements specified in Section 4-3 of NFPA 30, *Flammable and Combustible Liquids Code.*

3-3.1.2 Flammable liquid storage areas shall meet the requirements of 4-5.1, 4-5.2, and 4-5.5.

3-3.2 In operating areas, containers of flammable liquids and aerosol cans shall be stored at least 25 ft (7.6 m) away from potential ignition sources such as energized trolley wire, energized electrical equipment, and other operating equipment.

3-3.3 The aggregate quantity of flammable liquids, including aerosol cans, in a flammable liquid storage area shall not exceed 60 gal (227 L).

3-4 Dispensing Flammable Liquids.

3-4.1 Flammable liquids shall be drawn from or transferred into containers within a storage area using only the following methods:

(a) From safety cans;

(b) From a container by means of a device that draws through an opening in the top of the container; or

(c) By gravity through a listed or approved self-closing valve or self-closing faucet.

3-4.2 Transferring flammable liquids by means of pressurizing a container with air shall be prohibited. Transferring flammable liquids by pressure of inert gas shall be permitted only if controls, including pressure relief devices, are provided to limit the pressure so it cannot exceed the design pressure of the container.

3-4.3 Where electrically-powered pumps are used to transfer flammable liquids, a clearly identified and accessible switch or circuit breaker shall be provided at a location remote from dispensing devices, including remote pumping systems, to shut off the power to all dispensing devices in the event of an emergency.

3-4.4 Where flammable liquids are dispensed from containers, the containers shall be provided with approved vents, bonding, and flame arresters.

3-4.5 At least one portable fire extinguisher having a nominal capacity of 20 lb (9.1 kg) with a minimum rating of 10-A:60-B:C shall be located not more than 40 ft (12.2 m) from any area where flammable liquid is dispensed.

Chapter 4 Combustible Liquids

4-1 General.

4-1.1 Combustible liquids in use, such as diesel fuel in the fuel tanks of diesel-powered vehicles, hydraulic fluid in the reservoirs of hydraulic equipment, and lubricating oil in the lubrication reservoirs of operating equipment, are not covered in this chapter.

4-1.2 Combustible liquids in approved tanks or containers meeting the following requirements shall not require any special consideration and are exempt from the requirements for storage areas:

(a) Class II combustible liquids stored in containers meeting the requirements of this chapter and not exceeding 60 gal (227 L); or

(b) Class III combustible liquids stored in containers or approved tanks as specified in this chapter and not exceeding 660 gal (2,498 L).

4-1.3 Combustible liquid containers shall be stored as follows:

(a) Drums holding 55 gal (208 L) and 30 gal (114 L) shall be set vertically and not over 1 drum high;

(b) Drums holding 16 gal (60.6 L) shall be set vertically and not over 2 drums high;

(c) Pails holding 5 gal (18.9 L) shall be set vertically and not over 4 pails high;

(d) Cartons holding grease cartridges shall not be stacked over 3 cartons high; and

(e) Containers shall be kept closed during storage.

4-1.4 Ventilation shall be provided wherever combustible liquids are stored to prevent the accumulation of ignitible vapors.

4-2 Combustible Liquid Containers and Tanks.

4-2.1 Tanks for handling combustible liquids shall be substantially constructed, fitted with filler caps and vents, and shall have discharge valves that are protected in the event of derailment or ribbing of the vehicle.

4-2.2 Shipping containers and portable tanks for combustible liquids authorized by the U.S. Department of Transportation or conforming to the requirements of NFPA 386, *Standard for Portable Shipping Tanks for Flammable and Combustible Liquids*, shall be acceptable as storage containers.

4-2.3 Shipping containers larger than 5 gal (18.9 L) shall be provided with vacuum and pressure relief.

4-2.4 Containers and portable tanks for combustible liquids shall conform to the capacity limitations as defined in Section 1-4.

4-2.5 Combustible liquid storage tanks intended for fixed installation and engineered portable tanks shall be of materials compatible with the liquid stored and shall be designed and built in accordance with good engineering practices.

4-2.6 Atmospheric tanks shall be built in accordance with good engineering practices.

NOTE 1: Information on the design and construction of atmospheric tanks can be found in API 650, *Standard for Welded Steel Tanks for Oil Storage*, or UL 142, *Standard for Steel Above-Ground Tanks for Flammable and Combustible Liquids*, or UL 80, *Standard for Steel Inside Tanks for Oil Burner Fuel.*

NOTE 2: Low pressure tanks and pressure vessels can be permitted to be used as atmospheric tanks.

4-2.7 The operating pressure of storage tanks shall not exceed their design working pressure.

4-2.8 Low pressure tanks shall be built in accordance with good engineering practices.

NOTE: Information on the design and construction of atmospheric tanks can be found in API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, or the principles of the ASME *Boiler and Pressure Vessel Code*, "Code for Unfired Pressure Vessels," Section VIII, Division I.

4-2.9 The operating pressure of the vessel shall not exceed the design working pressure.

4-2.10 Pressure vessels shall be built in accordance with good engineering practices.

NOTE: Information on the design and construction of pressure vessels can be found in the ASME *Boiler and Pressure Vessel Code*, "Code for Unfired Pressure Vessels," Section VIII, Division I.

4-2.11 Storage tanks shall be vented to prevent the development of vacuum or pressure sufficient to distort the shell or roof of the tank as a result of filling or emptying and atmospheric temperature changes. Protection shall also be provided to prevent overpressure from any filling source exceeding the design pressure of the tank.

4-2.12 Storage tank vents shall be at least as large as the filling or withdrawing lines but no less than 1¼ in. (21.8 mm) nominal inside diameter. If more than one fill or withdraw line can be used simultaneously, the vent capacity shall be based on the maximum anticipated simultaneous flow.

NOTE: Information on venting can be found in API 2000, *Standard for Venting Atmospheric and Low-Pressure Storage Tanks.*

4-2.13 Vent pipes shall be constructed to drain toward the tank without sags or traps to collect liquid.

4-2.14 Connections for all tank openings shall be liquidtight.

4-2.15 Each connection to a tank through which liquid normally can flow shall be provided with an internal or external valve located as close as practicable to the shell of the tank.

4-2.16 Tanks containing combustible liquids shall be provided with a means for quick cutoff of flow in the event of fire in the vicinity of the tank.

4-2.17 Openings for manual gauging, if independent of the fill pipe, shall be kept closed when not gauging. Each such opening for any liquid shall be protected against liquid overflow and possible vapor release by means of a spring-loaded check valve or other appropriate device. Substitutes for manual gauging are acceptable.

4-3 Transfer and Transport of Combustible Liquids.

4-3.1 The terms "transfer" and "transport" are used synonymously to mean movement of combustible liquid in closed containers, tanks, safety cans, or pipelines between underground locations. Included in this section are the storage requirements for combustible liquid in an operating area.

4-3.2 Combustible liquid shall be permitted to be transferred into the mine by pipeline, portable tank, closed container, or safety can.

4-3.3 When combustible liquid is transferred into the mine, it shall be transported or transferred directly to the storage area or location where it will be used.

4-3.4* Pipeline systems used for combustible liquid transfer shall be permitted to be either wet- or dry-pipe installations.

4-3.4.1 Piping, valves, and fittings used for combustible liquid transfer shall be suitable for the expected working pressures and structural stresses. Piping, valve, and fitting burst strengths shall be at least 4 times the static pressure. The mechanical and thermal stresses of the pipeline caused by exposure to fire shall be considered in the selection of components and design of the pipeline system.

4-3.4.2 A manual shutoff valve shall be installed in the pipeline at the surface storage tank and at the point of underground discharge. An additional shutoff valve also shall be installed in each branch line where the branch line joins the main line.

4-3.4.3 The pipeline system shall be guarded so as to be protected against physical damage. Guarding by choice of location shall be considered an acceptable practice.

4-3.4.4 Combustible liquid pipeline transfer systems shall be maintained in good working order.

4-3.4.5 A fire risk assessment shall be conducted for the location(s) intended for installation of combustible liquid pipeline systems. (*See A-2-7.1.*)

4-3.5 Combustible liquid shall not be transported in the same conveyance with personnel unless the items are secured or small and can be carried safely by hand.

4-3.6 Combustible liquid containers or tanks loaded on rail or trackless vehicles shall be secured against shifting and damage during transit.

4-3.7 Rail or trackless vehicles that carry supplies for production areas in addition to combustible liquids shall have provisions for securing or separating those supplies from the lubricants so that, in the event of derailment or ribbing, the supplies will not puncture containers or tanks.

4-3.8 Vehicles carrying combustible liquids shall be kept reasonably clean of accumulations of oil, grease, and other combustible material. Spilled combustible liquids shall be cleaned up promptly. Any remaining residue shall be covered with an oil absorbent or rock dust.

4-3.9 Combustible liquid containers or tanks shall be at least 12 in. (305 mm) below energized trolley wires, or protected from contacting the wire by insulation, while being transported by trolley wire-powered systems.

4-3.10* The quantity of combustible liquid in containers or tanks off-loaded from transport vehicles and stored in an operating area shall not exceed a 3-day supply for normal operations in that area.

Exception: A single tank or container with a capacity exceeding a 3-day supply shall be permitted.

4-4 Areas for the Storage of Combustible Liquids in Portable Containers.

4-4.1 Portable combustible liquid storage areas shall be a minimum of 100 ft (30.5 m) from explosives magazines, electrical substations, shops, working faces, or other combustible liquid storage areas or shall be separated by unexcavated coal or rock or a masonry bulkhead. The storage area, unless equipped with an approved fire protection system, shall be a minimum of 100 ft (30.5 m) from any shaft station and 25 ft (7.6 m) from energized trolley wire.

4-4.2 A portable combustible liquid storage area shall be recessed or otherwise located and protected from accidental damage by mobile equipment or blasting.

4-4.3 The storage area shall be vented to the return.

4-4.4 The aggregate quantity of Class II and Class III combustible liquids in a combustible liquid storage area for portable containers shall not exceed 1,000 gal (3,785 L).

4-5 Fixed Areas for Combustible Liquid Storage.

4-5.1 Fixed combustible liquid storage areas shall be located:

(a) A minimum of 100 ft (30.5 m) from explosive magazines, electrical substations, shaft stations, and shops;

(b) A minimum of 100 ft (30.5 m) from other flammable or combustible liquid storage areas or separated by unexcavated coal, rock, or masonry bulkhead. The masonry bulkhead shall be a minimum thickness of 4 in. (102 mm) of blocks or 2 in. (51 mm) of reinforced Gunite;

(c) A minimum of 100 ft (30.5 m) from any working face and out of the line of sight of blasting, or a minimum of 500 ft (152 m), within line of sight, from any working face to avoid damage from fly rock; and

(d) A minimum of 25 ft (7.6 m) from normally energized trolley wire.

4-5.2 All fixed combustible liquid storage areas shall be enclosed and protected by an automatic fire suppression system.

4-5.2.1 All fixed combustible liquid storage area enclosures shall be of fire resistive construction, including floor, roof, roof supports, doors, and door frames. Exposed coal within all fixed combustible liquid storage areas shall be covered with noncombustible materials such as gunite, shotcrete, or preformed masonry. Bulkheads, if used, shall be tightly sealed and shall be built of, or covered with, noncombustible materials.

4-5.2.2 All fixed combustible liquid storage area enclosures shall be constructed to provide for suitable spill containment or shall be provided with a suitable floor drain to direct spilled liquid to a containment sump or vessel.

4-5.2.3 All openings to the storage area enclosures shall be sealed with substantial, fire-resistive stoppings. The access opening through which containers are moved shall be located on the intake side. All openings shall be equipped with self-closing metal doors. A metal personnel access door shall be provided at the opposite end of the storage area.

4-5.2.4 The storage area enclosure shall be vented to the return.

4-5.3 Tanks shall rest on the ground or on foundations made of concrete, masonry, piling, or steel. Tank foundations shall be designed to prevent accumulation of combustible liquid under the tank, to minimize the possibility of uneven settling of the tank, and to minimize corrosion in any part of the tank resting on the foundation.

NOTE: Information on tank foundations can be found in Appendix E of API 650, *Standard for Welded Steel Tanks for Oil Storage*, and Appendix B of API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks.*

4-5.4 All piping, valves, and fittings shall be suitable for the expected working pressures and structural stresses.

4-5.5 Fixed combustible liquid storage areas shall have exhaust directed to an exhaust ventilating system. Adequate ventilation shall be provided to prevent the accumulation of ignitible vapors.

4-5.6 Empty or idle combustible pallet storage within the combustible liquid storage area shall be limited to a maximum pile size of 250 ft^2 (23.2 m^2) and a maximum storage height of 7 ft (2.1 m). Idle pallet storage shall be separated from combustible liquids by at least 4 ft (1.2 m).

4-5.7 The aggregate quantity of Class II and Class III combustible liquids in a fixed combustible liquid storage area shall not exceed 5,000 gal (18,925 L).

4-6 Mobile Equipment for the Storage, Transport, and Dispensing of Combustible Liquids.

4-6.1 Where combustible liquids are stored on mobile equipment such as mobile service trucks, the equipment shall be parked at fixed or portable combustible liquid storage areas when not in use.

4-6.2 The aggregate quantity of combustible liquids carried on mobile equipment shall not exceed 1,000 gal (3,785 L).

4-7* Dispensing Combustible Liquids.

4-7.1 Combustible liquids shall be permitted to be dispensed through the application of positive pressure to containers or tanks only where they are certified as pressure vessels.

4-7.2 Where electrically powered pumps are used to dispense combustible liquids, a clearly identified and accessible switch or circuit breaker shall be provided at a location away from dispensing devices, including remote pumping systems, to shut off the power to all dispensing devices in an emergency.

4-7.3 Dispensing nozzles shall be of the self-closing type without a latch-open device.

4-7.4 Combustible liquids shall not be dispensed within 50 ft (15.2 m) of cutting or welding operations.

4-7.5 At least one portable fire extinguisher having a nominal capacity of 20 lb (9.1 kg) with a minimum rating of 10-A:60-B:C shall be located not more than 40 ft (12.2 m) from any area where combustible liquid is dispensed.

4-7.6 Dispensing combustible liquid from containers or tanks shall be accomplished by an approved transfer pump or by gravity flow. Where needed, containers or tanks shall be equipped with an approved vent. If a manual valve is used, it shall be of the self-closing type.

4-7.7 Spillage shall be cleaned up promptly. Remaining residue shall be covered with an oil absorbent or rock dust.

Chapter 5* Fire Protection

5-1 Portable Fire Extinguishers.

5-1.1 General Requirements.

5-1.1.1 Portable fire extinguishers used in underground coal mines shall be listed, multipurpose (ABC) dry-chemical types having a minimum nominal capacity of 10 lb (4.6 kg) of extinguishing agent and shall meet the requirements of NFPA 10, *Standard for Portable Fire Extinguishers.*

NOTE: Larger capacity extinguishers that provide more agent and longer discharge time are recommended.

5-1.1.2 Portable extinguishers shall be kept in their designated places.

5-1.1.3 Extinguishers shall be located conspicuously where they will be readily accessible in the event of fire.

Exception: In areas where visual obstruction cannot be completely avoided, visible markings shall be provided to indicate the location.

5-1.1.4 Extinguishers subject to dislodgment shall be installed in brackets specifically designed for this problem.

5-1.1.5 Extinguishers shall be protected from physical damage. Damaged extinguishers shall be repaired, replaced, or removed from service.

5-1.1.6 At least one hand-portable fire extinguisher having a nominal capacity of 20 lb (9.1 kg) with a minimum rating of 10-A:60-B:C shall be located outside of, but not more than 10 ft (3.0 m) from, the opening into each flammable and combustible storage area and maintenance shop. The installation of manual or automatic fire suppression systems shall not waive this requirement.

5-1.1.7 Where portable fire extinguishers are provided within flammable and combustible storage areas, travel distance to a portable extinguisher shall not exceed 40 ft (12.2 m).

5-1.2 Selection and Application.

5-1.2.1 Multipurpose (ABC) dry-chemical extinguishers shall be provided for protection of the following:

(a) Ventilation doors on trolley wire-supplied track haulageways;

(b) Pumps and pump rooms;

(c) Conveyor belt drives;

(d) Belt head loading equipment;

(e) Air compressors;

(f) Electrical equipment such as transformers, load centers, rectifiers, circuit breakers, generators, and starters;

(g) Rotary dump areas;

(h) Battery-charging areas;

(i) Intervals of 100 ft (15.2 m) along a longwall face unless washdown hoses are present;

(j) Flammable and combustible liquid storage areas;

(k) Mobile equipment used for the storage, transport, and dispensing of combustible liquids;

(l) Electric or diesel-powered mobile equipment; and

(m) Self-propelled equipment.

5-1.2.2 The installation of an automatic or manually operated fire suppression system shall not eliminate the requirement for a portable fire extinguisher.

5-1.2.3 At least one multipurpose (ABC) dry-chemical extinguisher having a minimum nominal capacity of 30 lb (13.6 kg) of agent, or two multipurpose (ABC) dry-chemical extinguishers having a minimum nominal capacity of 20 lb (13.6 kg) of agent each, shall be provided in each working section of a mine, including the headgate of a longwall face. If the coal seam is exceptionally gaseous and gas blowers are present, two multipurpose (ABC) dry-chemical extinguishers having a minimum nominal capacity of 20 lb (13.6 kg) of agent each shall be provided.

5-1.3 Inspection and Maintenance.

5-1.3.1 Portable fire extinguishers shall be inspected, maintained, and recharged as specified in NFPA 10, *Standard for Portable Fire Extinguishers,* Chapter 4, and shall include the requirements of 5-1.3.2 through 5-1.3.9.

5-1.3.2 Portable fire extinguishers shall be inspected visually at least monthly. The visual inspection shall confirm the following:

(a) The extinguisher is in its designated place;

(b) The tamper seals are intact;

(c) The extinguisher gauge is in the operable range (if extinguisher is stored pressure-type); and

(d) There is no obvious physical damage or condition to prevent operation.

NOTE: Visual inspections require documentation only at 6-month intervals.

5-1.3.3 Extinguishers shall be subjected to a thorough maintenance examination at least once every 12 months.

5-1.3.4 Maintenance procedures shall include a thorough examination of the extinguisher, including mechanical parts, extinguishing agent, and means of expulsion.

5-1.3.5 Any detected troubles or impairments shall be corrected or replaced immediately by competent personnel.

5-1.3.6 Each extinguisher shall have a durable tag or label securely attached on which the date of the maintenance services shall be recorded.

5-1.3.7 All extinguishers shall be recharged after any discharge.

5-1.3.8 All extinguishers shall be recharged as indicated by an inspection, or when performing maintenance.

5-1.3.9 Portable extinguishers shall be hydrostatically tested at intervals not exceeding those specified in NFPA 10, *Standard for Portable Fire Extinguishers*, Chapter 5.

5-2 Water Supply for Mine Fire Protection.

5-2.1 General Requirements.

5-2.1.1* Water distribution lines shall extend from the surface to each operating area.

Exception: Water lines that extend from a suitable underground supply of water are acceptable, provided the power for the pump(s) is not interrupted during a fire.

5-2.1.2 The operator shall choose the entry in which the water line is located, and it shall be adequately protected by the choice of location.

5-2.1.3 Water flow and ventilation airflow shall be in the same direction, unless suitable provision is made to ensure the availability of fire-fighting water on the upwind side of a fire in the entry containing the water line.

5-2.1.4 Where applicable, water lines shall be protected against freezing.

5-2.1.5 Water lines that are 2 in. (5 cm) or larger in diameter shall be joined with flanges, mechanical grooved fittings, threaded fittings, or other suitable fittings. At least every third joint shall be capable of allowing limited motion and emergency rearrangement.

5-2.1.6 Pipe and fittings shall be of substantial construction and shall be adequate for the water pressure intended.

5-2.1.7 Water lines shall be equipped with shutoff valves at intervals not exceeding 5,000 ft (1525 m). A shutoff valve shall be provided in each branch line at the point where it is coupled to the main water line.

NOTE 1: Shutoff valve intervals of 1,000 ft (305 m) are recommended.

NOTE 2: Indicator-type shutoff valves with labels specifying the normal operating position are recommended.

5-2.2 Water Demand.

5-2.2.1* All coal mine water systems shall be capable of simultaneously supplying 3 hose streams, each with a flow rate of at least 50 gpm (3.2 L/sec), and a nozzle pressure of at least 50 psig (345 kPa) for a total of 150 gpm (9.6 L/sec), applied through the maximum expected lay of hose.

NOTE: Higher nozzle pressures are recommended.

5-2.2.2 The mine water system shall be capable of supplying the required hose stream water demand continuously for 24 hours or the sprinkler water demand continuously for 2 hours, whichever is the greater supply.

NOTE: This equals a minimum supply of 216,000 gal (817,560 L).

5-2.3 Hydrants.

5-2.3.1* Hydrants suitable for supplying water to a fire hose shall be provided on the water line at intervals not exceeding 500 ft (152.5 m).

5-2.3.2 Hydrants shall be located at or close to an accessible crosscut(s). Stopping(s) in such crosscut(s) shall be fitted with a man door. If staggered crosscuts are used, hydrant location and crosscuts with man doors shall be located to provide a favorable route for laying a fire hose to parallel entries.

5-2.3.3 At least one hydrant shall be located upwind of the area protected by an automatic sprinkler system. Fire hose of sufficient length to reach all points of the sprinklered area with an adjustable nozzle shall be stored close to the hydrant.

5-2.3.4* Multiple hydrant assemblies, with the tools needed for their installation, shall be provided as part of each cache of emergency materials. (*See A-5-2.3.4 for suggested construction of multiple hydrants.*)

5-2.4 Maintenance. The water supply system shall be maintained operable.

5-3 Fire Protective Signaling Systems.

5-3.1 General Requirements.

5-3.1.1* All fire detectors shall be approved for the intended use and installed in accordance with NFPA 72, *National Fire Alarm Code*, or the manufacturer's instructions.

5-3.1.2* All signaling systems shall be approved for the intended use.

5-3.1.3 Fire detectors and related signaling system components used to initiate an audible or visual alarm, automatic activation of a fire suppression system, or equipment shutdown shall be approved for the intended use.

5-3.1.4 Fire detectors shall be listed for the application.

5-3.1.5 Signaling system input, alarm, and releasing circuits shall be supervised. The presence of a fault, alarm, or release shall initiate a signal in the protected area and remotely in a constantly attended location. This signal shall indicate which condition has occurred.

Exception: A trouble signal shall not be required when the main power supply is intentionally shut off during periods of mine inactivity.

NOTE: For further information see NFPA 72, *National Fire Alarm Code.*

5-3.1.6 A sprinkler system with a water flow switch connected to the signaling system shall be permitted in lieu of fire detection, but only in the area covered by the sprinkler system.

5-3.1.7 All components of protective signaling systems used inby the last open crosscut or in return air shall be classified as permissible or intrinsically safe.

NOTE: Electrical equipment classified as "permissible" or "intrinsically safe" is certified as meeting the requirements of the *Code of Federal Regulations*, Chapter 1, Title 30, Part 18.

5-3.2 Selection and Application.

5-3.2.1 Fire detectors shall be installed over all belt conveyors and at all unattended automatic belt heads (where mine cars are loaded automatically).

NOTE: The detector wiring and detectors should be installed on one side of the conveyor belt to allow safe maintenance and repair of the circuit wiring without shutting down the conveyor belt.

5-3.2.2 Compartment sizes and contours, airflow patterns, obstructions, and other characteristics of the protected area shall determine the placement, type, sensitivity, and, where applicable, the number of detectors.

5-3.3 Inspection, Maintenance, and Testing.

5-3.3.1 All fire detection systems and associated equipment shall be tested after installation according to the manufacturer's or designer's instruction manual.

Exception: Testing shall not require the discharge of any associated fire suppression system.

5-3.3.2 The detection system shall be inspected visually in accordance with an approved schedule according to conditions determined by the mine operator.

5-3.3.3 At least every 12 months, all fire detection systems, including alarms, shutdowns, and other associated equipment, shall be examined and checked thoroughly for proper operation in accordance with the manufacturer's or designer's instruction manual. Deficiencies shall be corrected, and the system shall be retested for proper operation.

5-4* Fire Suppression Systems.

5-4.1 General Requirements.

5-4.1.1 Mining equipment requiring a fixed fire suppression system shall be protected by a system of sufficient capacity to suppress the largest anticipated fires in the protected areas and shall:

(a) Be listed or approved for the purpose;

(b) Be suitably located or guarded so as to be protected against physical damage;

(c) Be either automatically or manually actuated. Automatically actuated systems also shall have a manual actuator capable of being activated from the operator's compartment or other accessible location;

NOTE: Depending on the size of the equipment, additional manual actuators could be needed to provide quick access for activation of the system.

(d) Provide agent distribution hose or pipe secured and protected against damage, including abrasion and corrosion;

(e) Be provided with discharge nozzle blow-off caps or other suitable devices or materials to prevent the entrance of moisture, dirt, or other material into the piping. The discharge nozzle protective device shall blow off, blow out, or open upon agent discharge; and

(f) The automatic fire suppression system shall be installed so that system actuation causes shutdown of the protected equipment.

Exception: Paragraphs 5-4.1.1 (c) and (e) shall not apply to automatic water-based sprinkler systems.

5-4.1.2 Fire suppression systems, as applicable, shall be in accordance with NFPA 11, *Standard for Low-Expansion Foam*; NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*; NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*; NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*; NFPA 16, *Standard on the Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems*; NFPA 17, *Standard for Dry Chemical Extinguishing Systems*; or NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*.

5-4.2 Applications.

5-4.2.1* The following equipment and facilities shall be protected by approved automatic fire suppression systems satisfying the requirements of 5-4.2.2 through 5-4.3.5:

(a)* Drive areas of belt conveyors, including drive motor(s), reducer, head pulley, tail pulley, belt storage unit, controls, discharge chute (to next belt), and takeup, including its power unit;

Exception: The tail pulley at the system loading point shall not require an automatic fire suppression system.

(b) Flammable and combustible liquid storage areas;

(c) Maintenance shops;

(d) Unattended hydraulic equipment, unless fire-resistant hydraulic fluid is used;

(e) Unattended electrical equipment such as enclosed electric motors, controls, transformers, rectifiers, and other similar equipment that does not have a hydraulic system; and

Exception No. 1: Equipment located on noncombustible material and spaced at least 2 ft (0.61 m) from coal or other combustible material.

Exception No. 2: Equipment located on noncombustible material and separated from coal or other combustible material by a fire-resistive layer or wall.

(f)* Air compressors. Air compressors shall be protected by one of the following:

1. An automatic sprinkler system;

2. A person in constant attendance, within the line of sight of the compressor, equipped with a readily available portable fire extinguisher in addition to the requirement of 5-4.2.1 for an automatic fire suppression system; or

3. Containment within an enclosure. Such an enclosure shall be constructed of noncombustible materials, ventilated to prevent overheating of the compressor, designed to provide containment of any possible fire involving the compressor, and protected by an automatic fire suppression system in accordance with 5-4.2.1.

5-4.2.2 Where high-expansion foam is used, provision shall be made to supply uncontaminated air for foam-making.

5-4.2.3 Automatic fire suppression systems, other than automatic sprinkler systems, shall be:

(a) Approved for the application;

(b) Installed, operated, inspected, and maintained in accordance with the applicable NFPA document;

(c) Equipped with one or more manual actuators accessible for quick actuation and maintained in operable condition; and

(d) In compliance with the requirements of 5-5.1(a), (b), and (d) through (h).

5-4.3 Sprinkler System Requirements.

5-4.3.1* Automatic sprinkler systems installed for the protection of Class I or Class II liquid storage areas shall be of the foam-water type.

NOTE: See the applicable sections of NFPA 16A, *Standard for the Installation of Closed-Head Foam-Water Sprinkler Systems.*

5-4.3.2 Where the requirements of Section 5-4 are satisfied by installing automatic sprinkler systems, such systems shall comply with the following:

(a) An indicating, full-flow, slowly-opening water control valve shall be located at the tap of the water line supplying the sprinkler system. When the sprinkler system is put into operation, the valve shall be sealed in the open position;

(b) A water flow switch or alarm valve, with associated inspector's test connection, capable of detecting the flow through one opened sprinkler shall be installed in the piping feeding the sprinklers. The alarm device shall be connected to an alarm system that will alarm at a constantly attended location and shall identify the sprinkler system involved. In dry-pipe automatic sprinkler systems, the alarm system shall be activated by flow through a dry-pipe valve, and paddle-type water flow switches shall not be used;

NOTE: The alarm system serving sprinklers protecting the drive area of a belt conveyor also should be permitted to serve as the fire detection system installed over that portion of the belt conveyor.

(c) Sprinklers shall be standard orifice pendent, upright, or sidewall-type automatic sprinklers [usually 1/2 in., 175°F to 225°F (79°C to 107°C)]. Sprinklers shall be installed in the upright position on a dry-pipe system;

CAUTION: Some automatic sprinklers might not withstand the water pressure that can be encountered in deep mines. Information on the effect of high water pressure on automatic sprinklers can be found in U.S. Bureau of Mines Report of Investigations 9451, "Effect of Pressure on Leakage of Automatic Sprinklers."

(d)* For sprinkler systems installed to protect the equipment and facilities indicated in 5-4.2.1(a), sprinklers shall be placed no more than 10 ft (3.05 m) apart. For sprinkler systems installed to protect equipment and facilities indicated in 5-4.2.1(b) through (f), sprinklers shall be spaced no more than 12 ft (3.66 m) apart, and the protection of any one sprinkler shall not exceed 100 ft^2 (9.3 m^2);

(e)* Sprinklers shall be located so that the discharge will not be obstructed. Sprinkler deflectors shall not be located at a distance below the roof of less than 1 in. (25.4 mm) nor greater than 20 in. (508 mm). Roof cavities containing combustible material such as wood or coal in the area to be protected shall be protected by installing upright sprinklers within the cavity at the top of riser pipes so that the deflectors are within 20 in. (508 mm) of the roof;

(f)* Piping in sprinkler systems shall comply with 5-2.1.5 and 5-2.1.6. Nonmetallic pipe shall not be used downstream of the sprinkler control valve unless investigated and approved for this purpose;

(g) Hangers supporting sprinkler piping shall be metallic. At least one hanger shall be attached to each length of pipe; and

(h) Provision shall be made to drain all parts of the system properly. Drain connections shall be sized as shown in Table 5-4.3.2(h).

Table 5-4.3.2(h) Sizes of Drain Connections

Riser or Main Size	Size of Drain Connection
Up to 2 in.	3/4 in. or larger
2 1/2 in. - 3 1/2 in.	1 1/4 in. or larger
4 in. and larger	2 in. only

For SI units: 1 in. = 2.54 cm.

Trapped piping sections shall be equipped with auxiliary drains or otherwise arranged to facilitate draining.

5-4.3.3 Wet-pipe sprinkler systems shall not be used where chance of freezing exists.

5-4.3.4 Where danger of freezing exists, sprinkler systems filled with antifreeze solution shall be permitted and shall meet the following requirements:

(a) If automatic sprinkler systems are connected to public water supplies or to piping supplying water for drinking, antifreeze solutions other than water solutions of pure glycerine (C.P. or U.S.P. 96.5 percent grade) or propylene glycol shall not be used. The glycerine-water and propylene glycol-water mixtures provided in Table 5-4.3.4(a) shall be permitted to be used;

NOTE: Local plumbing or health codes should be consulted for specific requirements and permissibility.

Table 5-4.3.4(a) Water-Based Solutions†

Material	Solution (by volume)	Specific Gravity at 60°F (15.6°C)	Freezing (°F)	Freezing (1°C)
Glycerine	50% water	1.133	-15	-26.1
C.P. or U.S.P. Grade*	40% water	1.151	-22	-30.0
	30% water	1.165	-40	-40.0
Propylene Glycol	70% water	1.027	+9	-12.8
	60% water	1.034	- 6	-21.1
	50% water	1.041	-26	-32.2
	40% water	1.045	-60	-51.1

*C.P. Chemically pure.
U.S.P. United States Pharmacopoeia 96.5%.
†Hydrometer scale 1.000 to 1.200 (subdivisons 0.002).

(b) If automatic sprinkler systems are not connected to public water systems or to piping supplying water for drinking, the commercially available materials provided as shown in Table 5-4.3.4(b) shall be permitted to be used in antifreeze solutions;

(c)* A soft-seat check valve shall be connected to the tee in the water line feeding the automatic sprinkler system. The water control valve [*see 5-4.3.2(b)*] shall be connected close to the discharge side of the check valve;

(d) A 1/4-in. (6.35-mm) soft-seat relief valve made of corrosion-resistant bronze or stainless steel shall be connected to the sprinkler piping near the shutoff valve. The

Table 5-4.3.4(b) Antifreeze Solutions to Be Used if Public Water Is Not Connected to Sprinklers†

Material	Solution (by volume)	Specific Gravity at 60°F (15.6°C)	Freezing (°F)	(1°C)
Glycerine	[If glycerine is used, see Table 5-4.3.4(a)]			
Diethylene Glycol	50% water	1.078	-13	-25.0
	45% water	1.081	-27	-32.8
	40% water	1.086	-42	-41.1
Ethylene Glycol	61% water	1.056	-10	-23.3
	56% water	1.063	-20	-28.9
	51% water	1.069	-30	-34.4
	47% water	1.073	-40	-40.0
Propylene Glycol	[If propylene glycol is used, see Table 5-4.3.4(a)]			
Calcium Chloride 80% "Flake"	Lb $CaCl_2$ per gal of water			
Fire Protection Grade*;	2.83	1.183	0	-17.8
Add corrosion inhibitor	3.38	1.212	-10	-23.3
of sodium bichromate	3.89	1.237	-20	-28.9
1/4 oz/gal water	4.37	1.258	-30	-34.4
	4.73	1.274	-40	-40.0
	4.93	1.283	-40	-45.6

*Free from magnesium chloride and other impurities.
†Hydrometer scale 1.000 to 1.200 (subdivisions 0.002).

relief valve shall be set to open at a pressure of 200 psi (1379 Pa) above the maximum water-line pressure (i.e., the maximum system pressure);

(e)* A suitable air chamber shall be connected to the piping. A recommended formula for calculating the suitability of an air chamber can be found in A-5-4.3.4(e). The connection port to the chamber shall be fitted with a small, high pressure, corrosion-resistant ball valve. The connection from the ball valve to the sprinkler piping shall be permitted to use a small-diameter hydraulic hose having a working pressure of at least the maximum system pressure. The air chamber shall be filled with compressed air at a pressure equal to the maximum water-line pressure. Where connected to the system piping, the air chamber shall be oriented so that the connection port is located at the bottom of the chamber. With the shutoff valve still closed, the sprinkler piping shall be filled with the antifreeze solution. High points of the piping shall be vented to obtain reasonably complete filling. The valve on the air chamber shall be opened and sealed. If possible, the pressure of the antifreeze solution shall be raised to the line pressure before the shutoff valve is opened and sealed. Finally, the system shall be checked carefully for leaks;

(f)* An alternative arrangement to 5-4.3.4(e) is to fully fill the sprinkler piping with antifreeze solution and then withdraw a suitable volume to create an air chamber. A recommended formula for calculating the volume to be withdrawn can be found in A-5-4.3.4(e). With all other fill, drain, and vent valves closed, a high pressure air compressor shall be connected to a valve opening and pressure in the piping shall be raised at least to the water-line pressure. The valve at the opening shall be closed and the valve shall be plugged. The system shall be checked carefully for leaks, especially in the area of the piping where the air is believed to exist. If the pressure gauge shows that the system is still tight after 24 hours, the shutoff valve shall be opened, making the system operational. The shutoff valve shall be sealed in the open position;

(g) Sprinkler systems filled with antifreeze solution shall employ antifreeze solution mixtures that are rated for the lowest temperature to which the sprinkler system could be exposed;

(h)* The antifreeze solution shall be mixed and tested before being pumped into the sprinkler system piping; and

(i) A pressure gauge should be provided in a protected location on the downstream side of the shutoff valve.

5-4.3.5* Where danger of freezing exists, a dry-pipe sprinkler system shall be permitted and shall meet the following requirements:

(a) The dry-pipe valve and its accessories shall be installed in a separate area and shall be protected against freezing and mechanical injury. If this area is ventilated with return air, all electrical components shall be permissible or intrinsically safe (*see note to 5-3.1.7*);

(b) Water pressure shall be regulated not to exceed the maximum pressure specified by the manufacturer of the dry-pipe valve;

(c) The dry-pipe valve shall be installed in accordance with the manufacturer's instructions;

(d) Mechanical grooved couplings, including gaskets used on dry-pipe systems, shall be listed for dry-pipe service;

(e) Operation of the dry-pipe system and supervision of the system, including pressure of the air supply, shall be signaled to an attended location. Such signaling shall be permitted to utilize alarm systems serving fire detection equipment; and

(f) The system air supply shall be provided from a reliable source such as a dedicated compressor and shall be equipped with an air maintenance device.

5-4.4 Inspection, Maintenance, and Testing.

5-4.4.1 All fire suppression systems shall be tested after installation in accordance with the manufacturer's or designer's instruction manual. Testing shall not require the discharge of suppressant unless there is no other satisfactory manner in which the reliability and integrity of the system can be verified.

5-4.4.2 Between regular maintenance examinations or tests, the fire suppression system shall be inspected visually, following a schedule determined by the mine operator.

5-4.4.3 At least every 12 months, all fire suppression systems, including alarms, shutdowns, and other associated equipment, shall be examined and checked thoroughly for proper operation in accordance with the manufacturer's or designer's instruction manual. Deficiencies shall be corrected, and the system or affected portion of the system shall be retested for proper operation.

5-4.4.4 The mine operator or mine operator's designee shall be provided with a copy of the manufacturer's installation and maintenance manual or owner's manual that describes system operation, required maintenance, and recharging.

5-4.4.5 Fire suppression systems, including foam-water sprinklers, installed in accordance with the requirements of this standard, shall be maintained in accordance with the manufacturer's instructions or designer's recommendations.

5-4.4.6 All persons who inspect, test, operate, or maintain fire suppression systems shall be trained thoroughly. Annual refresher training shall be provided.

5-4.4.7 New Automatic Sprinkler System Testing.

5-4.4.7.1 Flushing of Water-Line Connections. Water-line connections and lead-in connections shall be flushed at the maximum flow rate available before connection is made to the sprinkler piping to remove foreign material. Flushing shall be continued until the water is clear.

5-4.4.7.2 Flow Testing of Sprinkler Systems. Wet-pipe closed automatic sprinkler systems shall be flow-tested by operating flow through the maximum number of sprinklers expected to open, but not through fewer than 8 open sprinklers (all sprinklers if the system contains fewer than 8). If the residual pressure measured downstream of the opened sprinklers is 10 psi (68.9 Pa) or greater, the system is acceptable.

Exception No. 1: Closed sprinkler systems installed to protect areas where the water discharge could damage the area or its contents shall not be required to be tested by operating flow through opened sprinklers. Instead, an alternative test, operating flow through a 2-in. (50.8-mm) valve test connection, shall be permitted to be used.

Exception No. 2: Portable sprinkler systems that are frequently or occasionally dismantled and reinstalled in new areas shall be flow-tested following the initial installation.

5-4.4.8 Tests of Dry-Pipe Sprinkler Systems.

5-4.4.8.1 New dry-pipe systems shall be flow-tested in accordance with 5-4.4.7.2 and hydrostatically tested in accordance with 5-4.4.8 where there is no risk of freezing. A dry-pipe valve shall be tested according to manufacturer's recommendations.

5-4.4.8.2 Where there is risk of freezing in dry-pipe systems, an air pressure of 40 psi (276 kPa) shall be pumped up and allowed to stand 24 hours, and all leaks that allow a loss of pressure over 1½ psi (10.3 kPa) for the 24 hours shall be stopped.

NOTE: The clapper of a differential-type dry-pipe valve should be held off its seat during any test in excess of 50 psi (345 kPa) to prevent damaging the valve.

5-4.4.9 Sprinkler System Maintenance.

5-4.4.9.1 All sprinkler systems shall be maintained in accordance with the manufacturer's requirements or with instructions in appropriate NFPA standards. As a minimum, all closed sprinkler systems, except antifreeze systems, shall be retested annually by operating flow through the end fitting in all lines to remove any silt buildup. If pendent sprinklers are used on wet-type sprinkler systems, the end sprinkler on each line shall be removed and examined annually to check for silt buildup. If silt buildup is found, all sprinklers on the line shall be removed, the line flushed, and new sprinklers installed, preferably in the upright position.

5-4.4.9.2 Antifreeze Systems. Each year, at the onset of freezing weather, a small amount of antifreeze shall be drawn from the drain valve and the test valve(s) and tested with a hydrometer to ensure that the solution is suitable for the lowest temperature expected. If this test shows that the solution is not suitable, the solution shall be emptied into convenient containers. The drained solution shall be brought to the proper specific gravity if it is to be reused.

5-5 Fire Suppression for Self-Propelled Equipment.

5-5.1* Fire suppression systems consisting of an agent container and a network of agent distribution hose or pipe with discharge nozzles attached shall be used to protect self-propelled equipment. The system shall comply with the following:

(a) The system shall be sufficient to suppress any potential fire on the equipment it is intended to protect;

(b) The fire suppression system shall be approved for the purpose. When installed, the components shall be located or guarded to protect against damage;

(c) Fire suppression systems shall be either automatically or manually actuated. Automatically actuated systems designed to incorporate manual actuation shall be equipped with one or more such devices accessible for quick actuation and shall be maintained in operable condition;

(d) Discharge nozzles shall be provided with blow-off caps or other suitable devices to prevent the entrance of moisture or other environmental materials into the piping. The protective device shall blow off, blow out, or open upon agent discharge;

(e) The electrical components of systems installed on equipment that might be operated inby the last open crosscut or in return air shall be permissible or intrinsically safe (*see note to 5-3.1.7*), as defined in Section 1-4;

(f) A standby source of power shall be provided if electrical power is the only means of actuation;

(g) All fire suppression equipment and systems shall be tested after installation in accordance with the manufacturer's or designer's recommendations. Testing shall not require the discharge of agent unless there is no other satisfactory way to evaluate the system; and

(h) An installation and maintenance manual shall be provided for all fire suppression systems.

NOTE: Since exposure to some agents or their decomposition products could be hazardous to personnel, it is recommended that the appropriate NFPA standard for the agent under consideration be consulted to determine its use and limitations, recognizing that the mine environment can make prompt evacuation difficult.

5-5.2* Fire suppression systems shall be provided for protection of the attended, electrically powered, self-propelled equipment such as cutting machines, continuous miners, shearers, roof and coal drills, loaders, shuttle cars, scoops, and locomotives that use hydraulic fluid.

Exception: Cutting machines, continuous miners, shearers, and other machines that are supplied water through a hose for dust control while mining, shall be permitted to use this water source for fire protection, provided a diversion valve is at or outby the operator's station to permit quick and convenient diversion of water to the fire suppression nozzles.

5-6 Fire Fighting and Control.

5-6.1 Hand Hose Line Systems.

5-6.1.1* General Requirements. The mine operator shall choose the entry in which the hydrants are to be located and shall locate man doors and provide sufficient fire hose to reach parallel entries where risk of fires can exist.

5-6.1.2 Selection and Application.

5-6.1.2.1* Fire hose for use in underground coal mines shall be a minimum of 1½ in. (3.8 cm) in diameter, single or multiple jacket, and of a type suitable for coal mine use. The hose shall meet the minimum applicable standards of NFPA 1961, *Standard for Fire Hose*. Hose lines employing natural fibers shall not be used in underground coal mines.

5-6.1.2.2* Fire hose, including couplings, shall be adequate for the maximum line pressure that can exist on the mine water system, or there shall be provision for limiting the line pressure to the working pressure of the hose. Nozzle flow-pressure shall be adjusted to provide for safe hose control.

5-6.1.2.3* Couplings for fire hose used in underground coal mines shall have straight, iron pipe threads (referred to as NPSH) or National Standard Thread (NH, also known as NST and NS).

NOTE 1: Rocker lug couplings are preferred to pin-type couplings.

NOTE 2: Most mines use NPSH threads because the couplings will attach to male pipe threads of the same size.

5-6.1.2.4 Where hose or hose-connected equipment might be brought in from outside the mine, compatible adapters shall be available.

5-6.1.2.5* Hose nozzles shall be capable of delivering a straight stream and a spray discharge.

5-6.1.2.6* Fire hose shall be stored in caches, and caches shall contain sufficient hose to reach all areas covered by the hydrants that the cache will serve. Each cache shall contain at least one hose nozzle and one hose wrench.

5-6.1.2.7 Caches of fire hose shall be provided at strategic locations underground as follows:

(a) Near each intersection with an active sub-main;

(b) Near the mouth of each panel;

(c) Near and on the intake side of each conveyor belt drive;

(d) Near the entrance to each shop and storage area as defined in Sections 2-4, 3-1, and 4-1;

(e) In each operating area; and

(f) At intervals not to exceed 5,000 ft (1525 m) along the main haul route or travelway.

NOTE 1: Consideration should be given to providing caches at intervals of less than 5,000 ft (1525 m) where conditions warrant.

NOTE 2: A single hose cache might satisfy more than one of the required locations.

5-6.1.2.8 Hand hose line systems, if used, shall be installed in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, Sections 4-1 and 4-2 and Chapters 5 and 7, and shall be a minimum of either 1½ in. (38 mm) lined or 1 in. (25 mm) hard rubber.

5-6.1.2.9 Hand hose lines designated for fire fighting and accessible to Class I or Class II liquid storage areas shall be equipped to discharge a foam-water solution and shall be installed in accordance with the applicable sections of NFPA 11, *Standard for Low-Expansion Foam*, Chapter 3.

5-6.1.3 Maintenance. Caches of fire hose shall be checked at least every 6 months to ensure that the inventory of hose, nozzles, wrenches, and adapters is complete and in good condition. Annually, at least one length of hose from each cache shall be pressure tested according to NFPA 1961, *Standard for Fire Hose*. The tested hose shall be tagged and dated so that a different length of hose is tested each year. If any length of hose fails the pressure test, all lengths of hose in the cache shall be tested. Hose lines that fail the test shall be replaced.

5-6.2 Portable Foam-Generating Devices.

5-6.2.1 General Requirements.

5-6.2.1.1 Portable foam-generating devices and associated equipment shall be approved for that purpose.

5-6.2.1.2 Portable foam generators, fire hose, foam concentrate, and stopping materials shall be accessible for timely transport.

5-6.2.2 Maintenance. At least annually, a thorough maintenance examination of the foam-generating devices and associated equipment, including foam concentrate, shall be made by the mine operator. Operation of foam-generating equipment during training sessions conducted at least annually shall satisfy the maintenance examination requirement.

5-6.3 Rock Dust. At least 240 lb (109 kg) of bagged, dry rock dust shall be stored upwind and kept available for fire fighting at or near the following areas:

(a) Maintenance and shop areas;

(b) Combustible liquid storage area;

(c) Working section;

(d) Belt drive area;

(e) Belt-head loading area; and

(f) Ventilation doors on trolley wire-supplied track haulageways.

Exception: Where it is impractical to store for fire extinguishment purposes, rock dust shall be permitted to be replaced with an additional portable extinguisher having a minimum nominal capacity of 10 lb (4.6 kg) of multipurpose (ABC) dry chemical extinguishing agent.

5-6.4 Emergency Materials.

5-6.4.1 Emergency materials for fighting mine fires shall be readily available near the shaft bottom or other entrance to the mine. If the shaft bottom or other entrance to the mine is over 2 miles (3.22 km) from a working section, additional caches of emergency materials shall be strategically located to ensure timely access.

5-6.4.2 Emergency materials shall include fire hose and necessary adapters, multiple hydrants, wrenches and nozzles, brattice boards and cloth, wood posts, cap pieces, wood wedges, spad guns and spads or other specialized equipment for installing line brattice, nails, bags of sealant or cement, saws, hammers, axes, shovels, and picks.

5-6.4.3 Caches of emergency materials shall be checked at least every 6 months to ensure that the inventory of materials is complete.

5-7* Training.

5-7.1 All miners shall be instructed annually in fire prevention and fire-fighting techniques.

5-7.2 All employees shall be instructed in emergency evacuation procedures.

5-7.3 All persons who might be expected to inspect, test, operate, or maintain fire suppression systems shall be trained thoroughly in the functions they are to perform.

Chapter 6 Referenced Publications

6-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

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

NFPA 10, *Standard for Portable Fire Extinguishers*, 1994 edition.

NFPA 11, *Standard for Low-Expansion Foam*, 1994 edition.

NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*, 1994 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 1993 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 1992 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 1993 edition.

NFPA 16, *Standard on the Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems*, 1991 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 1994 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 1993 edition.

NFPA 70, *National Electrical Code*, 1993 edition.

NFPA 72, *National Fire Alarm Code*, 1993 edition.

NFPA 386, *Standard for Portable Shipping Tanks for Flammable and Combustible Liquids*, 1990 edition.

NFPA 1961, *Standard for Fire Hose*, 1992 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 1994 edition.

6-1.2 ASTM Publications. American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM D5, *Standard Method of Test for Penetration of Bituminous Materials*, 1986 edition.

ASTM D56, *Standard Method of Test for Flash Point by the Tag Closed Cup Tester*, 1993 edition.

ASTM D86, *Standard Method of Test for Distillation of Petroleum Products*, 1993 edition.

ASTM D93, *Standard Method of Test for Flash Point by the Pensky-Martens Closed Tester*, 1990 edition.

ASTM D3243, *Standard Method of Tests for Flash Point of Aviation Turbine Fuels by Setaflash Closed Tester*, 1977 edition.

ASTM D3278, *Standard Method of Tests for Flash Point of Liquids by Setaflash Closed Tester*, 1989 edition.

ASTM E136, *Standard Method of Test for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C*, 1993 edition.

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-1-1 The diesel engine was developed in the 1890s by Rudolf Diesel and has proven itself a reliable workhorse of industry. Today, diesel equipment is used safely and productively in all types of underground mines worldwide. Eight years of experience has demonstrated that the technology exists to reduce fire hazards associated with diesel equipment to acceptable levels.

Diesel fuel is a combustible liquid. As with any combustible liquid, it can be safely transferred, transported, stored, and used if the physical, chemical, and hazardous properties are fully understood and the necessary precautions and safeguards are observed.

A-1-1.1 In developing this document, the data available in the "Annotated Bibliography of Coal Mine Fire Reports" prepared by the Allen Corp. of America under the U.S. Bureau of Mines Report No. J0275008, dated July 1978 was examined. This bibliography covers the period from 1950 to mid-1977 and Table A-1-1.1(a) provides data for the period from 1970 to 1977. Data since mid-1977 was from fire reports furnished by MSHA in a memorandum entitled "Mine Fires During 10-Year Period" and is shown in Table A-1-1.1(b) for the period from 1978 to 1988.

The record of fires together with the record of underground coal production and percentage of production by continuous miners is shown in Tables A-1-1.1(a) and (b) and Figure A-1-1.1(c).

It is believed that this data provides logical reasons for the seemingly unaccountable increase in fire incidents that were at a low annual figure during the early 1950s, grew rapidly from 1952 to 1960, and then returned at a somewhat slower rate to the low figure of 1971.

A number of observers working in the industry during this period believe that the introduction of continuous miners in the late 1940s put demands on the existing underground direct current (DC) power systems that they could not support. Starting a DC-powered continuous miner produced a current flow that approached that of a bolted fault. The power systems that were available for a DC-powered continuous miner were unable to respond to an arcing fault. Fires resulted. The industry was not accustomed to using and maintaining the wiring and trailing cables that carried the required current capacity. Many fires originated from bad connections, bad cables, and bad splices. During this same period, there was a substantial growth in the number of belt conveyors used, and the incidence of belt fires became serious.

After 1960, the incidence of fire returned to that of the early 1950s experience. In addition to the fact that the industry was learning safer use of the new equipment, technical solutions were being developed and adopted. Most notable was the introduction of AC power for face equipment, first tested in the mid-1950s. By the early 1960s the change from DC to AC was underway, and the

Table A-1-1.1(a) Half-Hour Fires in Underground Coal Mines from 1970 to 1977

Description	Year								
	1970	1971	1972	1973	1974	1975	1976	1977	Total
Electrical									
Mobile equipment	3	1	2	0	0	0	1	1	8
Trailing cable	6	2	0	2	0	1	2	0	13
Fixed equipment	2	0	3	1	0	0	2	1	9
Trolley wire	2	1	3	1	0	4	2	3	16
Friction									
Belt drive area	3	0	0	0	0	0	0	0	3
Belt—other areas	1	1	0	1	1	0	1	2	7
Other friction	1	0	0	0	0	0	0	0	1
Flame cutting and welding	1	1	2	1	1	0	1	0	7
Spontaneous	0	2	5	1	2	1	3	0	14
Miscellaneous	2	1	0	1	1	2	3	1	11
Unknown	2	0	0	1	0	1	0	2	6
Total	23	9	15	9	5	9	15	10	95

Table A-1-1.1(b) Half-Hour Fires in Underground Coal Mines from 1978 to 1988

Description	Year											
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Total
Electrical												
Mobile equipment	0	2	1	3	1	0	1	2	2	2	2	16
Trailing cable	1	1	3	1	3	0	2	0	1	0	0	12
Fixed equipment	0	0	1	0	3	2	1	0	5	2	2	16
Trolley wire	3	0	0	1	2	0	1	1	2	1	0	11
Friction												
Belt drive area	0	0	0	0	0	1	1	1	0	1	0	4
Belt—other areas	0	0	2	2	1	1	1	2	1	1	1	12
Other friction	0	0	0	0	0	0	0	0	0	3	0	3
Flame cutting and welding	1	0	2	2	5	1	3	5	3	1	3	26
Spontaneous	1	3	3	1	0	4	3	3	1	0	2	21
Miscellaneous	1	1	1	1	1	1	0	0	0	2	1	9
Unknown	0	2	1	2	0	1	0	2	1	3	2	14
Total	7	9	14	13	16	11	13	16	16	16	13	144

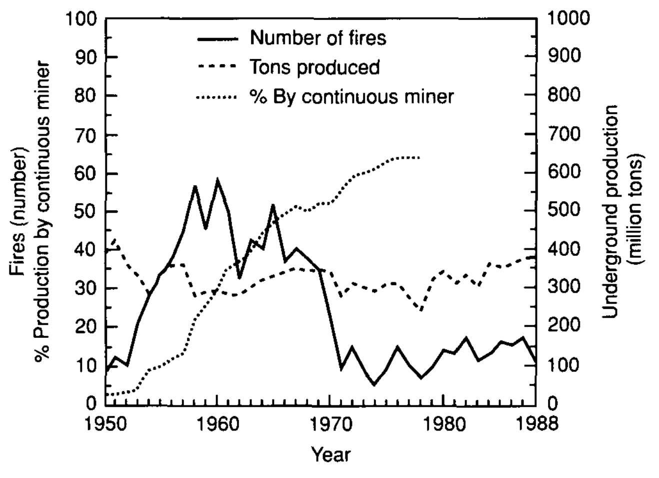

Figure A-1-1.1(c) Time trends for underground fires.

incidence of belt fires decreased as the industry learned how to set up and maintain belt conveyors. The virtual elimination of timber for roof support in favor of roof bolts also helped to reduce fires. Therefore, while the changing technology of the 1950s caused the increased incidence of fire, technical solutions adopted during the 1960s have served to reduce the fire problem.

It should be noted that the data in the Allen Report available from MSHA is based upon the legal requirement that only those fires that burn for 30 min or longer are required to be reported. However, it is believed that a similar reduction in unreported fires also has occurred.

A-2-5 Belt fires originating away from the drive area usually have been caused by idlers with defective or stuck bearings. Tests have shown that such idlers can become moderately hot [200°F to 300°F (93°C to 149°C)]. The subcommittee has been unable to find reliable evidence that idlers can become hot enough to ignite fire retardant belting directly.

It appears that a warm or hot idler can cause fine coal dust accumulated around the idler to ignite. Then, when the belt has been stopped, coal burning beneath the belt ignites the belting.

The key to avoiding belt fires is to prevent the accumulation of fine coal around idlers. If a metal deck is not provided between the carrying strand and the return strand of the belt, no coal dust accumulates around the troughing idlers. Where possible, return idlers should be supported at a substantial height above the bottom so that coal dust is not likely to build up around return idlers. With proper clearance beneath these idlers, accumulations of coal dust can be cleaned up more easily.

Slat-type, self-cleaning tail pulleys are recommended. Coal dust discharged by such pulleys should be cleaned up frequently. Good maintenance and good fire prevention both necessitate that noisy bearings, which might indicate probable failure, be changed promptly before they become hot.

Conveyor belt fires have been caused by belts that lose proper alignment, with the edge of the moving belt then contacting combustible material. Loss of alignment can result from a number of factors, including displacement of idlers or pulleys and movement of supporting structure, spillage of conveyed material, and failure of a bearing (typically on a pulley). Where alignment is affected significantly, the edge of the belt can rub abrasively on the structure and objects near the edge of the belt. If the object on which the belt rubs is metal, the metal can become worn and heated. The edge of the belt can be damaged extensively, but it is believed that the belt will not ignite. This is because a point on the edge of the moving belt is in contact with the metal for only a very short period and will cool before it returns to the point of contact. The metal can become quite warm; however, because it is a good conductor of heat, it will not become hot enough to ignite the belt if the belt stops. Nevertheless, if the material contacted is wood or another combustible, the combustible material could be heated by the friction of the edge of the moving belt until it ignites. Keeping combustible material away from the edge of the belt and use of alignment switches should prevent such fires.

A-2-7.1 Fire Risk Assessment. Fire risk assessment for underground mining operations consists of four phases:

I. Identify the fire potential.

II. Assess the consequences of fire.

III. Determine the need for fire protection.

IV. Select appropriate fire protection option(s).

The following fire risk assessment outline is a suggested procedure for identification of the elements in phases I through IV above:

Additional guidance in performing risk assessment is provided in several of the publications referenced in Appendix B.

I. Identify the Fire Potential.

A. Ignition Sources.

1. *High Temperature.* High temperatures usually are found in the vicinity of an engine, exhaust system, turbochargers, and malfunctioning devices such as bearings, brakes, and gears.

2. *Electrical.* Batteries, generators, instrument panels, motors, pumps, switches, transformers, and wiring.

3. *Cutting and Welding.*

4. *Other.* Smoking materials and spontaneous ignition sources are examples of other sources.

B. Fuel Sources.

1. *Class A.* Class A sources include combustible debris, wood, rags, electrical insulation, combustible minerals, upholstery, hose lines, and tires.

2. *Class B.* Class A sources include flammable and combustible liquids such as diesel fuel, starting fluids, some hydraulic fluids, coolants, grease, oil, and cleaning solvents.

C. Probability of the Coexistence of Fuel and Ignition Sources.

1. *Proximity of Fuel to Ignition Sources.* An analysis of equipment design can indicate areas where lubrication, hydraulic oil, or fuel lines are in proximity to ignition sources. In identifying fire risk areas, note that a combustible liquid can spray or drip onto a hot surface that is remote from the rupture or leak point. Sparks from a battery or an electrical short can ignite combustibles in another area of the machine.

Typical areas where a potential fire risk can exist include the engine compartment, exhaust system, transmission area, vehicle articulation points, parking brakes, engine pan area, and battery compartments.

Thermal shields, spray shields, water-cooled exhaust compartments, hydraulic fuel and electrical line routing, and electrical harnesses can affect the potential for fire.

2. *Fire Incident Experience.* Previous fire experience on similar machines can indicate that special risks exist.

3. *Quality of Maintenance.* The quality and frequency of equipment maintenance can affect the number and severity of equipment fires. A maintenance program should consider the manufacturer's recommended guidelines, the quality of replacement parts, the competence and training of maintenance personnel, the frequency of preventive maintenance, and operating conditions.

4. *Housekeeping.* Accumulations of combustible materials such as oil-soaked waste, fuel spillage, excess lubricant, and coal or coal dust represent potential fire risks.

5. *Operational Damage.* Physical impact from external material at a chute or face, which can roll or slide onto equipment, can cause leaks in fuel or hydraulic lines as well as damage to electrical components and wiring.

II. Assess the Consequences of Fire.

A. Personnel Exposure. Determine whether personnel can be exposed to the effects of a fire. These effects could include:

1. Direct exposure of the operator or nearby personnel to heat, smoke, and toxic fire gases from the burning equipment.

2. Exposure of personnel remotely located from the fire site to toxic products of combustion carried by the ventilation system. The U.S. Bureau of Mines has developed a computer simulation program that can be used to analyze the spread of combustion products by a mine ventilation system. Information on this program, including instructions for obtaining a free copy, are provided in U.S. Bureau of Mines Information Circular 9245, "A User's Manual for MFIRE: A Computer Simulation Program for Mine Ventilation and Fire Modeling."

3. Spread of a fire from the point of origin to other combustibles, most notably the coal, but also to timber supports, explosives, diesel fuel, and lubricants, among others. Such fires can grow in intensity, producing increased

quantities of toxic combustion products, complicating fire-fighting efforts, and interfering with evacuation and rescue operations. If the coal ignites, the likelihood of extinguishing the fire without sealing all or part of the mine diminishes significantly.

4. Possibility of the fire causing highly complex ventilation disturbances such as throttling or reversals. Such disturbances can be extremely difficult to predict but can affect miner evacuations and fire fighting profoundly by causing the contamination of airways thought to be safe. The MFIRE computer simulation program previously described also can be used to evaluate the effects of a fire on a mine ventilation system.

B. Economic Risks. Determine the economic loss resulting from a fire on a piece of equipment, including both property damage and business interruption costs, and consider the following factors:

1. Fire involving a single piece of equipment could cause property damage and loss of production until the fire is extinguished and the equipment is repaired or replaced.

2. Fire spread to nearby combustible material, including the coal, can have greater economic effects than the initial fire.

III. Determine the Need for Fire Protection. If the risk analysis discloses unacceptable personnel risks, economic risks, or both, appropriate fire protection options should be determined.

IV. Select Appropriate Fire Protection Option(s).

A. Hazard Reduction.

1. *Equipment Design.* Evaluate equipment to determine if the risk from the start or the spread of a fire can be reduced.

2. *Operating Procedures.* Mine operators, through implementation of company policies and procedures, can reduce the threat of fire. Examples include effective equipment maintenance programs, adequate housekeeping procedures, proper employee training, development of emergency plans, and strategies that deal with fire.

3. *Evaluation of Hazard Reduction.* Determine whether fire-risk reduction practices reduce risks to acceptable levels. If risks are acceptable, no further action is necessary. If unacceptable risks still exist, action is needed either to reduce risks further or to install fire detection/suppression equipment, or a combination of both.

B. Fire Detection and Suppression Equipment. Identify available fire detection and suppression equipment alternatives.

1. *Portable Protection.* Options include portable hand extinguishers, hose reels and lines, wheeled extinguishers, and skid-mounted extinguishers.

For difficult fires, larger capacity extinguishers that provide more agent, greater range, and longer discharge time are recommended. See Section IV C for agent selection.

2. *Detection.* Fire detection devices can be permitted to be used to provide early warning of fires, actuate a fire suppression system, shut down equipment, and operate other fire control systems such as ventilation devices and fire doors.

For a discussion of detector and control options, selection, and placement, see Section IV C.

3. *Fixed Fire Suppression Systems.*

a. Fixed system protection can be accomplished by local application, total flooding, a combination of both, or automatic sprinklers. See Paragraph IV C 1 for agent selection. See Paragraph IV C 2 for fixed fire suppression options.

b. Compare capability with need. Identified needs should be matched with the most cost-effective approach to fire detection, fire suppression, or both.

c. Select equipment. The selection of all equipment used for all detection and suppression of fires in mining equipment should be based on consideration of the environment in which the equipment functions.

d. Evaluate fixed fire suppression systems. Determine whether fire risk reduction complies with mandatory requirements and reduces risks to acceptable levels. If risks are within acceptable levels, no further action is necessary. If not, additional action is needed either to reduce fire risks or to install fire detection/suppression equipment, or a combination of both.

C. Fire Protection Agents and Equipment.

1. *Fire Suppression Agents.* The following extinguishing agents commonly are used in the mining industry:

a. Class A:

(i) Dry chemicals (ABC) with ammonium phosphate as the basic ingredient;

(ii) Foams such as protein, fluoroprotein, aqueous film-forming, medium- and high-expansion;

(iii) Water;

(iv) Water-based antifreeze solution.

b. Class B:

(i) Dry chemicals (BC) with sodium bicarbonate, ammonium phosphate, potassium bicarbonate, urea-based potassium bicarbonate, or potassium chloride as the basic composition;

(ii) Foams such as protein, fluoroprotein, aqueous film-forming, medium- and high-expansion;

(iii) Carbon dioxide;

(iv) Halons (halon substitutes);

(v) Water spray or fog;

(vi) Water-based antifreeze solution.

c. Class C:

(i) Dry chemicals (ABC or BC) with sodium bicarbonate, ammonium phosphate, potassium bicarbonate, urea-based potassium bicarbonate, or potassium chloride as the basic composition;

(ii) Carbon dioxide;

(iii) Halons (halon substitutes);

(iv) Fixed water spray;

(v) Water fog.

d. Class D:

(i) Dry powder agents composed of sodium chloride or graphite with other particulate material added. Inert materials such as dry sand and foundry flux.

2. *Method of Application.*

a. Portable Extinguisher. Extinguisher of the hand-held or wheeled type or transportable systems consisting of a hose reel or rack, hose, and discharge nozzle connected to an extinguishing agent supply.

b. Fixed Systems.

(i) Local application consisting of a supply of extinguishing agent permanently connected to a distribution system, arranged to discharge onto a defined area or space;

(ii) Total flooding consisting of a supply of extinguishing agent permanently connected to a distribution system, arranged to discharge onto an enclosed space;

(iii) A combination of items a and b above;

(iv) Automatic sprinklers consisting of a supply of extinguishing agent (normally water) permanently connected to a distribution system to discharge the suppressant;

(v) Water spray;

(vi) Water fog.

3. *Detector Selection and Options.*

a. For guidance in selection and placement of fire detectors, see NFPA 72, *National Fire Alarm Code.* Some fire detectors used in conjunction with mining equipment, but not covered in NFPA 72, include:

(i) Fusible Plastic Tube. A sensing element consisting of a plastic tube pressurized with inert gas. Heat from the fire causes the tube to burst, releasing the gas pressure and activating a mechanical pneumatic actuator.

(ii) Thermistor Strip. A line-type device with a sensing element consisting of a thin metal tube containing two electrical conductors. The conductors are separated by a thermistor material whose resistance (or capacitance) varies with temperature. By monitoring resistance (or capacitance) changes, corresponding temperature changes can be detected.

(iii) Metal Hydride. A line-type device with a sensing element consisting of a thin metal tube containing a hydrogen-charged metal hydride wire. The tube is sealed at one end and is connected to a sensitive pressure switch at the other end. When exposed to the heat from a fire, copious amounts of hydrogen gas are released from the metal hydride wire, actuating the pressure switch.

b. Fire Detector Placement. Consideration should be given to the physical configuration of the area or equipment to be protected when selecting and installing detectors. For spacing information, see NFPA 72, *National Fire Alarm Code.*

Among the factors affecting detector performance are its proximity to a fire, ambient temperatures, climatic conditions, shock and vibration, air contamination, ventilation flows, and maintenance requirements.

4. *Control Options.*

a. Depending on mining equipment configuration, use, ground speed capability, enclosures, location of operating personnel, and other factors, the following special control options should be considered:

(i) Mechanical or electrical equipment engine shutdown,

(ii) Discharge time delay,

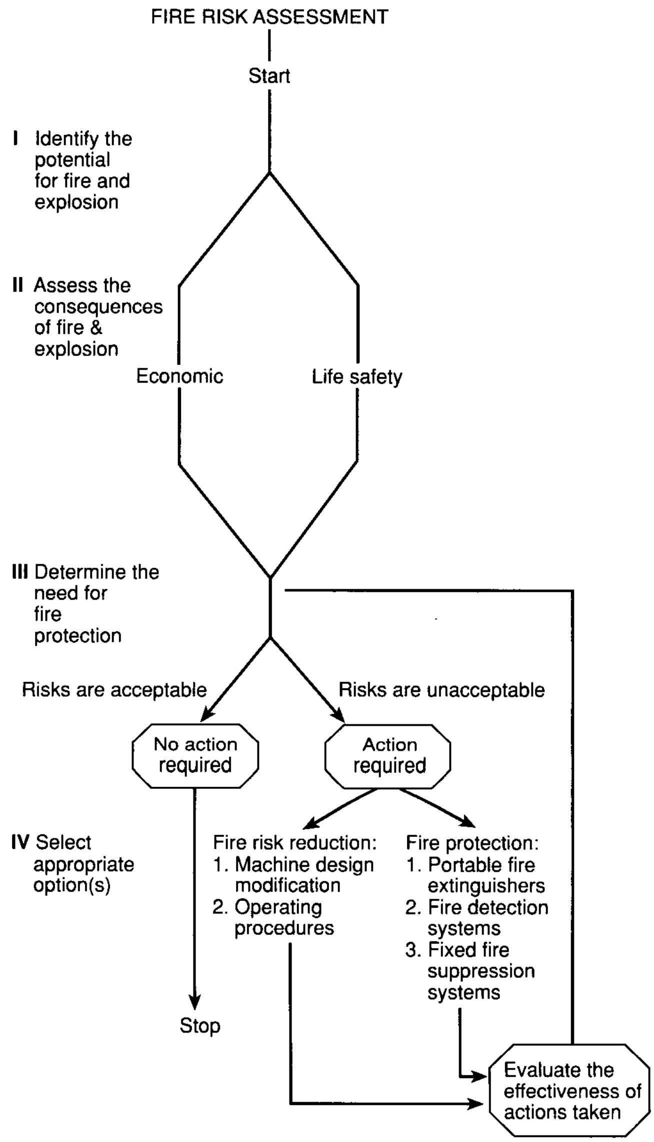

Figure A-2-7.1 Fire risk assessment chart.

(iii) Discharge abort switch,

(iv) Audible and visual alarms,

(v) Predischarge alarm,

(vi) Detection circuit supervision.

b. Consideration should be given to the advisability of providing automatic engine shutdown on mobile equipment. Factors such as ground speed, slope braking capability, and availability of secondary steering as described in SAE J1511, *Steering for Off-Road Rubber-Tired Machines,* should be included in this analysis.

A-4-3.4 Where pressurized pipeline systems are used for combustible liquid transfer, consideration should be given to providing a pressure-sensing interlock downstream of the transfer pump discharge. This interlock should be suitable for Class I, Division 2 locations and should be arranged to shut down the pump immediately upon loss of line pressure.

A-4-3.10 The greatest risk of fire involving substantial quantities of combustible liquids exists when rail supply cars are being moved, especially on a trolley wire-powered rail system. In contrast, cars parked where trolley and feed wire are absent or deenergized represent a distinctly lower risk. In the opinion of the committee, limiting the storage of lubricants in operating areas to a 3-day rather than a 1-day supply reduces the frequency of transport and, as a result, the overall risk of fire.

A-4-7 No requirements for bonding or grounding to dissipate static electricity are included in NFPA 30, *Flammable and Combustible Liquids Code,* which does not require bonding or grounding for combustible liquids handled at temperatures below their flash points.

It is recognized, however, that certain conditions can exist that could necessitate bonding or grounding, such as those of temperature and altitude, which can reduce the flash point of diesel fuel.

For additional information on static electricity, see NFPA 77, *Recommended Practice on Static Electricity.*

A-5 Automatic detection systems and automatic sprinkler systems in mining facilities need to be specifically addressed for the following reasons:

(a) The contents of a mine occupancy are continually changing. Most items are not fixed and are designed to be moved with the mining operation. A mine operates as a heavy-duty excavation construction site and, thus, has the same transitory nature as a construction site.

(b) Unlike aboveground industrial occupancies, great distances are not unusual within an underground mine. Mines covering 25 mi^2 (64.75 km^2) or greater are common.

(c) Mines have extremely harsh and unusual environments compared to aboveground industrial occupancies. Heavy concentrations of combustible dusts, the presence of explosive gases, temperature extremes, saturated humidity conditions, standing water, unstable strata, roof-to-floor heights that vary from 28 in. to 20 ft (0.7 m to 6.1 m), and complex ventilation systems are all commonplace. The possibility of abuse from heavy machinery is a common hazard.

(d) Mining occupancies exhibit physical characteristics that are unique from those of any other type of occupancy. One example is the extreme pressures that can occur in a water line.

(e) Mines employ specialized facilities, equipment, and production processes that are utilized in no other industry. Fire protection efforts that fail to consider the unusual operating characteristics and fire protection requirements of underground coal mining systems could result in nonoptimal protection or the inadvertent introduction of hazards.

A-5-2.1.1 Routing of water lines has caused severe problems in fighting fires at some large mines. These mines had multiple intake shafts spaced apart at considerable distances. Such a ventilation can create a neutral point between the shafts, with fresh air moving from each shaft toward the neutral point. At the original opening of one mine, a water source was established and the water line was extended as the mining developed further away from the original opening. With the water line extended to each new intake shaft and passing through each neutral point, a condition of opposite direction of flow of air and water existed beyond each neutral point.

If a fire occurs in an area of opposite flow, the fire has to be approached in the same direction as the airflow, but the water flow is moving through the fire area. Usually water lines in a fire area are damaged or broken by the falls of sections of burning roof. When a water line breaks in this situation, the fire fighters are without water, and direct fire fighting is no longer possible. The fire then can be controlled only by sealing. At least one large coal mining company now provides an additional water source at each new intake shaft to ensure the ability to fight such fires.

The likelihood of this problem appears to be increasing as more mines are ventilating belt entries with air moving outby, while the water flow is inby. In some cases, mine management has recognized the problem and has developed procedures to change the direction of airflow in the event of a fire. Reversing the airflow should be done at a point close to and outby the fire to avoid pushing smoke-laden air back onto the fire. After the belt entry outby the fire has been cleared of smoke, the air-flow can be reversed for the full length of the entry if desired.

Mines that obtain their water supply from an underground source also can have this problem of opposite directions of airflow and water flow. Usually there is no sure solution, except to provide an alternative source of water or a large storage of water on the surface. If the power for the pumps is fed from the high voltage system that feeds the mine and the fire damages the high voltage cable anywhere on the system, it can trip the entire system and shut down the pumps. Coordination of the electrical protective equipment, or even a separate power supply, might be needed to ensure that the pumps continue to supply water for fire fighting.

Even in situations where air and water are flowing in the same direction, management must recognize that water lines or hydrants in a burning entry are likely to be broken by the falls of sections of burning roof. In this situation, a planned shutdown of the water line should be undertaken as soon as possible to install a multiple hydrant (*see A-5-2.3.4*) in the water line at a convenient location close to the fire. With the multiple hydrant in place, at least three fire hoses can be served effectively from the water line.

Because of the many factors that should guide the choice of location of water lines and hydrants, it is felt that management should be properly qualified to select these locations; but it is also felt that management should be able to justify its choice. Reliability of the water supply and ability of fire hose streams to reach a fire at any location or entry served by the water line should be the criteria by which the location is chosen.

A-5-2.2.1 Water distribution lines generally cannot meet the capacity requirements of 5-2.2.1 unless 5-in. or 6-in. pipe is used for main water lines and 4-in. pipe is used for branch lines to producing areas.

A-5-2.3.1 Hydrants in a coal mine normally are only a valve screwed onto a tee that is installed on the water line. In order for the female coupling of a fire hose to be connected to a male thread, a pipe nipple usually is screwed into the discharge side of the valve. The threads of steel pipe nipples generally corrode badly if left exposed. Brass nipples often are used instead of steel nipples. Many mines have begun to use Schedule 80 plastic nipples instead of steel. Regardless of the nipple material, the threads of the nipple should be protected against physical damage.

A properly designed system of hydrants and fire hoses should be able to make a good connection of fire hose lines to the hydrants without the need for tools.

The choice of locations for hydrants should be made to ensure that fire hose lines can be laid quickly from hydrants located on the water line through crosscuts to a fire located in any parallel entry or crosscut, rather than to provide convenience for use in the entry where the water line is located.

A-5-2.3.4 A multiple hydrant is a short length of 3-in. or 4-in. pipe, usually with three valved outlets (hydrants) to which fire hose lines can be connected. If the mine is equipped with a foam generator for fighting fires, there should be an additional outlet to feed the generator. An alternative is to assemble the hydrants from grooved pipe fittings that also have threaded tee connections to which the valved outlets are connected. The multiple hydrants should have adapters that allow them to be connected to any of the pipe sizes in use at the mine.

A-5-3.1.1 An automatic fire detector is a device designed to detect the presence of fire and initiate action. For the purpose of this standard, automatic fire detectors are classified as:

Heat Detector. A device that detects an abnormally high temperature or rate of temperature rise.

Smoke Detector. A device that detects the visible or invisible particles of combustion.

Flame Detector. A device that detects the infrared, ultraviolet, or visible radiation produced by a fire.

Fire-Gas Detector. A device that detects gases produced by a fire.

Other Fire Detectors. Devices that detect a phenomenon other than heat, smoke, flame, or gases produced by a fire.

Fire detectors should be installed as follows:

Vertical Placement. Because the hot gases from a fire will rise owing to buoyancy forces, combustion products will initially be stratified near the roof of an entry. As this stratified gas layer moves away from the fire, the resultant cooling and dilution will eventually produce a well-mixed flow of combustion products. Data from full-scale fires indicates that some degree of stratification can exist at distances of hundreds of feet from the source of the fire.

Because of this effect, fire detectors should be located at a vertical distance from the entry roof that does not exceed 25 percent of the average entry height. For example, in an entry with a height of 6 ft (1.8 m), the maximum distance from the roof at which a sensor should be located is 1½ ft (0.5 m). This refers to the location of the actual sampling intake of the detector used.

Lateral Placement. In general, the point of origin of a fire is quite unpredictable. It can occur along the floor, ribs, or roof of the entry. In order to provide optimum protection, it is recommended that the fire detectors be located within 2 ft (0.6 m) of the approximate midpoint of the entry.

For entries in which the point of origin of the fire can be better estimated (such as a belt entry), the detectors should be located in such a manner that they provide for the estimated best coverage of that entry.

A-5-3.1.2 Batteries charged by the mine power system should indicate the condition of the battery(ies) upon either manual or automatic activation of a battery-check circuit.

A-5-4 Automatic sprinkler systems are the most desirable means of protection against fire hazards in an underground bituminous coal mine. However, other systems or the use of foam in automatic sprinkler systems, as permitted in 1-1.4, might be permitted to be utilized if approved by the authority having jurisdiction.

A-5-4.2.1 Wet-pipe automatic sprinkler systems have been found to be the preferred fire suppression systems for underground coal mines for the following reasons:

(a) They are the simplest systems available;

(b) They are the most reliable systems available;

(c) They provide selective operation, since only sprinklers close to the fire operate;

(d) They have the best performance record, especially on fires of Class A materials and of Class IIIB combustible liquids;

(e) They need minimal maintenance;

(f) They are nonelectrical;

(g) They use a limited quantity of water; and

(h) The initial investment is low.

The major problem associated with automatic sprinkler systems in underground coal mines is the possibility of exposure to freezing conditions during cold weather. Another problem that can exist in very deep mines is that some of the listed components for automatic sprinkler systems might be unable to withstand the very high water pressure encountered. It is not uncommon to encounter pressures above 500 psig (3448 kPa). The committee recommends testing sprinkler system components under anticipated maximum pressures. If sprinkler components are found to be unable to withstand the maximum pressure of the water line, the use of pressure regulators might be necessary. Experience has shown that pressure regulators can require considerable maintenance. Also, if the pressure regulating valve should leak, it might be necessary to provide a small relief valve on the discharge side of the regulating valve to prevent overpressure.

A-5-4.2.1(a) Under Report No. H0122086, "Suppression of Fires on Underground Coal Mine Conveyor Belts," the Department of the Interior, U.S. Bureau of Mines (USBM) conducted a series of full-scale fire tests. These are the only tests known that used typical mine conveyor belting on typical mine conveyor structures without a deck between the upper and lower strands of the belt.

The tests demonstrated that standard, ½-in. (12.7-mm) orifice, nominal 212°F (100°C) automatic sprinklers, located over the belt on 10-ft (3-m) centers, effectively controlled every test fire while opening only two sprinklers, with residual pressure held to a constant 10 psig (69 kPa).

Since the USBM tests were run, underground belts have tended to become wider to carry increased tonnage, so belt fire suppression systems should be designed to supply more sprinklers than indicated by these tests. Since many conveyor belts stretch a long distance in a straight line, a fire scenario would involve only a portion of the belt, regardless of the overall length of the belt. As the actual incidence of belt fires is low in underground coal mines, and most of these are in the area of the belt drive and the belt takeup, protection of only the area from the discharge pulley to the end of the takeup is needed. If the belt structure contains a deck between upper and lower strands of the belt, automatic sprinklers should be located beneath the deck, and this virtually doubles the size of the sprinkler system.

If the sprinkler system is extended to cover a distance greater than 100 ft (30.5 m) in one direction from the point where the pipe, holding the automatic sprinklers along the roof, is fed, then a hydraulic calculation of the system is recommended. Long runs of pipe should be flow-tested as required by 5-4.4.7.2, with the eight open sprinklers installed at the distant end of the pipe run. Branch piping intended to protect limited areas should be piped with adequately sized pipe to carry the water flow required. Table A-5-4.2.1(a) should be used to determine the minimum size of pipe.

Table A-5-4.2.1(a) Minimum Pipe Sizes

1-in. (25.4-mm) pipe	2 sprinklers
1¼-in. (31.7-mm) pipe	3 sprinklers
1½-in. (38.1-mm) pipe	5 sprinklers

Larger systems should be separately flow-tested as required by 5-4.4.7.2.

A-5-4.2.1(f) Since many air compressors are moved frequently, the fire suppression system needs to be equally portable. Some compressors having a deck or lid over the compressor have been fitted with piping and sprinklers attached to the underside of the deck. Other compressors without the deck have suitable piping with at least two sprinklers 10 ft (3.0 m) apart. The piping is made to be attached to roof bolts or otherwise suitably supported over the centerline of the compressor. The piping needs to be equipped with a pressure switch that prevents the operation of the compressor unless the piping is under pressure and with a flow switch that shuts the compressor down if water flows. If a fire hose is used to connect the piping to a water line, the connection point of the hose to the sprinkler piping should be located so that a fire on the compressor will not damage the fire hose.

A-5-4.3.1 Automatic Foam-Water Sprinkler Systems. Underground shaft mines that use diesel-powered equipment generally employ underground diesel fuel storage areas to facilitate equipment refueling. Adit-type mines in the western United States might initially locate diesel fuel storage and refueling facilities on the surface; however, as the active mine workings progress further from the adit portal(s), these facilities will likely be moved underground.

A common means of fire protection currently found in many underground diesel fuel storage areas is the use of fixed water sprinkler systems. The federal Mine Safety and Health Administration (MSHA) currently approves such systems for this application. However, it is felt that this situation represents a significant safety hazard. According to the NFPA *Fire Protection Handbook*, water sprinklers can be permitted to be used on diesel fuel for control but not for extinguishment.

In "The Health and Safety Implications of the Use of Diesel-Powered Equipment in Underground Mines," a report by an interagency task group prepared for MSHA in 1985, the simple conclusion was that "water spray or fog usually will not extinguish diesel fuel fires."

In an underground coal mine, fire control is not sufficient; fire extinguishment is essential for the following reasons:

(a) Unlike an underground metal or nonmetal mine, the mineral comprising a coal mine is combustible, and indeed, all fire prevention and protection provisions in an underground coal mine are aimed at preventing the ignition of the coal. In a metal or nonmetal mine, if fire control efforts are unsuccessful in extinguishing a piece of diesel equipment or diesel fuel fire, personnel can be evacuated and the fire can be allowed to consume all available fuel materials, thereby self-extinguishing. In an underground coal mine, this practice would almost certainly result in the ignition of the coal and the consequent loss of part or all of the mine.

(b) Even if a fire does not grow in intensity or spread to the coal, as long as it burns, toxic smoke and fire gases are produced that can endanger persons within the mine.

(c) According to the NFPA *Fire Protection Handbook*, over-pressure failure of containers when exposed to fire is considered the principal hazard of closed-container flammable and combustible liquid storage.

(d) Even a "controlled" fire can cause such container failure, producing a fire so intense that the sprinkler system is unable to control it, much less extinguish it.

(e) Water sprays are not effective in extinguishing pressure fires, running fuel fires, and obstructed spill fires, all of which could occur in a diesel refueling area.

(f) Water supplies are limited in many underground mines. Fire "control" should therefore be considered temporary, because the fire will grow immediately to the maximum intensity when the water supply is depleted.

(g) The vapor pressure of diesel fuel increases with elevation, due to reduced barometric pressure. As a result, even fuels without flash point-reducing additives can become flammable, depending on the altitude at which they are used. This reduction in flash point can result in reclassification of the diesel fuel to a Class 1-C flammable liquid. There is no clear consensus in the literature and industry practice as to the effectiveness of fixed water sprays in controlling and extinguishing fires involving Class 1-C flammable liquids. Although industry practice strongly favors fixed water sprays for such applications, the literature and available research results clearly indicate the ineffectiveness of fixed sprays on Class 1-C liquids, especially in the case of pressure fires, running fuel fires, and obstructed spill fires.

Therefore, water sprinkler systems installed for the protection of diesel fuel storage areas are considered inadequate; foam-water systems should be utilized.

A-5-4.3.2(d) The restrictions on sprinkler spacing apply to sprinklers on the same line and those located between sprinklers on adjacent lines.

A-5-4.3.2(e) Where sprinkler positioning is such that full coverage can be impaired, such as where a single line of sprinklers protects a belt conveyor with little clearance, a flow test should be conducted to determine if adequate wetting of surface areas is achieved. For belt conveyors, the entire top belt surface should be wetted. Additional sprinklers should be provided in the event that adequate coverage is not achieved, or alternate arrangements such as rotated lines or sidewall sprinklers should be considered. Consideration also should be given to the need for noncombustible baffles to protect sprinklers from the discharge of adjacent sprinklers located within 6 ft (1.8 m).

A-5-4.3.2(f) Pipe and fittings that permit limited motion of the pipe are recommended, as they allow the pipe to be held closer to the roof. If threaded fittings are used, the committee recommends steel pipe with extra-strength threaded fittings. Copper or aluminum might be permitted if adequate for the pressure.

A number of mines are using aluminum pipe or tubing with groove-type couplings and fittings. Where water pressure does not exceed 500 psi (3,448 kPa), grooved couplings having a ½-in. (12.7-mm) FNPT outlet are being used to provide connections for sprinklers. Piping put together in this manner can be located closer to an undulating roof, especially if the pipe lengths are short enough to put the couplings (and the automatic sprinklers) on 10-ft (3.0-m) centers. Mines using groove-type couplings claim that most of the pipe can be precut and grooved in the shop. This simplifies installation underground. Rolled grooves are recommended, since they do not reduce the strength of the pipe as much as cut grooves. If cut grooves are used, Schedule 40 or heavier pipe should be used.

A-5-4.3.4(c) A tee(s) should be located at any high point where a sizeable volume of air can be trapped. The tee should be fitted with a valve or plug to allow venting of air while the system is filled with antifreeze solution.

A-5-4.3.4(e) The purpose of the air chamber is to absorb the expansion of the liquid that takes place when the system is warmed by summer temperatures. The relief valve [*see 5-4.3.4(d)*] protects against excessive pressure that can occur if the chamber does not contain sufficient air.

The chamber can be filled with compressed air easily if a high pressure compressor is available; however, care should be used during pressurizing to avoid overpressure beyond the strength of the chamber. An alternate method is to use the water pressure to compress air into the chamber. The piping has to be empty of liquid. The drain and vent valves are closed. The chamber is connected to a high point of the piping, and the valve on the chamber is opened. The shutoff valve is partly opened so the piping will fill with water, but not too rapidly. The water compresses the air into the chamber to the proper pressure. The valve on the chamber is closed, and the piping is drained. The piping is then filled with mixed antifreeze solution, and the system can be put into operation in accordance with 5-4.3.4(f).

The following formula should be used to calculate the minimum volume of the air chamber required in 5-4.3.4(e) or the volume of the solution withdrawn as required in 5-4.3.4(f).

$$\% = V_c/V_s = (B)\,(\Delta T)\,[P_m/(P_m - P_l)]$$

Where

V_c = Volume of air chamber

V_s = Total volume of system piping

B(Beta) = Effective coefficient of expansion. [Table A-5-4.3.4(e) shows the variation of different solution concentrations for steel and aluminum pipe.]

ΔT = Total maximum expected temperature range to which the system will be exposed, from the highest in summer to the lowest in winter, in degrees celsius.

P_l = Maximum water-line pressure.

P_m = Maximum pressure designed for the sprinkler system. This pressure is the pressure setting of the relief valve.

Paragraph 5-5.4 of NFPA 13, *Standard for the Installation of Sprinkler Systems*, describes another satisfactory method to limit pressure. It uses a check valve with a small hole drilled in the clapper of the check valve and a "U-loop" pipe having a minimum drop of 5 ft (1.5 m). This check valve and the U-loop have to be installed in a nonfreezing area, and often the height might not allow a 5-ft (1.5-m) U-loop.

A-5-4.3.4(f) A number of coal mines have used antifreeze systems successfully but without an air chamber. The method used to fill the antifreeze systems was to calculate the amount of antifreeze (usually ethylene glycol) needed to protect the full volume of the piping. This amount was put into the empty system. Then with the drain and test valves closed, the shutoff valve was opened, allowing water to flow into the piping. This trapped air in the system, which absorbed expansion of the liquid. While this method did not provide accurate control of the concentration of the antifreeze solution and, initially, the mixing was not uniform, it did work if done before cold weather arrived. It appeared that the mix became uniform in about a month.

This method of filling the sprinkler piping allows the piping system to be simpler than the method that uses a special air chamber [*see 5-4.3.4(e)*]; however, it does pose certain problems. First, it should be recognized that compressed air can find leaks in piping that holds a liquid successfully. Also, air leaks are difficult to find, while liquid leaks are obvious. Finally, because of the greater contact between the air and the liquid in this method, there is a greater chance that the liquid will absorb more of the air than occurs in the alternate system. Therefore, it is recommended that the volume of liquid removed be substantially greater than the calculation.

It is important to recognize that any loss of air by leakage or solubility will be replaced by water from the water line. This also occurs as cold weather comes on, and the liquid contracts as it cools. This results in dilution of the antifreeze solution. The formulation of the antifreeze solution tends to provide more antifreeze than is indicated by Tables 5-4.3.4(a) and (b), so that the system can live with some dilution. Also, the committee has recommended a second test, to be performed annually, of the antifreeze solution so that mines using these antifreeze solutions gain experience in the safe operation of these systems.

A-5-4.3.4(h) The major reason for changing the method of filling and mixing is that, with the old method, there was a chance of discharging nearly pure antifreeze on a fire if it occurred before the mix became uniform. The glycols and glycerine are combustible liquids unless they are mixed with water to create solutions, as shown in Tables 5-4.3.4(a) and (b).

Solutions of calcium chloride are inherently fire-safe. Glycol or glycerine solutions are quite safe when applied at the minimum rate required by 5-4.4.7.2. In addition, continued flow of the sprinkler system will quickly discharge all of the antifreeze solution, after which the discharge is water only.

Care should be used in making calcium chloride-water solutions, as mixing flake calcium chloride and water will give off some heat. Also, the corrosion inhibitor is classified as a toxic chemical. Strict adherence to product safety data sheets, available from suppliers, should be followed.

Table A-5-4.3.4(e) Solution Concentrations Used to Compress Air in Steel and Aluminum Pipes

	Ethylene Glycol Solutions		Calcium Chloride Solutions		
% Water	Steel Pipe	Aluminum Pipe	Specific Gravity*	Steel Pipe	Aluminum Pipe
61	0.00050	0.00046	1.186	0.00020	0.00016
56	0.00051	0.00048	1.218	0.00020	0.00017
51	0.00052	0.00049	1.239	0.00026	0.00022
47	0.00053	0.00050	1.260	0.00028	0.00025
			1.272	0.00030	0.00026
			1.283	0.00030	0.00026

*Measured at 60°F (15.6°C).

A-5-4.3.5 Dry-pipe automatic sprinkler systems are more complex and more difficult to design and to install than wet-pipe systems. The committee recommends that all systems be designed and installed at a mine by skilled and experienced personnel.

A pressure-relief valve, set to relieve at a pressure below the maximum pressure rating of the dry-pipe valve, should be installed between the pressure regulating valve and the dry-pipe valve. The reclosing pressure of the relief valve should be higher than the set pressure of the regulating valve.

A-5-5.1 The actuation of a fire suppression system on self-propelled equipment should cause shutdown of the protected equipment.

A-5-5.2 Pipe or hose supplying open spray nozzles should be sized to avoid excessive pressure loss. Open nozzles provide a good spray pattern with 10 psi to 20 psi (68.9 Pa to 137.9 Pa) of water pressure at the nozzles. If nozzle pressure exceeds 25 psi (174.6 Pa), additional or larger orifice nozzles can be permitted to be used to increase the water flow. If nozzle pressure is less than 20 psi (137.9 Pa), smaller orifice nozzles should be used to increase the pressure. The objective is to obtain the maximum flow of water at a pressure high enough to provide a reasonable spray pattern.

The water spray should be directed upward to wet the roof over the machine. This prevents the fire from spreading to the coal, which should be the primary objective of the fire protection system. Also, water will fall back down onto the machine, cooling, and possibly extinguishing, the flames. Alternatively, the nozzles can be directed at the fire hazard areas of the machine. The risk of this method is that the fire could be in an area not covered by the sprays and spread to the coal.

A-5-6.1.1 Hydrant locations should ensure that fire hose can be laid quickly from hydrants, located on the water line in any of the entries, through crosscuts to a fire located in parallel entries or crosscuts, rather than being located for convenient use in the entry where the water line is located.

A-5-6.1.2.1 Fire hose require special consideration at coal mines. Cotton- or linen-jacketed hoses should not be used, as they are subject to mildew attack. Even mildew-treated hose does not endure. Rubber-lined and rubber-jacketed hose resists mildew attack; but this hose is heavy, stiff, and expensive. Neoprene-lined, polyester hose with rocker lug couplings is probably the best hose for mine use. The pins of pin-type couplings are easily broken or knocked off, and their use should be avoided.

In low coal and where the water supply can deliver about 50 gpm (3.2 L/sec) at proper pressure, 1½-in. (3.8-cm) hose should be used. Where the water supply is able to provide 100 gpm to 120 gpm (378.5 L/min to 757 L/min) at proper pressure, 2-in. (5-cm) hose is preferable. Hose of 2½ in. (6.4 cm) has no advantage over 2-in. (5-cm) hose, and the extra weight and cost of 2½-in. (6.4-cm) hose is considerable.

Many mines have standardized on 1½-in. (3.8-cm) fire hose, even though their water lines can supply substantially more water than is required to get proper discharge from a 1½-in. (3.8-cm) hose nozzle. Some of these mines provide at least two valved connections (hydrants) in operating areas so that more than a single 1½-in. (3.8-cm) hose line can be used if needed. In some cases, short lengths of pipe with two or more hydrants are available for use at other points along the water lines. These multiple hydrants can be put in the line at joints where the water line is joined with grooved couplings.

While the total water flow of two 1½-in. (3.8-cm) hose lines is about the same as one 2-in. (5-cm) hose line, in the opinion of many experienced mine fire fighters, two 1½-in. (3.8-cm) hose lines provide greater flexibility during a fire-fighting operation.

A-5-6.1.2.2 Fire hose should be purchased as an entire unit that should consist of the hose and couplings. The pressure rating should include both the hose and couplings.

A-5-6.1.2.3 Threads of 1½-in. (3.8-cm) or 2-in. (5-cm) hose couplings should be straight, iron pipe thread, now labeled NPSH. While it is always preferable to use fire hose adapters, NPSH couplings can be attached to standard male pipe threads. This is especially important because of the large number of hydrants needed on water lines.

Where the gasket of a fire hose coupling is in good condition, the coupling should be tightened with bare hand pressure only. It usually will not leak. Hose wrenches are needed to uncouple hose only. Overtightening couplings with hose wrenches harms the gaskets.

A-5-6.1.2.5 It should be noted that most mines are now shifting to 1½-in. (3.8-cm) plastic, adjustable nozzles, which are not available in 2-in. (5-cm) size.

A-5-6.1.2.6 In many fire situations, fire hose has to be carried to the fire. If manual transport is necessary, the hose should be coiled into "bundles" or "doughnuts," with the male coupling at the center. In this manner, the hose is in proper orientation for use, and the exposed threads of the male coupling are protected. Hose lengths should be limited to 100 ft (30.5 m) or less, as greater lengths make the hose bundle too large and heavy.

It is sometimes preferable to coil bundles or doughnuts of fire hose, starting with the approximate center point of the hose at the center of the bundle. A coil made in this manner positions the hose couplings on the outside, so that the hose can be laid starting at the hydrant moving toward the nozzle or from the nozzle back to the hydrant with equal efficiency.

A-5-7 While regulatory agencies have legal powers and responsibilities in a mine fire situation, the mine operator should have a preplanned organization capable of managing an effective fire-fighting effort. This organization has to be prepared, resolute, and capable. As part of periodic training, the organization should conduct fire drills that involve all levels of mine management. The regulatory agencies also should be invited to participate in fire drills. Training develops management capability and promotes cooperation between concerned agencies and mine management.

Appendix B Referenced Publications

B-1 The following documents or portions thereof are referenced within this standard for informational purposes only and thus are not considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

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

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1994 edition.

NFPA 16A, *Standard for the Installation of Closed-Head Foam-Water Sprinkler Systems*, 1994 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 1993 edition.

NFPA 72, *National Fire Alarm Code*, 1993 edition.

NFPA 77, *Recommended Practice on Static Electricity*, 1993 edition.

NFPA 327, *Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers Without Entry*, 1993 edition.

NFPA *Fire Protection Handbook*, 17th edition.

B-1.2 Other Publications.

B-1.2.1 API Publications. American Petroleum Institute, 2101 L Street NW, Washington, DC 20037.

API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, 1990 edition.

API 650, *Standard for Welded Steel Tanks for Oil Storage*, 1993 edition.

API 2000, *Standard for Venting Atmospheric and Low-Pressure Storage Tanks*, 1992 edition.

B-1.2.2 ASME Publication. American Society of Mechanical Engineers, 234 East 47th Street, New York, NY 10017.

ASME *Boiler and Pressure Vessel Code*, 1992 edition.

B-1.2.3 AWS Publication. American Welding Society, 550 N.W. LeJeune Road, P.O. Box 351040, Miami, FL 33135.

AWS F4.1, *Recommended Safe Practices for the Preparation for Welding and Cutting Containers and Piping That Have Held Hazardous Substances*, 1988 edition.

B-1.2.4 MSHA Publications. Mine Safety and Health Administration, Bruceton Safety Technology Center, Cochrans Mill Road, P.O. Box 18233, Pittsburgh, PA 15236.

"The Health and Safety Implications of the Use of Diesel-Powered Equipment in Underground Mines," Report by Interagency Task Group prepared for MSHA, 1985.

"Mine Fires During 10-Year Period," Memorandum from Lisa A. Tessmer to Steven J. Luzik, January 27, 1989.

B-1.2.5 SAE Publication. Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

SAE J1511, *Steering for Off-Road, Rubber-Tired Machines*, 1990 edition.

B-1.2.6 U.S. Bureau of Mines Publications. U.S. Bureau of Mines, Branch of Production and Distribution, Division of Publication, 4800 Forbes Avenue, Pittsburgh, PA, 15213.

Report of Investigations 9451, "Effect of Pressure on Leakage of Automatic Sprinklers, 1993."

Information Circular 9245, "A User's Manual for MFIRE: A Computer Simulation Program for Mine Ventilation and Fire Modeling," 1990.

Report No. H0122086, "Suppression of Fires on Underground Coal Mine Conveyor Belts."

B-1.2.7 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062.

UL 80, *Standard for Steel Inside Tanks for Oil Burner Fuel*, 1980 edition.

UL 142, *Standard for Steel Above-Ground Tanks for Flammable and Combustible Liquids*, 1987 edition.

B-1.2.8 U.S. Government Publication. U.S. Government Printing Office, Washington, DC 20402.

Code of Federal Regulations, Title 30.

B-2 Additional Reading. The following documents or portions thereof are not part of the requirements of this NFPA document, but are included for informational purposes only.

Mitchell, D., *Mine Fires*, McClean-Hunter, Chicago, IL

Information Circular 8865, "Underground Metal and Nonmetal Mine Fire Protection."

Technology News No. 160, "Automatic Fire Protection Systems for Underground Fueling Areas."

Information Circular 8954, "Automatic Fire Protection for Mobile Underground Mining Equipment."

Information Circular 9032, "Improved Fire Protection for Underground Fuel Storage and Fuel Transfer Areas."

Report of Investigations 9377, "Ultra Low Frequency Electromagnetic Fire Alarm System for Underground Mines."

Information Circular 8830, "A Statistical Analysis of Coal Mine Fire Incidents in the United States from 1950 to 1977."

Report of Investigations 9412, "Response of Underground Fire Sensors: An Evaluation."

Information Circular 8786, "Fire Detectors in Underground Mines."

Report of Investigations 9380, "Fire Detection for Conveyor Belt Entries."

Report of Investigations 9027, "Fire Endurance of Mine Stoppings."

Information Circular 9264, "Preventing Automatic Fire Suppression System Failures on Underground Mining Belt Conveyors."

The following Bureau of Mines research contract final reports are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA, 22161.

Christensen, B.C., and G. R. Reid. "Improved Fire Protection System for Underground Fueling Areas — Volume I." U.S. Bureau of Mines/Ansul Co. Final Report for Contract No. H0262023. U.S. Bureau Open File Report OFR-120-78. NTIS No. PB-288-298-AS.

McDonald, L., D. Kennedy, and G. Reid. "Improved Fire Protection System for Underground Fueling Areas — Volume II." U.S. Bureau of Mines/Ansul Co. Final Report for Contract H0262023. U.S. Bureau of Mines Open File Report OFR-160-82. NTIS No. PB-83-113-744.

Report No. J0275008, "Annotated Bibliography of Coal Mine Fire Reports," prepared by Allen Corp. of America, July, 1978.

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