

NFPA 123
Fire Prevention
and Control in
Underground
Bituminous
Coal Mines
1990 Edition



NOTICE

All questions or other communications relating to this document should be sent only to NFPA Headquarters, addressed to the attention of the Committee responsible for the document.

For information on the procedures for requesting Technical Committees to issue Formal Interpretations, proposing Tentative Interim Amendments, proposing amendments for Committee consideration, and appeals on matters relating to the content of the document, write to the Secretary, Standards Council, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

A statement, written or oral, that is not processed in accordance with Section 16 of the Regulations Governing Committee Projects shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Users of this document should consult applicable Federal, State and local laws and regulations. NFPA does not, by the publication of this document, intend to urge action which is not in compliance with applicable laws and this document may not be construed as doing so.

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.

Licensing Provision — This document is copyrighted by the National Fire Protection Association (NFPA).

1. Adoption by Reference — Public authorities and others are urged to reference this document in laws, ordinances, regulations, administrative orders or similar instruments. Any deletions, additions and changes desired by the adopting authority must be noted separately. Those using this method are requested to notify the NFPA (Attention: Secretary, Standards Council) in writing of such use. The term "adoption by reference" means the citing of title and publishing information only.

2. Adoption by Transcription — **A.** Public authorities with lawmaking or rule-making powers only, upon written notice to the NFPA (Attention: Secretary, Standards Council), will be granted a royalty-free license to print and republish this document in whole or in part, with changes and additions, if any, noted separately, in laws, ordinances, regulations, administrative orders or similar instruments having the force of law, provided that: (1) due notice of NFPA's copyright is contained in each law and in each copy thereof; and, (2) that such printing and republication is limited to numbers sufficient to satisfy the jurisdiction's lawmaking or rulemaking process. **B.** Once this NFPA Code or Standard has been adopted into law, all printings of this document by public authorities with lawmaking or rulemaking powers or any other persons desiring to reproduce this document or its contents as adopted by the jurisdiction in whole or in part, in any form, upon written request to NFPA (Attention: Secretary, Standards Council), will be granted a nonexclusive license to print, republish, and vend this document in whole or in part, with changes and additions, if any, noted separately provided that due notice of NFPA's copyright is contained in each copy. Such license shall be granted only upon agreement to pay NFPA a royalty. This royalty is required to provide funds for the research and development necessary to continue the work of NFPA and its volunteers in continually updating and revising NFPA standards. Under certain circumstances, public authorities with lawmaking or rulemaking powers may apply for and may receive a special royalty when the public interest will be served thereby.

3. Scope of License Grant — The terms and conditions set forth above do not extend to the index to this document.

(For further explanation, see the Policy Concerning the Adoption, Printing and Publication of NFPA Documents which is available upon request from the NFPA.)

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 accepts 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.

NFPA has no power or authority to police or enforce compliance with the contents of this document and any certification of products stating compliance with requirements of this document is made at the peril of the certifier.

Copyright © 1990 NFPA, All Rights Reserved

NFPA 123

Standard for Fire Prevention and Control in Underground Bituminous Coal Mines 1990 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 Annual Meeting held May 21-24, 1990 in San Antonio, TX. It was issued by the Standards Council on July 20, 1990, with an effective date of August 17, 1990, and supersedes all previous editions.

The 1990 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 have been included in the 1990 edition of NFPA 123. Most important among these are the addition of new criteria that specifically address protective signaling systems and automatic sprinkler systems used in underground bituminous coal mines. This 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.

Technical Committee on Mining Facilities

William H. Pomroy, *Chairman*
U.S. Bureau of Mines

E. Sanford Bell, *Vice Chairman*
Alexander & Alexander

Phil A. Anania, Kidde-Fenwal Protection Systems
David Brackett, Gypsum Assoc.
William R. Bragg, Levitt Safety (Eastern) Ltd.
Rep. FEMI of Canada
Byron G. Brumbaugh, ASARCO - Ray Unit
Donald E. Burkhart, Jr., NERCO, Antelope Coal Co.
David R. Cole, Colorado Mining Assoc.
Michael C. Diliberto, Diliberto & Assoc., Inc.
Jay S. Greene, Environmental Security Inc.
Richard M. Hansen, Commonwealth Edison Co.
Howard R. Healey, Fred S. James & Co. Inc.
A. Donald Holden, M&M Protection Consultants
Will B. Jamison, Jamison Engineering Inc.
Siegfried H. Krause, Chubb Group of Ins. Cos.
Daniel J. Larkin, AMAX Mineral Resource Co.

Vincent A. Lupo, Ansul Fire Protection
David E. Lynch, Bucyrus-Erie Co.
Paul McCormick, Sunward
Michael D. McGuire, MSHA Safety & Health Technology Ctr.
Robert W. Meyer, Johnson & Higgins
Larry J. Moore, Factory Mutual Research Corp.
J. W. Nugent, Colorado Div. of Mines
Donald E. Routon, Cyprus Shoshone Coal Corp.
Harold F. Shultz, Caterpillar Inc.
Barry A. Stewart, Kerr-McGee Corp.
Larry D. Tinker, Arco Coal Co.
William T. Trinker, The Mill Mutuals
Steven F. Vieira, Grinnell Fire Protection Systems Co.
Rep. NFSA
Robert L. Vines, Bituminous Coal Operators Assoc. Inc.

Alternates

Joseph L. Buckley, Factory Mutual Research Corp.
(Alternate to L. J. Moore)
Russell P. Fleming, National Fire Sprinkler Association
(Alternate to S. F. Vieira)

Daniel T. Grace, Ansul Fire Protection
(Alternate to V. A. Lupo)
Guy A. Johnson, U.S. Bureau of Mines
(Alternate to W. H. Pomroy)
Glenn D. Milligan, Kerr-McGee Corp.
(Alternate to B. A. Stewart)
Patrick M. Ryan, AMAX Coal Co.
(Alternate to D. J. Larkin)

Casey C. Grant, NFPA Staff Liaison

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.

Contents

Chapter 1 Introduction	123- 5
1-1 Scope.	123- 5
1-2 Purpose.	123- 5
1-3 Definitions.	123- 5
Chapter 2 Fire Prevention	123- 7
2-1 General.	123- 7
2-2 Housekeeping.	123- 7
2-3 Storage and Use of Flammable Liquids.	123- 7
2-4 Storage, Transport, and Use of Combustible Liquids.	123- 7
2-5 Cutting and Welding.	123- 8
2-6 Underground Maintenance Shops.	123- 9
2-7 Belt Conveyors.	123- 9
2-8 Hydraulic Fluids.	123- 9
2-9 Electrical Systems.	123-10
Chapter 3 Fire Protection	123-10
3-1 Portable Fire Extinguishers.	123-10
3-2 Water Supply for Mine Fire Protection.	123-11
3-3 Fire Protective Signaling Systems.	123-11
3-4 Automatic Fire Suppression Systems.	123-12
3-5 Fire Suppression for Self-Propelled Equipment.	123-15
3-6 Hand Hose Line Systems.	123-15
3-7 Portable Foam Generating Devices.	123-16
3-8 Rock Dust.	123-16
3-9 Emergency Materials.	123-16
3-10 Training.	123-16
Chapter 4 Referenced Publications	123-16
Appendix A	123-17
Appendix B Referenced Publications	123-23
Index	123-24

NFPA 123

Standard for Fire Prevention and Control in Underground Bituminous Coal Mines

1990 Edition

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 4 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. It does not cover explosion hazards; nor does it cover the use, handling, and storage of diesel fuel or diesel powered equipment.

1-1.2 This standard is based upon the present 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.

1-1.3 Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, reliability, strength, fire resistance, effectiveness, durability, and safety to those prescribed by this standard, providing technical documentation or other proof, such as demonstration, is submitted to the authority having jurisdiction to demonstrate equivalency and the system, method, or device is approved for the intended purpose.

1-2 Purpose.

1-2.1 This standard is prepared for the use and guidance of those charged with designing, constructing, installing, examining, approving, operating, and maintaining fire prevention, fire protection, and fire fighting equipment in underground bituminous coal mines. It may be necessary for many of those charged with purchasing, installing, inspecting, testing, approving, operating, and maintaining fire protection equipment to consult a competent fire protection engineer, experienced in the field of coal mining, in order to more effectively discharge their respective duties.

1-3 Definitions. The terms in this standard are in accord with general usage or dictionary definitions. Those listed below are used with the meanings indicated. A number of special terms are individually defined in the text.

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 or 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 which is in a position to determine compliance with appropriate standards for the current production of listed items.

Authority Having Jurisdiction. The "authority having jurisdiction" is 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, 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 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."

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

Container. Any approved vessel of 60 U.S. gallons or less used for transporting or storing liquids.

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 Resistant Construction. Masonry walls or equivalent having at least a 1-hr fire rating including compressible materials having an equivalent fire resistant capability.

Flammable and Combustible Liquids. For fire protection purposes, an arbitrary division of liquids that will burn has been established in NFPA 321, *Standard on Basic Classification of Flammable and Combustible Liquids*.

(a) *Flammable liquids.* Liquids having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 psi (2068.6 mm) at 100°F (37.8°C) shall be known as Class I liquids.

Class I liquids shall be subdivided as follows:

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

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

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

(b) *Combustible liquids.* Liquids having a flash point at or above 100°F (37.8°C) and 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 III liquids shall include those having flash points at or above 140°F (60°C) and shall be subdivided as follows:

Class IIIA liquids shall include those having flash points at or above 140°F (60°C) and below 200°F (93.4°C).

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

Flash Point. The minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid within the vessel as specified by appropriate test procedure and apparatus as follows:

The flash point of a liquid having a viscosity less than 45 SUS at 100°F (37.8°C) and a flash point below 200°F (93.4°C) shall be determined in accordance with ASTM D-56, *Standard Method of Test for Flash Point by the Tag Closed 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 D-93, *Standard Method of Test for Flash Point by the Pensky Martens Closed Tester.*

As an alternative, ASTM D-3278, *Standard Method of Tests for Flash Point of Liquids by Setaflash Closed Tester,* may be used for paints, enamels, lacquers, varnishes, and related products and their components having flash points between 32°F (0°C) and 230°F (110°C), and having a viscosity lower than 150 stokes at 77°F (25°C).

Hydrant. A valved hose connection.

Inby. A mining term meaning in the direction of the face or farther into the mine.

Intrinsically Safe. 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 ignitable composition.

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization 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 D-5, *Test for Penetration for 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.

Mobile. Any equipment in use without its own motive power train and normally moved by self-propelled equipment.

Noncombustible Material. A 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 passing, when tested in accordance with ASTM E-136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C (1382°F),* shall be considered noncombustible materials.

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

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

Permissible Equipment. A completely assembled electrical machine or accessory for which a formal approval has been issued.

Safety Can. An approved metal container, of not more than 5 gal (0.019 m³) capacity, having a spring-closing lid and spout cover and so designed that it will safely relieve internal pressure when subjected to fire exposure.

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.

Substantial Construction. Construction of such strength, material, and quality that enables an object to withstand reasonable shock, wear, and usage to which it will be subjected.

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

Tank. An approved vessel having a liquid capacity in excess of 60 gal (0.23 m³).

Chapter 2 Fire Prevention

2-1 General.

2-1.1 Fire prevention in an underground coal mine requires good housekeeping and cleanliness, safe operation of equipment and processes, proper supervision and operation of cutting and welding, and regular electrical and mechanical maintenance of equipment, facilities, and machinery.

2-1.2 Smoking and carrying of smoking materials, matches, or lighters underground shall not be permitted.

2-2 Housekeeping.

2-2.1 Efforts shall be made to remove, cover, or inert combustible materials.

2-2.2 Waste paper and other light combustibles shall not be allowed to accumulate.

2-2.3 Excessive amounts of coal dust shall be cleaned up, covered, or inerted with rock dust.

2-3 Storage and Use of Flammable Liquids.

2-3.1 Whenever possible, the storage and use of Class I flammable liquids underground shall be avoided.

2-3.1.1 Class I paints shall be available only in original containers or cans of not over 1 gal (3.8 L) capacity. All other Class I liquids shall be transferred while on the surface to a listed safety can of not over 1 gal (3.8 L) capacity before being taken underground.

2-3.1.2 All aerosol cans shall be treated as containing Class I liquids unless specifically identified to the contrary.

2-3.1.3 Containers, safety cans, and aerosol cans for flammable liquids shall be marked to identify the liquid content.

2-3.2 Class I liquids in underground storage areas as defined in 2-4.5 and in underground shops as defined in 2-6 shall be stored in approved storage cabinets.

2-3.3 In operating areas, containers of Class I 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, cutting and welding operations, and other operating equipment.

2-3.3.1 The quantity of Class I liquids and number of aerosol cans shall not exceed that required to meet the needs of 3 consecutive days of normal operations.

2-3.4 Class I liquids shall only be used in well-ventilated areas, at least 50 ft (15.2 m) from cutting or welding operations.

2-4 Storage, Transport, and Use of Combustible Liquids.

2-4.1 Class II and III liquids shall be kept in closed containers, safety cans, or tanks marked to identify the liquid content.

Exception: Grease cartridges may be kept in the original shipping carton.

2-4.2 Combustible liquids shall be transported in closed containers, safety cans, or tanks. When a vehicle is being used as a mantrip, it shall not be used for transporting combustible liquids.

2-4.2.1 Containers and tanks loaded on rail or trackless vehicles shall be secured against shifting and damage during transit. When loaded on a rail car for transport on a trolley wire-powered rail system, no container or tank shall be higher than the sides of the coal haulage mine car. When coal haulage is not by rail, the container or tank shall be at least 12 in. (30 cm) from any trolley wire.

2-4.2.2 Tanks for handling combustible liquids shall be substantially constructed, fitted with filler caps and vents, and have discharge valves that are protected in the event of derailment or ribbing of the vehicle.

2-4.2.3 Rail or trackless vehicles that carry supplies for production sections in addition to combustible liquids shall have provisions for securing or separating supplies from the lubricants so that, in the event of derailment or ribbing, the supplies will not puncture containers or tanks.

2-4.2.4 Vehicles carrying combustible liquids shall be kept clean of accumulations of oil, grease, and other combustible material. Combustible liquids spilled shall be cleaned up promptly. Any remaining residue shall be covered with an oil absorbent or rock dust.

2-4.3 When combustible liquids (lubricants) are stored on a vehicle located in an operating area, the vehicle shall not be parked under a trolley or trolley wire unless the wire is deenergized or insulated. Off loaded liquid containers or tanks shall be stored at a location outby the last open crosscut, not in an active roadway, and at least 25 ft (7.6 m) from trolley wires.

2-4.3.1* The quantity of combustible liquids stored in an operating area shall not exceed 3 days supply, except when the quantity in a single container exceeds 3 days supply.

2-4.4 Transferring of liquids from containers or tanks shall be accomplished by approved transfer pump or by gravity flow. Where needed, containers or tanks shall be equipped with approved vent. If a manual valve is used it shall be of the self-closing type.

2-4.4.1 Spillage shall be cleaned up promptly. Remaining residue shall be covered with an oil absorbent or rock dust.

2-4.5 Underground storage areas, where quantities of combustible liquid are stored in excess of that allowed in an operating area, shall meet the following requirements.

2-4.5.1 Storage areas shall be located a minimum of 100 ft (30 m) from explosive magazines, electrical substations, shops, or other combustible liquid storage places and at least 25 ft (7.6 m) from normally energized trolley wire.

2-4.5.2 The storage areas shall be of fire resistive construction or shall be enclosed and protected by an approved automatic fire suppression system. (*See Chapter 3 for information on fire suppression systems.*)

2-4.5.3 All enclosed combustible liquid storage areas, fire resistive construction or not, shall be built of noncombustible materials, including floor, roof, roof supports, doors, and door frames.

2-4.5.4 Enclosed storage areas shall be constructed to provide for suitable spill containment or shall be provided with a suitable floor drain to course spilled liquid to a containment sump or vessel.

2-4.5.5 All openings to the storage place shall be sealed with substantial, fire resistive stoppings. The access opening through which containers are moved shall be on the intake side. The access opening shall be equipped with self-closing metal door(s). A metal man door shall be provided at the opposite end of the storage area.

2-4.5.6 The storage place shall be vented directly to the return.

2-4.5.7 Combustible liquid containers shall be stored as follows:

(a) 55 gal (208 L) drums and 30 gal (114 L) drums shall be set vertically and not over 1 drum high.

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

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

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

(e) Containers shall be kept closed during storage.

2-5 Cutting and Welding.

2-5.1 Cutting and welding shall be performed only by experienced persons instructed in precautions and procedures for safe operation.

2-5.2 Acetylene cylinders shall be secured in the upright position if the height of the coal seam permits or angled with the valve end higher for proper and safe operation during cutting and welding.

2-5.3 All cutting and welding equipment shall be maintained and used in accordance with the safety precautions provided by the manufacturer.

NOTE: Explosionproof regulators are recommended.

2-5.3.1 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.

2-5.3.2 The valves of the compressed gas cylinder shall be closed tightly and protected from physical damage when not in use.

2-5.4 Before cutting and welding operations are undertaken in an underground shop, the following precautions shall be observed:

(a) Flammable and combustible liquids shall not be dispensed during cutting and welding operations. Freshly painted surfaces shall be allowed to dry sufficiently so that ignitable vapor is not present before cutting or welding.

(b) Class II and III combustible liquid cleaning vats shall be covered or removed to prevent ignition during cutting and welding operations.

(c) Combustibles such as oil, grease, and coal, located within 15 ft (4.6 m) of the cutting or welding, shall be cleaned up in a reasonable manner. Any remaining material shall be covered with a noncombustible oil-absorbent material or rock dust. Open gear cases or other machinery components containing lubricants within 15 ft (4.6 m) shall be covered with noncombustible material.

(d) Extinguisher(s) having a minimum nominal capacity of 20 lb (9.1 kg) of multipurpose (ABC) dry chemical extinguishing agent shall be readily available.

(e) 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.

(f) Oxygen shall be used only for its intended purpose. It shall not be used to blow coal dust from clothing or machinery.

2-5.5 Before cutting and welding operations are permitted in other areas underground, the following precautions shall be observed:

(a) The immediate area shall be thoroughly wetted down with water or shall be thoroughly coated with rock dust.

(b) Fire extinguishing equipment, including multipurpose (ABC) dry chemical extinguishers, rock dust, or a water hose shall be immediately available.

(c) When equipment to be modified or repaired can be moved, it shall be moved out by the last open crosscut before cutting or welding.

(d) When cutting or welding is necessary in by the last open crosscut, a continuous fire watch shall be maintained. A qualified person shall also check for the presence of methane. Cutting and welding operations shall not be allowed unless the concentration of methane is less than 1 percent by volume.

(e) Open gear cases and combustible machine components located close to cutting or welding shall be covered with noncombustible material.

(f) Positive ventilation shall be established prior to cutting or welding.

2-5.6 Upon completion of cutting or welding, a fire watch shall be maintained until all material has cooled sufficiently to touch with the bare hand.

2-5.7 Cylinders of compressed gas for cutting and welding shall not be transported on mantrips carrying persons other than the driver.

2-5.8 Compressed gas cylinder for cutting or welding being transported shall be:

- (a) Disconnected from regulators.

Exception: Cylinders, regulators, hoses, and torches that are adequately protected against damage need not be disconnected during transport. This would 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.

(e) Compressed gas cylinders for cutting or welding shall be clearly labeled "empty" or "MT" when the gas has been expended.

2-5.9 Compressed gas cylinders stored in an underground coal mine for cutting or welding shall be:

(a) Placed in storage areas designated for the purpose. These areas shall be well rock dusted and free of trash and combustible or flammable liquids.

(b) Stored and secured in an upright position, if the height of the coal seam permits, or angled with the valve end higher.

(c) Protected against damage from falling material, contact with power lines and energized electrical machinery, and heat from cutting or welding operations.

2-5.10 Compressed gas cylinders shall not be stored or left unattended in by the last open crosscut of an underground coal mine.

2-5.11 Valves on unattended compressed gas cylinders shall be closed. Where located in other than underground shops, compressed gas cylinders not in use shall have regulators removed and, if appropriate, the valves covered with protective metal caps or approved equivalent protection.

2-6 Underground Maintenance Shops.

2-6.1 Underground maintenance shops that are intended for use longer than six months shall be of fire resistant construction, including floor, roof, roof supports, and door frames, or shall be protected with an automatic fire suppression system. (See Chapter 3 for information on fire suppression systems.)

2-6.2 Entrances to the shop shall be equipped with a closeable metal door(s).

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

2-6.3 The shop area shall be ventilated directly to the return.

2-7 Belt Conveyors.

2-7.1* Belt conveyors installed in underground coal mines shall meet the following minimum requirements:

- (a) Conveyor belting shall be approved.

(b) Entries in which belt conveyors are installed shall be kept reasonably free of accumulations of coal and coal dust and shall be rock dusted.

(c) All belt conveyors shall be equipped with an approved slippage switch system designed to shut down the belt if sliding friction 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.

(d) All conveyor belt systems shall be equipped with approved interlock systems, which will shut down in by belt conveyors or other coal-feeding equipment if any conveyor in the system should stop or reduce its normal speed.

(e) Fixed combustible material such as posts, cribbing, and roof supports shall be either metal guarded from contact by the belt or located at least half the width of the belt from any idler or pulley. An alternate method to minimize potential frictional ignition is the use of alignment switches at intervals sufficient to prevent the belt from contacting such materials. Machinery guarding in the drive area and at other points along the belt shall be of noncombustible material.

(f) New installations of belt conveyors shall utilize structure that does not provide a deck between upper and lower strands of belt.

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

2-8 Hydraulic Fluids.

2-8.1 Fire resistant hydraulic fluid shall be an approved type.

2-8.2 Where fire resistant fluids are required, samples of fire resistant fluids in use 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 the sample shows 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.

2-8.3 Unattended electrically powered nonmobile equipment such as car spotters shall employ fire resistant hydraulic fluid.

2-9 Electrical Systems.

2-9.1 Electrical systems shall be approved.

Chapter 3* Fire Protection

3-1 Portable Fire Extinguishers.

3-1.1 General Requirements.

3-1.1.1 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, meeting the requirements of NFPA 10, *Standard for Portable Fire Extinguishers*.

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

3-1.1.2 Portable extinguishers shall be kept in their designated places.

3-1.1.3 Extinguishers shall be conspicuously located 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.

3-1.1.4 Extinguishers installed under conditions in which they are subject to dislodgement shall be installed in brackets specifically designed to cope with this problem.

3-1.1.5 Extinguishers shall be protected from physical damage. Damaged extinguishers shall be repaired, replaced, or removed from service.

3-1.2 Selection and Application.

3-1.2.1 Portable fire extinguishers having a minimum nominal capacity of 20 lb (9.1 kg) of multipurpose (ABC) dry chemical agent shall be located just outside the main entrance doors of storage areas as defined in 2-4.5 and maintenance shops as defined in 2-6.1.

3-1.2.2 Multipurpose (ABC) dry chemical extinguishers shall be provided for the protection of fixed installations including:

- (a) Ventilation doors on trolley wire-supplied track haulways.
- (b) Pumps and pump rooms.
- (c) Conveyor belt drives.
- (d) Belt head loading equipment.
- (e) Compressor rooms.

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

(g) Rotary dump areas.

(h) Battery-charging area.

(i) At 50-ft (15.2-m) intervals along a longwall face unless washdown hoses are present.

3-1.2.3 At least one multipurpose (ABC) dry chemical extinguisher having a minimum nominal capacity of 30 lb (13.6 kg) of agent 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 30 lb (13.6 kg) of agent each, shall be provided.

Exception: In low coal, where a 30 lb (13.6 kg) extinguisher may be too large to employ, three 10 lb (4.6 kg), two 20 lb (9.1 kg), or one of each shall be acceptable.

3-1.2.4 All vehicles, self-propelled equipment, and mobile equipment shall be equipped with a portable multipurpose (ABC) dry chemical extinguisher including:

- (a) Locomotives, portal busses, and mantrip vehicles.
- (b) Battery tractors and other haulage units.
- (c) Self-propelled production equipment including miners, shuttle cars, roof bolters, and scoops.
- (d) Mobile equipment including air compressors and feeder breakers.

3-1.2.5 The installation of an automatic or manually operated fire suppression system shall not eliminate the requirement for a portable fire extinguisher.

3-1.3 Maintenance.

3-1.3.1 Portable fire extinguishers shall be inspected, maintained, and recharged as specified in NFPA 10, *Standard for Portable Fire Extinguishers*, Chapter 4, Inspection, Maintenance, and Recharging, including the following.

3-1.3.1.1 Portable fire extinguishers shall be visually inspected at least monthly.

3-1.3.1.2 The visual inspection shall confirm that: the extinguisher is in its designated place, the tamper seals are intact, the extinguisher gauge is in the operable range (if extinguisher is stored pressure type), and that there is no obvious physical damage or condition to prevent operation.

3-1.3.1.3 Extinguishers shall be subjected to a thorough maintenance examination at least once every 12 months.

3-1.3.1.4 Maintenance procedures shall include a thorough examination of the extinguisher, including mechanical parts, extinguishing agent, and expelling means.

3-1.3.1.5 Any detected troubles or impairments shall require immediate correction or replacement by competent personnel.

3-1.3.1.6 Each extinguisher shall have a durable tag or label securely attached on which the date and the initials of the person performing the maintenance services shall be recorded. The same record tag or label shall also indicate if recharging was performed.

3-1.3.1.7 All extinguishers shall be recharged after use, as indicated by an inspection, or when performing maintenance.

3-1.3.2 Portable extinguishers shall be hydrostatically tested at intervals not exceeding those specified in NFPA 10, *Standard for Portable Fire Extinguishers*, Chapter 5, Hydrostatic Testing.

3-2 Water Supply for Mine Fire Protection.

3-2.1 General Requirements.

3-2.1.1* All mine water systems shall be capable of supplying simultaneously 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.

3-2.1.2 The mine water system shall be capable of supplying the required hosestream water demand continuously for 24 hours or the sprinkler water demand continuously for 2 hours, whichever is the greater supply.

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

3-2.1.3* Water distribution lines shall extend from the surface to each operating area.

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

3-2.1.3.1 The operator shall choose the entry in which the water line is located.

3-2.1.3.2 Water flow and ventilation air flow 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 waterline.

3-2.1.4 Where applicable, water lines shall be protected against freezing.

3-2.1.5 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.

3-2.1.6 Pipe and fittings shall be adequate for the water pressure.

3-2.1.7 Water lines shall be equipped with shut-off valves at intervals not to exceed 5000 ft (1525 m). A shut-off 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 1000 ft (305 m) are recommended.

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

3-2.1.8* Hydrants, suitable for supply water to a fire hose, shall be provided on the water line at intervals not to exceed 500 ft (152.5 m).

3-2.1.8.1 Hydrants shall be located at or close to a travelable crosscut or crosscuts. 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 so as to give a favorable route for laying a fire hose to parallel entries. Locations chosen shall favor routing to those entries where fire risk is greater.

3-2.1.8.2 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.

3-2.1.9* Multiple hydrant assemblies, with tools needed for their installation, shall be provided as part of each cache of emergency materials. (See 3-9.) (See A-3-2.1.9 for suggested construction of multiple hydrants.)

3-2.2 Maintenance. The water supply system shall be maintained operable.

3-3 Fire Protective Signaling Systems.

3-3.1 General Requirements.

3-3.1.1 All components of protective signaling systems used in by the last open crosscut or in return air shall be permissible or intrinsically safe.

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

3-3.1.2* All fire detectors shall be approved for the intended use and installed in accordance with NFPA 72E, *Standard on Automatic Fire Detectors*, or the manufacturer's instruction.

3-3.1.3 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.

3-3.1.4 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. (For further guidance, refer to NFPA 72, 72E, and 72H.)

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

3-3.1.5* All signaling systems shall be approved for the intended use.

3-3.1.6 A sprinkler system with a water flow switch connected to the signaling system shall be acceptable in lieu of fire detection but only in the area covered by the sprinkler system.

3-3.2 Selection and Application. Fire detectors shall be installed over all belt conveyors and at all unattended automatic belt heads (where mine cars are loaded automatically). The same fire detectors may be extended to cover the automatic belt head and the belt feeding that belt head. Fire detectors may also be used or required in other areas of the mine.

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

3-3.3 Test and Maintenance. Test and maintenance shall be in accordance with the manufacturer's recommendations.

3-4* Automatic Fire Suppression Systems.

3-4.1* The following equipment and facilities shall be protected by approved automatic fire suppression systems satisfying the requirements of 3-4.2 through 3-4.2.4:

(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. The automatic fire suppression system shall be installed such that system actuation causes shutdown of the conveyor.

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

(b) Flammable and combustible liquid storage areas as defined in 2-4.5.

(c) Maintenance shops as defined in 2-6.1.

(d) Unattended electrically powered equipment having a hydraulic system, such as car spotters.

(e)* Air compressors.

Exception: For automatic fire suppression system installations other than automatic sprinklers, the air compressor shall be constantly attended by a person within line-of-sight of the compressor, and a hand portable extinguisher shall be readily available to that person.

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

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.

3-4.2 Where the requirements of Section 3-4 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 (*see NFPA 13*), 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. On 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 shall also be permitted to serve as the fire detection system installed over that portion of the belt conveyor.

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

CAUTION: Some automatic sprinklers may not withstand the water pressure that may be encountered in deep mines.

(d)* For sprinkler systems installed to protect the equipment and facilities indicated under 3-4.1(a), sprinklers shall be placed no greater than 10 ft (3.05 m) apart. For sprinkler systems installed to protect equipment and facilities indicated under 3-4.1(b) through 3-4.1(f), sprinklers shall be spaced no greater than 12 ft (3.66 m) apart, and the protection of any one sprinkler shall not exceed 100 sq ft (9.3 m²).

(e)* Sprinklers shall be located so that the discharge will not be obstructed. The distance of sprinkler deflectors below the roof shall not be 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)* Pipe in sprinkler systems shall comply with 3-2.1.5 and 3-2.1.6. Nonmetallic pipe shall not be used downstream of the sprinkler control valve unless investigated and listed for this purpose.

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

(h) Provision shall be made to drain all parts of the system properly. Drain connections shall be sized as shown in the following table:

Table 3-4.2(h)

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

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

3-4.2.1 Wet pipe sprinkler systems shall not be used where chance of freezing exists.

3-4.2.2 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. Suitable glycerine-water and propylene glycol-water mixtures are shown in Table 3-4.2.2(a).

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

Table 3-4.2.2(a)

Material	Solution (by Volume)	Specific Gravity at 60°F (15.6°C)	Freezing	
			°F	°C
Glycerine C.P. or U.S.P. Grade*	50% Water	1.133	-15	-26.1
	40% Water	1.151	-22	-30.0
	30% Water	1.165	-40	-40.0
Hydrometer Scale 1.000 to 1.200				
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
Hydrometer Scale 1.000 to 1.200 (Subdivisions 0.002)				

*C.P. — Chemically Pure.
U.S.P. — United States Pharmacopoeia 96.5%

(b) If automatic sprinkler systems are not connected to public water systems or to piping supplying water for drinking, the commercially available materials shown in Table 3-4.2.2(b) are suitable for use in antifreeze solutions.

Table 3-4.2.2(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 Point	
			°F	°C
Glycerine	If glycerine is used, see Table 3-4.2.2(a)			
Diethylene Glycol	50% Water	1.078	-13	-25.0
	45% Water	1.081	-27	-32.8
	40% Water	1.086	-42	-41.1
Hydrometer Scale 1.000 to 1.120 (Subdivisions 0.002)				
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
Hydrometer Scale 1.000 to 1.120 (Subdivisions 0.002)				
Propylene Glycol	If propylene glycol is used, see Table 3-4.2.2(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 per gal water	4.37	1.258	-30	-34.4
	4.73	1.274	-40	-40.0
	4.93	1.283	-50	-45.6

* Free from magnesium chloride and other impurities.

(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 3-4.2(b)] shall be connected close to the discharge side of the check valve.

(d) A 1/4 in. soft seat relief valve made of corrosion resistant bronze or stainless steel shall be connected to the

sprinkler piping near the shutoff valve. The relief valve shall be set to open at a pressure of 200 psi above the maximum waterline pressure.

NOTE: The setting of the relief valve will be 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-3-4.2.2(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 may 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. When connected to the system piping, the air chamber shall be oriented so that the connection port is 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. If possible, the pressure of the antifreeze solution shall be raised to the line pressure before the shutoff valve is opened and sealed. The valve on the air chamber shall be opened and sealed. Finally, the system shall be checked carefully for leaks.

(f)* An alternative arrangement to 3-4.2.2(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-3-4.2.2(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 that opening shall be closed and the valve plugged. The system shall be checked carefully for leaks, especially in the area of the piping where the air is believed to be. 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.

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

3-4.2.3* 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 3-3.1.1 note*).

(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 signalled to an attended location. Such signalling may utilize alarm systems serving fire detection equipment.

(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.

3-4.2.4 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

(d) in compliance with the requirements of 3-5.1(a), (b), and (d) through (h).

3-4.2.5 New Automatic Sprinkler System Testing.

3-4.2.5.1 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 water is clear.

3-4.2.5.2 Flow Testing of Sprinkler Systems. Wet pipe closed automatic sprinkler systems shall be flow tested by flowing through the maximum number of sprinklers expected to open, but not less than 8 open sprinklers (all if the system contains less than 8). If the residual pressure measured downstream of the opened sprinklers is 10 psi or greater the system is acceptable.

Exception No. 1: Closed sprinkler systems installed to protect areas where the water discharge may damage the area or its contents need not be tested by flowing through opened sprinklers. Instead, an alternative test, by flowing through a 2-in. valve test connection, may be used.

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

3-4.2.6 Tests of Dry Pipe Sprinkler Systems.

3-4.2.6.1 New dry pipe systems shall be flow tested according to 3-4.2.5.2 and hydrostatically tested in accordance with 3-4.2.6 when there is no risk of freezing. A dry pipe valve shall be tested according to manufacturer's recommendations.

3-4.2.6.2 When there is risk of freezing in dry pipe systems, an air pressure of 40 psi (2.8 bars) shall be pumped up, allowed to stand 24 hr, and all leaks that allow a loss of pressure over 1½ psi (0.1 bar) for the 24 hr should 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 (3.4 bars) to prevent damaging the valve.

3-4.2.7 Sprinkler System Maintenance.

3-4.2.7.1 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 flowing through the end

fitting in all lines to remove any silt buildup in the lines. 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.

3-4.2.7.2 Antifreeze systems. Each year, at the onset of the 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.

3-5 Fire Suppression for Self-Propelled Equipment.

3-5.1 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 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 may be operated in by the last open cross-cut or in return air shall be permissible or intrinsically safe (see 3-3.1.1 note).

(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 need not require the discharge of the agent unless there is no other satisfactory way to evaluate the system.

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

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

3-5.2* 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, may 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.

3-6 Hand Hose Line Systems.

3-6.1* General Requirements. The mine operator shall choose the entry in which the hydrants are located and shall locate man doors and provide sufficient fire hose to reach parallel entries where risk of fires may exist.

3-6.2 Selection and Application.

3-6.2.1* Fire hose for use in underground coal mines shall be 1½-in. (3.8-cm) or 2-in. (5-cm) diameter, single or multiple jacket, of a type suitable for coal mine use. The hose shall meet the minimum applicable standards of NFPA 1961, *Standard for Fire Hose*. Hoses employing natural fibers shall not be used in underground coal mines.

3-6.2.2* Fire hose, including couplings, shall be adequate for the maximum line pressure that may exist on the mine water system, or there shall be provision for limiting the line pressure not to exceed the working pressure of the hose. Nozzle flow pressure shall be adjusted to provide for safe hose control.

3-6.2.3* Couplings for fire hose used in underground coal mines shall have straight iron pipe threads (NPSH) or National Standard Thread (NH, also known as NST and NS). Rocker lug couplings are preferred to pin-type couplings.

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

3-6.2.3.1 When hose or hose connected equipment may be brought in from outside the mine, compatible adaptors shall be available.

3-6.2.4* Hose nozzles shall be capable of delivering a solid stream and a spray discharge.

3-6.2.5* Fire hose shall be stored in caches and contain sufficient hose to reach all areas covered from hydrants that the cache will serve. Each cache shall contain at least one hose nozzle and one hose wrench.

3-6.2.6 Caches of fire hose shall be provided at strategic locations underground as follows:

(a) At intervals not to exceed 5000 ft (1525 m) along the main haulageway or travelway

(b) Near each intersection with an active sub-main

(c) Near the mouth of each panel

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

(e) Near the entrance to each shop and storage area as defined in 2-4.5 and 2-6

(f) In each operating area.

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

3-6.3 Maintenance. Caches of fire hose shall be checked at least every 6 months to ensure that the inventory of hose, nozzles, wrenches, and adaptors is complete and in good condition. Annually at least 1 length of hose from each cache shall be pressure tested according to NFPA 1961. The tested hose shall be tagged and dated so that a different length of hose will be tested each year. If any length of hose fails the pressure test, all lengths of hose in the cache shall be tested. Hoses that fail the test shall be replaced.

3-7 Portable Foam Generating Devices.

3-7.1 General Requirements. Portable foam generating devices and associated equipment shall be approved for the purpose.

3-7.2 Selection and Application. Portable foam generators, fire hose, foam concentrate, and stopping materials shall be accessible for immediate transport.

3-7.3 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.

3-8 Rock Dust.

3-8.1 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
- (f) Ventilation doors on trolley wire-supplied track haulways.

Exception: Where it is impractical to store for fire extinguishment purposes, rock dust may 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.

3-9 Emergency Materials.

3-9.1 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 from a working section, additional materials shall be readily available at locations within 2 miles of the working section(s).

3-9.2 Emergency materials shall include fire hose and necessary adaptors, 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 wood fibreplaster or cement, saws, hammers, axes, shovels, and picks.

3-9.3 Caches of emergency materials shall be checked at least every 6 months to ensure that the inventory of materials is complete.

3-10* Training.

3-10.1 All operating employees shall be instructed annually in fire prevention and fire fighting techniques.

3-10.2 All employees shall be instructed on emergency evacuation procedures.

Chapter 4 Referenced Publications

4-1 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.

4-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10-1990, *Standard for Portable Fire Extinguishers*

NFPA 13-1989, *Standard for the Installation of Sprinkler Systems*

NFPA 72-1990, *Standard for the Installation, Maintenance, and Use of Protective Signaling Systems*

NFPA 72E-1990, *Standard on Automatic Fire Detectors*

NFPA 321-1991, *Standard on Basic Classification of Flammable and Combustible Liquids*

NFPA 1961-1987, *Standard for Fire Hose*

4-1.2 Other Publications.

4-1.2.1 ASTM Publications. American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

ASTM D-5-86, *Standard Test Method for Penetration of Bituminous Materials*

ASTM D-56-87, *Standard Test Method for Flash Point by the Tag Closed Tester*

ASTM D-93-85, *Standard Test Method for Flash Point by the Pensky-Martens Closed Tester*

ASTM D-3278-82, *Standard Test Methods for Flash Point of Liquids by Setflash Closed-Cup Apparatus*

ASTM E-136-82, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*

4-1.2.2 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

"Mineral Resources," Title 30, *Code of Federal Regulations*, Part 18

Appendix A

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

A-1-1.1 In the formulation of this document, the subcommittee examined data available in the "Annotated Bibliography of Coal Mine Fire Reports" prepared by the Allen

Corp. of America under Bureau of Mines Contract Number J0275008, dated July, 1978. This bibliography covers the period from 1950 to mid-1977 and is shown in Figure A-1-1.1(a) for the period from 1970 to 1977. Data since mid-1977 was taken from fire reports furnished by MSHA and is shown in Figure 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 Figures A-1-3.2 (a), (b), and (c).

DESCRIPTION	YEAR								TOTAL
	1970	1971	1972	1973	1974	1975	1976	1977	
Electrical									
Mobile Equip.	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 & Welding									
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

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

DESCRIPTION	YEAR										
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Electrical											
Mobile Equip.	0	2	1	3	1	0	1	2	2	2	2
Trailing Cable	1	1	3	1	3	0	2	0	1	0	0
Fixed Equipment	0	0	1	0	3	2	1	0	5	2	2
Trolley Wire	3	0	0	1	2	0	1	1	2	1	0
Friction											
Belt Drive Area	0	0	0	0	0	1	1	1	0	1	0
Belt Other Areas	0	0	2	2	1	1	1	2	1	1	1
Other Friction	0	0	0	0	0	0	0	0	0	3	0
Flame cutting & Welding											
Welding	1	0	2	2	5	1	3	5	3	1	3
Spontaneous	1	3	3	1	0	4	3	3	1	0	2
Miscellaneous	1	1	1	1	1	1	0	0	0	2	1
Unknown	0	2	1	2	0	1	0	2	1	3	2
TOTAL	7	9	14	13	17	11	13	16	16	16	13

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

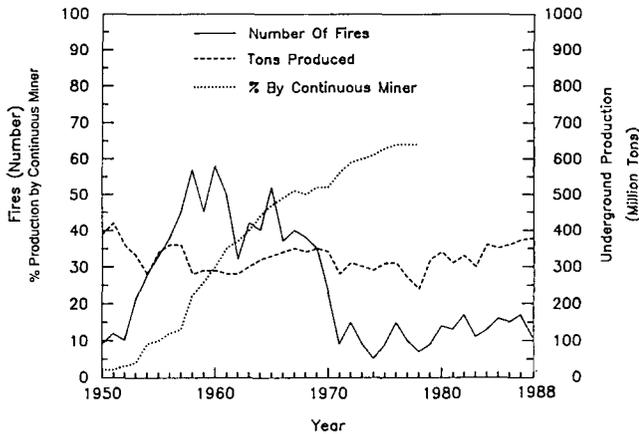


Figure A-1-1.1(c) Time Trends for Underground Fires.

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

A number of observers working in the industry throughout this period opine that the introduction of continuous miners in the late 1940's caused demands on the existing underground direct current (dc) power systems, which they could not handle. 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 were a result. The industry was just not accustomed to using and maintaining wiring and trailing cables carrying 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 fell back to the early 1950 experience. In addition to the fact that the industry was learning safer use of the new equipment, technical solutions were being developed and adopted. The most notable contributor was the introduction of ac power for face equipment, first tested in the mid-1950's. By the early 1960's the change from dc to ac was underway, and the 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 reduce fires. So, while the changing technology of the 1950's caused the increased incidence of fires, technical solutions adopted during the 1960's have served to reduce the fire problem.

Please note that the subcommittee is aware that the data in the Allen Report and available from MSHA is based upon the legal requirement that only those fires that burned for thirty minutes or longer are required to be reported. However, the subcommittee believes that a similar reduction in unreported fires has occurred.

A-2-4.3.1 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 lesser 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 will reduce the frequency of transport and as a result the overall risk of fire.

A-2-7.1 Belt fires originating away from the drive area have usually been caused by idlers with defective or stuck bearings. Tests have shown that such idlers can become moderately hot, in the order of 200°F (93°C) to 300°F (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 will ignite the belting.

The key to avoiding this type of fire 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, there will not be accumulations of coal dust around the troughing idlers. Where possible, return idlers should be supported at a good height above the bottom so that coal dust is not likely to build up around return idlers. With good 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 require that noisy bearings, which may indicate probable failure, be changed promptly before they can become hot.

Fires of conveyor belts have been caused by belts running off of proper alignment and the edge of the moving belt then contacting combustible material. Loss of alignment can result from a number of causes, including displacement of idlers or pulleys and movement of supporting structure, spillage of conveyed material, and failure of a bearing (typically on a pulley). When alignment is greatly affected, the edge of the belt may rub severely on the structure and objects near the edge of the belt. If the object on which the belt rubs is metal, the metal may be worn and heated. The edge of the belt may 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 again. The metal can get quite warm; but, because it is a good conductor of heat, it will not get hot enough to ignite the belt if the belt stops. But, if the material contacted is wood or another combustible, the combustible material may 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-3 Automatic detection systems and automatic sprinkler systems in mining facilities need to be specifically addressed because of the following reasons:

(a) The occupancy of a mine is continually changing and moving. Most items are not fixed and are designed to move 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 sq mi (64.75 sq km) or greater are common.

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

(d) Mining occupancies have unique physical restraints that are unlike any other occupancy. An 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 which fail to account for 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-3-2.1.1 Water distribution lines generally cannot meet the capacity requirements of 3-2.1.1 unless 5- or 6-in. pipe size is used for main water lines and 4-in. pipe is used for branch lines to producing sections.

A-3-2.1.3 Routing of water lines has caused severe problems in fighting fires at some large mines. These mines had multiple intake shafts spaced considerable distances apart. This ventilation situation can create a neutral point between the shafts, and fresh air moves from each shaft toward the neutral point. At the original opening of the mine, a water source was established and the water line was extended as the mining developed away from the first opening. With the water line extended on to each new intake shaft and going 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 must be approached in the same direction as the air flow, 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 roof caused by the fire. When a water line breaks in this situation, the fire fighters are without water, and direct fire fighting is no longer possible. Then the fire can only be controlled 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 probability of this problem appears to be increasing as more mines are ventilating belt entries with air moving outby, and the water flow direction is inby. In some cases, mine management has recognized the problem and has developed procedures to change the direction of air flow in the event of a fire. Reversing the air flow 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 on the full length of the entry if desired.

Mines that obtain the water supply from an underground source may also have this problem of opposite directions of air and water flow. Usually there is no sure solution except to provide for 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 any place on the system, it may 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 would 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 falls of roof caused by the fire. In this situation, a planned shutdown of the water line should be undertaken as soon as possible to insert a multiple hydrant (see A-3-2.1.9) in the water line at a convenient location close to the fire. With the multiple hydrant in place, at least 3 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, the committee feels that management should be better qualified to select such locations; but the committee also feels that management should be able to justify its choice. Reliability of the water supply and ability to get fire hose streams on a fire at any location or entry served by the water line should be the criteria upon which the location is chosen.

A-3-2.1.8 Hydrants in a coal mine normally are just a valve screwed onto a tee that is installed on the water line. To have a male thread to which the female coupling of a fire hose can be connected, usually a pipe nipple is screwed into the discharge side of the valve. The threads of steel pipe nipples generally corrode badly if left exposed. Often brass nipples are used instead of steel nipples. Many mines have started to use Schedule 80 plastic nipples instead of steel. Irrespective of the material of the nipple, the threads of the nipple should be protected against physical damage.

A properly designed system of hydrants and fire hoses should meet the test of being able to make a good connection of fire hoses to the hydrant without the need for any tools.

The choice of locations for hydrants should be to ensure that fire hose 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 just being convenient for use in the entry where the water line is located.

A-3-2.1.9 A multiple hydrant is a short length of 3- or 4-in. pipe usually with 3 valved outlets (hydrants) to which fire hoses 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 it 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-3-3.1.2 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 listed below:

Heat Detector:	A device that detects 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 or 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.

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 sensors 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 may occur along the floor, ribs, or roof of the entry. In order to provide optimum protection, it is recommended that the fire sensors 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 sensors should be located in such a manner that they provide for the estimated best coverage of that entry.

A-3-3.1.5 Batteries kept 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-3-4 The committee believes automatic sprinkler systems are the most desirable means of protecting against fire hazards in an underground bituminous coal mine. However, other systems or the use of foam in automatic sprinkler systems, as permitted in 1-1.3, may be utilized if approved by the authority having jurisdiction.

A-3-4.1 Wet pipe automatic sprinkler systems have been found to be the preferred fire suppression systems for underground coal mines for a number of reasons:

1. Simplest system available
2. Most reliable system available
3. Selective operation since only sprinklers close to the fire operate
4. Best performance record, especially on fires of Class A materials and of Class IIIB combustible liquids
5. Minimal maintenance required
6. Nonelectrical
7. Limited quantity of water required
8. Low initial investment.

The major problem of automatic sprinkler systems in underground coal mines is the possibility of exposure to freezing conditions during cold weather. Another problem that may exist in very deep mines is that some of the listed components for automatic sprinkler systems may 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 may be necessary. Experience has shown that pressure regulators may require considerable maintenance. Also, if the pressure regulating valve should leak, it may be necessary to provide a small relief valve on the discharge side of the regulating valve to prevent over pressure.

A-3-4.1(a) Under Contract Number H0122086, the Department of the Interior, Bureau of Mines (USBM) conducted a series of full scale fire tests on the "Suppression of Fires on Underground Coal Mine Conveyor Belts." These tests are the only tests that the committee knows about 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 showed 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 only opening 2 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 these tests indicated. Since many conveyor belts stretch a long distance in a straight line, a fire scenario would involve only a portion of the belt, irrespective 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 the area from the discharge pulley to the end of the takeup only is required. 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 will virtually double 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 3-4.2.5.2, with the 8 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. The following schedule should be used to determine the minimum size of pipe:

Table A-3-4.1(a)

1-in. (25.4-mm) pipe.....	2 sprinklers
1 1/4-in. (31.7-mm) pipe.....	3 sprinklers
1 1/2-in. (38.1-mm) pipe.....	5 sprinklers

Larger systems should be separately flow tested as required by 3-4.2.5.2.

A-3-4.1(e) Since many air compressors are moved frequently, the fire suppression system must 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 2 sprinklers 10 ft (3.0 m) apart. The piping is made to be attached to roof bolts or otherwise suitably supported over the center line of the compressor. The piping must be equipped with a pressure switch that will prevent the operation of the compressor unless the piping is under pressure and with a flow switch that will shut 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 must be located so that a fire on the compressor will not damage the fire hose.

A-3-4.2(d) The restrictions on sprinkler spacing apply both to sprinklers on the same line and between sprinklers on adjacent lines.

A-3-4.2(e) Where sprinkler positioning is such that full coverage may 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 obtained. For belt conveyors, the entire top belt surface should be wetted. Additional sprinklers should be provided in the event adequate coverage is not obtained, or alternate arrangements such as rotated lines or sidewall sprinklers should be considered. Consideration should also 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-3-4.2(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 is acceptable if adequate for the pressure.

A number of mines are using aluminum pipe or tubing with groove-type couplings and fittings. When water pressure does not exceed 500 psi (3448 kPa), grooved couplings having a 1/2-in. (12.7-mm) FNPT outlet are being

used to provide connections for sprinklers. Piping put together in this manner can be 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 pre-cut 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 must be used.

A-3-4.2.2(c) 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 during filling the system with antifreeze solution.

A-3-4.2.2(e) The purpose of the air chamber is to absorb the expansion of the liquid that will take place when the system is warmed by summer temperatures. The relief valve [see 3-4.2.2(d)] is to protect against excessive pressure that may occur if the chamber does not contain sufficient air.

The chamber can be filled by compressed air easily if a high pressure compressor is available; however, care must be used during pressurizing to avoid over pressure beyond the strength of the chamber. An alternate method is to use the water pressure to compress air into the chamber. The piping must 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 shut-off valve is partly opened so the piping will fill with water but not too fast. The water will compress the air into the chamber, to the proper pressure. The valve on the chamber is closed, and the piping is drained. Then the piping is filled with mixed antifreeze solution, and the system can be put in operation in accord with 3-4.2.2(f).

The following formula should be used to calculate the minimum volume of the air chamber required in 3-4.2.2(e) or the volume of the solution withdrawn required in 3-4.2.2(f).

$$\% = V_c/V_s = (B) (\Delta T) [P_m/(P_m - P_1)]$$

V_c Volume of air chamber

V_s Total volume of system piping

B (BETA) Effective coefficient of expansion. Notice that Table A-3-4.2.2(e) shows the variation of B for different solution concentrations and 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 CENTIGRADE.

P_1 Maximum water line pressure.

P_m Maximum pressure designed for in the sprinkler system. This pressure will be the pressure setting of the relief valve.

Table A-3-4.2.2(e)

% Water	Ethylene Glycol Solutions		Calcium Chloride Solutions		
	Steel Pipe	Al Pipe	Sp.Gr.*	Steel Pipe	Al 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)

Paragraph 5-5.4 of NFPA 13, *Standard for the Installation of Sprinkler Systems*, shows another and very 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 must be installed in a non-freezing area, and often the height may not allow a 5-ft (1.5-m) U-loop.

A-3-4.2.2(f) A number of coal mines have used antifreeze systems successfully but without the 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 give 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 or so.

This method of filling the sprinkler piping allows the piping system to be simpler than the method which uses a special air chamber [see 3-4.2.2(e)]; however, it does have certain problems. First, it must be recognized that compressed air can find leaks in piping that will hold a liquid successfully. Also, air leaks are difficult to find while leaks of liquid are obvious. Finally, because of the greater contact between the air and the liquid in this method, there will be a greater chance that the liquid will absorb more of the air than will occur in the alternate system. Therefore, it is suggested 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 will also occur as cold weather comes on, and the liquid will contract as it cools. This results in dilution of the antifreeze solution. It is suggested that the formulation of the antifreeze solution tends to provide more antifreeze than is suggested by the antifreeze tables so that the system can live with some dilution. Also, the committee has suggested a second test annually of the antifreeze solution so that mines using these antifreeze solutions will gain experience in the safety of these systems.

A-3-4.2.2(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

one occurred before the mix became uniform. The glycols and glycerine are combustible liquids unless they are mixed with water to give solutions as shown in Tables 3-4.2.2(a) and 3-4.2.2(b).

It should be recognized that solutions of calcium chloride are inherently firesafe. Glycol or glycerine solutions are quite safe when applied at the minimum rate required by 3-5.2.5.2, Flow Testing of Sprinkler Systems. Also, continued flow of the sprinkler system will quickly discharge all of the antifreeze solution, and then the discharge is water only.

Care must 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, is required.

A-3-4.2.3 Dry pipe automatic sprinkler systems are more complex and more difficult to design and to install than wet pipe systems. The committee suggests 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 above the set pressure of the regulating valve.

A-3-5.2 Pipe or hose supplying open spray nozzles should be sized to avoid excessive pressure loss. Open nozzles provide a good spray pattern with 10 to 20 psi of water pressure at the nozzles. If nozzle pressure exceeds 25 psi, additional or larger orifice nozzles may be used to increase the water flow. If nozzle pressure is less than 20 psi, 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 give a reasonable spray pattern.

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

A-3-6.1 The objective of the hydrant locations is to assure 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 crosscut rather than just being convenient for use in the entry where the water line is located.

A-3-6.2.1 Fire hose requires 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. Probably the best hose for mine use is neoprene lined, polyester hose with rocker lug couplings. 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 good pressure, 1½-in. (3.8-cm) hose should be used. When the water supply is able to provide 100 to 120 gpm at good pressure, 2-in. (5-cm) hose is better. Two and one-half in. (6.4-cm) hose 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 a good discharge from a 1½-in. (3.8-cm) hose nozzle. Some of these mines provide at least 2 valved connections (hydrants) in operating areas so that more than one 1½-in. (3.8-cm) hose line can be used if needed. In some cases, short lengths of pipe with 2 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 give greater flexibility during a fire fighting operation.

A-3-6.2.2 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-3-6.2.3 Threads of 1½- or 2-in. (3.8- or 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 with the large number of hydrants required 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 will harm the gaskets.

A-3-6.2.4 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-3-6.2.5 In many fire situations, fire hose may have to be carried to the fire. If manual transport is required, 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.

Others prefer 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 puts the hose couplings at the outside so that the hose can be laid starting at the hydrant toward the nozzle or from the nozzle back to the hydrant with equal efficiency.

A-3-10 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 must be prepared, resolute, and capable. As part of periodic training, the organization should conduct its own fire drills that involve all levels of mine management. The regulatory agencies should be invited to participate in fire drills also. Training will develop management capability and will promote 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 Publication. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 13-1989, *Standard for the Installation of Sprinkler Systems*

NFPA 72H-1988, *Guide for Testing Procedures for Local, Auxiliary, Remote Station, and Proprietary Protective Signaling Systems*

B-1.2 Other Publications.

B-1.2.1 Bureau of Mines Publications. Bureau of Mines, Office of Technology Transfer, 2401 E Street, NW, Washington, DC 20241

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

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

B-1.2.2 MSHA Publication. Mine Safety and Health Administration, Bruceton Safety Technology Center, Cochran's Mill Road, P.O. Box 18233, Pittsburgh, PA 15236.

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