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NFPA 121 Self-Propelled and Mobile Surface Mining Equipment 1986

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

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

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

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

Statement on NFPA Procedures

This material has been developed under the published procedures of the National Fire Protection Association, which are designed to assure the appointment of technically competent Committees having balanced representation. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities 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.

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NFPA 121

Standard on Fire Protection for

Self-Propelled and Mobile Surface Mining Equipment

1986 Edition

This edition of NFPA 121, *Standard on Fire Protection for Self-Propelled and Mobile Surface Mining Equipment*, was prepared by the Technical Committee on Mining Facilities, and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 18-20, 1985 in Baltimore, Maryland. It was issued by the Standards Council on December 10, 1985, with an effective date of December 30, 1985, and supersedes all previous editions.

The 1986 edition of this standard has been approved by the American National Standards Institute.

Origin and Development of NFPA 121

The Mining Facilities Committee was formed in 1977 to fulfill the need for consensus firesafety for mining. The task of developing the draft of this standard was assigned to the Subcommittee on Surface Mining. It was then submitted to the Technical Committee on Mining Facilities for release to the Association. This standard was revised in 1981 with no significant changes. This latest edition includes a title change to verify that it includes self-propelled mining equipment. In addition it added a provision for a hazard analysis on each piece of mining equipment and includes a complete rewrite.

Technical Committee on Mining Facilities

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

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

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Information on referenced publications can be found in Chapter 3 and Appendix B.

Foreword

Fires adversely impact all types of self-propelled and mobile surface mining equipment including, but not limited to, trucks, front-end loaders, crawlers, drills, shovels, and draglines. Most fires occur on or near engine exhaust systems, high speed drive lines, malfunctioning high pressure - high temperature hydraulic systems, or faulty electrical components.

Total elimination of fire hazards is impossible since sources of ignition and fuel for fires are inherent in the basic equipment design. The fire problem is further complicated by the collection of environmental debris. Therefore, efforts to reduce fire losses must be aimed at fire prevention and fire suppression.

To improve fire protection and prevention on surface mining equipment, some manufacturers of mining equipment have placed emphasis on reduction of fire potential of specific items in the original design of their equipment. Such items include turbo chargers, exhaust manifolds and exhaust pipe shielding and insulation, location of combustible and flammable liquid reservoirs, and hydraulic and fuel line routing.

Most surface mining equipment is required to have at least one hand-portable extinguisher mounted in a readily accessible location. They are most effective when used by trained operators. However, considering the size and configuration of machines found at a mine, fires may be difficult or impossible to fight with a hand-held extinguisher. For this reason, fire suppression systems have been developed to aid in suppressing these hard-to-get-at fires and thereby reduce "off-road" equipment fire losses.

The key to operator protection is early detection of fires to provide a warning to the operator and to suppress the fire during its earliest stages. A fire detection/warning/suppression system may provide these key elements. To be totally effective, however, system operation must be fully understood by owners and operators and provisions must be made for periodic inspection and maintenance.

Fire suppression systems, including hand-portable extinguishers, offer the mining industry a cost-effective tool by which personnel and investments in mining equipment can be protected.

Chapter 1 Introduction

1-1 Scope. This standard covers minimum requirements for safeguarding life and property against fire and related hazards associated with self-propelled and mobile surface mining equipment.

1-2 Purpose. This standard is for use by those charged with mine fire prevention and protection and with the responsibility for purchasing, designing, installing, testing, inspecting, approving, listing, operating, or maintaining both mine fire protection equipment and self-propelled and mobile surface mining equipment.

1-2.1 It may be necessary for those charged with purchasing, testing, approving, and maintaining fire protection equipment for self-propelled and surface mining equipment to consult an experienced fire protection specialist.

1-2.2 Because of the uniqueness of surface mining, provisions in this standard may differ from commonly accepted fire protection standards and guides for other types of occupancies.

1-2.3 Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard, providing technical documentation is submitted to the authority having jurisdiction to demonstrate equivalency and the system, method, or device is approved for the intended purpose.

1-3 Definitions.

Explanation of Definitions. The definitions used in this standard are in accordance with general mining industry usage or dictionary definitions.

Approved. Means "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."

Combustible. Capable of undergoing combustion.

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

Combustion. A chemical process that involves oxidation sufficient to produce light or heat.

Emergency Egress. An egress from a compartment or work station in emergencies when the normal egress is unusable.

Equipment Operator. The authorized person who starts, controls, or stops mining equipment.

Fixed Suppression System. A total flooding or local application system consisting of a fixed supply of extinguishing agent permanently connected to fixed piping with fixed nozzles arranged to discharge an extinguishing agent into an enclosure (total flooding) or directly onto a fire (local application) or a combination of both or an automatic sprinker system.

Flammable. A combustible that is capable of easily being ignited and rapidly consumed by fire. Flammables may be solids, liquids, or gases exhibiting these qualities.

Flammable Liquid. A liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 lb per sq in. (absolute) (2,068 mm Hg) at 100°F (37.8°C) shall be known as a Class I liquid in accordance with NFPA 30, *Flammable and Combustible Liquids Code*.

Flash Point. The minimum temperature at which sufficient vapor is released by a liquid or solid to form an ignitable vapor-air mixture at atmospheric pressure.

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

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.

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.

Mine Operator. Any owner, lessee, or other person who operates, controls, or supervises a mine.

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

Noncombustible. Material that, in the form in which it is used under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. Materials reported as noncombustible when tested in accordance with ASTM E 136, *Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, shall be considered noncombustible materials.

Normal Operation. The regular performance of those functions for which a machine or accessory is designed.

Portable Extinguisher. Extinguishers of the hand-held or wheeled type which are capable of being carried or moved about; or transportable systems consisting of a hose reel or rack, hose, and discharge nozzle assembly connected to a supply of suppressant.

Self-Propelled Equipment. Any unit that contains a motive power train as an integral part of the unit and is not rail mounted.

Shall. Indicates a mandatory requirement.

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

Chapter 2 Fire Protection

2-1 Fire Protection. Fire protection for the purposes of this standard is defined in the broad sense to include fire prevention, fire detection, and fire suppression. The following sections address these three aspects of fire protection within the context of a fire hazards analysis.

2-2 Hazard Analysis.

NOTE: See Appendix A.

2-2.1 A hazard analysis shall be performed on all self-propelled and mobile surface mining equipment. This analysis shall include evaluation of the potential for the start and spread of fire, generation of smoke, gases, or toxic fumes, and explosion which may endanger the lives and safety of personnel or cause damage to property.

2-2.1.1 A separate hazard analysis for each piece of mining equipment is only required when variations in design, use, condition, and environment could change the fire potential.

2-2.2 The analysis shall include an evaluation of:

(1) methods for minimizing or eliminating existing hazardous conditions;

(2) use of detection and early fire warning devices;

(3) normal and emergency means of egress from a workplace;

(4) presence of barriers or enclosures to prevent or contain the spread of fire;

(5) availability of fire fighting personnel and existing fire suppression equipment;

(6) any other devices or procedures necessary to protect life and property; and

(7) use of fire suppression systems and equipment.

NOTE: For additional information see Appendix A.

2-3 Hazard Reduction.

2-3.1 Hazard reduction practices shall follow the principles of minimizing ignition sources and reducing exposure of combustible materials to ignition sources. (*See Appendix A.*)

2-3.2 Housekeeping.

2-3.2.1 Spills, leaks, excess lubricants, and combustible materials such as oil-soaked wastes, rubbish, and accumulations of environmental debris shall not be allowed to accumulate in quantities that could create a fire hazard.

2-3.2.2 Approved metal receptacles shall be provided when oil-soaked wastes or rubbish are not immediately removed to a safe place for disposal.

2-3.2.3 The storage and handling of flammable or combustible liquids on or within equipment shall be in accordance with Section 5-9 of NFPA 30, *Flammable and Combustible Liquids Code*.

2-3.2.4 Access to fire protection equipment on mining equipment shall be kept clear of obstructions.

2-3.3 Welding and Cutting.

2-3.3.1 Cutters, welders, and their supervisors shall be trained in the proper operation of equipment.

2-3.3.2 Cutting and welding equipment shall be maintained in good operating condition with all necessary safeguards in place and functioning.

2-3.3.3 Compressed gases used for cutting and welding on or within the equipment shall be stored in accordance with Chapter 2 of NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting and Allied Processes*.

2-3.3.4 Fully charged and operable fire extinguishers, specifically designed for the class of fire to be expected, shall be available at the work area. Where extinguishant hoselines are available, they shall be connected and ready for service.

2-3.3.5 Combustibles posing a fire hazard shall be relocated or protected with a fire retardant cover or fire retardant barrier. Openings or cracks in walls, partitions, floor decks, or ducts shall be tightly covered to prevent the passage of sparks to adjacent areas.

2-3.3.6 When welding on a metal wall, partition, ceiling, or roof, precautions shall be taken to prevent ignition of combustibles on the other side due to conduction or radiation. Such combustibles shall be relocated or a fire watch shall be provided on the opposite side from the work.

2-3.3.7 When a fire watch is required it shall be maintained for a minimum of 30 minutes after completion of cutting or welding operations to detect and extinguish smoldering combustibles.

(a) The fire watch shall have fire extinguishing equipment readily available and be trained in its use.

(b) Fire watchers shall be familiar with the facilities and the procedures for sounding an alarm in the event of a fire.

2-3.3.8 Welding or cutting on equipment or within enclosed areas of equipment shall not be performed in the presence of atmospheres containing flammable mixtures of gases, vapors or liquids with air, or combustible mixtures of dust in suspension with air.

(a) Welding or cutting shall not be performed on or within containers or tanks located on equipment that have contained combustible or flammable materials until such containers or tanks have been thoroughly purged and cleaned or inerted. (For additional information, see NFPA 327, *Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers*; and American Welding Society A-6.0, *Safety Practices for Welding and Cutting Containers that Have Held Combustibles*).

(b) Welding or cutting on equipment shall not be performed within 50 ft (15.7 m), measured horizontally, of explosives, blasting agents, or mine fuel storage areas.

2-3.4 Inspection and Maintenance. Hydraulic, coolant, lubrication and fuel lines, electrical wiring, and fire prevention devices shall be inspected and maintained in proper condition in accordance with manufacturer's recommendations.

2-3.5 Training. Personnel shall be instructed in the proper emergency procedures to be followed during a fire.

2-4 Fire Detection and Suppression Equipment.

2-4.1 Portable Fire Extinguishers.

2-4.1.1 Portable extinguishers installed on self-propelled and mobile mining equipment shall be listed multipurpose (ABC) dry chemical, having a minimum rating of 2A-10BC and a minimum nominal capacity of 5 lb (2.27 kg) of extinguishing agent. (*For additional information see Appendix A.*)

2-4.1.2 Fire extinguishant applied by hand-portable extinguishers to hazards involving energized electrical equipment shall be nonconductive.

2-4.1.3 Portable extinguishers shall be maintained in a charged and operable condition, and kept in their designated places at all times.

2-4.1.4 Extinguishers shall be conspicuously located and shall be accessible.

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

2-4.1.5 Extinguishers installed under conditions where they may be subject to physical damage shall be guarded to protect against damage.

2-4.1.6 Size and Placement.

(a) All self-propelled surface mining equipment, including but not limited to: dozers, front-end loaders, haulage trucks, cranes, graders, scrapers, draglines, drills, shovels, and movable diesel and electrical equipment, shall be equipped with at least one portable multipurpose (ABC) dry chemical extinguisher.

(b) A hazard analysis shall determine the size, number, and ratings of extinguishers required and whether mobile equipment requires portable extinguishers.

2-4.1.7 The installation of an automatic or manually operated fire suppression system shall not eliminate the portable fire extinguisher requirement.

2-4.1.8 Inspection, Maintenance, and Recharging. Portable fire extinguishers shall be inspected, maintained and recharged as specified in NFPA 10, *Standard for Portable Extinguishers*, Chapter 4, "Inspection, Maintenance, and Recharging," including the following:

(a) Portable fire extinguishers shall be visually inspected at least monthly.

(b) The visual inspection shall ensure that: the extinguisher is in its designated place, the tamper seals are intact, the extinguisher gage is in the operable range (if extinguisher is stored pressure type), and that there is no obvious physical damage or condition that will prevent proper operation.

(c) Extinguishers found to be defective or deficient by visual inspection shall be replaced.

(d) Extinguishers shall be subjected to a maintenance examination at least once every year.

(e) Maintenance procedures shall include a thorough examination of the extinguishers, including mechanical parts, extinguishing agent, and expellant.

(f) Any troubles or impairments shall be corrected by competent personnel.

(g) All extinguishers shall be recharged after use in accordance with the manufacturer's recommendations.

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

2-4.1.9 Portable extinguishers shall be hydrostatically tested at intervals not exceeding those specified in NFPA 10, *Standard for Portable Fire Extinguishers*, Chapter 5, "Hydrostatic Testing."

2-4.2 Fire Detection.

2-4.2.1 Fire detectors may be used to initiate audible or visual warning, automatic actuation of a fire suppression system, or equipment shutdown.

2-4.2.2 Fire detectors shall be tested and listed for the application. (*See Appendix A.*)

2-4.2.3 Compartment sizes and contours, airflow patterns, obstructions, and other characteristics of the protected area shall determine the placement, type, sensitivity, durability and, where applicable, the number of detectors.

2-4.2.4 All fire detection systems and associated equipment shall be tested after installation according to the manufacturer's or designer's manual of instruction. Testing need not require the discharge of any associated fire suppression system.

2-4.2.5 At least every 12 months, all fire detection systems including alarms, shutdowns, and other associated equipment shall be thoroughly examined and checked for proper operation by competent personnel in accordance with the manufacturer's recommendations. Any equipment found deficient shall be repaired or replaced and the system retested for proper operation.

2-4.2.6 Between the regular maintenance examinations or tests, the detection system shall be visually inspected by competent personnel, in accordance with an approved schedule necessitated by conditions as determined by the mine operator.

2-4.3 Fixed Suppression Systems.

2-4.3.1 A hazard analysis (*see Appendix A for suggested procedure*) shall determine whether self-propelled and mobile equipment require a fixed fire suppression system.

2-4.3.2 Mining equipment requiring a fire suppression system shall be protected by a system of sufficient size to suppress potential fires in the protected areas and shall comply with the following:

(a) The fire suppression system shall be approved for the purpose. When installed, the equipment shall be suitably located or guarded so as to be protected against physical damage.

(b) Fire suppression systems shall be either automatically or manually actuated. Automatically actuated systems shall also have a manual actuator capable of being activated from the operator's compartment or other suitable location.

(c) Depending upon the size of the equipment, additional manual actuators may be needed to provide quick access for manual activation of the system.

(d) Agent distribution hose or pipe shall be secured and protected against damage, including abrasion and corrosion.

(e) Discharge nozzles shall be protected against entrance of environmental debris, including moisture, dust, dirt, or insects, by blowoff caps or other similiar devices or materials. The nozzle cover shall open or blow off upon discharge of the system.

Exception: Paragraphs (b), (c), and (e) do not apply to suppression systems using automatic sprinklers.

2-4.3.3 A standby source of power shall be provided where electrical power is the only means of fire suppression system actuation.

2-4.3.4 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 suppressant unless there is no other satisfactory manner in which the reliability and integrity of the system may be verified.

2-4.3.5 An installation-and-maintenance or owners' manual which describes system operation and maintenance requirements shall be provided for all fire suppression equipment.

2-4.3.6 At least every 12 months, all fire suppression systems including alarms, shutdowns, and other associated equipment shall be thoroughly examined and checked for proper operation by competent personnel in accordance with the manufacturer's recommendations. Any equipment found deficient shall be repaired or replaced and the system retested for proper operation. Between the regular maintenance examinations or tests, the system shall be inspected visually by competent personnel, following an approved schedule.

2-4.3.7 Fire suppression systems shall be maintained in proper operating condition at all times. Use, impairment, and restoration of the system shall be reported promptly to the mine operator.

2-4.3.8 All persons who may be expected to inspect, test, maintain, or operate a fire suppression system shall be trained to perform their intended tasks.

2-4.3.9 When inadvertent discharge of the fire suppression system during servicing could result in injury to personnel, provisions shall be made to safeguard against accidental actuation of the system.

2-4.4 Training. All self-propelled and mobile equipment operators, supervisors, and maintenance personnel shall be trained in the proper use of fire suppression equipment.

Chapter 3 Referenced Publications

3-1 The following documents of 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 current as of the date of the NFPA issuance of this document. These references are listed separately to facilitate updating to the latest edition by the user.

3-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 10-1985, *Standard for Portable Fire Extinguishers*

NFPA 30-1984, *Flammable and Combustible Liquids Code*

NFPA 51-1983, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting and Allied Processes*

NFPA 327-1982, *Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers*

3-1.2 ASTM Publication. American Society of Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E 136-1982, *Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*

3-1.3 AWS Publication. American Welding Society (AWS), PO Box 351040, Miami, FL.

AWS A-6.0-1965, *Safety Practices for Welding and Cutting Containers that Have Held Combustibles*

Appendix A Hazard Analysis

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

A-1 Hazard Analysis. A hazard analysis consists of four phases: I. Identify the potential for fire and explosion; II. Assess the consequences of fire and explosion; III. Determine the need for fire protection; and IV. Select appropriate option(s).

The following hazard analysis outline is a suggested procedure to identify the elements in the items defined above.

Additional guidance in performing hazard analyses is provided in several of the reference publications listed in Appendix B.

I. Identify the Potential for Fire and Explosion.

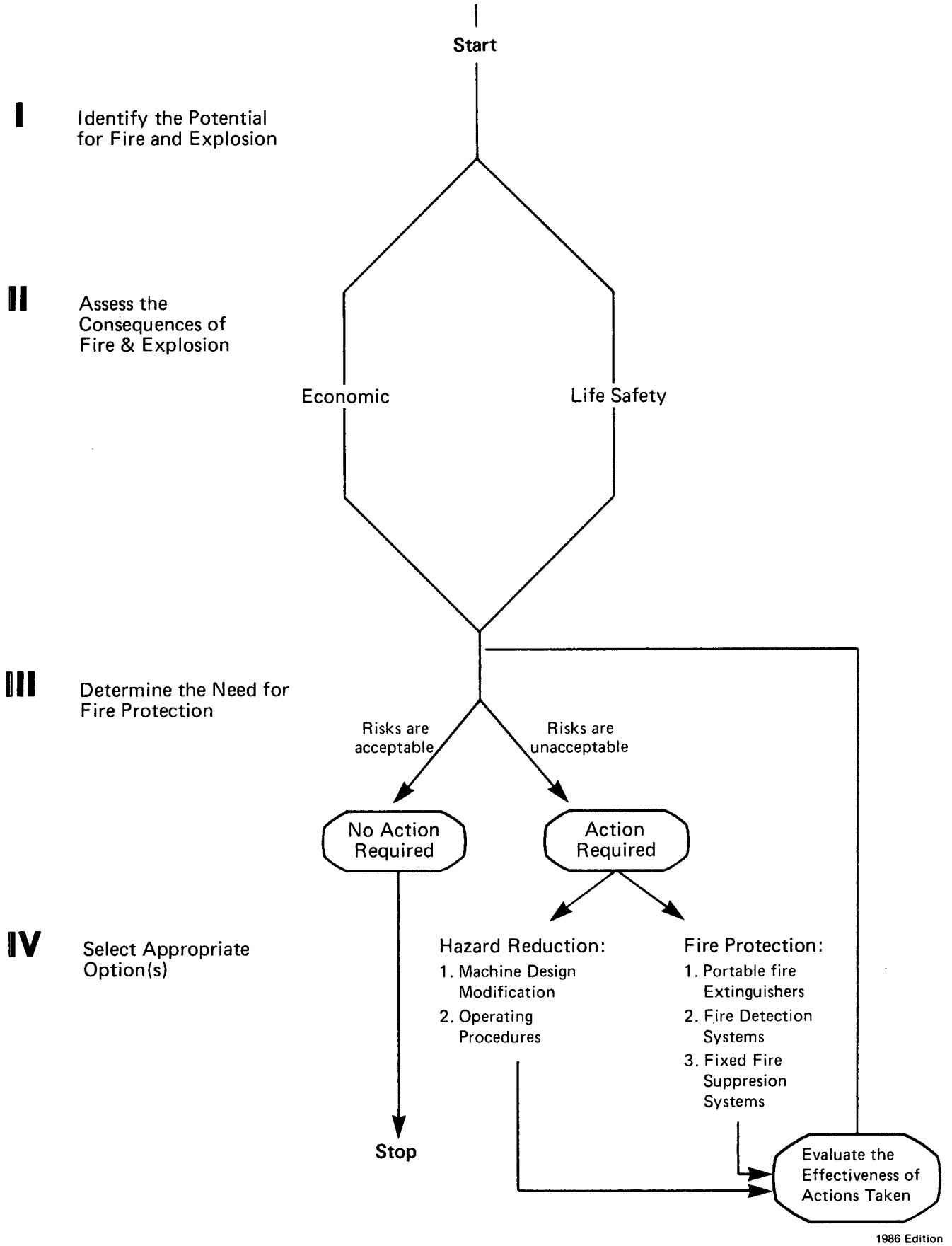
A. Ignition Sources.

1. *High Temperature.* High temperatures are usually found in the vicinity of a vehicle engine, exhaust system, pumps, turbochargers, batteries, wiring, switches, electrical motors, generators, and friction sources such as bearings, brakes, and gears.

2. *Electrical.* Electrical ignition sources include switchgear, motor control centers, circuit breakers, motors and generators, transformers, battery boxes, substations, cable reels, trays, and splices and collector rings.

3. *Welding and Cutting.*

Hazard Analysis



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

B. Fuel Sources.

1. *Class A.* These materials include combustible debris, wood, rags, electrical insulation, coal dust, upholstery, hoses, tires, and seats.

2. *Class B.* This group includes flammable and combustible liquid materials such as gasoline, diesel fuel, liquefied petroleum gas (propane) hydraulic fluids, some coolant combinations, grease, and oil.

3. *Class D.* Some new machines have magnesium transmission components which cannot be extinguished with conventional fire suppression agents.

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

1. *Proximity of Fuel to Ignition Sources.*

(a) *Machine Design.* An analysis should be made of existing areas where lubrication, hydraulic oil, or fuel lines are in proximity to an engine surface or other heat-emitting equipment component. Other areas include equipment articulation points, parking brakes, engine pan area and battery compartments. Areas not to be overlooked on larger equipment include roller path/collector ring areas, electrical switchgear, and transformer compartments. Existing thermal shields, hose routing, electrical harnesses, and their support may affect the potential for fire.

(b) In identifying hazard areas note that a combustible liquid may spray or drip onto a hot surface remote from the rupture or leak point. Likewise, spatter from a battery or an electrical switch short can carry heat to another area of the machine.

(c) Many similarities of equipment design and operation exist among the manufacturers. However, within each of the equipment categories there are variations in configurations which could directly affect the fire potential.

2. *Fire Incident Experience.* Previous fire experience on similar machines should be considered in the fire hazard analysis. Past experience may indicate special hazards exist, such as hydraulic hose that frequently comes loose at a specific connection on the equipment; equipment that has an adverse fire history; or other component failures that increase fire potential.

3. *Quality of Maintenance.*

(a) *Type and Quality of Replacement Parts.* Replacement parts should be at least equal in performance to original parts. Examples are hoses, bearings, fittings, and electrical equipment.

(b) *Frequency.* Maintenance should be performed in accordance with recommendations and schedules supplied by the equipment manufacturer.

4. *Housekeeping.* The presence of accumulations of combustible materials such as oil-soaked waste, fuel spillage, excess lubricant, and coal dust represent potential fire hazards.

II. Assess the Consequences of Fire and Explosion.

A. Personnel Exposure.

1. *Number and Location.* Determine the number of persons involved and their location during routine and maintenance operations.

2. *Hazard Exposure.* Determine the exposure to potential fire and explosion hazards for each person, and whether the fire and smoke could impair safe egress from their work locations.

B. Economic Risks.

1. *Property Damage.* Consider the cost of repairs, replacement, cleanup, and damage to the work site.

2. *Business Interruption.* Items to consider are production loss, personnel overtime, interruption of customer deliveries, and replacement equipment rental.

III. Determine the Need for Fire Protection.

A. Mandatory Requirements. Certain fire prevention and fire suppression requirements are mandated by company policy, insurance companies, and government agencies.

B. Identified Needs. Additional fire precautions beyond those that are mandated may be necessary, as a result of the hazard analysis.

C. Evaluate. If the hazard analysis has disclosed unacceptable personnel risks, economic risks, or both, appropriate fire protection options must be determined. If the risks are found acceptable, no further action is required.

IV. Select Appropriate Option(s).

A. Hazard Reduction.

1. *Machine Design.* Evaluate equipment to determine whether the risk from the start or the spread of a fire, or the risk to personnel from a fire can be reduced. Examples to reduce the start or spread of a fire include physical barriers between fuel sources and ignition sources, thermal shields over hot surfaces, hose and wiring harness routing, support, and protection, and power shutoffs. Examples of reducing the threat of fire to personnel include emergency egress provisions and relocating or shielding potential fire hazards.

2. *Operating Programs and Procedures.* Mine operators, through implementation of policies and procedures, can reduce the threat of fire and explosion. Examples include effective equipment maintenance programs, adequate housekeeping procedures, proper employee training, and development of emergency plans and strategies that deal with fire and explosion hazards. Such emergency plans may include use of company fire brigades and other available equipment such as fire trucks and water wagons, and the response of local fire departments.

3. *Evaluate.* Determine whether hazard reduction reduces risks to acceptable levels. If risks are within acceptable levels no further action is required. If unacceptable risks still exist then further action is required to either further reduce hazards or to install fire detection/suppression equipment or a combination of both.

B. Fire Detection and Suppression Equipment.

Note: A more detailed discussion of fire suppression and detection equipment can be found in the references in Appendix B and NFPA 10, *Standard for Portable Fire Extinguishers.*

1. *Identify Available Alternatives.*

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

To handle difficult fires, larger capacity extinguishers which provide more agent, greater range, and longer discharge time are recommended for agent selection [*see V(A)*].

(b) *Detection.* Fire detection devices may be used to provide early warning of fires, actuate a fire suppression system, shut down equipment, and operate other systems such as door closers and exhaust fans. [*For a discussion of detector and control options, selection, and placement, see V(C) and V(D)*].

(c) *Fixed Fire Suppression Systems.* Fixed system protection can be accomplished by local application, total flooding, or a combination of both, or automatic sprinklers. [*For agent selection see V(A). For fixed fire suppression system options see V(B)*].

2. *Compare Capability with Need.* Mandatory requirements and identified needs should be matched with the most cost effective approach to fire detection, fire suppression, or both.

3. *Select Equipment.* The selection of all equipment used for detection and suppression of fires in mining equipment should be based upon consideration of the environment in which the equipment will function and should be tested. Testing should include provisions for determining the adequacy and durability of the equipment and the manufacturer should demonstrate that such tests have been conducted.

4. *Evaluate.* Determine whether hazard reduction results in compliance with mandatory requirements, or reduces risks to acceptable levels, or both. If risks are within acceptable levels no further action is required. If unacceptable risks still exist then further action is required to either further reduce hazards or to install fire detection/suppression equipment or a combination of both.

V. Fire Protection Agents and Equipment.

A. Fire Suppression Agents. The following extinguishants are commonly used in the mining industry:

1. *Class A:* Dry chemicals (ABC) with ammonium phosphate as the basic ingredient.

Foams: protein; fluoroprotein; aqueous film forming; medium and high expansion.

Water.

Water-based antifreeze solution.

Halons.

2. *Class B:* Dry chemicals (BC) with sodium bicarbonate, ammonium phosphate, potassium bicarbonate, urea-based potassium bicarbonate, or potassium chloride as the basic composition.

Foams: protein; fluoroprotein; aqueous film forming foam; medium and high expansion.

Carbon dioxide.

Halons.

Water spray or fog.

Water-based antifreeze solution.

3. *Class C:* Dry chemicals (ABC or BC) with sodium bicarbonate, ammonium phosphate, potassium bicarbonate, urea-based potassium bicarbonate, or potassium chloride as the basic composition.

Carbon dioxide.

Halons.

Fixed water spray.

Water fog.

4. *Class D:* Dry powder agents composed of sodium chloride or graphite with other particulate material added. Inert materials such as dry sand, foundry flux, etc.

B. Method of Application.

1. *Fixed Systems.* The design and layout of fixed fire suppression systems should be based upon the method of application of the fire suppressant to the area to be protected. Methods of delivery include the following:

(a) Local application consisting of a supply of suppressant permanently connected to a distribution system arranged to discharge onto a defined area or space.

(b) Total flooding consisting of a supply of suppressant permanently connected to a distribution system arranged to discharge into an enclosed space.

(c) A combination of (a) and (b) above.

(d) Automatic sprinklers consisting of a supply of suppressant (normally water) permanently connected to a distribution system to discharge the suppressant.

C. Detector Options.

1. Automatic fire detection devices are covered by NFPA 72E, *Standard on Automatic Fire Detectors.* Some fire detectors which are commonly used in self-propelled and mobile mining equipment but are not covered in 72E include:

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

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

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

2. *Fire Detector Placement.* Consideration should be given to the physical configuration of the area to be protected when selecting and locating detectors. A detector's response time is dependent upon its type and proximity to

a fire. For spacing see NFPA 72E, *Standard on Automatic Fire Detectors*.

Other factors to be considered are ambient temperature, climatic conditions, shock and vibration, air contamination, ventilation flows, and maintenance requirements.

D. Control Options.

1. Depending on mining equipment configuration, use, ground speed capability, degree of hazard enclosure, operating personnel locations, and other factors, consideration may be required of system control options such as:

(a) mechanical or electrical shutdown,

(b) discharge time delay,

(c) discharge abort switch,

(d) audible and visual alarms,

(e) pre-discharge alarm, and

(f) detection circuit supervision.

2. Guidance in determining the advisability of providing automatic engine shutdown is provided in SAE J53, *Minimum Performance Criteria for Emergency Steering of Wheeled Earthmoving Construction Machines*.

A-2 Electrical Ignition Hazards.

Self-propelled and mobile surface mining equipment powered by electrical energy are normally supplied through portable electrical power cables carrying high voltage, three-phase, AC power. Existing regulations require that the electrical system be designed to protect personnel by limiting the voltage rise of the machine frame, in the event of a ground fault, to a maximum of 100 volts. Protection on such electrical systems includes:

(a) normal overcurrent protection,

(b) ground fault current limitation (normally to about 15 amperes),

(c) ground fault overcurrent tripping (usually at about 7 to 10 amperes), and

(d) monitoring of continuity of the ground conductor in the trailing cable and instantaneous tripping if continuity is lost.

Electrical systems having these protective features are singularly free of fires as fault current is low and faults are cleared rapidly.

When equipment contains one or more transformers designed and installed to reduce the high voltage supplied through the portable cable to a lower utilization voltage, no requirements for ground fault current limitation or tripping on ground fault interruptors are necessary. All equipment on the machine is effectively frame grounded and there is no risk to personnel due to frame voltage rise.

Alternatively, a ground detection system can be used on an ungrounded utilization voltage system provided the first ground, which would cause an alarm, is found and repaired promptly. Use of a time delay to allow an orderly and safe shutdown of a machine followed by automatic removal of power from the grounded circuit is recommended.

Appendix B Referenced Publications

B-1 The following documents or portions thereof are referenced within this standard for informational purposes only and thus should not be considered part of the recommendations of this document. The edition indicated for each reference is current as of the date of the NFPA issuance of this document. These references are listed separately to facilitate updating to the latest edition by the user.

B-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 11-1983, *Standard for Low Expansion Foam and Combined Agent Systems*

NFPA 11A-1983, *Standard for Medium and High Expansion Foam Systems*

NFPA 12-1985, *Standard on Carbon Dioxide Extinguishing Systems*

NFPA 12A-1985, *Standard on Halon 1301 Fire Extinguishing Systems*

NFPA 12B-1985, *Standard on Halon 1211 Fire Extinguishing Systems*

NFPA 12C-T-1983, *Halon 2402 Fire Extinguishing Systems*

NFPA 13-1985, *Standard for the Installation of Sprinkler Systems*

NFPA 14-1986, *Standard for the Installation of Standpipe and Hose Systems*

NFPA 15-1985, *Standard for Water Spray Fixed Systems for Fire Protection*

NFPA 17-1985, *Standard for Dry Chemical Extinguishing Systems*

NFPA 20-1983, *Standard for the Installation of Centrifugal Fire Pumps*

NFPA 22-1984, *Standard for Water Tanks for Private Fire Protection*

NFPA 51B-1984, *Standard for Fire Prevention in Use of Cutting and Welding Processes*

NFPA 69-1978, *Standard on Explosion Prevention Systems*

NFPA 70-1984, *National Electrical Code®*

NFPA 72E-1984, *Standard on Automatic Fire Detectors*

NFPA 231-1985, *Standard for General Storage*

NFPA 231C-1986, *Standard for Rack Storage of Materials*

NFPA 327-1982, *Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers*

NFPA 385-1985, *Standard for Tank Vehicles for Flammable and Combustible Liquids*

NFPA 1962-1979, *Standard for the Care, Use, and Maintenance of Fire Hose Including Connections and Nozzles*

NFPA 1963-1985, *Standard for Screw Threads and Gaskets for Fire Hose Connections*

Fire Protection Guide on Hazardous Materials, 8th Edition, NFPA, 1984

Fire Protection Handbook, 15th Edition, NFPA, 1981

B-1.2 Other Publications.

B-1.2.1 ANSI Publications. American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018.

ANSI A92.2-1979, *Vehicle-Mounted Elevating and Rotating Aerial Devices*

ANSI A92.3-1980, *Elevating Work Platforms, Manually Propelled*

ANSI B30.5-1982, *Mobil and Locomotive Cranes*

ANSI 505-1982, *Powered Industrial Trucks* (NFPA 505-1981)

ANSI 583-1977, *Battery Powered Trucks* (UL 583-1977)

B-1.2.2 IEEE Publication. Institute of Electrical and Electronic and Engineers, Inc. (IEEE), 345 East 47th Street, New York, NY, 10017.

IEEE Standard 446-1980, *Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications*

B-1.2.3 SAE Publications. Society of Automotive Engineers (SAE), 400 Commonwealth Drive, Warrendale, PA 15096.

SAE J53-1978, *Minimum Performance Criteria for Emergency Steering of Wheeled Earthmoving Construction Machines, Recommended Practice*

SAE J185-1981, *Access Systems for Off-Road Machines, Recommended Practice*

SAE J833A USA, *Male and Female Physical Dimensions for Construction and Industrial Equipment*, 1980

SAE J925-1965, *Minimum Access Dimensions for Construction and Industrial Equipment*

B-1.3 Additional References.

B-1.3.1 SAE Publications. The following reports are available from the Society of Automotive Engineers, Inc. (SAE), 400 Commonwealth Drive, Warrendale, PA 15096.

deLime, T. L., "Improved Fire Protection for Off-Highway Equipment" Society of Automotive Engineers Off-Highway Vehicle Meeting, Milwaukee, Sept. 1979, SAE 790882

Jewett, J., "Fire Suppression Systems" Society of Automotive Engineers Off-Highway Vehicle Meeting, Milwaukee, Sept. 1979, SAE 790779

Johnson, G.A., "Improved Fire Protection Systems for Surface Coal Equipment" Society of Automotive Engineers Off-Highway Vehicle Meeting. Sept. 1977, SAE 770744

Pomroy, W. H., "Improved Automatic Fire Protection Systems for Off-Highway Mine Vehicles" Society of Automotive Engineers Off-Highway Vehicle Meeting, Milwaukee, Sept. 1979, SAE 790880

B-1.3.2 U.S. Department of Interior Bureau of Mines Publications. The following Bureau of Mines reports are available for Open File (OFR) inspection at Bureau of Mines facilities in Denver, CO; Pittsburgh, PA; Spokane, WA: Minneapolis, MN; and Washington, DC. They may also be obtained directly from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22151.

Baker, R. M., "An Annotated Bibliography of Metal and Nonmetal Mine Fire Reports," 1980. U.S. BuMines OFR 68 (1)-(3)-81. NTIS PB 81-223711

*Kasten, A. E., "Develop and Test an Automatic Fire Control System for Surface Mining Machinery, Volume I, Systems Development," 1977. U.S. BuMines OFR 119-78. NTIS PB 293 983

Lease, W., "Development and Testing of a Fire Protection System for Coal Augers," 1975. U.S. BuMines OFR 25-76. NTIS PB 249-865

Lease, W., "Development, Installation, and Testing Services for an Automatic, Point-Type Thermal Sensor Fire Protection System on a Mining Dozer," 1976. U.S. BuMines OFR 71-77. NTIS PB 266075/AS

*Lease, W. D., "Development of an Automatic Fire Protection System for Surface Vehicles," 1981. U.S. BuMines OFR 73-82. NTIS PB 82-215765

*McDonald, L.A., "Development and Test of an Automatic Fire Control System for Surface Mining Machinery, Volume II, Reliability Testing," 1981

*McDonald, L.A., "Improved Fire Protection System for AN-FO Haulers and Loaders," 1982. U.S. BuMines OFR 46-83

*Stevens, R. B., "Improved Sensors and Fire Control System for Mining Equipment," 1972. U.S. BuMines OFR 25 (1)-(2)-74. NTIS PB 232405 and NTIS PB 232406

Stevens, R. B., "Automatic Fire Sensing and Suppression System for Mobile Mining Equipment," 1978. U.S. BuMines OFR 34-79. NTIS PB 294 731.

The following Bureau of Mines reports are available for the Section of Publications, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh, PA 15213

Johnson, G. A., "Automatic Fire Protection Systems for Large Haulage Vehicles; Prototype Development and In-Mine Testing," 1978. U.S. BuMines IC 8683

*Pomroy, W. H., "Automatic Fire Protection Systems for Surface Mining Equipment," 1980. U.S. BuMines IC 8832

Pomroy, W. H., "A Statistical Analysis of Coal Mine Fire Incidents in the United States from 1950 to 1977," 1980. U.S. BuMines IC 8830

*Pomroy, W. H., "Economic Analysis of Surface Mining Mobile Equipment Fire Protection Systems," 1982. U.S. BuMines RI 8698

U.S. BuMines Mining Research Staff, "Metal Mine Fire Protection Research," 1977, BuMines IC 8752

U.S. Mines Technology News No. 27, 1976, "Automatic Fire Protection for Surface Coal Augers"

U.S. BuMines Technology News No. 50, 1978, "Bulldozer Fire Protection"

Note: Publications marked with an asterisk provide information on hazard analysis.

U.S. BuMines Technology News No. 70, 1979, "Fire Protection for Blasthole Drill"

U.S. BuMines Technology News No. 74, 1979, "Fire Protection for Front-End Loaders"

U.S. BuMines Technology News No. 77, 1980, "Loading Shovel Fire Protection"

U.S. BuMines Technology New No. 78, 1980, "Fire Protection for Hydraulic Excavators"

U.S. BuMines Technology News No. 79, 1980, "Automatic Fire Protection for Mining Trucks"

U.S. BuMines Technology News No. 106, 1981, "Dragline Fire Protection"

U.S. BuMines Technology News No. 107, 1981, "An-Fo Hauler Fire Protection"

Jenson, R., ed., "Fire Protection for the Design Professional," 1975. Cahners Books, A Division of Cahners Publishing Co., Inc., 89 Franklin Street, Boston, MA 02110

Accident Prevention Manual for Industrial Operations. National Safety Council, 425 North Michigan Avenue, Chicago, IL 60611.

SUBMITTING PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

Contact NFPA Standards Administration for final date for receipt of proposals on a specific document.

INSTRUCTIONS

Please use the forms which follow for submitting proposed amendments. Use a separate form for each proposal.

1. For each document on which you are proposing amendment indicate:
   (a) The number and title of the document
   (b) The specific section or paragraph.

2. Check the box indicating whether or not this proposal recommends new text, revised text, or to delete text.

3. In the space identified as "Proposal" include the wording you propose as new or revised text, or indicate if you wish to delete text.

4. In the space titled "Statement of Problem and Substantiation for Proposal" state the problem which will be resolved by your recommendation and give the specific reason for your proposal including copies of tests, research papers, fire experience, etc. If a statement is more than 200 words in length, the technical committee is authorized to abstract it for the Technical Committee Report.

5. Check the box indicating whether or not this proposal is original material, and if it is not, indicate source.

6. If supplementary material (photographs, diagrams, reports, etc.) is included, you may be required to submit sufficient copies for all members and alternates of the technical committee.

NOTE: The NFPA Regulations Governing Committee Projects in Paragraph 10-10 state: Each proposal shall be submitted to the Council Secretary and shall include:

(a) identification of the submitter and his affiliation (Committee, organization, company) where appropriate, and

(b) identification of the document, paragraph of the document to which the proposal is directed, and

(c) a statement of the problem and substantiation for the proposal, and

(d) proposed text of proposal, including the wording to be added, revised (and how revised), or deleted.