NFPA 121
Standard on Fire Protection for Self-Propelled and Mobile Surface Mining Equipment

1996 Edition

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

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Standard on Fire Protection for

Self-Propelled and Mobile Surface Mining Equipment

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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 13-15, 1995, in Chicago, IL. It was issued by the Standards Council on January 12, 1996, with an effective date of February 2, 1996, and supersedes all previous editions.

This edition of NFPA 121 was approved as an American National Standard on February 2, 1996.

Origin and Development of NFPA 121

The Mining Facilities Committee was formed in 1977 to fulfill the need for consensus fire safety for mining. The task of developing the draft of this standard was assigned to the Subcommittee on Surface Mining. It was submitted to the Technical Committee on Mining Facilities for release to the Association and was issued in 1981 as a first edition. The next edition followed in 1986 and included 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. The 1990 edition includes a variety of minor changes, including the replacement of the term "hazard analysis" with "fire risk assessment" throughout the document. This edition of the standard is a reconfirmed version of the 1990 edition with editorial corrections and changes to conform to the NFPA *Manual of Style*.

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

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

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

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

FOREWORD

Fires adversely affect 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 the reduction of the 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. Extinguishers are most effective where used by trained operators. However, considering the size and configuration of machines found at a mine, fires can 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, fuel shut-off to minimize fuel for the fire, and fire suppression during its earliest stages. Specialized systems to perform these functions can be required to protect the operator and the machines. 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 the use of 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 At times it will 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 can 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. The definitions used in this standard are in accordance with general mining industry usage or dictionary definitions.

Approved.* Acceptable to the authority having jurisdiction.

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

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.

Fire Risk Assessment. 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.

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 sprinkler 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 ignitible vapor-air mixture at atmospheric pressure.

Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Listed.* Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets identified standards or has been tested and found suitable for a specified purpose.

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 that 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 risk assessment.

2-2 Fire Risk Assessment. (*See Appendix B.*)

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

2-2.1.1 A separate fire risk assessment 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 assessment shall include an evaluation of:

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

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

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

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

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

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

(g) use of fire suppression systems and equipment.

(*For additional information, see Appendix B.*)

2-3 Risk Reduction. Risk reduction practices shall follow the principles of minimizing ignition sources and reducing exposure of combustible materials to ignition sources. (*See Appendix B.*)

2-3.1 Housekeeping.

2-3.1.1 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.

2-3.1.2 Approved metal receptacles shall be provided where oil-soaked wastes or rubbish are not immediately removed to a safe place for disposal.

2-3.1.3 The storage and handling of flammable or combustible liquids on or within equipment shall be in accordance with Section 4-5 of NFPA 30, *Flammable and Combustible Liquids Code.*

2-3.1.4 Access to fire protection equipment on mining equipment shall be kept clear of obstructions.

2-3.2 Welding and Cutting.

2-3.2.1 Cutters, welders, and their supervisors shall be trained in the proper operation of equipment.

2-3.2.2 Cutting and welding equipment shall be maintained in good operating condition with all necessary safeguards in place and functioning.

2-3.2.3 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.*

2-3.2.4 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.

2-3.2.5 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.

2-3.2.6 Where 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.

2-3.2.7 Where 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.

2-3.2.8 The fire watch shall have fire extinguishing equipment readily available and be trained in its use.

2-3.2.9 Fire watchers shall be familiar with the facilities and the procedures for sounding an alarm in the event of a fire.

2-3.2.10 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.

2-3.2.11* 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.

2-3.2.12 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.

2-3.3 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.

2-3.4 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 B.*)

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 shall be 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 can be subject to physical damage shall be guarded to protect against damage.

2-4.1.6 Size and Placement. All self-propelled surface mining equipment, including but not limited to: bulldozers, 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.

2-4.1.7 A fire risk assessment shall determine the size, number, and ratings of extinguishers required and whether mobile equipment requires portable extinguishers.

2-4.1.8 The installation of an automatic or manually operated fire suppression system shall not eliminate the portable fire extinguisher requirement.

2-4.1.9 Inspection, Maintenance, and Recharging. 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:

(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 gauge 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 can indicate if recharging was also performed.

2-4.1.10 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 shall be permitted to 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 B.*)

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 in accordance with the appropriate NFPA signaling systems standard and fire suppression systems standards. It shall not be necessary for testing to 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 fire risk assessment (*see Appendix B for suggested procedure*) shall determine whether self-propelled and mobile equipment shall 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. Where 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 ground level manual actuators could 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 similar devices or materials. The nozzle cover shall open or blow off upon discharge of the system.

Exception: Paragraphs (b), (c), and (e) shall 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 shall not need to require the discharge of suppressant unless there is no other satisfactory manner in which the reliability and integrity of the system can be verified.

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

2-4.3.6 In accordance with manufacturer's or designer's recommended inspection and maintenance procedures and schedules, but not to exceed 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. 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, in accordance with the manufacturer's or designer's recommended schedule. Testing shall be in accordance with the appropriate NFPA standard.

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 can be expected to inspect, test, maintain, or operate a fire suppression system shall be trained to perform their intended tasks.

2-4.3.9 Where 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 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.

3-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10, *Standard for Portable Fire Extinguishers*, 1994 edition.
NFPA 30, *Flammable and Combustible Liquids Code*, 1993 edition.
NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*, 1992 edition.

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

ASTM E136, *Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, 1994.

Appendix A Explanatory Material

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

A-1-3 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of

such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations that is in a position to determine compliance with appropriate standards for the current production of listed items.

A-1-3 Authority Having Jurisdiction. The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A-1-3 Listed. 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.

A-2-3.2.11 For additional information, see NFPA 327, *Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers Without Entry*; and American Welding Society A-6.0, *Safety Practices for Welding and Cutting Containers that Have Held Combustibles.*

Appendix B Fire Risk Assessment

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

B-1 Fire Risk Assessment. A fire risk assessment 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 fire risk assessment outline is a suggested procedure to identify the elements in the items defined above.

Additional guidance in performing fire risk assessments is provided in several of the reference publications listed in Appendix C.

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.

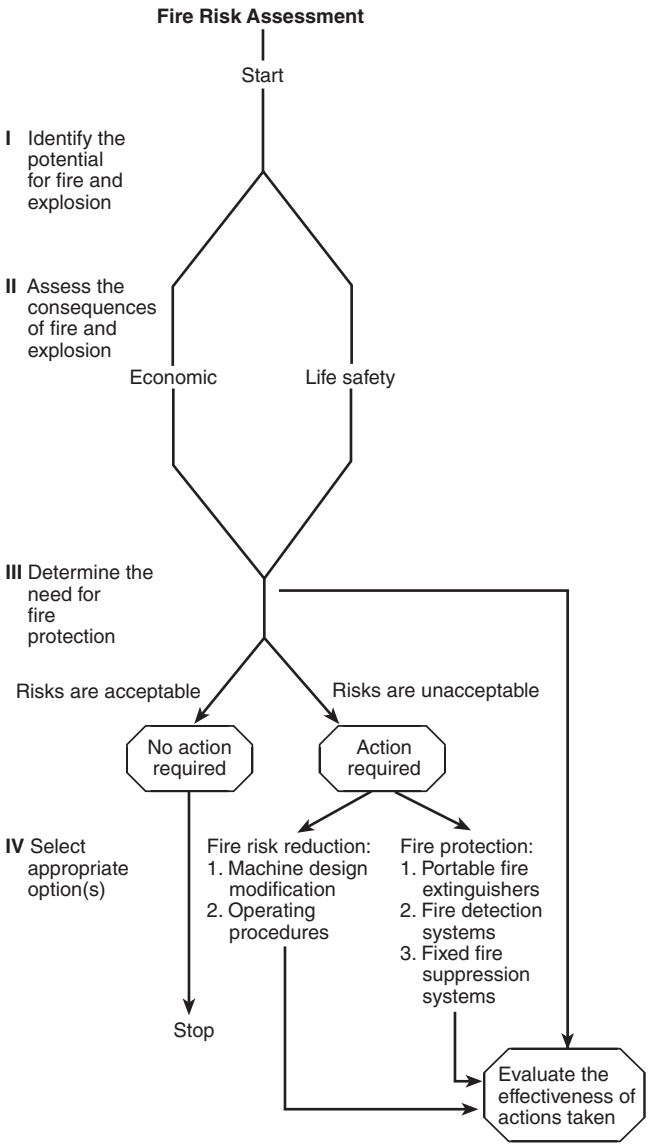

Figure B-1 Fire risk assessment chart.

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.*

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 that cannot be extinguished with conventional fire suppression agents.

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

1. *Proximity of Fuel to Ignition Sources.*

(a) *Machine Design.* An assessment 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 can influence the potential for fire.

(b) In identifying risk areas note that a combustible liquid can 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 that could directly influence the fire potential.

2. *Fire Incident Experience.* Previous fire experience on similar machines should be considered in the fire risk assessment. Past experience can indicate that 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. *Risk Exposure.* Determine the exposure to potential fire and explosion risks 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 might prove to be necessary, after the fire risk assessment.

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

IV. Select Appropriate Option(s).

A. Risk 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 concerning how 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 for 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 can 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 risk 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 either to 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 C 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 that provide more agent, greater range, and longer discharge time are recommended for agent selection [*see V(1)*].

(b) *Detection.* Fire detection devices can 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(3) and V(4).*]

(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(1). For fixed fire suppression system options, see V(2).*]

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 where 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 risk 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.

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

(a) *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.

(b) *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.

(c) *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.

(d) *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.

2. Method of Application.

(a) *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:

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

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

(iii) A combination of (i) and (ii) above.

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

3. Detector Options.

(a) Automatic fire detection devices are covered by NFPA 72, *National Fire Alarm Code.* Some fire detectors that are commonly used in self-propelled and mobile mining equipment but are not covered in NFPA 72 include:

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

(ii) *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.

(iii) *Metal Hydride.* A line-type device with a sensing element consisting of a thin metal tube containing a hydrogen-charged metal hydride wire. The tube is sealed at one end and is connected to a 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.

(b) *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 72, *National Fire Alarm Code.*

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

4. Control Options.

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

(i) mechanical or electrical shutdown,

(ii) discharge time delay,

(iii) discharge abort switch,

(iv) audible and visual alarms,

(v) pre-discharge alarm, and

(vi) detection circuit supervision.