NFPA

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FIRE PROTECTION FOR MOBILE SURFACE MINING EQUIPMENT 1981

NATIONAL FIRE PROTECTION ASSN.
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Standard on Fire Protection for
Mobile Surface Mining Equipment

NFPA 121-1981

1981 Edition of NFPA 121

This edition of NFPA 121, *Standard on Fire Protection for Mobile Surface Mining Equipment*, was prepared by the Technical Committee on Mining Facilities and acted on by the National Fire Protection Association, Inc. on May 19, 1981 at its Annual Meeting in Dallas, Texas. It was issued by the Standards Council with an effective date of July 29, 1981.

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 then submitted to the Committee on Mining Facilities for release to the Association.

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Standard on Fire Protection for
Mobile Surface Mining Equipment

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

Information on referenced publications can be found in Appendix B.

Chapter 1 Introduction

1-1 Scope. This standard covers minimum requirements for safeguarding life and property against fire and related hazards associated with surface self-propelled mobile mining equipment. Portable mining equipment is not treated in this standard.

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 mobile surface mining equipment.

1-2.1 Only those skilled in fire protection are competent to design and supervise the installation of mine fire protection equipment.

NOTE: It may be necessary for those charged with purchasing, testing, approving, and maintaining fire protection equipment for mobile mining equipment to consult an experienced fire protection specialist.

1-2.2 Where the fire hazard has little bearing on personnel safety, property fire protection shall be commensurate with the magnitude of the potential loss.

1-3* 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."

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.

Mobile Mining Equipment. Off-highway mining equipment that is self-propelled and in use.

Portable Mining Equipment. Mining equipment that may be moved frequently, is constructed or mounted to facilitate such movement, but is not self-propelled.

Shall. Indicates a mandatory requirement.

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

1-4 New Technologies. Nothing in this document is intended to restrict new technologies or alternative arrangements, providing the level of safety or protection or both prescribed by this standard is not lowered.

Chapter 2 General Information

2-1 Classes of Fire. Class of fire refers to the nature of the fuel involved, or, in the case of Class C fires, the presence of energized electrical conductors. Fires are classifed as follows:

Class A: Fires involving ordinary combustible materials such as wood, cloth, rubber, and many plastics.

Class B: Fires involving flammable or combustible liquids, flammable gasses, greases, and similar materials.

Class C: Fires involving energized electrical equipment.

Class D: Fires involving certain combustible metals, such as magnesium, titanium, sodium, potassium, etc.

2-2* Fire Detection.

2-2.1 Three types of detectors are commonly used to sense the presence of fire: heat, smoke, and flame. Heat detectors sense an abnormally high temperature or rate of temperature rise. Heat detectors are generally classified as fixed temperature or rate-of-rise. Smoke detectors sense the presence of visible or invisible particles of combustion. Flame detectors sense the infrared, visible, or ultraviolet light emitted by a fire.

2-2.2* Compartment sizes and contours, air-flow patterns, obstructions, and other characteristics of the protected area shall be taken into account in the placement, type, sensitivity and number of detectors used.

2-2.3 Fire detectors may be used for audible or visual warning, automatic actuation of a fire suppression system, or equipment shutdown.

2-3 Fire Suppression.

2-3.1 Fire Suppressant Agents. There are seven common fire suppressant agents: water (with or without antifreeze additives), dry chemical, dry powder, foam, carbon dioxide, halons, and antifreeze solutions.

2-3.1.1 Water extinguishes a fire by cooling, smothering, diluting, or emulsifying. Additives may be introduced into water to control properties such as freezing point or friction.

2-3.1.2 Dry chemical is composed of tiny particles of various compounds. Smothering, cooling and radiation shielding contribute to its extinguishing efficiency but studies suggest that a chain breaking reaction in the flame may be the principal cause of extinguishment.

2-3.1.3 Dry powder is composed of very small particles of various compounds. It is used on Class D metal fires to absorb heat and remove oxygen from the burning metal.

2-3.1.4 Foam is an aggregate of gas-filled bubbles formed from an aqueous solution. Foam extinguishes a fire by cooling and smothering the fuel. It also prevents reignition by suppressing formation of flammable vapors.

2-3.1.5 Carbon dioxide is a relatively inert, electrically nonconductive gas which extinguishes a fire by reducing the concentrations of oxygen or the gaseous phase or both of the fuel in the air to the point where combustion stops.

2-3.1.6 Halons are a class of vaporizing liquid and liquefied gas-type agents. According to present knowledge, Halons extinguish a fire by inhibiting the chemical reaction of fuel and oxygen.

2-3.1.7 Antifreeze solution is a listed, proprietary product with a Class B rating intended for use in suppression systems. It extinguishes a fire by cooling, dilution, or breaking the combustion chain reaction.

2-3.2 Selection of Suppressant.

2-3.2.1 The selection of the fire suppressant shall take into account the class of fire which can be expected in the area to be protected and any special characteristics of the equipment installed in that area and the expected ambient conditions.

2-3.2.2 The following suppressants are commonly used in mining:

Class A: Dry chemicals of the monoammonium phosphate and diammonium phosphate basic composition.

Foams formed from aqueous base solutions of the protein, fluoroprotein, and synthetically produced types.

Water

Antifreeze solution

Halons

Class B: Dry chemicals of the sodium bicarbonate, monoammonium phosphate, diammonium phosphate, potassium bicarbonate, urea-based potassium bicarbonate, and potassium chloride basic composition.

Foams formed from aqueous base solutions of the protein fluoroprotein, and synthetically produced types.

Carbon dioxide

Halons

Water-spray or fog

Antifreeze solution

Class C: Dry chemicals of the sodium bicarbonate, monoammonium phosphate, diammonium phosphate, potassium bicarbonate, urea-based potassium bicarbonate, and potassium chloride basic composition.

Carbon dioxide

Halons

Fixed water-spray

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.

All Classes: In some cases, fires may be extinguished by burying the involved machine with sand, soil, or other readily available inert material.

2-3.3 Fire Suppression Equipment.

2-3.3.1 All fire suppression equipment shall be listed or approved for the purpose intended.

2-3.3.2 The installation of fire suppression equipment shall consider the method of delivery of the fire suppressant to the area to be protected. Such methods of delivery include the following:

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

(b) *Fixed Systems.*

1. Manually actuated systems which consist of a fixed means of agent distribution and are activated manually; or

2. Automatic systems which consist of a fixed means of agent distribution and are actuated automatically by one or more detectors. Such systems, except automatic sprinkler systems,shall additionally have the capability of being manually actuated.

2-3.3.3 Fire suppression equipment consisting of a fixed installation designed to protect a particular area may include one or more of the following:

(a) Local application system consisting of a sufficient supply of suppressant permanently connected to a distribution system arranged to discharge into a defined area, or space, but not designed for total flooding.

(b) Total flooding system consisting of a sufficient supply of suppressant permanently connected to a distribution system arranged to discharge into and totally flood a specific enclosed space.

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

(d) Automatic sprinkler system consisting of a sufficient supply of suppressant (normally water), permanently connected to a distribution system with sprinklers affixed to selectively discharge the suppressant only to the affected area.

2-3.4 Installation Precautions.

2-3.4.1 Fire suppression means applied to hazards involving energized electrical equipment shall be safe in the act of utilization. Portable means of fire suppression shall be of the nonconductive suppressant type (Class C). Portable means of fire suppression of other types shall not be present to prevent their inadvertent use.

2-3.4.2 Where operation of the fire suppression system could result in injury, provision shall be made to prevent inadvertent actuation of the system.

2-3.4.3 Particular attention shall be paid to locating fire suppression equipment so that the environmental restrictions such as temperature or moisture of the listing or approval of the equipment is strictly adhered to.

Chapter 3 Fire Protection Requirements

3-1 General Requirements and Recommendations.

3-1.1* A hazard analysis shall be performed on each piece of mobile surface mining equipment. This analysis shall start with the evaluation of the relative danger of the start and spread of fire, generation of smoke, gasses or toxic fumes, or the possibility of explosion or other occurrence endangering the lives and safety of personnel or causing significant damage to property.

3-1.2 The analysis shall then include an identification of the means available for eliminating existing hazardous conditions, detecting and giving an early warning of fire, normal or emergency means of egress from a workplace to escape a fire situation, presence of barriers or enclosures to prevent or contain the spread of fire, availability of fire fighting personnel or provision of fire fighting and fire suppression equipment, and any other procedures necessary to protect life and property.

NOTE: Any one of these means of protection may be adequate, although in many cases a combination of these means is necessary.

3-1.3 All mobile equipment shall be equipped with portable means of fire suppression. Such means shall be readily accessible and immediately available in the event of fire. Such means shall additionally be securely mounted to minimize mechanical damage and sealed or secured to discourage tampering. The installation of manual or automatic systems for a specific hazard shall not eliminate the need for portable protection.

3-1.4 All fire detection and fire suppression equipment shall be periodically inspected, maintained and tested according to manufacturers' recommendations. Appropriate inspection records shall be maintained.

3-1.5 The following methods of fire protection shall be considered:

3-1.5.1 Detection and Early Warning. When the presence of fire cannot be readily detected by the operator because of equipment configuration, a fire detection and warning system shall be provided.

3-1.5.2 Fixed Fire Protection. Where a fire hazard area is sufficiently enclosed or inaccessible, or where a fire could develop so rapidly as to prevent adequate fire fighting and suppression by portable means, a fixed fire suppression system shall be installed. Where a fixed fire suppression system is required the system shall be activated by automatic means if one or both of the following conditions exist:

(a) The fire hazard is such that the fire is expected to occur when the equipment is unattended.

(b) The equipment is attended but where personnel may be unable to activate the system, because the fire blocks egress and a manual actuator is not readily accessible.

3-1.5.3 All fire detection and fire suppression equipment and systems shall be tested after installation according to the manufacturer's or designer's instructions. Testing need not require the discharge of suppressant.

3-1.5.4 A backup source of power shall be provided where electrical power is the sole means of suppression system actuation.

3-1.5.5 The authority having jurisdiction shall determine when a detection system requires backup electrical power.

3-1.6 Location of Extinguishers and Manual Actuators. Due to the extreme environment and rugged operating conditions in which most mobile mining equipment must operate, compliance with the usual extinguisher and manual actuator station location requirements detailed in other NFPA standards may not be practical or safe. Location of extinguishers and manual actuator stations shall be appropriate to each application protected against physical damage and accessible. Consideration shall be given to multiple locations on larger machines to permit utilization from both normal operator locations and ground level.

3-1.7 Housekeeping.

3-1.7.1 Combustible materials such as oil-soaked wastes, rubbish, etc. shall not be allowed to accumulate in any area or in any manner so as to create a fire hazard.

3-1.7.2 Access routes on equipment shall be kept clear of obstructions to permit ready access to and use of fire protection equipment.

3-1.7.3 Equipment shall be reasonably clear and free of excessive lubricant accumulations which significantly increase the fire hazard. Only approved water solutions or detergents, sweeping compounds and grease absorbents shall be used for cleaning. Certain areas which cannot be kept clean of excessive amounts of lubricants shall be protected with a fire suppression system.

3-1.7.4 Where space permits, approved metal receptacles shall be provided for the storage of oil-soaked wastes or combustible rubbish until removed to a safe place for disposal.

3-1.7.5 The storage and handling of flammable and/or combustible liquids shall be in accordance with applicable portions of NFPA 30, *Flammable and Combustible Liquids Code*.

3-1.8 Training and Organization.

3-1.8.1 All mobile mining equipment operators, supervisors, maintenance personnel, and other individuals exposed to mobile mining equipment fire hazards shall be trained in the proper use of hand portable extinguishers and any other fire protection equipment provided. Personnel shall also be instructed in the proper emergency procedures to be followed during a fire.

3-1.8.2 Every property shall provide a pre-fire plan to deal with fires and related emergencies. The potential magnitude of fires and the availability and suitability of public fire department assistance shall be evaluated to determine the extent of the organization to be provided, if any.

3-1.8.3 If a private fire brigade is required, provisions of NFPA 27, *Recommendations for Organization, Training, and Equipment of Private Fire Brigades*, shall be followed.

3-2 Special Requirements.

3-2.1 Normally Unattended Areas. When a fire can be expected to occur in an area not normally under observation and could develop to the point where it would expose attended areas to a hazard, a fire detection system connected to a warning system in a normally occupied area shall be provided for early warning of a fire.

3-2.2 When an area is enclosed and locked, provisions shall be made for the safe and sequential de-energizing of electrical equipment involved in a fire.

3-2.3 Welding and Cutting.

3-2.3.1 Management shall be responsible for the safe usage of cutting and welding equipment on its property. Cutters or welders and

their supervisors shall be suitably trained in the safe operation of their equipment, and emergency procedures in the event of a fire. The individual responsible for cutting and welding operations shall be aware of the fire hazards involved.

3-2.3.2 Cutting and welding equipment to be used shall be in satisfactory operating condition and in good repair.

3-2.3.3 Compressed gasses shall be stored in accordance with Chapter 2 of NFPA 51, *Standard for the Installation and Operation of Oxygen Fuel Gas Systems for Welding and Cutting.*

3-2.3.4 Fully charged and operable fire extinguishers, appropriate for the class of fire to be expected, shall be available at the work area. Where hose lines are available, they shall be connected and ready for service.

3-2.3.5 All combustibles 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.

3-2.3.6 If welding is to be done 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, by relocating combustibles. Where combustibles cannot be relocated, a fire watch on the opposite side from the work shall be provided.

3-2.3.7 Welding shall not be performed in the presence of explosive atmospheres (mixtures of flammable gasses, vapors, liquids, or dusts with air), or explosive atmospheres that may develop inside uncleaned or improperly prepared drums, tanks, or other containers, and equipment which previously contained such materials, or that may develop in areas with an accumulation of combustible dusts. (*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.*)

3-2.3.8 Where automatic sprinkler protection is installed in the cutting or welding site, it shall be maintained in service, if possible, while the work is being done.

3-2.3.9 Sparks from burning or welding shall be contained and not permitted to contact operating (moving) conveyor belts that could carry the sparks to combustible materials.

3-2.3.10 A fire watch shall be required whenever cutting or welding is performed in locations where the fire hazard warrants.

3-2.3.11 When a fire watch is required it shall be maintained for at least a half hour after completion of cutting or welding operations to detect and extinguish possible smoldering fires. Fire watchers shall have fire extinguishing equipment readily available and be trained in its use. Fire watchers shall be familiar with facilities and procedures for sounding an alarm in the event of a fire.

3-2.3.12* When welding or cutting is to be performed in locations where the fire hazard warrants, a program of systematic pre-job planning, involving, for example, maintenance, operating, and loss prevention personnel, and use of a welding permit system shall be considered by management.

3-2.4 Inspection and Maintenance. Hydraulic, coolant, lubrication and fuel lines, electrical wiring, and spray shields on mobile surface mining equipment shall be regularly inspected and maintained in safe operating condition in accordance with manufacturer's instructions.

Appendix A

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

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

Combustible is used to refer to a material or structure which can burn. Combustible is a relative term; many materials which will burn under one set of conditions will not burn under others; e.g., structural steel is noncombustible, but fine steel wool is combustible. The term combustible does not usually indicate ease of ignition, burning intensity, or rate of burning, except when modified by a word such as highly, as in highly combustible interior finish.

Combustible liquid is a liquid which has a flash point at or above 100°F.

Fire prevention refers primarily to measures directed towards avoiding the inception of fire. Fire prevention, as used in the standard, is not synonymous with fire protection.

Fireproof has been officially discontinued in NFPA publications as misleading as no material is immune to the effects of fire of sufficient intensity and duration, although fireproof as popularly used is synonymous with fire-resistive as defined here.

Fire load refers to the amount of combustibles present in a given situation, usually expressed in terms of weight of combustible material per square foot. This measure is employed frequently to calculate the degree of fire resistance required to withstand a fire or to judge the rate of application and quantity of extinguishing agent needed to control or extinguish a fire.

Fire protection is used in two senses. The general sense, typified by the use of the term in the National Fire Protection Association name, includes everything related to the prevention, detection, and suppression of fire, reduction of losses and other matters covered in the standard. It covers both the safeguarding of human life and the preservation of property. In its specific sense, fire protection refers to the methods of providing for fire control or fire suppression.

Fire resistance is a relative term, used with a numerical rating or modifying adjective to indicate the extent to which a material or structure resists the effect of fire, e.g., "fire resistance of two hours, as measured on the Standard Time-Temperature Curve."

Fire-resistive refers to properties or designs to resist the effects of any fire to which a material or structure may be expected to be subjected. Fire-resistive materials or assemblies of materials are noncombustible, but noncombustible materials are not necessarily fire-resistive; fire-resistive implies a higher degree of fire resistance than noncombustible.

Fire retardant, in general, denotes a substantially lower degree of fire resistance than fire-resistive and is often used to refer to materials or structures which are combustible in whole or in part, but have been subjected to treatments or have surface coverings to prevent or retard ignition or the spread of fire under the conditions for which they are designed.

Flameproof and flameproofing are misleading terms and their use is discouraged in favor of flame retardant or flame resistant.

Flame retardant refers to materials which, due to chemical treatment or inherent properties, do not ignite readily or propagate flaming under small to moderate exposure. It is the preferable term to denote chemicals, processes, paints, or coatings used for the treatment of such materials as fabrics and similar items. Flame retardant denotes a lower degree of resistance than fire retardant.

Flammable is used to describe a combustible material that ignites very easily, burns intensely, or has a rapid rate of flamespread. Flammable is used in a general sense without reference to specific limits of ignition temperature, rate of burning, or other property. Where exact differentiations are necessary, numerical divisions are made, such as Class I and Class II flammable liquids. Flammable and inflammable are identical in meaning. Flammable is used in preference to inflammable to avoid possible confusion due to the prefix "in," which indicates the negative in many words, e.g., incombustible.

Flammable liquid is a liquid that has a flash point below 100°F and a vapor pressure not exceeding 40 pounds per square inch (absolute) at 100°F.

Hazard (hazardous) is used in different senses. One is to indicate materials of more than average combustibility or materials that are dangerous because of their instability, or toxicity, e.g., cellulose nitrate which is hazardous because of ease of ignition and intensity of burning, or a combustible dust which presents a hazardous condition when in suspension. A second use of hazardous is to describe the overall degree of fire vulnerability of a property, thinking in terms of its fire load. For example, sprinklers require closer spacing in an extra hazard occupancy than in an ordinary hazard occupancy. A third use of hazard is to describe rate of burning, e.g,, wood in the form of shavings is more hazardous than in the form of solid timber. Then,

too, the term hazard is used to describe the nature of the fire problem, e.g., common hazards are ignition sources encountered in almost any class of property (smoking, heating, electrical, etc.), while special hazards are those considered peculiar to an individual piece of mobile equipment, e.g., pressurized flammable fluids.

There is no sharp line of demarcation between common and special hazards as the same potential fire cause may be considered a common hazard in one occupancy and a special hazard in another.

Incombustible has the same meaning as noncombustible, but may be subject to misunderstanding due to the prefix "in" (*see Flammable*); noncombustible is accordingly preferred.

Inflammable. See Flammable.

Mobile mining equipment means mining equipment that is self-propelled.

Noncombustible means not combustible (*see Incombustible*).

Nonflammable means not flammable.

Portable equipment means equipment that may be moved frequently and is constructed or mounted to facilitate such movement.

A-2-2 Fire Detectors.

Types of Detectors.

Line-type Detector. A device in which detection is continuous along a path. Typical examples are rate-of-rise pneumatic tubing detectors, projected beam smoke detectors, and heat sensitive cable.

Spot-type Detector. A device whose detecting element is concentrated at a particular location. Typical examples are bimetallic detectors, fusible alloy detectors, certain pneumatic rate-of-rise detectors, certain smoke detectors and thermoelectric detectors.

Air Sampling-type Detector. A sampling-type detector consists of piping or tubing distribution from the detector unit to the area(s) to be protected. An air pump draws air from the protected area back to the detector through the air sampling ports and piping or tubing. At the detector, the air is analyzed for fire products.

Operating Modes.

Nonrestorable Detector. A device whose sensing element is designed to be destroyed by the process of detecting a fire.

Restorable Detector. A device whose sensing element is not ordinarily destroyed by the process of detecting a fire. Restoration may be manual or automatic.

Self-Restoring Detector. A restorable detector whose sensing element is designed to be returned to normal automatically.

Classification of Fire Detectors.

For the purpose of this standard, automatic fire detectors are classified as listed below:

Heat Detector. A device which detects abnormally high temperature or rate-of-temperature rise.

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

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

Other Detectors. A device which detects a phenomenon other than heat, smoke or flame produced by a fire.

Heat Detectors.

Fixed Temperature Detector. A fixed temperature detector is a device which will respond when its operating element becomes heated to a predetermined level. When a fixed temperature device operates, the temperature of the surrounding air will always be higher than the operating temperature of the device itself. This difference between the operating temperature of the device and the actual air temperature is commonly spoken of as "thermal lag," and is proportional to the rate at which the temperature is rising.

Typical examples of fixed temperature sensing elements are:

(a) *Bimetallic.* A sensing element comprised of two metals having different coefficients of thermal expansion arranged so that the effect will be deflection in one direction when heated and in the opposite direction when cooled.

(b) *Electrical Conductivity.* A sensing element comprised of an electrical resistor whose resistance varies as a function of temperature.

(c) *Fusible Alloy.* A sensing element of a special composition (eutectic) metal which melts rapidly at its rated temperature.

(d) *Heat Sensitive Cable.* A line-type device whose sensing element comprises, in one type, two current-carrying wires held separated by a heat-sensitive insulation which softens at the rated temperature, thus allowing the wires to make electrical contact. In another type, a single wire is centered in a metallic tube and the intervening space filled with a substance which, at a critical temperature, becomes conductive, thus establishing electrical contact between the tube and the wire.

(e) *Liquid Expansion.* A sensing element comprising a liquid capable of marked expansion in volume in response to temperature increase.

(f) *Fusible Plastic Tube.* A sensing element comprising a long plastic tube pressurized with inert gas. Heat from the fire causes the tube to burst, releasing the gas pressure and actuating a mechanical device.

(g) *Thermister Strip.* A line-type device whose sensing element comprises 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.

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

Rate Compensation Detector. A rate compensation detector is a device which will respond when the temperature of the air surrounding the device reaches a predetermined level, regardless of the rate of temperature rise.

Rate-of-Rise Detector. A rate-of-rise detector is a device which will respond when the temperature rises at a rate exceeding a predetermined amount.

Typical examples are:

(a) *Pneumatic Rate-of-Rise Tubing.* A line-type detector comprising small diameter tubing, usually copper. The tubing is terminated in a detector unit, containing diaphragms and associated contacts set to actuate at a predetermined pressure. The system is sealed except for calibrated vents which compensate for normal changes in temperature.

(b) *Spot-type Pneumatic Rate-of-Rise Detector.* A device consisting of an air chamber, diaphragm, contacts and compensating vent in a single enclosure. The principle of operation is the same as that described under (a).

(c) *Thermoelectric Effect Detector.* A device whose sensing element comprises a thermocouple or thermopile unit which produces an increase in electric potential in response to an increase in temperature. This potential is monitored by associated control equipment, and an alarm is initiated when the potential increases at an abnormal rate.

Smoke Detectors.

Ionization Smoke Detection Principle. Smoke detectors utilizing the ionization principle are usually of the spot type. An ionization smoke detector has a small amount of radioactive material which ionizes the air in the sensing chamber, thus rendering it conductive and permitting a current flow through the air between two charged electrodes. This gives the sensing chamber an effective electrical conductance. When smoke particles enter the ionization area, they decrease the conductance of the air by attaching themselves to the ions, causing a reduction in mobility. When the conductance is less than a predetermined level, the detector circuit responds.

Photoelectric Light Obscuration Smoke Detection Principle. Smoke detectors utilizing the photoelectric light obscuration principle consist of a light source which is projected onto a photosensitive device. Smoke particles between the light source and the photosensitive device reduce the light reaching the device, causing the detector to respond.

Projected Beam Smoke Detector. This is a line type obscuration smoke detector, where the light beam is projected across the area to be protected.

Photoelectric Light Scattering Smoke Detection Principle. Smoke detectors utilizing the photoelectric light scattering principle are usually of the spot type. They contain a light source and a photosensitive device so arranged that the light rays do not normally fall onto the photosensitive device. When smoke particles enter the light path, light strikes the particles and is scattered onto the photosensitive device, causing the detector to respond.

Cloud Chamber Smoke Detection Principle. A smoke detector utilizing the cloud chamber smoke detection principle is usually of the sampling-type. An air pump draws a sample of air from the protected areas into a high humidity chamber within the detector. After the air is in the humidity chamber, the pressure is lowered slightly. If smoke particles are present, the moisture in the air condenses on the particles forming a cloud in the chamber. The density of the cloud is then measured by a photoelectric principle. When the density is greater than a predetermined level, the detector responds.

Flame Detectors.

Flame Detector. A device which responds to the appearance of radiant energy visible to the human eye (approximately 4000 to 7700 Angstroms) or to radiant energy outside the range of human vision.

Flame Flicker Detector. A photoelectric flame detector including means to prevent response to visible light unless the observed light is modulated at a frequency characteristic of the flicker of a flame.

Infrared Detector. A device whose sensing element is responsive to radiant energy outside the range of human vision (above approximately 7700 Angstroms).

Photoelectric Flame Detector. A device whose sensing element is a photocell which either changes its electrical conductivity or produces an electrical potential when exposed to radiant energy.

Ultraviolet Detector. A device whose sensing element is responsive to radiant energy outside the range of human vision (below approximately 4000 Angstroms).

Other Detectors.

Combustible Gas Detector. An instrument which samples air and indicates whether there is an explosive mixture present and the percentage of the lower explosive limit of the air/gas mixture that has been reached.

A-2-2.2 Fire Detection Selection and Placement.

Consideration should be given to physical configuration when mounting detectors. A detector will ordinarily operate sooner if it is nearer to the potential source of fire. Spacing will depend on:

(a) Need for rapid response.

(b) Need for small fire response.

(c) Need to accomodate location geometry.

(d) Need to consider air movement and obstruction.

Other factors to be considered are ambient temperatures, climatic conditions, shock and vibration, air contamination, ventilation flows, and maintenance requirements. Operators are encouraged to select detection devices which have been proven in similar applications.

A-3-1.1 Hazard Analysis.

Introduction.

Before fire protection equipment is ordered, an analysis of the fire protection needs of the mobile mining equipment must be made. Such an analysis should begin with an identification of the fire hazards on the machine to be protected. The installed equipment should be selected to protect the hazard areas rather than the entire machine.

A general guide in defining a hazard area is one in which fuel and/or heat exist, or may exist. Fuel includes such materials as fuel oil, gasoline, cleaning solvents, sound suppression materials, lubricants, coolants, upholstery, engine oil, hydraulic fluids, hose, plastics, elec-

trical insulation, fabric, waste, debris, and other combustible materials. Heat is usually found around the vehicle engine, exhaust system, pumps, turbochargers, batteries, wiring, switches, bearings, brakes and gears. Previous fire experience on similar machines should be considered in the fire hazard analysis. Typical hazard areas on mobile mining equipment are:

Areas where lubrication, hydraulic or fuel lines are close to an engine surface or other heat-emitting vehicle component.
Articulation areas.
Parking brake.
Engine pan area.
Battery compartment.
Roller path/ring areas.
Electrical switch gear.
Transformer compartments.

In identifying hazard areas, note that combustible fluid from a ruptured line may spray or drip onto a hot surface remote from the rupture point. Likewise, spatter from a battery or switch short can carry heat to another area of the machine. Past experience may indicate special hazards, such as a hydraulic hose, which frequently comes loose at a certain connection on the vehicle.

Many similarities of equipment design and operation exist among the manufacturers. However, within each of the equipment categories there are variations in configuration which could directly affect or limit the selection of fire protection equipment for a specific piece of equipment. These variations, typically related to the degree of enclosure integrity or access to a specific area, eliminate the possibility of an agent or agent/detection combination that could be universally applied to all or each of the equipment types.

As part of the hazards analysis, consideration should be made of the machine configuration and the mine environment.

Factors affecting agent selection are suitability, the machinery space enclosure integrity, the degree of human occupancy, and agent residue removal.

Factors pertaining to choice of detection are ambient conditions, location cleanliness, welding maintenance, vibration/shock, temperature variations, and machinery space ventilation.

Each piece of mobile surface mining equipment should be analyzed for fire hazards and the appropriate means of protection identified. Operators are encouraged to select hardware which has been proven in similar applications.

Suggested Hazard Analysis Outline

I. The following factors should be considered in establishing priorities for the design and installation of fire protection equipment on mobile surface mining equipment:
   A. Safety of Personnel.
   B. Value of Equipment.
   C. Application of the Machine.
      (a) Special hazards.
      (b) Key machine in the production process.
   D. Government Regulations.

II. Personnel Safety. The following machine characteristics should be considered:
   A. Personnel station locations relative to potential fire locations.
   B. Personnel station height.
   C. Egress routes past potential fire location.
   D. Potential fire locations not normally observable by operating.
   E. Totally enclosed potential fire locations.
   F. High ground-speed capability.

III. Machine Application. Application considerations which contribute to high fire risk include:
   A. Unavoidable accumulation of combustible materials on the equipment.
   B. High temperature operating environment.
   C. Machine failure mode (*see A-3-1.1*).

IV. Nonproduction Situation. Fire protection should be considered for those periods when the machine may not be in production but in use.
   A. Servicing or maintaining the equipment.
      (a) Fueling.
      (b) Lubricating.
      (c) Welding.
   B. Unattended machine.
      (a) Engine left running for long periods.
      (b) Combustible materials. Combustible materials on the machine after the engine is shut off.

V. Portable Fire Extinguishers.
   A. A minimum 20-lb (0.62-kg) (nominal) capacity is preferred.
   B. Extinguishers are to be operational from -40°C to 50°C.
   C. The fire extinguisher must be located so that it is readily accessible to operating personnel in case of fire.

D. Fire extinguishers should be installed in quick release approved vehicle brackets.

E. Fire extinguishers should be in the same locations on machines of the same type.

F. The fire extinguisher shall be mounted with operating instructions visible.

G. Accessibility from ground level should be considered.

VI. Fire Suppression Systems.

A. Types.
   (a) Local application.
   (b) Total flooding.
   (c) Combination (A & B).
   (d) Sprinkler.
   (e) Other.

B. Actuation.
   (a) Manual.
   (b) Automatic.

C. Fire detection.
   (a) Heat.
      (i) fixed temperature spot.
      (ii) fixed temperature line
      (iii) rate of rise spot.
      (iv) rate of rise line.
   (b) Flame.
      (i) infrared.
      (ii) ultraviolet.
   (c) Smoke.
      (i) ionization.
      (ii) photoelectric.
   (d) Combustible gas.
   (e) Other.

D. Agent.
   (a) BC dry chemical.
   (b) ABC dry chemical.
   (c) Halon 1301.
   (d) Halon 1211.
   (e) Aqueous film forming foam.
   (f) High expansion foam.
   (g) Low expansion foam.
   (h) Carbon dioxide.
   (i) Dry powder.
   (j) Antifreeze solution.
   (k) Water.

E. Personnel warning.

A-3-2.3.12 A suggested welding permit form (may be modified to suit local conditions).

(Front)

PERMIT
FOR CUTTING AND WELDING
WITH PORTABLE GAS OR ARC EQUIPMENT

Date .....

Building.....

Dept..... Floor.....

Work to be done. .....

.....

Special Precautions.....

.....

Is fire watch required?.....

The location where this work is to be done has been examined, necessary precautions taken, and permission is granted for this work. (See other side)

Permit expires.....

Signed.....
(Individual responsible for authorizing welding and cutting)

Time started..... Completed.....

FINAL CHECK-UP

Work area and all adjacent areas to which sparks and heat might have spread (including floors above and below and on opposite sides of walls) were inspected 30 minutes after the work was completed and were found firesafe.

Signed.....
(Supervisor or Fire Watcher)