NFPA 122

Standard for

Fire Prevention and Control in Metal/Nonmetal Mining and

Metal Mineral Processing Facilities

2004 Edition

This edition of NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities*, was prepared by the Technical Committee on Mining Facilities and acted on by NFPA at its May Association Technical Meeting held May 23–26, 2004, in Salt Lake City, UT. It was issued by the Standards Council on July 16, 2004, with an effective date of August 5, 2004, and supersedes all previous editions.

This edition of NFPA 122 was approved as an American National Standard on August 5, 2004.

Origin and Development of NFPA 122

In 1978 the Technical Committee on Mining Facilities, through its membership and current Mine Safety and Health Administration regulations, identified the need for guidance in storage and handling of flammable and combustible liquids in underground nonmetal mines. The first edition of NFPA 122 was approved in 1986 as a result and was titled NFPA 122, *Storage of Flammable and Combustible Liquids Within Underground Metal and Nonmetal Mines (Other than Coal)*. The second edition was issued in 1990 and included a variety of minor editorial changes to provide consistency with the other NFPA Mining Facilities documents.

The 1995 edition was a complete revision that focused the document on the overall fire protection of metal and nonmetal mines, as indicated by the document's new title, NFPA 122, *Standard for Fire Prevention and Control in Underground Metal and Nonmetal Mines*. Furthermore, this edition incorporated the requirements that were previously included in NFPA 124, *Standard for Fire Protection of Diesel Fuel and Diesel Equipment in Underground Mines*, which was withdrawn. Further changes included editorial corrections and revisions that provided consistency with other NFPA mining-related standards.

The 2000 edition of the standard was reconfirmed by the technical committee. There were no technical changes made. The fire risk assessment material in Appendix A was editorially

moved to Appendix B.

In 2004, the Technical Committee reorganized the mining standards and combined NFPA 121, *Standard on Fire Protection for Self-Propelled and Mobile Surface Mining Equipment*, with NFPA 122. The committee also added a new Chapter 13, Fire Protection of Surface Metal Mineral Processing Plants. The committee incorporated the concept of conducting a fire risk assessment throughout the standard.

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

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 Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for mandatory extracts are given in Chapter 2 and those for nonmandatory extracts are given in Annex C. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1* Scope.

1.1.1 This standard covers minimum requirements for safeguarding life and property against fire and related hazards associated with metal and nonmetal underground and surface mining and metal mineral processing plants.

1.1.2 As applies to underground mining, this standard shall cover only the following:

(1) Diesel-powered equipment

(2) Storage and handling of flammable and combustible liquids

1.1.3 As applies to underground mining, this standard shall not cover flammable and combustible liquids produced in underground mines, such as shale oil mines.

1.1.4 As applies to surface mining, this standard shall cover only the following:

(1) Mobile equipment in use without its own motive power train and normally moved by self-propelled equipment

(2) Self-propelled equipment that contains a motive power train as an integral part of the unit and is not rail-mounted

1.1.5 This standard shall not cover buildings or employee housing and support facilities for a mining operation, or preparation or use of explosives.

1.1.6* As applies to metal mineral processing, this standard shall cover fire and related hazards associated with surface metal mineral processing plants including but not limited to conveying, crushing, fine milling, beneficiation, flotation, drying, filtering, ore and concentrate storage, and support facilities for the mineral processing activity.

1.1.7* As applies to surface metal mineral processing plants, this standard shall not cover the following:

(1) Solvent extraction plants

(2) Pressure-leaching processes

(3) Alumina refineries

(4) Nonmetal mineral processing plants

(5) Metal smelters including roasting, sintering, and calcining

(6) Metal refineries such as electrowinning or electro-refining processes

(7) Gas, liquid, or solid waste handling or storage systems

1.1.8 Nothing in this standard is intended to prohibit the use of new methods or devices, provided sufficient technical data are submitted to the authority having jurisdiction to demonstrate that the new method or device is equivalent in quality, effectiveness, durability, and safety to that specified by this standard.

1.2 Purpose.

This standard shall be intended for use by those charged with fire prevention and fire protection or with responsibility for purchasing, designing, installing, testing, inspecting,

approving, listing, operating, or maintaining the following:

(1) Facilities and equipment for the storage and handling of flammable and combustible liquids within underground metal and nonmetal mines

(2) Diesel-powered equipment in underground metal and nonmetal mines, mobile and self-propelled surface mining equipment in metal and nonmetal mines, and metal mineral processing plants

1.3 Application.

Only those skilled in fire protection shall be permitted to design and supervise the installation of fire protection systems.

1.4 Retroactivity.

The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

Chapter 2 Referenced Publications

2.1 General.

The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2002 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam,* 2002 edition.

NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems,* 1999 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems,* 2000 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems,* 2004 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2002 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* 2003 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems,* 2003 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems,* 2002 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* 2002 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2002 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2003 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes,* 2002 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2003 edition.

NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks,* 2003 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2004 edition.

NFPA 70, *National Electrical Code®,* 2005 edition.

NFPA 72®, *National Fire Alarm Code®,* 2002 edition.

NFPA 85, *Boiler and Combustion Systems Hazards Code,* 2004 edition.

NFPA *101®*, *Life Safety Code®,* 2003 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2004 edition.

NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting,* 2001 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems,* 2004 edition.

2.3 Other Publications. (Reserved)

Chapter 3 Definitions

3.1 General.

The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not included, common usage of the terms shall apply.

3.2 NFPA Official Definitions.

3.2.1* **Approved.** Acceptable to the authority having jurisdiction.

3.2.2* **Authority Having Jurisdiction (AHJ).** An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 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.

3.2.4* **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 appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

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

3.2.7 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1 Boiling Point. The temperature at which the vapor pressure of a liquid equals the surrounding atmospheric pressure. For purposes of defining the boiling point, atmospheric pressure shall be considered to be 14.7 psia (760 mm Hg). For mixtures that do not have a constant boiling point, the 20 percent evaporated point of a distillation performed in accordance with ASTM D 86, *Standard Test Method for Distillation of Petroleum Products*, shall be considered to be the boiling point. [**30:**3.3]

3.3.2 Closed Container. A container as herein defined, so sealed by means of a lid or other device that neither liquid nor vapor will escape from it at ordinary temperatures. [**30A:**3.3]

3.3.3 Combustible. Capable of undergoing combustion.

3.3.4 Combustible Liquid Storage Area.

3.3.4.1 ***Large Combustible Liquid Storage Area.*** An area used for storage of Class II and Class III combustible liquids where the aggregate quantity present is greater than 3785 L (1000 gal). Handling of liquids incidental to transfer can take place within a storage area.

3.3.4.2 *Small Combustible Liquid Storage Area.* An area used for storage of Class II and Class III combustible liquids where the aggregate quantity present is from 227 L to 3785 L (60 gal to 1000 gal). Handling of liquids incidental to transfer can take place within a storage area.

3.3.5 Combustion. A chemical process of oxidation that occurs at a rate fast enough to produce heat and usually light in the form of either a glow or flame.

3.3.6 Container. Any vessel of 450 L (119 gal) or less capacity used for transporting or storing liquids. [**30:**3.3]

3.3.7 Cutoff Room. A room within a building and having at least one exterior wall.

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

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

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

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

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

3.3.13 Fixed Diesel Fuel Storage Area. A designated location used to facilitate fuel dispensing for the storage of diesel fuel in containers, tanks, or both, exceeding an aggregate quantity of 2498 L (660 gal), from which tanks or containers are not moved or transported within the mine.

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

3.3.15 Flammable Liquid Storage Area.

3.3.15.1 *Large Flammable Liquid Storage Area.* An area used for storage of Class I liquids where the aggregate quantity present is greater than 37.8 L (10 gal).

3.3.15.2 *Small Flammable Liquid Storage Area.* An area used for storage of Class I liquids where the aggregate quantity present is 37.8 L (10 gal) or less.

3.3.16 Flash Point. The minimum temperature of a liquid at which sufficient vapor is given off to form an ignitable mixture with the air, near the surface of the liquid or within the vessel used, as determined by the appropriate test procedure and apparatus specified in NFPA 30, *Flammable and Combustible Liquids Code*, 1.7.4. [**30:**3.3]

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

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

3.3.19 Hot Work. Any work involving burning, welding, or similar operations that is capable of initiating fires or explosions.

3.3.20 Liquid.

3.3.20.1 ***Combustible Liquid.*** A liquid that has a closed-cup flash point at or above 37.8°C (100°F). [**30:**3.3]

3.3.20.2 ***Flammable Liquid.*** A liquid that has a closed-cup flash point that is below 37.8°C (100°F) and a maximum vapor pressure of 2068 mm Hg (40 psia) at 37.8°C (100°F). [**30:**3.3]

3.3.21 Metal and Nonmetal. Minerals other than coal.

3.3.22 Metal Mineral. Belonging to the class of inorganic metal compounds occurring in the earth's crust that are transformed into pure metals by metallurgical refining, including gold, silver, lead, zinc, nickel, and copper.

3.3.23* **Metal Mineral Processing Plant.** A surface processing facility used to size, separate, and concentrate valuable metals from raw ore.

3.3.24 Mine Operator. Any owner, lessee, or other person who operates, controls, or supervises a mine. [**120:**3.3]

3.3.25* **Mineral.** A naturally formed inorganic substance occurring in the earth's crust and having a consistent and distinct set of physical properties and a composition that can be expressed by a chemical formula.

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

3.3.27* **Noncombustible Material.** A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat.

3.3.28 Nonmetal Mineral. Belonging to the class of inorganic structural and industrial minerals that do not become metals through metallurgical refining, such as potash, asbestos, sulfur, granite, and rock aggregates.

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

3.3.30 Ore. A mixture of valuable metal mineral and waste rock.

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

flammable or combustible liquids.

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

3.3.33 Pressure Vessel. A container or other component designed in accordance with the ASME *Boiler and Pressure Vessel Code*. [**52:**3.3]

3.3.34* Safe Area. An area where hot work such as cutting and welding, burning, or grinding is done routinely and frequently and has been identified, inspected, and designated as being safe for hot work operations.

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

3.3.36 Self-Closing Door. Doors that, when opened and released, return to the closed position. [**80:**1–4]

3.3.37 Self-Igniting Ore. See 3.3.38, Self-Igniting Rock.

3.3.38* Self-Igniting Rock. Rock containing minerals prone to self-heating and ignition due to chemical oxidation and spontaneous combustion, if such minerals are present in sufficient amounts and occur in a form known to present a spontaneous combustion hazard.

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

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

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

3.3.41.1 *Atmospheric Tank.* A storage tank that has been designed to operate at pressures from atmospheric through a gauge pressure of 6.9 kPa (1.0 psig) (i.e., 760 mm Hg through 812 mm Hg) measured at the top of the tank. [**30:**3.3]

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

3.3.41.3 *Portable Tank.* Any closed vessel having a liquid capacity over 230 L (60 gal) and not intended for fixed installation. This includes intermediate bulk containers (IBCs) as defined and regulated by the U.S. Department of Transportation. [**30:**3.3]

Chapter 4 General

4.1 General.

Provisions in Chapter 4 shall apply to all underground and surface metal and nonmetal mines and to surface metal mineral processing plants, subject to scope limitations.

4.2 Housekeeping.

4.2.1 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, as determined by a fire risk assessment.

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

4.2.3 Maintenance operations shall include written procedures and practices to identify and prevent leakage and accidental escape of flammable or combustible liquids.

4.2.4 Spillage of flammable or combustible liquids shall be cleaned up.

4.2.5 Where flammable or combustible liquids are used or handled, means shall be provided to dispose of leakage or spills.

4.2.6 Access routes shall be kept clear of obstructions to allow access and use of fire protection equipment.

4.3 Ignition Source Control.

4.3.1 Smoking and open flames shall be prohibited in areas or locations where fire or explosion hazards exist.

4.3.2 Signs warning against smoking and open flames shall be posted conspicuously.

4.4 Hot Work.

4.4.1 Hot work shall be in accordance with NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*.

4.4.2 Compressed gases used for hot work 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*.

4.4.3 A hot work permit system shall be developed for all areas of the mine and surface metal processing facilities where hot work is conducted outside of designated safe areas.

4.4.4 Hot work shall be performed only by personnel who have been trained in precautions and procedures for safety in these operations.

4.4.5 Before hot work is performed, prior approval shall be granted by the plant/mine superintendent or designated agent.

4.4.6 All hot work equipment shall be maintained to ensure it is in proper condition.

4.4.7 A flashback arrester shall be installed at the outlet of each pressure regulator on compressed flammable gas cylinders.

4.4.8 When not in use, the compressed gas cylinder valve shall be closed.

4.4.9 Appropriate personal protective equipment, including gloves, goggles, and welding

hoods, shall be worn by personnel during hot work operations.

4.4.10 Combustible materials such as oil, grease, wood, or cardboard boxes and rags within 4.6 m (15 ft) of hot work shall be removed, covered, or wetted down before hot work is started.

4.4.11 Hot work shall not be performed within 15.2 m (50 ft) of explosives, blasting agents, or mine fuel storage areas, unless separated by a suitable noncombustible barrier.

4.4.12 Open gear cases or other exposed machinery components containing lubricants located within 4.6 m (15 ft) shall be covered with noncombustible material before hot work is started.

4.4.13 Noncombustible barriers shall be installed below hot work operations that are being performed in or over shafts, silos, or bins, and similar openings that are constructed of or contain combustible materials or flammable gases.

4.4.14 Openings or cracks in walls, partitions, floor decks, or ducts shall be covered tightly to prevent the passage of sparks to adjacent areas.

4.4.15 Where hot work is 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.

4.4.16 Noncombustible barriers shall be installed below hot work operations that are being performed over empty open-topped tanks or process equipment that are lined with rubber, plastic, or other combustible linings.

4.4.17 As an alternative to providing barriers over open-topped lined equipment in 4.4.16, the equipment shall be filled with water or an ore-water slurry (pulp).

4.4.18 Rubber or plastic lined or constructed vessels, process equipment, or piping shall be clearly labeled using placards or stencils warning of hot work fire hazard.

4.4.19 The hot work permit system shall include explicit wording warning of rubber and plastic lined or constructed equipment hazards and special precautions to be taken.

4.4.20 Hot work 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.

4.4.21* Hot work shall not be performed on or within containers that have contained combustible or flammable materials until such containers or tanks have been thoroughly purged and cleaned or inerted.

4.4.22 A charged water hose line or a multipurpose dry chemical portable extinguisher having a minimum nominal capacity of 9.1 kg (20 lb) shall be available at the work site before hot work is started.

4.4.23 Inspection for sparks, smoldering material, and fire shall be made during hot work operations.

4.4.24 Where hot work is performed near combustible materials that cannot be removed or protected, a trained fire watch person equipped with extinguishing devices shall be present to

guard against fire during and after hot work operations.

4.4.25 Where a fire watch is required, a search of the area, including all levels or floors above and below, shall be made and the fire watch shall be maintained for a minimum of 30 minutes after completion of hot work operations to detect and extinguish smoldering combustibles.

4.4.26 Fire watchers shall be familiar with alarm location and procedures for sounding an alarm in the event of a fire.

4.4.27 Tests for methane and other flammable gases shall be made before hot work in any area where flammable gas could be present.

4.4.28 Cutting or welding shall not be allowed to begin or continue unless the concentration of flammable gas is less than 25 percent of the lower explosive limit.

4.5 Maintenance.

4.5.1 The operator shall establish a maintenance program that ensures that equipment is in proper working order.

4.5.2 All ore handling and concentrating equipment and machinery shall be maintained in accordance with the manufacturers' recommendations.

4.6 Fire Protection Equipment Inspection, Maintenance, and Testing.

4.6.1 Portable extinguishers shall be inspected, tested, and maintained in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*.

4.6.2 Any fire suppression system shall be inspected, tested, and maintained in accordance with the applicable NFPA standards for the type of system.

4.7 Training.

4.7.1 All site personnel shall receive annual instruction on the different classes of fires and types of fire-fighting equipment, fire prevention, and emergency procedures to be followed during a fire.

4.7.2 All site personnel shall receive annual training in the use or operation of fire suppression and detection devices in their work areas or on the equipment they operate, supervise, or maintain.

4.7.3 All site personnel who inspect, test, and maintain a fire suppression system shall be trained to perform their intended tasks.

4.7.4 All site personnel shall receive annual instruction on emergency evacuation procedures.

4.8 Flammable and Combustible Liquid Handling and Storage.

4.8.1 Fixed, unburied flammable or combustible liquid storage tanks shall be provided with containment or drainage in accordance with NFPA 30, *Flammable and Combustible Liquids*

Code.

4.8.2 Flammable or combustible liquids shall not be stored or processed underneath cable trays or inside cable-spreading rooms or tunnels.

4.8.3 Subsection 4.8.1 shall not apply to underground mines.

4.8.4 Ignition.

4.8.4.1 Precautions shall be taken to prevent the ignition of flammable and combustible liquid vapors.

4.8.4.2 Possible sources of ignition shall include, but are not limited to, the following:

(1) Open flames

(2) Smoking

(3) Cutting and welding

(4) Hot surfaces

(5) Frictional heat

(6) Static, electrical, and mechanical sparks

(7) Spontaneous ignition, including heat-producing chemical reactions

(8) Radiant heat

4.8.5 Where a fire risk assessment determines the need, ventilation air volume and velocity shall be designed to dilute and carry away flammable or explosive concentrations of vapors before they reach 25 percent of the lower explosive limit.

4.9 Vehicle Refueling.

4.9.1 Vehicles using liquid fuels shall be refueled only at locations designated for that purpose and from approved dispensing pumps and nozzles.

4.9.2 While fueling, vehicles, regardless of fuel type, shall be constantly attended.

4.9.3 Engines, except diesel engines, shall be shut off during refueling.

Chapter 5 Fire Risk Assessment and Risk Reduction

5.1* Fire Risk Assessment.

5.1.1 A documented fire risk assessment shall be performed for all diesel-powered underground mining equipment, all self-propelled and mobile surface mining equipment, storage and handling of flammable and combustible liquids, and surface metal mineral processing facilities.

5.1.2 Only those skilled in fire risk assessment techniques shall be permitted to conduct a fire risk assessment.

5.1.3 The fire risk assessment shall be kept on file at the mine site.

5.1.4* The fire risk assessment shall determine whether mobile or other equipment, fuel depots, and surface buildings and metal mineral processing facilities require a fixed fire suppression system.

5.1.5 The fire risk assessment shall determine whether an on-site fire fighting organization is required, based on the distance to the nearest local public fire department and response time.

5.1.6 Where required by the authority having jurisdiction, fixed fire protection systems shall be provided.

5.1.7 This assessment shall include evaluation of the risk potential for the start and spread of a fire and the generation of smoke, gases, or toxic fumes that could endanger the lives and safety of personnel or cause damage to property.

5.1.8 A separate fire risk assessment for each piece of mobile or self-propelled mining equipment — whether underground or on the surface — shall be required when variations in design, use, condition, and environment could change the fire potential.

5.1.9 If the fire risk assessment identifies unacceptable risks, further assessment shall include an evaluation of each of the following:

(1) Methods for reducing or eliminating existing hazardous fire conditions

(2) Use of detection and early fire-warning devices

(3) Use of fixed fire suppression systems

(4) Requirements for on-site fire water availability and capacity

(5) Normal and emergency means of egress from equipment or workplaces and evacuation to a safe location, such location to be determined by the fire risk assessment

(6) Compartmentalization of equipment, isolation of areas, or provision of barriers or enclosures to prevent or contain the spread of fire

(7) Availability of fire-fighting personnel and fire suppression equipment

(8) Spread of fire to combustible materials in proximity

(9) Ventilation control structures to contain or redirect products of combustion (underground mines only)

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

5.1.10 Modifications affecting the fire risk of mobile, self-propelled, or other mining equipment or buildings shall be analyzed to determine whether such modifications decrease or increase fire risks.

5.1.11 Working plans for fixed fire protection systems shall be submitted for approval to the authority having jurisdiction.

5.2 Risk Reduction.

5.2.1 Risk reduction practices shall follow the principles of minimizing ignition sources, reducing exposure of combustible materials to ignition sources, and control or suppression of fire spread.

5.2.2 For purposes of this standard, fire protection shall include fire prevention, fire detection, and fire suppression.

Chapter 6 Fire Detection and Suppression Equipment

6.1 Portable Extinguishers.

6.1.1 All areas or process equipment in underground and surface mines and metal mineral processing plants where combustible materials are present, processed, or handled shall be provided with approved portable multipurpose fire extinguishers in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*.

6.1.2 The number of such extinguishers, their type, and their distribution shall be in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*, except that the smallest extinguisher shall have a nominal capacity of 4.5 kg (10 lb) or greater of agent and a minimum rating of 4A:10B:C.

6.1.3 Extinguishers employing agents having a B:C rating shall be permitted to be used on electrical hazards.

6.2 Hand Hose Line Systems.

6.2.1 All areas or process equipment in underground and surface mines and metal mineral processing plants where combustible materials, liquids, or other fire hazards exist, as determined by the fire risk assessment, shall be provided with approved hand hose line systems.

6.2.2 Hand hose line systems shall be installed in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, and shall be a minimum of either 38 mm (1½ in.) lined or 25 mm (1 in.) hard rubber.

6.2.3 When automatic sprinkler systems are supplied through the hand hose line standpipe system, hydraulic calculations shall be used to ensure that the piping and water supply will supply the hose and automatic sprinkler demands simultaneously.

6.2.4 Hose stations in conveyor galleries shall be provided with hoses that are of length equal to the distance between water supply connections.

6.3 Fire Detection.

6.3.1 Fire detectors shall be permitted to be used to initiate audible or visual warning, automatic actuation of a fire suppression system, equipment shutdown, or any combination thereof.

6.3.2 Fire detection systems and applicable equipment in surface mineral concentrating plants shall be installed and tested in accordance with *NFPA 72*, *National Fire Alarm Code*.

6.3.3 Fire detection systems in underground mines and on surface mobile and self-propelled equipment shall be tested in accordance with *NFPA 72*, *National Fire Alarm Code*.

6.3.4 Fire detectors shall be listed for their application.

6.3.5 Equipment compartment and room 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.

6.3.6 Detector testing shall not require the discharge of the fire suppression system on underground diesel-powered or surface mobile or self-propelled equipment.

6.3.7 Any equipment found deficient shall be repaired or replaced and the system retested for operation in accordance with the manufacturer's instructions.

6.3.8 The mine operator, plant superintendent, or a designee shall have a copy of the manufacturer's installation and maintenance manual or owner's manual that describes detection system operation and required maintenance.

6.4 Fire Suppression Equipment.

6.4.1 Fire suppression systems shall be installed, tested, and maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*; NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*; NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*; NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*; NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*; NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*; and NFPA 17, *Standard for Dry Chemical Extinguishing Systems*.

6.4.2 Testing shall not require the discharge of suppressant unless there is no other satisfactory manner in which the reliability and integrity of the system can be verified.

6.4.3 The mine operator, plant superintendent, or a designee shall have a copy of the manufacturer's installation and maintenance manual or owner's manual that describes suppression system operation, required maintenance, and recharging.

6.4.4 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.

Chapter 7 Fire Protection for Diesel-Powered Equipment in Underground Mines

7.1 Equipment Modification.

7.1.1* All diesel-powered mining equipment shall be analyzed to determine whether fire risks can be reduced through equipment modification.

7.1.2* Modifications affecting the fire risk of diesel-powered mining equipment shall be analyzed to determine whether such modifications decrease or increase the fire risk.

7.2 Equipment Inspection and Maintenance.

Hydraulic fluid, coolant, lubrication and fuel lines, electrical wiring, mechanical components, and fire prevention devices shall be inspected and maintained in accordance with the manufacturers' recommendations.

7.3 Portable Fire Extinguishers.

7.3.1 All self-propelled, diesel-powered underground equipment shall be equipped with at least one portable, multipurpose (ABC) dry chemical extinguisher having a nominal capacity of 4.6 kg (10 lb) of extinguishing agent and a minimum rating of 4-A:10-B:C.

7.3.2 The risk assessment shall determine whether larger or additional extinguishers are needed.

7.4 Fixed Suppression Systems.

Diesel-powered equipment shall be protected by a fixed fire suppression system to suppress the largest anticipated fires in the protected areas and shall include the following:

(1) Be listed or approved for the purpose

(2) Be located or guarded to be protected against physical damage

(3) Be automatically actuated by a fire detection system

(4)* Have a manual actuator in the operator's compartment or other accessible location

(5) Be provided with agent distribution hose or pipe secured and protected against damage, including abrasion and corrosion

(6) Be provided with discharge nozzle blowoff caps or other suitable devices or materials to prevent the entrance of moisture, dirt, or other material into the piping

(7) Be installed so that the system actuation causes shutdown of the protected equipment

(8) Permit up to a 30-second delay in equipment shutdown

Chapter 8 Transfer of Flammable or Combustible Liquids in Underground Mines

8.1 Fire Risk Assessment.

The fire risk assessment for surface flammable or combustible liquid storage areas located near underground mines shall include the following:

(1) The potential for the generation of smoke, gases, or toxic fumes that could contaminate the mine intake air

(2) The topography and relative elevation of storage tanks and mine openings

(3) Air currents

(4) Vegetation

8.2 Proximity of Surface Flammable and Combustible Liquid Storage to Underground Openings.

8.2.1 Surface flammable or combustible liquid storage areas shall be located away from any mine opening to prevent contamination of mine intake air, but in no case shall they be closer than 30.5 m (100 ft) unless the boreholes are drilled specifically for the transfer of combustible liquids to the underground mine.

8.2.2 Drainage from flammable or combustible liquid storage areas shall be designed and maintained to prevent liquid flow toward any mine opening.

8.3 Surface-to-Underground Transfer.

8.3.1 Flammable or combustible liquid shall be permitted to be transferred into the mine by pipeline, portable tank, closed container, or safety can.

8.3.2 Persons shall not be transported on conveyances with flammable or combustible liquids unless the items are secured or are small and can be carried safely by hand.

8.3.3 Where flammable or combustible liquid is transferred into the mine, it shall be transferred directly to a storage area or a location where it will be used.

8.3.4* Pipeline systems used for flammable or combustible liquid transfer shall be permitted to be either wet or dry pipe installations.

8.3.5 Piping, valves, and fittings used for flammable or combustible liquid transfer shall be suitable for the expected working pressures and structural stresses.

8.3.6 Piping, valve, and fitting burst strengths shall be at least four times the static pressure.

8.3.7 The mechanical and thermal stresses of the pipeline caused by exposure to fire shall be considered in the selection of components and the design of the pipeline system.

8.3.8 A manual shutoff valve shall be installed in the pipeline at the surface storage tank and at the point of underground discharge.

8.3.9 An additional shutoff valve shall be installed in each branch line where the branch line joins the main line.

8.3.10 The pipeline system shall be guarded by location or other acceptable practice so as to be protected against physical damage.

8.3.11 Flammable or combustible liquid pipeline transfer systems shall be maintained to function as designed.

8.3.12 A fire risk assessment shall be conducted for the location(s) intended for installation of flammable or combustible liquid pipeline systems.

8.4 Underground Transfer.

8.4.1 Persons shall not be transported on conveyances with flammable or combustible liquids unless the items can be carried by hand.

8.4.2 Flammable or combustible liquid containers or tanks loaded on rail or trackless vehicles shall be secured against shifting and damage during transit.

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

8.4.4 Vehicles transporting flammable or combustible liquids shall be kept clear of accumulations of oil, grease, and other combustible material.

8.4.5 Vehicles transporting flammable or combustible liquids shall not be stored under an energized trolley wire.

8.4.6 Unless in a single tank or container, the quantity of flammable or combustible liquids in containers or tanks off-loaded from transport vehicles and stored in an operating area shall not exceed a three-day supply for equipment normally operating in that area.

Chapter 9 Flammable Liquid Storage in Underground Mines

9.1* General.

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

9.1.2 Flammable liquids in storage shall be kept in closed containers.

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

9.1.4 Flammable liquid containers shall be returned to a flammable liquid storage area after use.

9.1.5 Other than Class 1A liquids in aerosol cans, flammable liquids with flash points below -18°C (0°F), such as gasoline, shall not be permitted.

9.2 Flammable Liquid Containers.

9.2.1 Safety cans or containers for flammable liquids authorized by the U.S. Department of Transportation (DOT) shall be acceptable as storage containers.

9.2.2 Containers for flammable liquids shall conform to the capacity limitations specified in

Table 9.2.2.

Table 9.2.2 Maximum Allowable Size of Containers for Flammable Liquids

	Class IA		Class IB		Class IC	
Container Type	**L**	**gal**	**L**	**gal**	**L**	**gal**
Original metal containers (other than DOT containers) or approved plastic containers	3.79	1	18.93	5	18.93	5
Safety cans	7.57	2	18.93	5	18.93	5
Containers, other than safety cans, complying with 9.2.1		Not allowed	227.1	60	227.1	60

9.2.3 All flammable liquid containers shall be labeled clearly with the word "flammable."

9.2.4 Flammable liquid containers shall be stored to prevent overturning or toppling.

9.3 Small Flammable Liquid Storage Areas.

9.3.1 Small flammable liquid storage areas shall be separated from other small flammable or combustible liquid storage areas by at least 14.2 m (50 ft) or from large flammable liquid storage areas by a distance of at least 30.5 m (100 ft), or they shall be separated by unexcavated rock or masonry bulkheads.

9.3.2 Storage of flammable liquids in small flammable liquid storage areas shall be in cabinets specifically designed and constructed for such purpose.

9.4 Large Flammable Liquid Storage Areas.

9.4.1 The total aggregate quantity of flammable liquids to be stored in any one storage area shall not exceed 624 L (165 gal).

9.4.2 Large flammable liquid storage areas shall be separated from other flammable or combustible liquid storage areas by at least 30.5 m (100 ft) or separated by an unexcavated rock or masonry bulkhead and shall be located a minimum of 30.5 m (100 ft) from any shaft station or explosives magazine or electrical substation and transformers.

9.4.2.1* Electrical equipment within 15.2 m (50 ft) from the storage area shall be Class I, Division 1, as specified in NFPA 70, *National Electrical Code*, or shall be classified as "permissible" electrical equipment.

9.4.2.2 Large flammable liquid storage areas shall be located a minimum of 30.5 m (100 ft) from any working face and out of the line of sight of blasting, or they shall be located a minimum of 152.4 m (500 ft) within the line of sight of any working face.

9.4.2.3 Large flammable liquid storage areas shall not be constructed in an area bounded at any point by self-igniting rock.

9.4.3 Large flammable liquid storage areas shall be enclosed and of noncombustible construction.

9.4.3.1 The enclosure shall be tightly sealed and have a minimum 2-hour fire resistance rating.

9.4.3.2 Each opening into a large flammable liquid storage area shall be limited to a maximum area of 9.2 m^2 (100 ft^2).

9.4.3.3 Openings shall be equipped with self-closing fire doors with a minimum 1½-hour fire resistance rating.

9.4.3.4 The entire storage area below the sill shall be capable of containing the total amount of flammable liquids stored, or means shall be provided to remove the spilled flammable liquid safely.

9.4.3.5 Large flammable liquid storage areas shall have exhaust directed to an exhaust ventilating system with air movement with a velocity to maintain flammable vapors at less than 25 percent of the lower explosive limit.

9.4.4 Noncombustible storage cabinets meeting the requirements specified in NFPA 30, *Flammable and Combustible Liquids Code*, Section 4.3, shall be considered as complying with the construction requirements for large flammable liquid storage areas.

9.4.4.1 Combustible rock shall be covered with noncombustible material, such as gunite, shotcrete, or preformed masonry units.

9.5 Dispensing Flammable Liquids.

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

(1) From safety cans

(2) From a container by means of a device drawn through an opening in the top of the container

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

9.5.2 Transfer.

9.5.2.1 Transfer of flammable liquids by means of pressurizing a container with air shall be prohibited.

9.5.2.2 Transfer of flammable liquids by pressure of inert gas shall be permitted only if controls, including pressure-relief devices, are provided to limit the pressure so it cannot exceed the design pressure of the container.

9.5.3 Where electrically powered pumps are used to transfer flammable liquids, a clearly identified and accessible switch or circuit breaker shall be provided at a suitably remote

location, as determined by a fire risk assessment, to shut off the power to all dispensing and pumping devices in the event of an emergency.

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

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

Chapter 10 Combustible Liquid Storage in Underground Mines

10.1 General.

10.1.1 Chapter 10 shall apply to the storage and handling of combustible liquids in containers, portable tanks, and tanks intended for fixed installations.

10.1.2 Combustible liquids in use shall not be covered in this chapter.

10.1.3 Combustible liquids in approved tanks or containers meeting the following requirements shall not require any special consideration and shall be permitted to be exempt from the requirements for storage areas if the containers or tanks are located at least 15.2 m (50 ft) from a working face, explosives magazines, electrical substations, shafts, other exempt containers or tanks, or any storage area and if they are located out of the line of sight of blasting and out of the way of vehicular traffic:

(1) Class II combustible liquids stored in containers meeting the requirements of this chapter and not exceeding an aggregate of 227 L (60 gal) in any single location

(2) Class III combustible liquids stored in containers or approved tanks as specified in this chapter and not exceeding an aggregate of 2498 L (660 gal) in any single location

10.1.4 Ventilation shall be provided to prevent the accumulation of ignitable vapors.

10.2 Combustible Liquid Containers and Tanks.

10.2.1 Shipping containers and portable tanks of combustible liquids authorized by the U.S. Department of Transportation shall be acceptable as storage containers.

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

10.2.1.2 Containers and portable tanks for combustible liquids shall conform to the capacity limitations defined in Chapter 3.

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

10.3* Atmospheric Tanks.

Atmospheric tanks shall not be used for storage of a combustible liquid at a temperature above its boiling point.

10.4* Low-Pressure Tanks.

The operating pressure of the tanks shall not exceed the design working pressure.

10.5* Pressure Vessels.

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

10.6 Venting Atmospheric and Low-Pressure Combustible Liquid Storage Tanks.

10.6.1 Storage tanks shall be vented to prevent the development of a vacuum or pressure that could distort the shell or roof of the tank as a result of filling or emptying and atmospheric temperature changes.

10.6.2 Protection also shall be provided to prevent overpressure from any filling source exceeding the design pressure of the tank.

10.6.2.1* Vents shall be at least as large as the filling or withdrawing lines but not less than 32 mm (1¼ in.) nominal inside diameter.

10.6.3 If more than one fill or withdraw line can be used simultaneously, the vent capacity shall be based on the maximum anticipated simultaneous flow.

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

10.7 Additional Considerations.

10.7.1 Connections for all tank openings shall be liquidtight.

10.7.2 Each connection to a tank through which liquid normally can flow shall be provided with a valve located at the flange nearest the shell of the tank.

10.7.3 Tanks containing combustible liquids shall be provided with a means, such as a remote manual or automatically actuated valve, for quick cutoff of flow in the event of fire in the vicinity of the tank.

10.7.4 Openings for manual gauging, if independent of the fill pipe, shall be kept closed when not gauging.

10.7.5 Each such opening for any liquid shall be protected against liquid overflow and possible vapor release by means of a spring-loaded check valve or other device.

10.7.6 Substitutes for manual gauging shall be permitted.

10.8 Small Combustible Liquid Storage Areas.

10.8.1 Combustible liquid storage areas shall be located a minimum of 30.5 m (100 ft) from

explosives magazines, electrical substations, working faces, or other combustible liquid storage areas or shall be separated by unexcavated rock or masonry bulkheads.

10.8.2 The storage area, unless equipped with an approved fire protection system, shall be located a minimum of 30.5 m (100 ft) from any shaft station.

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

10.8.4 Combustible liquid storage areas shall not be constructed in an area bounded at any point by self-igniting ore.

10.8.5 Where combustible liquid storage areas are constructed of combustible materials or are located where there is rock capable of self-propagating combustion, the material or rock shall be covered with noncombustible material such as gunite, shotcrete, or preformed masonry units.

10.8.6 Where tanks are used, a means shall be provided to confine within or remove from the combustible liquid storage area the contents of the largest tank in the event of a tank rupture.

10.9 Large Combustible Liquid Storage Areas.

10.9.1 The total quantity of combustible liquids in storage tanks intended for fixed installation shall not be restricted.

10.9.2 In areas not protected by automatic fire suppression systems, the total quantity of combustible liquids in containers and portable tanks shall be restricted in accordance with Table 10.9.2, but in no case shall the aggregate quantity exceed 189,250 L (50,000 gal) in any single storage area.

Table 10.9.2 Unprotected Storage of Combustible Liquids in Containers and Portable Tanks

Container Storage						
	Maximum Pile Height		Maximum Quantity per Pile		Maximum Total Quantity	
Class	m	ft	L	gal	L	gal
II	2.13	7	7,570	2,000	15,140	4,000
IIIA	2.13	7	26,495	7,000	52,990	14,000
IIIB	2.13	7	26,495	7,000	105,992	28,000
Portable Tank Storage						
II	3.05	10	11,355	3,000	22,710	6,000
IIIA	3.05	10	41,635	11,000	83,270	22,000

Table 10.9.2 Unprotected Storage of Combustible Liquids in Containers and Portable Tanks

Container Storage						
	Maximum Pile Height		Maximum Quantity per Pile		Maximum Total Quantity	
Class	m	ft	L	gal	L	gal
IIIB	3.05	10	41,635	11,000	166,558	44,000

10.9.3 The use of racks shall not be permitted in unprotected areas.

10.9.3.1 Where combustible liquid storage areas are protected by automatic fire suppression systems, the total quantity of combustible liquids in containers and portable tanks shall not be restricted.

10.9.4 Within a combustible liquid storage area, the quantity stored in a single pile shall be in accordance with Table 10.9.4.

Table 10.9.4 Storage Arrangements for Protected Palletized or Solid Pile Storage of Combustible Liquids in Containers and Portable Tanks

	Maximum Storage Height				Maximum Quantity per Pile			
	Containers		Portable Tanks		Containers		Portable Tanks	
Class	m	ft	m	ft	L	gal	L	gal
II	2.13	7	3.05	10	28,387	7,500	75,700	20,000
III	3.05	10	4.57	15	37,850	10,000	75,700	20,000

10.9.4.1 For mixed storage of Class II and Class III liquids in a single pile or rack, the maximum quantity and maximum height in that pile or rack shall be as specified for Class II liquids *(see Table 10.9.4 and Table 10.9.5.1)*, as applicable.

10.9.5 Individual piles *(see Table 10.9.2 and Table 10.9.4)* shall be arranged so that piles are separated from each other by at least 1.22 m (4 ft).

10.9.5.1 Where racks are used, the heights and quantities per rack shall be in accordance

10.9.4.1 For mixed storage of Class II and Class III liquids in a single pile or rack, the maximum quantity and maximum height in that pile or rack shall be as specified for Class II liquids *(see Table 10.9.4 and Table 10.9.5.1)*, as applicable.

10.9.5 Individual piles *(see Table 10.9.2 and Table 10.9.4)* shall be arranged so that piles are separated from each other by at least 1.22 m (4 ft).

10.9.5.1 Where racks are used, the heights and quantities per rack shall be in accordance with Table 10.9.5.1.

Table 10.9.5.1 Storage Arrangements for Protected Rack Storage of Combustible Liquids in Containers

		Maximum Storage Height		Maximum Quantity per Rack	
Class	**Rack Type**	**m**	**ft**	**L**	**gal**
II	Double row or single row	4.57	15	34,068	9,000
III	Multirow, double row, or single row	6.1	20	90,840	24,000

10.9.6 Single-row or double-row rack storage *(see Table 10.9.5.1)* shall be separated by minimum 2.44 m (8 ft) aisles from other rows of rack storage or other pile storage.

10.9.7 Empty or idle combustible pallet storage within the combustible liquid storage area shall be limited to a maximum pile size of 23.2 m^2 (250 ft^2) and a maximum storage height of 2.13 m (7 ft).

10.9.8 Idle pallet storage shall be separated from combustible liquids by at least 1.22 m (4 ft).

10.9.8.1 Combustible liquid storage areas shall be located a minimum of 30.5 m (100 ft) from explosives magazines or electrical substations.

10.9.9 Combustible liquid storage areas shall be located a minimum of 30.5 m (100 ft) from any shaft station, unless equipped with an approved fire protection system.

10.9.10 Combustible liquid storage areas shall be located a minimum of 30.5 m (100 ft) from any working face and out of the line of sight of blasting, or they shall be located a minimum of 152 m (500 ft) within the line of sight of any working face to avoid damage from fly rock.

10.9.11 Combustible liquid storage areas shall be separated from other flammable or combustible liquid storage areas by a distance of at least 30.5 m (100 ft), or they shall be separated by unexcavated rock or masonry bulkheads.

10.9.12 The masonry bulkhead shall have a minimum thickness of 102 mm (4 in.) of block or 51 mm (2 in.) of reinforced gunite.

10.9.12.1 Combustible liquid storage areas that are enclosed shall be built of noncombustible materials.

10.9.13 Combustible rock within all large combustible liquid storage areas shall be covered with noncombustible material such as gunite, shotcrete, or preformed masonry.

10.9.13.1 If enclosed, each opening into a combustible liquid storage area shall be equipped with a self-closing metal door.

10.9.14 Bulkheads, if used, shall be sealed tightly and shall be built or covered with noncombustible materials.

10.9.14.1 No storage areas shall be constructed in a location bounded at any point by self-igniting ore.

10.9.15* Tanks shall rest on the ground or on foundations made of concrete, masonry, piling, or steel.

10.9.16 Tank foundations shall be designed to minimize the possibility of uneven settling of the tank and to minimize corrosion in any part of the tank resting on the foundation.

10.9.16.1 The entire combustible liquid storage area below the door sill shall be capable of containing the total amount of combustible liquid, or means shall be provided to remove the combustible liquid.

10.9.17 All piping, valves, and fittings shall be designed for the expected working pressures and structural stresses.

10.9.18 Combustible liquid storage areas not buried or equipped with automatic fire suppression systems shall have exhaust directed to an exhaust ventilating system.

10.10* Dispensing Combustible Liquids.

10.10.1 Dispensing combustible liquid from containers or tanks shall be permitted to be accomplished by transfer pump or gravity flow.

10.10.2 Means shall be provided to control the flow and prevent leakage and accidental discharge.

10.10.2.1 Combustible liquids shall be permitted to be dispensed through the application of positive pressure to containers or tanks only if they are certified as pressure vessels.

10.10.3 Manual dispensing valves, if used, shall be of the self-closing type.

10.10.3.1 Where electrically powered pumps are used to dispense combustible liquids, a clearly identified and accessible switch or circuit breaker shall be provided at a suitably remote location, as determined by a fire risk assessment, to shut off the power to all dispensing and pumping devices in the event of an emergency.

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

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

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

10.10.7 Spillage shall be cleaned up.

Chapter 11 Fire Suppression for Flammable or Combustible Liquid Storage Areas in Underground Mines

11.1 Portable Fire Extinguishers.

11.1.1 At least one hand portable fire extinguisher having a nominal capacity of 9.1 kg (20 lb) with a minimum rating of 4-A:60-B:C shall be located outside of, but not more than 3.0 m (10 ft) from, the opening into each storage area.

11.1.2 The installation of manual or automatic fire suppression systems shall not exempt the requirements for a portable fire extinguisher.

11.1.2.1 Where portable fire extinguishers are provided within storage areas, travel distance to a portable extinguisher shall not exceed 12.2 m (40 ft).

11.2 Hand Hose Line Systems.

Hand hose lines designated for fire fighting and accessible to flammable and combustible storage areas shall be equipped to discharge a foam-water solution and shall be in accordance with NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*.

11.3 Fire Suppression Systems.

11.3.1* Where provided, automatic sprinkler systems installed for the protection of flammable liquid or diesel fuel storage areas shall be of the foam-water type.

11.3.2 Where provided, automatic sprinkler systems used for the protection of other underground mine combustible liquid storage areas shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

11.3.3 Where the fire suppression requirements of this standard are met by means other than an automatic sprinkler system but an automatic sprinkler system is installed to supplement such means, the water supply provisions for automatic sprinkler systems of NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall not be required.

11.3.4 Fire suppression systems other than automatic foam-water sprinkler systems in underground mines shall be in accordance with NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*; NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*; NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*; NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*; NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*; NFPA 17, *Standard for Dry Chemical Extinguishing Systems*; and NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*.

Chapter 12 Fire Protection of Surface Mobile and Self-Propelled Equipment

12.1* General.

12.1.1 Housekeeping. The storage and handling of flammable or combustible liquids on or within equipment shall be in accordance with Section 5.5 of NFPA 30, *Flammable and Combustible Liquids Code*.

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

12.2 Fire Detection and Suppression Equipment.

12.2.1 Portable Fire Extinguishers.

12.2.1.1 All self-propelled and mobile diesel and electrical equipment shall be equipped with at least one listed portable multipurpose (ABC) dry chemical extinguisher having a minimum

rating of 4-A:60-B:C and a nominal capacity of 4.6 kg (10 lb) or greater of extinguishing agent.

12.2.1.2 The fire risk assessment shall be used to determine whether larger or additional extinguishers are needed.

12.2.2 Fixed Suppression Systems.

12.2.2.1* Large mobile diesel and self-propelled mining equipment shall be protected by a fire suppression system and the system shall include the following:

(1) Be approved for the purpose

(2) Be located or guarded so as to be protected against physical damage

(3) Be automatically actuated

(4)* Have a manual actuator capable of being activated from the operator's compartment or other location

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

12.2.2.1.2 Except for automatic sprinkler systems, 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.

12.2.2.1.3 Except for automatic sprinkler systems, the nozzle cover shall open or blow off upon discharge of the system.

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

12.2.2.1.5 Up to a 30-second delay shall be included in the design of the interlock system for the operator to maintain control of the equipment.

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

Chapter 13 Fire Protection of Surface Metal Mineral Processing Plants

13.1 General.

Chapter 13 shall include the following:

(1) Mill (concentrator) processing buildings

(2) Crushers and crushing buildings

(3) Conveyor systems

(4) Combustible and flammable liquids mixing buildings and tank farms

(5) Other ore processing facilities such as filter rooms, process pump houses, and thickeners

(6) Electrical substations, transformers, control rooms, cable-spreading rooms and tunnels, and motor control center (MCC) rooms

(7) Offices, shops, laboratories, warehouses, fuel depots, maintenance garages, and other ancillary nonproduction buildings on the site of and supporting the operation of the mineral processing plant

13.2 Emergency Response and Manual Fire Fighting.

13.2.1 Based on the fire risk assessment, an on-site fire fighting organization shall be developed.

13.2.2 Detailed and documented fire fighting procedures shall be developed for site- and process-specific fire scenarios.

13.2.3 Training of the fire fighting organization shall be based upon specific fire scenarios.

13.2.4 Emergency procedures shall include a documented plan for rapid assembly, transportation of emergency personnel and equipment to the fire scene, and operation of the fire suppression equipment available at the facility.

13.3 Construction.

Buildings and structures greater than 465 m^2 (5000 ft^2) shall be of noncombustible construction or protected by an automatic sprinkler system.

13.4 Lightning Protection.

Where lightning protection is required, it shall be in accordance with NFPA 780, *Standard for the Installation of Lightning Protection Systems*.

13.5 Egress and Exiting.

13.5.1 Two means of egress in accordance with NFPA *101*, *Life Safety Code*, shall be provided on every floor of all buildings.

13.5.2 Emergency lighting shall be provided at the means of egress stairways in accordance with NFPA *101*, *Life Safety Code*, Section 5.9.

13.5.3 Emergency exit signs shall be provided at the means of egress stairways in accordance with NFPA *101*, *Life Safety Code*, Section 5.10.

13.6 Yard Hydrant Systems.

13.6.1 The fire risk assessment shall be used to determine requirements for and location of yard hydrants.

13.6.2 Yard hydrants shall be in accordance with NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*.

13.7* Water Supply and Water Distribution Systems.

13.7.1 The fire risk assessment shall be used to determine requirements for water supply and water distribution systems.

13.7.2 Where a fire water supply is required by the risk assessment, capacity and availability shall provide the water demand for fire-fighting purposes, including hose and sprinkler systems, for a minimum duration of 2 hours.

13.7.3* Where fire mains and hydrants are required by the risk assessment, the water supply system shall be installed and maintained in accordance with NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*.

13.7.4 Where public or private fire mains are not provided, alternate water supplies shall comply with NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting*.

13.7.5 Where allowed by the fire risk assessment, process water systems shall be permitted to supply fire mains.

13.8 Flammable and Combustible Liquids.

13.8.1 The storage, use, and handling of flammable and combustible liquids in and around metal mineral processing facilities and on or in equipment in such plants shall conform with NFPA 30, *Flammable and Combustible Liquids Code*.

13.8.2 Material Safety Data Sheets or equivalent listing the flammability characteristics and flash point of flammable and combustible materials shall be kept on site for review by employees and the authority having jurisdiction.

13.9 Compressed Gases.

The storage, use, and handling of compressed gases shall be in accordance with NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*, and NFPA 58, *Liquefied Petroleum Gas Code*.

13.10 Rubber and Plastic Lined Equipment.

13.10.1* The fire risk assessment shall be used to determine protection requirements of rubber and plastic lined equipment.

13.10.2 Equipment with internal combustible rubber or plastic linings shall be clearly labeled by placards or stenciling on the side of the lined equipment.

13.10.3 The label shall indicate that a combustible lining is present and shall state “Hot work such as cutting and welding should be avoided.”

13.10.4 The label shall be clearly visible.

13.10.5 When hot work must be performed on lined equipment, guidelines in Section 4.4

shall be followed.

13.10.6 Repairs and modifications to rubber or plastic lined equipment using flammable solvents shall require ventilation during solvent use.

13.10.7 Electrical lights and other electrical appliances shall be rated for the hazard when used during repairs and modifications to rubber or plastic lined equipment using flammable solvents.

13.10.8 Equipment and personnel repairing internal liners using flammable solvents shall be grounded against static discharge.

13.10.9 A written pre-planned procedure for emergency response shall be developed for fighting an internal rubber or plastic lined equipment fire.

13.11 Plastic Equipment.

13.11.1* The fire risk assessment shall be used to determine protection requirements of equipment constructed from plastic.

13.11.2 Plastic equipment shall be clearly labeled by placards or stenciling on the side of the equipment.

13.11.3 The label shall indicate that combustible plastic is present and shall state "Hot work such as cutting and welding should be avoided."

13.11.4 The label shall be clearly visible.

13.11.5 When hot work must be performed on plastic equipment, guidelines in Section 4.4 shall be followed.

13.11.6 Repairs and modifications to plastic equipment using flammable solvents shall require ventilation during solvent use.

13.11.7 Electrical lights and other electrical appliances shall be listed for the hazard when used during repairs and modifications to plastic equipment using flammable solvents.

13.11.8 Equipment and personnel repairing plastic equipment using flammable solvents shall be grounded against static discharge.

13.11.9 A written pre-planned procedure for emergency response shall be developed for fighting a plastic equipment fire.

13.12 Belt Conveyors.

13.12.1 Belt alignment limit switches shall be provided on conveyors to shut down belts that are tracking improperly.

13.12.2 Motion-sensing switches shall be provided to detect a slipping or jammed belt and shall be interlocked to shut off driving power when the belt stops or slows down by more than 20 percent of its normal speed.

13.12.3 Sequence switches shall be provided on contributing conveyors to prevent any

operating conveyor from discharging material to a stopped downstream conveyor.

13.12.4* Conveyor belt systems shall be inspected and maintained to prevent ignition sources.

13.12.5 Accumulations of rock shall be removed from areas where the rock could jam or contact a rotating part and cause ignition of the belt.

13.12.6* The fire risk assessment shall be used to determine protection requirements of conveyor belts.

13.12.7 Acceptable protection systems for conveyors shall include automatic sprinklers, water spray systems, foam water systems, smoke and heat detection systems, portable extinguishers, and hand hose lines.

13.13 Hydraulic Fluids and Lubricating Oil Systems.

13.13.1* The fire risk assessment shall be used to determine protection requirements of hydraulic fluid and lubrication oil systems.

13.13.2 Acceptable protection systems shall include automatic sprinklers, water spray systems, portable hand hose lines and extinguishers, and detection.

13.13.3 The use of listed fire-retardant or resistive fluids shall be acceptable as an alternate protection solution for fixed suppression on hydraulic systems.

13.13.4 Hydraulic fluid systems shall be capable of being shut off by one of the following measures:

(1) Actuation of automatic fire suppression or detection systems

(2) Actuation of automatic reservoir low-level, loss-of-pressure, or flow switches

(3) Actuation of manual power shutoff located at least 15.2 m (50 ft) from the hydraulic system or in a separate cutoff area from the hydraulic system

13.13.5 Hydraulic fluid and lubrication oil tanks and pumps, of individual or aggregate quantity in excess of 1892 L (500 gal), shall be located in dedicated cutoff rooms of 1-hour fire resistance.

13.13.6 Individual hydraulic and lubricating oil systems shall be located in a curb or pan capable of containing the entire reservoir capacity.

13.14* Thermal Oil Heating Systems.

13.14.1* Fire protection of thermal oil heating systems shall include as a minimum the following:

(1) A cutoff room of 1-hour fire resistance for thermal oil heater, storage, and expansion tanks and pumps

Exception: Heat exchangers or other appliances using thermal oil to dry the ore may be located in the general production area.

(2) Interlocks to shut off the thermal oil system upon actuation of a fixed suppression or detection systems

(3) Automatic fixed fire protection system inside the cutoff room

13.14.2 Acceptable fixed fire protection systems described in 13.14.1(3) shall include automatic sprinklers, water spray systems, or foam-water systems.

13.15 Fuel Fired Equipment.

Burner management systems for solid, gas, and liquid fuel delivery systems shall be in accordance with NFPA 85, *Boiler and Combustion Systems Hazards Code*.

13.16* Electrical Equipment Spaces.

13.16.1 The fire risk assessment shall be used to determine fire protection requirements of MCC, switch rooms, cable-spreading spaces, cable distribution tunnel and control rooms with electrical switch panels, transformers, and grouped electrical cables.

13.16.2 Electrical equipment shall be installed, tested, inspected, and maintained in accordance with NFPA 70, *National Electrical Code*.

13.16.3 Acceptable fire protection systems for MCC, control rooms, cable-spreading rooms, transformers, and electrical switch rooms shall include, but not be limited to, cutoffs and barriers, smoke or heat detection, fire-retardant coating, automatic sprinklers, water spray systems, foam water systems, gaseous suppression systems, dry chemical systems, and portable extinguishers.

13.17 Battery Charging Installations.

13.17.1 Battery charging installations shall have ventilation for the removal of generated gases from charging batteries.

13.17.2 Means shall be provided to flush spilled electrolyte.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1 Because of the uniqueness and often remoteness of metal and nonmetal mines and ore processing facilities, provisions in this standard could differ from commonly accepted fire protection standards and guides devised for other types of occupancies. The provisions of this document are considered necessary to provide a reasonable level of protection from loss of life and property from fire and explosions. They reflect situations and the state of the art at the time the standard was issued.

As of 2001, there were 12,479 metal/nonmetal mining and processing operation in the United States. In the most recent 12-year period, approximately 515 fires of all types were

reported.

Fires and explosions in mines and mineral processing plants have caused major loss of property, production equipment, buildings, and business interruption. In the five-year period from 1994 to 1998, mines and quarries of all types averaged $12.3 million a year in direct damage in fires reported to U.S. local fire departments. In the same period, nonmetallic mineral processing and product manufacturing facilities averaged $16.1 million a year in direct damage in fires reported to U.S. local fire departments. *(For more information, see the NFPA Fire Protection Handbook, 2003 edition, Chapter 29.)*

Fires adversely affect all areas of mining and mineral processing operations, including underground and surface self-propelled and mobile mining equipment, underground fuel storage areas, surface ore concentrating and processing buildings and equipment, and support facilities associated with these activities.

Fire and related hazards in metal ore processing facilities include but are not limited to conveyor belts; rubber lined equipment; combustible and flammable reagents; gaseous, liquid, or solid fuels; mineral extraction solvents and carriers; dielectric, thermal, and lubricating oils; hydraulic fluids; grouped plastic electric cables; and combustible construction. Significant fire and explosions have occurred in concentrator mills due to these hazards.

Ignition sources for these hazards are present and cannot always be controlled. The most common ignition source in this industry is uncontrolled hot work.

Control and awareness of combustible loading, including “hidden” combustibles like rubber or plastic lined equipment, is important to understanding these hazards. Automatic fire suppression systems coupled with effective emergency response have been effective in limiting fire damage in processing facilities.

Most fires involving mobile or self-propelled mining equipment — whether underground or surface — 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 on equipment 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 on mobile equipment must be aimed at fire prevention and fire suppression.

To improve fire protection and prevention on 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 turbochargers, exhaust manifolds and exhaust pipe shielding and insulation, location of combustible and flammable liquid reservoirs, and hydraulic and fuel line routing.

Most 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 those fires that are hard to access and thereby to reduce “off-road” equipment fire losses.

The key to operator protection is early detection of fires to provide a warning to the operator, fuel shutoff 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.

It could be necessary for those charged with purchasing, testing, approving, and maintaining fire protection equipment for the mining industry to consult an experienced fire protection specialist.

A.1.1.6 A typical metal mineral processing plant — also called a concentrating or dressing mill — is physically separated from the mining operation, although it can be connected by conveyor systems. Typical metals produced using concentrator plants are gold, silver, platinum, nickel, zinc, lead, molybdenum, and copper. Essentially any metal can be concentrated in this manner. Some concentrating mills are located on floating dredges, such as those used in titanium mining.

The general purpose of the processing plant is to receive crushed ore, further reduce it in size by additional crushing, milling, and screening, and separate waste materials (gangue) from desirable metal mineral values. Most metal mineral mills are similar in that they have large semi-autogenous, ball, or roll mills for fine grinding the ore into a pulp or slurry. Once ground, the slurry is processed by flotation or beneficiation using reagents. After flotation, the concentrate — which can be in the 20 percent to 30 percent metals value range — is filtered or thermally dried and stored. Some metals, like molybdenum, feature combustible thermal oils in the drying process. Concentrate is sent to metallurgical refineries to recover the final pure product. The refinery might be adjacent to the mill but is usually separate.

By-products produced in a typical metal concentrator mill include tailings, which consist of waste gangue and entrained water and process chemicals. This waste is sent to a tailings disposal facility.

A.1.1.7 There are number of processes associated with concentration or refining of metal ores that are not applicable to this standard but deserve mention due to their hazards and integration with the concentration process. These include solvent extraction–electrowinning (SX–EW); pressure leaching processes (using high-pressure autoclave reactors); alumina refineries; metal smelters, including flash furnaces; roasting, sintering, calcining, and electro-refining processes; and gas, liquid, or solid waste handling systems. There are also nonmetal mineral processing plants such as those used for recovering phosphates, nitrates, potash, and soda ash. All of these processes are chemical in nature, and all have serious fire and explosion hazards.

Of particular mention and importance from a potential fire hazard standpoint are solvent extraction (SX) plants.

An SX plant is a separations process using combustible solvents like kerosene or alcohol for separating valuable metal minerals. An SX process facility often features thousands of gallons of solvent in plastic tanks using plastic piping and can be located outdoors or inside buildings. SX plants are common at copper mines where the oxide content of the ore body allows acid leaching in heaps. They are also common for uranium, nickel, and cobalt.

While kerosene is usually a Class II combustible liquid and in a cold state is relatively difficult to ignite, once ignited it burns similar to other lower flash point hydrocarbons. At high elevations, the flash point can render the material a Class I flammable liquid. In very hot climates, the material can be above its flash point and the potential for heating is increased when the solution is carried in black plastic piping subject to solar heating.

Protection of SX plants needs to consider response time of fire fighters and types of fire fighting appliances and suppression agents. Because of the large quantities of combustible liquids and use of plastic piping and process systems — which can fail prematurely due to fire impingement and rapidly release additional combustible liquids — a well-developed and large area fire could occur in minutes, and responding fire fighters could be faced with protecting exposures rather than suppression of the incipient event. For this reason the use of fast-acting automatic detection and suppression systems is advised. Foam-water systems have proven effective in suppressing combustible liquid fires. If used, consideration needs to be given to providing protection over and under mixer-settlers and tanks, in tunnels with plastic piping, under pipe racks, over pumps, and inside mixer-settlers.

Provision of drainage, confinement, control of static electricity by bonding and grounding, and selection of stout piping systems, such as stainless steel or structural fiberglass reinforced plastic instead of less robust polyethylene, is advised.

A mineral SX plant should not be confused with an agricultural SX plant that uses low flash point flammable solvents, like hexane, for recovering oils from soybeans, canola, and corn, and that has a higher hazard. NFPA 36, *Standard for Solvent Extraction Plants*, applies to protection of agricultural solvent extraction plants but does not apply to protection of mineral solvent extraction plants. There currently are no NFPA standards on mineral SX plants.

A.3.2.1 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 that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase “authority having jurisdiction,” or its acronym AHJ, 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.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations 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.3.3.17 Flash Point of a Liquid. The flash point of a liquid having a viscosity less than 45 SUS at 37.8°C (100°F) or a flash point of 93.4°C (200°F) or higher shall be determined in accordance with ASTM D 56, *Standard Method of Test for Flash Point by the Tag Closed Cup Tester*.

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

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

A.3.3.23 Metal Mineral Processing Plant. A mineral processing plant, also called a concentrator mill or a dressing plant, can have crushers; grinding mills; fuel-fired dryers; separation circuits featuring flammable, combustible, or toxic liquid reagents in flotation cells; and possibly special hazard circuits using thermal oils and solvent extraction. A mineral processing plant is usually located close to the mine due to cost of shipping raw ore long distances.

A.3.3.25 Mineral. *Mineral* in this document refers only to metal or nonmetal ores and not to coal.

A.3.3.27 Noncombustible Material. Materials that are reported as passing ASTM E 136, *Standard Method of Test for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C*, are considered noncombustible materials.

A.3.3.34 Safe Area. Examples are designated welding shops.

A.3.3.38 Self-Igniting Rock. In metal/nonmetal mines this usually pertains to sulfide ores or coal deposits.

A.4.4.21 For additional information, see NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*, and AWS F4.1, *Recommended Safe Practices for the Preparation for Welding and Cutting of Containers and Piping*.

A.5.1 See Annex B for suggested procedure to conduct a fire risk assessment.

A.5.1.4 Examples of where fixed protection might be needed in mineral processing plants include conveyor belts, galleries, tunnels, over rubber and plastic constructed or lined equipment, switch gear rooms, control rooms, change houses, and combustible and flammable liquids storage or process areas. Areas with noncombustible construction or noncombustible contents are areas where fixed protection might not be needed.

A.7.1.1 Some examples of equipment modifications that can favorably reduce risk of fire include physical barrier between fuel and ignition sources, thermal shields over hot surfaces, hydraulic hose and electrical wiring harness rerouting, and power shutoffs.

A.7.1.2 Modifications could affect the life expectancy and certification of diesel-powered equipment and diesel-powered equipment components. It is possible that such a modified machine would not be covered by the manufacturer's warranty or certification. Questions concerning the effect of a proposed modification should be discussed with the diesel-powered equipment manufacturer or the manufacturer's representative.

A.7.4(4) 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.

A.8.3.4 Where pressurized pipeline systems are used for combustible liquid transfer, consideration should be given to providing a pressure-sensing interlock downstream of the transfer pump discharge. This interlock should be suitable for Class I, Division 2 locations and should be arranged to shut down the pump immediately upon loss of line pressure.

A.9.1 Because of the inherent hazards associated with flammable liquids, the underground storage of flammable liquids should be avoided.

A.9.1.1 Electrical equipment classified as “permissible” is certified as meeting the requirements of 18 CFR, Chapter 1.

A.9.4.2.1 Electrical equipment classified as “permissible” is certified as meeting the requirements of 18 CFR, Chapter 1.

A.10.3 Atmospheric tanks should be built in accordance with good engineering practices.

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

Low-pressure tanks and pressure vessels can be permitted to be used as atmospheric tanks.

A.10.4 Low-pressure tanks should be built in accordance with good engineering practices.

A.10.5 Pressure vessels should be built in accordance with good engineering practices.

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

A.10.6.2.1 Information on venting can be found in API 2000, *Standard for Venting Atmospheric and Low-Pressure Storage Tanks*.

A.10.9.15 Information on tank foundations can be found in API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, Appendix B, and API 650, *Standard for Welded Steel Tanks for Oil Storage*, Appendix E.

A.10.10 No requirements for bonding or grounding to dissipate static electricity are included in this standard for combustible liquids, based upon the fact that NFPA 30, *Flammable and Combustible Liquids Code*, does not require bonding or grounding for combustible liquids handled at temperatures below their flash points.

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

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

A.11.3.1 Underground shaft mines that use diesel-powered equipment generally employ underground diesel fuel storage areas to facilitate equipment refueling. Adit-type mines in the western United States can initially locate diesel fuel storage and refueling facilities on the surface; however, as the active mine workings progress further from the adit portal(s), these facilities usually are moved underground.

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

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

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

(1) As long as a fire burns, even if it does not grow in intensity or area and appears to be responsive to fire control, toxic smoke and fire gases are produced that can endanger persons in the mine.

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

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

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

(5) Water supplies are limited in many underground mines. Fire control, therefore, should be considered temporary, because the fire will grow immediately to maximum

intensity when the water supply is depleted.

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

Water sprinkler systems installed for the protection of diesel fuel storage areas might not be effective in suppression even though they do provide good control through cooling; foam-water systems can provide suppression.

For further information on foam-water systems, see NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*.

A.12.1 Diesel fuel is a combustible liquid. As with any combustible liquid, it can safely be transferred, transported, stored, and used if its physical, chemical, and hazardous properties are fully understood and the necessary precautions and safeguards are observed.

The risk of starting a fire associated with diesel equipment and the control methods used to reduce this risk are essentially the same for both underground and surface operations. The confining environment found in underground mines, however, can compound the consequences of a fire and might necessitate separate evaluations to determine the degree of safeguards needed. In addition to the recognized differences between surface and underground mines, there are also differences in their physical environments, such as those created by product combustibility within underground mines.

Such differences could require individual evaluations to determine the appropriate fire prevention and fire protection safeguards.

A.12.2.2.1 Examples of large equipment include the following:

(1) Haul trucks over 85 tons capacity

(2) Track dozer of 300 h.p. or more or 70,000 lb weight or more (e.g., Caterpillar D8R)

(3) Front end loader of 400 h.p. or more and vehicle weight of 100,000 lb (e.g., Caterpillar 988)

(4) Wheel dozer of 300 h.p. or more and vehicle weight of 60,000 lb or more (e.g., Caterpillar 824G)

(5) Grader of 275 h.p. or more and vehicle weight of 55,000 lb or more (e.g., Caterpillar 16H)

(6) Pull type scraper of 450 h.p. or more and vehicle weight of 98,000 lb or more (e.g., Caterpillar 631E)

(7) Scraper push/pull twin engine of 450 h.p. and 490 h.p. or more and vehicle weight of 113,000 lb or more (e.g., Caterpillar 637E)

(8) Blast hole drill of 360 h.p. or more and weight of 68,000 lb or more (e.g., Ingersol-Rand DM-30)

A.12.2.2.1(4) 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.

A.13.7 A readily available supply can include a dedicated fire protection water supply, a pond or other large body of water, an industrial process water system, or large water trucks (tankers). If water trucks (tankers) are used, they should be of a capacity and quantity to deliver a continuous source of water for the duration of the fire-fighting effort. Personnel should be trained in emergency vehicle operation and mobile water supply shuttle procedures. If an impounded body of water is provided, it should be close and accessible enough to the protected property to allow fire fighters a quick response.

A.13.7.3 Chapter 5 and Appendix G of NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting*, outline suggested methods for determining the estimated water supply (fire flow) that can be necessary for fire-fighting purposes.

A.13.10.1 The following should be considered when conducting a fire risk assessment on rubber and plastic lined equipment:

(1) Many fires occur annually inside rubber lined equipment in concentrator plants.

(2) Many rubber lined equipment fires are quickly controlled and not reported, but some have spread throughout a circuit or several circuits and have caused significant property damage and business interruption. If located near a wall or ceiling, heat inside an internal rubber lined system might cause structural damage.

(3) Rubber lined equipment fires are usually caused by hot work. These fires can occur when heating the outside of a steel pipe lined with rubber or plastic, with heat passing into the interior lining and ignition inside. They could also occur due to hot work over open-topped tanks and vessels, which will normally occur when the plant is down for maintenance and the systems are dry.

(4) Once a fire enters the inside of a dry rubber lined system, it can spread unchecked.

(5) Where practical during new process installations or modifications, the use of rubber or plastic lining and plastic vessel and piping should be minimized or eliminated.

(6) Hot work on or over plastic or rubber lined vessels should be minimized, and alternate methods of repair exhausted prior to permitting hot work.

(7) When hot work is necessary, and where practical, vessels can be flooded with process or fire protection water to minimize internal ignition.

(8) When hot work is necessary, and where practical, vessels and piping should be isolated by closing process valves or breaking connection to minimize internal fire spread between processing circuits.

(9) Protection options might include smoke or heat detection, local fixed automatic sprinkler or water spray suppression, extinguishers, or hand hose lines. Flooding a circuit with process water is a good suppression technique as long as the responding emergency team knows which valves to open and has planned for this contingency.

A.13.11.1 The following should be considered when conducting a fire risk assessment on plastic constructed equipment:

(1) Similar to rubber or plastic lined equipment, there is increasingly new equipment constructed entirely of plastic, such as process vessels, pipes, and cooling towers.

(2) Hazards are similar to rubber lined equipment, and identification, labeling, hazard awareness, and fire planning are required.

(3) The use of fixed automatic sprinkler systems over large concentrations of plastic equipment have been effective.

A.13.12.4 The following should be considered when conducting a fire risk assessment on a conveyor system:

(1) Belt fire retardancy

(2) Size and speed

(3) Degree of confinement

(4) Accessibility for manual fire fighting

Automatic sprinklers have been effective in limiting damage in conveyor systems.

A.13.12.6 Conveyor belt ignition sources include friction points, hot bearings, tracking, frame damage, electrical, combustible storage, hot work, and spontaneous combustion of spilled fuels.

A.13.13.1 The following should be considered when conducting a fire risk assessment on a hydraulic or lubricating oil system:

(1) Individual and aggregate quantity of fluid or oil

(2) System location

(3) System design

(4) Type and fire hazard of fluid or oil

(5) Pressures

(6) Temperatures

(7) Presence of ignition sources

(8) Importance

(9) Attended or not

(10) Presence of personnel in area

Hydraulic fluid and lubrication oil tanks and pumps should be located as to not expose grouped electrical cables, rubber or plastic equipment, or other critical equipment to fire damage.

A.13.14 Thermal oil systems are used in some mineral processing plants, such as molybdenum concentrator mills, for drying ore.

Chapter 9 of NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, is the primary reference in NFPA standards for thermal oil systems used in industrial processes. Even though the woodworking industry has unique equipment, the hot oil heating and distribution systems are similar, and the concepts provided in this standard can be utilized for the mineral processing industry.

A.13.14.1 As determined by the fire risk assessment, additional fire protection might be needed to fully protect thermal oil systems.

The following should be considered when conducting a fire risk assessment on a thermal oil system:

(1) Additional or back-up fixed fire suppression

(2) Locating the heater and tanks outdoors or in detached buildings

(3) Proper location and confinement of expansion and storage tanks and heaters

(4) Proper piping arrangement

(5) Process interlocks and controls

(6) Explosion protection

(7) Damage limiting construction from an oil mist explosion

A.13.16 Positive pressure should be maintained in electrical equipment rooms such as switch gear, motor control centers, and cable-spreading rooms to prevent the entry of fugitive dust that can cause overheating or short circuits.

Thermographic scanning can be performed on transformers, switchgear, and motor starters on an annual basis.

Annex B Fire Risk Assessment

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

B.1 Fire Risk Assessment.

There are many techniques available to assess risk. The four general techniques are experience, augmented experience, creative, and analytical.

Experience (qualitative) techniques are as follows:

(1) Use of standard designs

(2) Use of recognized standards

(3) Use of experts

(4) Qualitative approach

Augmented experience (qualitative) techniques are as follows:

(1) Secondary safety checks outside of design process

(2) Safety review meetings

(3) Multidisciplinary teams

(4) Avoid blind spots

(5) "What-if" analysis

(6) Qualitative approach

Creative (qualitative) techniques are as follows:

(1) Seek improvements or innovations

(2) Brainstorming

(3) Hazard and operability studies

Analytical (quantitative) techniques are as follows:

(1) Logic trees

(2) Fault event trees

(3) Failure modes and analysis

(4) Quantitative risk assessment

(5) Detailed analytical checklists

In all cases, a fire risk assessment consists of the following four steps:

(1) Identify the potential for fire and explosion.

(2) Assess the consequences of fire and explosion.

(3) Determine the need for fire protection.

(4) Select appropriate option(s).

The following fire risk assessment outline is a suggested procedure to identify the elements in the items defined above. Figure B.1 provides a diagram of the process. Specific examples are given for risks associated with mobile and self-propelled equipment, but the process can be used for other hazards such as conveyor belts, rubber lined equipment, and building protection.

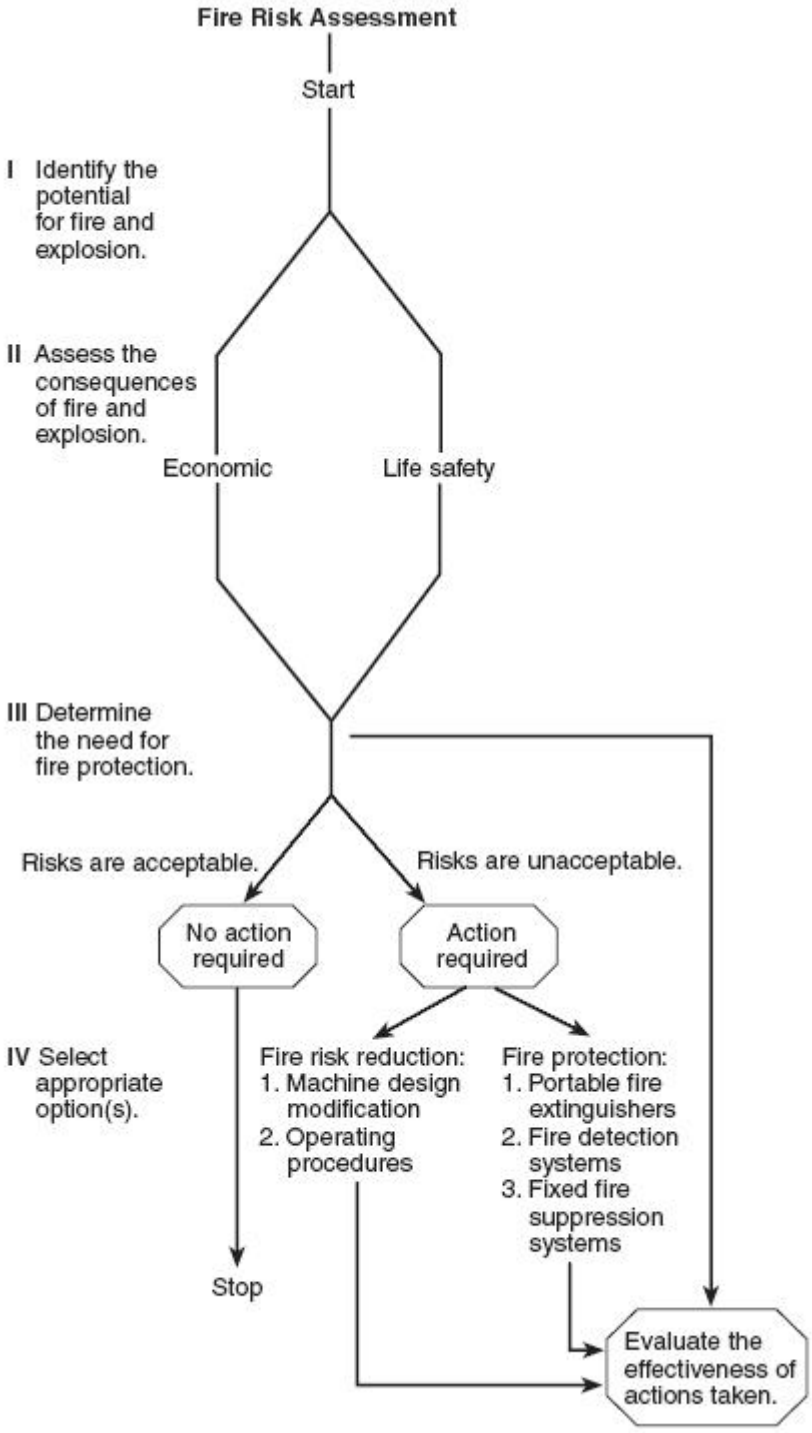

FIGURE B.1 Fire Risk Assessment Chart.

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

B.1.1 Identify the Potential for Fire and Explosion.

B.1.1.1 Ignition sources are as follows:

(1) High temperatures, which are usually found in the vicinity of a vehicle engine and exhaust system; pumps; batteries; wiring; switches; electrical motors; generators; and friction sources such as bearings, brakes, and gears

(2) Electrical, including switch gear; MCC; circuit breakers; motors and generators; transformers; battery boxes; substations; cable reels, trays, and splices; and collector rings

(3) Hot work such as cutting and welding

(4) Other, including smoking materials, chemical reactions, and spontaneous ignition sources

B.1.1.2 Fuel sources are as follows:

(1) Class A, including combustible debris, wood, rags, electrical insulation, coal dust, upholstery, hoses, tires, and seats

(2) Class B, including 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, which includes some new mobile equipment that have magnesium transmission components that cannot be extinguished with conventional fire suppression agents

B.1.1.3 Probability of the coexistence of fuel and ignition sources is as follows:

(1) Proximity of fuel to ignition sources should be assessed as follows:

(a) An assessment should be made of existing areas where lubrication, hydraulic oil, fuel lines, rubber and plastic, and other combustibles are in proximity to an ignition source.

(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.

(2) Previous fire experience on mobile equipment and in industrial settings similar to mining should be considered in the fire risk assessment.

(3) Quality of maintenance should be assessed as follows:

(a) Replacement parts should be at least equal in performance to original parts. Examples are hoses, bearings, fittings, and electrical equipment on mobile equipment or bearings on motors for conveyor systems.

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

(4) The presence of accumulations of combustible materials such as oil-soaked waste and fuel spillage represent potential fire hazards.

B.1.2 Assess the Consequences of Fire and Explosion.

B.1.2.1 Personnel exposure should be assessed as follows:

(1) Determine the number of persons involved and their location during routine and maintenance operations.

(2) Determine the exposure to potential fire and explosion risks for each person and whether the fire and smoke could impair safe egress from his or her work location.

B.1.2.2 Economic risks should be assessed as follows:

(1) Consider the cost of repairs, replacement, cleanup, and damage to the work site.

(2) Items to consider are production loss, personnel overtime, interruption of customer deliveries, and replacement equipment rental.

B.1.3 Determine the Need for Fire Protection.

B.1.3.1 Mandatory Requirements. Certain fire prevention and fire suppression requirements are mandated by company policy, insurance companies, and government agencies.

B.1.3.2 Identified Needs. Additional fire precautions beyond those that are mandated might prove to be necessary, after the fire risk assessment.

B.1.3.3 Evaluation. If the fire risk assessment has disclosed unacceptable personnel risks, economic risks, or both, appropriate fire protection options should be determined. If the risks are found acceptable, no further action is required.

B.1.4 Select Appropriate Option(s).

B.1.4.1 Risk reduction should be considered as follows:

(1) 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) Reduce the threat of fire and explosion through implementation of policies and procedures. 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) 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 action is required either to further reduce hazards or to install fire detection/suppression equipment or a combination of both.

B.1.4.2 Fire detection and suppression equipment should be considered as follows:

(1) Identify available alternatives as follows:

(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 B.1.5.1).*

(b) 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 B.1.5.3 and B.1.5.4.)*

(c) Fixed system protection can be accomplished by local application, total flooding, or a combination of both, or automatic sprinklers. *(For agent selection, see B.1.5.1. For fixed fire suppression system options, see B.1.5.2.)*

(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 action is required either to reduce hazards further or to install fire detection/suppression equipment or a combination of both.

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

B.1.5 Fire Protection Agents and Equipment.

B.1.5.1 The following extinguishants are commonly used in the mining industry for mobile equipment:

(1) Class A agents are as follows:

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

(b) Foams such as protein, fluoroprotein, aqueous film forming, and medium and high expansion

(c) Water

(d) Clean agents (gaseous)

(2) Class B agents are dry chemicals (BC) with sodium bicarbonate, ammonium

phosphate, potassium bicarbonate, urea-based potassium bicarbonate, or potassium chloride as the basic composition, as follows:

(a) Foams such as protein, fluoroprotein, aqueous film forming, and medium and high expansion

(b) Carbon dioxide

(c) Water

(d) Clean agents

(3) Class C agents are dry chemicals (ABC or BC) with sodium bicarbonate, ammonium phosphate, potassium bicarbonate, urea-based potassium bicarbonate, or potassium chloride as the basic composition, as follows:

(a) Carbon dioxide

(b) Water

(c) Clean agents

(4) Class D agents are dry powder agents composed of sodium chloride or graphite with other particulate material added, as well as inert materials such as dry sand, foundry flux, and so on.

B.1.5.2 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:

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

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

(3) A combination of B.1.5.2(1) and B.1.5.2(2) above

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

B.1.5.3 Detector options are as follows:

(1) Automatic fire detection devices are covered by *NFPA 72*, *National Fire Alarm Code*. One fire detection device that is commonly used in self-propelled and mobile mining equipment but is not covered in *NFPA 72* is fusible plastic tube. It comprises 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.

(2) Consideration should be given to the physical configuration of the area to be protected when selecting and locating fire 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 in fire detector placement are

ambient temperature, climatic conditions, shock and vibration, air contamination, ventilation flows, and maintenance requirements.

B.1.5.4 Depending on mining equipment configuration, use, ground speed capability, degree of hazard enclosure, operating personnel locations, and other factors, consideration can be required of system control options such as the following:

(1) Discharge time delay

(2) Discharge abort switch

(3) Audible and visual alarms

(4) Pre-discharge alarm

(5) Detection circuit supervision

B.2 Electrical Ignition Hazards.

Self-propelled and mobile surface mining equipment powered by electrical energy is 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 the following:

(1) Normal overcurrent protection

(2) Ground-fault current limitation (normally to about 15 amperes)

(3) Ground-fault overcurrent tripping (usually at about 7 amperes to 10 amperes)

(4) Monitoring of continuity of the ground conductor in the trailing cable and instantaneous tripping if continuity is lost

(5) Operational damage

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

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.

B.2.1 Assess the consequences of fire, as follows:

(1) Determine whether personnel can be exposed to the effects of a fire. These effects could include the following:

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

(b) Exposure of personnel located away from the equipment fire site to products of combustion by the mine ventilation.

(c) Equipment fire spread to other combustibles such as timber supports, combustible minerals, explosives, and lubricants. Such fires can grow in intensity, producing increased quantities of toxic combustion products, complicating fire-fighting efforts, and interfering with evacuation and rescue operations.

(d) The possibility of the equipment fire or secondary fires causing ventilation disturbances such as throttling or reversals, contaminating escapeways in an unpredictable manner.

(2) Determine the economic loss resulting from a fire on a piece of equipment, including both property damage and business interruption costs, and consider the following factors:

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

(b) Fire spread to nearby combustible material, including combustible mineral seams, can have greater economic effects than the initial fire.

B.2.2 Determine the need for fire protection. If the risk analysis discloses unacceptable personnel risks, economic risks, or both, appropriate fire protection options should be determined.

B.2.3 Select appropriate fire protection option(s), as follows:

(1) Hazard reduction should be considered as follows:

(a) Evaluate equipment to determine if the risk from the start or the spread of a fire can be reduced.

(b) Reduce the threat of fire through implementation of company policies and procedures. Examples include effective equipment maintenance programs, adequate housekeeping procedures, proper employee training, development of emergency plans, and strategies that deal directly with fire.

(c) Determine whether fire risk reduction practices reduce risks to acceptable levels. If risks are acceptable, no further action is necessary. If unacceptable risks still exist, action is needed either to reduce risks further or to install fire detection/suppression equipment, or a combination of both.

(2) Identify available fire detection and suppression equipment alternatives as follows:

(a) Portable protection options include portable hand extinguishers, hose reels and lines, wheeled extinguishers, and skid-mounted extinguishers. For difficult fires, larger capacity extinguishers that provide more agent, greater range, and longer discharge time are recommended. *(See B.1.5.1 for agent selection.)*

(b) Fire detection devices can be used to provide early warning of fires, actuate a fire suppression system, shut down equipment, and operate other fire control systems such as ventilation devices and fire doors. *(For a discussion of detector and control options, selection, and placement, see B.1.5.3 and B.1.5.4.)*

(c) Fixed fire suppression systems should be considered as follows:

i. Accomplish fixed system protection by local application, total flooding, a combination of both, or automatic sprinklers. *[See B.2.3(3) for agent selection. See B.2.3(3)(b)ii for fixed fire suppression options.]*

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

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

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

(3) Fire protection agents and equipment should be considered as follows:

(a) The following extinguishing agents commonly are used in the mining industry:

i. Class A, including dry chemicals (ABC) with ammonium phosphate as the basic ingredient; foams such as protein, fluoroprotein, aqueous film-forming, and medium- and high-expansion; water; and water-based antifreeze solution

ii. Class B, including dry chemicals (BC) with sodium bicarbonate, ammonium phosphate, potassium bicarbonate, urea-based potassium bicarbonate, or potassium chloride as the basic composition; foams such as protein, fluoroprotein, aqueous film-forming, and medium- and high-expansion; carbon dioxide; water spray or fog; and water-based antifreeze solution

iii. Class C, including 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; fixed water spray; and water fog

iv. Class D, including dry powder agents composed of sodium chloride or graphite with other particulate material added and inert materials such as dry sand and foundry flux

(b) Method of application should be as follows:

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

ii. Fixed systems, including local application consisting of a supply of extinguishing agent permanently connected to a distribution system, arranged to discharge onto a defined area or space; total flooding consisting of a supply of extinguishing agent permanently connected to a distribution system, arranged to discharge into an enclosed space; combination of B.2.3(3)(a)i and B.2.3(3)(a)ii; automatic sprinklers consisting of a supply of extinguishing agent (normally water) permanently connected to a distribution system to discharge the suppressant; water spray; and water fog

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

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

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

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

Consideration should be given to the physical configuration of the area or equipment to be protected when selecting and installing detectors. For spacing information, see *NFPA 72*, *National Fire Alarm Code*. Among the factors affecting detector performance are its proximity to a fire, ambient temperatures, climatic conditions, shock and vibration, air contamination, ventilation flows, and maintenance requirements.

(4) Depending on mining equipment configuration, use, ground speed capability,

enclosures, location of operating personnel, and other factors, the following special control options should be considered:

(a) Mechanical or electrical equipment engine shutdown

(b) Discharge time delay

(c) Discharge abort switch

(d) Audible and visual alarms

(e) Pre-discharge alarm

(f) Detection circuit supervision

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

Annex C Informational References

C.1 Referenced Publications.

The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not part of the requirements of this document unless also listed in Chapter 2.

C.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2002 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, 2003 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2003 edition.

NFPA 36, *Standard for Solvent Extraction Plants*, 2004 edition.

NFPA 72®, *National Fire Alarm Code®*, 2002 edition.

NFPA 77, *Recommended Practice on Static Electricity*, 2000 edition.

NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*, 1999 edition.

NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, 2002 edition.

NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting*, 2001 edition.

Fire Protection Handbook, 17th Edition, NFPA, 1991.

C.1.2 Other Publications.

C.1.2.1 API Publications. American Petroleum Institute, 1220 L. Street, N.W., Washington, DC, 20005-4070.

API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks,*2002.

API 650, *Standard for Welded Steel Tanks for Oil Storage,* 2003.

API 2000, *Standard for Venting Atmospheric and Low-Pressure Storage Tanks,* 1999.

C.1.2.2 ASME Publications. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

Boiler and Pressure Vessel Code, 2004.

C.1.2.3 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 56, *Standard Method of Test for Flash Point by the Tag Closed Cup Tester*, 2004 edition.

ASTM D 86, *Standard Method of Test for Distillation of Petroleum Products*, 1993 edition.

ASTM D 93, *Standard Method of Test for Flash Point by the Pensky-Martens Closed Tester*, 2002 edition.

ASTM D 3278, *Standard Method of Tests for Flash Point of Liquids by Setaflash Closed Tester*, 1997 edition.

ASTM E 136, *Standard Method of Test for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C*, 2004 edition.

C.1.2.4 AWS Publications. American Welding Society, 550 N.W. Le Jeune Road, Miami, FL 33126.

AWS F4.1, *Recommended Safe Practices for the Preparation for Welding and Cutting of Containers and Piping,* 1999.

C.1.2.5 SAE Publications. Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

SAE J1511, *Steering for Off-Road, Rubber-Tired Machines,*1994.

C.1.2.6 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 80, *Standard for Steel Inside Tanks for Oil Burner Fuel,* 2003.

UL 142, *Standard for Steel Above-Ground Tanks for Flammable and Combustible Liquids,* 2002.

C.1.2.7 U.S. Government Publications. U.S. Government Printing Office, Washington, DC, 20402.

Title 18, Code of Federal Regulations, Chapter 1, Federal Financial Institutions.

"The Health and Safety Implications of the Use of Diesel-Powered Equipment in Underground Mines," Mine Safety and Health Administration, Arlington VA, 1985.

C.2 Informational References.

The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

C.2.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2003 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2003 edition.

NFPA 52, *Compressed Natural Gas (CNG) Vehicular Fuel Systems Code*, 2002 edition.

NFPA 70, *National Electrical Code®*, 2005 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*, 2004 edition.

NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*, 1999 edition.

C.2.2 U.S. Department of Interior Bureau of Mines Publications. National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161.

The following former Bureau of Mines reports and articles are available for purchase from the NTIS and for Open File (OFR) inspection at the following locations: National Institute for Occupational Safety & Health (NIOSH) Facilities: Pittsburgh, PA and Spokane, WA; U.S. Geological Survey, Reston, VA; and the National MSHA Technical Information Center and Library, Beaver, WV (e-mail: Library@MSHA.gov).

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, 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 from the U. S. Government Printing Office, Washington, DC 20402.

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., “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. BuMines Technology News No. 50, 1978, “Bulldozer Fire Protection.”

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 News 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.”

The following U.S. Bureau of Mines research contract final reports are available from NTIS.

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

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

C.2.3 Other Publications. Jenson, R., ed., “Fire Protection for the Design Professional,” Cahners Books, Boston, MA, 1975.

C.3 References for Extracts.

The following documents are listed here to provide reference information, including title and edition, for extracts given throughout the nonmandatory sections of this standard as indicated by a reference in brackets [ ] following a section or paragraph. These documents are not a part of the requirements of this document unless also listed in Chapter 2 for other reasons.

NFPA 30, *Flammable and Combustible Liquids Code*, 2003 edition.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2003 edition.

NFPA 52, *Compressed Natural Gas (CNG) Vehicular Fuel Systems Code*, 2002 edition.

NFPA 80, *Standard for Fire Doors and Fire Windows*, 1999 edition.

NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*, 2004 edition.