

NFPA® 122

Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities

2023 Edition



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NFPA® 122

Standard for

Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities

2023 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. It was issued by the Standards Council on November 29, 2022, with an effective date of December 19, 2022, and supersedes all previous editions.

This document has been amended by one or more Tentative Interim Amendments (TIAs) and/or Errata. See “Codes & Standards” at www.nfpa.org for more information.

This edition of NFPA 122 was approved as an American National Standard on December 19, 2022.

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 on the storage and handling of flammable and combustible liquids in underground nonmetal mines. As a result, the first edition of NFPA 122 was approved in 1986 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 for 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in NFPA 124, *Standard for Fire Protection of Diesel Fuel and Diesel Equipment in Underground Mines*, which was withdrawn.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 for 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. In addition, the committee incorporated the concept of conducting a fire risk assessment throughout the standard.

For the 2010 edition, the technical committee assigned a task group the responsibility of revising NFPA 122 to update the existing fire protection requirements that were included in portions of the existing Sections 4.3 and 7.4 to improve operator safety and the reliability of the required suppression systems. Similarly, Chapter 12, Fire Prevention and Fire Protection of Surface Mining Equipment, was completely revised to make it consistent with fire protection industry practices and the updated provisions in NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*.

Concurrently, another task group was assigned the responsibility of revising NFPA 122 to include fire protection requirements for hydro-metallurgical solvent extraction (SX) plants. This resulted in two new sections being added into Chapter 13, Section 13.18 for new and existing hydro-metallurgical SX plants and Section 13.19 for new hydro-metallurgical SX plants. Sections 13.18 and 13.19 include a fire risk assessment of the facility and requirements for fixed fire suppression systems.

To support these new sections on hydro-metallurgical SX plants, additional references and definitions were added to Chapters 2 and 3, respectively.

The 2014 edition of NFPA 122 included various technical and editorial updates. The committee also established a common definition and a protection scheme for *self-propelled equipment*, *mobile equipment*, and *portable equipment*.

For the 2020 edition, the technical committee added new fire safety material to Chapter 13 related to the use of combustible concentrators in gravimetric ore concentrator facilities. Direction was also provided regarding best practices for fire suppression and steps to be taken during welding and cutting operations within the vicinity of combustible concentrators. In addition, associated Annex A material has been added for further guidance on fire suppression and welding and cutting operations near combustible concentrators.

In the 2023 edition, the technical committee has added a new Chapter 14, Conveyors, which includes requirements for conveyors to align with NFPA 120, and a new Chapter 15, Ventilation in Underground Mines, which includes safety requirements for ventilation to reduce combustible gas concentrations and align with NFPA 120. In addition, the committee has added a new Chapter 16, Emergency Preparedness and Response, which includes requirements for emergency preparedness and response plans. Revisions have also been made to reorganize and update the requirements in Chapter 13, including new annex material added to strengthen fire protection guidance that relies heavily on risk assessments. Additionally, changes were made throughout the document to the terms *flammable and combustible liquid* to align with the *ignitable (flammable and combustible) liquid* terminology updated in NFPA 30.

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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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NFPA 122

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Information on referenced and extracted 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 ignitable (flammable and combustible) liquids

1.1.3 As applies to underground mining, this standard shall not cover ignitable (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 metal mineral processing plants — whether underground or on the surface — including but not limited to conveying, crushing, fine milling, beneficiation, flotation, hydro-metallurgical solvent extraction, 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 electrorefining 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 ignitable (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*, 2022 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2021 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2022 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2022 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2022 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2019 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2022 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2021 edition.

NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*, 2021 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2022 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2023 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2021 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*, 2023 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2019 edition.

NFPA 70®, *National Electrical Code*®, 2023 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*®, 2022 edition.

NFPA 85, *Boiler and Combustion Systems Hazards Code*, 2023 edition.

NFPA 101®, *Life Safety Code*®, 2021 edition.

NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*, 2023 edition.

NFPA 400, *Hazardous Materials Code*, 2022 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2023 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2023 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2022 edition.

NFPA 2010, *Standard for Fixed Aerosol Fire-Extinguishing Systems*, 2020 edition.

2.3 Other Publications.

2.3.1 ASME Publications. American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

Boiler and Pressure Vessel Code, 2019.

2.3.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*, 2020a.

ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C*, 2019.

ASTM E2652, *Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C*, 2018.

2.3.3 NETA Publications. InterNational Electrical Testing Association, 3050 Old Centre Avenue, Suite 101, Portage, MI 49024.

ANSI/NETA MTS, *Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems*, 2019.

2.3.4 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2021 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2021 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2019 edition.

NFPA 52, *Vehicular Natural Gas Fuel Systems Code*, 2019 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2022 edition.

NFPA 101®, *Life Safety Code*®, 2021 edition.

NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*, 2023 edition.

NFPA 5000®, *Building Construction and Safety Code*®, 2021 edition.

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 defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

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. An NFPA standard, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA manuals of style. When used in a generic sense, such as in the phrases “standards development process” or “standards development activities,” the term “standards” includes all NFPA standards, including codes, standards, recommended practices, and guides.

3.3 General Definitions.

3.3.1 Boiling Point. The temperature at which the vapor pressure of a liquid equals the surrounding atmospheric pressure. [30, 2021]

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. [30, 2021]

3.3.3 Combustible. Capable of undergoing combustion.

3.3.4 Combustible Liquid Storage Area.

3.3.4.1 Combustible Liquid Storage Area — Fixed. An area used for storage of Class II and Class III combustible liquids that is infrequently moved, and where the aggregate quantity present shall not exceed 18,925 L (5000 gal). Handling of liquids incidental to transfer can take place within a storage area. [120, 2023]

3.3.4.2 Small Combustible Liquid Storage Area — Portable. An area used for storage of Class II and Class III combustible liquids that is periodically moved, and where the aggregate quantity present does not exceed 3785 L (1000 gal).

Handling of liquids incidental to transfer can take place within a storage area. [120, 2023]

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. [5000, 2021]

▲ **3.3.6 Container.** Any vessel of 450 L (119 gal) or less capacity used for transporting or storing liquids.

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. [120, 2023]

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. An engineered or pre-engineered 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.

3.3.14.1 Engineered Systems. Those systems requiring individual calculation and design to determine the flow rates, nozzle pressures, pipe size, area, volume protected by each nozzle, quantity of suppression agent, number and types of nozzles, and their placement in a specific system.

3.3.14.2 Pre-Engineered Systems. Those systems having predetermined flow rates, nozzle pressures, and quantities of extinguishing agent and having specific pipe size, maximum and minimum pipe lengths, flexible-hose specifications, number of fittings, and number and types of nozzles. [17, 2021]

3.3.15 Flammable Liquid Storage Area. Area used for storage of Class I liquids. [120, 2023]

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 Section 4.4 of NFPA 30. [30, 2021]

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

3.3.18 Hot Work. Work involving burning, welding, or a similar operation that is capable of initiating fires or explosions. [51B, 2019]

3.3.19 Inherent Safety. A protection layer that relies on the reduction or elimination of hazardous conditions, materials, or processes through changes in the chemistry, physics, and physical design of a process.

3.3.20 Liquid.

△ **3.3.20.1 Combustible Liquid.** Any liquid that has a closed-cup flash point at or above 37.8°C (100°F), as determined by the test procedures and apparatus set forth in Section 4.4 of NFPA 30. Combustible liquids are classified according to Section 4.3 of NFPA 30.

△ **3.3.20.2 Flammable Liquid.** Any liquid that has a closed-cup flash point below 37.8°C (100°F), as determined by the test procedures and apparatus set forth in Section 4.4 of NFPA 30, and a Reid vapor pressure that does not exceed an absolute pressure of 276 kPa (40 psi) at 37.8°C (100°F), as determined by ASTM D323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*. Flammable liquids are classified according to Section 4.3 of NFPA 30.

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.

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. Wheeled, skid-mounted, track-mounted, or rail-mounted equipment capable of moving or being moved.

3.3.27 Noncombustible Material. See Section 4.10.

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

3.3.30 Pipeline System. An arrangement of piping, valves, connections, and allied equipment installed in a mine for the purpose of transporting, transferring, or dispensing ignitable (flammable or combustible) liquids.

3.3.31 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.

3.3.32 Pressure Vessel. A container or other component designed in accordance with the ASME *Boiler and Pressure Vessel Code*. [52, 2019]

3.3.33* 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.

3.3.34 Safety Can. A listed container of not more than 20 L (5.3 gal) capacity having a screen or strainer in each fill and pour opening and having a spring-closing lid and spout cover designed to safely relieve internal pressure when exposed to fire. [30, 2021]

3.3.35 Self-Closing Doors. Doors that, when opened and released, return to the closed position. [80, 2022]

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

3.3.37* 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.

3.3.38 Self-Propelled Equipment. Any unit that contains a motive power train as an integral part of the unit.

3.3.39* Solvent Extraction (SX) Facility. Within this standard, a solvent extraction (SX) facility is a hydro-metallurgical processing facility associated with a mining or mineral refining facility that uses organic or alcohol-based solvents to extract desirable metals.

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 US 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 psi) (i.e., 760 mm Hg through 812 mm Hg) measured at the top of the tank. [30, 2021]

3.3.41.2 Low Pressure Tank. A storage tank designed to withstand an internal gauge pressure above 3.5 kPa (0.5 psi) but not more than 103.4 kPa (15 psi).

3.3.41.3 Portable Tank. Any closed vessel having a liquid capacity over 230 L (60 gal) intended for storing liquids and not intended for fixed installation. [30, 2021]

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 Combustible materials 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 ignitable (flammable or combustible) liquids.

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

4.2.5 Where ignitable (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.

4.4.2 Compressed gases used for hot work shall be stored in accordance with Chapter 4 of NFPA 51.

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 All combustibles shall be relocated at least 11 m (35 ft) in all directions from the work site.

4.4.11 Hot work shall not be performed within 15.24 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) of hot work shall be covered in accordance with 4.4.13.

4.4.13 Where relocation of combustible materials per 4.4.10, 4.4.11, and 4.4.12 is impractical, the materials shall be protected by a listed welding curtain, welding blanket, welding pad, or equivalent.

4.4.14 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.

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

4.4.16 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.

4.4.17 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.

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

4.4.19 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.

4.4.20 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.

4.4.21 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.

4.4.22* 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.

4.4.23 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.

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

4.4.25 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.

4.4.26 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 1 hour after completion of hot work operations to detect and extinguish smoldering combustibles.

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

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

4.4.29 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.

4.6.2 Any fire suppression system shall be inspected, tested, and maintained in accordance with the manufacturer's listed installation and maintenance manual or owner's manual (inspection) and the applicable NFPA standard for the type of system.

4.6.2.1 A fire suppression system, approved for use on diesel-powered, mobile, and self-propelled equipment, shall be inspected on a monthly basis or more frequently as required by the manufacturer.

4.6.2.2 Inspections shall be in accordance with the fire suppression system manufacturer's listed installation and maintenance manual or owner's manual.

4.7 Training.

4.7.1 All site personnel shall receive annual instruction on the different classes of fires and types of firefighting 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 Ignitable (Flammable and Combustible) Liquid Handling and Storage.

4.8.1 For surface operations, ignitable (flammable and combustible) liquid handling and storage shall be in compliance with NFPA 30.

4.8.2 For underground operations, ignitable (flammable and combustible) liquid handling and storage shall be in compliance with Chapters 9, 10, and 11 of this standard.

4.8.3 Ignitable (flammable or combustible) liquids shall not be stored or processed underneath cable trays or inside cable-spreading rooms or tunnels.

4.8.4 Ignition.

4.8.4.1 Precautions shall be taken to prevent the ignition of ignitable (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 from approved dispensing pumps and nozzles only at locations designated for that purpose or evaluated for risks in accordance with Chapter 5.

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.

N 4.10* Noncombustible Material. A material that complies with any of the following shall be considered a noncombustible material:

- (1)* 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
- (2) A material that is reported as passing ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C*
- (3) A material that is reported as complying with the pass/fail criteria of ASTM E136 when tested in accordance with the test method and procedure in ASTM E2652, *Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C*

[101:4.6.13]

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 ignitable (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 firefighting 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 The fire risk 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 firefighting 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 Fire Extinguishers.

6.1.1 General Requirements. 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 that comply with NFPA 10.

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

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

6.1.4 At least one hand-portable fire extinguisher having a nominal capacity of 9.1 kg (20 lb) or greater and a minimum rating of 10-A:60-B:C shall be located outside of, but not more than 3 m (10 ft) from, the opening into each ignitable (flammable and combustible) liquid storage or dispensing area and maintenance shop.

6.1.5 Where portable fire extinguishers are provided within ignitable (flammable and combustible) liquid storage or dispensing areas and maintenance shops, travel distance to a portable extinguisher shall not exceed 9.1 m (30 ft).

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 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.

6.3.3 Fire detection systems in underground mines, on underground diesel-powered equipment, and on surface mobile and self-propelled equipment shall be tested in accordance with NFPA 72 or the manufacturer's recommendations, whichever is more stringent.

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.

Δ 6.4.1 Fire suppression systems shall be designed, installed, and tested in accordance with the following NFPA standards:

- (1) NFPA 11
- (2) NFPA 12
- (3) NFPA 12A
- (4) NFPA 13
- (5) NFPA 17
- (6) NFPA 17A
- (7) NFPA 25
- (8) NFPA 750
- (9) NFPA 2001
- (10) NFPA 2010

6.4.1.1 A pre-engineered fire suppression system shall be approved for use and shall be designed, installed, and tested in accordance with the fire suppression system manufacturer's listed installation and maintenance manual.

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 diesel-powered equipment 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 that system shall have the following characteristics:

- (1) Be listed or approved for the purpose
- (2) Be automatically actuated by a fire detection system
- (3)* Have one manual actuator in the operator's compartment and at least one additional actuator accessible from the ground
- (4) Be provided with an agent container and a network of agent distribution hoses or pipes with discharge nozzles
- (5) 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
- (6) Have all system components secured and protected against damage, including abrasion and corrosion
- (7) Be installed so that the system actuation causes shutdown of the protected equipment
- (8) Permit up to a 30-second agent discharge delay
- (9) Include a standby source of power if electrical power is the only means of actuation
- (10) Have an installation and maintenance manual or owner's manual

7.4.1 Post-installation testing shall be in accordance with the manufacturer's or designer's recommendations.

7.4.2 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.

Chapter 8 Transfer of Ignitable (Flammable or Combustible) Liquids in Underground Mines

8.1 Fire Risk Assessment. The fire risk assessment for surface ignitable (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 Ignitable (Flammable and Combustible) Liquid Storage to Underground Openings.

8.2.1 Surface ignitable (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 ignitable (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 Ignitable (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 ignitable (flammable or combustible) liquids unless the items are secured or are small and can be carried safely by hand.

8.3.3 Where ignitable (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 ignitable (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 ignitable (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 Ignitable (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 ignitable (flammable or combustible) liquid pipeline systems.

8.4 Underground Transfer.

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

8.4.2 Ignitable (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 Ignitable (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 ignitable (flammable or combustible) liquids shall be kept clear of accumulations of oil, grease, and other combustible material.

8.4.5 Vehicles transporting ignitable (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 ignitable (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 *NEPA 70*, 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 IA 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 US 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.

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 ignitable (flammable or combustible) liquid storage areas by at least 15.24 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 ignitable (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.

Table 9.2.2 Maximum Allowable Size of Containers for Flammable Liquids

Container Type	Class IA		Class IB		Class IC	
	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	227.12	60	227.12	60

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*, 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 m² (100 ft²).

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 Section 9.5 of *NFPA 30* 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 9.1 m (30 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 15.24 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 **US** 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 190,000 L (50,000 gal) in any single storage area.

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.

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.

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

Container Storage						
Class	Maximum Pile Height		Maximum Quantity per Pile		Maximum Total Quantity	
	m	ft	L	gal	L	gal
II	2.1	7	7,570	2,000	15,100	4,000
IIIA	2.1	7	26,500	7,000	53,000	14,000
IIIB	2.1	7	26,500	7,000	106,000	28,000
Portable Tank Storage						
II	3.0	10	11,360	3,000	22,700	6,000
IIIA	3.0	10	41,640	11,000	83,300	22,000
IIIB	3.0	10	41,640	11,000	166,600	44,000

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 1.2 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.

10.9.6 Single-row or double-row rack storage (*see Table 10.9.5.1*) shall be separated by minimum 2.4 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 m² (250 ft²) and a maximum storage height of 2.1 m (7 ft).

10.9.8 Idle pallet storage shall be separated from combustible liquids by at least 1.2 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 ignitable (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.

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

Class	Maximum Storage Height				Maximum Quantity per Pile			
	Containers		Portable Tanks		Containers		Portable Tanks	
	m	ft	m	ft	L	gal	L	gal
II	2.1	7	3.0	10	28,400	7,500	75,700	20,000
III	3.0	10	4.6	15	37,850	10,000	75,700	20,000

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

Class	Rack Type	Maximum Storage Height		Maximum Quantity per Rack	
		m	ft	L	gal
II	Double row or single row	4.6	15	34,000	9,000
III	Multirow, double row, or single row	6.1	20	90,850	24,000

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 15.24 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 9.1 m (30 ft) from any area where combustible liquid is dispensed.

10.10.7 Spillage shall be cleaned up.

Chapter 11 Fire Suppression for Ignitable (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 9.1 m (30 ft).

11.2 Hand Hose Line Systems. Hand hose lines designated for firefighting 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.

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.

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 shall not be required.

Δ 11.3.4 Fire suppression systems other than automatic foam-water sprinkler systems in underground mines shall be in accordance with NFPA 11, NFPA 12, NFPA 12A, NFPA 17, and NFPA 2001.

Chapter 12 Fire Prevention and Fire Protection of Surface Mining Equipment

12.1 General. This chapter shall cover haul trucks, front end loaders, bulldozers, graders, scrapers, blast hole drills, shovels, hydraulic and bucket wheel excavators, draglines, and other mobile and self-propelled equipment.

12.2* Fire Prevention. Risk reduction practices shall follow the principles of minimizing ignition sources and reducing exposure of combustible materials to ignition sources.

12.2.1 Housekeeping.

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

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

12.2.1.3 The storage and handling of ignitable (flammable or combustible) liquids on or within equipment shall be in accordance with Chapter 17 of NFPA 30.

12.2.1.4 Access to fire protection equipment on mining equipment shall be kept clear of obstructions.

12.2.2 Inspection and Maintenance of Equipment. Hydraulic, coolant, lubrication and fuel lines, electrical wiring, and fire prevention devices shall be inspected and maintained in accordance with the manufacturers' recommendations.

12.2.3 Ignitable (Flammable and Combustible) Liquid Storage on Equipment. Ignitable (flammable and combustible) liquid storage and usage shall be in accordance with Section 4.8.

12.2.4 Compressed Gas Storage and Usage. Compressed gas storage and usage shall be in accordance with Section 4.4.

N 12.2.5* Battery Electric Vehicles. (Reserved)

12.3 Fire Protection.

12.3.1 Fire protection for the purposes of this standard shall be defined in the broad sense to include fire detection and fire suppression.

12.3.2 Fire suppression systems shall include dry chemical, wet chemical, gaseous, water mist, foam, or sprinklers.

12.3.3 Fire suppression systems and fire alarm systems shall be installed in accordance with applicable NFPA standards.

12.3.4 Portable Fire Extinguishers.

12.3.4.1* 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.

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

12.3.4.3 The fire-extinguishing agent applied by hand-portable extinguishers to hazards involving energized electrical equipment shall be nonconductive.

12.3.4.4 Portable fire extinguishers shall be maintained in accordance with NFPA 10 and kept in their designated places at all times.

12.3.4.5 Portable fire extinguishers shall be located on each vehicle and shall be accessible.

12.3.4.6 In areas where obstruction to visual observation cannot be completely avoided, visible markings shall be provided to indicate the location of the portable fire extinguishers.

12.3.4.7 Extinguishers installed under conditions where they can be subject to physical damage shall be guarded to protect against damage.

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

12.3.4.9 Portable fire extinguishers shall be inspected, maintained, and recharged as specified in Chapter 7 of NFPA 10 and the following:

- (1) Portable fire extinguishers shall be inspected visually at least monthly.
- (2) The visual inspection shall ensure the following:
 - (a) The extinguisher is in its designated place.
 - (b) The tamper seals are intact.
 - (c) The extinguisher gauge is in the operable range (if the extinguisher is the stored-pressure type).
 - (d) There is no obvious physical damage or condition that will prevent proper operation.
- (3) Extinguishers found to be defective or deficient by visual inspection shall be replaced.
- (4) Extinguishers shall be subjected to a maintenance examination at least once every year.
- (5) Maintenance procedures shall include a thorough examination of the extinguishers, including mechanical parts, extinguishing agent, and expellant.
- (6) Any troubles or impairments shall be corrected.
- (7) All extinguishers shall be recharged after use in accordance with the manufacturer's recommendations.
- (8)* Each extinguisher shall have a permanent tag attached on which the inspection date shall be recorded.

12.3.4.10 Portable extinguishers shall be tested hydrostatically at intervals not exceeding those specified in Chapter 8 of NFPA 10.

12.3.5 Draglines, Bucket Wheel Excavators, Electric Shovels, and Hydraulic/Electric Excavators.

12.3.5.1 Center Pin/Collector Ring Area.

12.3.5.1.1 An automatic fire suppression system shall be installed in the center pin/collector ring area. If an electrical spark cannot communicate from the collector ring (e.g., a sealed ring) to the grease around the center pin, a fire suppression system is not required.

12.3.5.1.2 An automatic fire suppression system shall be installed in the ring gear area.

12.3.5.1.3 An audible and visual suppression system alarm shall be transmitted to the operator's cab.

12.3.5.1.4 A manual actuator shall be provided just outside the center pin/collector ring area.

12.3.5.2 Hydraulics.

12.3.5.2.1 An automatic fire suppression system shall be installed to protect the hydraulic pump(s), hydraulic control valves, and associated lines and equipment in the hydraulic pump area and other areas where fires can spread.

12.3.5.2.2* The system shall send audible and visual alarms to the operator's cab.

12.3.5.2.3 A manual actuator shall be located just outside the hydraulic compartment area.

12.3.5.3 Lube Oil Pumping and Storage.

12.3.5.3.1* Automatic lube oil systems that are located in a segregated room shall be provided with an automatic fire suppression system.

12.3.5.3.2 The system shall send an audible and visual alarm to the operator's cab.

12.3.5.3.3 A manual actuator shall be located just outside the lube oil room.

12.3.5.3.4 Lube oil rooms shall have automatic door closers or shall have the door interlocked to shut upon actuation of the fire suppression system.

12.3.5.4 Transformers.

12.3.5.4.1 Oil-filled transformers located in the tail section, enclosed rooms, or other inaccessible locations shall be provided with an automatic fire suppression system.

12.3.5.4.1.1 The system shall transmit an audible and visual alarm to the operator's cab.

12.3.5.4.1.2 A manual actuator shall be located just outside the transformer area.

12.3.5.4.2* Transformers located in areas other than those listed in 12.3.5.4.1 shall be protected with a Class B:C, minimum 45.4 kg (100 lb) fire extinguisher.

12.3.5.4.3 Oil analysis, including dissolved gas, shall be conducted on combustible oil-filled transformers based upon manufacturer's recommendations or the ANSI/NETA MTS, *Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems*, whichever is more stringent.

12.3.5.4.4 Thermographic scanning shall be performed on transformers on an annual basis.

12.3.5.5 Electrical Room or Cabinet.

12.3.5.5.1 Enclosed electrical rooms shall be protected with a total flooding gaseous extinguishing agent or equivalent fire suppression system.

12.3.5.5.1.1 The gaseous extinguishing system shall be installed in accordance with NFPA 2001.

12.3.5.5.1.2 The gaseous extinguishing system shall be actuated by a smoke, ultraviolet/infrared (UV/IR), or heat detector system and send an audible and visual alarm to the operator's cab.

12.3.5.5.1.3 The ventilation system shall be interlocked to the gaseous extinguishing system to shut down upon first detection.

12.3.5.5.1.4 The room shall be sealed to maintain the design gaseous extinguishing concentration.

12.3.5.5.2 Electrical rooms shall be maintained at a positive pressure to reduce the chances of dust entering the room.

12.3.5.5.3 Electrical cabinets shall be protected with a gaseous fire suppression system.

12.3.5.5.3.1 The system shall be installed in accordance with NFPA 2001.

12.3.5.5.3.2 The system shall be actuated by a smoke, UV/IR, or heat detector system and send an audible and visual alarm to the operator's cab.

12.3.5.6 Manual Extinguishing Equipment.

12.3.5.6.1 Minimum 45.4 kg (100 lb) ABC-type extinguishers shall be accessible to persons on the main deck of the dragline.

12.3.5.6.2 The location and number of extinguishers shall be determined by what is practical for the machine.

12.3.6 Hydraulic/Diesel Excavators.

12.3.6.1 An automatic fire suppression system shall be provided to protect the engine compartment, hydraulic pumps, and associated equipment.

12.3.6.1.1* For diesel-powered generators with hydraulic systems containing more than 567.8 L (150 gal) in the lines, a dual agent system shall be provided.

12.3.6.1.2 A manual actuator shall be located in the operator's cab and at the means of egress from the machine.

12.3.6.2 The machine shall be interlocked to shut down upon discharge of the extinguishing system.

12.3.6.3 A means shall be provided to automatically relieve the hydraulic pressure upon discharge of the extinguishing system.

12.3.6.4 Adequate fire resistance shielding shall be provided between the hydraulic hoses and the turbocharger and engine manifold to prevent hydraulic fluid from being sprayed on hot mechanical parts.

12.3.6.5 The fire detection electrical wiring within fire hazard areas, such as battery compartments, engine compartments, and so forth, shall be outfitted with a fire-resistant sleeve.

12.3.6.6 Fire suppression system manual actuation lines shall not be routed near high heat surfaces and shall not be routed within fire hazard areas unless fitted with fire-resistant sleeves.

12.3.7 Mobile Equipment.

12.3.7.1 Fire Protection. Portable extinguishers installed on mobile mining equipment, including but not limited to mobile generators and compressors, shall have a minimum rating of 2-A:10-B:C and a nominal capacity of 2.3 kg (5 lb) of extinguishing agent.

12.3.8 Self-Propelled Equipment.

12.3.8.1 Portable Fire Extinguishers.

12.3.8.1.1* All self-propelled quarrying, open-pit, aggregate, and surface mining equipment, including but not limited to bulldozers, front-end loaders, haulage trucks, cranes, graders, scrapers, draglines, drills, shovels, floating dredges, screening equipment, both diesel and electrical equipment, shall be equipped with at least one listed, portable, multipurpose (ABC), dry chemical extinguisher having a nominal capacity of 4.5 kg (10 lb) or greater of agent.

12.3.8.1.2 Portable extinguishers installed on small units of self-propelled mining equipment, including but not limited to miniature loaders and individual personnel transports, shall have a minimum rating of 2-A:10-B:C and a nominal capacity of 2.3 kg (5 lb) of extinguishing agent.

12.3.8.2 Fire Detection.

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

12.3.8.2.2 Fire detectors shall be tested and listed for the application.

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

12.3.8.2.4 All fire detection systems and applicable equipment shall be tested after installation in accordance with *NFPA 72* and fire suppression systems standards.

12.3.8.2.4.1 It shall not be necessary for testing to require the discharge of any associated fire suppression system.

12.3.8.2.5* At least every 6 months, all fire detection systems, including alarms, shutdowns, and other associated equipment, shall be thoroughly examined and checked for proper operation in accordance with the manufacturer's recommendations.

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

12.3.8.2.6 Between the maintenance examinations or tests, the detection system shall be inspected visually, in accordance with an approved schedule necessitated by conditions as determined by the mine operator.

12.3.8.3 Fixed Suppression Systems.

12.3.8.3.1 Haul trucks with a capacity of over 77 metric tons (85 tons) shall have a fixed fire suppression system protecting

the engine compartment and hydraulic pump and other hazard areas.

12.3.8.3.2* Other large mining equipment such as, but not limited to, bulldozers, end loaders, drills, graders, and scrapers shall have a fixed fire suppression system protecting the engine compartment and hydraulic pump and other hazard areas.

N 12.3.8.3.3 Self-propelled equipment with a hydraulic system that exceeds 568 L (150 gal) in the lines shall be provided with a dual-agent fire suppression system.

12.3.8.3.4 Mining equipment requiring a fire suppression system shall be protected by a system to suppress potential fires in the protected areas and shall comply with the following:

- (1) The fire suppression system shall be listed or approved for the purpose.
- (2) Where installed, the equipment shall be located or guarded so as to be protected against physical damage.
- (3) Fire suppression systems shall be automatically actuated.
- (4)* Automatically actuated systems shall also have a manual actuator capable of being activated from the operator's compartment or other location.
- (5) Agent distribution hose or pipe shall be secured and protected against damage, including abrasion and corrosion.
- (6) Except for automatic sprinkler systems, discharge nozzles shall be protected against entrance of environmental debris, including moisture, dust, dirt, or insects, by blow-off caps or other similar devices or materials.
- (7) Except for automatic sprinkler systems, the nozzle cover shall open or blow off upon discharge of the system.
- (8) The automatic fire suppression system shall be installed so that system actuation causes shutdown of the protected equipment.
- (9) 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.

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

12.3.8.3.6 All fire suppression equipment and systems shall be tested after installation in accordance with the manufacturer's or designer's recommendations.

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

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

12.3.8.3.8* In accordance with the manufacturers' or designers' recommended inspection and maintenance procedures and schedules, but not to exceed every 6 months, all fire suppression systems, including alarms, shutdowns, and other associated equipment, shall be thoroughly examined and checked for proper operation by trained and competent personnel.

12.3.8.3.8.1 Any equipment found deficient shall be repaired or replaced, and the system retested for proper operation.

12.3.8.3.8.2 Between regular maintenance examinations or tests, the system shall be inspected visually, in accordance with the manufacturer's or designer's recommended schedule.

12.3.8.3.8.3 Testing shall be in accordance with the applicable NFPA standards.

12.3.8.3.9 Fire suppression systems shall be maintained in operating condition at all times.

12.3.8.3.10 Use, impairment, and restoration of the system shall be reported to the mine operator.

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

12.3.8.3.12 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.

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

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) Ignitable (flammable and combustible) liquids mixing buildings and tank farms
- (5) Other ore processing facilities such as filter rooms, process pump houses, and thickeners
- (6) Electrical or control spaces containing transformers, concentrated power cabling trays, motor control centers (MCC), switchgear, concentration of control wiring trays, wire spreading, control equipment, and operator control 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 Firefighting.

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

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

13.2.3 Training of the firefighting 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 m² (5000 ft²) 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.

13.5 Egress and Exiting.

13.5.1 Two means of egress in accordance with NFPA 101 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 Section 7.9 of NFPA 101.

13.5.3 Emergency exit signs shall be provided at the means of egress stairways in accordance with Section 7.10 of NFPA 101.

13.6 Yard Hydrant Systems.

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

N 13.6.2 Where provided, yard hydrants shall not be spaced less than 91 m (300 ft).

13.6.3 Yard hydrants shall be in accordance with NFPA 24.

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 firefighting 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.

13.8 Ignitable (Flammable and Combustible) Liquids.

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

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.

Δ 13.9* Compressed Gases. The storage, use, and handling of compressed gases shall be in accordance with relevant standards.

N 13.10* Oxidizers. The storage, use, and handling of oxidizers (liquid or gas) shall be in accordance with NFPA 400.

13.11 Belt Conveyors.

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

13.11.2 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.

13.11.3 Sequence switches shall be provided on contributing conveyors to prevent any operating conveyor from discharging material to a stopped downstream conveyor.

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

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

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

13.12 Rubber- and Plastic-Lined Equipment.

13.12.1* The fire risk assessment as required in Section 5.1 shall include an evaluation of each of the following:

- (1)* Engineered methods for eliminating or reducing the fire hazard
- (2)* Engineered methods to eliminate or control ignition source hazards
- (3) Availability of trained firefighting personnel and manual firefighting equipment, as well as safe their accessibility to attack the fire or defensively limit thermal damage
- (4) Fixed water-based fire protection systems at lined equipment openings
- (5) Ability to start process pumps to flood or at least flow water through subject dry equipment

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

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

13.12.4 The label shall be clearly visible.

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

N 13.12.5.1 In addition to the requirements of NFPA 51B, where welding or cutting operations are to occur directly above or within 10.5 m (35 ft) of open rubber- or plastic-lined equipment, and for closed equipment, where hot surfaces or sparks might expose rubber or plastic linings, the following fire prevention measures shall be taken:

- (1) A hot work permit shall be created and approved by an individual designated by management to authorize cutting and welding operations before commencing welding or cutting work.
- (2) The hot work permit shall, at a minimum, include the requirements for performing a risk assessment before work commences in accordance with requirements in Section 4.4.
- (3) Lines shall be flushed with water to thoroughly wet internal surfaces and shall be wetted periodically as required by the authority having jurisdiction for the duration of welding and cutting activities.
- (4) A trained fire watch shall be posted within the visual vicinity of the lined equipment when hot work is in process and shall be guided by the provisions in 4.4.24, 4.4.25, 4.4.26, and 4.4.27.
- (5) A fire watch shall be maintained for a minimum of 1 hour following completion of all hot work.
- (6) A charged water hose line or fire extinguishers shall be available during hot work as prescribed in 4.4.23.
- (7) Interconnected lined equipment shall be flooded or isolated to prevent ignition near the hot work area and limit fire spread.

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

13.12.7 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.

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

13.12.9* A written **preplanned** procedure for emergency response shall be developed for fighting an internal rubber- or plastic-lined equipment fire.

N 13.12.10* Where supported by the fire risk analysis or required by the authority having jurisdiction, fixed water-based fire protection systems shall be required at openings in rubber- or plastic-lined equipment.

13.13 Plastic Equipment (Other than Spirals).

13.13.1* The fire risk assessment required in Section 5.1 shall include an evaluation of each of the following:

- (1)* Engineered methods for eliminating or reducing the fire hazard
- (2)* Engineered methods to eliminate or control ignition source hazards
- (3) Availability of trained firefighting personnel and manual firefighting equipment, as well as safe their accessibility to attack the fire or defensively limit thermal damage
- (4) Fixed water-based fire protection systems over plastic equipment and at equipment openings
- (5) Ability to start process pumps to flood or at least flow water through subject dry equipment

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

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

13.13.4 The label shall be clearly visible.

Δ 13.13.5 In addition to the requirements of NFPA 51B, where welding or cutting operations are to occur directly above or within 10.5 m (35 ft) of plastic equipment, and for closed equipment, when hot surfaces or sparks can expose plastic surfaces, the following fire prevention measures shall be taken:

- (1) A hot work permit shall be created and approved by an individual designated by management to authorize cutting and welding operations before commencing welding or cutting work.
- (2) The hot work permit shall, at a minimum, include the requirements for performing a risk assessment before work commences in accordance with Section 4.4.
- (3) Lined equipment shall be flushed with water to thoroughly wet internal surfaces and shall be wetted periodically as required by the authority having jurisdiction for the duration of welding and cutting activities.
- (4) A trained fire watch shall be posted within the visual vicinity of the plastic equipment when hot work is in process and shall be guided by the provisions in 4.4.24, 4.4.25, 4.4.26, and 4.4.27.

- (5) A fire watch shall be maintained for a minimum of 1 hour following completion of all hot work.
- (6) A charged water hose line or fire extinguishers shall be available during hot work as prescribed in 4.4.23.
- (7) Interconnected lined equipment shall be flooded or isolated to prevent ignition near the hot work area, and limit fire spread.

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

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

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

13.13.9 A written **preplanned** procedure for emergency response shall be developed for fighting a plastic equipment fire.

N 13.13.10* Where supported by the fire risk assessment or required by the authority having jurisdiction, fixed water-based fire protection systems shall be required over plastic equipment.

13.14 Gravimetric Ore Concentration Plants Using Combustible Spiral Concentrators.

Δ 13.14.1 The fire risk assessment as required in Section 5.1 shall include an evaluation of each of the following:

- (1)* Engineered methods for eliminating or reducing the fire hazard
- (2)* Engineered methods to eliminate or control ignition source hazards
- (3)* Potential for fire propagation/spread beyond initial fuel package involved to secondary fuel packages and/or other mineral processing areas
- (4) Availability of trained firefighting personnel and manual firefighting equipment, as well as safe their accessibility to attack the fire or defensively limit thermal damage
- (5) Fixed water-based fire protection systems over spirals
- (6) Ability to start process pumps to flood or at least flow water through subject dry equipment

Δ 13.14.2 In addition to the requirements of NFPA 51B, where welding or cutting operations are to occur directly above or within 10.5 m (35 ft) of a gravimetric ore spiral concentrator, the following fire prevention measures shall be taken:

- (1) A hot work permit shall be created and approved by an individual designated by management to authorize cutting and welding operations before commencing welding or cutting work.
- (2) The hot work permit shall, at a minimum, include the requirements for performing a risk assessment before work commences in accordance with Section 4.4.
- (3) Spirals shall be flushed with water to thoroughly wet the spiral surfaces and shall be wetted periodically as required by the authority having jurisdiction for the duration of welding and cutting activities.
- (4) A trained fire watch shall be posted within the visual vicinity of the spirals when hot work is in process, and shall be guided by the provisions in 4.4.24, 4.4.25, 4.4.26, and 4.4.27.

- (5) A fire watch shall be maintained for a minimum of 1 hour following completion of all hot work.
- (6) A charged water hose line or fire extinguishers shall be available during hot work as prescribed in 4.4.23.
- (7) Fire-resistant barriers shall be used where practical to isolate the spirals from hot material or debris.
- (8) Signage shall be posted permanently around spirals, prohibiting smoking or open flame and requiring approved hot work permits before commencing any welding or cutting tasks in accordance with 4.3.2.

13.14.3* Where supported by the fire risk analysis or required by the authority having jurisdiction, fixed water-based fire protection systems shall be required for the spirals.

13.15 Hydraulic Fluids and Lubricating Oil Systems.

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

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

13.15.3 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 15.24 m (50 ft) from the hydraulic system or in a separate cutoff area from the hydraulic system

13.15.4 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.

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

13.16* Thermal Oil Heating Systems.

▲ **13.16.1*** 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
- (2) Interlocks to shut off the thermal oil system upon detecting upset system conditions, or actuation of a fixed fire protection system or fire detection system
- (3) Automatic fixed fire protection system inside the cutoff room

13.16.2 Acceptable fixed fire protection systems described in 13.16.1(3) shall include automatic sprinklers, water spray systems, or foam-water systems.

13.17 Fuel-Fired Equipment. Burner management systems for solid, gas, and liquid fuel delivery systems shall be in accordance with NFPA 85.

13.18* Electrical and Control Equipment Spaces.

13.18.1* The fire risk assessment shall be used to determine fire protection requirements for rooms or areas containing switchgear, motor control centers, concentration of power

cabling, transformers, concentration of control wire trays, control wire spreading, control equipment, and operator control rooms.

13.18.2 Electrical equipment shall be installed, tested, inspected, and maintained in accordance with NFPA 70.

▲ **13.18.3** When warranted per the risk assessment, electrical and control equipment spaces shall be protected with an acceptable fire protection system, including but not limited to noncombustible cutoff rooms and barriers, fire detection, fire-retardant coatings, automatic fixed fire protection systems (sprinklers, water spray, water mist, foam-water, gaseous suppression, dry chemical), and portable extinguishers.

13.19 Battery Charging Installations.

13.19.1 Battery charging installations shall have continuous ventilation for the removal of generated gases during battery charging.

13.19.2 Means shall be provided to flush spilled electrolyte.

13.20* Hydro-Metallurgical Solvent Extraction (SX) Facilities. This section shall apply to both new and existing SX facilities.

13.20.1* The fire risk assessment as required in Section 5.1 shall include an evaluation of each of the following:

- (1) Use of inherent safety in design of facilities
- (2) Methods for reducing or eliminating hazardous fire conditions
- (3) Impact of radiant heat, wind effects, and liquid drainage patterns
- (4) Use of detection and early fire-warning devices
- (5) Use of fixed fire protection systems
- (6) Requirements for on-site fire water availability, quality, and capacity
- (7) 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
- (8) Compartmentalization of equipment, isolation of areas, or provision of barriers or enclosures to prevent or contain the spread of fire
- (9) Use of drainage systems to channel spilled solvents during a fire emergency
- (10) Availability and accessibility of firefighting personnel and fire suppression equipment
- (11) Spread of fire to combustible materials in proximity
- (12) Any other devices or procedures necessary to protect life and property
- (13) Use of combustible plastics in construction and process equipment
- (14) Prevention of mist and aerosol generation
- (15) Ignition source control
- (16) Production and elimination of static electrical sources
- (17) Impact of altitude on flash point of the solvents used

13.20.1.1 The fire risk assessment shall not preclude the need for the requirements of Section 13.20.

13.20.2 Yard hydrants shall be installed to cover the entire SX facility.

13.20.2.1 Water duration for yard hydrant systems shall be for 120 minutes.

13.20.2.2 Yard hydrants shall be provided with foam injection capability.

13.20.3 Hot work shall be controlled in SX facilities in accordance with Section 4.4.

13.20.4 Electrical equipment shall be designed in accordance with electrical hazard classification ratings in *NFPA 70* based on the flammability and process conditions of the solvent.

13.20.5* To prevent static electrical charges, all metallic piping and vessels containing ignitable (flammable or combustible) liquids or vapors shall be bonded and grounded.

13.20.6 Where nonconductive plastic pipes, vessels or flanges are used and cannot be grounded, static charge shall be eliminated by other means.

13.20.7 Enclosed buildings containing ignitable (flammable or combustible) liquids shall be mechanically ventilated in accordance with NFPA 30.

13.20.8* Outdoor mixer-settler cells and other process equipment with covers shall not require mechanical ventilation.

13.20.9* Fire detection with alarm shall be provided where ignitable (flammable or combustible) liquids are present, including but not limited to over solvent tanks, in pipe trenches, over pumps, and inside mixer-settler buildings.

13.20.10* As part of the emergency response, provisions shall be made to shut off valves on pregnant liquor supply (PLS) lines and on organic solvent lines.

13.21* New Solvent Extraction (SX) Facilities. This section shall apply to new SX facilities.

13.21.1 Fixed fire protection shall be provided for the following SX facility areas and equipment:

- (1) Buildings housing SX processes
- (2) Interior of all mixer-settler vessels/cells
- (3) Crud tanks that include treatment filters and centrifuges
- (4) Coalescers
- (5) Along launders and weirs outside of mixer-settler vessels
- (6) Inside pipe trenches carrying solvents
- (7) Inside organic solvent and diluent tanks
- (8) Inside dikes enclosing organic solvent storage tanks
- (9) Over organic solvent pumps
- (10) Over elevated pipe racks carrying organic solvents in plastic pipes
- (11) Other areas handling, processing, or exposed to ignitable (flammable or combustible) liquids

13.21.1.1* Fire suppression for applications in 13.21.1 shall be water, foam, dry chemical, or water mist.

Δ 13.21.1.2* Design of fire suppression systems in 13.21.1 shall be based on criteria set forth in NFPA 11, NFPA 15, and NFPA 17.

13.21.1.3* Actuation of fire suppression systems in 13.21.1 shall be automatic.

13.21.2 As exposure protection, automatic water-only deluge (open-head) sprinkler systems shall be provided between mixer-settler trains if spaced closer than 15.24 m (50 ft) from each other.

13.21.3 As exposure protection, automatic water-only deluge sprinkler systems shall be provided around the exterior perime-

ter of organic solvent tanks if spaced closer than 15.24 m (50 ft) from each other.

13.21.4 As exposure protection, automatic fire suppression shall be provided over other critical equipment (i.e., transformers) or outside along important building walls [i.e., motor control center (MCC) rooms] that are within 15.24 m (50 ft) of a solvent fire area.

13.21.5 Hydraulic design of automatic fire suppression systems in 13.21.1 shall include the simultaneous operation of all fire protection systems associated with a single (multi-cell) train.

13.21.6 The total flow rate of foam application and water associated with the discharge of automatic fire extinguishing systems, fixed monitors, and hydrants shall determine the total volume of fire water required.

13.21.7 Solvent spills from the SX facility shall be drained to a safe area, such as a catchment area or pond, via buried or enclosed piping or channels.

13.21.7.1 The drainage system design shall consider both solvent flow as well as water flow from fire suppression systems.

13.21.7.2 Drainage piping or channeling systems shall be arranged to prevent burning solvents from flowing to the safe catchment area or pond.

13.21.7.3 Concrete, steel, or rigid thermoset plastics such as polyvinyl chloride (PVC) or glass fiber reinforced plastic (FRP) shall be permitted for drainage piping or channels.

13.21.7.4 When plastic materials are used for drainage pipes or channels, such pipes or channels shall be buried.

13.21.8 Bulk storage tanks of flammable or combustible solvent shall be located outdoors in a diked area in accordance with the requirements for flammable liquid tanks in NFPA 30.

13.21.9 Solvent extraction process areas shall be provided with minimum 150 mm (6 in.) high curbing to confine and channel solvent spills.

13.21.9.1 Individual curbed areas shall not exceed 465 m² (5000 ft²).

13.21.10 Where trenches or plastic piping containing flammable or combustible organics enter a lower-grade tank farm or pumping area, a barrier wall shall be provided to prevent spilled liquids at the higher level from flowing into the lower area.

13.21.10.1 Where plastic piping containing ignitable (flammable or combustible) liquids passes through a barrier wall, a steel spool pipe of a minimum 1.5 m (5 ft) shall be provided on both sides of the wall.

13.21.10.2 An emergency, remotely actuated shutoff valve shall be provided on pipe lines containing ignitable (flammable or combustible) liquids that penetrate the barrier wall.

13.21.11 Shutoff valves on PLS lines shall be capable of being shut off remotely.

N Chapter 14 Conveyors

N 14.1 General Requirements.

N 14.1.1 Belt conveyors shall meet the following minimum requirements:

- (1) Belt alignment limit switches shall be provided on conveyors to shut down belts that are tracking improperly.
- (2) Slip switches shall be provided to detect a slipping or jammed belt and interlocked to shut off driving power when the belt stops or slows down by more than 20 percent of its normal speed.
- (3) Slip switches shall be tested on an annual basis.
- (4) Chute plug interlocks shall be provided.
- (5) Pull cords to manually shut down the conveyor shall be provided.
- (6) Shutoff power shall be provided on contributing conveyors to prevent any operating conveyor from discharging material to a stopped downstream conveyor.
- (7) Means shall be provided to remove tramp metal and other foreign objects as early in the handling process as possible.
- (8) Hydraulic systems for belt alignment, if provided, shall use only listed fire-retardant hydraulic fluids or shall be protected by an automatic fire protection system.
- (9) Alarms shall annunciate in the operator's control room or constantly attended location.
- (10) Electrical equipment shall be classified in accordance with *NFPA 70*, where required.
- (11) Guarding for machinery in the drive area and at other points along the belt shall be made of noncombustible material.

N 14.1.2 Structures supporting belt conveyors shall be designed to prevent significant accumulations of the material they are conveying.

N 14.1.2.1 The design shall include any surface near the belting that can catch and retain combustible particles and dust that might be liable to ignite spontaneously.

N 14.1.3 Consideration shall be given to the possibility of static electrical discharge at the conveyor head and tail pulleys located in dry and low humidity climates.

N 14.1.3.1 Factors that shall be considered are belting materials, belt speed, and housekeeping of spilled material.

N 14.1.3.2 Where such conditions as described in Section 14.3 exist, the use of static dissipaters or eliminators shall be considered.

N 14.1.4 Attention shall be given to the prevention and cleaning of accumulations of fine dust beneath and close to belt conveyors.

N 14.2 Underground Conveyors.

N 14.2.1 Underground conveyor belts shall be of a flame-resistant material and approved by the authority having jurisdiction.

N 14.2.2 Entries in which belt conveyors are installed shall be kept free of accumulations of combustible material.

N 14.2.3 Fixed combustible material such as posts, cribbing, and roof supports shall be guarded from contact with the belt by the use of noncombustible material.

N 14.2.4 Such fixed combustible material shall be located at a distance of at least 152.4 mm (6 in.) from any idler or pulley.

N 14.2.5 Belt conveyor installations shall use a support structure without a deck between the upper and lower belt flights.

N 14.2.6 Belts that carry the load of the belt on a low-friction metal deck without rollers shall be permitted to be used.

N 14.2.7 If automatic sprinkler protection is provided, it shall be in accordance with *NFPA 13*, as much as practicable.

N 14.3 Overland Conveyors.

N 14.3.1 Rip detection shall be provided for long runs of belt or critical conveyor systems.

N 14.3.2 The conveyor path shall be kept free of all grass, weeds, trash, or any other material that could create an exposure to the belt should it catch on fire.

N 14.3.3 Motor control center (MCC) buildings for conveyor systems shall be kept free of accumulations of coal dust.

N 14.4 Belowgrade Reclaim Conveyors.

N 14.4.1 Electrical equipment shall be in accordance with *NFPA 70*.

N 14.4.2 Belowgrade reclaim conveyor tunnels shall be kept free of accumulations of combustible material.

N 14.4.3 Hydraulic units more than 7.6 m (25 ft) inside the entrance and greater than 189 L (50 gal) total capacity shall have listed fire-resistive hydraulic fluid or be provided with an automatic fire suppression system.

N 14.4.3.1 The fire suppression system shall be interlocked to shut down the hydraulic unit and send an alarm to a constantly attended location.

N 14.4.4 Belowgrade reclaim conveyors shall be provided with an automatic sprinkler system in accordance with *NFPA 13*, as much as practicable.

N 14.4.4.1 Belowgrade reclaim conveyors less than 152.4 m (500 ft) in length shall not be required to be provided with an automatic sprinkler system.

N 14.4.4.2 Sprinkler protection shall not be required on the underside of belts less than 1.2 m (4 ft) in width.

N 14.4.5 Means of egress shall be provided in belowgrade reclaim conveyor tunnels.

N 14.4.5.1 Means of egress shall be provided every 91.4 m (300 ft) of travel distance in reclaim conveyor tunnels not provided with an automatic sprinkler system.

N 14.4.5.2 Means of egress shall be provided every 152.4 m (500 ft) of travel distance in reclaim conveyor tunnels provided with an automatic sprinkler system.

N 14.4.6* If a secondary emergency escape path is provided it shall meet the criteria in 14.4.6.1 through 14.4.6.4.

N 14.4.6.1 A self-closing, fire-rated door with a minimum rating of 1½ hours separating the main areas from the escape pathway shall be provided.

N 14.4.6.2 The pathway shall allow for persons to pass through the area without crawling.

N 14.4.6.3 Emergency lighting or use of alternative methods to mark the exit pathway shall be provided.

N 14.4.6.4 The exit shall not be obstructed.

N 14.5 Manual Firefighting.

N 14.5.1 Water lines shall be installed parallel to the entire length of underground belt conveyors and shall be equipped with fire taps with valves at 91.4 m (300 ft) intervals.

N 14.5.1.1 The threads on the hose taps shall be protected against dirt and rock grit that can prevent a quick connection.

N 14.5.1.2 The hose tap at the belt drive area shall be at least 15.2 m (50 ft) upwind of the belt drive.

N 14.5.2 At least 152.4 m (500 ft) of fire hose with fittings shall be stored at strategic locations along the conveyor belt, that is, at transfer points, drive areas, and tailpieces.

N 14.5.3 For each conveyor belt exceeding 610 m (2000 ft) in length, an additional cache of materials as specified in 14.5.5 shall be provided.

N 14.5.4 For mines using a track haulage system, the same criteria shall be met.

N 14.5.5 The following materials shall be stored within 91.4 m (300 ft) or 5 minutes of a belt drive:

- (1) 152.4 m (500 ft) of fire hose or a high-expansion foam device and 61 m (200 ft) of hose
- (2) Tools to open a stopping between the belt entry and the adjacent intake entry
- (3) 109 kg (240 lb) of rock dust

N 14.5.6 Fire extinguishers shall be provided in accordance with NFPA 10.

N 14.6 Automatic Fire Suppression Systems at the Belt Drive.

N 14.6.1 If installed, deluge water spray systems, foam sprinkler systems, closed-head sprinkler systems, or dry chemical systems automatically actuated by rise in temperature shall be installed at main and secondary belt conveyor drives.

N 14.6.1.1 If sprinkler or water spray systems are installed, they shall comply with NFPA 13, as much as practicable.

N 14.6.1.2 If dry chemical systems are installed, they shall be installed and maintained in accordance with NFPA 17 and the manufacturer's instructions.

N 14.6.2 Fire suppression systems shall extend to the drive areas of belt conveyors, including drive motor(s), reducer, head pulley, and belt storage unit (take-up), including any hydraulic power unit; its electrical controls; and the top and bottom of the first 15.2 m (50 ft) of belt from the drive on the downwind side.

N 14.6.2.1 Where a pre-engineered dry chemical fire suppression system is to be used, protection shall also be provided for the top surface of both the top and bottom belts, and the bottom surface of the top belt of the first 15.2 m (50 ft) of fire-resistant belt or 45.7 m (150 ft) of non-fire-resistant belt from the drive on the downward side.

N 14.6.3 Water-Based Fire Protection Systems.

N 14.6.3.1 Water Supply.

N 14.6.3.1.1 The water supply shall be free of excessive sediment and corrosives.

N 14.6.3.1.2 An approved strainer with a flush-out connection and manual shutoff valve shall be provided.

N 14.6.3.1.3 The water supply shall provide the required flow for not less than 60 minutes.

N 14.6.3.1.4 Approved or listed flexible connections shall be permitted from the water main to the pressure reducing device or shutoff valve to the sprinkler system.

- (1) The flexible connection shall be rated at a pressure that exceeds the maximum water pressure expected on the system.
- (2) If a nonmetallic connection is used, it shall not be within 3.0 m (10 ft) of the belt drive motors or primary roller drive.

N 14.6.3.1.5 If a pressure regulator is used, it shall be set below the maximum pressure allowed by the pressure rating of the piping and fittings.

N 14.6.3.1.6 If a pressure regulator is used, it shall be inspected and tested on a weekly basis to ensure that it is functioning properly and the sprinkler system has the right amount of pressure.

N 14.6.3.2 General Sprinkler Requirements. Sprinkler systems shall meet the following requirements:

- (1) The sprinklers shall be installed in accordance with NFPA 13 as much as practicable and shall have components that have been listed.
- (2) The sprinkler activation temperature shall not be less than 65.6°C (150°F) or greater than 148.9°C (300°F).
- (3) Sprinklers shall be kept free of excessive rock dust, muck, conveyor string, or any other material that can block the discharge or insulate the fusible link.
- (4) The application rate shall not be less than 10.2 L/min/m² (0.25 gpm/ft²) over the top surface of the upper belt.
- (5) The discharge shall be directed at both the top and bottom surfaces of the upper belt and to the top surface of the lower belt.
- (6) With a water flow and pressure that is present under normal mine operating conditions, the residual pressure measured downstream of the opened sprinklers or the eight-head inspector's test connection of 70 kPa (10 psi) or greater for belt drive systems shall be maintained at all times.
- (7) Maximum distance between nozzles on a branch line shall not exceed 2.4 m (8 ft).
- (8) Minimum distance between wet pipe sprinklers shall be 1.8 m (6 ft) apart.
- (9) Piping for the deluge, foam, or closed-head sprinkler system shall be metal and listed for sprinkler applications.
- (10) Sprinkler piping shall be supported by UL-listed pipe hangers or other substantial metal supports such as angle iron, U bolts, or heavy chain.
- (11) The system shall be interlocked to shut down the conveyor.
- (12) The system shall provide an audible and visual alarm.

- (13) The components of the system shall be located so as to minimize the possibility of damage by roof collapse or by the moving belt and its load.

N Chapter 15 Ventilation in Underground Mines

N 15.1* Ventilation Plan. The mine shall have a written ventilation plan.

N 15.1.1 The ventilation plan shall be updated at least annually.

N 15.1.2 A ventilation map with the mine name shall have the following features:

- (1) Direction and quantity of principal air flows
- (2) Locations of seals used to isolate abandoned workings
- (3) Locations of areas withdrawn from the ventilation system
- (4) Locations of all main, booster, and auxiliary fans
- (5) Locations of air regulators and stoppings and ventilation doors
- (6) Locations of airway crossover devices such as overcasts and undercasts
- (7) Locations of known oil or gas wells
- (8) Locations of known underground mine openings adjacent to the mine
- (9)* Locations of permanent underground shops, combustible liquid storage, battery charging stations, and explosive storage
- (10) Significant changes in the ventilation system projected for one year

N 15.1.3 The plan shall have mine fan data for all active fans.

N 15.1.4 The plan shall have diagrams, descriptions, or sketches showing how ventilation is accomplished in each typical type of working place, including the approximate quantity of air provided.

N 15.1.5 The plan shall have the number and type of internal combustion engine units used underground, including make and model of unit, type of engine, make and model of engine, brake horsepower rating of engine, and approval number.

N 15.1.6 If the mine has the potential for combustible gas generation, the additional requirements in Chapter 14 of NFPA 120 shall be followed.

N 15.2 Mine Fans.

N 15.2.1* All mine main and booster fans installed and used to ventilate the active workings of the mine shall be operated continuously while persons are underground in the active workings.

N 15.2.2 In the event of main or booster fan failure due to a malfunction, accident, power failure, or other such unplanned or unscheduled event, either 15.2.2.1 or 15.2.2.2 shall apply.

N 15.2.2.1 The air quality in the affected active workings shall be tested at least within 2 hours of the discovery of the fan failure and at least every 4 hours thereafter by a competent person for compliance with the time-weighted average threshold limits of airborne contaminants as identified by the authority having jurisdiction until normal ventilation is restored.

N 15.2.2.2 The following actions shall be taken before persons are permitted to enter the affected active workings:

- (1) All persons, except those working on the fan, shall be withdrawn.

(2) The ventilation shall be restored to normal.

(3) The air quality in the affected active workings shall be tested by a competent person to ensure that the air quality meets the requirements of the time-weighted average threshold limits of airborne contaminants as identified by the AHJ.

N 15.2.3 All underground main fans shall have controls placed at a suitable protected location remote from the fan and preferably on the surface.

N 15.2.4 Main fans shall be maintained according to either the manufacturer's recommendations or a written periodic schedule adopted by the operator, which shall be available on request of the authority having jurisdiction.

N 15.2.5 Where auxiliary fan systems are used, such systems shall minimize recirculation and be maintained to provide ventilation air that effectively sweeps the working places.

N 15.2.5.1 Auxiliary fans installed and used to ventilate the active workings of the mine shall be operated continuously while persons are underground in the active workings, except for scheduled production-cycle shutdowns or planned or scheduled fan maintenance or fan adjustments where air quality is maintained and all persons underground in the affected areas are advised in advance of such scheduled or planned fan shutdowns, maintenance, or adjustments.

N 15.2.5.1.1 In the event of auxiliary fan failure due to malfunction, accident, power failure, or other such unplanned or unscheduled event, either 15.2.5.1.1.1 or 15.2.5.1.1.2 shall apply.

N 15.2.5.1.1.1 The air quality in the affected active workings shall be tested at least within 2 hours of the discovery of the fan failure and at least every 4 hours thereafter by a competent person to ensure acceptable air quality until normal ventilation is restored.

N 15.2.5.1.1.2 The following actions shall be taken before persons are permitted to enter the affected active workings:

- (1) All persons, except those working on the fan, shall be withdrawn.
- (2) The ventilation shall be restored to normal.
- (3) The air quality in the affected active workings shall be tested by a competent person to ensure that the air quality is acceptable.

N 15.3 Oxygen-Deficiency Testing. Flame safety lamps or other suitable devices shall be used to test for acute oxygen deficiency.

N 15.4 Ventilation Doors.

N 15.4.1 Ventilation doors shall be in accordance with the following:

- (1) Substantially constructed
- (2) Covered with fire-retardant material, if constructed of wood
- (3) Maintained in good condition
- (4) Self-closing, if manually operated
- (5) Equipped with audible or visual warning devices, if mechanically operated

N 15.4.2 When ventilation control doors are opened as a part of the normal mining cycle, they shall be closed as soon as possible to reestablish normal ventilation to working places.

N 15.5 Unventilated Areas.

N 15.5.1 Unventilated areas shall be sealed or barricaded and posted against entry.

N 15.5.1.1 Seals shall be provided with the means for checking the quality of air behind the seal.

N 15.5.1.2 A means shall be provided to prevent a water head from developing unless the seal is designed to impound water.

N 15.6* Shaft Mines.

N 15.6.1 Shaft mines shall be provided with at least one of the following means to control the spread of fire, smoke, and toxic gases underground in the event of a fire:

- (1) Control doors
- (2) Reversal of mechanical ventilation

- (3) Effective evacuation procedures

N 15.6.1.1 Control Doors. If used as an alternative, control doors shall be in accordance with the following:

- (1) Installed at or near shaft stations of intake shafts and any shaft designated as an escapeway or at other locations that provide equivalent protection
- (2) Constructed and maintained according to Table 15.6.1.1
- (3) Provided with a means of remote closure at landings of timbered intake shafts unless a person specifically designated to close each door in the event of a fire can reach the door within 3 minutes
- (4) Closed or opened only according to predetermined conditions and procedures
- (5) Constructed so that once closed they will not reopen as a result of a differential in air pressure
- (6) Constructed so that they can be opened from either side by one person or be provided with a personnel door that can be opened from either side
- (7) Clear of obstructions

N Table 15.6.1.1 Control Door Location and Construction Requirements

Location	Minimum Required Construction
At least 15 m (50 ft) from timbered areas, exposed combustible rock, and any other combustible material	Control door that meets the requirements for a ventilation door
Within 15 m (50 ft) but no closer than 6 m (20 ft) of timbered areas, exposed combustible rock, or other combustible material	Control door that serves as a barrier to the effects of fire and air leakage. The control door shall provide protection at least equivalent to a door constructed of no less than 6 mm (¼ in.) of plate steel with channel or angle-iron reinforcement to minimize warpage. The framework assembly of the door and the surrounding bulkhead, if any, shall be at least equivalent to the door in fire and air-leakage resistance and in physical strength.
Within 6 m (20 ft) of any timbered areas or combustible rock, provided that the timber and combustible rock within the 6 m (20 ft) distance are coated with 25 mm (1 in.) of shotcrete, 13 mm (½ in.) of gunite, or other material with equivalent fire protection characteristics and no other combustible material is within that distance	
Within 6 m (20 ft) of timbered areas, exposed combustible rock, or other combustible material	Control door that serves as a barrier to fire, the effects of fire, and air-leakage. The door shall provide protection at least equivalent to a door constructed of two layers of wood, each a minimum of 19 mm (¾ in.) in thickness. The wood grain of one layer shall be perpendicular to the wood grain of the other layer. The wood construction shall be covered on all sides and edges with no less than 24-gauge sheet steel. The framework assembly of the door and the surrounding bulkhead, if any, shall be at least equivalent to the door in fire and air-leakage resistance and in physical strength. Roll-down steel doors with a fire-resistance rating of 1½ hours or greater, but without an insulation core, are acceptable if an automatic sprinkler or deluge system is installed that provides even coverage of the door on both sides.

N 15.6.1.2 Mechanical Ventilation Reversal. If used as an alternative, reversal of mechanical ventilation shall comply with the following:

- (1) Provide at all times at least the same degree of protection to persons underground as would be afforded by the installation of control doors
- (2) Be accomplished by a main fan
- (3) Provide rapid air reversal that allows persons underground time to exit in fresh air by the second escapeway or find a place of refuge
- (4) Be done according to predetermined conditions and procedures

N 15.6.1.2.1 If the main fan is located underground the following shall apply:

- (1) The cable or conductors supplying power to the fan shall be routed through areas free of fire hazards.
- (2) The main fan shall be equipped with a second, independent power cable or set of conductors from the surface.
- (3) The power cable or conductors shall be located so that an underground fire disrupting power in one cable or set of conductors will not affect the other.
- (4) A second fan capable of accomplishing ventilation reversal shall be available for use in the event of failure of the main fan.

N 15.6.1.3 Evacuation. If used as an alternative, effective evacuation shall be demonstrated by actual evacuation of all persons underground to the surface in 10 minutes or less through routes that will not expose persons to heat, smoke, or toxic fumes in the event of a fire.

N 15.6.1.3.1 If the destruction of any bulkhead on an inactive level would allow fire contaminants to reach an escapeway, that bulkhead shall be constructed and maintained to provide at least the same protection as required for control doors under Table 15.6.1.1.

N 15.7 Underground Shops. To confine or prevent the spread of toxic gases from a fire originating in an underground shop where maintenance work is routinely done on mobile equipment, one of the following measures shall be taken:

- (1) Use of control doors or bulkheads
- (2) Routing of the mine shop air directly to an exhaust system
- (3) Reversal of mechanical ventilation
- (4) Use of an automatic fire suppression system in conjunction with an alternative escape route

N 15.7.1 The alternative used shall at all times provide at least the same degree of safety as control doors or bulkheads.

N 15.7.2 Control Doors or Bulkheads. If used as an alternative, control doors or bulkheads shall meet the following requirements:

- (1) Each control door or bulkhead shall be constructed to serve as a barrier to fire, the effects of fire, and air leakage at each opening to the shop.
- (2) Each control door shall be constructed as follows:
 - (a) Constructed so that, once closed, it will not reopen as a result of a differential in air pressure
 - (b) Constructed so that it can be opened from either side by one person or be provided with a personnel door that can be opened from either side
- (3) Clear of obstructions.

- (4) Provided with a means of remote or automatic closure unless a person specifically designated to close the door in the event of a fire can reach the door within 3 minutes.

N 15.7.2.1 If located 6 m (20 ft) or more from exposed timber or other combustible material, the control doors or bulkheads shall be in accordance with the following:

- (1) Control doors or bulkheads shall provide protection at least equivalent to a door constructed of no less than 6 mm (¼ in.) of plate steel with channel or angle-iron reinforcement to minimize warpage.
- (2) The framework assembly of the door and the surrounding bulkhead, if any, shall be at least equivalent to the door in fire and air-leakage resistance and in physical strength.

N 15.7.2.2 If located less than 6 m (20 ft) from exposed timber or other combustibles, the control door or bulkhead shall be in accordance with the following:

- (1) Control doors or bulkheads shall provide protection at least equivalent to a door constructed of two layers of wood, each a minimum thickness of 19 mm (¾ in.).
- (2) The wood-grain of one layer shall be perpendicular to the wood-grain of the other layer.
- (3) The wood construction shall be covered on all sides and edges with no less than 24-gauge sheet steel
- (4) The framework assembly of the door and the surrounding bulkhead, if any, shall be at least equivalent to the door in fire and air-leakage resistance and in physical strength.
- (5) Roll-down steel doors with a fire-resistance rating of 1½ hours or greater, but without an insulation core, shall be acceptable provided that an automatic sprinkler or deluge system is installed that provides even coverage of the door on both sides.

N 15.7.3 Routing Air to Exhaust System. If used as an alternative, routing the mine shop exhaust air directly to an exhaust system shall be done so that no person will be exposed to toxic gases in the event of a shop fire.

N 15.7.4 Mechanical Ventilation Reversal. If used as an alternative, reversal of mechanical ventilation shall be in accordance with the following:

- (1) Be accomplished by a main fan
- (2) Provide rapid air reversal that allows persons underground time to exit in fresh air by the second escapeway or find a place of refuge
- (3) Be done according to predetermined conditions and procedures

N 15.7.4.1 If the main fan is located underground, the following shall apply:

- (1) The cable or conductors supplying power to the fan shall be routed through areas free of fire hazards.
- (2) The main fan shall be equipped with a second, independent power cable or set of conductors from the surface.
- (3) The power cable or conductors shall be located so that an underground fire disrupting power in one cable or set of conductors will not affect the other.
- (4) A second fan capable of accomplishing ventilation reversal shall be available for use in the event of failure of the main fan.

N 15.7.5 Automatic Fire Suppression System and Escape Route.

If used as an alternative, the automatic fire suppression system and alternate escape route shall meet the following requirements:

- (1) The suppression system shall be in accordance with the following:
 - (a) Located in the shop area
 - (b) The appropriate size and type for the particular fire hazards involved
 - (c) Inspected at weekly intervals and properly maintained
- (2) The escape route shall bypass the shop area so that the route will not be affected by a fire in the shop area signed to impound water.

N 15.8 Air Courses and Trolley Haulage Systems. Where trolley haulage systems are maintained and where trolley wires or trolley feeder wires are installed, the authority having jurisdiction shall require enough entries or rooms as intake air courses to limit the velocity of air currents in the haulageways to minimize the hazards of fires and dust explosions in the haulageways.

N 15.9 Belt Air Course Ventilation.

N 15.9.1 The belt air course shall not be used as a return air course except as provided in 15.9.2.

N 15.9.1.1 The belt air course shall not be used to provide air to working sections or to areas where mechanized mining equipment is being installed or removed.

N 15.9.1.2 The belt air course shall be separated with permanent ventilation controls from return air courses and from other intake air courses.

N 15.9.1.3 Air velocities shall be compatible with all fire detection systems and fire suppression systems used in the belt entry.

N 15.9.2 Air from a belt air course shall be permitted to be used to ventilate a working section or an area where mechanized mining equipment is being installed or removed, provided the following additional requirements are met:

- (1) The belt entry shall be equipped with an atmospheric monitoring system (AMS) that is installed, operated, examined, and maintained.
- (2) All miners shall be trained annually in the basic operating principles of the AMS, including the actions required in the event of activation of any AMS alert or alarm signal.
- (3) This training shall be conducted prior to working underground in a mine that uses belt air to ventilate working sections or areas where mechanized mining equipment is installed or removed.
- (4) This training shall be conducted as part of a miner's new miner training, experienced miner training, or annual refresher training.

N 15.9.3 The primary escapeway shall be monitored for carbon monoxide or smoke.

N 15.9.4 The area of the mine with a belt air course shall be developed with three or more entries.

N 15.9.5 No more than 50 percent of the total intake air, delivered to the working section or to areas where mechanized mining equipment is being installed or removed, shall be permitted to be supplied from the belt air course.

N 15.9.5.1 The locations for measuring these air quantities shall be approved in the mine ventilation plan.

N 15.9.6 Additional intake air shall be permitted to be added to the belt air course through a point-feed regulator.

N 15.9.6.1 The location and use of point feeds shall be approved in the mine ventilation plan.

N 15.9.6.2 If the air through the point-feed regulator enters a belt air course that is used to ventilate a working section or an area where mechanized mining equipment is being installed or removed, the following conditions shall be met:

- (1) The air current that will pass through the point-feed regulator shall be monitored for carbon monoxide or smoke at a point within 15 m (50 ft) upwind of the point-feed regulator.
- (2) The air in the belt air course shall be monitored for carbon monoxide or smoke upwind of the point-feed regulator.
- (3) The sensor monitoring for carbon monoxide or smoke upwind of the point-feed regulator shall be in the belt air course within 15 m (50 ft) of the mixing point where air flowing through the point-feed regulator mixes with the belt air.
- (4) The point-feed regulator shall be provided with a means to close the regulator from the intake air course without requiring a person to enter the crosscut where the point-feed regulator is located.
- (5) The point-feed regulator shall also be provided with a means to close the regulator from a location in the belt air course immediately upwind of the crosscut containing the point-feed regulator.
- (6) A minimum air velocity of 1.52 m/s (300 ft/min) shall be maintained through the point-feed regulator.
- (7) The location(s) and use of a point-feed regulator(s) shall be approved in the mine ventilation plan and shown on the mine ventilation map.
- (8) An AMS shall be installed, operated, examined, and maintained.

N 15.10 Gas Drainage for Reduction of Combustible Gases Before Mining. (Reserved)**N 15.11 Refrigeration Systems. (Reserved)****N Chapter 16 Emergency Preparedness and Response**

N 16.1* Emergency Preparedness and Response Plan. A written emergency preparedness and response plan shall be developed to prepare for and respond to fire and explosion emergency.

N 16.1.1* This section shall apply to fire and explosion hazards.

N 16.1.2* The written emergency preparedness and response plan shall include the following:

- (1) Response to fire alarms and fire systems supervisory alarms
- (2) Notification of personnel identified in the plan
- (3) Evacuation of employees, contractors, and visitors not directly involved in firefighting activities from the fire area
- (4) Coordination of facility personnel to admit public fire department and other external emergency responders
- (5) Fire preplanning that defines fire-extinguishing scenarios
- (6) Specialized firefighting equipment

- (7) Education and training for external emergency responders to understand the hazards

N 16.2* Emergency Communications. A means shall be provided to notify personnel of an emergency.

N 16.3* Underground Operations. The operator shall develop and execute emergency preparedness and response plans and train employees, contractors, and visitors.

N 16.3.1 Objectives. Underground mine rescue objectives shall be the following:

- (1) To locate the victims and bring them to the surface
- (2) To locate and extinguish incipient or active fires
- (3)* To carry out certain tasks that require breathing apparatus until the emergency is resolved

N 16.4* Plan Review and Validation. The emergency preparedness and response plan shall be periodically reviewed and exercised.

N 16.4.1 The emergency preparedness and response plan shall be validated at least annually.

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 **US** 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 **US** local fire departments. (For more information, see Section 9.16 of the 2008 edition of NFPA's *Fire Protection Handbook*.)

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 **ignitable (flammable and combustible)** 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, which are covered in Section 13.20 (for new and existing facilities) and Section 13.21 (for new facilities).

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 firefighters and types of firefighting 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 firefighters 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 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.

Δ 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 or procedures, equipment, or materials, the “authority having jurisdiction” may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The “authority having jurisdiction” may also refer to the listings or labeling practices of an organization 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 standards in a broad manner because 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.3.3.9 Emergency Egress. See NFPA 101 for the use of the term.

Δ A.3.3.16 Flash Point. 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 should be determined in accordance with ASTM D56, *Standard Test Method for Flash Point by 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 should be determined in accordance with ASTM D93, *Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester*.

As an alternative, ASTM D3278, *Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus*, should 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.3.3.33 Safe Area. Examples are designated welding shops.

A.3.3.37 Self-Igniting Rock. In metal/nonmetal mines this usually pertains to sulfide ores or coal deposits.

A.3.3.39 Solvent Extraction (SX) Facility. A hydro-metallurgical solvent extraction facility is not to be confused with an agricultural solvent extraction plant that uses hexane or other low flash point ignitable (flammable or combustible) liquid to recover edible oils such as soy, palm, or corn oil. Agricultural solvent extraction plants are covered by NFPA 36. NFPA 36 is not to be used for protection requirements of hydro-metallurgical solvent extraction facilities.

A.4.4.22 For additional information, see NFPA 326 and AWS F4.1, *Safe Practices for the Preparation of Containers and Piping for Welding, Cutting, and Allied Processes*.

N A.4.10 The provisions of Section 4.10 do not require inherently noncombustible materials to be tested in order to be classified as noncombustible materials. [101:A.4.6.13]

N A.4.10(1) Examples of such materials include steel, concrete, masonry, and glass. [101:A.4.6.13.1(1)]

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

A.5.1.2 Examples of persons qualified to conduct fire risk assessments could include fire protection professionals, or those that can demonstrate qualification based on education, experience, and skills to adequately evaluate the fire risks associated with the equipment or areas.

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 ignitable (flammable and combustible) liquids storage or process areas. Areas with noncombustible construction or noncom-

bustible 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(3) 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 Chapter 1 of 18 CFR.

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

Δ 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 STD 650, *Welded Tanks for Oil Storage*; UL 80, *Steel Tanks for Oil-Burner Fuels and Other Combustible Liquids*; or UL 142, *Steel Aboveground 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 ASME *Boiler and Pressure Vessel Code*.

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

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

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 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.

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 NFPA's *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 NFPA's *Fire Protection Handbook*, overpressure failure of containers when exposed to fire is considered the principal hazard of closed-container **ignitable** (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, espe-

cially 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 11.

A.12.2 Fires adversely affect all types of self-propelled and mobile surface mining equipment, including, but not limited to, trucks, front-end loaders, crawlers, drills, shovels, and draglines. Most fires occur on or near engine exhaust systems, high-speed drive lines, malfunctioning high-pressure-high-temperature hydraulic systems, or faulty electrical components.

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

To improve fire protection and prevention on surface mining equipment, some manufacturers of mining equipment emphasize 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 **ignitable** (flammable and combustible) liquid reservoirs, and hydraulic and fuel-line routing.

Most surface mining equipment is required to have at least one hand-portable extinguisher mounted in a readily accessible location. Extinguishers are most effective when 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.

N A.12.2.5 UG mining vehicle manufacturers are developing battery electric vehicles powered by lithium-ion batteries as an alternative to diesel-powered vehicles. Despite the benefits, the introduction of new technology can create consequences that if left uncontrolled can cause fire hazards.

A.12.3.4.1 Depending on the size of the vehicle and size of the fire, a 9.1 kg (20 lb) fire extinguisher could be more effective.

A.12.3.4.9(8) The same record tag or label can also indicate if recharging was performed.

A.12.3.5.2.2 Smoke detectors are not recommended because of the harsh environment.

A.12.3.5.3.1 Automatic systems are not necessary if the area is easily accessible for manual firefighting.

A.12.3.5.4.2 Carbon dioxide would not be the best choice for fighting this type of fire due to the potential for the gas to be dispersed before the oxygen concentration is reduced enough to affect the fire.

For transformers over 5000 kVA, a fixed fire suppression system is recommended.

A.12.3.6.1.1 Equipment in this category is generally a vehicle weight of 90,720 kg (200,000 lb) or more and the size of a Hitachi 1800, Caterpillar 5230, Komatsu PC1000-6, Liebherr R984, DeMag H95, and Hitachi 1100.

A.12.3.8.1.1 Depending on the size of the vehicle and size of the fire, a 9.1 kg (20 lb) fire extinguisher could be more effective.

A.12.3.8.2.5 NFPA and manufacturers require 6-month inspections.

A.12.3.8.3.2 The following are examples of large equipment:

- (1) Track dozer of 300 horsepower or more or 31,750 kg (70,000 lb) weight or more (e.g., Caterpillar D8R)
- (2) Front-end loader of 400 horsepower or more and vehicle weight of 45,400 kg (100,000 lb) (e.g., Caterpillar 988)
- (3) Wheel bulldozer of 300 horsepower or more and vehicle weight of 27,200 kg (60,000 lb) or more (e.g., Caterpillar 824G)
- (4) Grader of 275 horsepower or more and vehicle weight of 25,000 kg (55,000 lb) or more (e.g., Caterpillar 16H)
- (5) Pull-type scraper of 450 horsepower or more and vehicle weight of 44,450 kg (98,000 lb) or more (Caterpillar 631E)
- (6) Scraper with push/pull twin engine of 450 horsepower and 490 horsepower or more and vehicle weight of 51,260 kg (113,000 lb) or more (e.g., Caterpillar 637E)
- (7) Blast hole drill of 360 horsepower or more and weight of 30,845 kg (68,000 lb) or more (e.g., Ingersol-Rand DM-30)

A.12.3.8.3.4(4) Depending on the size of the equipment, additional ground-level manual actuators could be needed to provide quick access for manual activation of the system.

A.12.3.8.3.8 Periodic maintenance is required by NFPA standards and by manufacturers. Although other training resources are available, the fire suppression system manufacturer is the best source for proper training regarding their equipment.

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 firefighting 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 Refer to Chapter 5 for production buildings, outdoor equipment, and process structures as well as Annex G of NFPA 1142 for ancillary nonproduction buildings when esti-

imating water supply (fire flow) that can be necessary for firefighting purposes.

N A.13.8.1 Reagents used in mineral concentrators can be ignitable (flammable or combustible) liquids.

N A.13.9 Examples of relevant NFPA standards include 51, 55, and 58.

N A.13.10 Reagents used in mineral concentrators can be oxidizers.

A.13.11.4 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 firefighting

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

A.13.11.6 Conveyor belt ignition sources include friction points, hot bearings, tracking, frame damage, electrical, combustible storage, hot work, and spontaneous combustion of spilled fuels. Acceptable protection systems for conveyors should include automatic sprinklers, water spray systems, foam water systems, smoke and heat detection systems, dry chemical systems, pre-engineered dry chemical or wet chemical systems, portable extinguishers, and hand hose lines.

Δ A.13.12.1 The following should be considered when conducting a fire risk assessment on rubber- and plastic-lined equipment:

Frequency

- (1) Many fires occur annually inside rubber-lined equipment in concentrator plants.
- (2) Many rubber-lined equipment fires are quickly controlled and not reported.
- (3) Rubber- or plastic-lined equipment fires are usually caused by hot work. During normal operation, rubber- or plastic-lined equipment is immersed in water or an otherwise very wet environment. However, when the plant is down for maintenance or other outage, the systems become dry, significantly changing the fire risk. Coincidentally, outages producing dry lining conditions are when hot work is most likely to occur. Hot work fires can occur on dry-lined equipment while heating or welding on the outside of steel-lined equipment with heat passing into the interior lining with internal ignition. Fires can also occur during hot work over open-topped tanks and vessels as sparks or slag fall onto lined equipment. Hot work on, over, or generally near plastic- or rubber-lined vessels should be minimized, and alternative cold work methods exhausted prior to permitting hot work. If hot work is performed, additional precautions should be taken to limit the potential for hot work ignition sources from contacting combustible linings (e.g., tarping, boxing, continuous wet-down or flooding, physically isolating exposed lined equipment from upstream and downstream equipment using a barrier or gap, or use of periodic thermographic scanning to monitor external temperatures of equipment exposed by hot work ignition sources).

Consequence

- (1) Similar to cooling towers, normally wet rubber- and plastic-lined equipment present a limited fire exposure while in operation. However, when allowed to dry, the fire hazard posed by the linings and their exposure changes. Within lined equipment, concentrations of dry plastic or rubber surface area combined with often vertical surface orientations can result in rapid fire spread and severe fire intensity.
- (2) If not detected by an early indication (e.g., smoke or heat) and not promptly extinguished, lining fires can spread rapidly when dry, especially with vertically oriented surfaces and openings that allow oxygen and flames to enter. Once developed, a fire can spread unchecked through interconnected plastic- or rubber-lined equipment and threaten to spread to nearby circuits and equipment as well.
- (3) Firefighting access is extremely difficult to impossible once the fire has spread through a portion of a circuit. Additionally, fire hoses might not extend high enough to cool adjacent fuel packages or structural members, especially when hampered by wind.
- (4) If located in a building, the dense smoke and toxic fumes typical of plastic and rubber fires will likely impede any internal firefighting efforts.
- (5) If located in a building or exposing steel supporting a process structure, a fully developed uncontrolled fire could cause thermal damage to the building and structural elements.
- (6) Not only are the linings consumed or damaged, requiring replacement, but often the metallic equipment can suffer significant thermal damage requiring repairs or replacement. Recovery time and subsequent business interruption following the fire can be significant.

N A.13.12.1(1) Examples of methods to eliminate or reduce fire hazard include minimizing the use of rubber or plastic linings.

N A.13.12.1(2) Examples of methods to eliminate or control ignitions include hot work management to use alternative cold work methods or additional required precautions where hot work is permitted.

N A.13.12.9 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.

N A.13.12.10 Fixed water-based fire protection at openings in lined circuits can control flames emanating from open equipment, cool equipment, or structural members, or possibly prevent fire spread to adjacent equipment or into other exposed openings in lined equipment circuits. An example of such an arrangement of lined equipment with openings is a screen deck with lined hopper beneath and ore chute above.

Refer to A.13.13.10 for additional discussion and design guidance.

Δ A.13.13.1 The following should be considered when conducting a fire risk assessment on plastic constructed equipment. Also, refer to A.13.12.1 for additional discussion on fire scenario considerations and fire protection options.

- (1) Similar to rubber- or plastic-lined equipment, new equipment constructed entirely of plastic is now more prevalent, including process equipment such as screens,

hydrocyclones, and filter presses; piping; and even building interior features such as plastic open grating and handrails.

- (2) Refer to the frequency and consequence guidance in A.13.12.1 on lined equipment for conducting a risk assessment and evaluating protection options

- (3) The use of fixed water-based fire protection systems over large concentrations of plastic equipment has been effective.

N A.13.13.1(1) Examples of methods to eliminate or reduce fire hazard include minimizing the use of rubber or plastic linings.

N A.13.13.1(2) Examples of methods to eliminate or control ignitions include hot work management to use alternative cold work methods or additional required precautions where hot work is permitted.

N A.13.13.10 Plastic equipment could include but is not limited to screen decks, hydrocyclones, filter presses, and concentration of plastic piping such as underneath or atop spirals.

Combustible loading in plants using mineral concentrators has increased gradually as rubber- or plastic-lined equipment or plastic equipment has replaced equipment that historically was constructed of steel, such as piping, cyclones, and screens. This equipment is normally installed aboveground in either open process structures or enclosed process buildings and constructed of or lined with rubber, fiberglass, polyurethane, or other unexpanded Group A plastic as defined by NFPA 13. Although normal operations wet interior combustible surfaces, the fire hazard changes as interior surfaces are allowed to dry during outages when hot work is likely to be conducted and process water might be locked out. Fixed water-based fire protection systems should be considered at openings to lined equipment circuits or over plastic equipment when determined by a fire risk assessment to protect important assets with significant business interruption potential. Fixed water-based fire protection systems can control flames, cool equipment or structural members, and possibly prevent fire spread.

While no fire test data is available at this time, it is anticipated that lined equipment or plastic equipment can be protected with fixed water-based fire protection systems intended for the protection of nonexpanded Group A plastics in manufacturing occupancies such as the types described in NFPA 13 Extra Hazard Group 1 or Extra Hazard Group 2, where greater concentrations of plastic or in cases where sprinkler/nozzle clearances to the combustible surfaces [e.g., typically around 9 m (30 ft)] become significant. Design approaches to be considered include wet, dry, deluge, or water spray systems.

N A.13.14.1(1) Consider minimizing the use of plastic equipment to reduce fire hazards.

N A.13.14.1(2) Consider hot work management such as alternative cold work or additional required precautions when hot work is authorized.

N A.13.14.1(3) Consider the possible fire propagation through the grinding circuit or spread through a portion of the concentrator.

Δ A.13.14.3 Combustible loading in gravimetric ore concentration plants using spiral concentrators has increased gradually as plastic equipment has replaced equipment that historically was constructed of steel. This equipment includes piping, spirals, cyclones, and screens. Combustible spirals normally are

installed above ground in either open air or enclosed process buildings. Spirals typically are constructed of fiberglass, polyurethane, or other nonexpanded Group A plastic as defined by NFPA 13. Although normal operations wet the spirals on one side as well as create a high-humidity atmosphere, spiral plants are susceptible to very large fires, particularly during outages when hot work is conducted and water to the spirals could be locked out. Fixed water-based fire protection systems should be considered for spiral installations where necessary for protection of important assets with large business interruption potential, as determined by a fire risk assessment.

While no fire test data is available at this time, it is anticipated that combustible spirals can be protected with water-based protection systems intended for the protection of nonexpanded Group A plastics. (Spiral installations, with the steel framework they are installed in, closely approximate a storage rack full of plastic materials.) Design approaches to be considered include wet, dry, deluge, or water spray systems.

Intermediate-level sprinklers or spray nozzles might be required for multilevel open floor spiral installations because of the significant underside area of the spirals that cannot be fully protected only by overhead sprinklers.

Automatic sprinkler protection designed to NFPA 13 should be provided above and 6.1 m (20 ft) beyond combustible spiral installations.

Small installations where sprinklers are not warranted will benefit from fixed monitor nozzles fed from existing hydrants.

Δ A.13.15.1 Hydraulic or lubrication oil systems can be found in headhouses serving hoists, crushers, or concentrators serving grinding circuits or filter presses.

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 to not expose concentrated power cabling, rubber or plastic equipment, or other critical equipment to fire damage.

Acceptable protection systems should include automatic sprinklers, water spray systems, dry chemical systems, pre-engineered dry chemical or wet chemical systems, portable hand hose lines and extinguishers, and detection.

Δ A.13.16 Thermal oil heating systems are used in some mineral processing plants, such as molybdenum concentrator mills, for drying ore.

NFPA 87 is the primary reference in NFPA standards for thermal oil heaters, while NFPA 664 contains additional guidance on thermal oil heating 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 used for the mineral processing industry.

A.13.16.1 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 protection system
- (2) Locating the heater, pumps and tanks outdoors or in detached buildings
- (3) Proper location and confinement of expansion and storage tanks, pumps and heaters
- (4) Proper piping arrangement
- (5) Process interlocks and controls
- (6) Explosion protection
- (7) Damage limiting construction from an oil mist explosion

N A.13.16.1(1) Heat exchangers or other appliances using thermal oil to dry the ore can be located in the general production area.

Δ A.13.18 Positive pressure should be maintained in equipment rooms containing switchgear, motor control centers, concentration of power cabling, transformers, bus bars, and control equipment 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.

N A.13.18.1 For example, stacked cable trays can be used to concentrate power cabling.

A.13.20 See Table A.13.20 for fire experience data justifying the addition of the requirements in Section 13.20.

A.13.20.1 The design intent within this standard for protection of hydro-metallurgical solvent extraction (SX) facilities is to limit a fire to a single train rather than to a single cell. A typical SX facility will have multiple (three or more) mixer-settler cells composing a single train. The distance between cells within a single train might be only a few meters (several feet), usually the width of a walkway. Parallel trains of multiple cells might also be present and these are usually separated from adjacent trains by 7.6 m to 15.24 m (25 ft to 50 ft), usually the width of a roadway.

Should the design intent be to limit the fire to a single cell, then additional fire protection might be required. The risk assessment should define the level of tolerable risk. The actions taken might then focus more on spatial separation, barriers, construction, and so forth.

Mining companies use SX processes to separate valuable base metal minerals. This technology is common with copper, uranium, nickel, cobalt, and many specialty metals. A typical hydro-metallurgical SX facility features thousands if not hundreds of thousands of cubic meters (gallons) of ignitable (flammable or combustible) liquids and is commonly located at a remote mining site near the ore body being mined. Larger SX facilities — notably copper and uranium — are located outdoors but might be located indoors for nickel, cobalt, lithium, iodine, and other metals.

Table A.13.20 Example Global Fire Losses Involving Hydro-Metallurgical Solvent Extraction Plants¹

Location	Date	Process	Protection	Incident	Cause	Results
Norway (Ref: 2)	1972	Cobalt-nickel SX using kerosene; glass piping; indoor process	Manual response with water hoses	Solvent spill into pit below M-S; glass piping failed under fire exposure	Hot work	Three fatalities; plant destroyed; \$75 M damage; six months production outage
US (Ref: Private files)	1975	Rhenium-tungsten SX using mineral spirits and perchloric acid; plastic piping (FRP); indoor process	Automatic sprinklers over process area; manual response with water hoses	Small solvent spill spread into M-S cells and through plant; additional solvent fed by failed plastic pipes	Perchloric acid reaction	Plant destroyed; >\$10 M damage; six months production outage
Namibia (Ref: Private files)	1978	Uranium SX using kerosene; outdoor process; plastic piping	Manual response with water hoses	Solvent leaked from plastic pipe; additional solvent fed by failed plastic pipes	Electrical	Total plant damage; >\$50 M damage; four months production outage
Australia (Ref: 3, 4)	1999	Uranium-copper SX using kerosene; outdoor process; plastic (HDPE) piping	Partial foam-water sprinklers; manual response with foam-monitor nozzles	Solvent release at plastic pipe; fire spread throughout local area; additional solvent fed by failed plastic pipes	Not reported	Partial plant damage; >\$40 M damage; nine months production outage
Australia (Ref: 3, 4)	2001	Uranium-copper SX using kerosene; outdoor process; plastic (HDPE) piping	Partial foam-water sprinklers; manual response with foam-monitor nozzles	Solvent release at plastic pipe; fire spread throughout wide area; additional solvent fed by failed plastic pipes	Possible static ignition inside nonconductive plastic pipe	Widespread plant severe damage; >\$100 M damage; two years production outage
US (Ref: 4, 5)	2003	Copper SX using kerosene solvent; outdoor process	Unknown	Solvent fire involving M-S cells	Unknown	Four M-S cells partially damaged; \$5–10 M damage reported by AP
Mexico (Ref: Internet news services)	2003	Copper SX using kerosene solvent; outdoor process	Unknown	Solvent fire involving M-S cells	Not reported	Not reported

Note: Financial loss estimates are indexed to 2005 US currency.

References for Table A.13.20

- Moore, L., "Using Principles of Inherent Safety for Design of Hydrometallurgical Solvent Extraction Plants," Society of Mining and Exploration (SME) 2006 Annual Meeting, St. Louis, MO, April 2006.
- Hoy-Peterson, R., *Fire Prevention in Solvent Extraction Plants*, Proceedings of the 1st International Loss Prevention Symposium, The Hague/Delft, the Netherlands, May 1974.
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A hydro-metallurgical SX facility should not be confused with an agricultural SX facility that uses low flash point flammable solvents like hexane for recovering edible oils from soybeans, canola, and corn and that has a higher hazard. NFPA 36 applies to the protection of agricultural SX plants but does not apply to and should not be applied for the protection of hydro-metallurgical SX facilities.

Severe fire hazards exist with mineral SX facilities due to large volumes of ignitable (flammable or combustible) liquids, often in large open pools. Because SX solvents are normally cold (that is, at ambient temperatures well below their boiling points), severe explosion hazards generally do not exist. Most large copper-uranium-type SX facilities use a grade of high purity kerosene, but some more refined metals like lithium

feature lower flash point alcohols. Fires are generally two-dimensional pool fires rather than three-dimensional fires. Rarely will a pressurized jet spray occur. SX operations at elevated temperatures also affect the flash point of the solvent (*refer to A.13.20.5*).

Historically, losses in hydro-metallurgical SX facilities have been infrequent but severe. Two significantly large SX fires occurred within 6 months at one Australian copper-uranium mine. The primary conclusions from the two Australian fires are the following:

- (1) Thermoplastic high density polyethylene (HDPE) pipes fail prematurely under fire conditions and rapidly release solvents.

- (2) Plastic pipes can allow fire spread internally within the pipes.
 - (3) Stainless steel piping is preferable to plastic but can be attacked by chlorides and might not be suitable for all SX facility services.
 - (4) While combustible, structural fiber reinforced plastic (FRP) piping is better than HDPE because it does not soften or fail as fast.
 - (5) Electrical static charge buildup can occur in both metal and plastic due to the movement of flammable or combustible solvents.
 - (6) Static charge can potentially ignite solvent mists inside pipes.
 - (7) Static charge can be minimized by the following measures:
 - (a) Conductive lining inside pipes
 - (b) Improved grounding and bonding
 - (c) Control of free-falling liquids and mist generation by submerging pipes in the solution
 - (8) High-speed fire detection systems are preferable.
 - (9) Fireproofing of control system cabling is needed.
 - (10) Larger capacity fire protection/suppression systems are needed as follows:
 - (a) High-capacity fire water pumping systems
 - (b) Foam-water systems on pipe racks
 - (c) Foam-water systems for all diked areas
 - (d) Deluge (open-head) protection on solvent feed pumps
 - (11) Foam-water suppression systems are preferable to water-based systems.
 - (12) High-capacity drainage systems are needed.
 - (13) Diversion systems for spilled solvents might be needed.
 - (14) Improved dike design is needed to minimize solvent pooling.
 - (15) Separation of equipment and financial assets.
- The fires demonstrated that more rigorous and comprehensive fire protection standards are needed for SX facilities. They also demonstrated the need for process safety management (PSM) oversight and the need for better inherent safety (IS) practices in SX facility design.
- The need for fixed automatic fire protection systems actuated by high-speed detection systems is readily apparent. A number of suppression systems — such as closed-head sprinkler or deluge water-spray, foam-water delivered by nozzles or foam chambers, dry chemical, or high pressure water mist — might be applicable and suitable, depending on local conditions. Drainage, isolation, and confinement are also important protection measures.
- Some protection solutions and options are as follows:
- (1) Where possible, avoid belowgrade spaces for tank farms and process equipment. Where possible, site all facilities at the same grade.
 - (2) Where lower grade tank farms are present and where solvents can flow from upper level processes, provide a barrier to flow. Where plastic pipes penetrate a barrier, the use of steel spools on both sides of the barrier should be considered. The steel spool pieces can help prevent internal fire spread within the plastic pipes. A 3 m (10 ft) long steel spool has proven effective.
 - (3) Where pipes enter a lower grade tank farm, provide automatic shutoff valves to prevent continued flow of organic solvents or drainage into a fire area.
 - (4) Avoid use of subgrade trenches for solvent piping systems. Where possible, locate pipes above grade. Where trenches are required, subdivide trenches with dikes or curbs and do not drain into lower grade areas such as tank farms.
 - (5) Provide dikes and curbs around tanks, pumps, and process vessels.
 - (6) Avoid or minimize the use of combustible (plastic) and frangible (glass) piping systems and vessels. Avoid the use of thermoplastics such as HDPE, medium density polyethylene (MDPE), and polypropylene (PP) for piping systems.
 - (7) Avoid the use of rubber couplings on solvent lines, especially on pump suction lines.
 - (8) Substitute steel or concrete for plastic where possible for vessels and piping.
 - (9) Where use of steel piping is not possible due to corrosive effects, substitute a structural (thermoset) plastic such as FRP or polyvinyl chloride (PVC).
 - (10) Consider drainage patterns during design. Where practical, provide emergency drainage to a remote catch basin or pond from all diked areas and pipe trenches.
 - (11) Provide emergency dump capability from all tanks and vessels that actuate either manually or upon fire detection with drainage to remote catch basins or ponds.
 - (12) Space mixer-settler tanks and storage tanks as far apart as possible.
 - (13) Lower roofs and covers on tanks and process vessels to minimize vapor collection space above liquid surfaces.
 - (14) Consider ignition sources in design as follows:
 - (a) Where nonconductive solvents [conductivity of 250 picosiemens per meter (pS/m) or greater] are used with plastic piping systems, provide a conductive internal pipe liner (i.e., carbon) to dissipate static charges generated by liquid flow. Bond and ground the system, including at flanges.
 - (b) Submerge or lower solvent feed pipes where they enter solvent pools (i.e., inside mixer-settler and tank discharge) to minimize static discharge from free-falling flammable liquids and to minimize solvent mist development.
 - (c) Inspect piping for jarosite or other nonconductive inorganic coating that might compromise conductive liners.
 - (d) Provide electrically classified electrical equipment in solvent handling areas. Base the classification on types and hazards of solvents in process. In some cases, explosionproof equipment might be needed.
 - (15) Provide fixed water, foam-water, or dry chemical fire protection systems as follows:
 - (a) Interior of mixer-settler vessels
 - (b) Over the surface of open mixer-settler tanks
 - (c) Along launders and open solvent weirs outside of mixer-settler vessels
 - (d) Inside subgrade pipe trenches carrying solvents where drainage is missing or poor and liquids can accumulate
 - (e) Inside solvent storage tanks
 - (f) Inside dikes enclosing solvent storage tanks
 - (g) Over solvent pumps
 - (h) Along the exterior sides of tanks and mixer-settlers if spaced closer than 15 m (50 ft) from each other