NFPA® 122

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

2015 Edition

NFPA®, 1 Batterymarch Park, Quincy, MA 02169-7471, USA
An International Codes and Standards Organization

IMPORTANT NOTICES AND DISCLAIMERS CONCERNING NFPA® STANDARDS

NOTICE AND DISCLAIMER OF LIABILITY CONCERNING THE USE OF NFPA STANDARDS

NFPA® codes, standards, recommended practices, and guides ("NFPA Standards"), of which the document contained herein is one, are developed through a consensus standards development process approved by the American National Standards Institute. This process brings together volunteers representing varied viewpoints and interests to achieve consensus on fire and other safety issues. While the NFPA administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy of any information or the soundness of any judgments contained in NFPA Standards.

The NFPA disclaims liability for any personal injury, property or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, or reliance on NFPA Standards. The NFPA also makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

In issuing and making NFPA Standards available, the NFPA is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is the NFPA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

The NFPA has no power, nor does it undertake, to police or enforce compliance with the contents of NFPA Standards. Nor does the NFPA list, certify, test, or inspect products, designs, or installations for compliance with this document. Any certification or other statement of compliance with the requirements of this document shall not be attributable to the NFPA and is solely the responsibility of the certifier or maker of the statement.

REMINDER: UPDATING OF NFPA STANDARDS

Users of NFPA codes, standards, recommended practices, and guides ("NFPA Standards") should be aware that NFPA Standards may be amended from time to time through the issuance of Tentative Interim Amendments or corrected by Errata. An official NFPA Standard at any point in time consists of the current edition of the document together with any Tentative Interim Amendment and any Errata then in effect.

In order to determine whether an NFPA Standard has been amended through the issuance of Tentative Interim Amendments or corrected by Errata, visit the Document Information Pages on NFPA's website. The Document Information Pages provide up-to-date, document specific information including any issued Tentative Interim Amendments and Errata.

To access the Document Information Page for a specific NFPA Standard, go to http://www.nfpa.org/docinfo to choose from the list of NFPA Standards or use the search feature on the right to select the NFPA Standard number (e.g., NFPA 101). In addition to posting all existing Tentative Interim Amendments and Errata, the Document Information Page also includes the option to sign-up for an "Alert" feature to receive an email notification when new updates and other information are posted regarding the document.

ISBN: 978-145591042-7 (Print)
ISBN: 978-145591088-5 (PDF)

IMPORTANT NOTICES AND DISCLAIMERS CONCERNING NFPA® STANDARDS

ADDITIONAL NOTICES AND DISCLAIMERS

Updating of NFPA Standards

Users of NFPA codes, standards, recommended practices, and guides ("NFPA Standards") should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of Tentative Interim Amendments or corrected by Errata. An official NFPA Standard at any point in time consists of the current edition of the document together with any Tentative Interim Amendments and any Errata then in effect. In order to determine whether a given document is the current edition and whether it has been amended through the issuance of Tentative Interim Amendments or corrected through the issuance of Errata, consult appropriate NFPA publications such as the National Fire Codes® Subscription Service, visit the NFPA website at www.nfpa.org, or contact the NFPA at the address listed below.

Interpretations of NFPA Standards

A statement, written or oral, that is not processed in accordance with Section 6 of the Regulations Governing the Development of NFPA Standards shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Patents

The NFPA does not take any position with respect to the validity of any patent rights referenced in, related to, or asserted in connection with an NFPA Standard. The users of NFPA Standards bear the sole responsibility for determining the validity of any such patent rights, as well as the risk of infringement of such rights, and the NFPA disclaims liability for the infringement of any patent resulting from the use of or reliance on NFPA Standards.

NFPA adheres to the policy of the American National Standards Institute (ANSI) regarding the inclusion of patents in American National Standards ("the ANSI Patent Policy"), and hereby gives the following notice pursuant to that policy:

> **NOTICE:** The user's attention is called to the possibility that compliance with an NFPA Standard may require use of an invention covered by patent rights. NFPA takes no position as to the validity of any such patent rights or as to whether such patent rights constitute or include essential patent claims under the ANSI Patent Policy. If, in connection with the ANSI Patent Policy, a patent holder has filed a statement of willingness to grant licenses under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license, copies of such filed statements can be obtained, on request, from NFPA. For further information, contact the NFPA at the address listed below.

Law and Regulations

Users of NFPA Standards should consult applicable federal, state, and local laws and regulations. NFPA does not, by the publication of its codes, standards, recommended practices, and guides, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

Copyrights

NFPA Standards are copyrighted. They are made available for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of safe practices and methods. By making these documents available for use and adoption by public authorities and private users, the NFPA does not waive any rights in copyright to these documents.

Use of NFPA Standards for regulatory purposes should be accomplished through adoption by reference. The term "adoption by reference" means the citing of title, edition, and publishing information only. Any deletions, additions, and changes desired by the adopting authority should be noted separately in the adopting instrument. In order to assist NFPA in following the uses made of its documents, adopting authorities are requested to notify the NFPA (Attention: Secretary, Standards Council) in writing of such use. For technical assistance and questions concerning adoption of NFPA Standards, contact NFPA at the address below.

For Further Information

All questions or other communications relating to NFPA Standards and all requests for information on NFPA procedures governing its codes and standards development process, including information on the procedures for requesting Formal Interpretations, for proposing Tentative Interim Amendments, and for proposing revisions to NFPA standards during regular revision cycles, should be sent to NFPA headquarters, addressed to the attention of the Secretary, Standards Council, NFPA, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101; email: stds_admin@nfpa.org

For more information about NFPA, visit the NFPA website at www.nfpa.org. All NFPA codes and standards can be viewed at no cost at www.nfpa.org/freeaccess.

NFPA® 122

Standard for

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

2015 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 11, 2014, with an effective date of December 1, 2014, and supersedes all previous editions.

This edition of NFPA 122 was approved as an American National Standard on December 1, 2014.

Origin and Development of NFPA 122

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

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

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

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

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 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 solvent extraction (SX) plants and Section 13.19 for new hydro-metallurgical solvent extraction (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 solvent extraction (SX) plants, additional references and definitions were added to Chapters 2 and 3, respectively.

The Metal/Nonmetal Mining Task Group for the 2010 edition consisted of the following members: Larry Moore, Chair, FM Global; Steve Behrens, Swiss Re; Dennis Brohmer, Tyco Fire Suppression & Building Products; J. J. Kenny, Marsh; L. Harvey Kirk, MSHA; Mario Orozco, Zurich; Pierre Tousignant, QIT Quebec; and Mark Yarbro, Freeport MacMoran Mining.

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

Technical Committee on Mining Facilities

Matthew J. Bujewski, *Chair*
MJB Risk Consulting, MO [SE]

David G. Aden, State of Alaska Department of Public Safety, AK [E]
Steven M. Behrens, XL Global Asset Protection Services, CT [I]
J. Emmett Bevins, Amerex Corporation, AL [M]
Dennis D. Brohmer, Tyco Fire Protection Products, WI [M]
Jack Douglas Conaway, Arch Coal, Inc., MO [U]
Thomas A. Delorie, Jr., Marsh Risk Consulting, PA [I]
L. Harvey Kirk III, U.S. Department of Labor, VA [E]
James M. Kohl, Cintas Fire Protection, IL [IM]
Rep. National Association of Fire Equipment Distributors
Larry J. Moore, FM Global, CO [I]
Mario G. Orozco, Zurich Services Corporation, IL [I]
Rob Rosovich, FireIce Inc., FL [M]
Steven A. Sheldon, Fisher Engineering, Inc., AZ [SE]
Alex C. Smith, National Institute for Occupational Safety & Health, PA [RT]
Thomas D. Stilwell, Xtralis, Inc., MA [M]
Brent Sullivan, North American Coal Corporation, ND [U]
Bruce Watzman, National Mining Association, DC [U]
Rick Wells, Peabody Energy, MO [U]
Robert A. Wessel, Gypsum Association, MD [U]
Chris Yoder, Pillar Innovations, MD [M]

Alternates

Michael A. Gardner, Gypsum Association, MD [U]
(Alt. to R. A. Wessel)
Jeff Krieger, APS Fire, TX [IM]
(Alt. to J. M. Kohl)
Eric Metheny, Arch Coal, Inc., WV [U]
(Alt. to J. D. Conaway)
Kendall A. Pate, Amerex Corporation, AL [M]
(Alt. to J. E. Bevins)
Dennis M. Phillips, Tyco Fire Protection Products, TN [M]
(Alt. to D. D. Brohmer)
Scott C. Strickling, FM Global, Chile [I]
(Alt. to L. J. Moore)

Susan Bershad, NFPA Staff Liaison

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

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

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

Contents

NFPA 122

Standard for

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

2015 Edition

IMPORTANT NOTE: This NFPA document is made available for use subject to important notices and legal disclaimers. These notices and disclaimers appear in all publications containing this document and may be found under the heading "Important Notices and Disclaimers Concerning NFPA Standards." They can also be obtained on request from NFPA or viewed at www.nfpa.org/disclaimers.

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

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex C. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

Chapter 1 Administration

1.1 Scope.

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

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

(1) Diesel-powered equipment
(2) Storage and handling of flammable and combustible liquids

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

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

(1) Mobile equipment in use without its own motive power train and normally moved by self-propelled equipment
(2) Self-propelled equipment that contains a motive power train as an integral part of the unit and is not rail-mounted

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

1.1.6* As applies to metal mineral processing, this standard shall cover fire and related hazards associated with 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 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,* 2013 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam,* 2010 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems,* 2015 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems,* 2015 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2013 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* 2013 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* 2012 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems,* 2015 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems,* 2013 edition.

NFPA 17A, *Standard for Wet Chemical Extinguishing Systems,* 2013 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* 2013 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2014 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2015 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes,* 2013 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2014 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* 2013 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2014 edition.

NFPA 70®, National Electrical Code®, 2014 edition.

NFPA 72®, National Fire Alarm and Signaling Code, 2013 edition.

NFPA 85, *Boiler and Combustion Systems Hazards Code,* 2015 edition.

NFPA *101®*, *Life Safety Code®*, 2015 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems,* 2015 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2014 edition.

NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting,* 2012 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems,* 2015 edition.

2.3 Other Publications.

2.3.1 ANSI/NETA Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor New York, NY 10036.

Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems, 2011.

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

ASME *Boiler and Pressure Vessel Code,* Section VIII, X, 2013.

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

ASTM D 323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*, 2008.

ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C,* 2012.

2.3.4 CSA Publications. Canadian Standards Association, 5060 Spectrum Way, Mississauga, ON, L4W 5N6, Canada.

CSA B51, *Boiler, Pressure Vessel and Pressure Piping Code,* 2009.

2.3.5 Other Publication.

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,* 2013 edition.

NFPA 17A, *Standard for Wet Chemical Extinguishing Systems,* 2013 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2015 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2014 edition.

NFPA 52, *Vehicular Gaseous Fuel Systems Code,* 2013 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2013 edition.

NFPA 120, *Standard for Fire Prevention and Control in Coal Mines,* 2015 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems,* 2015 edition.

NFPA 5000®, Building Construction and Safety Code®, 2015 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 phrase "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,** 2015]

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,** 2015]

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,** 2015]

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,** 2015]

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,** 2015]

3.3.6 Container. Any vessel of 450 L (119 gal) or less capacity used for transporting or storing liquids. [**30,** 2015]

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.

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,** 2013]

3.3.15 Flammable Liquid Storage Area. Area used for storage of Class I liquids. [**120,** 2015]

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 ignitible 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,** 2015]

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,** 2014]

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. [**30,** 2015]

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 40 psi (276 kPa) 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. [**30,** 2015]

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

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

3.3.29 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 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*, or CSA B51, *Boiler, Pressure Vessel and Pressure Piping Code*. [**52**, 2013]

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 a spout cover designed to safely relieve internal pressure when exposed to fire. [**30,** 2015]

3.3.35 Self-Closing Doors. Doors that, when opened and released, return to the closed position. [**80,** 2013]

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 U.S. gal).

3.3.41.1 ***Atmospheric Tank.*** A storage tank that has been designed to operate at pressures from atmospheric through a gauge pressure of 6.9 kPa (1.0 psi) (i.e., 760 mm Hg through 812 mm Hg) measured at the top of the tank. [**30,** 2015]

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 227 L (60 gal) and not intended for fixed installation. [**30,** 2015]

Chapter 4 General

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

4.2 Housekeeping.

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

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

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

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

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

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

4.3 Ignition Source Control.

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

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

4.4 Hot Work.

4.4.1 Hot work shall be in accordance with NFPA 51B.

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

4.4.11 Hot work shall not be performed within 15.24 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) shall be covered with noncombustible material before hot work is started.

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

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

4.4.15 Where hot work is done on a metal wall, partition, ceiling, or roof, precautions shall be taken to prevent ignition of combustibles on the other side due to conduction or radiation.

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

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

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

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

4.4.20 Hot work shall not be performed in the presence of atmospheres containing flammable mixtures of gases, vapors, or liquids with air, or combustible mixtures of dust in suspension with air.

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

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

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

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

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

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

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

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

4.5 Maintenance.

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

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

4.6 Fire Protection Equipment Inspection, Maintenance, and Testing.

4.6.1 Portable extinguishers shall be inspected, tested, and maintained in accordance with NFPA 10.

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 mobile and self-propelled equipment, shall be inspected on a monthly basis in accordance with the fire suppression system manufacturer's listed installation and maintenance manual or owner's manual.

4.6.2.2 A fire suppression system, approved for use on mobile and self-propelled equipment, shall be serviced/maintained at least semiannually in accordance with the fire suppression system manufacturer's listed installation and maintenance manual.

4.7 Training.

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

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

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

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

4.8 Flammable and Combustible Liquid Handling and Storage.

4.8.1 Fixed, unburied flammable or combustible liquid storage tanks shall be provided with containment or drainage in accordance with NFPA 30.

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

4.8.3 Subsection 4.8.1 shall not apply to underground mines.

4.8.4 Ignition.

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

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

(1) Open flames
(2) Smoking
(3) Cutting and welding
(4) Hot surfaces
(5) Frictional heat
(6) Static, electrical, and mechanical sparks
(7) Spontaneous ignition, including heat-producing chemical reactions
(8) Radiant heat

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

4.9 Vehicle Refueling.

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

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

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

Chapter 5 Fire Risk Assessment and Risk Reduction

5.1* Fire Risk Assessment.

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

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

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

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

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

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

5.1.7 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 fire-fighting personnel and fire suppression equipment
(8) Spread of fire to combustible materials in proximity
(9) Ventilation control structures to contain or redirect products of combustion (underground mines only)
(10) Any other devices or procedures necessary to protect life and property

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

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

5.2 Risk Reduction.

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

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

Chapter 6 Fire Detection and Suppression Equipment

6.1 Portable 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 flammable and combustible liquid storage or dispensing area and maintenance shop.

6.1.5 Where portable fire extinguishers are provided within 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 and on surface mobile and self-propelled equipment shall be tested in accordance with *NFPA 72*.

6.3.4 Fire detectors shall be listed for their application.

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

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

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

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

6.4 Fire Suppression Equipment.

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

(1) NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
(2) NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*
(3) NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*
(4) NFPA 13, *Standard for the Installation of Sprinkler Systems*
(5) NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*
(6) NFPA 17, *Standard for Dry Chemical Extinguishing Systems*
(7) NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*
(8) NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*
(9) NFPA 750, *Standard on Water Mist Fire Protection Systems*
(10) NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*

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 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 Flammable or Combustible Liquids in Underground Mines

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

(1) The potential for the generation of smoke, gases, or toxic fumes that could contaminate the mine intake air
(2) The topography and relative elevation of storage tanks and mine openings
(3) Air currents
(4) Vegetation

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

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

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

8.3 Surface-to-Underground Transfer.

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

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

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

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

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

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

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

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

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

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

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

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

8.4 Underground Transfer.

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

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

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

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

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

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

Chapter 9 Flammable Liquid Storage in Underground Mines

9.1* General.

9.1.1* Electrical equipment in large flammable liquid storage areas shall be Class I, Division 1, as specified in *NFPA 70*, 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 U.S. Department of Transportation (DOT) shall be acceptable as storage containers.

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

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

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

9.3 Small Flammable Liquid Storage Areas.

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

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

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

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

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

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

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

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

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

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

9.4.4 Noncombustible storage cabinets meeting the requirements specified in NFPA 30, Section 9.5, shall be considered as complying with the construction requirements for large flammable liquid storage areas.

Table 9.2.2 Maximum Allowable Size of Containers for Flammable Liquids

	Class IA		Class IB		Class IC	
Container Type	**L**	**gal**	**L**	**gal**	**L**	**gal**
Original metal containers (other than DOT containers) or approved plastic containers	3.79	1	18.93	5	18.93	5
Safety cans	7.57	2	18.93	5	18.93	5
Containers, other than safety cans, complying with 9.2.1		Not allowed	227.12	60	227.12	60

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 ignitible vapors.

10.2 Combustible Liquid Containers and Tanks.

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

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

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

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

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

10.4* Low-Pressure Tanks. The operating pressure of the tanks shall not exceed the design working pressure.

10.5* Pressure Vessels. The operating pressure of the vessel shall not exceed the design working pressure.

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

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

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

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

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

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

10.7 Additional Considerations.

10.7.1 Connections for all tank openings shall be liquidtight.

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

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

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

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

10.7.6 Substitutes for manual gauging shall be permitted.

10.8 Small Combustible Liquid Storage Areas.

10.8.1 Combustible liquid storage areas shall be located a minimum of 30.5 m (100 ft) from explosives magazines, electrical substations, working faces, or other combustible liquid storage areas or shall be separated by unexcavated rock or masonry bulkheads.

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

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

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

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

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

10.9 Large Combustible Liquid Storage Areas.

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

10.9.2 In areas not protected by automatic fire suppression systems, the total quantity of combustible liquids in containers and portable tanks shall be restricted in accordance with Table 10.9.2, but in no case shall the aggregate quantity exceed 190,000 L (50,000 gal) in any single storage area.

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

	Maximum Pile Height		Maximum Quantity per Pile		Maximum Total Quantity	
Class	m	ft	L	gal	L	gal
Container Storage						
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

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

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

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

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

	Maximum Storage Height				Maximum Quantity per Pile			
	Containers		Portable Tanks		Containers		Portable Tanks	
Class	m	ft	m	ft	L	gal	L	gal
II	2.1	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

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

10.9.5 Individual piles *(see Table 10.9.2 and Table 10.9.4)* shall be arranged so that piles are separated from each other by at least 1.2 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.

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

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

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 m^2 (250 ft^2) 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 flammable or combustible liquid storage areas by a distance of at least 30.5 m (100 ft), or they shall be separated by unexcavated rock or masonry bulkheads.

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

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

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

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

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

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

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

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

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

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

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

10.10* Dispensing Combustible Liquids.

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

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

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

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

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

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

10.10.5 Combustible liquids shall not be dispensed within 15.24 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 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 fire fighting and accessible to flammable and combustible storage areas shall be equipped to discharge a foam-water solution and shall be in accordance with NFPA 11.

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.

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 16, 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 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 Flammable and Combustible Liquid Storage on Equipment. 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.

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 NFPA 10, Chapter 7, 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 NFPA 10, Chapter 8.

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 surface mining equipment, including but not limited to bulldozers, front-end loaders, haulage trucks, cranes, graders, scrapers, draglines, drills, shovels, and 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, endloaders, drills, graders, and scrapers shall have a fixed fire suppression system protecting the engine compartment and hydraulic pump and other hazard areas.

12.3.8.3.3 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 blowoff 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.

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

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

12.3.8.3.5.1 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.

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

12.3.8.3.7* 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.

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

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

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

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

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

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

12.3.8.3.11 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.

12.3.8.3.12 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) Combustible and flammable liquids mixing buildings and tank farms
(5) Other ore processing facilities such as filter rooms, process pump houses, and thickeners
(6) Electrical substations, transformers, control rooms, cable-spreading rooms and tunnels, and motor control center (MCC) rooms
(7) Offices, shops, laboratories, warehouses, fuel depots, maintenance garages, and other ancillary nonproduction buildings on the site of and supporting the operation of the mineral processing plant

13.2 Emergency Response and Manual Fire Fighting.

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

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

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

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

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

13.4 Lightning Protection. Where lightning protection is required, it shall be in accordance with NFPA 780.

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 NFPA *101*, Section 7.9.

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

13.6 Yard Hydrant Systems.

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

13.6.2 Yard hydrants shall be in accordance with NFPA 24.

13.7* Water Supply and Water Distribution Systems.

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

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

13.7.3* Where fire mains and hydrants are required by the risk assessment, the water supply system shall be installed and maintained in accordance with NFPA 24.

13.7.4 Where public or private fire mains are not provided, alternate water supplies shall comply with NFPA 1142.

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

13.8 Flammable and Combustible Liquids.

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

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

13.9 Compressed Gases. The storage, use, and handling of compressed gases shall be in accordance with NFPA 55 and NFPA 58.

13.10 Rubber and Plastic Lined Equipment.

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

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

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

13.10.4 The label shall be clearly visible.

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

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

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

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

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

13.11 Plastic Equipment.

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

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

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

13.11.4 The label shall be clearly visible.

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

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

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

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

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

13.12 Belt Conveyors.

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

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

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

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

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

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

13.13 Hydraulic Fluids and Lubricating Oil Systems.

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

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

13.13.3 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

13.13.4 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.

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

13.14* Thermal Oil Heating Systems.

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

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

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

(2) Interlocks to shut off the thermal oil system upon actuation of a fixed suppression or detection systems
(3) Automatic fixed fire protection system inside the cutoff room

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

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

13.16* Electrical Equipment Spaces.

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

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

13.16.3 Control rooms, cable-spreading rooms, transformers, and electrical switch rooms shall be protected with an acceptable fire protection system, including but not limited to cutoffs and barriers, smoke or heat detection, fire-retardant coating, automatic sprinklers, water spray systems, water mist systems, foam water systems, gaseous suppression systems, dry chemical systems, and portable extinguishers.

13.16.4 MCCs shall be protected with an acceptable fire protection system, including but not limited to, 1-hour cutoffs and barriers, smoke or heat detection, fire suppression systems, and portable extinguishers. Acceptable fire suppression systems include automatic sprinklers, water spray systems, water mist systems, foam-water systems, gaseous suppression systems, and dry chemical systems. A fire risk assessment shall be used to determine if fire suppression is not required for MCCs.

13.17 Battery Charging Installations.

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

13.17.2 Means shall be provided to flush spilled electrolyte.

13.18* Hydro-Metallurgical Solvent Extraction (SX) Facilities. Section 13.18 shall apply to both new and existing SX facilities.

13.18.1* 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 suppression 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 fire-fighting 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

13.18.1.1 The fire risk assessment shall not preclude the need for the requirements of Section 13.18.

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

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

13.18.2.2 Yard hydrants shall be provided with foam injection capability.

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

13.18.4 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.

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

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

13.18.7 Enclosed buildings containing flammable or combustible liquids shall be mechanically ventilated in accordance with NFPA 30.

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

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

13.18.10* 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.

13.19* New Solvent Extraction (SX) Facilities. Section 13.19 shall apply to new SX facilities.

13.19.1 Fixed fire suppression 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 flammable or combustible liquids

13.19.1.1* Fire suppression for applications in 13.19.1 shall be water, foam, dry chemical, or water mist.

13.19.1.2* Design of fire suppression systems in 13.19.1 shall be based on criteria set forth in NFPA 11, NFPA 15, NFPA 16, and NFPA 17.

13.19.1.3* Actuation of fire suppression systems in 13.19.1 shall be automatic.

13.19.2 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.

13.19.3 As exposure protection, automatic water-only deluge sprinkler systems shall be provided around the exterior perimeter of organic solvent tanks if spaced closer than 15.24 m (50 ft) from each other.

13.19.4 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.

13.19.5 Hydraulic design of automatic fire suppression systems in 13.19.1 shall include the simultaneous operation of all fire protection systems associated with a single (multi-cell) train.

13.19.6 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.

13.19.7 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.

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

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

13.19.7.3 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.

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

13.19.8 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.

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

13.19.9.1 Individual curbed areas shall not exceed 465 m^2 (5000 ft^2).

13.19.10 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.

13.19.10.1 Where plastic piping containing 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.

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

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

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

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

Fires and explosions in mines and mineral processing plants have caused major loss of property, production equipment, buildings, and business interruption. In the five-year period from 1994 to 1998, mines and quarries of all types averaged $12.3 million a year in direct damage in fires reported to U.S. local fire departments. In the same period, nonmetallic mineral processing and product manufacturing facilities averaged $16.1 million a year in direct damage in fires reported to U.S. local fire departments. *(For more information, see the NFPA Fire Protection Handbook, 2008 edition, Chapter 9, Section 9.16.)*

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

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

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

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

Most fires involving mobile or self-propelled mining equipment — whether underground or surface— occur on or near engine exhaust systems, high-speed drive lines, malfunctioning high-pressure–high-temperature hydraulic systems, or faulty electrical components. Total elimination of fire hazards on equipment is impossible since sources of ignition and fuel for fires are inherent in the basic equipment design. The fire problem is further complicated by the collection of environmental debris. Therefore, efforts to reduce fire losses on mobile equipment must be aimed at fire prevention and fire suppression.

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

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

The key to operator protection is early detection of fires to provide a warning to the operator, fuel shutoff to minimize fuel for the fire, and fire suppression during its earliest stages. Specialized systems to perform these functions can be required to protect the operator and the machines. To be totally effective, however, system operation must be fully understood by owners and operators, and provisions must be made for periodic inspection and maintenance.

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

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

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

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

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

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

Of particular mention and importance from a potential fire hazard standpoint are solvent extraction (SX) plants, which are covered in Section 13.18 (for new and existing facilities) and Section 13.19 (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 fire fighters and types of fire fighting appliances and suppression agents. Because of the large quantities of combustible liquids and use of plastic piping and process systems — which can fail prematurely due to fire impingement and rapidly release additional combustible liquids — a well-developed and large area fire could occur in minutes, and responding fire fighters could be faced with protecting exposures rather than suppression of the incipient event. For this reason the use of fast-acting automatic detection and suppression systems is advised. Foam-water systems have proven effective in suppressing combustible liquid fires. If used, consideration needs to be given to providing protection over and under mixer-settlers and tanks, in tunnels with plastic piping, under pipe racks, over pumps, and inside mixer-settlers.

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

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

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.9 Emergency Egress. See NFPA *101* for the use of the term.

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 shall be determined in accordance with ASTM D56, *Standard Method of Test for Flash Point by the Tag Closed Cup Tester.*

The flash point of a liquid having a viscosity of 45 SUS or more at 37.8°C (100°F) or a flash point of 93.4°C (200°F) or higher shall be determined in accordance with ASTM D93, *Standard Test Methods for Flash Point by the Pensky-Martens Closed-Cup Tester.*

As an alternative, ASTM D3278, *Standard Method of Tests for Flash Point of Liquids by Small-Scale Closed-Cup Apparatus*, shall be permitted to be used for paints, enamels, lacquers, varnishes, and related products and their components having flash points between 0°C to 110°C (32°F to 230°F), and having a viscosity lower than 150 stokes at 25°C (77°F).

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

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

A.3.3.27 Noncombustible Material. Materials that are reported as passing ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, are considered noncombustible materials.

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 hydrometallurgical solvent extraction facility is not to be confused with an agricultural solvent extraction plant that uses hexane or other low flash point 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 hydrometallurgical solvent extraction facilities.

A.4.4.21 For additional information, see NFPA 326 and AWS F4.1, *Safe Practices for the Preparation of Containers and Piping for Welding and Cutting.*

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

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

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

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

A.7.4(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 18 CFR, Chapter 1.

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

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

Information on the design and construction of tanks can be found in API 650, *Standard for Welded Steel Tanks for Oil Storage*; UL 80, *Standard for Steel Tanks for Oil Burner Fuels or Other Combustible Liquids*; or UL 142, *Standard for 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 *Code for Unfired Pressure Vessels*, Section VIII, Division I, of the ASME *Boiler and Pressure Vessel Code.*

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

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

A.10.10 No requirements for bonding or grounding to dissipate static electricity are included in this standard for combustible liquids, based upon the fact that NFPA 30 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 the NFPA *Fire Protection Handbook*, water sprinklers can be used on diesel fuel for control but not for extinguishment.

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

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

(1) As long as a fire burns, even if it does not grow in intensity or area and appears to be responsive to fire control, toxic smoke and fire gases are produced that can endanger persons in the mine.
(2) According to the NFPA *Fire Protection Handbook*, overpressure failure of containers when exposed to fire is considered the principal hazard of closed-container flammable and combustible liquid storage.
(3) Even a "controlled" fire can cause container failure, producing a fire so intense that the sprinkler system is unable to control it, much less extinguish it.
(4) Water sprays are not effective in extinguishing pressure fires, running fuel fires, and obstructed spill fires, all of which can occur in a diesel refueling area.
(5) Water supplies are limited in many underground mines. Fire control, therefore, should be considered temporary, because the fire will grow immediately to maximum intensity when the water supply is depleted.
(6) The vapor pressure of diesel fuel increases with elevation due to reduced barometric pressure. As a result, even fuels without flash point–reducing additives can become flammable, depending on the altitude at which they are used. This reduction in flash point could result in reclassification of the diesel fuel to a Class IC flammable liquid. There is no clear consensus in the literature and industry practice as to the effectiveness of fixed water sprays in controlling and extinguishing fires involving Class IC flammable liquids. Although industry practice strongly favors fixed water sprays for such applications, the literature and available research results clearly indicate the ineffectiveness of fixed sprays on Class IC liquids, especially on pressure fires, running fuel fires, and obstructed spill fires.

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

For further information on foam-water systems, see NFPA 16.

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 combustible and flammable liquid reservoirs, and hydraulic and fuel-line routing.

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

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.12.3.5.2.1 A dry-chemical system is the preferred system for these areas.

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 fire fighting.

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.12.3.8.3.3(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.12.3.8.3.7 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 fire-fighting effort. Personnel should be trained in emergency vehicle operation and mobile water supply shuttle procedures. If an impounded body of water is provided, it should be close and accessible enough to the protected property to allow fire fighters a quick response.

A.13.7.3 Chapter 5 and Appendix G of NFPA 1142 outline suggested methods for determining the estimated water supply (fire flow) that can be necessary for fire-fighting purposes.

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

(1) Many fires occur annually inside rubber lined equipment in concentrator plants.
(2) Many rubber lined equipment fires are quickly controlled and not reported, but some have spread throughout a circuit or several circuits and have caused significant property damage and business interruption. If located near a wall or ceiling, heat inside an internal rubber lined system might cause structural damage.
(3) Rubber lined equipment fires are usually caused by hot work. These fires can occur when heating the outside of a steel pipe lined with rubber or plastic, with heat passing into the interior lining and ignition inside. They could also occur due to hot work over open-topped tanks and vessels, which will normally occur when the plant is down for maintenance and the systems are dry.
(4) Once a fire enters the inside of a dry rubber lined system, it can spread unchecked.
(5) Where practical during new process installations or modifications, the use of rubber or plastic lining and plastic vessel and piping should be minimized or eliminated.
(6) Hot work on or over plastic or rubber lined vessels should be minimized, and alternate methods of repair exhausted prior to permitting hot work.
(7) When hot work is necessary, and where practical, vessels can be flooded with process or fire protection water to minimize internal ignition.
(8) When hot work is necessary, and where practical, vessels and piping should be isolated by closing process valves or breaking connection to minimize internal fire spread between processing circuits.
(9) Protection options might include smoke or heat detection, local fixed automatic sprinkler or water spray suppression, extinguishers, or hand hose lines. Flooding a circuit with process water is a good suppression technique as long as the responding emergency team knows which valves to open and has planned for this contingency.

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

(1) Similar to rubber or plastic lined equipment, there is increasingly new equipment constructed entirely of plastic, such as process vessels, pipes, and cooling towers.
(2) Hazards are similar to rubber lined equipment, and identification, labeling, hazard awareness, and fire planning are required.
(3) The use of fixed automatic sprinkler systems over large concentrations of plastic equipment has been effective.

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

(1) Belt fire retardancy
(2) Size and speed
(3) Degree of confinement
(4) Accessibility for manual fire fighting

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

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

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

(1) Individual and aggregate quantity of fluid or oil
(2) System location
(3) System design
(4) Type and fire hazard of fluid or oil
(5) Pressures
(6) Temperatures
(7) Presence of ignition sources
(8) Importance
(9) Attended or not
(10) Presence of personnel in area

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

Acceptable protection systems shall include automatic sprinklers, water spray systems, dry chemical systems, preengineered dry chemical or wet chemical systems, portable hand hose lines and extinguishers, and detection.

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

Chapter 8 of NFPA 664 is the primary reference in NFPA standards for thermal oil systems used in industrial processes. Even though the woodworking industry has unique equipment, the hot oil heating and distribution systems are similar, and the concepts provided in this standard can be utilized for the mineral processing industry.

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

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

(1) Additional or back-up fixed fire suppression
(2) Locating the heater and tanks outdoors or in detached buildings
(3) Proper location and confinement of expansion and storage tanks and heaters
(4) Proper piping arrangement
(5) Process interlocks and controls
(6) Explosion protection
(7) Damage limiting construction from an oil mist explosion

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

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

A.13.18 See Table A.13.18 for fire experience data justifying the addition of the requirements in Section 13.18.

A.13.18.1 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 comprising a single train. The distance between cells within a single train might be only a few meters (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 solvent extraction (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 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.

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 protection of agricultural solvent extraction plants but does not apply to and should not be applied for protection of hydro-metallurgical SX facilities.

Severe fire hazards exist with mineral SX facilities due to large volumes of combustible or flammable liquids, often in large open pools. Because SX solvents are normally cold (that is, at ambient temperature 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.13.18.5).

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:
    (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) Foam-water suppression systems are preferable to water-based systems.
    (b) High capacity fire water pumping systems.
    (c) Foam-water systems on pipe racks.
    (d) Foam-water systems for all diked areas.
    (e) Deluge (open-head) protection on solvent feed pumps.
(11) High capacity drainage systems are needed.
(12) Diversion systems for spilled solvents might be needed.
(13) Improved dike design is needed to minimize solvent pooling.
(14) Separation of equipment and financial assets.

Table A.13.18 Example Global Fire Losses Involving Hydro-Metallurgical Solvent Extraction Plants[1]

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
U.S. (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
U.S. (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 U.S. currency.

References for Table A.13.18

1. 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.

2. Hoy-Peterson, R., *Fire Prevention in Solvent Extraction Plants*, Proceedings of the 1st International Loss Prevention Symposium, The Hague/Delft, the Netherlands, May 1974.

3. Rizzuto, F., "Fire Protection for Solvent Extraction Plants, What We Can Learn from Olympic Dam," *Plumbing Engineer*, 2002, pp. 43–49.

4. *Mining Journal* (various 1999–2004), Albert House, 1 Slinger Street, London, UK, Published by Mining Communications Ltd.

5. Associated Press, *Fire deals big hit to Phelps Dodge*, Oct. 21, 2003.

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 practices in SX facility design.

The need for fixed automatic fire suppression systems actuated by high speed detection systems is readily apparent. A number of suppression systems such as closed head 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 below-grade 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 sub-grade 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 fiber reinforced plastic (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 actuates either manually or upon fire detection with drainage to remote catch basin or pond.
(12) Space mixer-settler tanks and storage tanks as far apart as possible.
(13) Lower roofs and covers on tanks and process vessel to minimize vapor collection space above liquid surfaces.
(14) Consider ignition sources in design.
    (a) Where nonconductive* solvents 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. [*Note: A conductive fluid is one with a conductivity of 250 picosiemens per meter (pS/m) or greater.]
    (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 may be needed.
(15) Provide fixed water, foam-water, or dry chemical fire suppression 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 sub-grade 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
    (i) Over elevated pipe racks carrying flammable solvents in plastic pipes
    (j) Over other critical equipment (like transformers) or outside along important building walls (i.e., MCC rooms) that are within 15 m (50 ft) of a solvent fire area
(16) Conduct a process hazard analysis (such as a HAZOP) on all new and existing SX facilities. Conduct revalidation process hazard analysis (PHA) every 5 years and during major changes.
(17) Operate facility under a process safety management system with emphasis on management of change.

The use of inherent safety (IS) principles in design and operation of solvent extraction (SX) facilities is advised.

The mining industry has designed and constructed facilities with an emphasis on personnel safety, production efficiency, and cost effectiveness. The use of IS to eliminate or minimize property fire exposures in the mining industry has not seen widespread practice. Lessons learned from the mainstream chemical processing industries (CPI) appear not to have been well-communicated or applied.

As an example, most copper SX facilities in use today have been designed to use some form of a sub-grade processing area (tank farm) and one-way gravity flow as a cost- and production-effective solution for transferring liquids and minerals through the process. This has resulted in SX facilities constructed with process equipment at different grade levels so that solutions can flow “downhill” and accumulate. Because of the use of large quantities of combustible or flammable liquids and the potential for these liquids — if released — to flow unimpeded into other areas, gravity SX processes represent severe inherent fire consequences unless costly barriers, drainage, and channeling are also provided.

While this layout is used to ensure a cost-effective operation, it has resulted in significant exposures to high value production and equipment. The use of sub-grade production units is a generally inherent unsafe layout where flammable liquids are used.

Gravity-assist layout is only one example where copper SX facilities have been designed and constructed without IS consideration. The use of combustible and frangible corrosion-resistant materials — such as glass, wood, and plastic — for flammable/combustible liquid storage, processing, and piping systems has significantly increased the fire hazards of these facilities. These construction materials are not of sufficient strength and durability to prevent fire spread and can rapidly fail under fire conditions, releasing flammable contents.

Another example of inherently unsafe layout is the widespread use of sub-grade trenches to carry solvent pipe systems. Access to trenches for fire fighting is usually limited and the trenches often drain directly into the lower grade tank farm areas. Trenches usually encircle solvent-filled cells and have open grated coverings; therefore they represent severe fire risk to production equipment such as mixer-settlers (M-S). Trenches also offer low spots for vapors or liquids to accumulate and might require mechanical ventilation systems to prevent flammable vapor accumulation. The use of plastic piping in trenches further increases the hazard. The CPI long ago discontinued the use of sub-grade trenches for transporting combustible/flammable materials, replaced with elevated, easily accessible, and well-ventilated pipe racks.

The classical and common approach to loss prevention for industrial facilities has been to accept a hazard and to protect against it. This approach usually requires expensive and sophisticated retrofitted protection systems, which are subject to failure during the life of the plant. An inherently safer plant eliminates or reduces the hazard to where protection systems might not be needed or can be reduced, saving initial installation cost, lifetime maintenance and testing, and potential loss costs should systems fail.

The "hypothetical" ideal IS approach would be to completely change the technology or process chemistry of SX facilities. The extent to which this could be technically or economically achieved is not known, but some ideas are the following:

(1) Develop and use a nonflammable organic solvent.
(2) Develop and use a less flammable organic solvent.
(3) Find an additive that lowers the resistance coefficient of the solvent to eliminate the potential for static electricity generation.
(4) Develop a new process to extract minerals by significant reduction in quantities and flow of solvent and eliminate large open pools of flammable liquids.

Given that the basic science and technology of a well-established process cannot always be economically changed and that combustible solvents will likely continue to be used in large quantities, potential IS opportunities should focus on changes to design and layout concepts. Some ideas are the following:

(1) Stop or reduce the practice of gravity flow in the SX process.
(2) Install equipment and processes at the same grade level rather than using lower grade tank farms.
(3) Eliminate the use of sub-grade trenches for piping; place piping on elevated pipe racks located away from solvent storage or drainage discharge areas.
(4) Separate buildings, vessels, and process areas based on a risk assessment that includes the impact of radiant heat, wind effects, and drainage patterns.
(5) Lower mixer-settler roofs to rest on or near the top of the liquid layer to minimize or eliminate space for flammable vapor accumulation.
(6) Provide liquid barriers such as walls, curbs, and dikes between buildings, vessels, and process areas.
(7) Provide high-capacity drainage systems for spilled solvents, with discharge to a safe, remote area.
(8) Provide high-capacity emergency dump systems for mixer-settler cells and other vessels that contain large quantities of solvents, with discharge to a safe, remote area.
(9) Locate solvent pumps outside of dikes or sub-grade areas that enclose solvent tanks and other equipment.
(10) Separate process control and safety interlock instrumentation from power cables.
(11) Use robust, fire-resistant, conductive materials (like stainless steel) for piping and vessels rather than combustible, frangible, or nonconductive materials like thermoplastics or glass. When steel cannot be used, consider use of a more durable and fire-resistant structural thermoset plastic such as FRP/GRP with a conductive lining.
(12) Eliminate polymeric materials such as rubber for flexible connections on piping and pumps.
(13) Use seal-less or double sealed pumps for solvents.
(14) Use cooling water jackets around pump seals and bearings.
(15) Find methods to reduce static or mist/aerosol generation in solvent systems such as submerging in-feed nozzles, minimizing bends and restrictions in piping, reducing solvent flow velocities, and using low-turbulence pumps.
(16) Provide high capacity emergency dump systems for mixer-settler cells and other vessels containing large quantities of solvents, with discharge to a safe, remote area.

A.13.18.5 Because some SX facilities are located at high altitudes, flash point assignment can be critical to the risk assessment. Flash points, when tested, are calibrated and reported based on mean sea level in accordance with ASTM D56, *Standard Test Method for Flash Point by the Tag Closed Cup Tester*. Due to partial pressure effects, flash points decrease as altitude increases. For example, a combustible liquid with a flash point of 41°C (105°F) at sea level has a flash point of 33°C (91°F) at 3,048 m (10,000 ft) and 30°C (86°F) at 4,268 m (14,000 ft).

A.13.18.8 Because mineral solvents are usually organic, they are heavier than air, and suction for ventilation systems, when provided, should be near floor level.

A.13.18.9 Suppressing a fire in flammable solvents depends to a great extent on speed of detection. UV/IR detection systems have proven suitable for enclosed mixer-settler cells. Electrical resistance wires have proven effective in pipe trenches and along pipe racks. Other more conventional heat and flame detection systems are also suitable if properly located, spaced, and calibrated.

A.13.18.10 Pregnant liquor solution (PLS) feed is a noncombustible acidic feedstock solution feeding the facility. This is usually gravity-fed from a PLS holding pond above the SX facility. Should a fire occur and PLS solution be allowed to continue to flow into the SX facility, mixer-settler cells might overflow and spread burning and/or high-acid concentration solvents throughout the facility. It is necessary to have control over this feed system in an emergency from both a fire perspective and an environmental perspective. Either manual or automatic valves are suitable. When manual valves are used, the emergency response plan should include provisions to shut off the PLS valve.

A.13.19 See Table A.13.18 for fire experience data justifying the addition of the requirements in Section 13.19.

A.13.19.1.1 Although water-only deluge, foam-water, and dry chemical systems might be effective in controlling or suppressing SX facility fires, there might be use for more than one application in a given facility. Manual response has been ineffective in recent losses, and automatic suppression is advised for both existing and new facilities.

While water spray can be effective, due to potentially high flow requirements a mixer-settler cell might overflow during the suppression process. This might create additional concerns with drainage and fire spread.

Foam has been shown to be an effective suppressant medium for SX fires. However, environmental aspects, potential contamination of process liquids (particularly associated with accidental system initiation), and the difficulty or inability to conduct system flow tests on a periodic basis are negative points in the selection of foam.

High pressure water mist or fog might prove to be a potentially effective suppressant medium and might not create the contamination, environmental, and testing obstacles that accompany foam or the large volumes that accompany conventional high density water deluge systems. Currently, there are no public domain tests conducted on mist systems for pool fires of the size involved in a large SX settler; thus, actual suppressability under all fire conditions has not been demonstrated.

A.13.19.1.2 The following best practices design guidance for automatic fire suppression systems is advised:

For settler tanks or cells, use either Type 1 foam chambers or open head deluge sprinklers with foam discharge. When using foam chambers, provide a 3 percent aqueous film-forming foam (AFFF) foam discharge, in accordance with NFPA 11, with a density of 4.1 L/min/m^2 (0.10 gpm/ft^2) over the entire settler area. When using open head deluge sprinklers, provide a 3 percent AFFF foam discharge, in accordance with NFPA 16, with a density of 6.5 L/min/m^2 (0.16 gpm/ft^2). Design for a 20-minute discharge period.

For mixers, launders, drainage sumps, and piping trenches, use open head deluge sprinklers and provide a 3 percent AFFF foam discharge, in accordance with NFPA 16, with a density of 6.5 L/min/m^2 (0.16 gpm/ft^2) and a 20-minute foam discharge period.

For the interior of tank farm vessels containing combustible or flammable liquids such as loaded organic tanks, coalescers, crud treatment tanks, and diluent tanks use a Type 1 foam chamber and provide a 3 percent automatic AFFF foam discharge, in accordance with NFPA 11, into each of the tanks with a density of 4.1 L/min/m^2 (0.10 gpm/ft^2) and a 20- minute foam discharge period.

For the exterior surfaces of tank farm equipment containing combustible or flammable liquids such as loaded organic tanks, coalescers, crud treatment tanks, diluent tanks, crud treatment filters, centrifuges, pumps, and pipe racks, provide automatic open head (water only) deluge sprinklers based on a discharge density of 10.2 L/min/m^2 (0.25 gpm/ft^2).

A.13.19.1.3 Actuation of automatic fire suppression systems can be done using ultraviolet/infrared (UV/IR) dual spectrum detectors, heat detection cable, rate of rise heat detectors, or standard air pilot heads. High speed detection is considered advisable to suppress a solvent fire in its incipient stages.

Annex B Fire Risk Assessment

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

B.1 Fire Risk Assessment. There are many techniques available to assess risk. The four general techniques are experience, augmented experience, creative, and analytical.

Experience (qualitative) techniques are as follows:

(1) Use of standard designs
(2) Use of recognized standards
(3) Use of experts
(4) Qualitative approach

Augmented experience (qualitative) techniques are as follows:

(1) Secondary safety checks outside of design process
(2) Safety review meetings
(3) Multidisciplinary teams
(4) Avoid blind spots
(5) "What-if" analysis
(6) Qualitative approach

Creative (qualitative) techniques are as follows:

(1) Seek improvements or innovations
(2) Brainstorming
(3) Hazard and operability studies

Analytical (quantitative) techniques are as follows:

(1) Logic trees
(2) Fault event trees
(3) Failure modes and analysis
(4) Quantitative risk assessment
(5) Detailed analytical checklists

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

(1) Identify the potential for fire and explosion.
(2) Assess the consequences of fire and explosion.
(3) Determine the need for fire protection.
(4) Select appropriate option(s).

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

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

B.1.1 Identify the Potential for Fire and Explosion.

B.1.1.1 Ignition sources are as follows:

(1) High temperatures, which are usually found in the vicinity of a vehicle engine and exhaust system; pumps; batteries; wiring; switches; electrical motors; generators; and friction sources such as bearings, brakes, and gears
(2) Electrical, including switch gear; MCC; circuit breakers; motors and generators; transformers; battery boxes; substations; cable reels, trays, and splices; and collector rings
(3) Hot work such as cutting and welding
(4) Other, including smoking materials, chemical reactions, and spontaneous ignition sources

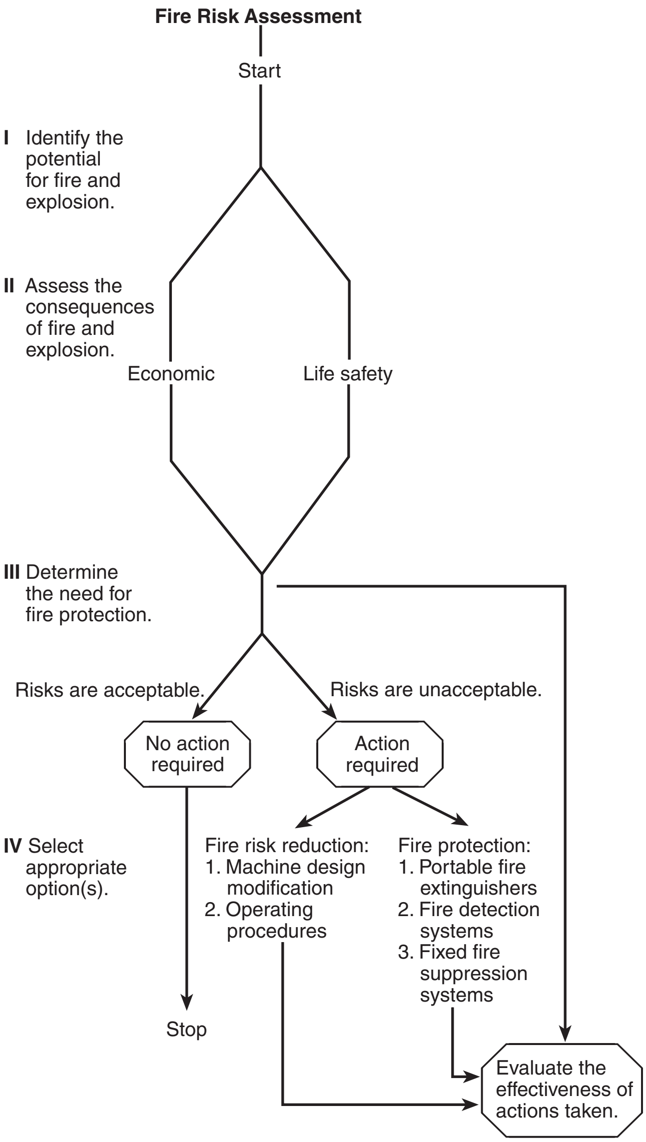

FIGURE B.1 Fire Risk Assessment Chart.

B.1.1.2 Fuel sources are as follows:

(1) Class A, including combustible debris, wood, rags, electrical insulation, coal dust, upholstery, hoses, tires, and seats
(2) Class B, including flammable and combustible liquid materials such as gasoline, diesel fuel, liquefied petroleum gas (propane), hydraulic fluids, some coolant combinations, grease, and oil
(3) Class D, which includes some new mobile equipment that have magnesium transmission components that cannot be extinguished with conventional fire suppression agents

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

(1) Proximity of fuel to ignition sources should be assessed as follows:
    (a) An assessment should be made of existing areas where lubrication, hydraulic oil, fuel lines, rubber and plastic, and other combustibles are in proximity to an ignition source.
    (b) In identifying risk areas, note that a combustible liquid can spray or drip onto a hot surface remote from the rupture or leak point.
(2) Previous fire experience on mobile equipment and in industrial settings similar to mining should be considered in the fire risk assessment.
(3) Quality of maintenance should be assessed as follows:
    (a) Replacement parts should be at least equal in performance to original parts. Examples are hoses, bearings, fittings, and electrical equipment on mobile equipment or bearings on motors for conveyor systems.
    (b) Maintenance should be performed in accordance with recommendations and schedules supplied by the equipment manufacturer.
(4) The presence of accumulations of combustible materials such as oil-soaked waste and fuel spillage represent potential fire hazards.

B.1.2 Assess the Consequences of Fire and Explosion.

B.1.2.1 Personnel exposure should be assessed as follows:

(1) Determine the number of persons involved and their location during routine and maintenance operations.
(2) Determine the exposure to potential fire and explosion risks for each person and whether the fire and smoke could impair safe egress from his or her work location.

B.1.2.2 Economic risks should be assessed as follows:

(1) Consider the cost of repairs, replacement, cleanup, and damage to the work site.
(2) Items to consider are production loss, personnel overtime, interruption of customer deliveries, and replacement equipment rental.

B.1.3 Determine the Need for Fire Protection.

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

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

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

B.1.4 Select Appropriate Option(s).

B.1.4.1 Risk reduction should be considered as follows:

(1) Evaluate equipment to determine whether the risk from the start or the spread of a fire or the risk to personnel from a fire can be reduced. Examples concerning how to reduce the start or spread of a fire include physical barriers between fuel sources and ignition sources; thermal shields over hot surfaces; hose and wiring harness routing, support, and protection; and power shutoffs. Examples for reducing the threat of fire to personnel include emergency egress provisions and relocating or shielding potential fire hazards.
(2) Reduce the threat of fire and explosion through implementation of policies and procedures. Examples include

effective equipment maintenance programs, adequate housekeeping procedures, proper employee training, and development of emergency plans and strategies that deal with fire and explosion hazards. Such emergency plans can include use of company fire brigades and other available equipment such as fire trucks and water wagons, and the response of local fire departments.

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

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

(1) Identify available alternatives as follows:
   (a) Portable protection options include hand-portable extinguishers, hose reels and lines, wheeled extinguishers, and skid-mounted extinguishers. To handle difficult fires, larger capacity extinguishers that provide more agent, greater range, and longer discharge time are recommended for agent selection *(see B.1.5.1)*.
   (b) Fire detection devices can be used to provide early warning of fires, actuate a fire suppression system, shut down equipment, and operate other systems such as door closers and exhaust fans. *(For a discussion of detector and control options, selection, and placement, see B.1.5.3 and B.1.5.4.)*
   (c) Fixed system protection can be accomplished by local application, total flooding, or a combination of both, or automatic sprinklers. *(For agent selection, see B.1.5.1. For fixed fire suppression system options, see B.1.5.2.)*
(2) Compare capability with need. Mandatory requirements and identified needs should be matched with the most cost-effective approach to fire detection, fire suppression, or both.
(3) Select equipment. The selection of all equipment used for detection and suppression of fires in mining equipment should be based upon consideration of the environment where the equipment will function and should be tested. Testing should include provisions for determining the adequacy and durability of the equipment, and the manufacturer should demonstrate that such tests have been conducted.
(4) Evaluate. Determine whether risk reduction results in compliance with mandatory requirements or reduces risks to acceptable levels, or both. If risks are within acceptable levels, no further action is required. If unacceptable risks still exist, then action is required either to reduce hazards further or to install fire detection/suppression equipment or a combination of both.

NOTE: A more detailed discussion of fire suppression and detection equipment can be found in the references in Annex C and in NFPA 10.

B.1.5 Fire Protection Agents and Equipment.

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

(1) Class A agents are as follows:
   (a) Dry chemicals (ABC) with ammonium phosphate as the basic ingredient
   (b) Foams such as protein, fluoroprotein, aqueous film forming, and medium and high expansion
   (c) Water
   (d) Clean agents (gaseous)
(2) Class B agents are dry chemicals (BC) with sodium bicarbonate, ammonium phosphate, potassium bicarbonate, urea-based potassium bicarbonate, or potassium chloride as the basic composition, as follows:
   (a) Foams such as protein, fluoroprotein, aqueous film forming, and medium and high expansion
   (b) Carbon dioxide
   (c) Water
   (d) Clean agents
(3) Class C agents are dry chemicals (ABC or BC) with sodium bicarbonate, ammonium phosphate, potassium bicarbonate, urea-based potassium bicarbonate, or potassium chloride as the basic composition, as follows:
   (a) Carbon dioxide
   (b) Water
   (c) Clean agents
(4) Class D agents are dry powder agents composed of sodium chloride or graphite with other particulate material added, as well as inert materials such as dry sand, foundry flux, and so on.

B.1.5.2 The design and layout of fixed fire suppression systems should be based upon the method of application of the fire suppressant to the area to be protected. Methods of delivery include the following:

(1) Local application consisting of a supply of suppressant permanently connected to a distribution system arranged to discharge onto a defined area or space
(2) Total flooding consisting of a supply of suppressant permanently connected to a distribution system arranged to discharge into an enclosed space
(3) A combination of B.1.5.2(1) and B.1.5.2(2) above
(4) Automatic sprinklers consisting of a supply of suppressant (normally water) permanently connected to a distribution system to discharge the suppressant

B.1.5.3 Detector options are as follows:

(1) Automatic fire detection devices are covered by *NFPA 72*. One fire detection device that is commonly used in self-propelled and mobile mining equipment but is not covered in *NFPA 72* is fusible plastic tube. It comprises a sensing element consisting of a plastic tube pressurized with inert gas. Heat from the fire causes the tube to burst, releasing the gas pressure and activating a mechanical pneumatic actuator.
(2) Consideration should be given to the physical configuration of the area to be protected when selecting and locating fire detectors. A detector's response time is dependent upon its type and proximity to a fire. For spacing, see *NFPA 72*. Other factors to be considered in fire detector placement are ambient temperature, climatic conditions, shock and vibration, air contamination, ventilation flows, and maintenance requirements.

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

(1) Discharge time delay
(2) Discharge abort switch

(3) Audible and visual alarms
(4) Pre-discharge alarm
(5) Detection circuit supervision

B.2 Electrical Ignition Hazards. Self-propelled and mobile surface mining equipment powered by electrical energy is normally supplied through portable electrical power cables carrying high-voltage, three-phase, ac power. Existing regulations require that the electrical system be designed to protect personnel by limiting the voltage rise of the machine frame, in the event of a ground fault, to a maximum of 100 volts. Protection on such electrical systems includes the following:

(1) Normal overcurrent protection
(2) Ground-fault current limitation (normally to about 15 amperes)
(3) Ground-fault overcurrent tripping (usually at about 7 amperes to 10 amperes)
(4) Monitoring of continuity of the ground conductor in the trailing cable and instantaneous tripping if continuity is lost
(5) Operational damage

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

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

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

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

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

(1) Determine whether personnel can be exposed to the effects of a fire. These effects could include the following:
    (a) Direct exposure of the operator or nearby personnel to heat, smoke, and toxic fire gases from the burning equipment.
    (b) Exposure of personnel located away from the equipment fire site to products of combustion by the mine ventilation.
    (c) Equipment fire spread to other combustibles such as timber supports, combustible minerals, explosives, and lubricants. Such fires can grow in intensity, producing increased quantities of toxic combustion products, complicating fire-fighting efforts, and interfering with evacuation and rescue operations.
    (d) The possibility of the equipment fire or secondary fires causing ventilation disturbances such as throttling or reversals, contaminating escapeways in an unpredictable manner.
(2) Determine the economic loss resulting from a fire on a piece of equipment, including both property damage and business interruption costs, and consider the following factors:
    (a) Fire involving a single piece of equipment could cause property damage and loss of production until the fire is extinguished and the equipment is repaired or replaced.
    (b) Fire spread to nearby combustible material, including combustible mineral seams, can have greater economic effects than the initial fire.

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

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

(1) Hazard reduction should be considered as follows:
    (a) Evaluate equipment to determine if the risk from the start or the spread of a fire can be reduced.
    (b) Reduce the threat of fire through implementation of company policies and procedures. Examples include effective equipment maintenance programs, adequate housekeeping procedures, proper employee training, development of emergency plans, and strategies that deal directly with fire.
    (c) Determine whether fire risk reduction practices reduce risks to acceptable levels. If risks are acceptable, no further action is necessary. If unacceptable risks still exist, action is needed either to reduce risks further or to install fire detection/suppression equipment, or a combination of both.
(2) Identify available fire detection and suppression equipment alternatives as follows:
    (a) Portable protection options include portable hand extinguishers, hose reels and lines, wheeled extinguishers, and skid-mounted extinguishers. For difficult fires, larger capacity extinguishers that provide more agent, greater range, and longer discharge time are recommended. *(See B.1.5.1 for agent selection.)*
    (b) Fire detection devices can be used to provide early warning of fires, actuate a fire suppression system, shut down equipment, and operate other fire control systems such as ventilation devices and fire doors. *(For a discussion of detector and control options, selection, and placement, see B.1.5.3 and B.1.5.4.)*
    (c) Fixed fire suppression systems should be considered as follows:
        i. Accomplish fixed system protection by local application, total flooding, a combination of both, or automatic sprinklers. *[See B.2.3(3) for agent selection. See B.2.3(3)(b)ii for fixed fire suppression options.]*
        ii. Compare capability with need. Identified needs should be matched with the most cost-effective approach to fire detection, fire suppression, or both.
        iii. Select equipment. The selection of all equipment used for all detection and suppression of fires in mining equipment should be based on consideration of the environment in which the equipment functions.
        iv. Evaluate fixed fire suppression systems. Determine whether fire risk reduction complies with mandatory requirements and reduces risks to acceptable levels. If risks are within acceptable levels, no further action is necessary. If not, additional action is needed either to reduce fire risks or to install fire detection/suppression equipment, or a combination of both.