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NFPA 480 Storage, Handling and Processing of Magnesium 1987 Edition

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

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Policy Adopted by NFPA Board of Directors on December 3, 1982

The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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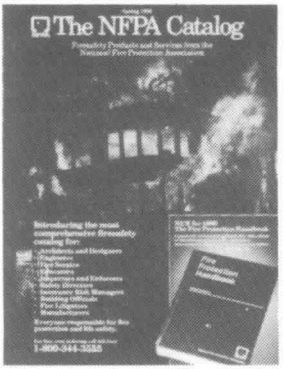

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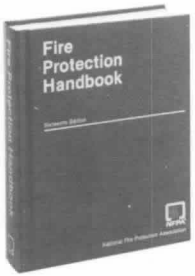

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NFPA 480

Standard for the

Storage, Handling and Processing of Magnesium

1987 Edition

This edition of NFPA 480, *Standard for the Storage, Handling and Processing of Magnesium*, was prepared by the Technical Committee on Combustible Metals, and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 17-20, 1986, in Denver, Colorado. It was issued by the Standards Council on December 10, 1986, with an effective date of December 30, 1986, and supersedes all previous editions.

The 1987 edition of this standard has been approved by the American National Standards Institute.

Origin and Development of NFPA 480

This standard was begun in 1946, tentatively adopted in 1950, and adopted by the National Fire Protection Association in May, 1951. Revisions were adopted by the Association in 1952, 1954, 1957, 1959, 1961, and 1967. The 1967 edition was reconfirmed in 1974.

The 1974 edition was completely revised in 1980, primarily to comply with the NFPA Manual of Style. Minor technical amendments were made at that time. This complete revision of the 1974 edition was acted on by the Association at its 1981 Fall Meeting and the revision was designated the 1982 edition.

This 1987 edition is a reconfirmation of the 1982 edition. The only changes made are minor editorial improvements and redesignation of the standard as NFPA 480.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

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.

Contents

NFPA 480

Standard for the

Storage, Handling and Processing of Magnesium

1987 Edition

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

Information on referenced publications can be found in Chapter 7 and Appendix C.

Chapter 1 General

1-1 Scope.

1-1.1 This standard shall apply to the storage, handling, and processing of magnesium at magnesium foundries, processing plants, and commercial storage facilities.

1-1.2 This standard shall not apply to the primary production of magnesium.

1-1.3 This standard shall not apply to the production of magnesium powder. (*See NFPA 651, Standard for the Manufacture of Aluminum and Magnesium Powder.*)

1-2 Purpose. The purpose of this standard is to call attention to the fire and explosion hazards in the storage, handling, and processing of magnesium or magnesium alloys marketed under different trade names but commonly referred to as magnesium, and to emphasize the measures that can be taken to control such hazards. The requirements of this standard are based on conclusions drawn from available reports and data on magnesium fire tests and actual fire experience. (*See Appendix B, "Supplementary Information on Magnesium."*)

1-3 Definitions. For the purpose of this standard, the following terms shall have the meanings given below.

Approved. Acceptable to the "authority having jurisdiction."

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

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

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

Fire-Resistive. Meeting the requirements for Type I or Type II construction, as described in NFPA 220, *Standard on Types of Building Construction.*

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

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The "authority having jurisdiction" should utilize the system employed by the listing organization to identify a listed product.

Magnesium. Refers to either pure metal or alloys having the generally recognized properties of magnesium, marketed under different trade names and designations.

Noncombustible. In the form used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. (Materials reported as noncombustible, when tested in accordance with ASTM E136, *Standard Method of Test for Noncombustibility of Elementary Materials,* shall be considered noncombustible materials.)

Shall. Indicates a mandatory requirement.

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

Swarf. Finely divided metal particles produced by sawing and cutting operations.

Chapter 2 Magnesium Mill and Foundry Operations

2-1 Melting and Casting Operations.

2-1.1* Buildings of noncombustible construction with high roofs and adequate ventilation shall be considered for melting and casting operations. Floors of buildings shall be noncombustible. Melt rooms shall have easy and adequate access to facilitate fire control.

2-1.2* All metal added to melting pots shall be thoroughly dried. Floors around melting operations shall be of hard-burned or vitreous paving block, cast-iron plate, or steel plate, laid in concrete and kept clean and free of moisture. Fuel supply lines to melting pots shall have remote fuel shutoffs.

2-1.3 Furnace settings shall be kept dry and free of iron scale. Safety runoff containers shall be provided for all melting pots and crucibles. Melting pots and crucibles shall be inspected regularly. Pots and crucibles that show evidence of possible failure or that allow molten metal to contact concrete or iron scale shall be discarded.

2-1.4 Ladles, skimmers, and sludge pans shall be thoroughly dried and preheated before contacting molten metal.

2-1.5 Extreme care shall be exercised in pouring magnesium castings to avoid spillage. Permanent molds shall be thoroughly preheated before pouring. Permanent molds shall also be purged with sulfur dioxide gas prior to use and between pourings.

2-1.6 Operators in melting and casting areas shall wear flame-resistant clothing, high foundry shoes, and adequate face protection.

2-2 Rough Finishing of Castings.

2-2.1* Provisions shall be made for proper removal of dust produced at grinders and for immediate quenching of sparks produced by such equipment.

2-2.2 Cuttings and swarf from saws shall be swept up at regular intervals to prevent excessive accumulations in work areas.

2-2.3 Good housekeeping shall be maintained.

2-2.4 Electrical equipment and wiring, including motors, shall be approved for use in Class II, Group E atmospheres and shall be installed in accordance with Article 502 of NFPA 70, *National Electrical Code®*.

2-2.5 Work benches and other equipment shall be noncombustible.

2-2.6 Operators in finishing areas shall wear caps and hard-finished or flame-resistant outer clothing without pockets or cuffs.

2-3* Heat Treating.

2-3.1 A standard procedure for checking the uniformity of temperatures at various points within heat-treating furnaces shall be established. Furnaces shall be tested prior to use and at regular intervals during use to locate undesirable hot spots.

2-3.2 Furnaces shall be properly and tightly constructed. Gas- or oil-fired furnaces shall be provided with combustion safety controls.

2-3.3 All furnaces shall have two sets of temperature controls operating independently: one to maintain the desired operating temperature; the other, to operate as a high temperature limit control, shall cut off fuel or power to the heat-treating furnace at a temperature slightly above the desired operating temperature.

2-3.3.1 To further retard ignition of magnesium, a dilute sulfur dioxide or carbon dioxide atmosphere may be provided in furnaces operating above 750°F (399°C).

2-3.4 Magnesium parts to be put in a heat-treating furnace shall be carefully freed of magnesium turnings, chips, and sawdust.

2-3.5 Magnesium billets, castings, and wrought products shall not be placed in a heat-treating furnace with wood spacers or pallets.

2-3.6* Aluminum parts, sheets, or separators shall not be included in a furnace load of magnesium.

2-3.7 There shall be strict adherence to the heat-treating temperature cycle recommended by the alloy manufacturer.

2-3.8* Molten salt baths containing nitrates or nitrites shall not be used for heat treating magnesium alloys. Special salt fluxes may be safely used for dip-brazing of magnesium.

2-3.9 The possibility of accidental immersion of magnesium alloys in salt baths used for aluminum is ever present in areas where both metals are being processed. Every effort shall be made to keep these metals segregated and easily identified.

Chapter 3 Machining and Fabrication of Magnesium

3-1* Machining.

3-1.1 Cutting tools shall not be allowed to ride on the metal without cutting, as the frictional heat may ignite any fine metal that is scraped off. For the same reason, the tool shall be backed off as soon as the cut is finished. Cutting tools shall be kept sharp and ground with sufficient clearance to prevent rubbing on the end and sides of the tool.

3-1.2* When drilling deep holes (depth greater than five times drill diameter) in magnesium, high helix drills (45 degrees) shall be used to prevent packing of the chips produced.

3-1.3 Adequate relief on tools used in grooving and parting operations shall be maintained, since the tool tends to rub the sides of the groove as it cuts. Side relief shall be 5 degrees; end relief shall be between 10 degrees and 20 degrees.

3-1.4 Flashing of chips during machining may be minimized by any of the following methods:

(a) Keep surface speed below 300 ft per minute (91.4 m/min) or above 2200 ft per minute (670.6 m/min).

(b) Increase feed rate to 0.008 to 0.010 in. per revolution (0.2 to 0.25 mm per revolution).

(c) Control relative humidity in the machining area to 45 percent or lower.

(d) Use an alloy containing 3 percent or less aluminum and 1 percent or less zinc.

(e) Use high aluminum (9 percent)/high zinc (2-3 percent) magnesium alloy in the solution heat-treated condition (T4).

(f) Use carbide tools.

(g) Apply a coolant.

3-1.5* If lubrication is needed, as in tapping or extremely fine grooving, a high flash point neutral mineral oil shall be used. Water, water-soluble oils, and oils containing more than 0.2 percent fatty acids shall not be used, as they may generate flammable hydrogen gas.

3-1.6 Where compressed air is used as a coolant, special precautions shall be taken to keep the air dry.

3-1.7 All machines shall be provided with a pan or tray to catch chips or turnings. The pan or tray shall be installed so that it can be readily withdrawn from the machine in case of fire. It shall be readily accessible for chip removal and for application of extinguishing agent to control a fire.

3-1.7.1 In case of a fire in the chips, the pan or tray shall be immediately withdrawn from the machine, but it shall not be picked up or carried away until the fire has been extinguished.

3-2 Grinding, Buffing, and Wire Brushing.

3-2.1 Dust Collection.

3-2.1.1* Dust shall be collected by means of suitable hoods or enclosures at each operation. Hoods and enclosures shall be connected to a liquid precipitation separator in such a way that the dust will be converted to sludge without contact, in the dry state, with any high speed moving parts. [*See Figures 3-2.1 (a) and (b) for examples of liquid precipitation separators.*]

3-2.1.2 Connecting ducts or suction tubes shall be completely grounded and as short as possible, with no unnecessary bends. Ducts shall be carefully fabricated and assembled, with a smooth interior and with internal lap joints pointing in the direction of airflow. Ducts shall have no unused capped side outlets, pockets, or other dead-end spaces that might allow an accumulation of dust. (*See NFPA 91, Standard for the Installation of Blower and Exhaust Systems.*)

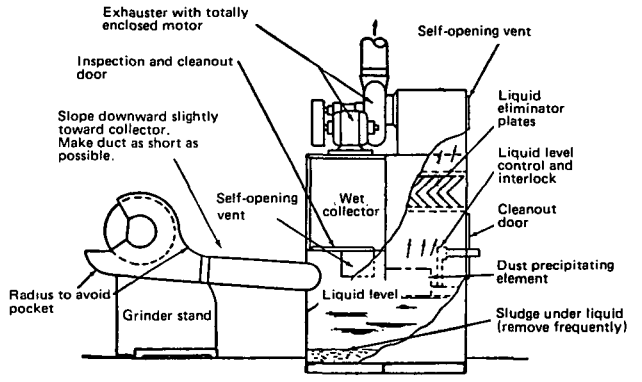

Figure 3-2.1 (a) Typical Liquid Precipitation Separator for a Fixed Grinding Unit.

NOTE: This drawing is schematic and intended only to indicate some of the features that are incorporated in the design of a separator. The volume of all dust-laden air spaces is as small as possible.

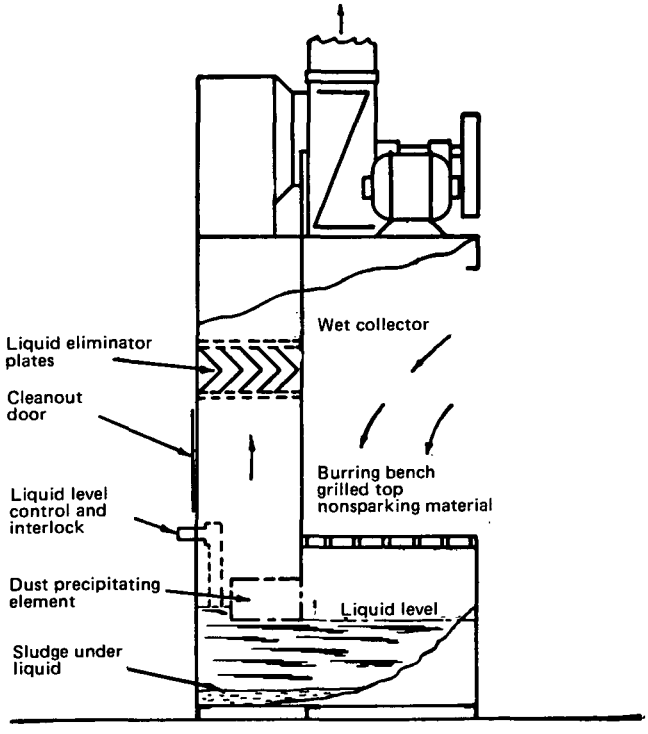

Figure 3-2.1 (b) Typical Liquid Precipitation Separator for a Portable Grinding Unit. [*See Note following Figure 3-2.1(a).*]

3-2.1.3 Each dust-producing machine shall be equipped with its own dust-separating unit.

Exception: With multiunit machines, two dust-producing machines may be served by a single separator.

3-2.1.4 Not more than four portable dust-producing machines in a single enclosure or stand may be served by a single separator.

3-2.1.5 The power supply to dust-producing machines shall be interlocked with the motor driving the exhaust

blower and the liquid-level controller of the liquid precipitation separator in such a way that improper functioning of the dust collection system will shut down the machine it serves. A time delay switch or equivalent device shall be provided on the dust-producing machine to prevent starting of its motor drive until the liquid precipitation separator is in complete operation and several air changes have swept out any residual hydrogen.

3-2.2 Cleaning.

3-2.2.1 Systematic cleaning of the entire grinding area, including roof members, pipes, conduits, etc. shall be carried out daily or as often as conditions warrant.

3-2.2.2 Cleaning shall be done by means of soft brushes and nonsparking scoops and containers or by means of a fixed suction pipe and outlet vacuum cleaning system.

3-2.2.3 If a fixed vacuum cleaning system is used, it shall meet the following requirements:

(a) The dust separator shall be of the liquid precipitation type.

(b) The suction system shall be of standard mild steel pipe, with standard recessed drainage fittings.

(c) A check valve shall be installed at each outlet.

(d) Implements and hoses shall be completely grounded.

(e) A rupture diaphragm shall be installed in the piping at its point of connection to the inlet of the separator so that a possible explosion in the piping may be safely vented to atmosphere.

3-2.3 Electrical Equipment.

3-2.3.1 Electric motors, lighting fixtures, control equipment, and wiring within proximity of or attached to dust-producing machines, including those used in connection with separator equipment, shall be approved for use in Class II, Group E atmospheres and shall be installed in accordance with Article 502 of NFPA 70, *National Electrical Code*.

3-2.3.2 All electrical equipment shall be inspected and cleaned periodically.

3-2.3.3 Where flashlights or storage battery lamps are used, they shall be approved for the intended use.

3-2.4 Grounding of Equipment. All equipment shall be securely grounded by permanent ground wires to prevent accumulation of static electricity. (*See NFPA 77, Recommended Practice on Static Electricity.*)

3-2.5 Safety Precautions.

3-2.5.1 Operators' clothing shall be easily removable and shall be kept clean and free from dust. Any smooth clothing, from which dust can be readily brushed off, may be worn. Clothing shall be made without pockets or cuffs and shall have nonferrous snap fasteners. Fabrics used in such clothing shall be flame resistant. Woolen, silk, or fuzzy outer clothing and shoes with exposed steel parts shall be prohibited.

3-2.5.2 Machinery and equipment described in 3-2.1 shall not be used for processing ferrous metals until the entire grinder and dust-collecting system are thoroughly cleaned. The grinding wheel or belt shall be replaced prior to work on other metals.

3-2.5.3 No open flames or electric or gas cutting or welding equipment shall be permitted in the section of the building where magnesium dust is produced or handled while dust-producing equipment is in operation. When cutting or welding equipment is used in such areas, all machinery in the area shall be shut down and the area shall be thoroughly cleaned to remove all accumulations of magnesium dust. All internal sections of grinding equipment, ducts, and dust collectors shall be completely free of moist or dry magnesium dust and any hydrogen shall be flushed out.

3-2.5.4 Special precautions are necessary to prevent ignitions while dressing wheels used for grinding magnesium castings. Hot metal thrown off by the dressing tool may ignite dust or magnesium deposits in the hood or duct. If it is not feasible to move the wheels to a safer location for dressing, the hoods shall be thoroughly cleaned or removed entirely before dressing operations are started, and all deposits of dusts on and around the wheel shall be removed before, during, and after dressing.

3-2.5.5 Nonsparking tools shall be used when making repairs or adjustments around grinding wheels, hoods, or collector units where magnesium dust may be present.

3-2.5.6 Dust collection equipment shall not have filters or other obstructions that will allow accumulation of dust.

3-2.5.7 Sludge pits shall be arranged so that they are well ventilated at all times.

3-2.5.8 When grinding chrome-pickled magnesium surfaces, special precautions shall be taken to prevent accumulations of dust or formation of explosive concentrations of dust and air within range of sparks that may be produced.

3-3 Drawing, Spinning, and Stamping.

3-3.1 Reliable means to prevent overheating shall be provided when heating magnesium for drawing or spinning.

3-3.2 Clippings and trimmings shall be collected at frequent intervals and placed in clean, dry steel or other noncombustible containers. Fine particles shall be handled according to the requirements of Section 4-2.

Chapter 4 Handling and Disposal of Scrap

4-1 Disposal of Sludge from Separators.

4-1.1 Sludge from separators and vacuum cleaning system precipitators shall be removed daily or as often as conditions warrant.

4-1.2 Covered, vented metal containers, preferably holding not more than 50 lb (22.7 kg) each, shall be used to transport sludge for disposal.

4-1.3 Sludge shall be disposed of in one of the following methods:

4-1.3.1 Sludge may be mixed with sand in a ratio of 5 parts sand to 1 part sludge and then shall be discarded in a protected dump.

4-1.3.2* Sludge may be dumped in an open pit. The pit shall be fenced or guarded from public access.

4-2 Disposal of Chips, Turnings, and Swarf.

4-2.1 Chips, turnings, and other fines shall be removed from the pans under machines and from any other places where they collect at such frequency as may be needed to prevent accumulation of any large amount. Each pan shall be cleaned at the end of each day's work.

4-2.2 Magnesium fines shall be placed in covered, plainly labeled, clean, dry steel or other noncombustible containers and removed to a detached scrap storage building or to a special scrap storage room of fire-resistive construction for subsequent salvage.

4-2.3 Magnesium fines that are not being salvaged shall be disposed of by burning in thin layers at a safe location where surrounding combustible material will not be ignited.

4-2.4 Magnesium fines that are to be recovered shall be kept free of all foreign matter other than neutral mineral oils.

4-2.5* If magnesium fines have been wet with coolants other than neutral mineral oils, they shall be handled with special care and stored outdoors.

4-2.6 Magnesium chips or turnings that are wet or damp with water present a definite fire and explosion hazard when attempts are made to melt or process them in foundry operations. If such chips or turnings are included with scrap to be remelted, special precautions shall be taken to ensure that the mixture is free of moisture or water-oil emulsion.

4-3 Disposal of Clippings and Castings.

4-3.1 Solid magnesium scrap such as clippings and castings can be readily salvaged by secondary smelters. Such scrap shall not be contaminated with combustible materials, as a fire in wood, heavy cardboard, or flammable liquids could ignite thin sections of the solid metal.

4-3.2* Care shall be taken to see that no pieces of scrap that are moist are thrown into a salvage pot containing molten metal. The scrap shall be preheated prior to melting to prevent a metal-water explosion.

Chapter 5 Storage of Magnesium

5-1* Storage of Pigs, Ingots, and Billets.

5-1.1 Good storage arrangement is important. The size of piles shall be limited and aisle widths shall be based on the height of the piles, in accordance with 5-1.2 and 5-1.3.

5-1.2 Yard (Outdoor) Storage.

5-1.2.1 Magnesium ingots shall be carefully piled on firm and approximately level areas to prevent tilting or toppling. Storage areas and yard pavements shall be well drained. The storage area shall be kept free of grass, weeds, and accumulations of combustible materials.

5-1.2.2 Combustible flooring or supports shall not be used under piles of ingots.

5-1.2.3 The quantity of magnesium stored in any pile shall be kept to a minimum, but in no case shall the amount exceed 1,000,000 lb (453 600 kg).

5-1.2.4 Aisle widths shall be not less than one-half the height of the piles, but in no case shall they be less than 10 ft (3.05 m).

5-1.2.5 Readily combustible material shall not be stored within a distance equal to the height of the piles plus 10 ft (3.05 m) from any pile of magnesium ingots.

5-1.2.6 An open space, equal to the height of the piles plus 10 ft (3.05 m), shall be provided between the stored magnesium ingots and adjoining property lines where combustible material or buildings are exposed or where the adjacent occupancy may provide fire exposure to the magnesium.

5-1.2.7 Trash shall not be burned near the storage area.

5-1.3 Indoor Storage.

5-1.3.1 Storage shall be in buildings of noncombustible construction.

5-1.3.2 Floors shall be of noncombustible construction and shall be well drained to prevent accumulations of water in puddles.

5-1.3.3 Supports used under piles of magnesium ingots shall be noncombustible.

5-1.3.4 Storage of magnesium ingots shall be on the first or ground floor. There shall be no basement or depression below the magnesium storage area into which water or molten metal may flow or fall during a fire.

5-1.3.5 The quantity of magnesium ingots stored in any one pile shall be kept to a minimum, but in no case shall the amount exceed 500,000 lb (226 800 kg).

5-1.3.6 Aisle widths shall comply with 5-1.2.4.

5-1.3.7 There shall be no combustible material stored in the same building with magnesium.

5-2* Storage of Heavy Castings.

5-2.1* Buildings used for the storage of magnesium castings shall be noncombustible, with particular attention given to construction and maintenance of floors.

Exception: Storage may be in buildings of combustible construction if the buildings are fully protected by an automatic sprinkler system.

5-2.2 There shall be no basement or depression below the magnesium storage area into which water or molten metal may flow or fall during a fire.

5-2.3 All magnesium castings shall be inspected prior to storage to see that they are clean and free of chips or fine particles of magnesium.

5-2.4 The size of storage piles of heavy magnesium castings, either in cartons or crates or free of any packing material, shall be limited to 1250 cu ft (35 m^3). Proper aisles shall be maintained to permit inspection and effective use of fire protection equipment. Aisle widths shall be not less than one-half the height of the piles.

5-2.5 Automatic sprinkler protection shall be provided in magnesium storage buildings where combustible cartons, crates, or packing material presents a fire hazard.

5-3 Storage of Light Castings.

5-3.1* Light magnesium castings, particularly in large quantities, shall be stored in noncombustible buildings and shall be segregated from any combustible material.

5-3.2 Piles of stored light magnesium castings, either in cartons or crates or without packing, shall be limited in size to 1000 cu ft (28 m^3). Light castings shall be segregated from other combustible materials and kept away from flames or sources of heat capable of causing ignition.

5-3.3 Aisle widths shall be not less than one-half the height of the piles.

5-3.4 Automatic sprinkler protection shall be provided in magnesium storage buldings where combustible cartons, crates, or packing materials present a fire hazard.

5-4 Storage in Mills, Warehouses, and Processing Plants.

5-4.1 Buildings shall be of noncombustible construction, with particular attention given to construction and maintenance of floors.

Exception: Storage may be in buildings of combustible construction if the buildings are fully protected by an automatic sprinkler system.

5-4.2 Magnesium shall not be stored in or over a basement or similar subgrade space because of the difficulty of venting and relieving explosion pressures produced by contact of molten metal with water.

5-4.3 Stocks of magnesium shall be stored separately from combustible materials.

5-4.4 Storage piles of heavy castings, forgings, bars, rods, and plates shall be limited to 1250 cu ft (35 m^3) and piles of light castings, structural shapes, sheets, and subassemblies to 1000 cu ft (28 m^3). Proper aisles shall be maintained to permit inspection and effective use of fire protection equipment. Aisle widths shall be not less than one-half the height of the piles.

5-4.5 When the storage area is protected by an automatic sprinkler system, the pile size for both heavy and light castings, structural shapes, sheets, and subassemblies may be increased to 4000 cu ft (112 m^3).

5-4.5.1 Original shipping cartons, crates, or skids need not be removed.

5-4.5.2 Standard packaging of finished products shall be permitted.

5-4.5.3 Clearance from automatic sprinklers shall comply with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

5-4.6 When the storage area is not protected by an automatic sprinkler system, combustible packing materials shall be removed prior to stock storage whenever practical.

5-5* Storage in Racks or Bins.

5-5.1 Racks may extend along walls with the length optional. Aisle spaces in front of racks shall be equal to the height of the racks. All aisle spaces shall be kept clear.

5-5.2 Combustible packaging such as dry or oiled paper wrapping or cardboard cartons shall be removed prior to storage. When sheet and plate products are stored on similar racks, paper or cardboard wrappings shall be removed. Wood crates or skids and sheet separators may be left in place.

5-5.3 Combustible rubbish, spare crates, and separators shall not be permitted to accumulate within the rack space. Separators and metal sheets shall not be stacked on edge, leaning against racks, as they will prevent heat from a small fire from activating automatic sprinklers and act as shields against sprinkler discharge.

5-5.4 Aluminum sheets shall not be stored in piles of magnesium. Prolonged contact at heat-treating temperatures resulting from an internal fire may yield a readily ignited magnesium-aluminum compound.

5-6* Storage of Magnesium Chips.

5-6.1 Buildings shall be of noncombustible construction.

5-6.2 All other combustible materials shall be excluded from the area used for storage of magnesium chips.

5-6.3 The amount of magnesium chips to be held in storage shall be determined in each individual case, based on use, value, and probable loss.

5-7 Storage of Scrap Magnesium Fines.

5-7.1 This section shall apply to the storage of scrap magnesium in the form of chips, turnings, swarf, or other fine particles.

5-7.2 Magnesium fines shall be kept well separated from other combustible materials. They shall be kept in covered steel or other noncombustible containers and shall be kept in such manner or locations that they will not become wet.

5-7.3 Storage in quantities greater than 50 cu ft (1.4 m^3) (six 55-gal drums) shall be kept separate from other occupancies by fire-resistive construction without window openings or by an open space of at least 50 ft (15.3 m). Such buildings shall have explosion vents designed according to information contained in NFPA 68, *Guide for Explosion Venting*.

5-8* Storage of Solid Scrap.

5-8.1 Solid magnesium scrap, such as clippings and castings, shall be stored in noncombustible bins or containers pending salvage. The storage building shall be of noncombustible construction.

5-8.2 Oily rags, packing materials, and similar combustibles shall not be permitted in storage bins.

5-8.3* Solid scrap may be shipped loose to secondary smelters.

5-9 Storage of Finished Products.

5-9.1 This section shall apply to storage, in warehouses, wholesale facilities, and retail outlets, of magnesium in the form of finished products in which magnesium makes up the major portion of the article on a volumetric basis.

5-9.2 Storage in quantities greater than 50 cu ft (1.4 m^3) shall be separated from storage of other materials that are either combustible or in combustible containers by aisles equal in width to not less than the height of the piles of magnesium products.

5-9.3 Magnesium products stored in quantities greater than 1000 cu ft (28 m^3) shall be separated into piles each not larger than 1000 cu ft (28 m^3) with aisles equal in width to not less than the height of the piles.

5-9.4* Where storage in quantities greater than 1000 cu ft (28 m^3) is in a building of combustible construction, or the magnesium products are packed in combustible crates or cartons, or there is other combustible storage within 30 ft (9.1 m) of the magnesium, the storage area shall be protected by automatic sprinklers.

Chapter 6 Fire Protection

6-1 General Precautions.

6-1.1* Fire protection shall be provided in all areas where magnesium is melted, machined, fabricated, or stored. Extinguishing agents that accelerate the intensity of magnesium fires shall not be used.

6-1.2* Direct contact of burning magnesium with clothing, shoes, and skin shall be avoided and protected against.

6-2 Extinguishing Powders.

6-2.1 A supply of extinguishing powder approved for use on magnesium fire shall be kept within easy reach of each operator performing a machining, grinding, or other operation on magnesium. The powder shall be kept in suitable containers with easily removable covers and a hand scoop shall be provided at each container for application of the powder. Approved portable extinguishers designed for use with these powders may replace the scoop and container.

6-2.2 The amount of extinguishing powder to be provided will depend on the amount of chips or turnings involved. Where conditions may permit the development of a fire requiring a large quantity of powder, that quantity shall be provided and long-handled shovels provided for its application. Heat-resistant gloves and face guards shall be available for protection of the personnel applying the powder.

6-2.3 Containers of extinguishing powder shall be plainly labeled.

6-2.4 Extinguishing powder shall be applied by making a ring around the fire with the powder and then spreading the powder evenly over the surface of the fire to a depth sufficient to smother it. Care shall be taken to avoid scattering the burning metal. If smoking continues in spots, more powder may be added as required. Where burning magnesium is on a combustible surface, a 1- or 2-in. (25- to 50-mm) layer of powder shall be spread out nearby, after the fire has been covered as described above, and the burning metal shoveled onto this layer, with additional powder added as required.

6-3 Foundry Flux. The most effective means of extinguishing fires in foundry melting and pouring areas is by application of readily available foundry flux. The flux melts or crusts over the hot metal, excluding air from the burning metal.

6-4 Water.

6-4.1 Small streams of water from portable extinguishers shall not be used on magnesium chip fires since they will violently accelerate the fire. However, a few burning chips may be extinguished by dropping them into a bucket of water.

6-4.2 Water shall not be used on any large chip fire since it is impossible to apply enough cooling capacity to handle the large surface area of the burning metal. However, automatic sprinklers will extinguish the typical shop fire where quantities of chips are limited.

6-4.3* Burning parts such as castings, wrought products, and fabricated parts may be cooled and extinguished with coarse streams of water applied with stan-

dard fire hoses. A straight stream scatters the fire, but coarse drops produced by a fixed nozzle operating from a distance or by use of an adjustable nozzle flow over and cool the unburned metal. The hose streams are then worked into the fire where some temporary acceleration takes place, followed by rapid extinguishment as water application is continued.

6-4.4 Water fog shall not be used as it tends to accelerate a magnesium fire rather than cool it.

6-4.5 Application of water to magnesium fires where quantities of molten metal are likely to be present shall be avoided. The steam formation and possible metal-water reactions may be explosive.

6-4.6 With the exercise of care to keep water from reaching molten metal, water spray applied with caution may be used to safely fight fires in combustible material near melting pots.

6-5* Automatic Sprinklers.

6-5.1 Automatic sprinkler protection, installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall be provided where specified by other sections of this standard.

6-5.2 Substantially constructed tight tote boxes (with or without covers) have considerable confining effect on the burning of small magnesium parts within. This confining effect makes the use of such tote boxes of definite value in the control of magnesium fires by sprinklers. Noncombustible tote boxes shall be used. Tote boxes shall not be used as containers for chips or dust.

6-5.3 In general, automatic sprinkler installations shall be considered for all buildings where magnesium is machined, fabricated, or stored, particularly if combustible solids, flammable liquids, or flammable gases are present.

6-5.4 Foundry operations shall be protected by automatic sprinklers.

Exception: Automatic sprinklers shall not be provided over melting pots, die casting operations, or heat-treating furnaces.

6-6 Heat-Treating Furnaces.

6-6.1 Magnesium fires in heat-treating furnaces shall be controlled with dry extinguishing powders, foundry fluxes, or gases approved for use on such fires.

6-6.2 If powder is used, the burning metal shall, if feasible, be removed from the furnace before application of the powder.

6-6.3 Foundry fluxes may be successfully applied to the burning metal in the furnace.

6-6.4* If an approved gas is to be used, entry ports shall be provided in the furnace at a low point, preferably near the floor level. Experience indicates that boron trifluoride gas (BF_3) is an effective extinguishing agent for small magnesium fires in heat-treating furnaces at concentrations as low as 0.04 percent in the presence of normal air. The cylinder or cylinders [containing about 60 lb (27.2 kg) of BF_3] may be permanently connected to the furnace or may be mounted on a suitable buggy for transportation to the furnace when needed. No heat is required to expel the gas from the cylinder. The tanks of BF_3 may be equipped with Monel Metal needle valves, flexible bronze, or Teflon hose for distribution and ¼-in. (6.35-mm) black iron pipe for insertion into the furnace. This system at 30 psi (207 kPa) will discharge about 2 lb per minute (0.9 kg/min).

6-6.4.1 When a fire in a heat-treating furnace is discovered, power, fuel, and sulfur dioxide feed shall be immediately shut off and the BF_3 cylinder connected to the entry port, if the BF_3 extinguishing system is not permanent. The valve on the BF_3 cylinder shall be opened enough to supply about 2 lb per minute (0.9 kg/min) depending on the size of the furnace and the number of cylinders used. The furnace circulating fans shall be turned on for about 1 minute while the BF_3 is flowing into the furnace. The flow of gas shall be maintained until the furnace temperature falls to 700°F (371°C), indicating the fire has been extinguished.

6-6.4.2 All cylinders of BF_3 shall be weighed every six months.

6-6.5 If the heat-treating furnace fire involves more than several hundred pounds of magnesium, is well advanced prior to discovery, involves a large pool of molten metal on the floor of the furnace, or is in a furnace with excessive air leaks, BF_3 cannot be expected to extinguish the fire completely. However, the gas is valuable in slowing or suppressing the fire until it can be extinguished by other means.

6-6.6 Water may be used to fight fire in combustible material nearby, but shall not be used in fighting fires in furnaces.

6-6.7 Where automatic sprinkler protection is provided, a deflector shield shall be provided over the furnace, or the sprinkler heads over the furnace shall be removed and the ceiling or roof construction shall be modified to be noncombustible.

Chapter 7 Referenced Publications

7-1 The following documents or portions thereof are referenced within this document and shall be considered part of the requirements of this document. The edition indicated for each reference shall be the current edition as of the date of the NFPA issuance of this document. These references shall be listed separately to facilitate updating to the latest edition by the user.

7-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 13-1987, *Standard for the Installation of Sprinkler Systems*

NFPA 70-1987, *National Electrical Code*

NFPA 220-1985, *Standard on Types of Building Construction.*

7-1.2 ASTM Publication. American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

ASTM E136-1973, *Standard Method of Test for Noncombustibility of Elementary Materials.*

Appendix A

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

A-2-1.1 While noncombustible construction is preferred for buildings occupied by magnesium melting and casting operations, limited-combustible and combustible construction may be permitted in appropriate circumstances.

A-2-1.2 Moisture and foreign material are dangerous where molten metal is present.

A-2-2.1 Flash fires in fine dust may result in serious injury to the operator. While the chance of a flash fire igniting castings is remote, a fire in accumulated dust may be intense enough to cause ignition of castings.

A-2-3 Fire may occur in furnaces or ovens when magnesium is being heat treated if there is lack of proper temperature control or if the surface of the metal is not free of dust or fine particles of metal. Failure to provide for proper circulation of the heated air in the furnace may result in overheating or higher temperatures in certain zones than those indicated by the thermocouples that operate the temperature control devices.

A-2-3.6 Direct contact between aluminum and magnesium at heat-treating temperatures promotes diffusion of one metal into the other, resulting in formation of a low-melting, readily ignitible compound. The high-temperature flame of the burning compound can ignite the heated magnesium.

A-2-3.8 Certain commonly used molten mixtures of nitrates and nitrites can react explosively with magnesium alloys immersed in them.

A-3-1 Machining includes sawing, turning, chipping, drilling, routing, reaming, tapping, milling, and shaping. Magnesium can usually be machined at the maximum speeds obtainable on modern machine tools. The low power required permits heavy depths of cut and high rates of feed, as may be consistent with good workmanship. The resulting chips are thick and relatively massive; they seldom ignite due to their relatively large heat capacity.

A-3-1.2 Use of the high helix drills prevents frictional heat and possible flash fire in the fines. High helix drills are also recommended for drilling deep holes through composite or sandwich sections.

A-3-1.5 Magnesium scrap wet with animal or vegetable oils may ignite spontaneously.

A-3-2.1.1 Water in large volume is normally the precipitating medium.

A-4-1.3.2 The fire and explosion hazards of the sludge must be kept in mind when this method of disposal is used.

A-4-2.5 Fines, wet with water, water-soluble oils, and oils containing more than 0.2 percent fatty acids may generate flammable hydrogen gas. Fines wet with animal or vegetable oils may ignite spontaneously.

A-4-3.2 Such moisture may result from outdoor storage or by collection of condensate during indoor storage.

A-5-1 Magnesium pigs, ingots, and billets are not easily ignited, but they will burn if exposed to fire of sufficient intensity.

A-5-2 Heavy castings [25 lb (11.3 kg) or more] having walls of large cross section [at least ¼ in. (6.4 mm)] may be ignited after some delay when in contact with burning magnesium chips or when exposed to fires in ordinary combustible materials.

A-5-2.1 Single-story storage buildings with well-drained noncombustible floors are recommended.

A-5-3.1 A slow-burning fire in nearby combustible material may develop enough heat to ignite thin-section magnesium, producing a well-involved magnesium fire before automatic sprinklers operate. Special importance, therefore, should be attached to prompt fire detection and alarm service, prompt automatic sprinkler operation, and avoidance of obstructions to sprinkler discharge.

A-5-5 In a distribution warehouse, extruded shapes (including bars and rods) are normally stored on long open metal racks with metal dividers.

A-5-6 Prime (commercially pure) magnesium chips and fines are commonly used in Grignard and other chemical reactions. These chips are completely free of contaminants and are not subject to spontaneous ignition. Where prime chips are produced, shipped, and stored for chemical and metallurgical process purposes, the conditions of handling and storage are such that a fire is unlikely.

While water should not be applied to a large chip fire, automatic sprinklers would be valuable in confining or extinguishing an incipient fire in packaging and small amounts of chips, provided detection and discharge were rapid.

A-5-8 The danger of ignition of this solid scrap is very low, provided combustible materials are not stored with

it. However, automatic sprinkler protection is recommended.

A-5-8.3 Scrap magnesium is usually received by secondary smelters in truck or carload quantities. Solid scrap may be shipped loose, but chips and turnings are packed in multi-ply oilproof paper bags or covered steel drums. This scrap is commonly stored outdoors in a paved area and is covered with tarpaulins to avoid contact with water. Such scrap is ordinarily processed promptly so there is no need for a storage building. Since storage is in the open, incipient fires can be readily detected and extinguished.

A-5-9.4 The entire building should be protected by automatic sprinklers.

A-6-1.1 Magnesium fires are easily extinguished if attacked with the proper extinguishing agents during the early stages of the fire. Certain extinguishing agents will accelerate a magnesium fire. These agents include foam, carbon dioxide, halogenated agents, and dry chemical agents containing mono- or diammonium phosphate. Also, use of water on a magnesium chip fire should be avoided.

A-6-1.2 While the flame temperature of burning magnesium is about 7200°F (3983°C), the heat of combustion is only about half that of typical petroleum products. Thus, fire fighting personnel can approach a fire closely during extinguishment, if they are careful.

A-6-4.3 Well-advanced fires in several hundred pounds of magnesium scrap have been extinguished in less than one minute with two 1½-in. fire hoses.

A-6-5 Special importance should be attached to prompt fire detection and alarm service, prompt sprinkler operation, and avoidance of obstructions to sprinkler discharge, which would permit combustible materials to continue to burn and result in ignition of magnesium.

A-6-6.4 Tests of several years' duration in which animals were exposed to various concentrations of airborne boron trifluoride have indicated no injury at or below 2-3 ppm (parts per million). The recommended threshold limit value/time-weighted average is 1 ppm for continuous exposure in a normal 40-hour work week. At these levels, boron trifluoride has rather poor warning properties and detection must be made with air sampling devices. While higher concentrations (5-10 ppm) are present in the vicinity of the heat-treating furnace during fire control, the time the operator or fire fighter is in the area is short enough to prevent overexposure. The operator or fire fighter should wear an acid mask or Type N filter-canister mask or self-contained breathing apparatus to avoid the slight irritating effect of the vapors. Under the conditions of use and concentration in fire extinguishing, boron trifluoride gives good warning through the presence of a white cloud in the air. Contrary to expectations, hydrofluoric acid is not one of the decomposition products.

Boron trichloride gas (BCl_3) has also been used to suppress magnesium fires in heat-treating furnaces. However, the required concentration is about 10 times that of boron trifluoride. Also, to assure an adequate and even flow of BCl_3, means must be provided to heat the cylinders to a temperature above 54°F (12.2°C), preferably to 70°F (21°C), a practice not recommended by the suppliers. Also, a special valve and gage is needed to control the gas flow from the cylinder. Flexible ⅝-in. (16-mm) neoprene hose may be used to conduct the gas from the cylinder to the entry port of the furnace. Operations in handling a furnace fire are similar to those described for boron trifluoride.

Appendix B Supplementary Information on Magnesium

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

B-1 Properties.

Magnesium, a silvery white metal with an atomic weight of 24.32 and specific gravity of 1.74, is sometimes described as the lightest known structural metal possessing properties of permanence and stability. The melting point of magnesium is 1202°F (650°C) and the ignition temperature is generally considered to be very close to the melting point but ignitions of magnesium in certain forms may occur at air temperatures below the temperature given as the melting point. Magnesium ribbon and fine magnesium shavings can be ignited under certain conditions at air temperatures of about 950°F (510°C), and a very finely divided magnesium powder has been ignited at air temperatures below 900°F (482°C).

Commercially pure magnesium may contain traces of aluminum, copper, iron, manganese, nickel, and silicon, but these contaminants in typical analyses generally total less than 0.2 percent. Metal marketed under different trade names and commonly referred to as magnesium may be one of a large number of different alloys containing widely different percentages of magnesium, aluminum, zinc, and manganese. Some of these alloys may have ignition temperatures considerably lower than that determined for pure magnesium and in some cases it may be necessary to consider the eutectic melting point of certain alloys of these metals, which may be as low as 800°F (427°C), because the metal will ignite if it is held at this lower temperature for some time.

B-2 Radioactive Alloys.

There are several magnesium alloys produced that contain thorium. These alloys are used primarily where it is essential that the metal retain good mechanical properties at elevated temperatures. Thorium, which is a low-level radioactive material, is used in these alloys up to a nominal concentration of 3 percent. While it is possible with a sensitive radiation survey meter to detect the radiation from such alloys, the level of external gamma radiation is so low that there is no hazard to personnel. The level seldom goes much above one or two milliroentgens per hour at the surface and on small masses is less than one.

The natural decay or daughter products of thorium are locked up in the alloy until such time as the metal is

melted, burned, or chemically disintegrated. Under fire conditions these decay products are normally within visible fumes and are diluted as the visible fumes dissipate into the air. These elements could be inhaled with possible excessive irradiation of the lung tissue and deposition in the bone structure. Maximum permissible airborne concentrations of such radioactive materials have been set up through the Nuclear Regulatory Commission and are based on continuous exposure for a normal 40-hour work week.

B-3 Spot Tests for Magnesium.

In the construction or assembling of certain machinery or equipment, magnesium or one of its alloys having similar properties may have been used for only a few of the component parts and where finished or painted products are being stored or handled it may be difficult to determine what percentage consists of magnesium. Investigation has shown that silver nitrate, vinegar, or acetic acid can be used to distinguish between parts composed of magnesium and those composed of aluminum. The portion of metal to be tested is first cleaned of grease, dirt, oxide, etc., by abrading with sandpaper or steel wool. After the test area has been prepared a drop of the test solution is placed on it.

B-3.1 Silver Nitrate Test.

The test solution is prepared by dissolving about 5 g of silver nitrate ($AgNO_3$) in 1 L of distilled water. A black coloration is immediately produced on magnesium or magnesium alloy. (This coloration is essentially reduced silver.) No coloration is noted on aluminum and its alloys, or most other metals. Zinc and cadmium will show a similar black coloration but are much heavier.

B-3.2 Vinegar or Acetic Acid Test.

Ordinary vinegar or a weak solution of acetic acid will give a bubbling reaction in contact with magnesium while other common metals are not affected.

B-4 Combustibility and Explosibility.

The ease of ignition of magnesium depends to a large extent upon the size and shape of the material as well as the size or intensity of the source of ignition. In the form of ribbon, shavings, or chips with thin featherlike edges, or grinding dust, a spark or the flame of a match may be sufficient to start the material burning. Heavier pieces such as ingots and thick-wall castings are difficult to ignite because heat is conducted rapidly away from the source of ignition. If the entire piece of metal can be raised to the ignition temperature [about 1200°F (649°C) for pure magnesium and many of the alloys], self-sustained burning will occur.

The combustibility of magnesium, the ineffectiveness of ordinary types of extinguishing agents on magnesium fires, and the fact that under certain conditions the application of some of these agents intensifies the burning and may release hydrogen to form an explosive gas-air mixture, all combine to create serious fire and explosion hazards.

Magnesium, in its solid form, melts as it burns and may form puddles of molten magnesium which, in the presence of sufficient moisture, may present explosion hazards similar to those associated with other molten metals.

B-5 Extent of Hazard.

Magnesium is widely used in the construction of household appliances, furniture, office equipment, portable tools, luggage, automobiles, buildings, machine parts and engines, and structural members of airplanes. As a result of this general usage, the fire hazards associated with this material are of interest to fire fighting and fire prevention organizations.

Appendix C

C-1 The following documents or portions thereof are referenced within this document for informational purposes only and thus are not considered part of the requirements of this document. The edition indicated for each reference should be the current edition as of the date of the NFPA issuance of this document. These references should be listed separately to facilitate updating to the latest edition by the user.

C-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 68-1978, *Guide for Explosion Venting*

NFPA 77-1983, *Recommended Practice on Static Electricity*

NFPA 91-1983, *Standard for the Installation of Blower and Exhaust Systems For Dust, Stock and Vapor Removal or Conveying*

NFPA 651-1987, *Standard for the Manufacture of Aluminum and Magnesium Powder.*

C-1.2 Other Publications

Lawrence, K.D., et al, *New Agents for the Extinguishment of Magnesium Fires*, Washington, DC, Dept. of the Navy, Naval Research Laboratory, April, 1978, CEEDO-TR-78-19

Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment, Cincinnati, OH, American Conference of Governmental Industrial Hygienists, 1977.

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SUBMITTING PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

Contact NFPA Standards Administration for final date for receipt of proposals on a specific document.

INSTRUCTIONS

Please use the forms which follow for submitting proposed amendments. Use a separate form for each proposal.

1. For each document on which you are proposing amendment indicate:
   (a) The number and title of the document
   (b) The specific section or paragraph.

2. Check the box indicating whether or not this proposal recommends new text, revised text, or to delete text.

3. In the space identified as "Proposal" include the wording you propose as new or revised text, or indicate if you wish to delete text.

4. In the space titled "Statement of Problem and Substantiation for Proposal" state the problem which will be resolved by your recommendation and give the specific reason for your proposal including copies of tests, research papers, fire experience, etc. If a statement is more than 200 words in length, the technical committee is authorized to abstract it for the Technical Committee Report.

5. Check the box indicating whether or not this proposal is original material, and if it is not, indicate source.

6. If supplementary material (photographs, diagrams, reports, etc.) is included, you may be required to submit sufficient copies for all members and alternates of the technical committee.

NOTE: The NFPA Regulations Governing Committee Projects in Paragraph 10-10 state: Each proposal shall be submitted to the Council Secretary and shall include:

(a) identification of the submitter and his affiliation (Committee, organization, company) where appropriate, and

(b) identification of the document, paragraph of the document to which the proposal is directed, and

(c) a statement of the problem and substantiation for the proposal, and

(d) proposed text of proposal, including the wording to be added, revised (and how revised), or deleted.

FORM FOR PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

Mail to: Secretary, Standards Council
National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269

Date 5/18/85 Name John B. Smith Tel. No. 617-555-1212

Address 9 Seattle St.. Seattle, WA 02255

Representing (Please indicate organization, company or self) Fire Marshals Assn. of North America

1. a) Document Title: Protective Signaling Systems NFPA No. & Year NFPA 72D

   b) Section/Paragraph: 2-7.1 (Exception)

2. Proposal recommends: (Check one) ☐ new text
   ☐ revised text
   ☒ deleted text.

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted):

   Delete exception.

4. Statement of Problem and Substantiation for Proposal:

   A properly installed and maintained system should be free of ground faults. The occurrence of one or more ground faults should be required to cause a "trouble" signal because it indicates a condition that could contribute to future malfunction of the system. Ground fault protection has been widely available on these systems for years and its cost is negligible. Requiring it on all systems will promote better installations, maintenance and reliability.

5. ☒ This Proposal is original material.
   ☐ This Proposal is not original material; its source (if known) is as follows: _____

(Note: Original material is considered to be the submitter's own idea based on or as a result of his own experience, thought, or research and, to the best of his knowledge, is not copied from another source.)

I agree to give NFPA all and full rights, including rights of copyright, in this Proposal and I understand that I acquire no rights in any publication of NFPA in which this Proposal in this or another similar or analogous form is used.

John B. Smith

Signature

PLEASE USE SEPARATE FORM FOR EACH PROPOSAL