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NFPA 651 Manufacture of Aluminum and Magnesium Powder 1987 Edition

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

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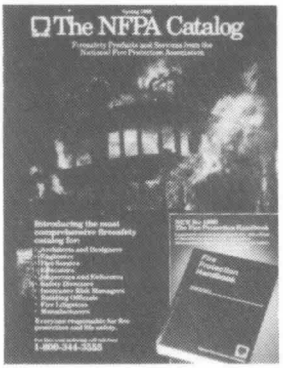

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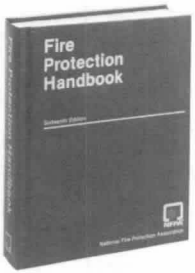

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NFPA 651

Standard for the

Manufacture of

Aluminum and Magnesium Powder

1987 Edition

This edition of NFPA 651, *Standard for the Manufacture of Aluminum and Magnesium Powder,* was prepared by the Technical Committee on Metal Dust, released by the Correlating Committee on Dust Explosion Hazards, 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.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

Origin and Development of NFPA 651

NFPA 651, *Manufacture of Aluminum Powder,* was originally prepared by the Committee on Dust Explosion Hazards in 1938 and 1939. It was first adopted in 1939, and revised in 1946, 1952, 1959, 1963, 1967, and 1972. The 1967 edition was approved by the American National Standards Institute in 1967 and designated ANSI Z12.11.

NFPA 652, *Plants Producing or Handling Magnesium Powder,* was originally prepared by the Committee on Dust Explosion Hazards in 1942 and was first adopted in 1944. Amendments were adopted in 1945, 1946, 1952, 1959, and 1968. The 1968 edition was approved by the American National Standards Institute in 1968 and designated ANSI Z12.15.

In 1973 NFPA 651 and 652 were combined into a single standard, NFPA 651-T, and tentatively adopted at the 1973 Annual Meeting and officially adopted at the 1974 Annual Meeting. Revisions were adopted in 1980 and 1986.

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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.

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NFPA 651

Standard for the

Manufacture of

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

Information on referenced publications can be found in Chapter 9 and Appendix C.

Chapter 1 General

1-1 Scope.

1-1.1* This standard shall apply to manufacturing facilities which produce light metal flake powder, or paste, atomized light metal granules, or the dust of any light metal alloy that is explosive in an environmental atmosphere.

1-1.2 This standard shall not apply to the production of waste metal dust by operations such as grinding, buffing, and polishing of semifinished light metal products. (*See NFPA 65, Standard for the Processing and Finishing of Aluminum, and NFPA 48, Standard for the Storage, Handling, and Processing of Magnesium.*)

1-2 Purpose. The objective of this standard is to minimize the occurrence of and resulting damage from fire and explosion in areas where light metal powder products are manufactured.

1-3 Retroactivity.

1-3.1 Unless otherwise stated, the requirements of this standard shall not be applied retroactively.

1-4 Equivalent Protection.

1-4.1 Existing plants, equipment, structures, and installations which do not comply strictly with the requirements of this standard shall be considered to be in compliance if it can be shown that an equivalent level of protection has been provided or that no specific hazard will be created or continued through noncompliance.

1-4.2 This standard is not intended to prevent use of systems, methods, or devices which provide equivalent protection from fire and explosion. NFPA 69, *Guide for Explosion Prevention*, shall be referred to when considering the use of optional systems.

1-5 Definitions.

1-5.1 The term "light metal powder," as used in this standard, shall mean aluminum and magnesium powders only.

Chapter 2 Location and Construction of Light Metal Powder Production Plants

2-1 Location.

2-1.1 Light metal powder production plants shall be located on a site large enough so that the buildings in which powder is manufactured will be at least 300 ft (91.4 m) from public roads and from any occupied structure, such as public buildings, dwellings, business or manufacturing establishments, other than those buildings which are a part of the light metal powder production plant.

2-1.2 Different production operations shall be located in separate buildings located at least 50 ft (15.24 m) from each other.

Exception: Where two buildings are less than 50 ft (15.24 m) apart, one of the facing walls shall be capable of resisting a blast pressure of 2.0 psig (13.8 kPa) and shall be nonload-bearing, noncombustible, dust-tight, and without openings. (See also 2-5.3.)

2-1.3 Electric or steam power generators shall be housed in a separate building (or buildings) located at least 100 ft (30.5 m) from any building containing a dust explosion hazard.

2-2 Security.

2-2.1 This section shall be applied to new and existing facilities.

2-2.2 The site on which the powder production plant is located shall be surrounded by strong fencing at least 6 ft (2 m) high with suitable entrance gates.

2-2.3 All gates that are not kept locked shall be under the supervision of a guard.

2-3 Building Construction.

2-3.1 All buildings used for the manufacture, packing, or loading for shipment of light metal powders shall, where practical, be single story, without basements, constructed of noncombustible materials throughout, and have nonload-bearing walls. The buildings shall be designed so that all internal surfaces are readily accessible to facilitate cleaning.

2-3.2 All buildings used for the manufacture of light metal powders shall be subdivided into as many small units as practical by pressure-resistant, nonload-bearing, noncombustible, dust-tight walls.

2-3.3 All walls of areas where dust may be produced, which are not of monolithic construction, shall have all masonry joints thoroughly slushed with mortar and trowelled smooth so as to leave no interior or exterior voids where light metal powder may infiltrate and accumulate.

2-3.4 Floors shall be hard-surfaced and nonslip, installed with a minimum number of joints in which light metal powder may collect. The requirements of this sec-

tion shall also apply to elevated platforms, balconies, floors, or gratings. (*See Appendix B.*)

2-3.5 Roofs of buildings which house dust-producing operations shall be supported on girders or structural members designed to minimize surfaces on which dust may collect. Where such surfaces are unavoidably present, they shall be covered by a smooth concrete, plaster, or noncombustible mastic fillet having a minimum slope of 55° to the horizontal.

2-3.6 Roof decks shall be water tight.

2-4 Doors and Windows.

2-4.1 All door and window frames shall be metal.

2-4.2 Each room shall have at least two widely separated exits to exit corridors or to the outside. All doors in interior openings shall be approved self-closing fire doors, installed in accordance with NFPA 80, *Standard for Fire Doors and Windows*. Hardware for emergency exit doors shall conform to requirements of NFPA 80 and of NFPA *101®*, *Life Safety Code®*. (*See Section 5-11 and Chapter 14 of NFPA 101.*)

2-4.2.1 Emergency exit doors shall be provided from all areas, including balconies and elevated platforms.

2-4.3 Windows shall be installed so that they automatically open in case of internal explosion. They shall be hinged at the top, shall open outward, and shall be held in place by friction latches. (*See NFPA 68, Guide for Explosion Venting.*)

2-5 Communication Between Buildings.

2-5.1 Buildings separated by not less than 50 ft (15.24 m) or small units of one major process section may communicate through enclosed passageways of noncombustible construction.

2-5.2 Enclosed passageways leading from production or storage areas shall be specifically designed to relieve internal pressure from an explosion and shall be protected by automatic self-closing Class A fire doors. (*See NFPA 68, Guide for Explosion Venting.*)

2-5.3 When two buildings are less than 50 ft (15.24 m) apart, only one of the facing walls shall have windows and doors. (*See also Exception to 2-1.2.*)

2-5.4 All enclosed passageways shall be provided with an exit door leading to the outside.

2-6 Grounding and Lightning Protection.

2-6.1 All steel process equipment and all building steel shall be bonded and grounded to a suitable ground connection outside the building in accordance with NFPA 78, *Lightning Protection Code*.

2-6.2 Lightning rods shall be provided for all boiler stacks and chimneys and for the high points of all buildings.

2-6.3 Power lines shall be adequately protected against lightning. (*See NFPA 78, Lightning Protection Code.*)

2-6.4 A lightning arrestor system shall be provided around or within the building area of such capacity as to fully protect all buildings from lightning.

2-7 Electrical Power.

2-7.1 All electrical equipment and wiring shall be installed in accordance with NFPA 70, *National Electrical Code®*.

2-7.2 All parts of manufacturing buildings shall be considered Class II, Group E locations, as described in Articles 500 and 502 of NFPA 70, *National Electrical Code*.

Exception No. 1: Offices and similar areas so occupied and segregated as to be reasonably free from dust and so classed by the authority having jurisdiction.

Exception No. 2: Control equipment meeting the requirements of NFPA 496, Standard for Purged and Pressurized Electrical Equipment, or NFPA 493, Standard for Intrinsically Safe Apparatus for Use in Class I, II and III, Division 1 Hazardous Locations.

2-7.3 Electrical equipment that is not approved for Class II, Group E locations shall be located in an area free from hazardous concentrations or accumulations of metal dust.

2-7.4* Each building shall be provided with remote manual cutoff of all electrical power. The remote manual cutoff shall be located at least 10 ft (3.05 m) from the nearest opening in the affected building.

2-7.4.1 Provisions shall also be made for remote manual cutoff of all electrical power to manufacturing areas from one or more central locations, such as offices, watchman's booth, or other appropriate locations.

2-7.5 All manufacturing buildings shall be provided with emergency lighting systems capable of providing 1 ft-candle (10.7 lux) of illumination for all aisles leading to emergency exits. The emergency lighting systems shall be energized automatically on loss of electrical power to the building. (*See 5-9.2.3 of NFPA 101, Life Safety Code.*)

2-7.6 Electrical equipment shall be inspected and cleaned at least once each year or more frequently if conditions warrant.

2-7.7 Flashlights and storage battery lamps may be used if approved for the locations in which they are used.

Chapter 3 Machinery and Operations

3-1 General Precautions.

3-1.1 This chapter shall be applied to new and existing facilities.

3-1.2 In powder handling or manufacturing buildings and in the operation of dust conveying systems, every precaution shall be taken to avoid the production of sparks from static electricity, electrical faults, or impact (e.g., iron or steel articles on stones, on each other, or on concrete).

3-1.3 Water leakage in or into any building where it can contact light metal powder shall be prevented to avoid possible spontaneous heating.

3-1.4 Electrical heating to a high temperature of any wire or resistance element or load in an area containing a dust hazard shall be prevented.

3-1.5* Serious local friction heating in any machine located in an area containing a dust hazard shall be prevented.

3-2 Requirements for Machinery.

3-2.1 All dust-producing machines and conveyors shall be constructed so that escape of dust is minimized.

3-2.2 All machinery shall be bonded and grounded to minimize accumulation of static electric charge. (*See NFPA 77, Recommended Practice on Static Electricity.*) This requirement shall be applicable to stamp mortars, mills, fans, and conveyors in all areas where dust is produced or handled, finishing and polishing equipment, filters, driers, dust screens, fixed storage bins, and dust collection and transport systems of all types. (*See also 2-6.1.*)

3-2.3* Ball or roller bearings, properly sealed against dust, shall be used for shafts and high speed equipment. Where exposed bearings must be used, they shall be protected as well as possible to prevent ingress of light metal dust.

3-2.4 Internal machine clearances shall be maintained to prevent internal rubbing or jamming.

3-2.5 Approved magnetic separators or approved pneumatic separators or screens shall be installed ahead of mills, stamps, or pulverizers wherever there is any possibility that tramp metal or other foreign objects may be introduced into the manufacturing operation.

3-2.5.1 Electromagnets shall be approved for use in Class II, Group E atmospheres.

3-3 Heating of Light Metal Powder Production Buildings.

3-3.1 Heating of buildings shall be done by hot air heating systems or by bare pipe heating systems using steam or hot water as the heat transfer medium. The air may be heated by steam or hot water coils located in a relatively dust-free area adjacent to the room or building where heated air is required.

3-3.2 Fans or blowers used to convey the heated air shall also be located in a relatively dust-free location. The air supply shall be taken from outside or from a relatively dust-free location.

3-3.3 Make-up air for building heating shall have a dew point low enough to insure that no free moisture can condense at any point where the air is in contact with light metal dust or powder.

3-3.4 The requirements of 3-3.1, 3-3.2, and 3-3.3 shall not apply to areas where metal is melted for purposes of atomization.

3-4 Start-up Operations. All the machine processing contact areas shall be thoroughly cleaned and free from water before being charged with metal and placed into operation.

3-5 Charging and Discharging Light Metal Powders.

3-5.1 All containers shall be sealed with metallic, waterproof covers while in storage or transit.

3-5.2 When charging light metal powders to machines (or discharging from), the containers shall be positively grounded by a conducting cable from the container to a suitable ground connection.

3-6* Packing and Storage. Light metal powder shall be packed into steel drums or other closed containers acceptable to the U.S. Department of Transportation (DOT). The containers shall be tightly sealed and stored in a dry location until ready for shipment or repacking.

3-7* Wet Milling of Aluminum Powder.

3-7.1 Where aluminum is ball milled in the presence of a liquid which is chemically inert with respect to the metal, the milling shall be done in air in a vented mill.

3-7.2 Where aluminum is slurried in tanks or processed in blenders or other similar equipment in the presence of a liquid which is chemically inert with respect to the metal, the operation shall be carried out in air or an inerting atmosphere containing sufficient oxygen to oxidize any newly exposed surfaces as they are formed.

3-7.3 The dew point of the atmospheres in 3-7.1 and 3-7.2 shall be maintained substantially below the point where condensation could occur.

3-7.4 Bearings of wet mills shall be grounded across the lubricating film by use of current collector brushes.

3-7.5 Adequate ventilation, forced or natural, shall be maintained in areas where solvents are handled.

3-7.6 Solvent or slurry pumps shall be installed with proper controls to insure that they are shut down should they run dry.

3-7.7 All alarms and electrical equipment shall be installed in accordance with appropriate provisions of NFPA 70, *National Electrical Code*.

Chapter 4 In-Plant Conveying of Light Metal Powder

4-1 Wheeled Containers.

4-1.1 This section on wheeled containers, except paragraph 4-1.4, shall apply to new and existing facilities.

4-1.2 Movable containers for in-plant transportation of light metal powders shall be constructed entirely of nonferrous minimum-sparking metal or of nonmagnetic minimum-sparking stainless steel.

4-1.3 Drums approved by the U.S. Department of Transportation (DOT) for shipment of light metal powders may be used when moved on 2- or 4-wheeled trucks or when moved on pallets by lift trucks.

4-1.4 All wheeled containers, hand trucks, and lift trucks shall have nonsparking, static conductive tires and wheels which have been bonded through or around the lubricating film in the bearings.

4-2 Pneumatic Conveying.

4-2.1 Conveyor ducts shall be fabricated of nonferrous minimum-sparking metal or of nonmagnetic minimum-sparking stainless steel.

4-2.2 Ducts shall be electrically bonded and grounded to minimize accumulation of static electric charge. (*See NFPA 77, Recommended Practice on Static Electricity.*)

4-2.3 Plastics or other nonconductive ducts or duct liners shall not be used.

4-2.4* If the conveying gas is air, the metal dust-to-air ratio throughout the conveying system shall be held safely below the minimum explosive concentration of the metal dust at normal operating conditions.

4-2.4.1* Inert gas explosion prevention systems shall be used in any pneumatic conveying system where the concentration of light metal powder is or may be within the explosive range. (*See Standard on Explosion Prevention Systems, NFPA 69.*)

4-2.4.2* The inert gas used shall be based on such gases as nitrogen, argon, or helium, and shall have an oxygen concentration appropriate to the inerting gas and the particle size of the metal dust, but in no case less than 1 percent.

4-2.4.3 The inert gas shall contain no carbon monoxide.

4-2.4.4 The inert gas shall have a dew point such that no free moisture can condense or accumulate at any point in the system.

4-2.4.5 The inert gas stream shall be continuously monitored for oxygen content and shall be arranged to sound an alarm if the oxygen content is not within the prescribed range.

4-2.4.6 The inert gas for magnesium dust shall not contain carbon dioxide or nitrogen.

4-2.5* Where the conveying duct is exposed to weather or moisture, it shall be moisture-tight.

4-2.6 A minimum conveying velocity of 4500 ft/min (1371 m/min) shall be maintained throughout the conveying system to prevent the accumulation of dust at any point and to pick up any dust or powder that may drop out during an unscheduled system stoppage.

4-2.7 If the conveying gas is inducted into the system in a relatively warm environment and the ducts and collectors are relatively cold, the ducts and the collectors shall be either insulated or provided with heating so that the gas temperature does not fall below the dew point, causing condensation.

4-2.8* If the dust is collected in a liquid, such as in a spray tower, any liquid used shall not have a flashpoint below 100°F (37.8°C) and shall be nonreactive with metal dust or reactive at a controlled rate under favorable operating conditions. The liquid remaining in or on the product shall be compatible with subsequent processing requirements.

4-3 Ductwork for Conveying Systems.

4-3.1 Wherever practical, explosion vents, openings protected by antiflashback swing valves, or rupture diaphragms, shall be provided on ductwork. Relief shall be to the outside of the building. Installation shall be in accordance with NFPA 68, *Guide for Explosion Venting.*

4-3.1.1 The inertia of swing valves shall be limited to the minimum required.

4-3.2 Wherever damage to other property or injury to personnel may result from the rupture of the ductwork, or where explosion relief vents cannot provide sufficient pressure relief, the ductwork shall be designed to withstand a suddenly applied internal pressure of at least 100 psig (689 kPa).

4-3.2.1 If a portion of the ductwork is so located that no damage to property or injury to personnel will result from its bursting, that portion may be of light construction so as to intentionally fail, thereby acting as an auxiliary explosion vent for the system.

4-4 Fan Construction and Arrangement.

4-4.1 Blades and housings of fans used to move air or inert gas in conveying ducts shall be constructed of conductive, nonsparking metal such as bronze, nonmagnetic stainless steel, or aluminum.

4-4.2 In no case shall the design allow the transported dust or powder to pass through the fan before entering the final collector.

4-4.3 Personnel shall not be permitted within 50 ft (15.5 m) of the fan while it is operating. No maintenance shall be performed on the fan until it is shut down.

Exception: If personnel must approach the fan while it is operating, such as for a pressure test, it shall be done under the direct supervision of competent technical personnel and with the knowledge and approval of operating management.

4-4.4* Fans shall be located outside of all manufacturing buildings and so located that entrance of dust is minimized.

4-4.5* Fans shall be equipped with ball or roller bearings. Bearings shall be equipped with suitable temperature-indicating devices and shall be arranged to sound an alarm in case of over-temperature.

4-4.6 Fans shall be electrically interlocked with dust-producing machinery so that the machines are shut down if the fan stops.

Chapter 5 Dust Collection

5-1* Dust Collectors.

5-1.1 Dry-type dust collectors shall be located outside, in a safe location, and shall be provided with suitable barricades or other means for protection of personnel.

5-1.2 Dust collectors shall be constructed of nonferrous, minimum-sparking metal or of nonmagnetic, minimum-sparking stainless steel.

5-1.3 Duct work shall comply with the provisions of Section 4-3.

5-1.4 The entire dust collecion system, including the dust collector, shall be completely bonded and grounded to minimize accumulation of static electric charge. (*See NFPA 77, Recommended Practice on Static Electricity.*)

5-2 Fans and Other Air-Moving Equipment.

5-2.1 Fans and other equipment for moving air shall be located so the fan is on the clean air side of the dust collector.

5-2.2 Fans shall be provided with ball or roller bearings.

5-3 High Temperature Warning.

5-3.1 Cyclone or other dry-type collectors shall be equipped with suitable instruments for recording the inside temperature. An over-temperature alarm or warning device shall be included and the limit setting shall be safely below the maximum service temperature of the filter medium or safely below the ignition temperature of the dust layer or dust cloud, whichever is lowest.

5-3.2 Alarms and actuating equipment shall be suitable for use in Class II, Group E locations or shall be located in a nonhazardous location.

5-3.3 All such instruments shall give indication and alarm at easily observed central locations.

5-4* Dust Collecting Filter Medium. Dust collecting filter medium made from synthetic fabrics which accumulate high static electric charges shall not be used. Replacement filter media shall be in accordance with this criteria.

Chapter 6 Prevention of Dust Accumulations

6-1 General.

6-1.1 This chapter shall apply to new and existing facilities.

6-1.2 Dust shall not be permitted to accumulate. Spills shall be removed at once, using conductive, nonsparking scoops and soft brooms or brushes having natural fiber bristles. Final cleanup may be accomplished using a vacuum cleaning system. Compressed air blowdown shall not be permitted. In certain areas impractical or impossible to clean otherwise, compressed air blowdown shall be done under carefully controlled conditions with all potential ignition sources prohibited in or near the area and the equipment shut down.

6-1.3 The use of water for cleaning shall not be allowed in manufacturing areas unless the following requirements are met:

(a) It has been ascertained by competent technical personnel that the use of water will be the safest method of cleaning in the shortest exposure time.

(b) Operating management has full knowledge of and has granted approval of its use.

(c) Adequate ventilation, either natural or forced, is available to maintain the hydrogen concentration safely below the lower explosive limit.

(d) Complete drainage of all water and powder to a safe, remote area is available.

6-2* Vacuum Cleaning Systems.

6-2.1 Vacuum cleaning systems shall only be used for removal of dust accumulations too small or too dispersed to be thoroughly removed by hand-brushing.

6-2.2 Vacuum cleaning systems shall be effectively grounded and bonded to minimize accumulation of static electric charge. (*See NFPA 77, Recommended Practice on Static Electricity.*)

6-2.3 If located in a dust-producing building or in an area where dust can accumulate, the vacuum cleaning system's electrical equipment shall be suitable for Class II, Group E locations.

6-2.4 Vacuum cleaner hoses shall be conductive and nozzles or fittings shall be made of conductive, nonsparking material.

6-2.5 Dust picked up by the vacuum cleaning system shall be discharged into a suitable receptacle or collector located outside the building.

6-2.6 Portable vacuum cleaners may be used only if approved for use in Class II, Group E locations, or shall be nonelectrically powered.

6-3 Cleaning Frequency.

6-3.1 Supervisors shall be alert to prevent the accumulation of excessive dust on any portions of buildings or machinery not regularly cleaned in daily operations.

6-3.2 Regular periodic cleaning, with all machinery idle and power off, shall be carried out as frequently as conditions warrant, but in no case less than once weekly.

6-3.3 Machinery shall be inspected once weekly and shall be cleaned if the unit has been in operation during that time.

Chapter 7* Fire Fighting Procedures

7-1 Dry Powders.

7-1.1 Sections 7-1 and 7-2 shall apply to new and existing facilities.

7-1.2 An incipient fire shall be ringed with a dam of dry sand, dry inert granular material or powder, or approved dry powder extinguishing agent. Extreme care shall be exercised during application to avoid any disturbance of the light metal powder, which could cause a dust cloud.

7-1.3 The dry material shall be carefully applied with a nonsparking metal scoop or shovel.

7-1.4 Care shall be exercised to eliminate drafts by shutting off fans and machinery and by closing doors and windows.

7-1.5 Areas where dry light metal powders are produced or handled shall not have fire extinguishers rated for Class A, B, or C fires. An ample and readily available supply of dry extinguishing material suitable for use with combustible metals (such as Class D extinguishing agent) shall be provided and suitable tools for application shall be kept in the same locations. The dry extinguishing material shall be stored in such a manner that it remains clean and dry.

7-1.6 In cases of fires involving magnesium powder or dust, it is permissible to use dry magnesium foundry flux as the extinguishing agent. The procedures stated in 7-1.2 through 7-1.4 shall apply to such use.

7-2* Solvent-Wetted Powders.

7-2.1 A fire occurring while the light metal powder is in slurry form may be fought using Class B extinguishing agents.

Exception: Halogenated extinguishing agents shall not be used.

7-2.2 A fire occurring in semi-wet material or filtercake shall be fought using suitable dry extinguishing material.

7-2.3 Carbon dioxide or nitrogen shall not be used on fires involving magnesium in any form.

7-2.4* Where carbon dioxide is used to extinguish fires involving solvent-wetted aluminum, the residual material shall be immediately covered with dry sand or with other suitable dry extinguishing material and the entire mass shall be allowed to cool until it reaches ambient temperature. When the material has cooled and it has been determined that there are no hot spots, the covered material shall be carefully removed for disposal. It shall be handled in small quantities in covered containers, preferably not more than 3 gal (11.4 dm^3) each in 5-gal (19.0-dm^3) containers.

7-2.5 Manual water application shall only be used on a solvent-metal powder fire as a last resort, when other methods of control have failed and the fire shows evidence of going out of control. Only low velocity spray or fog nozzles shall be used. Extreme care shall be exercised to avoid creating a dust cloud. Once water is used, its use shall be continued until the fire is extinguished or until the area becomes untenable.

7-2.5.1 After extinguishment, the area shall be immediately cleaned of all wetted powder, paste, or slurry.

7-2.5.2 Adequate ventilation shall be provided during cleanup to avoid concentrations of hydrogen from the exothermic reaction of the light metal with water.

7-2.5.3 Suitable drainage provisions to a safe area away from manufacturing buildings shall be provided.

7-3 Automatic Sprinkler Protection.

7-3.1 Automatic sprinkler protection may be used in areas where solvents are stored or used or where light metal powders are stored in sealed metal containers.

7-3.2 Automatic sprinkler systems shall be designed and installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

7-3.2.1 The selection, design, and installation of automatic sprinkler systems shall be made only with the guidance of experts who have knowledge of the special hazards of the particular light metal powder involved.

7-3.3 Attention shall be given to employee training and organizational planning to insure safe and proper evacuation of the area.

7-4 Fire Fighting Organization.

7-4.1 Work assignments shall be so planned that an organized crew, trained in fire fighting, is in or close to the hazardous area at all times during operation.

7-4.2 Only trained personnel shall be permitted to engage in fire control activity. All others shall be evacuated from the area.

7-4.3 Fire fighting personnel shall be given regular and consistent training in the extinguishment of test fires set

in a safe location away from manufacturing buildings. Training shall include all possible contingencies.

7-4.4* If professional or volunteer fire fighters are admitted onto the property in the event of a fire emergency, their activity shall be directed by the on-site ranking officer of the trained plant fire fighters.

Chapter 8 Safety Requirements

8-1 Protective Clothing for Workers.

8-1.1 This chapter shall apply to new and existing facilities.

8-1.2 Outer clothing shall be clean, flame resistant, nonstatic-generating and shall be designed to be easily removable. Tightly woven, smooth fabrics treated with a flame retardant chemical, if necessary, shall be used.

8-1.3 Work clothing shall have no external pockets unless covered with a flap fitted with a closure of some sort. Trousers shall not have cuffs.

8-1.4 Safety shoes meeting the following requirements shall be worn by all operating personnel except those persons who are required to work on electrical circuits or equipment.

(a) Soles shall be resistant to embedding particles and to petroleum solvents, if used.

(b) Soles and heels shall be attached by sewing or pegging.

(c) Nails, metal cleats, or metal plates shall not be used.

(d) Safety toe caps shall be completely covered with a scuff-resistant material.

(e) Soles and heels shall be static conductive.

8-2 Smoking and Matches.

8-2.1 Smoking materials, matches, and lighters shall not be carried or used by employees or visitors about the premises adjacent to or within any building in which light metal powder is produced, handled, or loaded for shipment.

8-3 Open Flames, Cutting and Welding Equipment, Propellant-Actuated Tools.

8-3.1* Maintenance workers and furnace or boiler operators shall be furnished such safe ignition tools as their duties require.

8-3.2* Cutting, welding, soldering, or brazing shall not be permitted in buildings housing powder-producing or handling machinery unless operations are completely shut down.

8-3.2.1 All machinery in the area where the hot work is to be done shall be completely shut down.

8-3.2.2 The area where the hot work is to be done and machinery located in the area shall be thoroughly cleaned.

8-3.3 Propellant-actuated tools shall not be used in areas where a dust explosion hazard may exist unless the procedures of 8-3.2.1 and 8-3.2.2 are followed. After use of such tools, a careful check shall be made to insure that no cartridges or charges are left in the area, where they could enter equipment or be accidentally discharged after operations have resumed.

8-3.4* Aluminum, copper, or bronze metal tools, including shovels and scoops, shall be used in all buildings where a dust explosion hazard exists. Iron, steel, or other spark-producing tools shall not be used.

Exception: In areas where the procedures of 8-3.2.2 are followed.

8-3.5 Dismantling of any no-longer-used powder-producing, handling, collecting, or conveying equipment, either indoors or outdoors, shall only be done with tools meeting the requirements of 8-3.4.

8-3.6 Powder or dust sweepings and other material swept from floors, machines, etc. shall be carefully screened to remove foreign material if the sweepings are to be returned to any machine for processing.

8-4 Employee Instruction.

8-4.1 All employees shall be carefully and thoroughly instructed by their supervisors regarding the hazards of their working environment and their behavior and procedures in case of fire or explosion.

8-4.2 All employees shall be shown the location of electrical switches and alarms, first aid equipment, safety equipment, and fire extinguishing equipment.

8-4.3 All employees shall be taught the permissible methods for fighting incipient fires in pastes and for isolating light metal powder fires.

8-4.4 The hazards involved in causing dust clouds and the danger of applying liquids onto an incipient fire shall be explained.

8-4.5 Strict discipline and scrupulous housekeeping shall be maintained at all times.

8-4.6 Attention shall be given to employee training and organizational planning to insure safe and proper evacuation of the area.

8-5 Periodic Inspection.

8-5.1 A thorough systematic inspection shall be made at regular intervals not to exceed one month.

8-5.2 Two or more competent persons shall conduct each inspection and the record of their findings and recommendations shall be permanently recorded in the principal plant office.

8-5.3 The inspection shall include the following:

(a) general safety precautions;
(b) fire fighting equipment;
(c) first aid equipment;
(d) housekeeping;
(e) electrical and mechanical equipment;
(f) procedures.

8-5.4 Indicating and recording instruments and alarm devices shall be checked daily and the results recorded. Instruments shall be calibrated every six months.

8-6 Deluge Showers. Deluge showers actuated by hinged floor valves shall be installed at strategic locations immediately outside critical working areas to immediately douse clothing fires.

8-7 Safety Blankets. Safety blankets shall be provided throughout the plant area.

Chapter 9 Referenced Publications

9-1 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.

9-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

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

NFPA 48-1982, *Standard for the Storage, Handling and Processing of Magnesium*

NFPA 65-1987, *Standard for the Processing and Finishing of Aluminum*

NFPA 68-1978, *Guide for Explosion Venting*

NFPA 69-1986, *Standard on Explosion Prevention Systems*

NFPA 70-1987, *National Electrical Code*

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

NFPA 78-1986, *Lightning Protection Code*

NFPA 80-1986, *Standard for Fire Doors and Windows*

NFPA *101*-1985, *Life Safety Code*

NFPA 493-1978, *Standard for Intrinsically Safe Apparatus for Use in Class I, II, and III, Division I Hazardous Locations*

NFPA 496-1986, *Standard for Purged and Pressurized Electrical Equipment*

Appendix A

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

A-1-1.1 Certain "nondusting" grades of aluminum flake powder are being produced. Although they exhibit less tendency to be dispersed into a dust cloud, the same precautions described in this standard should be observed.

A-2-7.4 Provisions may also be made to automatically cut off electrical power and lighting circuits in manufacturing buildings when one or more safety sensing devices are activated by high pressure, low airflow, abnormal oxygen content, excessive vibration, or other pertinent factors being monitored. Alternatively, these sensing devices may be arranged to sound an alarm in those locations where prompt corrective action can be taken.

A-3-1.5 Temperature-sensing elements connected to alarms or machine stop switches may be employed for locations where overheating of bearings or other elements may be anticipated.

A-3-2.3 Plain bearings must not be used because of the difficulty of maintaining proper lubrication to prevent overheating. Outboard bearings are used where practical because it is easier to check for overheating. In those instances where dust tends to penetrate bearings a continuous flow of inert gas (1½ to 5 percent oxygen) can be employed to pressurize the bearings and seals, or a compatible liquid may be used in the same manner.

A-3-6 Open bin storage is not desirable. Storage bins can be sealed and they can be purged with inert gas prior to filling. Once filled, the bins can be maintained inert by a suitable gas as detailed in 4-2.4.

A-3-7 When light metal is milled in the presence of a liquid which is chemically inert with respect to the metal, the air-dust explosion hazard is eliminated. When the resulting product is subsequently exposed to air, any unoxidized surfaces produced during milling will react and may generate enough heat to cause ignition. To prevent this, it is imperative that a controlled amount of oxygen be present in the milling operation and in slurries ahead of filters and blenders, so that new surfaces are oxidized as they are formed. The addition of a milling agent, such as stearic acid, does not eliminate the need for this added oxygen.

A-4-2.4 These minimum explosive concentrations are published in Explosibility of Metal Powders, RI 6516, U.S. Bureau of Mines, 4800 Forbes Ave., Pittsburgh, PA. Although the metal dust-air suspension may be held below the explosive concentration in the conveying system, the suspension will necessarily pass through the explosive range in the collector at the end of the system unless the dust is collected in liquid, such as in a spray tower. Also, the dust in the conveying line from the atomizer to the collector will, of necessity, approach the minimum explosive concentration.

A-4-2.4.1 Light metal and light metal alloy powders are produced by various mechanical means of particle size degradation. These processes, as well as certain finishing and transporting operations, tend to expose a continuously increasing area of new metal surface. Most metals immediately undergo a surface reaction with available atmospheric oxygen which forms a protective coating of metal oxide that serves as an impervious layer to inhibit further oxidation. This reaction is exothermic. If a fine or thin lightweight particle having a large surface area of "new" metal is suddenly exposed to the atmosphere, sufficient heat will be generated to raise its temperature to the ignition point.

Completely inert gas cannot be used as an inerting medium since the metal powder would eventually, at some point in the process, be exposed to the atmosphere, at which time the unreacted surfaces would be oxidized; enough heat would be produced to initiate either a fire or an explosion. To provide maximum safety, a means for the controlled oxidation of newly exposed surfaces is provided by regulating the oxygen concentration in the inert gas. The mixture serves to control the rate of oxidation, while materially reducing the fire and explosion hazard.

A-4-2.4.2 Oxygen limits of 3 to 5 percent have been maintained in aluminum powder systems using a controlled flue gas. Other limits are applicable where other inert gases are used. Refer to Inflammability and Explosibility of Metal Powders, RI 3722, U.S. Bureau of Mines, 4800 Forbes Ave., Pittsburgh, PA.

A-4-2.5 Any moisture entering the system can react with the light metal dust, generating heat.

A-4-2.8 Such wet collection is not always possible or desirable.

A-4-4.4 Ultimately, all fans in dust collector systems accumulate sufficient dust to become a potential explosion hazard.

A-4-4.5 Fans may also be provided with vibration-indicating devices, arranged to sound an alarm or to provide shutdown or both in the event of blade or rotor imbalance, or bearing or drive problems.

A-5-1 A high efficiency cyclone-type collector presents less hazard than a bag-type collector and, except for extremely fine powders, will usually operate with fairly high collection efficiency. When cyclones are used, the exhaust fan discharges to atmosphere away from other operations. It should be recognized that there will be some instances in which a centrifugal-type collector may be followed by a fabric or bag collector or by a scrubber-type collector where particulate emissions must be kept at a low level. The hazards of each collector must be recognized and protected against. In each instance, the fan will be the last element downstream in the system. Because of the initial capital cost of an efficient bag collector, the operating maintenance expense, the downtime cost, and the extreme hazard involved, a realistic evaluation of the losses from a multiple series cyclone with a liquid final stage should be seriously considered.

Industry experience has clearly demonstrated that an eventual explosion can be expected when a bag collector is used to collect aluminum or magnesium fines. Seldom, if ever, can the source of ignition be positively identified. In those unusual instances when it becomes necessary to collect extreme fines for a specific commercial product, it is customary for the producer to employ a bag collector. With the knowledge that strong explosive potential is present, s/he will locate the bag collector a safe distance from buildings and personnel. Usually s/he will surround the collector with a strong steel plate barricade to direct the force of the explosion upward and will cover it with a loose, lightweight, watertight cover which can blow off to provide venting. Under these very special conditions, when an explosion occurs, only a physical loss is incurred. Conventional sheet metal baghouse enclosures are not suitable.

If a bag collector is used, the shaking system or dust removal system can be such as to minimize sparking due to frictional contact or impact. Pneumatic or pulse-type shaking is more desirable because no mechanical moving parts are involved in the dusty atmosphere. If the bags are provided with grounding wires, they can be positively grounded through a low-resistance path to ground. When bags are used, it is customary that the baghouse be protected by an alarm to indicate excessive pressure drop across the bags. An excess air temperature alarm is also frequently employed. A bag collector is customarily located at least 50 ft (15.24 m) from any other building or operation. It is not customary to permit personnel to be within 50 ft (15.24 m) of the collector during operation or when shaking bags. Explosion vents are usually built into the system, as described in NFPA 68, *Guide for Explosion Venting*. Care is customarily exercised in locating the vents because of the possibility of blast damage to personnel or adjacent structures.

A-5-4 Some collector bags or screens have fine, noninsulated wire enmeshed into or woven with the cloth or otherwise fastened to it. These are always securely grounded. It should be pointed out that this is not a positive guarantee of static charge removal because there is no dependable force to cause the charges to move across the nonconducting area of the fabric to the grounded wires. Often, a substantial potential difference can be measured. Also, it is possible that a wire in the cloth may break in such a way that it is no longer grounded. Such a wire serves as a capacitor and may store a static charge.

A-6-2 Permanently installed vacuum cleaning systems provide the maximum safety because the dust collecting device and the exhaust blower can be located in a safe location outside the dust-producing area. The dust collector should be located outside the building, preferably more than 50 ft (15.24 m), away. If the collector is located closer than 50 ft (15.24 m), it is usually surrounded by a strong steel shield, cylindrical in shape and open at the top, or closed with a light, unfastened cover. The shield is closed at the bottom and designed to withstand a blast pressure of 200 psig (1378 kPa). Such a protective barricade will direct an explosion harmlessly upward and will protect both property and personnel. All suction lines should be provided with explosion vents and anti-flashback valves.

A-7 Since it is almost impossible to extinguish a massive fire in dry light metal powder, the fire problem resolves itself into the control of fires in the incipient stage. The requirements of Section 7-1 must be followed if the fire is to be controlled quickly. This is especially true with regard to the application of the extinguishing material, as even a minor dust cloud can explode violently.

A properly ringed fire will develop a hard crust of metal oxide which will ultimately exclude enough oxygen to cause self-extinguishment. It is customary practice, after dispensing the extinguishing material, to leave the area, closing all doors leading to the area and sealing them with sand. The area should not be re-entered until combustion has stopped and the material has cooled.

A-7-2 Milling of aluminum with combustible solvents is practiced in the manufacture of aluminum flake used in pigments and powders. The material is handled as a slurry during processing. Some of the product is marketed as a paste; other portions are filtered, dried, sometimes polished, and sold as dry flake powder. The solvents employed are generally moderately high flash-point naphthas. A fire in an aluminum powder slurry is primarily a solvent fire and can be fought using Class B extinguishing agents, except for halogenated extinguishing agents.

Major producers usually employ fixed extinguishing systems of carbon dioxide or foam in this area. Some Class B portable extinguishers are provided also. Obviously, judgment must be used in determining whether Class B extinguishing agents can be safely used. If the extinguishing agent is carefully applied, it will be very evident if it accelerates the fire. If it does, its use should be discontinued and a Class D extinguishing agent or dry inert granular material used. A fire in filter cake, a solvent-wetted but semi-dry material containing aluminum, may be a solvent fire or it may at some point exhibit the characteristic of a powder fire at which time it must be treated as such. If the aluminum metal has ignited, it may continue to burn under a crust without flames.

A-7-2.4 Reignition may occur due to high localized heat or spontaneous heating. To avoid reignition, the residual material must be immediately smothered.

A-7-4.4 It is recommended that a practice fire drill be conducted once each year to familiarize local fire department personnel with the proper methods of fighting Class D fires.

A-8-3.1 Ignition tools will generally be the flint-and-file type used for lighting torches or furnace burners.

A-8-3.2 Attention is called to the hazardous conditions that may exist both inside and outside the plant if cutting torches are used to dismantle dust collectors or powder-producing machinery before all dust accumulations have been removed.

It is a commonly recognized practice that operators of cutting or welding torches be required to obtain a written permit from the safety or fire protection officer of the plant before using their equipment under any condition around light metal powder plants.

A-8-3.4 Attention is directed to the fact that, under certain circumstances, principally impact with rusty iron or steel, where a minor thermite reaction can be initiated, aluminum cannot safely be considered to be nonsparking. For details, refer to "Aluminum and the Gas Ignition Risk," by H. S. Eisner, published in the *Engineer* (London, Feb. 17, 1967), and "Fire Hazards in Chemical Plant from Friction Sparks Involving the Thermite Reaction," by N. Gibson, F. C. Lloyd, and G. R. Perry, published in *Symposium Series No. 25,* Institution of Chemical Engineers (London).

Appendix B Electrically Conductive Floors

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

B-1 General.

B-1.1 Electrically conductive flooring is often employed in light metal powder plants, although it is recognized that it is difficult to maintain the conductivity of the floor over a period of time using currently available materials. Careful examination of the details of this standard will disclose the logic of the use of conductive flooring materials.

B-1.2 The surface of a conductive floor will provide a path of moderate electrical conductivity between all persons and portable equipment making contact with the floor, thus preventing the accumulation of dangerous electrostatic charges.

B-1.3 The maximum resistance of a conductive floor is usually less than 1,000,000 ohms, as measured between two electrodes placed three feet apart at any two points on the floor. The minimum resistance is usually greater than 25,000 ohms, as measured between a ground connection and an electrode placed at any location on the floor. This minimum resistance value provides protection for personnel against electrical shocks. Resistance values are checked at regular intervals, usually once each month.

B-2 Testing for Minimum and Maximum Resistance.

The following equipment and procedures are accepted practice.

B-2.1 Each electrode will weigh 5 lbs (2.26 kg) and will have a dry, flat, circular contact area 2.5 in. (63.5 mm) in diameter. The electrode will consist of a surface of aluminum foil 0.0005 in. (0.013 mm) to 0.001 in. (0.025 mm) thick, backed by a layer of rubber 0.25 in. (6.35 mm) thick and measuring 40 to 60 durometer hardness, as determined by a Shore Type A Durometer or equivalent.[1]

B-2.2 Resistance may be measured with a suitably calibrated ohmmeter which can operate on a nominal

[1]ASTM D2240-68, *Method of Test for Indentation of Rubber by Means of a Durometer,* American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

open circuit output voltage of 500 volts dc and a short circuit current of 2.5 to 10.0 m amp.

B-2.3 Measurements may be made at five or more locations in each room and the results averaged.[1]

B-2.4 For compliance with the maximum resistance limit, the average of all measurements should be less than 1,000,000 ohms.

B-2.5 For compliance with the minimum resistance limit, no individual measurement should be less than 10,000 ohms and the average of not less than five measurements should be greater than 25,000 ohms.

B-2.6 Where resistance to ground is measured, two measurements are customarily made at each location, with the test leads interchanged at the instruments between the two measurements. The average of the two measurements is taken as the resistance to ground at that location. Measurements are customarily taken with the electrode or electrodes more than 3 ft (0.92 m) from any ground connection or grounded object resting on the floor.[1]

[1]If resistance changes appreciably with time during a measurement, the value observed after the voltage has been applied for about five minutes may be considered the measured value.

Appendix C Referenced Publications

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.

Explosibility of Metal Powders, Report of Investigations 6516, U.S. Bureau of Mines, Pittsburgh, PA, 1964.

Industrial Chemists Engineering Symposium Series, No. 25, 1968, Gibson et al, "Fire Hazards in Chemical Plants from Friction Sparks Involving the Thermite Reaction."

Inflammability and Explosibility of Metal Powders, Report of Investigations 3722, U.S. Bureau of Mines, Pittsburgh, PA.

Method of Test for Indentation of Rubber by Means of a Durometer, ASTM D2240, American Society for Testing and Materials, Philadelphia, PA, 1975.

The Engineer, February 17, 1967, Eisner, H. S., "Aluminum and the Gas Ignition Risk."

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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