

NFPA

651



ALUMINUM & MAGNESIUM POWDER 1980



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See Official NFPA Definitions at the back of this pamphlet.

* Errata

NFPA 651 — 1980
Manufacture of Aluminum
and Magnesium Powder

The Technical Committee on Metal Dusts notes the following error on page 651-32 of NFPA 651, Standard for the Manufacture of Aluminum and Magnesium Powder, 1980.

1. In Appendix B, subsection B-2.1, the aluminum foil used for conductive flooring tests is specified as having a thickness ranging from 0.00005 to 0.0001 in. The correct thicknesses should be "0.0005 in (0.013 mm) to 0.001 in (0.025 mm)."

ERRATA NOV 5 1981

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Standard for the Manufacture of Aluminum and Magnesium Powder

NFPA 651-1980

1980 Edition of NFPA 651

This edition of NFPA 651, *Standard for the Manufacture of Aluminum and Magnesium Powder*, was prepared by the Technical Committee on Metal Dusts and was adopted by the Association on May 20, 1980 at its 1980 Annual Meeting in Boston, MA. The NFPA Standards Council released this edition on June 11, 1980.

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.

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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.

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Standard for the Manufacture of Aluminum and Magnesium Powder

NFPA 651-1980

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 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 semi-finished 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.

1-3.2 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 Definitions.

1-4.1 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 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.

2-2.2 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 having no openings. (See *Guide for Explosion Venting, NFPA 68*, and *Standard for the Prevention of Dust Explosions in Industrial Plants, NFPA 63*.)

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 section 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 as light as practical, noncombustible, and be so arranged that they will be blown off by an internal explosion.

2-3.6.1 Any sheet metal used as roof decking shall be well sealed to prevent leakage. Alternatively, sheet metal may be galvanized and well maintained to prevent corrosion which could lead to leakage.

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 the *Standard for Fire Doors and Windows, NFPA 80*. Hardware for emergency exit doors shall conform to requirements of NFPA 80 and of the *Life Safety Code*[®], NFPA 101[®]. (See *Section 5-11 and Chapter 14 of the Life Safety Code, 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 *Guide for Explosion Venting, NFPA 68*.)

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.

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 the *Lightning Protection Code*, NFPA 78.

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 Lightning Protection Code, NFPA 78.*)

2-6.4 A lightning arrester 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 the *National Electrical Code*[®], NFPA 70.

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

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 the Standard for Purged and Pressurized Electrical Equipment, NFPA 496, or the Standard for Intrinsically Safe Apparatus for Use in Class I, II and III, Division 1 Hazardous Locations, NFPA 493.

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 low voltage (24 to 32 volts) 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 14-2.5 of the Life Safety Code, NFPA 101.)

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 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).

3-1.2 Water leakage in or into any building where it can contact light metal powder shall be prevented to avoid possible spontaneous heating.

3-1.3 Electrical heating to a high temperature of any wire or resistance element or load in an area containing a dust hazard shall be prevented.

3-1.4* 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 Recommended Practice on Static Electricity, NFPA 77.*) 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 Light Metal Powder.

3-7.1 Where light metal is milled or comminuted in the presence of an inert liquid, the oxygen content shall be maintained at no less than 8 percent.

3-7.2 Where light metal is slurried in tanks or processed in blenders or other equipment in the presence of an inert liquid, the oxygen content shall be maintained at no less than 4 percent.

3-7.3 The dew point of the controlled oxygen atmosphere 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 the *National Electrical Code*, NFPA 70.

Chapter 4 In-Plant Conveying of Light Metal Powder

4-1 Wheeled Containers.

4-1.1 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.

4-1.2 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.

4-1.3 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 Recommended Practice on Static Electricity, NFPA 77.*)

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

4-2.4* 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.*)

4-2.4.1* 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.

4-2.4.2 The inert gas shall contain no carbon monoxide.

4-2.4.3 The inert gas shall have a dew point such that no free moisture can condense or accumulate at any point in the system.

4-2.4.4 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.

4-2.4.5 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 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.

4-2.8.1* 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. (*See Guide for Explosion Venting, NFPA 68.*)

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

5-2 Fans and Other Air-Moving Equipment.

5-2.1 Fans and other equipment for moving air shall be located so that entrance of dust into the fan housing is minimized.

5-2.1.1 Where the requirement of 5-2.1 cannot be met, the air moving equipment may be enclosed by construction designed to resist a suddenly applied internal pressure of 100 psig (689 kPa). The housing of the air moving equipment must be provided with explosion venting to the outside.

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.

Chapter 6 Prevention of Dust Accumulations

6-1 General.

6-1.1 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.

6-1.2 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 Recommended Practice on Static Electricity, NFPA 77.*)

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 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.

7-1.2 The dry material shall be carefully applied with a nonsparking metal scoop or shovel.

7-1.3 Care shall be exercised to eliminate drafts by shutting off fans and machinery and by closing doors and windows.

7-1.4 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.

7-1.5 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 7-1.1 through 7-1.3 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 filter-cake 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 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 dm³) each in 5-gal (19.0-dm³) 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 the *Standard for the Installation of Sprinkler Systems*, NFPA 13.

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 protected area within the time limits of the system operation.

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 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.

8-1.2 Work clothing shall have no external pockets. Trousers shall not have cuffs.

8-1.3 Metallic fasteners shall be avoided where possible.

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 only be allowed in the "change house" at the building entrance.

8-2.2 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.

8-2.3 The "change house" building shall be of fire-resistive construction, shall be normally accessible only from a single entrance, and shall be located at or near the entrance to the premises.

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 8-3.2.1 and 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.

8-5 Periodic Inspection.

8-5.1 A thorough systematic inspection shall be made at regular intervals not to exceed 1 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 6 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.

Appendix A

This Appendix is not a part of the requirements (recommendations) 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-3-1.4 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 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-4-2.4.1 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 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-4-2.8.1 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 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, he will locate the bag collector a safe distance from buildings and personnel. Usually 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.