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ALUMINUM & MAGNESIUM POWDER 1974

NATIONAL FIRE PROTECTION ASSOCIATION
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Standard for the Manufacture of

Aluminum or Magnesium Powder

NFPA No. 651 — 1974

1974 Edition of No. 651

This edition of NFPA No. 651 was prepared by the Sectional Committee on Metal Dusts and was approved by the Dust Explosion Hazards Correlating Committee. It is a revision of No. 651–T–1973 and supersedes both NFPA No. 651–1972, Manufacture of Aluminum Powder, and NFPA No. 652–1968, Plants Producing or Handling Magnesium Powder. It was adopted at the Annual Meeting in May 1974.

Origin and Development of No. 651

No. 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 ANS Z12.11.

No. 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 ANS Z12.15.

In 1973 No. 651 and 652 were combined into a single standard, No. 651-T, and tentatively adopted at the Annual Meeting.

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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.

Interpretation Procedure

Those desiring an interpretation shall supply the Chairman with five identical copies of a statement in which shall appear specific reference to a single problem, paragraph, or section. Such a statement shall be on the business stationery of the inquirer and shall be duly signed.

When applications involve actual field situations they shall so state and all parties shall be named.

An interpretations committee will reserve the prerogative to refuse consideration of any application that refers specifically to proprietary items of equipment or devices. Generally inquiries should be confined to interpretation of the literal text or the intent thereof.

Requests for interpretations should be addressed to the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA. 02210.

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NOTICE

An asterisk (*) preceding the number designating a paragraph indicates explanatory material on that paragraph in Appendix A.

Standard
For the Manufacture of
Aluminum or Magnesium Powder

NFPA No. 651 — 1974

Chapter 1. Introduction

1-1 The objective of this standard is to reduce the hazards of ignition and explosions in the manufacture of light metal flake powder, or paste, and atomized light metal granular particles and/or the dust of any light metal alloy that is explosive in an environmental gas, as determined by test. This revised standard is a consolidation of *Manufacture of Aluminum Powder*, NFPA No. 651–1972, and *Plants Producing or Handling Magnesium Powder*, NFPA No. 652–1968, because the major provisions of each are very similar. Provisions applicable to a specific metal powder are clearly indicated.

1-2 Retroactivity. Unless otherwise stated, it is not intended that the provisions of this standard be retroactive.

1-2.1 Existing plants, equipment, structures, and installations which were in compliance with the current provisions of the *Standard for Manufacture of Aluminum Powder*, NFPA No. 651, or the *Standard for Plants Producing or Handling Magnesium Powder*, NFPA No. 652, whichever is applicable, at the time of manufacture or installation may be continued in use if such continued use does not constitute a recognized hazard that is causing or is likely to cause, death or serious physical harm to employees.

1-3 All new installations shall be under the supervision of engineers qualified by experience in the design, construction and operation of equipment for this application.

1-4 This standard is not intended to apply to situations where waste dust is produced by operations such as grinding, buffing and polishing of light metal semifinished products. Prevention of fires and explosions in industries where light metals and light metal alloys are subject to processing or finishing operations in which a fine metallic dust is liberated is covered in *Standard for the Processing and Finishing of Aluminum*, NFPA No. 65–1973, or in *Standard for the Storage, Handling, and Processing of Magnesium*, NFPA No. 48–1967.

1-5 Definitions. Light metal powders as used in this standard means aluminum and magnesium powders.

Chapter 2. Location and Buildings of Light Metal Powder-Making Plants

2-1 Location of the Plant.

2-1.1 The plant shall be located on a tract of land large enough so that the buildings in which the powder is manufactured shall be at least 300 feet distant from occupied structures such as public buildings, dwellings, stores or manufacturing establishments other than those which are a part of the powder manufacturer's plant. The premises in which are located the powder-making buildings shall be surrounded by a high strong fencing at least six feet high with suitable entrance gates. Gates that are not locked shall be under charge of a guard. All unattended parking areas shall be illuminated to a minimum level of one foot candle; all inactive entrances to a minimum level of one foot candle; active pedestrian entrances to a minimum of two foot candles; active vehicular entrances to a minimum of one foot candle; and all fence lines to a minimum of 0.04 foot candles.

2-2 Location of Operations.

2-2.1 Different operations in the manufacture of light metal powder shall be located in separate buildings further subdivided into as many small units as practicable by blast-resistant, nonload-bearing, noncombustible, dust-tight division walls without openings. Separate buildings (other than the small units of a major process section) shall be separated by not less than 50 feet of space.

2-3 Electric or Steam Power Generators.

2-3.1 Electric or steam power generators shall be in a separate building or buildings which shall be at least 100 feet from any dust-making building.

2-4 Building Construction.

2-4.1 All buildings used for the manufacture, packing or loading for shipment of aluminum powder shall conform with the following requirements:

2-4.1.1 Character of Buildings: They shall, where practical be of one-story type with nonload-bearing walls, with no basements, and constructed of noncombustible materials throughout. The buildings shall be designed so that every internal surface is readily accessible to facilitate cleaning. In all building walls of rooms, where dust may be produced, which are not of monolithic construction, all masonry joints shall be thoroughly slushed with mortar and trowelled smooth so as to leave no interior or exterior voids for the

infiltration and accumulation of light metal powder. Where elevated floors, platforms or balconies are required, as possibly for tanks or collectors or other process reasons, the same principles shall apply. Floor covering and railings shall be of minimum sparking metal construction and shall be adequately grounded. Emergency exit doors shall be provided from all areas including balconies. These shall be exit doors as described in 2-4.1.4.

2-4.1.2 Construction with Reference to Position of Buildings: Where two buildings are less than 50 feet apart, one of the facing walls shall be capable of resisting a blast pressure of 2 psi and shall be nonload-bearing, noncombustible, and dust-tight without openings.

2-4.1.3 Communication between Buildings: Buildings separated by not less than 50 feet of space (or small units of one major process section) may communicate through enclosed passageways of noncombustible construction, provided that such enclosed passageways from production or storage areas are specially designed for the release of internal pressures and all openings to such passageways are protected by self-closing fire doors approved for the protection of openings in fire division walls. When two buildings are less than 50 feet apart, only one of those shall have windows or doors in the wall facing the other building. An exit door for escape from enclosed passageways to outdoors shall be provided. (*See 2-4.1.4.*)

2-4.1.4 Frames of Doors and Windows: They shall be of metal. The doors shall be approved self-closing fire doors. There shall be adequate window areas both for light and, in case of an explosion, to afford relief of pressure by automatic opening. Windows which may be opened shall be hinged at the top, shall open outward, and if fastened with catches these should release on moderate pressure from the inside. (*See the Guide for Explosion Venting*, NFPA No. 68–1974), for suggested vent ratios in specified room volumes. Each room shall have at least two widely separated exits to corridors or to the outside. All exit doors to the outside for escape purposes shall be of the emergency type, opening outward with a pressure bar latch and be self-closing to minimize drafts. (*See 5-216, Panic Hardware, Code for Safety to Life from Fire in Buildings and Structures*, NFPA No. 101–1973.)

2-4.1.5 Floors of Buildings: Hard surfaced nonslip floors shall be installed in a manner that avoids joints which might catch and collect dust.

2-4.1.6 Roofs of Buildings: Where there are dust-making operations the roofs shall be supported on girders designed to minimize the surface areas on which dust may collect. Where such

surfaces are unavoidably present, and on other more or less horizontal places such as girder flanges and window ledges, they shall be covered by a smooth, steeply sloping concrete or plaster filling having a minimum angle of 55 degrees with the horizontal. The roof covering shall be as light as practicable, but fire resistant, and shall be so arranged that it will be easily blown off by an internal explosion. Any sheet metal used in the roof covering shall be well cemented to prevent leakage and be well painted with aluminum paint, or else shall be galvanized and well maintained to prevent corrosion, which might cause leakage.

2-4.1.7 Grounding and Lightning Protection: All steel work shall be well grounded to a suitable ground outside the building in accordance with *Lightning Protection Code*, NFPA No. 78–1968. Lightning rods shall be provided for all boiler house stacks or chimneys and high points on buildings. The power lines shall be adequately protected against lightning. A lightning arrestor system shall be provided around or within the building area of such capacity as to fully protect all buildings in that area from lightning.

Chapter 3. Conveying Powder

3-1 Construction and Grounding of Dust-Making Machines.

3-1.1 All dust-making machines and conveyors shall be so constructed as to minimize the escape of dust into the rooms in which they are located. All parts of the machinery and conveyors shall be thoroughly bonded and grounded to minimize static discharges. (*See Chapter 5, Control of Static Electricity.*)

3-2 Conveying of Light Metal Powders.

3-2.1 Containers with Wheels: Movable containers for in-plant transportation of powders shall be constructed throughout of nonferrous minimum-sparking metal or nonmagnetic minimum-sparking stainless steel. Drums acceptable for DOT shipment may be used when moved on two or four wheel hand trucks or on pallets with lift trucks. All containers, hand trucks and lift trucks with wheels shall have nonsparking, static conductive tires and wheels which must be bonded through or around the lubricating film in the

bearings. All containers shall be sealed with metallic, waterproof covers while in storage or in transit. When charging or discharging the containers, the containers shall be positively grounded by a conducting cable from the container to a suitable ground connection.

3-2.2 Pneumatic Conveying: Pneumatic conveying is a common method of transferring the dust from place to place in a building or to an adjacent building. Conveyor ducts shall be fabricated from nonferrous, minimum sparking metal or nonmagnetic minimum sparking stainless steel. The ducts shall be electrically bonded and grounded. Plastic or other nonconductive liners shall not be used. Inert gas shall be used in such a system wherever the concentration of powder will come within the explosive range.

The inert gas shall be based upon such inert gases as nitrogen, argon, helium, etc. with a limiting oxygen concentration appropriate to the character of the inerting gas and the particle size of the metal dust in the system. It shall contain at least 1% oxygen, shall contain no carbon monoxide and shall have a dew point such that no free moisture can condense and/or accumulate at any point in the system. The inert gas for magnesium dust systems shall not contain carbon dioxide. Oxygen limits of 3 percent to 5 percent have been maintained in aluminum powder systems using a controlled type of flue gas. Other limits are applicable where other inert gases are employed. Reference should be made to Bureau of Mines publication RI-3722, *Inflammability and Explosibility of Metal Powders*, and to other pertinent research data.

There shall be a continuous monitor to sound alarm if the oxygen content of the inert gas is not within the established safe range.

3-2.3 Inert Atmosphere: 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, have a tendency to expose a continuously increasing area of new metal surface. Most metals immediately experience a surface reaction with available atmospheric oxygen to form a protective oxide coating which then serves as an impervious layer to inhibit further oxidation. This reaction is exothermic, producing sensible heat. If a fine or thin lightweight particle having a large area of new surface is suddenly exposed to the atmosphere, enough heat will be generated to raise its temperature to the ignition point. Completely inert gas shall not be used as an envelope to promote operational safety or for transport of light metal powder in a pneumatic or fluidized transfer device. This would be a very unsafe practice because somewhere in the process of manufacture, packaging, or ultimate use, the powder will eventually be exposed to the atmosphere where the unreacted surfaces will react suddenly with available oxygen to produce enough heat to cause either a fire or an

explosion. To provide maximum safety, a means for the controlled oxidation of newly exposed surfaces shall be provided as soon as they are exposed by regulating the oxygen content of the inert gas. Tests conducted by the U.S. Bureau of Mines and others have disclosed that an inert gas as described in Section 3-2.2 is effective for this purpose. This mixture serves to control the rate of oxidation and at the same time provides an environment which materially reduces the fire and explosion hazard.

*3-2.4 **Air Conveying.** If the conveying gas is air, as is often practiced in atomizing, the metal dust-air ratio throughout the conveying system shall be held below the minimum explosive concentration of the metal dust as determined by the Bureau of Mines and reported in Bureau of Mines Report of Investigations 6516, *Explosibility of Metal Powders.* 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 conveying system unless the dust is collected in a liquid such as in a spray tower. Such wet collection is not always possible or desirable. Any liquid used shall be nonflammable, nonreactive with metal dust, or reactive at a controlled minimum rate under favorably controlled conditions, and the liquid remaining in or on the product shall be compatible with subsequent processing requirements.

In an air conveying system, any dry collector must be considered as an explosion hazard containing a dust-air mixture in the explosive range. It shall, therefore, be sited in a safe location and be provided with the requisite barricades or other design means for the protection of personnel. It shall be constructed of nonferrous, nonsparking metal or nonmagnetic, nonsparking stainless steel. The entire system and particularly the collector shall be thoroughly and completely bonded and grounded. The entire ground system shall be checked with an ohmmeter to show less than 5 ohms resistance to ground. (*See Chapter 5, Control of Static Electricity.*)

3-2.4.1 Where the conveying duct is exposed to weather or moisture, it shall be moisture-tight because any moisture entering the system can react with the light metal dust, generating heat and serving as a potential source of ignition.

A minimum conveying velocity of 5,500 feet per minute shall be employed throughout the conveying system to prevent the accumulation of dust at any point and to pick up any powder that might drop out during an unscheduled system stoppage.

If the conveying gas is inducted into the system in a relatively warm environment and the duct work and collectors are relatively

cold, gas temperature may drop below the dew point causing condensation of moisture. To avoid this possible condensation, the ducts and collectors should be insulated or should be provided with heating means.

3-3 Relief Vents of Conveyor Ducts.

3-3.1 Whenever, in the ducts, it is practicable to have relief vents of sufficient area connected to ducts or openings protected with antiflash-back swing valves and extending to the outside of the building, these shall be provided. Care shall be taken to limit the inertia of swing valves to the minimum required. Rupture diaphragms may be used in place of swing valves.

3-3.2 Working Pressure Strength of Ducts. Wherever damage may result from the rupture of a duct, in case the relief vent fails to offer sufficient pressure relief, the duct shall be designed for an internal working pressure of 100 pounds per square inch minimum. Where it is so located that no damage will result from its bursting, it may be of very light construction to intentionally fail as an auxiliary vent for the system.

3-4 Fan Construction and Arrangement.

***3-4.1** Blades and housing of fans that are used to move air or inert gas in conveying ducts shall be constructed of conductive, nonsparking metal such as bronze, nonsparking stainless steel, or aluminum. In no case shall the design be such that the dust is drawn through the fan before entering the final collector. Personnel shall not be permitted within 50 feet of the fan during operation. This means that the fan and associated equipment shall be shut down for oiling, inspection or preventive maintenance. If the area must be approached during operation for pressure test or other technical reasons, it must only be done under the direct supervision of competent technical personnel and with the knowledge and approval of operating management. Ultimately, all fans in dust collector systems accumulate sufficient dust to be a potential hazard and for this reason they shall be located outside of all manufacturing buildings.

Fan bearings shall be equipped with suitable instruments for indicating the temperature and should be wired with an alarm device to give notice of over-temperature.

Chapter 4. Electricity for Light and Power

4-1 Electrical Wiring and Equipment.

4-1.1 All electrical wiring and equipment shall conform to the *National Electrical Code*, NFPA No. 70.

All parts of manufacturing buildings shall be considered Class II, Division 1 locations under Articles 500 and 502 of the *National Electrical Code*, NFPA No. 70–1974 except offices and similar locations so occupied and segregated as to be reasonably free from dust and so classed by the authority having jurisdiction.

4-2 Requirements of the National Electrical Code.

4-2.1 Attention shall be specifically directed to the requirements of the *National Electrical Code*, NFPA No. 70–1974 for the location of transformers, primary and secondary switchgear, type and location of motors, generators, and their control equipment, cables, fuses, circuit breakers, conduits, and lights of all types.

4-3 Special Provisions.

***4-3.1** Provision shall be made for manual cutoff of all standard light and power circuits from a remote station located a minimum of ten feet from the nearest opening in the affected building. It shall also be arranged so that the above circuits of the manufacturing areas can be cut off by switches located at one or more central points such as offices, watchman's booth or other appropriate location. In all manufacturing buildings provision shall be made for the automatic cut-in of a low voltage (24 to 32 volt) independent emergency lighting system to provide a minimum of one foot candle in aisles leading to emergency exits in event of the loss of standard lighting power. This is the emergency lighting covered in NFPA No. 101–1973, *Life Safety Code*. All exit lights in manufacturing buildings shall be provided with emergency low voltage auxiliary lighting.

All electrical equipment shall be inspected and cleaned at least once each year and at more frequent regular intervals if experience so dictates. Where flashlights or storage battery lamps are used, they shall be a type approved for these conditions of application.

Chapter 5. Control of Static Electricity

5-1 Grounding of Machinery to Remove Static Electricity.

*5-1.1 Grounding of machinery to remove static electricity in dust-making and collecting is vital for safety. It shall be thoroughly done according to *Recommended Practice on Static Electricity*, NFPA No. 77–1972, and the certain additional precautions described in 9-1.2 of this standard. This shall be applicable to stamp mortars and other mills, fans and conveyors in all parts of the plant where dust is made or handled, for finishing and polishing equipment, filters, driers, dust screens, fixed storage bins, and dust collection or transport systems of all types.

Chapter 6. Prevention of Dust Accumulations

6-1 Cleaning Methods and Systems.

6-1.1 Dust shall not be permitted to accumulate. Good housekeeping is a factor of utmost importance. Spills from the charging and discharging of dust-making machines and from any other source shall be removed at once. As much of this material as possible shall be removed using conductive nonsparking scoops and soft brooms or brushes having bristles of natural fibers. Final cleanup may be accomplished using a vacuum cleaning system. Vacuum cleaning systems shall be used only for the removal of dust accumulation too small and too dispersed to be thoroughly removed with brushes by hand.

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 building when the suction lines are provided with blowout relief vents and flash-back valves as outlined in 3-3.

Portable vacuum cleaners may be used if they are approved for use in this application. Standard industrial vacuum cleaners are unsafe for this purpose. If vacuum cleaners or vacuum cleaning systems are employed they shall be effectively grounded. The electrical system, if located in the dust-producing building or in a location where dust can accumulate shall be suitable for Class II, Group E atmospheres. Vacuum cleaner hoses shall be fully conductive and nozzles or fittings shall be made of conductive, non-

sparking material. Care shall be exercised to avoid sucking water into the vacuum cleaning pickup nozzle to avoid the caking of damp aluminum powder in the hose or the dust removal system.

6-1.2 In manufacturing areas the use of water for cleaning shall be prohibited, except in those special instances where it has been ascertained by competent technical personnel to be the safest method to clean the area in the shortest possible exposure time and when it is done with the full knowledge and approval of the operating management. This procedure shall be used only when adequate ventilation, normal or forced, is available to maintain the hydrogen content safely below the lower explosion limit. Complete drainage of all water and powder to a safe, remote area must be attainable.

6-2 Cleaning Frequency.

6-2.1 Competent supervision and periodic cleaning shall always be maintained. Supervisors shall be alert to prevent the accumulation of excessive dust on any portions of buildings or machinery which are not regularly cleaned in daily operations. Regular periodic cleaning, with all machinery idle and power off, shall be carried out as frequently as local conditions require to maintain safety, but in any case, shall be inspected at least once a week and cleaned if the unit has been in operation during that period.

6-3 Location of Discharge Receptacles of Dust Collectors.

***6-3.1** Dust removed from the workroom through a fixed vacuum cleaning system shall be discharged into a suitable receptacle or collector located outside the building.

6-4 Fans and Other Air Moving Equipment.

6-4.1 Fans and other equipment for moving the air shall be so located that the entrance of dust is minimized. Where this is not possible, they may be enclosed in an enclosure designed to resist an internal pressure of 200 pounds per square inch suddenly applied if also provided with an explosion vent system to the outside of adequate strength, size and capacity. Fans shall be provided with ball or roller bearings. When used for pneumatic conveying of dust from a machine or group of machines, they shall be electrically interlocked with the power supply for such machines so that, in case the fan stops, the machine will stop producing dust.

Chapter 7. Prevention of Ignition of Light Metal Powder

7-1 General Precautions.

*7-1.1 In the powder handling or manufacturing buildings and in the operation of the dust conveying systems every precaution shall be taken to avoid the production of sparks from static electricity, electrical faults, or sparks produced by impact, such as that of iron or steel articles or stones upon each other or upon concrete. The leakage of water in or into any building where it can come into contact with any light metal powder shall be prevented to avoid consequent spontaneous heating and ignition therefrom. The electrical heating to a high temperature of any wire or resistance element in a dusty or dust-producing building and the development of serious local heating in machinery due to friction shall likewise be prevented. All electrical components including thermostats, relays, etc., shall either be suitable for use in Class II, Group E atmospheres (light metal dust ignitionproof) or shall be located outside the building in a dust-free area.

7-2 Removal of Tramp Metal and Other Foreign Objects.

7-2.1 Approved magnetic separators or approved pneumatic separators or screens shall be installed ahead of mills, stamps or pulverizers wherever there is any possibility of tramp metal or other foreign objects being introduced in the manufacturing operation. Electro magnets shall be suitable for use in Class II, Group E atmospheres, suitable for use in an atmosphere of light metal dust.

7-3 Bearings.

*7-3.1 Ball or roller-bearings properly sealed against dust shall be used generally for shafts and high speed equipment instead of plain bearings because of the difficulty of maintaining proper lubrication in plain bearings to guarantee against overheating. Where exposed bearings must be used, they shall be protected as well as possible to prevent the ingress of light metal dust.

7-3.2 Internal machine clearances shall be maintained to insure against internal rubbing or jamming.

7-4 High Temperature Warning.

7-4.1 Cyclone and bag collectors shall be equipped with suitable instruments for recording the temperature therein and with an over-temperature warning device. The temperature limit setting shall be selected to be safely below the damage point for the bags

employed or safely below the ignition temperature of the dust layer, or safely below the ignition temperature of the dust cloud, whichever is lower. Synthetic fibers which tend to accumulate high static charges shall not be used for bags. Polishing equipment shall also be provided with temperature recording and alarm equipment to indicate to the operators any tendency towards excessive heating. All such instruments shall give their indications and make their record at easily observed central locations so the men in responsible charge may receive warning and take action to remedy the hazardous conditions. All alarms and actuating equipment shall be suitable for use in Class II, Group E atmospheres or shall be located outside the building in a dust-free area.

7-5 Open Flames, Cutting and Welding Equipment, Powder-Operated Tools.

*7-5.1 No cutting or welding, soldering, or brazing equipment employing open flames or electric cutting or welding shall be permitted within the building housing the powder producing or handling machinery during operation. If it becomes absolutely necessary to use such equipment for making repairs, all machinery in the room or section of the building where the repairs are to be made shall be shut down and the entire room or section with its machinery shall be thoroughly cleaned to remove all accumulations of light metal powder. Attention is called to the hazardous conditions that may exist either inside or outside the plant if cutting torches are used in dismantling dust collectors or powder producing machinery before all dust accumulations have been removed.

7-5.2 Powder Operated Tools. Gun-type tools using powder or cartridges for driving pegs or pins into concrete, brick, steel, etc. shall not be used where flammable dust or dust clouds are present. When the use of this type equipment becomes necessary, all dust-producing machinery in the area shall be shut down; all equipment, floors and walls shall be carefully cleaned, and all dust accumulations shall be removed. A careful check shall be made to be sure that no cartridges or charges are left on the premises where they could enter equipment or be accidentally discharged after operation of the dust-producing or handling machinery is resumed.

7-6 Spark-Producing Tools.

*7-6.1 Aluminum, copper or bronze metal tools, including shovels and scoops and not iron or other spark-producing tools, shall be used in any dust-making building except when that part of the plant is stopped and then only after thorough removal of dust accumulation. This rule shall also be followed in dismantling, either inside or outside, any discarded powder producing, handling,

or collecting equipment that may contain dust accumulations. Nonsparking tools or other hard objects shall not be allowed to strike any other hard surface in a dusty atmosphere because the energy so dissipated, if applied to only a few grains of powder, can raise the powder temperature to the ignition point. The stipulations of this Section do not apply to rooms in which metal is melted for the purpose of atomization.

7-7 Heating and Drying.

7-7.1 Heating and drying shall be done only by hot air. The air may be heated by steam or hot water coils which shall be located in a dust-free area adjacent to the room or building. Fans or blowers, also located in a dust-free location may be used to introduce the heated air. They should obtain their air supply from outside or from another dust-free source. Extreme care must be taken in design of these systems to insure that the moving air does not disturb dust accumulations to cause the dust to become air borne. Makeup air shall have a dew point sufficiently low to insure that no free moisture can condense at any point in contact with light metal dust. The stipulations in this Section shall not apply to rooms in which metal is melted for the purpose of atomization.

7-8 Sweepings.

7-8.1 Powder or dust sweepings and other materials swept from the floor, machines or other locations shall be carefully screened to remove foreign material if it is to be returned to any machine for further fabrication.

7-9 Starting Machinery after Shutdown.

7-9.1 All machines shall be thoroughly cleaned and shall be absolutely dry before they are charged with metal and placed in operation.

Chapter 8. Light Metal Powder Storage

8-1 Packing and Storage.

8-1.1 The light metal powder product, the conveyance of which is discussed in Section 3-2 and the collection of which is to be in a separate building, shall be packed into steel drums or other closed containers acceptable by DOT for shipment as soon as possible. These containers shall be tightly sealed and shall be stored in a dry location until they are ready to be shipped from the plant or repacked.

Chapter 9. Wet Milling of Light Metal Powder

9-1 Prevention of Ignition.

9-1.1 Spontaneous Heating. When light metal is milled or otherwise comminuted in the presence of a liquid which is inert chemically to the metal, the air-dust explosion hazard is eliminated. When the resulting product is subsequently exposed to air such as in filtering or drying, any unoxidized new surface produced during comminution will react and may generate sufficient heat to cause spontaneous ignition. To prevent this, it is imperative to have a controlled amount of oxygen present in the milling or other comminuting operation, and in slurries ahead of filters and blenders, to at all times oxidize the new surface as it is formed. The addition of a milling agent, such as stearic acid, does not eliminate the necessity for maintaining an adequate supply of oxygen to prevent the subsequent spontaneous ignition hazard. During milling, where fresh surface is being developed rapidly, the oxygen content shall be maintained at no less than 8 percent. For light metal being slurried in tanks or being processed in blenders or other equipment where new surfaces are not being developed rapidly, the oxygen content shall be no less than 4 percent. The dew point of this controlled oxygen atmosphere shall be maintained substantially below that which could result in condensation of water.

9-1.2 Static Sparks. Mill bearings shall be grounded across the lubricating film by the use of current collector brushes to provide for continuous low resistance grounding from the mill.

9-1.3 Flammable Vapors. Adequate ventilation, forced or otherwise, shall be maintained in all rooms handling solvents to reduce vapor hazards from accidental spillage.

9-1.4 Electrical grounding for removal of static charges shall include contact across bearing lubricating films by the use of current collector brushes or jumpers. All alarms and equipment shall be in accordance with the appropriate provisions of the *National Electrical Code*, NFPA No. 70–1974, or shall be located outside the building in a dust and vapor-free location.

9-1.5 Slurry or solvent pumps shall be installed with proper controls to make sure that they will be shut down if they run dry.

Chapter 10. Fire Fighting Methods

10-1 Dry Powders.

10-1.1 Inasmuch as it is virtually impossible to extinguish a massive fire in a dry light metal powder, the problem resolves itself into the control of fires in the incipient stage.

10-1.2 An incipient fire shall be ringed with a dam of dry sand, dry inert granular material or powder, or approved proprietary dry material during the application of which extreme care shall be exercised to avoid any disturbance of the light metal powder which could cause any of the powder to dust or become air borne. Even a minor dust cloud can explode with violence. The dry material shall be carefully applied with a nonsparking metal scoop or shovel. Care shall be exercised to eliminate drafts by shutting off fans and machinery and by closing doors and windows.

10-1.3 A properly ringed fire will produce a hard crust of oxide which will ultimately exclude enough oxygen to cause self-extinguishment. It is usual practice to leave the room, close the door and seal it with sand, and wait until combustion stops and the mass is cooled down.

10-1.4 Areas where dry light metal powders are produced or processed shall not have fire extinguishers rated for Class A, B, or C fires. An ample and readily available supply of dry extinguishing material shall be provided and suitable application tools shall be kept in the same location. The dry extinguishing material shall be so stored that it will remain dry and clean.

10-1.5 The direct application of water onto burning metal is dangerous to personnel.

10-1.6 To control a magnesium powder fire it is permissible to use dry magnesium foundry flux. After the isolating dam has been placed it is permissible to carefully place flux on the burning area provided extreme care is exercised to avoid the disturbance of the surface of the burning dust which could result in the creation of a dust cloud.

10-2 Solvent Wetted Powders.

10-2.1 Milling of fine light metal powders with combustible solvents is practiced principally in the production of aluminum leaf powders. During processing it is handled as a slurry. Some of the product is marketed as a paste while other portions are filtered, dried, often subsequently polished, and sold as dry flake powder. The solvents employed are generally in the family of moderately high flash point naphthas.

10-2.2 A fire which occurs while the material is a slurry (a practical value is approximately 50 percent organic solvent) is primarily a solvent fire and can be fought using extinguishing materials rated for Class B fires. The major producers employ fixed extinguishing systems using carbon dioxide or foam. Some first-aid extinguishers rated for Class B fires are provided in these areas.

10-2.3 A fire in filter cake, wetted but semi-dry material, or after the solvent has burned to less than the practical 50 percent value, tends to incur the hazards of a dry powder fire and shall be treated as such. Under these conditions the Class B fire extinguishing equipment shall not be used. Attention shall be directed to the fact than an explosion of semi-wetted material can project the sticky substance on the clothes of the fire fighter. There it is a sticky, non-removable, intensely burning substance, the result of which is usually a fatality.

10-2.4 Carbon dioxide, when employed, may be used to extinguish an aluminum fire. It may extinguish the fire but because of high localized heat or spontaneous heating it may reignite. To avoid this, the residual material shall be immediately covered with dry sand or other approved dry extinguishing material to exclude air, and the mass shall be allowed to cool until it reaches ambient temperature. When it has cooled and it is established 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 of not more than three gallons in a five-gallon container.

10-2.5 Carbon dioxide shall not be used on a fire which involves magnesium in any form.

10-2.6 Water shall only be used on a solvent-metal powder fire as a last resort when other methods of control have failed and when the fire shows evidence of going out of control. In this situation only low velocity spray or fog nozzles can be employed to provide a large volume of water particles to cool the area down. Extreme caution must be exercised to avoid the creation of an explosive dust cloud. Once water is used, its use shall be continued until the fire is extinguished or until the area becomes untenable. After extinguishment the area shall be immediately cleaned of all wetted powder, paste, or slurry. Good ventilation shall be provided during cleanup to avoid hydrogen concentrations resulting from the exothermic reaction of light metal powders with water. Suitable drainage provisions to a safe area away from manufacturing buildings shall be provided.

10-2.7 Sprinklers may be used in areas where solvents are employed or where light metal powders are stored in sealed metal

containers. They shall be of the preaction type or the on-off type. Their selection, design, and installation shall be made only with the guidance of experts who have knowledge of the specialized hazards of the particular light metal powder involved. Attention shall be given to employee training and organizational planning to insure safe and proper planned evacuation of the sprinklered area within the time limits of the system operation.

10-3 Fire Fighting Organization.

10-3.1 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.

10-3.2 Only trained personnel shall be permitted to engage in fire control activity. All others shall be evacuated from the area.

10-3.3 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. The training shall include all possible contingencies.

10-3.4 Professional or volunteer fire fighters from the outside community cannot be expected to be trained for the specific fire and life hazards entailed in light metal powder manufacture. If, in the event of a fire emergency, they are admitted to the property, their activity shall be directed by the on-site ranking officer of the trained plant fire fighters. This is in the interest of their own safety.

Chapter 11. Safety Provisions

11-1 Protective Clothing for Workmen.

11-1.1 Outer clothing shall be clean, fire resistant, nonstatic-generating, and it shall be designed to be easily removable. Tightly woven smooth fabrics, treated if necessary with fire retardant chemicals shall be used. Metallic fasteners shall be avoided where possible. These work clothes shall have no external pockets and the trousers shall have no cuffs. Safety shoes having soles which are resistant to embedding particles, and resistant to petroleum solvents if such exposure exists, shall be used. Soles and heels shall be attached by sewing or by using pegs. Safety toe caps must be completely covered with a scuff-resistant material. The use of nails, metal cleats or plates in soles and heels is prohibited. Safety shoes shall have a static conductive sole and heel. These shall be worn by all except persons who are required to work on electrical circuits or electrical equipment.

11-2 Smoking and Matches.

11-2.1 Smoking materials, matches, and lighters are forbidden except in the official "change house" at the entrance. They shall not be carried or used by employees or visitors about the premises adjacent to or in any building in which explosive dust is produced or loaded for shipment. Employees may bring such items in their street clothes provided that they remain in the "change house." The "change house" building shall be of fire resistive construction, shall be accessible only from its single entrance, and shall be located at or near the entrance to the premises.

Maintenance workers and furnace operators shall be furnished such safe ignition tools as their duties require. These will generally be the flint and file type for use in lighting torches or furnace burners under approved conditions.

11-3 Employee Instruction.

11-3.1 All employees in the light metal powder or paste manufacturing plant shall be carefully and thoroughly instructed by their supervisor regarding the hazards in their working environment and their behavior and procedure in case of fire or explosion.

They shall be shown the location of electrical switches and alarms and first aid and safety equipment. All employees shall be taught the permissible methods for controlling incipient paste fires and permissible methods used in the isolation of light metal powder fires. The hazards entailed in raising a dust cloud and the danger of applying liquids on an incipient fire of light metal dust shall be clearly explained.

11-4 Periodic Inspection.

11-4.1 Strict discipline and scrupulous housekeeping are essential at all times. A thorough systematic inspection shall be made at regular intervals not to exceed one month. Two or more competent persons shall make each inspection and the record of all their findings and recommendations shall be permanently recorded in the principal plant office. The inspection shall include general safety precautions, fire fighting equipment, first aid equipment, housekeeping effectiveness, electrical and mechanical equipment, and procedures. Indicating and recording instruments and alarm devices shall be checked daily and such records shall be kept. Instruments shall be regularly calibrated at intervals not to exceed six months.

11-5 Deluge Showers.

11-5.1 Deluge showers actuated by a hinged floor valve shall be installed at strategic points immediately outside of critical working areas to immediately douse any employee's clothing fire.

Appendix A

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

A-2-4.1.5 Electrically Conducting Floors: Electrically conducting floor material is often employed although it is recognized that it is difficult to maintain conductance over a period of time using materials now available. Careful examination of the details of this standard will disclose the logic of the employment of conducting floor materials.

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 to prevent the accumulation of dangerous electrostatic charges.

The maximum resistance of the conductive floor is usually less than 1,000,000 ohms, as measured between two electrodes placed three feet apart at any points on the floor.

The minimum resistance of the conductive floor will be more than 25,000 ohms, as measured between a ground connection and an electrode placed at any location on the floor. This minimum resistance value is used to provide protection for personnel against the hazard of electrical shocks.

Resistance values are customarily checked at regular intervals.

The following equipment and methods are accepted practice:

(1) Each electrode will weigh 5 pounds and will have a dry, flat, circular contact area 2½ inches in diameter, which will consist of a surface of aluminum foil 0.00005 to 0.001 inches thick, backed with a layer of rubber ¼ inch thick and measuring 40 to 60 durometer hardness as determined by a Shore Type A Durometer or equivalent.*

(2) Resistance may be measured with a suitably calibrated ohmmeter, which can be expected to operate on a nominal open circuit output voltage of 500 volts d.c. and a short circuit of 2.5 to 10 milliamperes (showing units of resistance).

(3) Measurements** may be made at five or more locations in each room and the results averaged.

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*American Society for Testing and Materials Method of Test for Indentation of Rubber by Means of a Durometer, ASTM Designation D-2240–68, obtainable from ASTM, 1916 Race Street, Philadelphia, Pa. 19103.

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