Tentative
Code for Explosion and Fire Protection
in
Plants Producing or Handling
Magnesium Powder or Dust

1942

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The Committee on Dust Explosion Hazards, at the 1942 Annual Meeting of the N.F.P.A., presented a Code for Explosion and Fire Protection in Plants Producing or Handling Magnesium Powder or Dust. This was referred to the Board of Directors for tentative adoption. After the addition of a second part on dust collection and the revision of Part I, the Code was submitted to the June 1942 meeting of the Board of Directors and was tentatively adopted.

This Code will be further considered by the Committee, and may be further revised before final adoption by the National Fire Protection Association. Any suggestions relative to changes in the Code should be filed with the Secretary of the Committee.

CODE FOR EXPLOSION AND FIRE PROTECTION IN PLANTS PRODUCING OR HANDLING MAGNESIUM POWDER OR DUST

Definitions:

The following terms are used in this code as defined below:

"Magnesium powder," fine magnesium, 30 mesh or finer, a product specially prepared in equipment designed or installed for the purpose.

"Magnesium dust," fine magnesium considered as a waste product in grinding or otherwise preparing magnesium parts.

"Shall" is intended to indicate requirements.

"Should" is intended to indicate recommendations or that which is advised but not required.

"Approved" refers to approval by the authority having jurisdiction in the enforcement of regulations.

Introduction:

Unusual explosion and fire hazards are present in plants producing or handling magnesium powder and in plants producing dust, shavings, or chips in connection with the sawing, grinding, machining, or buffing of castings or stampings made from magnesium or its alloys. Magnesium in the form of powder, shavings, chips, or dust can be ignited readily by a spark, flame, or friction sufficient to raise the temperature to about 900° F.

Magnesium powder or dust can be ignited readily and when mixed with air and ignited it will explode violently. In laboratory tests the pressure measured in magnesium dust explosions is nearly double the pressure obtained with aluminum or starch under similar conditions. The maximum rate of pressure rise in explosions of magnesium powder at concentrations of 500 milligrams per liter (500 ounces per 1,000 cubic feet) as determined in a Clement-Frazer test bomb is 788 pounds per square inch per second. This means that magnesium dust explosions are capable of causing severe structural damage to buildings and equipment involved, and emphasizes the importance of adopting all possible protective measures.

Burning magnesium produces a temperature of about 3000° F. and cannot be extinguished by the application of water, carbon dioxide, foam, carbon tetrachloride, or other common fire extinguishing agents. Application of these agents may intensify the burning or cause violent explosions.

The purpose of this code is to make available to plant operators precautions which can be taken and safe practices which should be followed in guarding against magnesium fire and explosion hazards. This code consists of two parts: Part I deals with the production and handling of magnesium powder. Part II deals with the collection, removal and disposal of magnesium dust.

PART I

MAGNESIUM POWDER PLANTS

Section 1. Location of Plants.

1-101. At the present time no practical method of providing 100 percent protection against ignitions and explosions during the manufacture of mag-

nesium powder is known. Accordingly, it is recommended that plants engaged in magnesium powder production be located in sparsely settled sections where sufficient space is available to permit location of the buildings in which the grinding, screening, collecting, and packaging equipment is installed, at least 500 feet distant from occupied buildings other than those which are a part of the plant.

1-102. The plant should not be located less than 100 feet from a main highway or transportation line.

1-103. The entire property should be surrounded with a high, strong fence designed to prevent unauthorized access to the plant or traversing of the grounds.

1-104. Gates or entrances to the property should be guarded.

Section 2. Construction and Location of Buildings

1-201. All buildings comprising a magnesium powder producing plant shall have walls of the fire-resistive type with only noncombustible materials used in construction and fittings.

1-202. Separate rooms or separate buildings shall be provided for each manufacturing operation such as cutting, grinding, screening and packaging. If separate rooms in one building are used the rooms shall have reinforced masonry division walls of 8 hour fire retardant rating extended as parapets 2 feet above the roof. Where separate buildings are used and two buildings face each other and both facing walls contain windows or other openings, the buildings shall have not less than 50 feet of clear space between them. Where only one facing wall has windows or openings and the other wall is reinforced masonry of 8 hour fire retardant rating, the buildings shall have not less than 25 feet of clear space between them.

1-203. Buildings housing the magnesium powder producing or handling equipment shall be at least 100 feet from electric or steam power plants.

1-204. Buildings in which the cutting or grinding, screening, collecting, or packaging machines are located shall be constructed without basements and be not more than one story in height.

1-205. Each grinding mill or screen shall be installed in a separate room or compartment with at least two exterior walls. At least one exterior wall shall be equipped with explosion vents or explosion venting sash of adequate area and be of light construction. The walls opposite the ones equipped with explosion vents shall be of relatively heavy construction. Where only two exterior walls are provided, one shall be equipped with explosion vents and the other shall be of relatively heavy construction and equipped with an approved Class A self-closing fire door with positive latch. This door shall open outward and be the normal means of entrance and exit. There shall be no direct communication between rooms or buildings.

1-206. Covered or enclosed passageways may be provided for communication between buildings or the rooms or compartments housing individual machines if such passageways are specially designed to prevent the propagation of fire or explosion from one unit to another. Such passageways shall be of light construction designed to release internal pressure quickly. Entrance to rooms shall be at right angles to the direction of travel through the passageway and all connections to the passageway shall be protected by approved Class A self-closing swinging fire doors. An opening from one room to the passageway shall not be directly opposite the opening from another room to the passageway.

1-207. At least two exits shall be provided from each screening and grinding room at widely separated locations. The exit in the light venting wall may be a panel or light door which shall be operable from the inside only.

1-208. Buildings shall be designed so that all horizontal ledges or surfaces above the floor level are eliminated as far as practical.

1-209. Floors shall be constructed of material which will prevent the production of metallic or static sparks or be covered with a nonsparking composition.

1-210. Floors shall be smooth with the junction of floor and walls free from cracks or other dust catchers. Fillets at floor and wall junctures are advisable.

1-211. All interior walls shall be made as smooth as possible to prevent the retention of dust on their surfaces. Coating of the walls with enamel or other material to produce a surface which will prevent the adherence of dust is recommended.

1-212. Roofs of buildings shall be as light as practical and arranged so that they will be easily blown off by an internal explosion. Piping or other equipment should not be supported by the roof deck but secured only to structural members not likely to be damaged by an explosion.

1-213. Roofs shall be constructed and maintained in a tight condition to prevent leakage.

1-214. Windows shall be large in area to provide maximum lighting and to provide a vent for the release of pressure in case of an explosion. A venting ratio of not less than 1 square foot for each 50 cubic feet of volume is recommended. Windows or sections of windows which open should be hinged at the top and be of an explosion venting type with catches designed to release on the application of pressure from within. Fixed glass should be scored on the outside with a glass cutter to reduce the resistance of the glass to pressure from within.

Section 3. Making and Handling Magnesium Powder

NOTE: *Several different methods of producing magnesium powder are now in use and new systems are being tried but comparable data on explosion hazards during operation are not available. Explosions have occurred where attempts were made to expedite production by conveying magnesium powder between mills, screens, collectors and packers by means of air streams in metal ducts. The following recommendations are based on past experiences and information now available on manufacturing methods.*

1-301. All magnesium powder should be produced and handled by the batch system as used in the manufacture of explosives.

1-302. Do not attempt to convey magnesium powder even for short distances by air stream.

1-303. Hand trucks, carts, and drums should be used for transporting both the magnesium in the process of being reduced to powder and the finished product itself.

1-304. Carts, trucks, boxes, or drums used during manufacture as containers for magnesium powder should be constructed of nonsparking metal or be lined with nonsparking material, and have nonsparking tires on wheels or casters.

1-305. Shovels or scoops used in handling magnesium powder should be made of magnesium, aluminum, copper, or other nonsparking metal.

1-306. All mills used in grinding magnesium powder should be constructed of nonsparking metal or have the grinding compartment fitted with a sparkproof lining.

1-307. Grinding equipment used for the production of magnesium powder should not be used for any other grinding.

1-308. Special precautions should be taken to remove all foreign material from the magnesium entering the grinders.

1-309. All powder producing and handling machinery should be as dust-tight as possible to prevent the escape of powder into the air of the room in which it is located.

1-310. Automatic operation of mills and screens should be arranged with remote controls for starting and stopping the machinery.

1-311. Operators should be instructed to shut down machinery before entering screen room or pulverizing room. This precaution is not necessary in the cutting rooms.

1-312. Preferably only one and not more than two persons should enter the rooms or compartments to charge or unload the machines or perform cleaning or maintenance duties.

1-313. Magnesium powder should be handled and transported in bulk containers and not allowed to fall through chutes or spouts into open bins or hoppers where dangerous dust clouds may be created.

1-314. If practical, all enclosed equipment for the production and handling of magnesium powder should be provided with explosion relief vents to the outside of the building. These vents should be so constructed that there will be no loss of fine powder and designed to prevent the entrance of moisture.

1-315. To make explosion vents most effective, mills or other machines should be installed close to walls or windows to permit using the shortest possible vent duct.

Section 4. Electrical Wiring and Equipment

1-401. All electrical wiring and equipment in buildings where magnesium powder is regularly produced or handled, and in other sections of the plant where magnesium powder or dust may be present, shall be in accordance with the requirements for Class II locations (Group E atmospheres containing metal dust), Article 500 of the 1940 edition of the National Electric Code and subsequent revisions thereof.

1-402. Provision should be made for remote control of the electrical circuits, so that the current for light and power in any dust making building may be cut off by switches outside of the building at a distance of at least 4 feet from the nearest doorway. It should also be arranged so that the power of the whole plant can be cut off by switches located at one or more central points, such as the office, watchman's booth, etc.

1-403. All electrical equipment shall be inspected and cleaned periodically.

1-404. Where flashlights or storage battery lamps are used, they should be of a type approved for the purpose.

1-405. Installation of transformers and capacitors shall be outside and at a safe distance from magnesium powder production buildings as now required in the National Electrical Code for plants producing aluminum bronze powder.

1-406. Electric lights for use in magnesium powder plants must be of a type which will operate continuously with all exposed parts of the lamp and fixture at a temperature well below the ignition temperature of the powder.

1-407. All electric lines in the vicinity of the powder buildings shall be underground. If overhead, they should be protected against arcing caused by lightning.

Section 5. Control of Static Electricity

1-501. Preventing the formation or accumulation of static electricity is essential for safety in magnesium powder plants. Grounding of all buildings, machines and equipment is necessary from the standpoint of static control as well as for lightning protection. Grounding shall be in accordance with the recommendations of the N.F.P.A. Committee on Static Electricity.

1-502. Magnesium powder should not be allowed to slide over metal aprons or chutes unless they are grounded to prevent static charges accumulating. Nonmetallic or insulated chutes may be dangerous.

1-503. To minimize the accumulating of static electricity, the moisture content of the atmosphere in screen rooms and pulverizing rooms should be not less than 4 grains per cubic foot; approximately 50 percent relative humidity at 70° F. Provision should be made to prevent any condensation drip reaching the magnesium powder.

Section 6. Lightning Protection

1-601. A lightning conductor system should be provided around or upon the powder producing and handling section of the plant, of sufficient size and capacity to protect fully all buildings in the area from lightning.

Section 7. Preventing Ignitions of Magnesium Powder

1-701. It has not been found practical to use inert gas to prevent ignition during the commercial production or handling of magnesium powder. The commonly used gases are not effective. Particular attention must therefore be given to the elimination of all possible sources of ignition in magnesium powder plants. In addition to the recommendations and requirements under previous headings, there are a number of general precautions to adopt.

1-702. No open flames, electric or gas, cutting or welding equipment shall be permitted within the buildings housing the powder producing or handling machinery. If it becomes absolutely necessary to use such equipment inside the building for making repairs, the plant shall be shut down and the section in which the repairs are to be made shall be thoroughly cleaned to remove all accumulations of magnesium powder.

1-703. Hot air heating should not be employed. The stirring action of a forced hot air heating system might easily be dangerous as it would keep fine dust in suspension. Heating by easily cleaned steam or hot water coils is entirely satisfactory and safe.

1-704. Only nonsparking tools shall be used in making repairs or adjustments on magnesium powder producing or handling equipment.

1-705. Grinding wheels shall not be used where magnesium powder is present.

1-706. Grinding wheels used for grinding magnesium, or wheels coated with magnesium powder should not be used for grinding other metals.

Section 8. Storage of Magnesium Powder

1-801. The principal precaution to observe in storing magnesium powder is to avoid storage in open bins or other open containers and limit the storage in any one area to the smallest possible amount.

1-802. Magnesium powder must be kept dry.

1-803. Magnesium powder should be protected against any form of heat capable of raising the temperature to the ignition point.

1-804. Magnesium in the process of being manufactured into powder should be kept in covered containers to protect it against possible ignition by sparks.

1-805. The finished product should be packed in cans, drums, or moisture-proof containers which can be closed to prevent accidental spilling during handling.

1-806. All containers in which magnesium is stored should be plainly labeled.

1-807. Special types of containers have been approved for use in shipping magnesium by common carrier.

Section 9. Fire Protection for Magnesium Powder Plants

NOTE: *Special attention is being given to the development of fire extinguishing equipment suitable for use in magnesium powder plants. The recommendations in this section are based on information at present available to the committee. Revisions will be made as promptly as possible in accordance with operating experience and data furnished to the committee. Comments by N.F.P.A. members and plant operators are solicited.*

1-901. Fire protection for magnesium plants is largely a fire prevention problem. Small magnesium fires can be extinguished but no satisfactory method of combating large fires is known. It is essential, therefore, that magnesium fires be detected in the incipient stage and the proper extinguishing procedure followed.

1-902. Do not use water, vaporizing liquid, foam, dry chemical, or carbon dioxide type extinguishers. These extinguishing agents when applied to a magnesium fire may stimulate the burning and may cause an explosion. To avoid the possibility of extinguishers of the types mentioned being used by persons unfamiliar with the hazard, it is recommended that all such extinguishers be excluded from sections of the plant in which magnesium fires may occur. Members of nearby fire departments who may be called to the plant should be advised of the possible hazards incident to the use of such extinguishers on magnesium powder fires.

1-903. Sprinkler systems shall not be installed in buildings where magnesium powder constitutes the principal fire hazard.

1-904. Violent disturbance of a magnesium powder fire by the application of extinguishing agents, drafts of air, or movement of the surface on which the fire is burning should be avoided. Magnesium powder thrown into the air under such conditions will explode violently.

1-905. Small fires in dry magnesium can be checked by carefully spreading graphite, dry sand, dry salt, clean cast iron borings, talc, slag, or certain other materials on and around the fire, but if air reaches the fire through this covering the magnesium will continue to burn and the mass will remain hot for a long time.

1-906. Coal-tar pitch of the type known as "very hard" with a softening point of approximately 300° F. has been found to be a satisfactory extinguishing agent for magnesium fires in tests made with quantities of burning magnesium ranging from 1 to 10 pounds. When spread over a hot magnesium fire the pitch softens and seals the burning magnesium with an airtight covering which smothers the flames. Because pitch is combustible and fine particles may ignite readily, it is important that only granulated pitch, through 6 mesh and on 40 mesh U. S. sieves, or pitch in flake or other form screened to remove the fines under 40 mesh, be used as an extinguishing agent. On tight noncombustible surfaces magnesium fires of moderate size, even when quite active, may be extinguished by carefully applying pitch of the type and size specified and allowing the pitch to cool and partially harden without disturbing the fire. The pitch should be stored in a cool place to prevent softening and caking.

1-907. Other effective extinguishing agents for magnesium fires are generally marketed as proprietary compounds. These are generally in powder or paste form and are applied by means of scoops, shovels, tubes or containers held over the fire. Their use is generally limited to fires of moderate size which can be approached closely enough to permit application of the extinguishing agent by hand.

1-908. Special groups of employees should be trained in fire-fighting operations by conducting tests and demonstrations with the extinguishing agents on fires built at a safe distance from the plant.

1-909. Extinguishing a magnesium fire may be a very dangerous undertaking because of the possibility of an explosion occurring when the burning powder is disturbed. For this reason many operators prefer to seal a magnesium fire in the room or compartment in which it originates and allow it to burn itself out. Sand or other noncombustible material can be used to seal openings around the fire doors at entrances to these rooms.

Section 10. Safety Precautions

1-1001. As in all other plants where fire and explosion hazards exist, good housekeeping is essential and all possible precautions should be taken to insure safe operation of the plant.

1-1002. Employees should be carefully instructed in their duties.

1-1003. All employees should be advised of the fire and explosion hazard and instructed in the procedure to follow in case of emergencies.

1-1004. Rules and regulations for safe operating procedure should be conspicuously posted throughout the plant.

1-1005. Thorough inspections of the plant should be made at frequent and regular intervals by competent persons to see that no powder or dust has been allowed to accumulate around the machines; that no excessive amounts of powder are stored in any one area; that all equipment is in perfect operating condition and that proper protection facilities are available. Records of such inspections should be kept on file.

1-1006. Cleanliness is a factor of utmost importance. Loose or spilled powder shall not be allowed to accumulate. Each time any of the powder-making machines are charged or discharged all dust and other material spilled on open surfaces of the machinery or on the floor of the room shall be promptly and thoroughly removed. Soft push brooms and nonsparking scoops shall be used for such cleaning.

1-1007. Competent supervision and periodic cleaning should always be maintained and the foreman should 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, should be carried out as often as local conditions require it to maintain safety, but in any case at least once a week.

1-1008. Smoking materials and matches shall be prohibited on the premises except in the official change-house at the entrance. They shall not be carried nor used by employees or visitors about the premises adjacent to or in any building in which explosive dust is made or loaded for shipment. This is not intended to preclude the bringing of tobacco by employees in their street clothes into the change- or wash-house. This building should be of fire-resistive construction, located at or near the entrance to the premises which should be surrounded by a fence. In this building the employees should leave their street clothes and put on the fire-resisting clothing without pockets. Nor does this provision preclude smoking in a recreational room in the change-house which may be provided by the company for the purpose, nor in the office. It is desirable that a fixed tobacco-lighter be furnished in such room to avoid accidental carrying of matches into the plant grounds and buildings.

1-1009. Special clothing for employees in magnesium powder producing plants is recommended. Employees' clothing should be kept clean and free from powder. Leather or other smooth clothing from which the dust can be brushed off readily may be worn. Smooth canvas or denim suits can be made fire-retardant. Wearing of woolen, silk, or fuzzy outer clothing should be prohibited. Shoes worn by employees or any one entering the powder buildings should have sewed soles and heels fastened with wooden pegs or copper nails. The wearing of steel toe or heel plates by powder mill employees should be prohibited.

PART II

COLLECTION AND DISPOSAL OF DUST FROM GRINDING, BUFFING AND SIMILAR DUST PRODUCING OPERATIONS IN THE HANDLING OF MAGNESIUM ALLOY CASTINGS

Section 1. Dust Collection

2-101. Dust shall be collected by means of suitable hoods or enclosures at each operation, such enclosures to be connected to a liquid precipitation type of separator, preferably oil, and the suction unit in such a way that the dust shall be converted to sludge without contact, in a dry state, with any high speed moving parts.

2-102. Connecting ducts or suction tubes shall be as small in diameter and as short as possible, and with no unnecessary bends. Ducts shall be carefully fabricated and assembled, with a smooth interior and with internal lap joints pointing in the direction of air flow, and without unused capped side outlets, pockets or other dead-end spaces which might allow an accumulation of dust.

2-103. Each machine shall be equipped with its individual dust separating unit, except that with multi-unit machines not more than two dust-producing units may be served by one separator unit. Not more than two portable dust-producing units in a single enclosure or stand may be served by one separator unit.

2-104. Power supply to machines shall be interlocked with (a) exhaust air flow and (b) liquid pressure level or flow of separators, in such a way that improper functioning of the dust removal and separator system will shut down the machine it serves.

Section 2. Cleaning

2-201. Systematic cleaning of entire area involved, including roof members, pipes, conduits, etc., should be conducted daily or as often as conditions warrant, (a) by use of soft brushes and nonsparking scoops and containers, or (b) by means of a fixed suction pipe and outlet vacuum cleaning system, provided the separator unit is of the liquid-precipitation type and is located outside the main building area, and provided also that the suction piping system is of standard mild steel pipe and standard recessed drainage fittings, with a check valve installed at each outlet. A rupture diaphragm must be provided in the piping at its connection to the inlet side of the separator in such a way that a possible explosion in the piping may be safely vented to atmosphere.

Section 3. Dust Disposal

2-301. Sludge from dust separators and vacuum cleaning unit precipitators should be removed at least daily or immediately following each clean-