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Indian Standard

CODE OF PRACTICE FOR FIRE SAFETY OF INDUSTRIAL BUILDINGS: ALUMINIUM/MAGNESIUM POWDER FACTORIES

(First Revision)

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CODE OF PRACTICE FOR FIRE SAFETY OF INDUSTRIAL BUILDINGS: ALUMINIUM/MAGNESIUM POWDER FACTORIES

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0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards on 7 June 1988, after the draft finalized by the Fire Safety Sectional Committee has been approved by the Civil Engineering Division Council.

0.2 The main causes of explosions and fires in production and/or storage of aluminium and magnesium powders are bad house keeping, congestion, improper electrical equipment, spark from foreign material in the stock, friction and static electricity. In order to prevent and reduce losses due to fires and explosions, it is necessary to plan carefully the layout of the buildings and provide adequate and suitable fire fighting equipment.

0.3 This standard was first published in 1967 covering aluminium power factories. Since then, the number of Indian Standards in regard to details of construction, fire safety and equipment have been formulated. This revision has, therefore, been prepared so as to keep details of construction and use of fire fighting equipment according to the latest codes. Since magnesium powder factories are also having similar type of hazard, the scope of this standard has now been enlarged to cover such types of factories as well.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard lays down the essential requirements for fire safety of factories in which powders of aluminium, magnesium and their alloys are manufactured and/or stored.

2. GENERAL

2.1 Ignition of aluminium, magnesium and allied powders in buildings free from the presence of any ostensible means of ignition may occur due to electrification of the particles, facilitated by the relatively low energy required. The metallic nature of aluminium and magnesium powders is not effective in extinguishing the potentials set up within a dust cloud since these powders behave as insulators. The risk of explosion shall, therefore, always be faced and precautions shall be taken in the design of the plant to confine its hazards.

3. LOCATION

3.1 To prevent and reduce possible damage from explosion or fire or from both to nearby and the community, the factory should have enough open space around it. It should be so located as to be easily accessible for fire fighting. The premises should be enclosed by a secure fencing or compound wall and guarded.

3.2 The factory buildings should at least be 100 m distant from a public building, dwelling, warehouse or manufacturing establishment.

3.3 The factory buildings should at least be 150 m away from a railway siding, yard or lines, preferably on the windward side of the tracks. If these tracks are serviced by diesel or electric locomotives, the distance may be reduced to 30 m.

3.4 The factory building should at least be 20 m away from high tension lines.

4. COMPOUNDS

4.1 The compounds should be of sufficient area to house all the buildings specified in **5.1** and to allow for future expansion and should be kept clear of all combustible material, such as grass, weeds and other vegetation.

4.2 The area should be such as to accommodate necessary pave or *pucca* roads in between the different buildings to allow free movement for fire fighting and rescue operations.

5. BUILDING CONSTRUCTION

5.1 There should be separate buildings for raw materials, store scratching and grinding, reduction by atomizing including melting, screening, collecting plant, and blending and finished product store. Each building should be further subdivided into smaller units, as necessary, by separating walls.

5.1.1 The separating walls should be of non-combustible material, and should have the same fire resistance as the walls of the main buildings in any case should and not be less than 400 mm thick.

5.1.2 No openings should be provided in these walls.

5.2 The minimum distance between any two buildings used for the manufacturing purposes should not be less than 15 m.

5.2.1 When the distance between any two buildings is less than 15 m, at least one of the facing walls should have no openings.

5.2.2 Buildings separated by not less than 15 m of space may communicate through enclosed passageways of non-combustible construction provided that such enclosed passageways are specially designed for the release of internal pressure and all the openings to such passageways are protected by fire-check doors conforming to IS : 3614 (Part 1)-1966* of 2 h rating.

5.3 Any or all of engine, transformer, electric generator or boiler buildings should be at least 30 m from the manufacturing process building.

5.4 Residential and office building should be at least 50 m from the nearest manufacturing process building.

5.5 Buildings wherein powders of aluminium, magnesium and their alloys are manufactured or packed should be of Type 1 construction as specified in IS : 1642-1988†. Roofs of such buildings should conform to the requirements of **5.12.**

5.6 Buildings used as godowns should be of Type 1 construction as specified in IS : 1642-1988†.

5.7 Building housing engine or transformer or both electric or steam power generator should be of Type 3 construction as specified in IS : 1642-1988†.

5.8 All buildings should be of single storey type with no basement and should be constructed of fire resisting materials throughout and the buildings should be so designed that every internal surface is readily accessible to facilitate cleaning. In all buildings, walls of rooms where metal dust may be produced and which are not of monolithic construction, all masonry joints should of thoroughly flushed with mortar and trowelled smooth so as to leave no interior or exterior voids for the infiltration and accumulation of the powders. Entry of water into the building and coming into contact with the powders should be prevented.

5.9 Flat surfaces, wide flanges to beams and girders and window ledges should be avoided, as far as possible, otherwise, they should be covered by a steeply sloping plaster filling. Covered ceilings and floor edges should be adopted to avoid dusty corners.

5.9.1 Tops of bins, hoppers and other equipment should have surface sloping at 60° with horizontal to enable shedding dust. Explosion vents should be provided.

5.9.2 Circular chutes and ducts should be preferred to square ones.

5.9.3 Sharp corners and dead ends in the ducts or conveyors should be avoided to prevent accumulation of dust.

5.9.4 Walls and ceilings should be painted with glossy and fire resistant paint to avoid accumulation of dust and to facilitate easy cleaning.

5.10 Floors and Plinth

5.10.1 Plinth of all buildings should be kept at least 60 cm above the surrounding ground level or the crown of the roadway and provided with a damp-proof course.

5.10.2 Plinth of godowns and warehouses should be kept at least 1 m above the adjoining ground level to facilitate direct loading and unloading to and from the wagons or trucks.

5.10.3 Floors of buildings where dust making operations are carried out, should be of concrete covered with material of non-sparking and non-combustible composition. If the flooring is conductive electrically, it should be properly earthed.

5.10.4 Floors of godowns and warehouse should be kept at least 30 cm above the sill level of the floor.

5.11 Doors and Windows

5.11.1 Doors should be of non-sparking metal and of self-closing fire-check type. Doors for venting should lead to the open sliding doors of self-closing doors with a strong spring device should not be used in the powder plant.

5.11.2 There should at least be two doors in each room and where possible, more than two doors should be provided.

*Specification for fire-check doors: Part 1 Plate metal covered and rolling type.

†Code of practice for fire safety of buildings (general) Details of construction (*first revision*).

5.11.3 There should be no other external windows or openings except those required for lighting and ventilation.

5.11.4 Where explosion risk is involved, windows should be fitted with 3 mm thick glass. They should be top hinged or pivoted so as to open outwards and should be provided with devices to prevent opening due to wind action but should be capable of opening if an explosion occurs. Wired glass should not be used.

5.11.5 Where fixed sash windows are used in powder plant building, light anchorage only should be used so that the whole windows blow out during an explosion.

5.11.6 The bottom of windows should be at least 2·2 m above the floor level to deflect the full force of an explosion above worker's heads.

5.11.7 Each room should have at least two separated exits to corridors or to the outside. All openings should open to the outside to enable the workmen to escape in the event of fire.

5.12 Roofs

5.12.1 Roofs should be directly supported from wall without any intermediate columns or posts. The roof covering should be as light as possible but should be fire resistant. If roofs are covered with corrugated iron sheets, they should be either galvanized or painted with aluminium paint, and cast iron or mild steel open grills should be inserted along the lower edges of the roof near the walls at intervals of 6 m to facilitate entry through the roof for fire fighting purposes. If underside of roof is to be painted, only non-flammable paint should be used.

5.12.2 Roofs should be leak-proof and no piping and other equipment should be supported from roofing.

5.12.3 Wherever roof is planned as a part of explosion venting methods, it should be of fragile material and should be fixed in such a way that the same can be blown away by an explosion.

5.12.4 At least 10 percent of the roof should be covered with fragile materials capable of giving way in case of explosions.

5.13 Ventilation and Venting

5.13.1 Where fixed sash windows and ventilators are used, sufficient number of exhaust fans should be employed.

5.13.2 Area of explosion vents should be at the rate of 1 m^2 for each 5 m^3 of the volume of the building. This area should be properly and evenly distributed in the whole building.

5.13.3 Windows, ventilators, skylights, etc. designed as part of the venting areas should have diagonally scored glass panels that can easily give way under an explosion

6. STORAGE AND PRECAUTIONS

6.1 Storage of powder should be in a separate building other than the powder making building.

6.2 The powder should be packed as soon as possible in non-sparking drums which should then be tightly sealed and stored in a dry place.

6.3 In no case should the powder be stored in open bins or gunny bags.

6.4 No other material should be stored along with powder as fire fighting methods for such materials are different from those involving metallic powders or dust. Moreover, such materials could serve as a source of ignition for the metallic powders.

6.5 There should be no leakage from roof, pipe lines, etc, into the storage area.

6.6 All machines should be suitably gauged that no temperature in the area rises beyond 35°C.

7. MACHINERY AND EQUIPMENT

7.1 All machinery and line shafts should be fitted with ball or roller bearings sleeves and they should be sealed against dust.

7.2 Machinery should be so installed, arranged and worked as to prevent, as far as possible, access of metallic powder to the moving parts of the machinery.

7.3 Powder grinding should be carried out in mills, each isolated by enclosure within a blast proof cubicle provided with an explosion vent. The doors should open outwards and should be interlocked with the drive to the mill with a time delay action so adjusted that the mill should cease rotating before the door can be opened.

7.4 Where aluminium/magnesium powder is produced by 'blowing', unit should be enclosed in a strong chamber preferably situated in the open. The discharge valve should be interlocked with the blowing mechanism to ensure that it cannot be opened when blowing is in progress Where a cyclone is installed to receive the discharge, it should be connected to a hopper through a valve which should be interlocked with the discharge valve from the hopper to ensure that the valves are not open simultaneously.

7.5 All machines should be thoroughly cleaned and be absolutely dry before they are charged with metal and placed in any machine for additional fabrication.

7.6 All machinery and equipment should be adequately earthed by permanent earth wires to prevent accumulation of static electricity.

7.7 Sparks caused by ferrous matter passing through cleaning, processing and grinding machines should be prevented by installing magnets or magnetic separators in the system.

7.8 Dust collecting system consisting of suitable hoods, enclosures, ducts, dust collectors, etc, should be installed. These should be of metal construction. Hoods should be so designed that the powder particles either fall or to projected into them in the direction of the air flow. The interior of the hoods and ducts should be smooth with internal lap joints pointing into the direction of the air-flow and having no dead end spaces which may allow accumulation of dust. Hand holes with metallic covers should be provided throughout the ducting at regular interval to facilitate cleaning.

7.9 All such ducting should be continuous and properly earthed.

7.10 The motors driving the dust producing machines should be electrically interlocked with the fan motors of the dust conveying system.

7.11 Dust collectors should be arranged to prevent contact of dust with high speed moving parts while still in the dry state. Grinding operation should not be served by same collectors as buffing and polishing operations. Dust from dry collectors and sludge from the wet collectors should be removed daily or more often as the conditions may require.

7.12 Sludge so removed should be transported in covered non-combustible containers of not over 25 kg each and should be disposed off by any of the following means:

a) Mixing with much larger volume of sand and discarding in a dump,

b) Dumping in an open pit which should be fenced or guarded from public access, and

c) Spreading over the ground in an isolated area fenced or guarded from public access where the sludge can oxidize.

7.13 Use of ducts or conveyors for conveying the magnesium/aluminium powder from place to place in a building or to an adjacent building should be prohibited. Such powder should be transported in specially designed containers of metal with tight fitting lids.

7.14 When aluminium/magnesium powder is conveyed pneumatically, the conveyor ducts should be of non-ferrous material. Pneumatic system should employ an inert gas mixture instead of air wherever the concentration of powder is within explosive range or likely to become so. Movable containers should be of non-ferrous, non-sparking material. Wheels and castors of such containers should be fitted with non-sparking tyres. When movable containers are used in the open, they should be provided with covers for protection from weather.

7.15 Conveyor ducts should be designed and installed to avoid condensation of moisture within the ducts and means should be provided to thoroughly dry out the ducts before putting into service after a period of idleness. Drying of ducts should be done thoroughly with warm dry air several hours before resuming operations. Wherever possible, ducts should be inclined to horizontal to facilitate cleaning, drying and draining.

7.16 Wherever possible, relief vents of sufficient area extending to the outside of the building should be provided in the ducts.

7.17 Wherever damage may result from the rupture of a duct, in case the relief vent does offer sufficient relief, the duct should be designed for a working pressure of at least 0·7 MN/m^2 ($\approx$7 kgf/cm^2).

7.18 Blades and housing of fans used either for dust collection system or conveyance of magnesium/aluminium powder should be of non-sparking material. The intercepting screen cloth filter should be properly grounded and the duct designed so as to prevent passage of dust into the fan. Whenever possible, fans into which dust may enter should be placed outside the dust making building.

7.19 All dust making machines and conveyors should be so constructed as to minimize escape of dust into the rooms and all such equipment should be properly earthed.

8. ELECTRICAL INSTALLATION

8.1 The electrical installation should be in accordance with IS : 1646-1982* and special attention should be given to the following:

a) All wiring should be carried out in heavy gauge screwed conduit;

b) All lighting fittings and switch gears should be of the enclosed type;

c) All electric motors should be flame-proof and dust-proof;

d) Provision should be made for remote control of the electrical circuits so that the current for lighting and power in any dust making building may be switched off by switches outside the building at a distance of 1·25 m from outside the nearest doorway. Provision should also be made for switching off the whole factory by switches located at one or more central points, such as the office and the watchmen's booth; and

*Code of practice for fire safety of building (general): Electrical installations (*first revision*).

e) All electric equipment should be inspected and cleaned periodically and maintained in good order.

9. ILLUMINATION

9.1 The factory should be fully illuminated as indicated below:

Open compounds	25 lux
Godowns	50 ,,
Grinding, packing and other work places	100 ,,

10. FIRE FIGHTING ARRANGEMENTS

10.1 Provision of first aid appliances and their maintenance should be in accordance with IS : 2190-1979*. All the workers should be trained and periodically practiced in the use of first aid fire fighting appliances placed near their place of work.

10.2 The factory should be equipped with a warning system for fire so that the warning is clearly audible throughout the factory and the compound. The appliance or appliances for giving such warning or means of operating the same should be located in conspicuous positions and should be painted fire red. All workers should be familiar with their location and method of operation.

10.3 All factories which do not have their own fire brigade or do not expect major fire fighting assistance from regular fire brigades within a short time, should make suitable fire fighting arrangements with the help of workers. Such factories should have at least one full time supervisory officer fully trained in fire fighting assisted by a few firemen for maintenance work. There should be an efficient hydrant system with the provision of hose boxes, hoses and branch-pipes (*see* IS : 9668-1980†). There should also be ample provision of special type of dry powders conforming to IS : 4861- 1984‡. Sufficient number of workers trained in the use of hydrant system and other extinguishing media should be available in each shift all the time. All these arrangements should be planned and executed in consultation with the fire experts.

10.4 Great care is required in dealing with fires involving burning metals or their powders. Provisions contained in **10.5** to **10.10** should be strictly followed.

10.5 Any mechanical agitation or disturbance of the burning powder or adjacent thereto should be avoided.

10.6 Water, steam or liquid spray of any kind should not be used for fire extinguishing. Such action may agitate or disturb the dust or the burning powder and may cause an explosion due to the reaction between water, steam or liquid spray and burning powder or dust.

10.7 Any extinguisher expelling water, carbon dioxide, foam, etc., should not be used for extinguishing fire in the operating plant. All fires involving metallic chips turnings, powders should be fought with fire extinguisher for metal fires (*see* IS : 11833-1986*).

10.8 The whole of the electric power in the effected building should be immediately cut off.

10.9 If the metallic powder is burning quietly in a place where it can be safely isolated, the same should be carefully ringed around but nor dropped on the burning powder, great care being taken to avoid fanning the dust into the air. The powder when burning quietly forms a crux which excludes and gradually extinguishes itself. As soon as the fire is isolated, the room should be closed, windows shut, the bottom of the doors sealed with sand and the fire allowed to burn itself out.

10.10 Close liaison should be maintained with the neighbouring fire brigades to ensure quick attendance in time of emergencies. The hazards involved in the use of water jets, carbon dioxide, foam or other liquids not allowed to deal with the fire involving metallic powders and also the special hazards relating to metallic dust should be explained to them.

11. HOUSE KEEPING

11.1 In buildings carrying out dusty operations or processes, accumulation and suspension of dust should be prevented. Vacuum sweeping system or soft push brooms may be employed. When vacuum cleaners are employed, bulk accumulation of powder and material should be removed by soft push brooms and non-sparking scoops before vacuum sweeping equipment is used. Bonded, non-conducting and non-sparking type hoses and nozzles for vacuum cleaning systems should be used; and the use of metallic fastener should be avoided wherever possible.

11.2 If there is a dust aspiration plant, sweep-up openings with closure flaps should be provided at floor level and connected to the aspiration plant.

11.3 The dust collected by a vacuum cleaning, brushing or from sweep-up openings or from both

*Code of practice for selection, installation and maintenance of portable first-aid fire extinguisher (*second revision*).

†Code of practice for provision and maintenance of water supplies for fire fighting.

‡Specification for dry powder for fighting fires in burning metals (*first revision*).

*Specification for dry powder fire extinguisher for metal fires.

should be discharged into a suitable receptable located outside the dust making plant. Each piece of group of such equipment should be surrounded with a tight, strong shield, preferably cylindrical, open at the top and closed at the bottom and designed to withstand an internal pressure of 1·5 MN/m^2 ($\approx$15 kgf/cm^2) so that if an explosion occurs in dust-collecting receptacles, its full force and flame will be diverted upward.

11.4 Regular periodic cleaning should be carried out on all buildings and machinery, with all machine idle and power out-off, as often as local conditions require, to maintain safety but in any case at least once every day (dust should not be allowed to accumulate in daily sweeping).

12. SAFETY PROVISIONS

12.1 Every boiler chimney in a factory compound should be fitted with an efficient spark arrestor and should be properly maintained.

12.2 No open flames, naked lights, smoking, electric or gas cutting and welding equipment should be permitted within the building having the powder producing and handling machinery during operation. If it becomes absolutely necessary to use such an equipment for making repairs, all machinery in the building or the section of building where repairs are to be carried out should be thoroughly cleaned to remove all accumulation of metallic powder. Operators of cutting and welding equipment should obtain prior permission from the appropriate authority before using their equipment under any condition around metallic powder plants.

12.3 Only aluminium, copper or bronze metal tools and shovels should be used in any dust making buildings. If it becomes necessary to use iron or spark producing tools inside such buildings or to dismantle any discarded powder producing equipment outside the building, the requirements laid down in **12.2** should be strictly followed.

12.4 Powder, dust sweepings and other materials should be swept from the floor. Machines or other locations should be carefully screened to remove foreign matter before being placed in any machine for additional fabrication. The dust sweeping should preferably be screened through a magnetic separator to remove any ferrous foreign matter.

12.5 Heating and drying should be done only by hot air, heated by steam or hot water coils. In buildings with metallic dust, the air should be forced by blower fans through a heating unit. Where dusty operations are carried out, the fans should draw their air supply from outside in order that no explosive dust accumulates in the heating chamber. The boilers or any heating appliance should be heated outside the boiler.

12.6 The outer clothing of the worker should be clean, fire-resistant and easily removable. It should not be of porous and loose weave aiding dust accumulation but should be of closely woven material. Pockets, cuffs, etc. where dust can accumulate should not be provided in trousers, aprons, etc.

12.7 Clothing of workers should not be of a material which will gather static electricity.

12.8 The soles of the shoes should be fastened with swing and wooden pegs or copper nails which should not project below the sole. Steel toe or heel plates should under no circumstances be permitted to be used in the factory premises.

12.9 Smoking materials and matches should not be allowed to be carried or used by employees or visitors, about the premises adjacent to or in any building in which manufacture, storage and loading of powder is done.

12.10 All employees in powder manufacturing plant should be carefully and thoroughly instructed as to behaviour and the procedure in case of fire or explosion, the location of electrical swithes, first-aid and safety equipment, permissible methods used in the isolation of metallic powder fires, the hazard of raising a dust cloud and hazard of throwing liquids on an incipient fire of metallic powder.

12.11 Cyclone and other collectors, and polishing equipment should be equipped with suitable instruments for recording the temperature and with an indicating device to give warning to operators of any tendency towards excessive heating. All such instruments should be kept at central locations so that they are easily observed by the man incharge and suitable action taken in time to remedy the hazardous conditions.

12.12 Contact of metallic powder with iron rust and oxidizable fats and oils should be avoided to prevent spontaneous combustion.

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