भारतीय मानक

औद्योगिक भवनों में आग से सुरक्षा हेतु रीति संहिता : कोयला चूर्णक और सम्बद्ध उपस्कर

(दूसरा पुनरीक्षण)

Indian Standard

CODE OF PRACTICE FOR FIRE SAFETY OF INDUSTRIAL BUILDINGS : COAL PULVERIZERS AND ASSOCIATED EQUIPMENTS

(Second Revision)

ICS 91.040.20; 13.220.20

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

August 2002

Price Group 7

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Fire Safety Sectional Committee had been approved by the Civil Engineering Division Council.

Coal pulverizers are essentially associated with storage of coal (usually equal to 90-100 days' requirements); pretreatment of coal, such as removal of scrap ferrous metal and rock/stones and drying; conveyance/transportation of coal to the pulverizer; collection, transportation and storage of pulverized coal; equipment for mixing the pulverized coal with air in correct proportion; and feeding the coal-air mixture in an uninterrupted flow to the fuel burning appliances. Fire/explosion hazard is present throughout these operations, which may endanger the safety of plant and buildings housing the plant and also the plant operators, unless adequate steps are taken to mitigate the hazard. These steps include proper planning in relation to the location of various machines/equipment, constructional and design aspects of the buildings, electrical installation, provision of adequate safety features in the design, installation and working of the machines/equipment, installation of automatic fire protection devices, fire prevention measures and correct operation of the plant.

This standard was first formulated in 1967 and revised in 1984 for the guidance of all concerned. Subsequent developments have necessitated several changes which have been incorporated in this revision. Additional information on storage of coal and general fire protection arrangements has also been included in this revision.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

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 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

CODE OF PRACTICE FOR FIRE SAFETY OF INDUSTRIAL BUILDINGS : COAL PULVERIZERS AND ASSOCIATED EQUIPMENTS

(Second Revision)

1 SCOPE

This standard covers the essential fire safety requirements for the storage and handling of coal, working of coal pulverizers and their associated equipment and the buildings housing the equipment in power houses and other industries where pulverized coal fired furnaces are used.

2 REFERENCES

The Indian Standards listed below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards given below:

IS No.	*Title*
636 : 1988	Non-percolating flexible fire fighting delivery hose (*third revision*)
903 : 1993	Fire hose delivery couplings, branch pipe, nozzles and nozzle spanner (*fourth revision*)
1641 : 1988	Code of practice for fire safety of buildings (general): General principles of fire grading and classification (*first revision*)
1646 : 1997	Code of practice for fire safety of buildings (general): Electrical installations (*second revision*)
2175 : 1988	Heat sensitive fire detectors for use in automatic fire alarm system (*second revision*)
2189 : 1999	Selection, installation and maintenance of automatic fire detection and alarm system — Code of practice (*second revision*)
2190 : 1992	Selection, installation and maintenance of first-aid fire extinguishers — Code of practice (*second revision*)
2871 : 1983	Specification for branch pipe, universal for fire fighting purposes (*first revision*)
2878 : 1986	Specification for fire extinguisher, carbon dioxide type (portable and trolly mounted) (*second revision*)
3594 : 1991	Code of practice for fire safety of industrial buildings: General storage and warehousing including cold storages (*first revision*)
4927 : 1992	Unlined flax canvas hose for fire fighting — specification (*first revision*)
6382 : 1984	Code of practice for design and installation of fixed carbon dioxide for fire extinguishing system (*first revision*)
8757 : 1999	Glossary of terms associated with fire safety (*first revision*)
9668 : 1990	Code of practice for provision and maintenance of water supplies and fire fighting

3 TERMINOLOGY

3.0 In addition to the definitions contained in IS 8757, the following definitions shall apply to this standard.

3.1 Auxiliary Air — Air or gas supplied from an auxiliary source to maintain a minimum velocity of coal dust-air/coal dust-gas mixture in the burner piping.

3.2 Barrier Valve — A valve for protection against explosions from furnace travelling back into pulverizer(s) or exhauster(s) opened for inspection or maintenance.

3.3 Bin (Bunker) and Feeder System — A system in which pulverized coal is conveyed from pulverizer to storage bins (bunker), from which it is fed to furnaces, but is not intimately mixed with air until it reaches the furnace; pulverized coal may be conveyed by screw conveyors or other means.

3.4 Burner — A device for the introduction of pulverized coal and air into a furnace at the required velocity/turbulence and concentration to establish and maintain proper ignition and stable combustion of fuel within the furnace. A burner may also be multiplicity of devices for supplying fuel and air into a common

flame envelope provided there is a complete intermixing of all the supplies within a limited volume of the furnace chamber.

3.5 Check Valve — A self-operating valve used to prevent reverse flow in any portion of the system.

3.6 Coal Drier — Equipment used solely for drying coal – solid or pulverized or both – in an inert atmosphere.

3.7 Control Valves — Valves used to control flow of air.

3.8 Cyclone — A separator in which pulverized coal is separated from pulverizer air (*see* **3.20**) by centrifugal means in a 'bin and feeder' system.

3.9 Dust-Tight Valves — Valves used for shutting off burner lines or any line carrying coal dust in suspension.

3.10 Exhauster — The exhaust fan for drawing pulverizer air through the pulverizer.

3.11 Feeder (Fuel) — A device for supplying a controlled amount of fuel (pulverized coal) to a system or sub-system.

3.12 Gate (Fuel) — A shut-off gate between the coal-dust bin and feeder.

3.13 Grindability — The characteristics of solid fuel representing its relative ease of pulverization.

3.14 Igniter — A device which provides adequate ignition energy to ensure immediate and smooth ignition of the fuel-air mixture at the main burner(s).

3.15 Interlock — A device or group of devices arranged to sense a limit or off limit condition or improper sequence of events and to shut down the offending or related piece of equipment or prevent proceeding in an improper sequence.

3.16 Piping — Pipes, fittings, valves, etc, used in the pulverizing system.

3.17 Pressure Furnace — A furnace which is operated above the surrounding atmosphere pressure.

3.18 Pressure Lock — A device for transferring pulverized coal between zones of different pressure without permitting appreciable flow of air or gas in either direction.

3.19 Pulverizer — A machine for reducing coal to particle size of the order of 75 microns.

3.20 Pulverizer Air — Air or gas introduced into the pulverizer to convey the pulverized coal from the pulverizer and to dry the coal, if required.

3.21 Pump — Device for transporting pulverized coal.

3.22 Seal Air or Gas — Air or gas supplied to any device or system or sub-system at a significantly higher pressure than the surrounding atmosphere for the specific purpose of preventing contamination.

3.23 Suction Furnace — A furnace which is operated at a pressure below that of its surroundings.

3.24 Tempering Air — Air or gas at a lower temperature added to a stream of preheated air or gas to modify its temperature.

3.25 Transport Air — Air or gas used to convey pulverized fuel.

3.26 Unit System — In this system, the pulverizer is located near the furnace and it delivers the coal dust directly to the furnace.

3.27 Vent Valve — A valve used to permit venting of air or gas from the system to the atmosphere. These valves are not to be considered as a protection in the event of an explosion within the system.

4 GENERAL

4.1 The use of pulverized coal for firing furnaces results in better utilization of coal, because each fine particle of coal gets enveloped in air and its combustion is complete, resulting in higher heat output, higher temperature and no appreciable formation of smoke. But pulverized coal has a higher fire hazard as compared to coal in lump form. It may also cause serious explosions if adequate precautions are not taken during the process of pulverization and while it is being used for firing the furnace(s). Due care must, therefore, be taken in the selection, installation and maintenance of coal handling, coal pulverization and associated equipment and in the operation of coal pulverization plants.

4.2 Coal received from more than one sources may vary in size and impurities that may exceed the capability of the plant equipment. In all such cases, therefore, care must be taken to ensure that the coal is well within the requirements of coal handling and coal burning equipment. Wide variations in the size of raw coal may also result in errartic or uncontrollable coal feeding with its attendant hazards.

4.3 Coal stored in bulk is susceptible to spontaneous combustion. Adequate precautions must, therefore, be taken during its storage as outlined in **7.3** to **7.3.12**. Care must also be taken to ensure that spontaneously heated coal is not fed into the system along with other coal.

4.4 Raw coal may contain foreign materials, such as scrap iron, wood shoring, rags and stones, which can interrupt the coal feed, damage or jam the equipment, or may cause ignition of coal dust within the pulverizer.

Interruption in coal flow may also cause total or partial flame-out at the burner(s) followed by possible re-ignition, which may result in a dangerous furnace puff or explosion. It is, therefore, essential to remove all foreign materials from the raw coal before it is fed into the pulverizer(s).

4.5 When coal dust in the open is disturbed or when it leaks from a pipe or machine, it gives rise to a coal dust cloud which can lead to serious explosion if ignited. All dust accumulations and leaks of coal dust must, therefore, be eliminated through careful design and maintenance of the plant.

4.6 Methane gas released from freshly crushed or pulverized coal may accumulate in enclosed spaces and explode when ignited by a chance spark or naked flame. Efficient mechanical ventilation of pulverizing plant rooms and elimination of all sources of ignition are, therefore, essential.

4.7 Coal dust-air mixture flowing through pipes and other equipment gives rise to the generation of static electrical charges, which can cause ignition of the mixture unless necessary precautions are taken to prevent accumulation of static electrical charges.

4.8 The 'bin (bunkers) and feeder' system involves collection and storage of coal dust from the pulverizers. The fire/explosion hazard is, therefore, spread over a large area – the pulverizers, pipes and the cyclone collectors or storage bins. In the 'unit system', the hazard is mainly confined to the pulverizers. In either case, however, certain precautions must be taken to ensure safe operation.

4.9 The fuel burning system shall be capable of burning the fuel supplied to its burners and producing unreactive products of combustion at a rate corresponding to the rate at which the fuel and air are fed to the burners. Its capacity shall be adequate to meet the operating requirements of the unit and its design shall be compatible with other component systems. Necessary controls shall be provided to make it suitable for the full operating range of the plant.

4.10 The air supply sub-system shall be designed to ensure a continuous flow of the required volume of air for all operating conditions and shall be capable of compensating the air flow during anticipated pulsation in the furnace.

4.11 The fuel supply sub-system shall be designed to ensure that supply of coal to the coal feeders is properly graded and freed of foreign material and that there is minimum interruption in the supply to feeders.

4.12 The capacity of the pulverizer shall be coordinated with the requirements of pulverized coal for the burners, so that the need for stopping/restarting of pulverizer during furnace load charges is reduced to the minimum.

4.12.1 The pulverizer shall be capable of pulverizing coal to the required degree of fineness; its design shall be compatible with the blower/compressor capacity and the design of the ducts and dampers to ensure proper velocity of coal dust-air mixture throughout its operating range and a minimum velocity to prevent coal dust from settling in the piping to the burners.

4.12.2 Automatic dampers shall be incorporated in the feed pipe and outlet duct(s) of the pulverizers.

4.13 The main burner sub-system shall be designed to ensure a continuous supply of coal dust-air mixture to the furnace so that a stable flame is maintained under all operating conditions. Its operating limits shall be carefully determined so that it is suitable for the given furnace design *vis-a-vis* the characteristics of the fuel and the normal variations in the fuel handling and burning equipment.

4.13.1 Suitable compensatory devices and interlocks shall be included in the design of the main burner sub-system to take care of momentary changes in the fuel supply and the flame.

4.13.2 A gas or oil fired igniter shall be provided in the main burner sub-system to ensure immediate and smooth ignition of the coal dust-air mixture at the main burner(s).

4.14 An efficient 'combustion control system' shall be incorporated in the plant design to ensure that fuel and air supplies to the furnace shall be maintained according to its requirements under varying conditions of operation.

4.14.1 The 'combustion control system' shall be capable of automatically controlling the furnace inputs and their relative rates of change to ensure continuous combustion and a stable flame throughout the operations.

4.14.2 The 'combustion control system' shall also be capable of controlling the temperature of coal dust-air mixture and ensuring adequate supply of primary air at the pressure necessary for the transport of the required fuel input.

4.15 An efficient 'operating system' shall be incorporated in the plant design to ensure that the correct operating sequence is followed at all times and that the fuel is admitted to the burners only when sufficient ignition energy and correct air flow are available to ensure trouble-free continuous burning within the furnace.

4.15.1 The 'operating system' shall also ensure soot blowing at the proper time to maintain thermal efficiency of the furnace.

5 LAYOUT OF THE COAL STORAGE, HANDLING AND PULVERIZING PLANT

5.1 Coal shall be stored in an area separated from the building(s) housing the pulverizing plant or other buildings/structures by at least 15 m.

5.2 Where separate coal driers are employed ahead of the pulverizer(s), they shall be housed in a separate building or a fire resisting compartment which is effectively separated from other parts of the building by separating walls.

5.3 Except in the 'unit system', where the drier and pulverizer are combined, the pulverizer shall be housed in a separate building or a fire resisting compartment which is effectively separated from other parts of the building by separating walls. It shall not be housed in the same compartment with the furnace.

5.4 Bins (bunkers) for pulverized coal shall be located well away from all sources of heat, such as boilers, flues, hot water or steam pipes.

5.5 The entire coal storage, handling and pulverizing facility shall be so laid out as to comply with the requirements of minimum distance(s) from other buildings/structures as laid down by the appropriate authority for the industry, of which such facility constitutes a part.

6 BUILDING CONSTRUCTION

6.1 Structural elements of bins of raw coal and buildings housing driers (where separate driers are installed ahead of pulverizers), pulverizers and pulverized coal storage bins shall have a fire resistance rating of not less than Type I buildings as specified in IS 1641. Where the driers, pulverizers and pulverized coal storage bins are located in separate compartments of the same building, the various compartments shall be effectively separated by separating walls having a fire resistance rating of not less than other structural elements of the building.

6.2 Structural elements of the building housing pulverized coal fired boiler(s) and/or furnace(s) shall have a fire resistance rating of not less than that of Type II buildings as specified in IS 1641. Where the boiler(s)/furnace(s) is(are) located in a compartment of the building housing the facilities mentioned in **6.1**, the separating wall(s) shall have a fire resistance rating of not less than that of Type I buildings as specified in IS 1641.

6.3 The building(s) housing the coal, crushing and pulverizing facilities shall preferably be of single storeyed construction. The roof of the building(s) shall be provided with explosion vents in the shape of either plain glass glazing or an approved type of automatic explosion venting device. The total area of explosion vents shall not be less than $1 m^2$ for every $10 m^3$ of room volume. The windows should be hinged and installed to open outward under pressure from inside the building.

6.3.1 Where it is unavoidable to house the facilities mentioned in **6.1** and **6.2** in a building having two or more storeys, each compartment shall have at least one external wall that may be used for providing explosion vents. In such cases, the remaining walls and roof shall be strengthened to withstand without failure the impact of an explosion.

6.4 As far as possible, no opening shall be provided in any separating wall. However, where such opening is unavoidable, it shall be protected by an automatic fire check door(s) having a fire resistance rating of not less than that of the separating wall.

6.4.1 If pipes pass through a separating wall, the aperture in the wall surrounding each pipe must be effectively closed by a fire resisting material.

6.5 Walls of the coal crushing room(s) shall be periodically white-washed so that coal dust deposits shall show up clearly.

6.5.1 Where large crushers are under continuous operation:

a) the walls, ceiling and floor of the coal crushing room shall be highly polished to prevent the coal dust from sticking on these surfaces; and

b) dust extractors shall be installed for continuous removal of coal dust to outdoors in such a manner that it cannot drift back into the building through air intake equipment of the building.

6.5.2 Ventilation of the coal crushing room(s) shall be carefully designed; it shall preferably be mechanical to guard against accumulation of methane gas in any part of the room.

6.6 Design and finish of the walls, ceiling, floors and other internal surfaces of rooms where pulverized coal is produced or handled shall be such as to prevent settling of coal dust on them and to facilitate cleaning; it is desirable that all internal surfaces of such rooms, other than the floors, have an inclination of not less than 60° to the horizontal.

7 STORAGE OF RAW COAL

7.1 When stored in bulk, coal is susceptible to spontaneous heating/ignition. High grade anthracite, under certain conditions, is an exception. It cannot be said with certainty which kind of coal has a higher hazard, because coal from different sources varies

widely in its composition. Thus, coal from certain collieries has a greater tendency to heat up/ignite spontaneously as compared to others.

7.2 The cause of spontaneous heating/ignition of coal can also not be pin-pointed because a number of factors may be responsible for this phenomenon. One of the factors is the complex composition of the coal itself which may comprise, among others, spontaneously flammable pyrites, readily flammable liquids (benzol, ligroin and the like) and flammable/explosive gases (carbon monoxide, hydrogen and methane), which form explosive mixtures with air. It is, therefore, erroneous to ascribe all cases of spontaneous heating/ ignition in coal to any single cause.

7.3 Coal shall be stored in the open in heaps/stacks or in bins (bunkers).

7.3.1 The ground on which the coal heaps/stacks/bins (bunkers) are located shall be rolled hard and shall preferably have a hard base of bricks or concrete. It shall be suitably graded to ensure adequate drainage.

7.3.2 The entire coal storage area shall be kept clear of all vegetation and foreign matter, such as leaves, weeds and oily/greasy rags.

7.3.3 A minimum of 15 m separation shall be maintained between the coal heaps/stacks and other structures/open storage. Where this is not practicable, a masonry wall of not less than 45 cm thickness shall be erected between the coal heaps/stacks and other structures/open storage; the height of the wall must not be less than 1m more than the height of the largest heap/stack.

7.3.4 Each coal heap/stack may be oblong in shape with a 3 m wide access-way around it. Where coal is stored in masonry bins/enclosures, at least one side of the bin/enclosure shall be open, preferably on the leeward side, and the access road shall be provided along that side.

7.3.5 No individual heap/stack shall contain more than 200 t of coal.

7.3.6 Maximum height of coal heaps/stacks shall be determined in accordance with the size of coal as indicated in Table 1.

7.3.6.1 Where a coal heap/stack contains mixed sizes of coal and also contains dust, its height shall be restricted to a maximum of 2 m.

7.3.7 Maximum width of coal heaps/stacks shall be determined in accordance with the availability of fire hydrants, as indicated in Table 2.

7.3.8 At the time of building a coal heap/stack, each successive layer of coal shall be compacted by mechanical means so that no cavities are left in the heap/stack. The slope on the sides of the heap/stack shall not exceed 30°.

Table 1 Maximum Permissible Height of Coal Heap/Stack in Relation to the Size of Coal

(*Clause* 7.3.6)

Sl No.	Averate Size of Coal	Maximum Permissible Height of Coal Heap/Stack
	cm	m
(1)	(2)	(3)
i)	15 or more	4.5
ii)	7.5 to 15	3.0
iii)	Less than 7.5	2.0

Table 2 Maximum Permissible Width of Coal Heap/Stack in Relation to the Avilability of Fire Hydrants

(*Caluse* 7.3.7)

Sl No.	Availability of Fire Hydrants	Maximum Permissible Width of Coal Heap/Stack
		m
(1)	(2)	(3)
i)	On one side of the heap/stack	45
ii)	On two opposite sides of the heap/stack	90

7.3.9 Coal shall not be wetted. Where possible, a shed with corrugated asbestos cement sheets roof may be erected over the storage area to prevent the coal from wetting by rain. Such a shed has the additional advantage of protecting the coal from the heat of the sun in hot climate.

7.3.10 Coal heaps/stacks shall be frequently inspected for signs of smoke, odour of coal gas or other signs of heating.

7.3.11 Inside temperature of each coal heap/stack shall be monitored by suspending thermometers inside metal pipes placed vertically at 4.5 m intervals in the heap/ stack. Each metal pipe shall be of a length that shall enable its bottom end to reach within 10 cm of the bottom of the heap/stack with a projection of not less than 1m above the top surface of the heap/stack; the pipes shall be closed and pointed at their lower ends. At least one reading shall be taken daily at each pipe. But if the temperature at any location is 5°C higher than the ambient temperature, particular attention shall be paid to that heap/stack, keeping a watch over it by increasing the frequency of temperature monitoring; if the temperature at any location rises to 60°C, it shall be considered dangerous. In all such cases, the heap/stack shall be opened up to expose the heated region and the hot coal removed for immediate consumption. Alternatively, the heated coal may be allowed to cool. However, if the temperature tends to rise further, water spray may be used to cool the hot

region. Cooling of a hot heap/stack with water must not be attempted until the hot region has been exposed and the natural air cooling is not of any help.

7.3.12 As far as possible, coal must not be stored for more than 3 months. Where it is unavoidable to store it for a longer period, the top and sides of each heap/ stack must be well sealed with oil or other suitable medium.

7.4 Storage of other materials shall conform to the provisions of IS 3594.

7.5 Flammable materials, such as paints and oils, shall be stored away from the coal pulverizing plant, except the quantity required for immediate use.

8 MACHINERY AND EQUIPMENT

8.1 All machinery and equipment for the pulverizing system shall be constructed of non-combustible materials.

8.2 Machinery and equipment, such as separate driers (where installed), pulverizers, pulverized coal bins (bunkers), cyclones, pneumatic and screw conveyors and casings of fans and pumps, that may be designed for operation at near atmospheric pressure, shall be capable of withstanding an internal pressure of 3.5 kgf/cm^2. Where any machine/equipment is required to operate at higher than atmospheric pressure, its capability to withstand internal pressure shall be 3.5 kgf/cm^2 per atmosphere of working pressure.

8.3 All pulverized coal bins, cyclones and piping for conveying coal dust mixture shall be filled with explosion vents extended to outdoors.

8.3.1 The minimum explosion vent area for pulverized coal bins shall be 1 m^2/10 m^3 of bin volume.

8.3.2 The minimum explosion vent area for piping shall be 1 m^2/6 m^3 of pipe volume. The vents on piping shall be not more than 3.0 m apart.

8.4 The pulverizing equipment shall be constructed of non-sparking material(s).

8.5 Wherever possible, cyclones and/or other types of dust collectors shall be located outdoors. When installed in conjunction with cyclones or other types of dust collectors, fans shall draw air from the collectors; the blades of such fans shall be made of bronze or similar non-sparking material and ample clearance shall be provided between blades and casings of fans; fan bearings shall be dust tight and shall be mounted outside the fan casing.

8.6 All machinery and equipment, including piping, shall be effectively bonded electrically and earthed; the resistance of earth connection shall be tested once a year.

8.7 Coal Crusher(s)

8.7.1 Coal crusher(s) shall be capable of accepting coal in sizes in which it is received at the plant and reducing it to a size which is well within the capability of the plant equipment.

8.7.2 Coal crusher(s) shall be constructed of non-combustible and non-sparking material(s).

8.7.3 Crusher(s) and the crushed coal grading screens shall be suitably and effectively enclosed to minimize dispersion of coal dust into the surrounding atmosphere.

8.8 Belt Conveyors

8.8.1 Fire on coal handling plant are infrequent, but the consequential fire damage potential is considerable. In incidents which have occurred, the damage has been severe, particularly where conveyor fires have reached and enveloped the boiler house bunkers or transfer points.

8.8.2 The major fire hazard is from the ignition of coal dust and from deposits built-up on the internal surfaces, walkways, etc, of the conveyor's junction towers, often ignited by maintenance activities (for example, weld spatter). Conveyor belt fires caused by friction from a defective part such as a jammed idler or belt cleaner resulting in subsequent overheating of the belt and steelwork have also occurred.

8.8.3 There is also a significant fire hazard associated with the conveyor drive unit due to a combination of brake faults, failure of fluid couplings and overfilling of the drive gearboxes as well as that due to an overheated motor which has become inadequately cooled in service due to the build-up of coal dust.

8.8.4 The design of conveyor housings is such that wind tunnelling or the 'chimney' effect is an inherent feature on inclined conveyors and this can cause rapid spread of fire through the conveyor plant. Should the belt catch fire, it can spread of fire rapidly to other areas, particularly as a result of the belt parting and 'flying' in opposite directions due to the belt operating under tension. All coal conveyor and coal handling plant fires generate large volumes of smoke, particularly when the fire is at an advanced stage.

8.8.5 The primary causes of coal plant fires fall, into three main areas:

a) Maintenance activities involving the use of electric or gas welding, gas cutting equipment, or similar activities.

b) Failure of part of the conveyor system (usually and idler or a pulley) can lead to localized overheating and, eventually, to the ignition of the coal dust, conveyor belting or

lubricating oil and greases associated with the plant.

c) Rubbing of a belt (running out of centre) with steel work resulting in localized overheating and eventually, belt catching fire, when stopped.

d) From the ignition of a quantity of spilt coal dust, either by self ignition or other causes.

8.8.6 Belt conveyor used for transporting coal from the coal storage yard to the crushers or from the crushers to the driers/pulverizers shall be of the totally enclosed type.

8.8.6.1 The conveyors housing (enclosure) and floor shall be constructed of non-combustible materials, such as steel, corrugated iron or asbestos sheets and concrete. Means of access to the inside of the conveyor housing (enclosure) shall be provided at suitable locations.

8.8.7 The conveyor belt shall be of the fire resistant type. Since after continuous use, the conveyor belt gets coated or impregnated with lubricants or residue of coal, its susceptibility to ignite gets enhanced with the passage of time. The periodicity of replacement of the conveyor belt must, therefore, be short, that is, it must be replaced more often, compared to a conveyor belt of similar characteristics used for conveying non-combustible materials.

8.8.8 A deck or shield of non-combustible material shall be provided between the outgoing and the return belts, so that any coal spilled from the outgoing belt shall be prevented from falling on the return belt. The design of the deck or shield shall be such that it does not present any difficulty in periodical cleaning and removal of the spilled material.

8.8.8.1 When the conveyor is not to be used for some time, it must be thoroughly cleaned of coal dust deposits, both on the outgoing and return belts and the deck shield.

8.8.9 Care shall be taken to ensure that hot coal, which may have heated up spontaneously while in storage, is not loaded on the belt. The belt must also not be overloaded.

8.8.10 All conveyor systems and transfer towers should be adequately illuminated in order to minimize the hazard to personnel and permit a good level of plant surveillance.

8.8.11 All belting should be fire resistant belting and should be used for strategic systems and for belts associated with shuttle conveyors over bunkers, transfer conveyors at the end of the bunker area and other conveyor inside buildings or enclosed gantries.

8.8.12 Particular care should be paid to the area to the rear of the conveyor. Attention should be given to ensure that rotating items such as pulleys, idlers, etc, are adequately cleaned and lubricated (not over-lubricated) and are not being jammed by coal spillage.

8.8.13 Regular maintenance of the conveyor shall be undertaken to ensure freedom from friction due to the slipping of belt over the drive or idle roller and/or its becoming misaligned or slipping off the roller and becoming jammed.

8.8.14 Fire detection alarm systems shall be installed as indicated in **10.1**(a) and (b) for fire protection of belt conveyors.

8.9 Coal Driers (Where Installed)

8.9.1 Driers shall be constructed of completely non-combustible materials, shall be dust-proof and shall have as smooth an interior surface as possible. The design shall be such that all ledges and horizontal areas, where dust can lodge, are eliminated.

8.9.2 Each drier shall be provided with explosion vents extended to outdoors. The open ends of the vents shall be protected with suitable wire mesh.

8.9.3 Heating of driers shall be thermostatically controlled and so arranged that it shuts down automatically in the event of the safe temperature being exceeded.

8.9.4 Fire detection alarm systems, as indicated in **10.1** (c) and (d), shall be installed for fire protection of driers.

8.10 Air-Intakes

8.10.1 All air-intakes of the air-supply system shall be adequately protected against entry of foreign matter, such as shreds of oily waste, paper and straw, and their surroundings shall be kept clean at all times.

8.10.2 The air-intakes shall be so located that fire, fire gases, smoke or sparks originating outside cannot be easily drawn in through them.

8.11 Coal Bunkers

8.11.1 The major fire hazards in bunkers arise from residual coal which has been compacted onto the bunker walls for long periods, even though the bunkers are in continuous use. The chance of self-ignition of this coal is greatly increased by any draught of air through the coal in the bunkers, particularly compressed air from air blast equipment. A secondary hazard also exists from stock coal which may be hot and about to burn when conveyed.

8.11.2 If bunkers gates, and feeder and mill isolation are not satisfactory and the level of coal within the

plant is low, pressurization of the boiler furnace could cause hot gas to pass into the bunkers, igniting coal dust enroute or even causing an explosion, unless non-return valves are fitted.

8.11.3 Conveyor fires can rapidly spread to the coal bunkers due to the 'chimney' effect, the high belt speeds and the whiplash effect of a broken conveyor belt.

8.11.4 In the event of a fire within the bunker, two primary hazards exist which might affect the safety of personnel. These are:

a) slow combustion of the coal will give rise to toxic and potentially explosive gases, the presence of which is not necessarily always immediately apparent.

b) in the event of a more serious fire in the bunker, smoke in the confined space could be a distinct hazard to plant operators or to personnel fighting the fire due to the lack of visibility and the risk from toxic and asphyxiating fumes.

8.11.5 Residual, compacted coal in bunkers should be avoided to reduce the risk of fire. Free flow in the bunker can be assisted on many occasions through the use of stainless steel lining materials.

An up-draught of air through a bunker increases the probability of a bunker fire. Where sealed type bunker outlet gates are fitted, they should be maintained to ensure that they close properly when the bunker is not in use. Dampers on the associated plant, etc, should also be maintained to ensure that a forced draught through the bunker cannot emanate from a shutdown mill.

Ventilation through the bunker bay area should be maintained and the venting arrangements should be maintained in working order.

8.11.6 If areas of static coal are found, coal flow can often be stimulated by appropriate agitation. If free flow throughout the bunker cannot be maintained by these means, it may be necessary to carry out manual trimming to clear any coal build-up. Such operations should be carried out with utmost safety precautions.

When it is known that associated plant is to be out of commission for a prolonged period, arrangements should be made to ensure that the bunker is run down as far as possible or emptied before the outage. If a sudden outage occurs due to plant failure and it seems probable that prolonged outage is likely consideration should be given to emptying the bunker by such means as are available.

8.12 Coal Feeders

8.12.1 Fire in coal feeders are usually a consequence of hot or burning coal passing from the coal bunkers, fires in milling plant propagating into the feeder, particularly at start-up of shutdown periods, or friction due to the mechanical failure of the feeder. Maintenance work frequently involves gas cutting operations which can lead to residual coal or gearbox oil fires.

8.12.2 Excessive heating of entrapped coal in the feeders will develop into a significant fire, but long before this situation occurs toxic and possibly explosive gases may be produced.

8.12.3 Routine cleaning of feeders from inside will reduce the extent of residual coal left compacted in dead spaces within the feeder. Bunker gates and mill dampers should be maintained to prevent the passage into the feeder of combustion products from fires elsewhere in the plant.

8.12.4 All cutting and welding operations should be undertaken only after issue of hot work permit.

8.13 Pulverizer

8.13.1 Pulverizer fires are mostly due to frictional sparks produced by small pieces of ferrous metal that may find their way into it with coal. Magnetic separators (suspension magnets) shall, therefore, be installed over the belt conveyors ahead of the pulverizer to remove all scrap ferrous metal before the coal is fed into the pulverizer.

8.13.2 Where drying of coal is accomplished by supplying hot air to the pulverizer, the temperature of coal-air mixture leaving the pulverizer must be maintained within predetermined limits by automatic temperature monitoring and control devices. If the temperature is too high, choking or burn-out of burner parts may result in increased possibility of pulverizer fire; if the temperature is too low, pulverization is impeded.

8.13.3 Temperature of bearings shall be constantly monitored through automatic devices.

8.13.4 Except where the burners of a suction furnace in the 'unit system' are fed by a single pulverizer and where the furnace cannot be fired by any other means, barrier valves shall be provided between each pulverizer and the burners.

8.13.5 In pressure furnaces of the 'unit system', each burner pipe shall be fitted with a dust-tight valve at the pulverizer or exhauster outlet, unless the furnace is fed by a single pulverizer and it cannot be fixed by any other means.

8.13.5.1 The dust-tight valves shall be installed in such a way that any dust accumulation underneath the valves shall fall into the exhauster or pulverizer.

8.13.6 In the 'unit system', means shall be provided for automatic monitoring of any interruption of flow of coal to the pulverizer to enable the operator to take suitable precautions before the burner lines are affected.

8.14 Coal Mills and Pulverized Fuel (p.f.) Pipework

8.14.1 Accumulations of pulverized fuel deposits on ducting, pipework, cable trays, scaffold boards and ledges occur from unsatisfactorily sealing of coal feeders, mills and perforated pulverized fuel pipelines and associated mill trunking.

8.14.2 There is a consequential risk of explosion and fire from raw pulverized fuel in suspension emanating either from a leak or, after dislodgement from surfaces, being ignited either from external sources or by spontaneous ignition.

8.14.3 Damaged or inadequate insulation and cladding can result in the accumulation of pulverized fuel dust in close proximity to hot surfaces. The dust may smoulder and cause further damage to insulation with the possibility of a serious fire developing.

8.14.4 The pulverized fuel pipework should be designed to minimize the release of dust. Particular attention should be paid to joints.

8.14.5 Accumulations of dust and the creation of dust clouds whilst brushing or hosing down (using compressed air or high pressure water jets) should be avoided. Caution is required to avoid the build-up of static electricity where vacuum cleaning or jet washing equipment is used.

8.15 Bin and Feeder System Equipment

8.15.1 A check valve shall be installed in each vent pipe connecting the cyclone or dust collector to the primary air fan or any portion of the furnace or stack of a suction furnace.

8.15.2 Where a system is connected to one or more burners of a pressure furnace, a dust-tight valve shall be installed in each burner pipe between the pulverized coal feeder and the burner.

8.15.3 Where a pressure furnace is fired by this system, air supply to the primary air fans shall be taken from forced draft lines.

8.15.4 Dust-tight valves shall be installed between the forced draft lines and the inlet of the primary air fan and also in the individual burner lines between the pulverized coal feeders and burners, unless the pressure furnace is fixed by one burner only.

8.15.5 Storage bins for pulverized coal shall be located well away from all sources of heat.

8.15.5.1 The capacity of individual storage bins shall be kept at the minimum consistent with the operational requirements of the system.

8.15.5.2 Pulverized coal bins shall be without any opening through which an overflowing bin can discharge coal dust inside the building.

8.15.5.3 High and low level indicators shall be installed on each bin; the high level indicator shall be arranged to operate the distributing valves so as to divert the flow to the next bin in service.

8.15.5.4 Each bin shall also be fitted with an additional high level indicator which shall be arranged to sound an alarm and to shut down the pulverizing system.

8.16 Boiler Burner Gallery Areas and Lighting-up Equipment

8.16.1 The principal fire hazards at the boiler burner galleries are from the ignition of preheated fuel oils on the hot boiler casing, the rupture of flexible connections on burner gas and fuel oil systems, the leakage of propane/LPG from boiler lighting-up systems and leakage from the pulverized fuel pipework. A minor fire involving spillage or leakage of oil near compressed air piping serving the boiler burners may lead to explosion or fire hazard. Power and control cables are usually severely affected and could cause operation difficulties. Propane leakage leads to an explosion or fire hazard from propane/air mixtures.

8.16.2 Only the minimum of electrical equipment should be permitted in the gallery area. Cable junction boxes and control cubicles should be excluded as far as practicable. Essential cables should be so arranged as to prevent fire damage, for example, by enclosure in fire-resistant material or by wrapping in mineral fibre blanket or by being run in short-time fire proof cable. For power cables, the de-rating effect caused by enclosure or wrapping should be taken into account. All electrical equipment in the fire protection zones should be waterproof or protected against the ingress of water to a minimum of IP 55W. Steam pipes for oil atomization should be thoroughly insulated.

8.16.3 Thermal insulation and any other oil absorbent surfaces in the vicinity should be rendered impervious to oil impregnation.

8.16.4 The feasibility of installing automatic piped drainage from the oil catchment vessel to a safe position at ground level should be explored.

8.16.5 Fire safe automatic isolating valves should be incorporated into the individual systems at strategic

locations and arranged to cut off the supply of propane LPG and oil in the event of a significant fire in the vicinity of the burner galleries.

8.16.6 Oil waste, rag and other combustible materials should not be allowed to accumulate. Prompt attention should be given to defects on burner connecting hoses and pipework. The removal of burner carriers for burner tip cleaning should be arranged in such a manner that the burner is purged before withdrawal from the register and only then after withdrawal any residual oil is drained into a container.

8.16.7 *Boiler Wind Boxes*

8.16.7.1 Internal wind box fires are caused by the accumulation of pulverized fuel (p.f.) and fuel oil leaking from the associated burners. Internal wind box fires are generally caused by a sudden boiler blow-back, or are ignited by the high temperature inside the wind box. They can remain undetected for some time which can result in a significant increase in the damage to the wind box casting and air flow control vanes.

8.16.7.2 Fire external to the wind boxes can occur as a result of the accumulation of pulverized fuel dust on horizontal surfaces and ledges of the wind box and its supports. The build-up from oil leakages which collects both in the insulation and on the cladding also poses a significant fire risk to the wind box and plant in the area. Oil and pulverized fuel jet fires can occur projecting outside the fixed fire protection normally provided for the oil burners and may seriously damage oil and propane supply pipework, hence adding to the fire hazard.

8.16.7.3 Smooth sloping surfaces should be provided within the wind boxes to avoid the accumulation of fuel. Thermal insulation should be rendered impervious to oil impregnation.

8.16.7.4 Oil waste, rag and other combustible materials should not be allowed to accumulate. Prompt attention should be given to defects on burner connecting hoses and pipework. The removal of burner carriers for burner tip cleaning should be arranged in such a manner that the burner is purged before withdrawal from the register and only then after withdrawal any residual oil is drained into a container.

8.17 Storage of Fuel and Lighting-up Oils

8.17.1 The main hazard involves the outbreak of fire and risk of explosion of fuels contained in storage tanks and associated equipment. Heavy fuel oils Class F are recognized as low hazard fuels and as such fixed fire protection coverage is considered to be unnecessary. Light fuel oils Class B, D and E represent a greater risk, the main hazards occurring during venting, gassing and filling operations following periods of hot weather when distillation may have occurred with low flash point vapours being discharged.

8.17.2 All oil storage tanks should be provided with bunds capable of retaining at least 110 percent of the design tank capacity and a sump pit to facilitate pumping out of water oil. Two tanks can share a common bund. Bunds are usually constructed of reinforced concrete, but where earth bunds are used, the grass around storage tanks should be kept short and all areas within the bund walls must be free of vegetation and any other combustible materials. Bunded areas should be watertight and able to prevent the seepage of oil into watercourses, etc. Bund areas should not be used as storage areas. Seepage into any drainage system due to tank pipework, bund or filling connection leakage should be avoided.

8.17.3 In the case of fuel oil, where immersion and outflow heaters are used and/or when hot oil is recycled, excess temperature safety systems and alarms should be installed on heater banks. Recycled, Class F oil should be cooled to below the flash point before returning to the storage tanks.

8.17.4 Bonding of all tanks, pipework, access galleries, etc, should be maintained in good order.

8.17.5 Tank should be clearly numbered and their total capacities indicated. Filling lines should be purged and road tanker connections should be kept secure when not in use.

8.17.6 Entry to bonded areas should be restricted to authorized persons and 'No Smoking' and 'No Naked Light' and 'Fire Action Notices' should be displayed in addition to contents identification and 'Haz Chem' signs near tank filling point.

8.17.7 Precautions are to be taken when welding, cutting, tank emptying and cleaning, tank inspections, vent inspections and maintenance works are carried out.

8.18 Interlocks

8.18.1 Failure/malfunctioning of any of the subsystems/components, or incorrect sequence of operations, may damage the equipment and/or cause injury to the operating personnel. To guard against such a contingency and to ensure safety, necessary mechanical and/or electrical interlocks shall be provided wherever necessary.

8.18.2 The interlocks shall not permit improper action(s) in the operating sequence by actuation of tripping devices when the operating condition is unsafe. The interlocks shall not permit over-riding by manual operation of any control until the defect or wrong sequence is rectified.

8.18.3 Mechanical and/or electrical interlocks shall also be provided to ensure that failure of any one item of machinery/equipment will automatically shut down all other machinery ahead of it to prevent coal from piling up in the system.

8.18.4 In the 'bin (bunker) and feeder system', the dust-tight valves (*see* **8.15.4**) shall be so interlocked that the burner line valves cannot open unless primary air line is open.

9 ELECTRICAL EQUIPMENT AND INSTALLATION

9.1 In addition to the requirements of this Code, all electrical equipment shall comply with the provisions of IS 1646.

9.2 All electrical equipment shall be periodically tested as laid down in IS 1646.

9.3 Only conduit, armoured or mineral insulated type of electrical wiring shall be installed.

9.4 Fittings and cut-out boxes shall be of dust-proof type and provided with threaded bosses for connection to conduit or cable terminal(s).

9.5 Use of flexible cable shall be kept to the minimum and, where used, such cables shall be provided with dust-proof seals at both ends. An additional conductor for grounding shall be provided in the flexible cord unless other acceptable means of grounding are provided.

9.6 Switches, circuit breakers, motor controllers and fuses shall be of flame-proof and dust-proof construction.

9.7 Flame-proof motors shall be either of totally enclosed type or pipe ventilated type.

9.7.1 The vent pipe for pipe ventilated type motors shall lead directly to a source of clean air outside the building and its open end shall be protected with suitable wire mesh.

9.8 Lighting fittings shall be installed as in flame-proof installations.

9.8.1 Pendant lighting fittings shall be suspended by threaded rigid conduit stems.

10 FIRE SPARK AND TEMPERATURE SENSING DEVICES AND ALARM SYSTEM

Fire spark and temperature sensing devices shall be installed at appropriate places on the plant. All sensing devices shall be linked with suitable control equipment so that an audio-visual indication of the location and nature of trouble shall be available to the operator instantly. The types of devices and their locations shall include the installation of:

a) detector system for detecting sparks/hot coal/ at the beginning of each belt conveyor used for conveying raw coal to the crushers and crushed coal to the pulverizer(s);

b) temperature sensors to continuously monitor the temperature of the drive and idle rollers while running;

c) temperature sensing and limiting devices (thermostats) for monitoring and controlling the temperature within the driers and for shutting them down when dangerous condition is reached;

d) temperature monitoring devices for the coal-air mixture as it leaves the pulverizer in plants where coal drying is accomplished by supplying hot air to the pulverizer; the temperature monitoring devices shall also be arranged to maintain the temperature of the coal-air mixture within acceptable limits;

e) fixed temperature heat detector, conforming to IS 2175 preferably of the linear type, for detection of fire in the belt conveyors;

f) fixed temperature heat detectors, conforming to IS 2175 preferably of the linear type, for detection of fire in power and control cables run on cable racks or through cable ducts throughout the plant; the fixed temperature heat detectors and control equipment shall be installed in accordance with IS 2189;

g) manually operated electrical fire alarm (system), call boxes at conspicuous locations on each floor/in each compartment of the plant; each call box shall be of the type where audiovisual indication is instantly and automatically transmitted to the control panel as soon as a small glass panel on the call box is broken; it must not have been spring loaded or have a moving part; all call boxes must be wired in a closed circuit, operating on 12/24 V battery(ies), trickle charged *in-situ* from the electric mains; the control panel shall be duplicated in the plant/public fire brigade watch room(s).

11 FIRE EXTINGUISHING EQUIPMENT/ INSTALLATIONS

11.1 Portable fire extinguishers of carbon dioxide type, conforming to IS 2878 or approved halon alternative shall be provided and installed near each electric motor, switchgear, other hazardous locations and on each floor/in each compartment of the plant so that they shall be readily available in the event of a fire. Except, where it is inconvenient to handle because of any peculiar location/feature, each extinguisher shall be of 6 kg capacity.

11.2 Fire hydrants shall be installed in the coal yard, on each floor/in each compartment of the plant building and alongside each belt conveyor so that not more than one length of hose may have to be laid in the event of a fire and each possible location of a fire is preferably covered by two hydrants. The pressure at each hydrant shall be not less than 3.5 kg/cm^2 when up to four hydrants are used simultaneously.

11.2.1 Adequate water supply shall be assured for feeding the hydrant system and for fighting fire from water stored in static tanks not less than two hours pumping capacity in the event of a serious fire (*see* IS 9668).

11.3 A glass fronted hose box shall be installed near each fire hydrant. Each hose box shall contain two lengths of hose, one branch pipe, one 12 mm nozzle, one 20 mm nozzle and one branch pipe, universal. The hose and equipment shall conform to the following Indian Standards:

a)	Fire hose inside the plant building	IS 636
b)	Fire hose in coal yard and alongside the belt conveyors	IS 4927
c)	63 mm instantaneous couplings for fire hose	IS 903
d)	Branch pipe and nozzles	IS 903
e)	Universal branch pipe	IS 2871

11.4 Automatic sprinklers shall be installed in all buildings housing coal pulverizing mills, raw coal bins, and driers of bins and feeder system, and between the outgoing and return belts of each belt conveyor.

11.5 In installations, where pulverizing is not carried out under an inert atmosphere, the bins, ducts and pulverizer(s) shall be protected with an automatic fixed carbon dioxide fire extinguishing system installed in accordance with IS 6382 or fixed halon fire extinguishing systems.

11.6 Unless a public fire brigade is located close to the plant (so that its response time does not exceed 5min), a plant fire brigade shall be maintained for fighting any major fire that may break out. The plant fire brigade personnel can also be made responsible for regular inspection of the plant from the point of view of fire prevention and also for the maintenance of all fire alarm and fire suppression equipment/ installations. The minimum requirements for the plant fire brigade may be worked out in consultation with fire experts.

11.6.1 In plants where no fire brigade is maintained and where assistance from public fire brigade is also not available within a short time, suitable fire fighting arrangements shall be made with the help of workers. In such cases, at least one whole time supervisory officer shall be appointed for fire prevention inspections and maintenance of fire suppression equipment/installations. He shall be fully trained in fire fighting and shall be assisted by a few firemen.

11.6.2 Where arrangement suggested in **11.6.1** is made, sufficient number of workers shall be trained in the use of fire hydrants.

11.6.3 In all cases, all workers shall be fully trained in the prevention of fires and use of portable fire extinguishers for fighting fires in the incipient stage.

11.7 Where a public fire brigade is located close to the plant and its speedy response to any fire in the plant is assured, close liaison shall be maintained with such fire brigade.

12 FIRE PREVENTION MEASURES

12.1 All exposed surfaces inside the plant buildings, exposed surfaces of machinery and equipment, horizontal ledges, cables, etc, shall be kept clean at all times.

12.1.1 Cleaning of coal dust from surfaces by compressed air or by dusters gives rise to dust clouds/ dispersion of dust into surrounding atmosphere that can be dangerous. All cleaning operations shall, therefore, be done by vacuum cleaners.

12.2 Extreme care shall be taken to prevent dispersal of coal dust during cleaning of pulverizers and associated equipment.

12.3 When driers or pulverizers are shut down, these and the connected piping shall be cleaned of coal dust.

12.4 No naked light of any kind shall be permitted in areas where coal dust may be afloat in the air.

12.5 Smoking shall be prohibited, except in separate rooms/areas especially set apart for such purposes 'NO SMOKING' signs shall be conspicuously displayed for this purpose.

12.6 Oily rags/waste shall not be permitted to lie around the coal yard and plant rooms. Metal receptacles with close fitting lids shall be provided at the required places for their disposal.

12.7 Flexible tubing used for conveying flammable fluids under pressure, such as fuel oil or gas for the igniters shall be fitted with an outer sleeve to contain escaping fluid in the event of the tubing developing a leak.

12.8 Welding and cutting operations shall not be allowed in the vicinity of coal pulverizer, pulverized coal bins, driers or fuel feed pipes unless:

a) all deposits of coal dust from the interior and exterior surfaces have been removed;

b) the surrounding area is thoroughly wetted with water; and

c) a trained person is standing by with fire extinguishing appliances.

12.9 Before the plant is commissioned/put in service, it shall be tested to ensure that all equipment, including igniters and interlocks, is functioning satisfactorily.

12.10 Manufacturers' instructions regarding safe operation and maintenance of pulverizer and associated equipment shall be scrupulously followed. A copy of the instructions shall be kept at each operator's station and shall be available for review by appropriate authority.

12.11 All portable fire extinguishers shall be installed and maintained in accordance with IS 2190.

12.12 Fire hydrants, fire hose and fittings, and automatic fire detection and fire extinguishing devices shall be maintained in accordance with good fire brigade practices.

ANNEX A

(Foreword)

COMMITTEE COMPOSITION

Fire Safety Sectional Committee, CED 36

Organization	*Representative(s)*
Tariff Advisory Committee, Mumbai	SHRI J. N. VAKIL (***Chairman***)
Bhabha Atomic Research Centre, Mumbai	SHRI A. K. TANDLE
Bharat Heavy Electricals Limited, Bhopal	DR S. A. PILLAI SHRI V. NATARAJAN (*Alternate*)
Building Materials and Technology Promotion Council, New Delhi	SHRI R. K. CELLY SHRI RAJESH MALIK (*Alternate*)
Central Building Research Institute, Roorkee	SHRI T. P. SHARMA SHRI GOPAL KRISHAN (*Alternate*)
Central Electricity Authority, New Delhi	MEMBER (HYDRO CONSTRUCTION MONITORING) SHRI R. S. CHADHA (*Alternate*)
Central Industrial Security Force, New Delhi	SHRI R. C. SHARMA
Centre for Environment & Explosive Safety, Delhi	DIRECTOR (FIRE SAFETY) DEPUTY DIRECTOR (FIRE SAFETY) (*Alternate*)
Controllerate of Quality Assurance (Fire Fighting), Pune	COL G. P. KRISHNAMURTHY LT-COL K. K. BARDHAN (*Alternate*)
Delhi Fire Services, New Delhi	SHRI S. K. DHERI SHRI SURINDER KUMAR (*Alternate*)
Director General of Factory Advice Service & Labour Institutes, Mumbai	SHRI A. K. GANGULY SHRI B. D. DUBEY (*Alternate*)
Engineer-in-Chief's Branch, Army Headquarters, New Delhi	SHRI AJAY SHANKAR SHRI SHIVOM PRAKASH (*Alternate*)
Engineering Industrial Technical Section, Ministry of Industry, New Delhi	SHRI P. K. SUNKARIA SHRI K. C. MATHUR (*Alternate*)
Engineers India Limited, New Delhi	SHRI M. M. KAPOOR SHRI P. C. SINGHAL (*Alternate*)
Housing & Urban Development Corporation Ltd, New Delhi	SHRI V. SURESH SHRIMATI TARANJOT KAUR GADHOK (*Alternate*)
In Personal Capacity, (*Nandavanam, No. 33/2965-A Veenala High School Road, Veenala, Cochin 602028*)	SHRI G. B. MENON
In Personal Capicity (*4/34 Haji Ali Municipal Office Cooperative Housing Society, Keshavrao Khadi Marg, Haji Ali, Mumbai 400034*)	SHRI V. D. NIKAM
In Personal Capicity (*B-4/5 A. G. Khan Road, Municipal Office Society, Worli, Mumbai 400018*)	SHRI S. M. DESAI
Institution of Fire Engineers (India), New Delhi	PRESIDENT GENERAL SECRETARY (*Alternate*)
Lloyd Insulations (India) Private Limited, New Delhi	SHRI K. K. MITRA SHRI SANJEEV ANGRA (*Alternate*)
Loss Prevention Association of India, Mumbai	MANAGING DIRECTOR SHRI D. K. SARKAR (*Alternate*)
MECON, Ranchi	SHRI SUNIL DAS SHRI R. N. CHACHRA (*Alternate*)
Ministry of Defence, New Delhi	SHRI P. K. CHATTERJEE
Ministry of Home Affairs, New Delhi	SHRI OM PRAKASH DEPUTY FIRE ADVISER (*Alternate*)
Mumbai Fire Brigade, Mumbai	CHIEF FIRE OFFICER DEPUTY CHIEF FIRE OFFICER (*Alternate*)
National Thermal Power Corporation Limited, New Delhi	CHIEF DESIGN ENGINEER- I CHIEF DESIGN ENGINEER- II (*Alternate*)
Northern Railway, New Delhi	SHRI I. M. MANSOORI

(*Continued on page* 15)

(*Continued from page* 14)

Organization	*Representative(s)*
Oil Industry Safety Directorate, New Delhi	SHRI SANJEEVI GANESAN K. SHRI D. K. VARSHNEY (*Alternate*)
State Bank of India, Mumbai	SHRI J. S. GAHLAUT
Tariff Advisory Committee (General Insurance), Ahmedabad/Chennai	SHRI P. K. MAJUMDAR SHRI T. R. A. KRISHNAN (*Alternate*)
Tata Consulting Engineers, Bangalore	SHRI D. PADMANABHA SHRI B. S. VENKATESH (*Alternate*)
BIS Directorate General	SHRI S. K. JAIN, Director & Head (Civ Engg) [Representing Director General (*Ex-officio*)]

Member Secretary
SHRI S. CHATURVEDI
Joint Director (Civ Engg), BIS

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc: No. CED 36 (6014).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 323 01 31, 323 3375, 323 94 02

Telegrams: Manaksanstha
(Common to all offices)

Regional Offices:		Telephone
Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002	323 76 17, 323 38 41
Eastern	: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi, KOLKATA 700054	337 84 99, 337 85 61 337 86 26, 337 91 20
Northern	: SCO 335-336, Sector 34-A, CHANDIGARH 160022	60 38 43 60 20 25
Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600113	254 12 16, 254 14 42 254 25 19, 254 13 15
Western	: Manakalaya, E9 MIDC, Marol, Andheri (East), MUMBAI 400093	832 92 95, 832 78 58 832 78 91, 832 78 92

Branches : AHMEDABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR. NALAGARH. PATNA. PUNE. RAJKOT. THIRUVANANTHAPURAM. VISAKHAPATNAM.

Printed at Simco Printing Press, Delhi