Indian Standard

(Reaffirmed 1999)

CODE OF PRACTICE FOR CONTROL OF AIR POLLUTION IN CEMENT PLANTS

UDC 628·511 : 666·94·05 : 006·76

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

 September 1987

Indian Standard

CODE OF PRACTICE FOR CONTROL OF AIR POLLUTION IN CEMENT PLANTS

Air Quality Sectional Committee, CDC 53

Chairman	*Representing*
Dr B. B. Sundaresan	University of Madras, Madras
Members	
Dr H. Kothandaraman (*Alternate* to Dr B. B. Sundaresan)	
Dr A. L. Agarwal	National Environmental Engineering Research Institute (CSIR), Nagpur
Shri P. K. Yennawar (*Alternate*)	
Dr J. S. Ahluwalia	Indian Oil Corporation Ltd, Faridabad
Shri V. S. More (*Alternate*)	
Shri N. G. Ashar	Dharmsi Morarji Chemical Co Ltd, Bombay
Dr M. S. Vaidya (*Alternate*)	
Dr B. B. Bansal	Central Mechanical Engineering Research Institute, Durgapur
Shri B. Bhadury (*Alternate*)	
Shri A. K. Basu	Calcutta Metropolitan Development Authority, Calcutta
Shri Ranjit Kumar Sengupta (*Alternate*)	
Shri S. Chakrabarty	Directorate General Factory Advice Service & Labour Institutes, Bombay
Dr Phulekar (*Alternate*)	
Shri P. Chatterjee	National Organic Chemicals Industries Ltd, Bombay
Shri K. D. Amre (*Alternate*)	
Dr Nilay Chaudhuri	Central Board for the Prevention and Control of Water Pollution, New Delhi
Member-Secretary (*Alternate*)	
Shri J. M. Dave	Jawaharlal Nehru University, New Delhi
Dr P. J. Deoras	Society for Clean Environment, Bombay
Dr S. B. Chaphekar (*Alternate*)	
Shri M. V. Desai	Indian Chemical Manufacturers' Association, Calcutta
Shri B. Saran (*Alternate*)	
Dr V. S. Gupta	Projects & Development India Ltd, Sindri
Shrimati M. Chandra (*Alternate*)	

(*Continued on page* 2)

(*Continued from page* 1)

Members	*Representing*
SHRI A. LAHIRI	Hindustan Lever Ltd, Bombay
SHRI A. MITRA (*Alternate*)	
DR N. K. MEHROTRA	Industrial Toxicology Research Centre (CSIR), Lucknow
SHRI M. M. LAL (*Alternate* I)	
SHRI J. L. KAW (*Alternate* II)	
SHRI A. K. MISSER	Cement Manufacturers' Association, New Delhi
SHRI P. A. MITRA	Union Carbide of India Ltd, Bombay
SHRI Y. G. PATANKAR (*Alternate*)	
SHRI A. K. MOOKHERJEE	Flakt India Ltd, Calcutta
SHRI M. CHAUDHRY (*Alternate*)	
DR P. N. MUKHERJEE	Central Fuel Research Institute (CSIR), Dhanbad
DR R. U. ROY (*Alternate*)	
DR V. PACHAIYAPAN	Fertilizer Association of India, New Delhi
DR S. NAND (*Alternate*)	
SHRI G. K. PANDEY	Department of Environment (Ministry of Environment and Forest), New Delhi
DR T. S. PATEL	National Institute of Occupational Health (ICMR), Ahmadabad
SHRI S. K. PATIL	Maharashtra Pollution Control Board, Bombay
SHRI D. R. RASAL (*Alternate*)	
SHRI C. R. MADHAVA RAO	Steel Authority of India Ltd (R & D Centre), Ranchi
SHRI I. JAYARAMAN (*Alternate*)	
SHRI A. N. RAO	Directorate General of Technical Development, New Delhi
SHRI P. K. RAMACHANDRAN	Ministry of Defence (DGI)
DR B. V. RAMANI (*Alternate*)	
SHRI CH V. RAMANAMURTHY	Central Electricity Authority, New Delhi
SHRI R. K. SHARMA (*Alternate*)	
DR S. G. RETARKAR	Municipal Corporation of Greater Bombay, Bombay
SHRI DHIRENDRA J. VYAS (*Alternate*)	
SHRI S. B. SARKAR	Coal India Ltd, Calcutta
SHRI B. F. SALUJA	Gujarat Pollution Control Board, Gandhinagar
DR U. I. BHATT (*Alternate*)	
DR V. V. SHIRVAIKAR	Bhabha Atomic Research Centre, Bombay
DR R. K. KAPOOR (*Alternate*)	
DR J. K. SINHA	Central Mining Research Station (CSIR), Dhanbad
SHRI A. K. BOSE (*Alternate*)	
SHRI SATISH CHANDER, Director (Chem)	Director General, BIS (*Ex-officio Member*)

Secretary

SHRI S. ARAVAMUDHAN
Joint Director (Chem), BIS

(*Continued on page* 12)

Indian Standard

CODE OF PRACTICE FOR CONTROL OF AIR POLLUTION IN CEMENT PLANTS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 January 1987, after the draft finalized by the Air Quality Sectional Committee had been approved by the Chemical Division Council.

0.2 Protection and improvement of air quality for present and future generations should be ensured. Also for uniform application of technology and operating practices, a code of practice containing the latest available information on air pollution sources, determination of emissions, control techniques, measurement and monitoring of emissions would be useful in the design and operation of dust control equipment in cement plants.

0.3 From the point of view of pollution of the atmosphere and habitation surrounding cement plants, the large amount of dust emitted by these plants needs prime consideration. This standard has been formulated in order to help the industry to identify the sources of pollution and to take suitable action for pollution abatement.

---

1. SCOPE

1.1 This standard covers:

a) air pollutants,

b) source of air pollutants,

c) pollution control techniques,

d) measurement of emissions,

e) location and layout, and

f) air pollution surveys.

2. AIR POLLUTANTS

2.1 The pollution of the atmosphere caused by cement industry is substantially different in nature from that caused by other industries like petro-chemicals, fertilizers, etc. The pollutants discharged into the atmosphere by a cement plant consist mostly of particulate matter with insignificant quantities of compounds of sulphur.

2.2 Particulates — The particulate matter emitted contains mostly limestone dust, Portland cement and coal dust.

2.3 Sulphur Compounds — These depend upon the chemical composition of coal. Normally Indian coals have low sulphur content. Thus the sulphur content with the emission can be termed as insignificant and thus no control needs to be exercised.

3. SOURCES OF AIR POLLUTION DUE TO PARTICULATES

3.1 The sources of air pollution in a cement plant are as given below.

3.2 Crushers — Crushers are used in the cement industry mainly for crushing limestone and coal.

3.2.1 *Limestone Crushers* — Crusher selection depends upon the characteristics of the raw materials. In the past the trend was to use jaw crushers as primary crusher and swing hammer reversible impact crushers as secondary crushers. Present trend in the cement plants is to use a single pass high capacity swing hammer mill or impact crushers to crush the limestone to the required size.

3.2.2 *Coal Crushers* — Impact or hammer mill crusher or ring granulators are used for crushing of coal.

3.3 Raw Mill

3.3.1 *Grinding Mill (Cylindrical Type) for Wet Process Cement Making* — Since grinding is done in wet conditions, there is no pollution at wet grinding installation.

3.3.2 *Grinding Mills for Dry Process/Semi-dry Process Cement Making*

3.3.2.1 *Open circuit conventional ball mill* — These mills are existing at a few of the very old cement plants of small capacity.

3.3.2.2 *Closed circuit ball mills* — Closed circuit grinding is adopted to avoid overgrinding and to control the particle size distribution over a narrow range. The amount of gases to be vented through the mill system depend upon the amount of moisture to be dried.

3.3.2.3 *Vertical grinding mills* — Vertical mills are the latest addition to the grinding techniques of limestone/raw materials. These mills are essentially of air swept type closed circuit mills having an inbuilt classifier. Entire ground product in such mills is carried away by the air/gases to the cyclone and then to the electrostatic precipitator or directly from the mill to an electrostatic precipitator.

NOTE — In dry process cement plants, the raw grinding mills generally utilize the exhaust gases from the kiln so as to make use of the available heat to dry the raw materials. However, the range of dust burden remains the same as given in Table 1.

3.4 Coal Mill

3.4.1 *Coal Dryer* — Rotary dryers are generally used for drying coal in the cement industry. Volume of the exhaust gases depends on moisture content of the coal.

3.4.2 *Coal Grinding* — Pulverised coal required for calcining and clinkering of the raw materials in the kiln is ground in air swept mills. These may be either ball type air swept mills or vertical grinding mills.

3.4.3 The exhaust gas volume, temperature of exhaust and dust burden are given in Table 1.

3.5 Kilns — The major portion of dust in cement plants is generated by the kiln exhaust gases. The particulate matter emitted contains mostly limestone dust. These particles get deposited in the surrounding areas. Dust concentration of exhaust gases varies with the type of process adopted for making cement.

3.5.1 *Kilns Used for Production of Clinker* — The various types of kilns used for production of clinker are given below.

NOTE — Cement manufacture has undergone rapid technological changes. In India we have cement plants using various types of kilns mentioned below. However, all the new cement plants coming up are dry process plants with precalcination technology incorporated.

3.5.2 *Shaft Kiln* — This process is used only for mini cement plants having a capacity of 20 to 200 tonnes/day.

3.5.3 *Wet Process Long Kiln* — In this process, wet slurry (33-38 percent moisture) is fed to a long kiln from one end and coal firing is done at the other end. Capacity range for such plants in India is 180 to 750 tonnes/day.

3.5.4 *Wet Process Calciner Kiln* — In this process the raw meal slurry first enters the calciner for partial drying and then enters a rotary kiln. Capacity range for such plants is 500 to 1 000 tonnes per day.

3.5.5 *Semi-Dry Process Kiln* (*Lepol Grate*) — In this process, raw meal is fed on the moving grate in the form of nodules (10 to 12 percent moisture). Flue gases from the kiln enter the grate chamber for drying and partial calcination of raw meal nodules. Capacity for such plants is about 500 tonnes per day.

3.5.6 *Dry Process Suspension Preheater Kiln* — In this process, raw material is fed in the form of dry powder from the top of suspension preheater and the hot flue gases from the kiln travel upwards. Heat transfer takes place while the particles are in suspension. The gas temperature would be 50-70°C lower for a 5-stage preheater as compared to the 4-stage preheater.

3.5.7 *Dry Process Suspension Preheater Kiln with Precalcination* — Dust burden and the quantity of gas generated is same as given in **3.5.6**. Higher kiln capacity would result in lower specific gas volume. The exit gas temperature may be slightly higher by about 20-50°C than in the case of suspension preheater kiln.

3.5.8 The exhaust gas volume, temperature of exhaust gases and their dust burden is also given in Table 1 for different types of kilns.

TABLE 1 EMISSIONS FROM MILLS AND KILNS

(*Clauses* 3.4.3 *and* 3.5.8)

SL No.	PROCESS	EXHAUST GAS VOLUME, Nm^3/kg OF PRODUCT	TEMPERATURE OF EXHAUST GASES, °C	DUST BURDEN, g/Nm^3
(1)	(2)	(3)	(4)	(5)
i)	Lime stone crushing			
	a) Jaw crusher	—	—	20-75
	b) Hammer mill	—	—	105-220
ii)	Coal crusher	—	—	50-165
iii)	Grinding mills			
	a) Open circuit conventional ball mills	—	90 to 100	105-170
	b) Closed ciruit ball mills	—	90 to 100	130-300
	c) Vertical grinding mill	1·5 to 2	90 to 100	450-700
iv)	Coal dryer	—	—	45-65
v)	Coal grinding	2-2·5	70 to 90	50-100
vi)	Shaft kilns	2-3	100 to 150	0·1-0·5
vii)	Wet process long kiln	3-5	150 to 200	15-45
viii)	Wet process calciner kiln	3·5-5	150 to 200	70-100
ix)	Semi-dry process (Lepol Grate kiln)	2·5 to 4	90 to 130	5-15
x)	Dry process suspension preheater kiln	1·6 to 2·5	340 to 370 (4-stage preheater)	50-70
xi)	Clinker cooler	1·9 to 2·5	150 to 200	7-18
xii)	Cement mill			
	a) Open circuit	0·3-0·5	100	100-200
	b) Close circuit	0·2-0·4	100	200-400

3.6 Clinker Cooler — Here the atmospheric air is forced inside the cooler to cool the hot clinker. During the process air picks up the fine particulates. Dust burden varies in the range of 5-10 g/m^3 and temperature of the air is around 150 to 200°C for clinker exit temperature of approximately 100°C. The air volume is in the range of 3 to 4 m^3/kg of clinker cooled.

3.7 Cement Mills — Both open circuit and closed circuit cylindrical ball type grinding mills are used for grinding the clinker into cement. The temperature of exit air is about 100°C if water spray is used inside the mill.

3.8 Packing — Dust generation in a packing plant takes place mainly on account of the use of jute bags for packing the cement. The other points of dust generation are:

a) conveying equipment from the cement silo to the packing machines,

b) packing machines where the bags are filled, and

c) various transfer points of the belt conveyors conveying the cement bags to the railway wagons or trucks.

3.9 Material Transfer Point — Dust is generated wherever there is a transfer of fine materials from one point to another especially in belt conveyor systems.

3.10 Fugitive Emissions — Fugitive emissions can occur due to improper operational practices, such as material falling from a height on to a surface, leakages in ducts, etc.

4. POLLUTION CONTROL TECHNIQUES

4.1 Control Methods — Control of pollutant emissions may be divided into two categories:

a) Control of material present in gas streams inside process equipment, and

b) Control of materials arising in open or unconfined areas. Strategies for control include basic changes in procedures and materials which eliminate or reduce emissions and the use of addon auxiliary equipment to remove pollutants prior to release of the carrier gas to the atmosphere. Often, changes in hooding, material handling and good house-keeping can reduce the emission of air pollutants into the atmosphere.

4.1.1 Equipment for the control of particulate emission includes dry inertial and centrifugal collectors, such as cyclones, low and high energy scrubbers, electrostatic precipitators and cleanable fabric filters.

Equipment selection may be made only from among those which are capable of performing the required task with consideration given to the cost of the equipment. The selection depends on the pollutant and carrier gas characteristics, particle concentration (average and range), average particle size and size distribution, particle shape, density, resistivity, gas flow rate, temperature, moisture content, etc.

4.2 Types of Equipment

4.2.1 *Cyclone* — Cyclone is the simplest form of pollution control equipment for suspended matter and separates suspended particulate matter from the gas carrying it. High efficiency cyclones are generally provided in clusters. Collection efficiency ranges from 60 to 85 percent. Particles above 20 micron size can be arrested. It is advisable to use cyclone separators only as primary dust control equipment.

4.2.2 *Wet Scrubbers*

4.2.2.1 *Venturi scrubbers* — In these scrubbers the help of a spray of water is taken to agglomerate finer dust particles. Collection efficiency ranges from 90-95 percent.

4.2.2.2 *Submerged type scrubbers* — In these type of scrubbers higher efficiencies of the range of 95-97 percent can be achieved by passing the entire volume of gases through a layer of water.

4.2.2.3 Both the above types present a problem of separating out the fine particles of dust collected in the water and of recovering water. These can be used in the processing of limestone and coal, but not in the processing of clinker and cement.

4.2.3 *Bag Type Filter* — This is the most widely used type of pollution control equipment in the cement industry. The efficiency of the dust collector can be over 99·5 percent. Cleaning of bags by pulse-jet of compressed air is generally preferred. Present day bag type filters are available for all kinds of applications including fine coal dust. However, proper safety precautions are required to be taken in the case of coal grinding and drying installations.

4.2.4 *Electrostatic Precipitator* — This is the most modern piece of equipment available for controlling air pollution. Collection efficiency can be over 99·9 percent. Basically electrostatic precipitator operation consists in the action of unidirectional electric field upon free electric charges present in the field. High voltage (30-80 KV) gives rise to emission of free electrons (carona effect). Under the influence of electrical field the dust particles move to collecting electrodes at migration velocity. It's effective and trouble free operation demands careful selection, design, fabrication, erection and handling.

4.2.5 *Gravel Bed Filters* — These filters are used in many countries for cleaning the vent gases from the clinker cooler. Though it has not been tried out in our country, this filter is suitable for the highly abrasive clinker particles.

4.3 Selection of Air Pollution Control Equipment

4.3.1 *Crusher Installations* — A bag type dust collector is necessary for large crushers of capacity 150 tonnes per hour and above. For smaller crushers, dust pollution may be reduced to a large extent by providing water sprays at appropriate locations in the system.

4.3.2 *Dry Raw Grinding Mills* — In case hot gas is drawn from the dry process kiln, it is better to vent the raw mill vent gases directly into the kiln exhaust gas dust control equipment. Otherwise, a pulse-jet type of bag dust collector may be used. However, in case moisture content of the raw material is high an electrostatic precipitator may also be considered.

4.3.3 *Coal Dryers*

4.3.3.1 *Coal dryer exhaust gases* — An electrostatic precipitator or special material bag type dust collector can be considered for cleaning coal dryer exhaust gases. Air pollution control installations should comply with all safety regulations.

4.3.3.2 *Coal dryers* — For bigger installations, electrostatic precipitators may be considered. In such cases proper safety regulation should be applied. For smaller installations special material bag type dust collectors are also suitable. In case water is available in adequate quantity, wet scrubbers can also be considered but they pose a problem in the disposal of coal sludge formed in these scrubbers.

4.3.4 *Kiln* — To meet the pollution control requirements, use of electrostatic precipitators is preferred.

4.3.4.1 In the case of dry process plants, exhaust gases are required to be conditioned in a conditioning tower before entering the electrostatic precipitator. Spraying of water inside the conditioning tower lowers down the temperature of gases to 150°C, and increases the dew point temperature to about 55°C, thus providing the best conditions for precipitation in an electrostatic precipitator. However, in the plants where availability of water is a problem, it is recommended to use fibre glass bag dust collectors with latest pulse jet type of arrangement.

4.3.4.2 Selection of dust control equipment for semi-dry process cement kilns with grate type preheaters needs careful consideration with respect to acid dew point temperature and analysis should be done with care for the same before installing electrostatic precipitators or bag type dust collectors.

4.3.4.3 In case of wet process kilns electrostatic precipitators are ideally suited. On the relatively old wet process kilns of small capacities, wet scrubbers may also be used.

4.3.5 *Clinker Coolers* — There is no generation of dust in the operation of planetary coolers. In the case of grate type clinker coolers, dust generation is not appreciable when operating under stable condition and a multicone dust collector is adequate for the control of dust pollution. Other options available for this are electrostatic precipitators and gravel bed filters.

4.3.6 *Cement Mills* — Electrostatic precipitators and pulse-jet type bag dust collectors are good for venting the exit gases from cement mills.

4.3.6.1 *Coal dryer exhaust gases* — An electrostatic precipitator or special material bag type dust collector can be considered for cleaning coal dryer exhaust gases. Air pollution control installations should comply with air safety regulations.

4.3.7 *Material Handling Operations* — In material handling operations, especially the transfer of material from one conveyor to other, hoods are to be provided from which the air can be drawn by means of suction and dedusted in a fabric filter. Several conveyor transfer points can thus be ventilated through a dust collector.

4.3.8 *Fugitive Emission Sources* — Fugitive emissions can be prevented by better operational practices.

5. SAMPLING AND MEASUREMENT

5.1 Sampling and measurement of particulate emission from stacks should be carried out in accordance with the method prescribed in IS : 11255 (Part 1)-1985*. Regular measurement of emissions from the various vent stacks in a cement plant is necessary. This, however, requires specialised equipment and considerable skill. It is, therefore, necessary that adequate training is given to the concerned personnel. Alternatively such measurements may be carried out with the aid of specialized agencies who are equipped for this work.

6. LOCATION AND LAYOUT

6.1 While deciding location of a new cement plant, the micrometeorological factor prevailing in the area and the topography of the area should be considered (*see* IS : 8829-1978†). Areas with frequent record of invention occurrence and valleys should not be considered as prospective location from air pollution episode view point. The location of

---

*Methods for measurement of emissions from stationary sources: Part 1 Particulate matter.

†Guidelines for micrometeorological techniques in air pollution studies.

residential areas should be such that they are located towards the cleaner side of the plant. There should be a green belt of adequate width around the plant boundary to absorb noise and arrest dust.

6.2 The layout of the plant should be such that a predominent wind direction is from cleaner side of plant to pollution emitting side of plant. The layout of highly polluting sections should be preferably perpendicular to the predominent wind direction.

7. AIR POLLUTION SURVEY

7.1 An air-pollution survey of the localities around the proposed plant or proposed expansion should be conducted to determine the background pollution level already existing, due to natural and other sources. If the background level is found to be excessive, measures should be taken to reduce it by modifying pollution control systems of the existing sources. The new pollution control units of the plant should then be designed to contribute only the difference between acceptable value of ground level concentration and the background level already existing.

7.2 In each cement plant, independent pollution monitoring facilities should be provided. A systematic record of emission inventories and ground level concentrations in residential location at predetermined grid points [*see* IS : 5182 (Part 14)-1979*] should be maintained by the pollution monitoring group. It is preferable to have a sampling and analysis laboratory and trained personnel for pollution monitoring in the plant itself.

8. EMISSION LIMITS

8.1 The emission limits for pollutants from cement plants are given in IS : 10693 (Part 1)-1983† and IS : 10693 (Part 2)-1986‡.

---

*Methods for measurement of air pollution: Part 14 Guidelines for planning the sampling of atmosphere (*first revision*).

†Limits for emission of particulate matter from cement plants: Part 1 Kilns.

‡Limits for emission of particulate matter from cement plants: Part 2 Raw grinding and cement mills.

(*Continued from page* 2)

Codes of Practice for Control of Air Pollution Subcommittee, CDC 53 : 4

Convener	*Representing*
Shri N. G. Ashar	Dharamsi Morarji Chemical Co Ltd, Bombay
Members	
Shri L. K. Jain (*Alternate* to Shri N. G. Ashar)	
Dr A. L. Agarwal	National Environmental Engineering Research Institute (CSIR), Nagpur
Shri G. K. Pandey (*Alternate*)	
Shri S. Chakrabarty	Directorate General Factory Advice Services and Labour Institute, Bombay
Dr Phulekar (*Alternate*)	
Shri P. Chatterjee	National Organic Chemical Industries Ltd, Thane
Shri K. D. Amre (*Alternate*)	
Shri P. R. Ghare Khan	Indian Petrochemicals Corporation Ltd, Vadodara
Shri M. K. Prabhu (*Alternate*)	
Dr V. S. Gupta	Projects & Development India Ltd, Sindri
Shri S. B. Sinha (*Alternate*)	
Shri D. B. Irani	National Council for Cement and Building Materials, New Delhi
Shri R. Ganapathy (*Alternate*)	
Shri J. P. Kapur	Indian Chemical Manufacturer's Association, Calcutta
Dr N. C. Mehta (*Alternate*)	
Shri M. M. Lal	Industrial Toxicology Research Centre (CSIR), Lucknow
Shri S. K. Maira	Flakt India Ltd, Calcutta
Shri B. Majumdar (*Alternate*)	
Dr V. Pachaiyapan	Fertilizer Association of India, New Delhi
Dr S. Nand (*Alternate*)	
Shri T. C. Parthasarathy	Bharat Heavy Electricals Ltd, Hyderabad
Shri P. R. Krishna Murthy (*Alternate*)	
Shri R. Ramanan	Batliboi & Co Ltd, Bombay
Shri J. N. Mehrotra (*Alternate*)	
Dr K. R. Ranganathan	Central Board for the Prevention and Control of Water Pollution, New Delhi
Dr B. Sengupta (*Alternate*)	
Dr B. Singh	Central Mining Research Station (CSIR), Dhanbad
Dr J. K. Sinha (*Alternate*)	
Shri S. A. Subramanian	Central Electricity Authority, New Delhi
Shri S. Venkataraman	Indian Oil Corporation Ltd, New Delhi
Shri M. Kannan (*Alternate*)	
Shri R. Virupakshiah	Voltas Limited, Bombay
Shri Dhirendra J. Vyas	Municipal Corporation of Greater Bombay, Bombay
Shri S. G. Retarkar (*Alternate*)	