Energy, Environment and Climate Change

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National Ambient Air Quality Standards

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THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981

No. 14 of 1981

[29th March, 1981]

An Act to provide for the prevention, control and abatement of air pollution, for the establishment, with a view to carrying out the aforesaid purposes, of Boards, for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith.

WHEREAS decisions were taken at the United Nations Conference on the Hum an Environment held in Stockholm in June, 1972, in which India participated, to take appropriate steps for the preservation of the natural resources of the earth which, among other things, include the preservation of the quality of air and control of air pollution;

AND WHEREAS it is considered necessary to implement the decisions aforesaid in so far as they relate to the preservation of the quality of air and control of air pollution;

BE it enacted by Parliament in the Thirty-second Year of the Republic of India as follows :-

CHAPTER I
PRELIMINARY

1. Short title, extent and commencement.

(1) This Act may be called the Air (Prevention and Control of Pollution) Act, 1981.

(2) It extends to the whole of India.

(3) It shall come into force on such date[1] as the Central Government may, by notification in the Official Gazette, appoint.

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NATIONAL AMBIENT AIR QUALITY STANDARDS
CENTRAL POLLUTION CONTROL BOARD
NOTIFICATION

New Delhi, the 18th November, 2009

No.B-29016/20/90/PCI-L—In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981), and in super session of the Notification No(s). S.O. 384(E), dated 11th April, 1994 and S.O. 935(E), dated 14th October, 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect, namely:-

NATIONAL AMBIENT AIR QUALITY STANDARDS

S. No.	Pollutant	Time Weighted average	Concentration in Ambient Air		Methods of Measurement
			Industrial, Residential, Rural and Other Area	Ecologically sensitive area (notified by Central Govt.)	
(1)	(2)	(3)	(4)	(5)	(6)
1	Sulphur Dioxide (SO_2), µg/m^3	Annual*	50	20	• Improved West and Geake • Ultraviolet fluorescence
		24 hours**	80	80	
2	Nitrogen Dioxide (NO_2), µg/m^3	Annual*	40	30	• Modified Jacob & Hochheiser (Na-Arsenite) • Chemiluminescence
		24 hours**	80	80	
3	Particulate Matter (size less than 10 µm) or PM_{10}µg/m^3	Annual*	60	60	• Gravimetric • TOEM • Beta attenuation
		24 hours**	100	100	
4	Particulate Matter (size less than 2.5 microns) or $PM_{2.5}$ µg/m^3	Annual*	40	40	• Gravimetric • TOEM • Beta attenuation
		24 hours**	60	60	
5	Ozone (O_3) µg/m^3	8 hours **	100	100	• UV photometric • Chemiluminescence • Chemical method
		1 hour **	180	180	
6	Lead (Pb) µg/m^3	Annual*	0.5	0.5	• ASS / ICP method after sampling on EPM 2000 or equivalent filter paper • ED – XRF using Teflon filter
		24 hours**	1.0	1.0	

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(1)	(2)	(3)	(4)	(5)	(6)
7	Carbon Monoxide (CO) mg/m^3	8 hours**	2	2	Non Dispersive Infra RED (NDIR) Spectroscopy
		1 hour**	4	4	
8	Ammonia (NH_3) µg/m^3	Annual*	100	100	• Chemiluminescence • Indophenol blue method
		24 hours**	400	400	
9	Benzene (C_6H_6) µg/m^3	Annual*	5	5	• Gas chromatography based continuous analyser • Adsorption and desorption followed by GC analysis
10	Benzo (a) Pyrene (BaP) – particulate phase only ng/m^3	Annual*	1	1	Solvent extraction followed by HPLC / GC analysis
11	Arsenic (As) ng/m^3	Annual*	6	6	AAS / ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni) ng/m^3	Annual*	20	20	AAS / ICP method after sampling on EPM 2000 or equivalent filter paper

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

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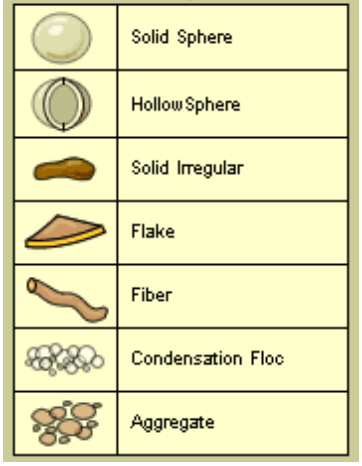
Figure 1. Example Particle Shapes



The **aerodynamic diameter** is the diameter of a spherical particle having a density of 1 gm/cm^3 that has the same inertial properties [i.e. terminal settling velocity] in the gas as the particle of interest.

PM_{10}

The term PM_{10} will be used to include all particles having an aerodynamic diameter of less than 10 micrometers.

$PM_{2.5}$

The term $PM_{2.5}$ is used to include all particles having an aerodynamic diameter of less than 2.5 micrometers.

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NATIONAL AIR QUALITY INDEX

Air Quality Index is a tool for effective communication of air quality status to people in terms, which are easy to understand. It transforms complex air quality data of various pollutants into a single number (index value), nomenclature and colour.

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Table 3.12 Health Statements for AQI Categories

AQI	Associated Health Impacts
Good(0–50))	Minimal Impact
Satisfactory (51–100)	May cause minor breathing discomfort to sensitive people
Moderately polluted (101–200)	May cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults
Poor (201–300)	May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease
Very Poor (301–400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases
Severe (401-500)	May cause respiratory effects even on healthy people and serious health impacts on people with lung/heart diseases. The health impacts may be experienced even during light physical activity

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AQI Category	AQI	Concentration range*							
		PM_{10}	$PM_{2.5}$	NO_2	O_3	CO	SO_2	NH_3	Pb
Good	0 - 50	0 - 50	0 - 30	0 - 40	0 - 50	0 - 1.0	0 - 40	0 - 200	0 - 0.5
Satisfactory	51 - 100	51 - 100	31 - 60	41 - 80	51 - 100	1.1 - 2.0	41 - 80	201 - 400	0.5 - 1.0
Moderately polluted	101 - 200	101 - 250	61 - 90	81 - 180	101 - 168	2.1 - 10	81 - 380	401 - 800	1.1 - 2.0
Poor	201 - 300	251 - 350	91 - 120	181 - 280	169 - 208	10 - 17	381 - 800	801 - 1200	2.1 - 3.0
Very poor	301 – 400	351 - 430	121 - 250	281 - 400	209 - 748*	17 - 34	801 - 1600	1200 -1800	3.1 - 3.5
Severe	401 - 500	430 +	250+	400+	748+*	34+	1600+	1800+	3.5+

* CO in mg/m^3 and other pollutants in $\mu g/m^3$; 2h-hourly average values for PM_{10}, $PM_{2.5}$, NO_2, SO_2, NH_3, and Pb, and 8-hourly values for CO and O_3.

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$$I_{p=} [\{(I_{HI} - I_{LO})/ (B_{HI} - B_{LO})\} \star (C_p - B_{LO})] + I_{LO}$$

B_{HI} = Breakpoint concentration greater or equal to given conc.

B_{LO} = Breakpoint concentration smaller or equal to given conc.

I_{HI} = AQI value corresponding to B_{HI}

I_{LO} = AQI value corresponding to B_{LO}

Finally;

$$AQI = \text{Max } (I_p) \text{ (where; p= 1,2,...,n; denotes n pollutants)}$$

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All the eight pollutants may not be monitored at all the locations. Overall AQI is calculated only if data are available for minimum three pollutants out of which one should necessarily be either PM2.5 or PM10. Else, data are considered insufficient for calculating AQI. Similarly, a minimum of 16 hours' data is considered necessary for calculating subindex.

NO_2 – 100 micrograms per cubic meter

$I_{HI} = 200$ $I_{LO} = 101$ $B_{HI} = 180$ $B_{LO} = 81$

$I_P = ((I_{HI} – I_{LO})/(B_{HI} – B_{LO}))*(C_P – B_{LO})) + I_{LO} = ((200-101)/(180 – 81)*(100 – 81)) + 101 = 120$

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Sr. No.	Industry	Parameter	Standards
1	2	3	4
"25.	Thermal Power Plant	TPPs (units) installed before 31st December, 2003*	
		Particulate Matter	100 mg/Nm³
		Sulphur Dioxide (SO_2)	600 mg/Nm³ (Units Smaller than 500MW capacity units) 200 mg/Nm³ (for units having capacity of 500MW and above)
		Oxides of Nitrogen (NOx)	600 mg/Nm³
		Mercury (Hg)	0.03 mg/Nm³(for units having capacity of 500MW and above)
		TPPs (units) installed after 1st January,2003, upto 31st December, 2016*	
		Particulate Matter	50 mg/Nm³
		Sulphur Dioxide (SO_2)	600 mg/Nm³ (Units Smaller than 500MW capacity units) 200 mg/Nm³ (for units having capacity of 500MW and above)
		Oxides of Nitrogen (NOx)	300 mg/Nm³
		Mercury (Hg)	0.03 mg/Nm³
		TPPs (units) to be installed from 1st January, 2017**	
		Particulate Matter	30 mg/Nm³
		Sulphur Dioxide (SO_2)	100 mg/Nm³
		Oxides of Nitrogen (NOx)	100 mg/Nm³
		Mercury (Hg)	0.03 mg/Nm³

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How to Express the Emission

While measuring the emission in a stack, the temperature, pressure, and humidity are to be recorded. The emission limits prescribed are expressed as concentration of pollutants per unit volume of air under standard or normal conditions, written as Nm^3. The standard conditions for air in India, hereinafter termed as Standard Air, are 25°C temperature, 760 mm Hg pressure, and zero percent moisture. Emissions measured at other conditions of air are to be computed for Standard Air for reporting compliance to the prescribed limits.

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A power plant of 500MW capacity burns 20 T coals/MW/Day. During thus burning process, the plant has the following information.

Sulphur in coal: 0.5% (weight/weight)

Temperature in stack: 125°C

Pressure in stack: 1.1 atm

Stack exit velocity: 15m/s

Diameter of stack: 10m

Estimate SO_2 concentration in kg/day, ppm & mg/N (normal) m^3

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VEHICULAR POLLUTION

Indian Emission Standards (4-Wheel Vehicles)			
Standard	Reference	YEAR	Region
India 2000	Euro 1	2000	Nationwide
Bharat Stage II	Euro 2	2001	NCR*, Mumbai, Kolkata, Chennai
		2003.04	NCR*, 13 Cities†
		2005.04	Nationwide
Bharat Stage III	Euro 3	2005.04	NCR*, 13 Cities†
		2010.04	Nationwide
Bharat Stage IV	Euro 4	2010.04	NCR*, 13 Cities†
Bharat Stage V	Euro 5	(to be skipped)	
Bharat Stage VI	Euro 6	2020.04 (proposed)	Entire country

* National Capital Region (Delhi)
† Mumbai, Kolkata, Chennai, Bengaluru, Hyderabad, Ahmedabad, Pune, Surat, Kanpur, Lucknow, Sholapur, Jamshedpur and Agra

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EMISSION TARGETS

Engine type	Mass of exhaust gas	BS4 limit	BS6 limit	Percentage decrease
Petrol	CO (in mg/km)	1000	1000	Nil
	HC (in mg/km)	100	100	Nil
	NOx (in mg/km)	80	60	25%
	PM (in mg/km)	-	4.5 (for gasoline direct injection engines only)	
Diesel	CO (in mg/km)	500	500	Nil
	HC + NOx (in mg/km)	300	170	43%
	NOx (in mg/km)	250	80	68%
	PM (in mg/km)	25	4.5	82%

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How is BS VI Different from BS IV?

- **The major difference between the existing BS-IV and forthcoming BS-VI norms is the presence of sulphur in the fuel. While the BS-IV fuels contain 50 parts per million (ppm) sulphur, the BS-VI grade fuel only has 10 ppm sulphur content.**
- **Also, the harmful NOx from diesel cars can be brought down by nearly 70%. In the petrol cars, they can be reduced by 25%.**
- **However, when we talk air pollution, particulate matter like PM 2.5 and PM 10 are the most harmful components and the BS VI will bring down the cancer causing particulate matter in diesel cars by a phenomenal 80%.**
- **Only those vehicles will be sold and registered in India from 1st April 2020 onwards, which comply to these norms.**

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Air Pollutant Types

- **Air pollutants are** Substances introduces into the air, natural or manmade, in concentrations detrimental to human, plant or animal life, or to property.

Pollutants can be grouped into two categories:

(1) primary pollutants, Materials that when released pose health risks in their unmodified forms or those emitted directly from identifiable sources.

(2) secondary pollutants, Primary pollutants interact with one another, sunlight, or natural gases to produce new, harmful compounds

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Primary Pollutants

The major primary pollutants include:

- **particulate matter (PM),**
- **sulfur dioxide,**
- **nitrogen oxides,**
- **volatile organic compounds (VOCs),**
- **carbon monoxide,**
- **lead.**
- **Organic compounds**
- **Radioactive compounds**

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Secondary Pollutants

- **Atmospheric sulfuric acid, nitric acid are examples of a secondary pollutant.**
- **Air pollution in urban and industrial areas is often called Photochemical smog.**
  - **Photochemical smog is a mixture of air pollutants formed by the reaction of nitrogen oxides and volatile organic hydrocarbons when they are exposed to sunlight.**
  - **More than 100 secondary pollutants can be formed. The major component of photochemical smog is ozone formed due to presence of nitrogen dioxide and hydrocarbons in presence of strong sunlight.**

Photochemical smog in the city of Los Angeles

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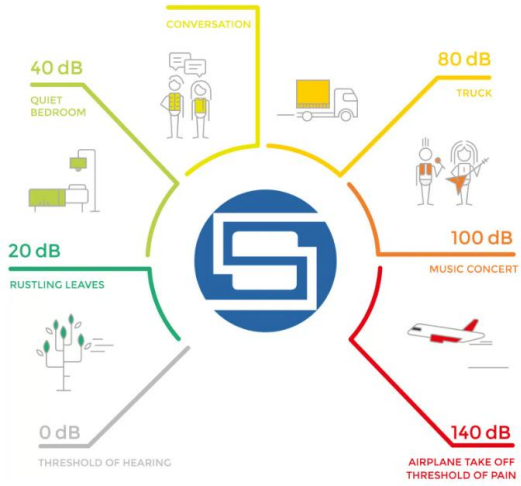
NOISE POLLUTION

Sound Pressure Level (SPL) Examples

The sound pressure level for some sources may vary depending on the distance between the source and the listener. The values in this table are provided as a general guide:

Source	Sound Pressure Level (dB)
Threshold of Hearing	0
Rustling leaves	20
Quiet whisper (1 m)	30
Quiet office	40
Normal conversation at 1 m	60
Inside a car	65-80
Loud singing	70
Vacuum cleaner (3 m)	75
Buses, diesel trucks, motorcycles (15 m)	80
Jackhammer (15 m)	90
Subway (inside)	94
Lawn mower (1 m)	107
Deafening, human pain limit	120
Jet plane (30 m)	130
Threshold of pain	140
Military Jet Take-off (30 m)	150
Large military weapons	180



Download the decibel level chart:

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SCHEDULE

(see rule 3(1) and 4(1))

Ambient Air Quality Standards in respect of Noise

Area Code	Category of Area / Zone	Limits in dB(A) Leq*	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

Note:- 1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority
4. Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.

* dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

A "decibel" is a unit in which noise is measured.

"A", in dB(A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.

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- The sound pressure level then is a logarithmic ratio L_p defined as:

$$L_p = 10\log\frac{p_{rms}^2}{p_{ref}^2} = 20\log\frac{p_{rms}}{p_{ref}}$$ Eqn. 2.15

where

p_{rms} = *the sound pressure of interest (in Pa) and*

p_{ref} = *reference sound pressure (in Pa) usually chosen as the limit of hearing of 20 μPa.*

- The unit for the sound pressure level, SPL or L_p, *is the decibel (dB)*

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Example 7-3. Compute the mean sound level from the following four readings (all dBA): 38, 51, 68, and 78.

Solution. First we compute the sum:

$$\sum_{j=1}^{4} = 10^{(38/20)} + 10^{(51/20)} + 10^{(68/20)} + 10^{(78/20)}$$

$$= 1.09 \times 10^4$$

Now we complete the computation:

$$\bar{L}_p = 20 \log \frac{1.09 \times 10^4}{4}$$

$$= 68.7 \text{ or } 69 \text{ dBA}$$

Straight arithmetic averaging would yield 58.7 or 59 dB.

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L_{eq} (equivalent continuous sound level) is defined as the steady sound pressure level which, over a given period of time, has the same total energy as the actual fluctuating noise.

L_{eq} is often frequency-weighted using an A-weighting filter, which is the most common method for assessing human perception of noise, and these values are labeled L_{Aeq} with units of dBA.

The L_{eq} Concept

- The equivalent continuous equal energy level (L_{eq}) can be applied to any fluctuating noise level.
- It is expressed as:

$$L_{eq} = 10 \log \sum_{i=t}^{i=n} (10^{L_i/10})(t_i) \qquad \text{Eqn. 2.22}$$

where n = the total number of samples taken
L_i = the noise level in dBA of the ith sample
t_i = fraction of total sample time

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Example 7-5. Consider the case where a noise level of 90 dBA exists for five minutes and is followed by a reduced noise level of 60 dBA for 50 minutes. What is the equivalent continuous equal energy level for the 55-minute period? Assume a five-minute sampling interval.

Solution. If the sampling interval is five minutes, then the total number of samples (n) is 11, and the fraction of total sample time (t_i) for each sample is 1/11 = 0.091. With these preliminary calculations, we may now compute the sum:

$$\sum_{t=1}^{2} = \left(10^{90/10}\right)(0.091) + \left(10^{60/10}\right)(0.91)$$

$$= (9.1 \times 10^7) + (9.1 \times 10^5) = 9.19 \times 10^7$$

And finally, we take the log to find

$$L_{eq} = 10 \log (9.19 \times 10^7) = 79.6 \text{ or } 80 \text{ dBA}$$

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