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Measurement, Monitoring and Environmental Assessment

WP 4.1.1 State of the art and future trends
Environmental legislation

A REVIEW OF THE BRIC COUNTRIES ENVIRONMENTAL LEGISLATION AND EMISSION MONITORING

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Appendix II: CHINA: Method Standard for stationary source emission and effective starting date.

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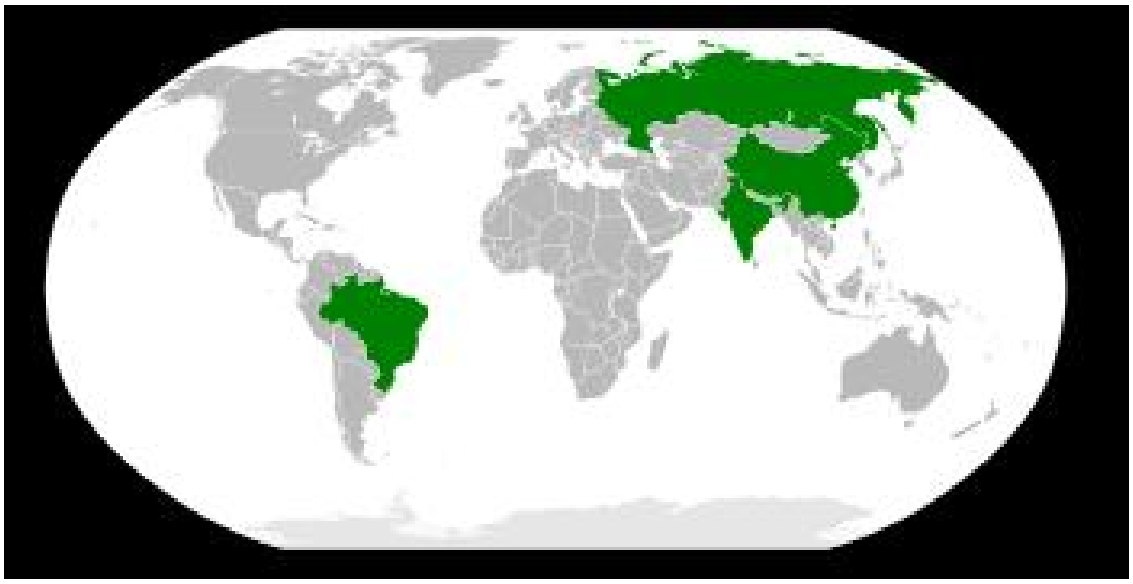

1. The BRIC countries

In economics, BRIC is a grouping acronym that refers to the countries of Brazil, Russia, India and China, which are all deemed to be at a similar stage of newly advanced economic development. It is typically rendered as "the BRICs" or "the BRIC countries". Goldman Sachs has argued that, since the four BRIC countries are developing rapidly, by 2050 their combined economies could eclipse the combined economies of the current richest countries of the world./1/

These countries encompass over 25% of the world's land coverage and 40% of the world's population and hold a combined Gross Domestic Product, GDP of 18.486 trillion dollars. On almost every scale, they would be the largest entity on the global stage. These four countries are among the biggest and fastest growing emerging markets./1,2/

In the next few years there will be a rise in the middle class of the nations classified as BRIC – Brazil, Russia, India and China. For years this has been a shift that aid workers, political analysts and anyone with a financial interest in these nations have been waiting for. But now, at a time when climate change and emissions reduction are high on the world's list of priorities, the implications of these growing powers and populations are just starting to become clear./3/

Along with the consequent increasing demand for high-priced goods, residents of the BRIC nations are now starting to demand more transport and more expensive and comfortable homes. Residential accounts for over 90% of building consumption in developing countries, and the level of power needed to heat, cool and light offices and

factories is growing significantly. More power is also required to produce the new cars, electrical/white goods and other comforts most in the western world have already become fairly reliant on. /3/

In the past, rapid development in the BRIC nations has often come at the expense of environmental degradation. This is 'profitable' in the short term but creates much higher clean-up costs for the future. China's cities are now among the most polluted in the world, and acid rain damages huge areas of countryside. Apart from anything else, this causes huge losses in GDP./3/

Environmental degradation may indeed turn out to be the factor that ultimately limits economic progress. However, the rich nations are on shaky ground when they try to moralise about the importance of the environment to the BRIC nations. Per-capita CO_2 emissions in the US are just over 20t – around double those of Brazil and China, and over 15 times higher than India. /3/

Table 1. *BRIC countries world ranking in 2011 by IMF. /1,2/*

Statistics Categories	Brazil	Russia	India	China
Area	5th	1st	7th	3rd
Population	5th	9th	2nd	1st
Population growth rate	107th	221st	90th	156th
Labour force	5th	7th	2nd	1st
GDP (nominal)	7th	11th	9th	2nd
GDP (real) growth rate	15th	88th	5th	6th
Human Development Index	73rd	65th	119th	89th
Exports	18th	9th	14th	1st
Imports	19th	17th	11th	2nd
Electricity consumption	9th	4th	3rd	2nd
Renewable energy source	3rd	5th	6th	1st
Motor vehicle production	7th	19th	6th	1st
Military expenditures	12th	5th	10th	2nd
Road network	4th	8th	3rd	2nd

A survey by the World Bank in 2006 states that carbon emissions from two of the world’s fastest growing economies, China and India, rose steeply over the past decade, with India alone increasing carbon dioxide emissions by 33% between 199 and 2002. However, India’s government says that it must increase energy use to lift its population out of poverty, with its per capita emissions a fraction of those of rich states that have burned fossil fuels unhindered since the Industrial Revolution Furthermore, Russian President Dmitry Medvedev announced an emissions target that could allow the country to increase emissions by up to 36% by 2020. However, the combustion of fossil fuels is the largest single contributor to CO_2 emissions and total greenhouse gas emissions (GHG) , and of all the major sources has grown most rapidly from 1970 to present./4/

2. Emission control and air quality regulations in the BRIC countries

This review focuses on air emission control laws and implementation in the BRIC countries. Though there is huge contrast between BRIC countries economic and politic environment, similarities between environmental regulations can be found.

The EU Industrial Emission directive sets emission limit values in Europe. BRIC countries have adapted part of the laws and standards from EU and U.S. Specially the guidelines and technical definitions may be similar though the terms and the definitions may be different. In EU term “standard” is known as a method for emission measurements, such as EN 14181 Stationary source emissions - Quality Assurance of Automated Measuring Systems whereas Indian and Chinese emission limit values are defined as “standards”. This may cause confusion comparing EU and BRIC air quality regulations.

3. Brazilian industrial emission legislation

The Brazilian federal legislation such as the resolution No 382 (2nd January 2006) of Ministry for the Environment defines pollutants and emission limit values for industrial emissions. The state environmental agency's decisions define guidelines for monitoring plans as well may introduce tighten requirements for emission monitoring than federal legislation. /5,6/

The political and administrative organization of Brazil comprises the federal government, the states, the federal district and the municipalities. The states are autonomous sub-national entities with their own constitutions and governments that, together with the other federative units, form the Federative Republic of Brazil. Currently, Brazil is divided politically and administratively into 27 federative units, being 26 states and one federal district. The most important Brazilian states (in terms of population and economic power) are São Paulo, Rio de Janeiro, Minas Gerais, Rio Grande do Sul, Paraná, Bahia, Pernambuco and Santa Catarina. /7/

3.1 Federal legislation

The resolution No 382 "National Guidance for Ambient Environment" CONAMA presents emission limit values for different industrial categories /5/:

- oil combustion
- natural gas combustion
- sugar cane combustion
- wood combustion
- gas turbines producing electric energy
- oil refineries
- cellulose industry
- lead smelting plant
- aluminium processing
- glass smelting plants
- cement industry
- fertilize production
- steel industry and iron mines

Tables 1 to 9 present overview of the pollutants and limit values. Resolution No 382 also describes terms for the minimum load during monitoring and ELV calculations for the combined boiler units. Individual measurements are required for each emission sources (stacks). For small oil, sugar cane and wood combustion units (<10MW_{th}) also carbon monoxide emission limit values are defined. Carbon emission may be

restricted in significance and coastal areas. When manual sampling method is used at least three parallel samples are required.

When measurements are carried out using continuous emission monitoring, emission limits are considered to be fulfilled when 90% of the daily averages are lower than limit value and 100% of daily averages are lower than 130% of the limit value. Daily average is valid when the monitor operating time is over 75%. Annual measurement is representative when source nominal capacity is over 90%.

Table 1. *Oil combustion emission limit values (mg/m^{3}n, dry, O_2 3%)./5/*

Total rated thermal input (MW)	Dust	NOx (NO_2)	SOx (SO_2)	CO
≤ 10	300	1600	2700	80
10 < P ≤ 70	250	1000	2700	n/a
> 70	100	1000	1800	n/a

Table 2. *Natural gas combustion emission limit values (mg/m^{3}n, dry, O_2 3%)./5/*

Total rated thermal input (MW)	NOx (NO_2)
≤ 10	1600
> 70	1000

Table 3. *Sugar cane combustion emission limit values (mg/m^{3}n, dry, O_2 8%)./5/*

Total rated thermal input (MW)	Dust	NOx (NO_2)
≤ 10	280	n/a
10 < P ≤ 75	230	350
> 75	200	350

Table 4. *Sugar cane combustion emission limit values (mg/m^{3}n, dry, O_2 8%)./5/*

Total rated thermal input (MW)	CO
< 0,05	6500
0,05 < P ≤ 0,15	3250
0,15 < P ≤ 1,0	1700
1,0 < P ≤ 10	1300

Table 5. *Wood combustion emission limit values (mg/^{m3n}, dry, O_2 8%)./5/*

Total rated thermal input (MW)	Dust	NOx (NO_2)
≤ 10	70	n/a
10 < P ≤ 30	520	650
30 < P ≤ 70	260	650
> 70	130	650

Table 6. *Wood combustion emission limit values (mg/m^{3}n, dry, O_2 8%)./5/*

Total rated thermal input (MW)	CO
< 0,05	6500
0,05 < P ≤ 0,15	3250
0,15 < P ≤ 1,0	1700
1,0 < P ≤ 10	1300

Table 7. *Gas turbine producing electric power, emission limit values (mg/m^{3}n, dry, O_2 3%)./5/*

Fuel	Dust	NOx (NO_2)	SOx (SO_2)	CO
Natural gas	n/a	50	n/a	65
Liquid	50	135	200	n/a

Table 8. *Oil refinery emission limit values (mg/m^{3}n, dry, O_2 3%)./5/*

Total rated thermal input (MW)	Dust	NOx (NO_2)	SOx (SO_2)
oven ≤ 10	150	320	70
oven 10 < P ≤ 70	125	320	70
oven > 70	50	200	70
cracking	75	600	1200
ammonia converter		720 (O2 1%)	

Table 9. *Cellulose emission limit values (mg/m^{3}n, dry, O_2 3%)./5/*

Process unit	Dust	NOx (NO_2)	SOx (SO_2)	Total S (SO_2)
Recuperator	100	470	100	15
Tank of Dissolution	0,1 kg/tSS	n/a	n/a	0,008 kg/tSS
Calcination	100	470	n/a	30

Process specific emission limit values are also defined for:

- lead smelting plant (dust, SOx and Pb),
- aluminium processing (dust and total fluoride),
- glass smelting plants (dust, NOx and SOx),
- cement industry (dust and NOx),
- fertilize production (ammonia, total fluoride and dust)and
- steel industry and iron mines (dust, SO_2, NOx).

3.2 State legislation

The State decisions for emission monitoring define requirement for monitoring frequency (Table 10 – 11). The São Paulo state requirement (CETESB No 10) is a

good example of the Brazilian industrial emission legislation. State environmental agency (CETESB) has published the standards ("technical norms") for required measurements, for example: gas flow, moisture, dust, NOx, SO_2, total sulphur, HS, SO_2 & SO_3 acid, NH_3 and VOC. Standards are also available for sampling protocol, calibration of the testing methods and calibration of the automated measurement systems (AMS). In addition following USEPA methods are approved:

- Method 18 – VOC by GC
- Method 23 – Dioxin and Furan
- Method 25A – Gaseous Organic Concentration (Flame Ionization).
- Method 26A – Hydrogen Halide & Halogen - Isokinetic. (Feb/2000).
- Method 29 - Metals Emissions from Stationary Sources. (Feb/2000).
- Method 0030 (EPA SW 846) - Volatile Organic Sampling Train (VOST) for Volatiles.
- Method 101 - Mercury From Chlor - Alkali Plants - Air Streams. (Feb/2000).
- Method 101A - Mercury from Sewage Sludge Incinerators. (Feb/2000). /6/

Table 10. *Sao Paulo state emission monitoring requirement. Energy and mineral industry./6/*

Industry type			MP	SOx	NOx	Total S	Pb	Inorg. subst.	F / HF	NH3	HCl	HC	VOC	D&F
Energy production	biomass	≤ 20 t/h	●●		●●									
	biomass	> 20 t/h	●		●									
	natural gas				●●							●●		
	oil	≤ 20 t/h	●●	●●	●●									
	oil	> 20 t/h	●	●	●							●		
	waste		●	●	●			●●	●●		●●	●●	●●	●●
	gas turbine				●							●		
Non metal minerals														
Cement	clinker oven		●	●	●									
	condenser		●											
	other sources		●●											
	cement oven		●	●	●			●●	●●		●●	● MC	●●	●●
Asphalt concrete			●●	●●	●●									
Lead	lead refining						∇							
	lead oxidation						∇							
	waste lead melting		∇	∇			∇							
Ceramics	single fuel ovens				●●				●●					
	waste fuel ovens		●●	●●	●●			●●	●●		●●	●●	●●	●●
Metalurgia	foundry		●●		●●									
	surface treatment				●●							●●	●●	

●	=	annual
●●	=	biennal
∇	=	semestral
MC	=	continuous measurement

MP = particulate matter, D&F = dioxins and furans

Table 11. *Sao Paulo state emission monitoring requirement. Paper and cellulose industry./6/*

Industry type		MP	SOx	NOx	Total S	Pb	Inorg. subst.	F / HF	NH3	HCl	HC	VOC	D&F
Paper and cellulose	power production - recuperator oven	●	●	●	●								
	power production - dissolution	●	●	●	●								
	power production - lime kiln	●	●	●	●								
	power production - other sources	●●	●●	●●	●●								
	paper production	●●		●●									
	paper absobent production	●●	●●	●●	●●								
	paper cellophane production	●●	●●	●●	●●								

●	=	annual
●●	=	biennal
∇	=	semestral
MC	=	continuous measurement

The state decision describes also good measurement platform and minimum contents of the emission report. The technical norms (standards) describe the measurement principles, objectives, equipment, execution procedures, calibration methods and calculations. All norms are available free for charge from CETESB webpages. /8/

4. Russian industrial emission legislation

4.1 Environmental authorities

The key authorities responsible for formulating and implementing the environmental policy and law at the federal level in Russia are The Ministry of Natural Resources and Environment of Russia (MNR&E) and its Subordinate services /9/:

1. The Federal Supervisory Natural Resources Management Service (Rosprirodnadzor);
2. The Federal Water Resources Agency;
3. Federal Service on Hydrometeorology and Environmental Monitoring (Gidromet);
4. The Federal Subsoil Resources Management Agency
5. Federal Forestry Agency

At present time, the compliance assurance functions were delegated to The Federal Supervisory Natural Resources Management Service (Rosprirodnadzor) that is subordinated to the (MNR&E). Together with the inspectors of Rosprirodnadzor, the analytic control is conducted by the CLATI (The Central Laboratory for Analytical and Technical Measurements) to control emissions into the air, discharges waste water into water bodies; Monitoring of Air of sanitary-protective zone, the soil (ground) around the Plants, and Plant waste generation. /9/

The State Register of main polluters was formed by the MNR&E and subjected to the Rosprirodnadzor while others are under the scope of Municipal Ecological Control. For example 1250 major sources have been registered in Saint Petersburg (26.10.2010). /10, 11/

4.2 Permits and emission limit values

Permits granted by environmental authorities (individually for air emissions, wastewater effluents, and solid waste generation) define enterprise-specific emission limit values (ELVs) for all applicable regulated pollutants. The ELVs are determined, using computerised dispersion models, on the basis of environmental quality standards, so called Maximum Allowable Concentrations (MACs). MACs are established and approved in State institution of Scientific-research Institute human ecology and environmental hygiene of the Russian Academy of medical Sciences, on the basis of comprehensive research on the simplest bio-organisms (Daphnia and etc.) and animals./9, 12/

Each plant's emission sources, pollution substances and the MACs are presented in the PDV-document ("allowed emission project"). The PDV also describes

requirements for monitoring methods, monitoring frequency and the authorized measuring laboratory. The PDV-document is valid for five years. The plant (operator) may compose the PDV itself or it can use commercial consultant to do it. In both cases plant is responsible of the content. The PDV document is a confidential document. /9/

For each source and also for the whole plant two MAC values have been determined: g/s and tons/year. Besides the inspection according to the PDV, Rosprirodnadzor organizes additional federal permit inspections. The Central Laboratory for Analytical and Technical Measurements (CLATI) laboratories are responsible for the measurements when federal inspection includes the emission measurement. Only accredited laboratories are allowed to perform official emission measurements. /9, 13/

The resulting ELVs are typically very stringent and as well far lower than the level of actual emission from the enterprises. To ease the requirements imposed by such strict limits, which generally would not be realistically achievable, so-called Temporary ELVs (TELVs) were introduced as a transitory measure with a goal of step-by-step attainment of environmental quality standards. /12/

4.3 Pollution charges

A central feature of the pollution charge system is that a set of pollutant-specific basic rates apply to discharges within established limits, whereas a much higher rate applies to discharges exceeding the limits. The applicable rate of pollution charges is 5 times the base rate for quantities discharged in excess of the ELV but within the temporary limit. For discharges in excess of the TELV (or those without a permit), the applicable rate is 25 times the base rate. These multipliers represent the “non-compliance component” of the pollution charge. Regional authorities also have a right to apply “coefficients of environmental conditions” to the rates to account for local environmental considerations. /12/

Introduced in the early 1990s, the charge rates were set at the level that was believed sufficient to compensate for the economic damage resulting from environmental pollution. The estimates were made for a few pollutants and extrapolated for the rest of the regulated pollutants by using “conventional tonnes”. The charges were payable quarterly on the basis of direct measurement (for very few substances) or indirect (mass balance, emission coefficient, etc.) estimation of pollutant discharges./12/

5. Indian industrial emission legislation

5.1 Environmental organisation

The Central Pollution Control Board (CPCB), statutory organisation, was constituted in September, 1974. CPCB serves as a field formation and also provides technical services to the Ministry of Environment and Forests of the provisions of the Environment (Protection) Act, 1986. Principal Functions of the CPCB /14, 15/;

(i) to promote cleanliness of streams and wells in different areas of the States by prevention, control and abatement of water pollution, and
(ii) to improve the quality of air and to prevent, control or abate air pollution in the country.

The National Air Monitoring Programme (NAMP) has been established with objectives to determine the present air quality status and trends and to control and regulate pollution from industries and other source to meet the air quality standards. It also provides background air quality data needed for industrial siting and towns planning. The NAMP network consists of three hundred and forty two (342) operating stations covering one hundred and twenty seven (127) cities/towns in twenty six (26) states and four (4) Union Territories of the country. /14/

Functions of the Central Board at the National Level /14, 15/

- Advise the Central Government on any matter concerning prevention and control of water and air pollution and improvement of the quality of air.
- Plan and cause to be executed a nation-wide program for the prevention, control or abatement of water and air pollution;
- Co-ordinate the activities of the State Board and resolve disputes among them;
- Provide technical assistance and guidance to the State Boards, carry out and sponsor investigation and research relating to problems of water and air pollution, and for their prevention, control or abatement;
- Plan and organise training of persons engaged in programme on the prevention, control or abatement of water and air pollution;
- Organise through mass media, a comprehensive mass awareness programme on the prevention, control or abatement of water and air pollution;
- Collect, compile and publish technical and statistical data relating to water and air pollution and the measures devised for their effective prevention, control or abatement;
- Prepare manuals, codes and guidelines relating to treatment and disposal of sewage and trade effluents as well as for stack gas cleaning devices, stacks and ducts;

- Disseminate information in respect of matters relating to water and air pollution and their prevention and control;
- Lay down, modify or annul, in consultation with the State Governments concerned, the standards for stream or well, and lay down standards for the quality of air; and

Functions of the Central Board as State Boards for the Union Territories /14, 15/

- Advise the Governments of Union Territories with respect to the suitability of any premises or location for carrying on any industry which is likely to pollute a stream or well or cause air pollutions;
- Lay down standards for treatment of sewage and trade effluents and for emissions from automobiles, industrial plants, and any other polluting source;
- Evolve efficient methods for disposal of sewage and trade effluents on land; develop reliable and economically viable methods of treatment of sewage, trade effluent and air pollution control equipment;
- Identify any area or areas within Union Territories as air pollution control area or areas to be notified under the Air (Prevention and Control of Pollution) Act, 1981;
- Assess the quality of ambient water and air, and inspect wastewater treatment installations, air pollution control equipment, industrial plants or manufacturing process to evaluate their performance and to take steps for the prevention, control and abatement of air and water pollution.

CPCB along with its counterparts State Pollution Control Boards (SPCBs) are responsible for implementation of legislations relating to prevention and control of environmental pollution /14/.

CPCB laboratory has obtained Laboratory Accreditation through National Accreditation Board for Testing and Calibration Laboratories (NABL), Department of Science and Technology as per ISO 17025. The accreditation covered 85 chemical and 6 biological parameters. The Central Laboratory of CPCB at Delhi has following five sections of laboratories /14/:

- Water and Wastewater Laboratories
- Air Laboratory
- Bio-Science Laboratory
- Treatability Laboratory
- Instrumentation Laboratory
- Trace Organics Laboratory

Air laboratory has following activities:

- Ambient Air Quality Monitoring
- Calibration Laboratory
- Source Emission Monitoring

Presently Central Pollution Control Board (CPCB) has three fixed Continuous Ambient Air Quality Monitoring Stations, one mobile van and one portable mobile station in Delhi. Following parameters are measured at these fixed stations and mobile vans /14, 25/:

(i) Carbon Monoxide,
(ii) Sulphur Dioxide,
(iii) Oxides of Nitrogen,
(iv) Benzene, Toluene & Xylene,
(v) Ozone,
(vi) Particulate Matters (PM10 & PM2.5) and
(vii) Meteorological Parameters like Wind Speed, Wind Direction, Temperature, Relative Humidity and Solar Radiation.

The CPCB has established one Project Office Laboratory at Agra and six Zonal Offices: Bengaluru, Bhopal, Kolkata, Lucknow, Shillong and Vadodara./14/

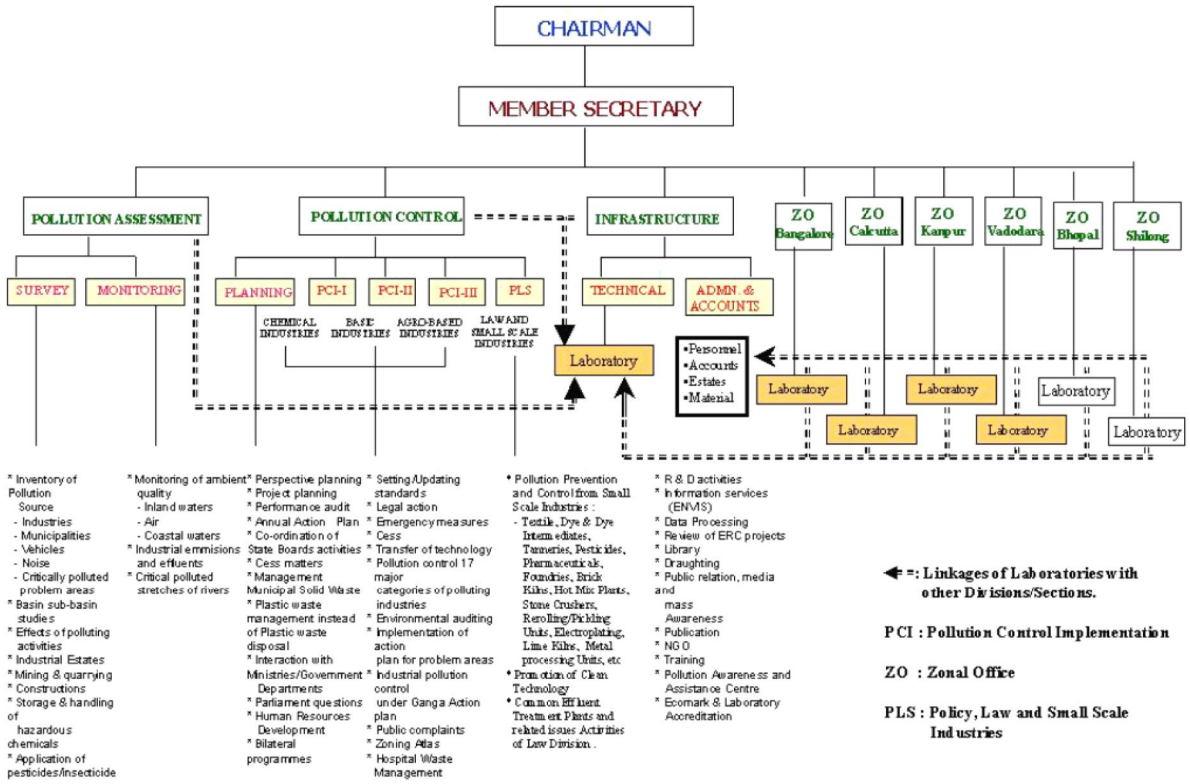

Figure 1. *The Central Pollution Control Board organization chart /14/.*

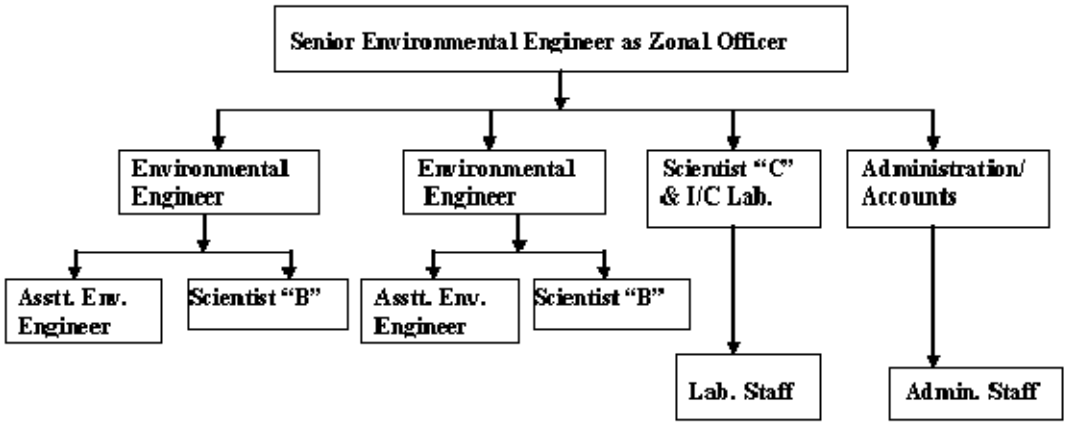

Figure 2. *Example of the Profile of Hierarchical Structure of the Zonal Office. The Western Zonal Office of Central Board, Vadodara /14/.*

There are 28 State Pollution Control Boards (SPCB) in India:

1. Andra Pradesh
2. Bihar
3. Goa
4. Gujarat
5. Haryana
6. Himachai Pradesh
7. Jammu & Kasimir
8. Jharkand
9. Karnataka
10. Madhya Pradesh
11. Maharashtra
12. Meghalaya
13. Orissa
14. Punjab
15. Rajasthan
16. Uttar Pradesh
17. West Bengal
18. Tamil Nadu
19. Kerala
20. Arunachal Pradesh
21. Tripura
22. Sikkim
23. Assam
24. Manipur
25. Pondicherry PCC
26. Chandigarh PCC
27. A& N Islands PCC
28. Mizoram

5.2 Emission limits and monitoring methods

Emission limits are defined for in industry specific environmental standards (The Environment Protection Rules, Appendix I). In addition new standard is proposed for “Emission Standards for Petrochemical Plants”. These standards define many environmental related parameters such as for thermal power:

- Condenser cooling waters (pH, temperature, free available chlorine)
- Boiler blow downs (suspended solids, oil and grease, copper , iron)
- Cooling tower blow down (free available chlorine, zinc, chromium, phosphates, other corrosion inhibiting material)
- Ash pond effluent (pH, suspended solids, oil and grease)
- Emissions (particulate matter)
- Stack height in meters

Emission limit values are defined in The Environment Protection Rules depending on industry type, capacity and raw materials. For thermal power (coal or lignite fuel) only dust emission limits values have been defined (Table 12). Standard No. 82 “Environmental Standards for Gas/Naptha-Based Thermal Power Plants” defines nitrogen oxides (NOx) emission limit values for gas turbine (Table 13). /16/

Table 12. *Particulate emission limit values for power plants (coal or lignite fuel). Standard No. 25. /16, page 425/*

Thermal Power Plants	Particulate matters emission [mg/Nm^3]
generation capacity 210 MW or more	150
generation capacity less than 210 MW	350
Small boilers, steam generation capacity [ton/hour]	Particulate matters emission [mg/Nm^3]
less than 2	1200
2 to less than 10	800
10 to less than 15	600
5 and above	150
Note: 12% of CO_2 correction shall be the reference value for particulate matter emission standards for all categories of small boilers.	

Table 13. *Limit for emissions of NOx, gas turbine. Standard No. 82. /16, page 481/*

Limit for emissions of NOx	(a) For existing units---150ppm (v/v) at 15% excess oxygen. (b) For new units with effect from 1.6.1999.
Total generation of gas turbine	*Limit for Stack NOx emission [(v/v),at 15% excess oxygen]*
(a) 400 MW and above	(i) 50 ppm for the units burning natural gas. (ii) 100 ppm for the units burning naphtha.
(b) Less than 400 MW but up to 100 MW	(i) 75 ppm for the units burning natural gas. (ii) 100 ppm for the units burning naphtha
(c) Less than 100 MW	100 ppm for units burning natural gas or naphtha as fuel
(d) For the plants burning gas in a conventional boiler.	100 ppm

For diesel engines emission limit values are defined for NOx, HC, CO and particle matter in standard No. 95 (Table 14). And even more monitored pollute substances are presented for hazardous waste incinerator (Table 15).

Table 14. *Emission Limits for New Diesel Engines (up to 800 KW) for Generator Sets (Gensets) Applications. Standard No. 95. /16, page 507/*

Capacity of diesel engines	**Date of imple-mentation**	**Emission Limits (g/kw-hr) for**				**Smoke Limit (light absorption coefficient, m^{-1}) (at full load)**	**Test Cycle**	
		NO_X	**HC**	**CO**	**PM**		**Torque %**	**Weighting Factor**
Upto 19 kW	1.7.2005	9.2	1.3	3.5	0.3	0.7	100	0.05
							75	0.25
>19 kW upto 176 kW	1.1.2004	9.2	1.3	5.0	0.5	0.7	50	0.30
	1.7.2004	9.2	1.3	3.5	0.3	0.7	25	0.30
>176 kW upto 800 kW	1.11.2004	9.2	1.3	3.5	0.3	0.7	10	0.10

Table 15. *Emission limits for common hazardous waste incinerator. Standard No. 100. /16, page 517/*

A. Emission		
	Limiting concentration in mg/Nm_3 unless stated	Sampling Duration in (minutes) unless stated
Particulate Matter	50	30
HCl	50	30
SO_2	200	30
CO	100	30
	50	24 hours
Total Organic Carbon	20	30
HF	4	30
NOx (NO and NO_2, expressed as NO_2	400	30
Total dioxins and furans	0.1 ngETQ/Nm^3	8 hours
Cd+Tl+their compounds	0,05	2 hours
Hg and its compounds	0,05	2 hours
Sb+As+Pb+Co+ Cr+Cu+Mn+Ni+ V+their compounds	0,50	2 hours

Notes:
i. All monitored values shall be corrected to 11 % oxygen on dry basis.

ii. The CO_2 concentration in tail gas shall not be less than 7%.

iii. In case, halogenated organic waste is less than 1% by weight in input waste, all the facilities in twin chamber incinerators shall be designed to achieve a minimum temperature of 950°C in secondary combustion chamber and with a gas residence time in secondary combustion chamber not less than 2 (two) seconds.

iv. In case halogenated organic waste is more than 1% by weight in input waste, waste shall be incinerated only in twin chamber incinerators and all the facilities shall be designed to achieve a minimum temperature of 1100°C in secondary combustion chamber with a gas residence time in secondary combustion chamber not less than 2 (two seconds).

v. Incineration plants shall be operated (combustion chambers) with such temperature, retention time and turbulence, as to achieve Total Organic Carbon (TOC) content in the slag and bottom ashes less than 3%, or their loss on ignition is less than 5% of the dry weight].

All of these standards set only few criteria for measurements and calculation. These standards don't say how measurement should be done or who are accepted to perform measurements. There are no monitoring frequency requirements either. All these requirements are defined in "Emission Regulations" /18/:

- The industrial units are required to monitor ambient air quality and stack emission within industrial premises.
- Stack monitoring shall be done the frequency given for each industry.

- Ambient air quality sampling shall be done on a 24 basis every alternate day.
- The parameters for stack monitoring, in addition to pollutant(s), must include the air flow rate (nm^3/hr) and the production during period of sampling.
- The new industrial units shall have sampling ports built into the stack and a permanent sampling platform.
- All monitoring equipment and instrument shall be standard design approved by the CPCB on an agency like SPCB as delegated b CPCB.
- The agency or laboratory performing the emission monitoring and ambient air quality tests shall have to be approved by the SPCB in consultation with CPCB or its approved laboratory.

In addition, CPCB and SPCB have published testing methods, specifications, manuals, codes and guidelines. Chargeable specifications "Laboratory Analytical Techniques Series (LATS)" and "Pollution Control Law Series (PCLS)" are available from CPCB. For free of charge Air Laboratory has published in the web selected parts of the "Emission Regulations part 3". There are guidelines for measurements, calculations and measurement places. /14/

The Emission Regulations gives monitoring frequency for industries like: cement, thermal power (Table 16), integrated iron and steel, fertilizer, nitric acid, sulphuric acid, primary aluminium, carbon black, calcium carbide and oil refinery. /18/

Table 16. *Emission monitoring frequency for thermal power plant. /18, page 3/*

Boiler Capacity MW	Ambient Air Quality Monitoring stations	Source Emission Monitoring
Less than 200	2 stations	Once in 4 weeks
Greater than and including 200	3 stations	Once in 2 weeks
Greater than and including 500	4 stations	Once in 1 week
The parameters to be monitored shall be suspended particulate matter, sulphur dioxide and nitrogen dioxide in the ambient air and total particulate matter and sulphur dioxide in the stack. All stack gas emission results shall be normalized to 12% CO_2 in the flue gas.		

In addition to air emissions, Environment Protection Act describes utilization requirement of fly and bottom ash. Building materials or products (bricks, tiles, cement etc.) shall contain certain amount of ash by weight. No person shall within 100 kilometres from coal or lignite based thermal plants manufacture or use building materials without mixing at least 25% of ash with soil on weight to weight basis. Thermal power plants have responsibilities as well. Utilization percentage should be at least 50% and 100% after five years from date of commissioning. /16, page 376/

5.3 Emission monitoring in practice

Emission monitoring is mostly based on ambient air measurements and industry emission fuel consumption reports. In addition laboratories approved by CPCB conduct annual stationary source emission measurements. The measurement methods are mostly based on EPA methods. Indian laboratories have their own accreditations according to the Indian National Accreditation Board for Testing and Calibration laboratories, NABL. /16/

India is a large country where different states have different climates and industrial activities, thus creating challenges in the harmonization of emission measurement methods. And on general level, the procedures for quality assurance of emission measurements should be developed. /16/

Figure 3. *Process Waste Incinerator measurements. Isokinetic dioxin and furan sampling device. /15/*

Air quality monitoring; the monitoring of pollutants is carried out for 24 hours (4-hourly sampling for gaseous pollutants and 8-hourly sampling for particulate matter) with a frequency of twice a week, to have one hundred and four (104) observations in a year. The monitoring is

being carried out with the help of Central Pollution Control Board; State Pollution Control Boards; Pollution Control Committees; National Environmental Engineering Research Institute (NEERI)./15/

Ministry of Environment and Forest has published June 2008 charges for sampling. The fee payable to the Central Pollution Control Board Laboratories in respect of analysis for various analytical parameters and sampling charges for the water, wastewater, soil, hazardous waste, air/fugitive emissions, source emission, noise monitoring, auto exhaust monitoring and ambient air quality monitoring are defined each type for sampling. Table 17 presents example of the source emission monitoring sampling charges. There are equivalent tables for each type of sampling and pollution substances. /16/

Table 17. *Source emission monitoring sampling charges (since 15th June 2008). /16/*

	Type of Sampling	Charges in Rs.	Charges in Euros[1]
(a)	Sampling/measurement of Velocity, Flow rate, temperature and molecular weight of Flue Gas (each specific location/each sample in duplicate for the mentioned parameter)	5500,00	87,00
(b)	Sampling of SO_2/NO_2	2000,00	32,00
(c)	Sampling of PAHs	3000,00	47,00
(d)	Sampling of VOCs/BTX	3500,00	55,00

Transportation charges will be separate as per actual basis.
Sample analysis charges of respectice parameters are separate as per list.
[1] Charges in Euros based on July 2012 exchange rates (Forex).

6. Chinese industrial emission legislation

6.1 Environmental governance structure

The Chinese government develops a Social and Economic Development Plan every five years, which is commonly known as a Five-Year Plan (FYP). The plan coordinates public policy priorities and lays down the development objectives. Based on the FYP, the Chinese environmental authorities prepare a corresponding Five-Year Environment Plan, which include detailed plans addressing specific environmental issues. /19/

The 9th FYP (1996–2000) selected 12 key pollutants and set the limit of aggregate quantity for each of them. The 10th FYP (2001–2005) set a clearer quantitative target. The State Council set out the 11th FYP for Preventing and Controlling Acid Rain and SO_2 emissions, setting a target of 10% reduction in SO_2 emissions from the 2005 level by 2010. /19/

Three government agencies are involved in law enforcement of air quality monitoring and pollution control, namely the National Development and Reform Commission (NDRC), Ministry of Industry and Information Technology (MIIT) and Ministry of Environmental Protection (MEP)./20/

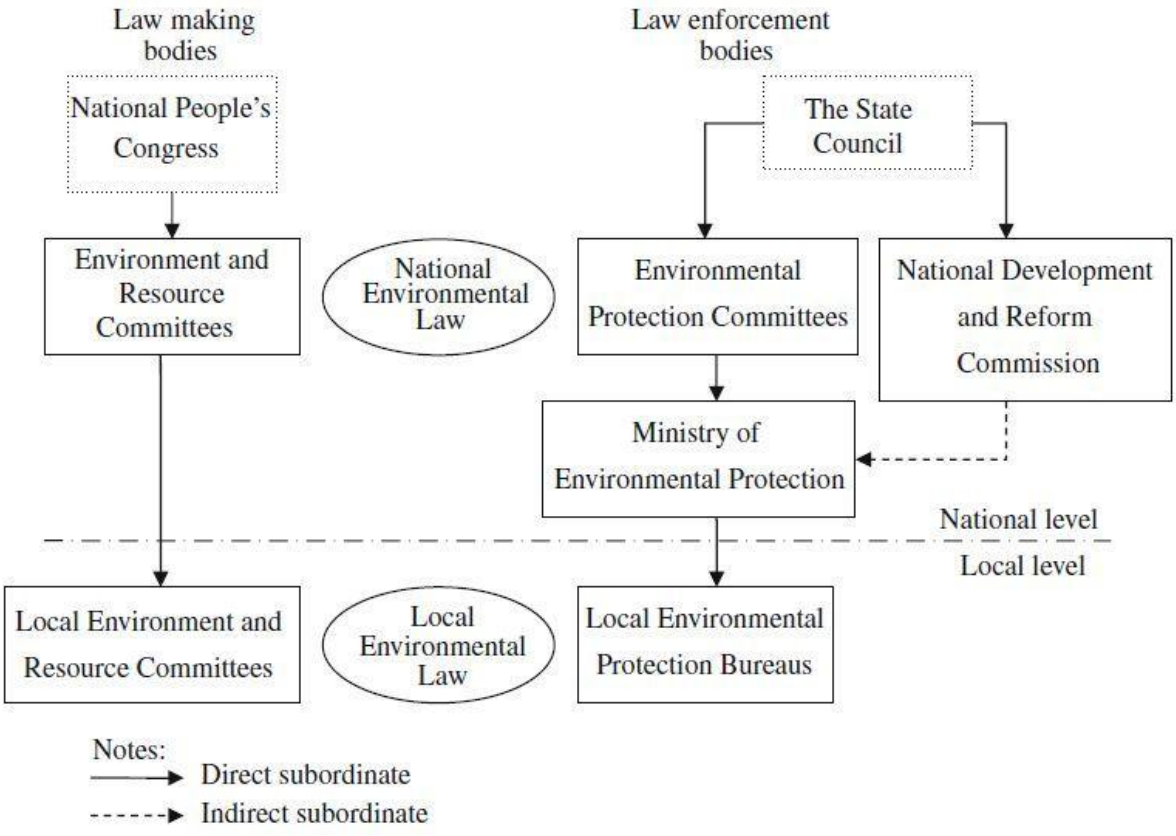

Figure 4. *Environmental governance structure in China. /19/*

Responsibilities of Ministry of Environmental Protection for air quality monitoring and pollution control /20/:

- Developing policies, programs, laws, administrative regulations, rules, standards and criteria for prevention and control of air pollution.
- Responsible for hitting national targets on emission reduction.
- Monitoring environmental quality and releasing the Report on the State of Environment in China.
- Responsible for monitoring of pollutant sources for emergency response and pre-warning.

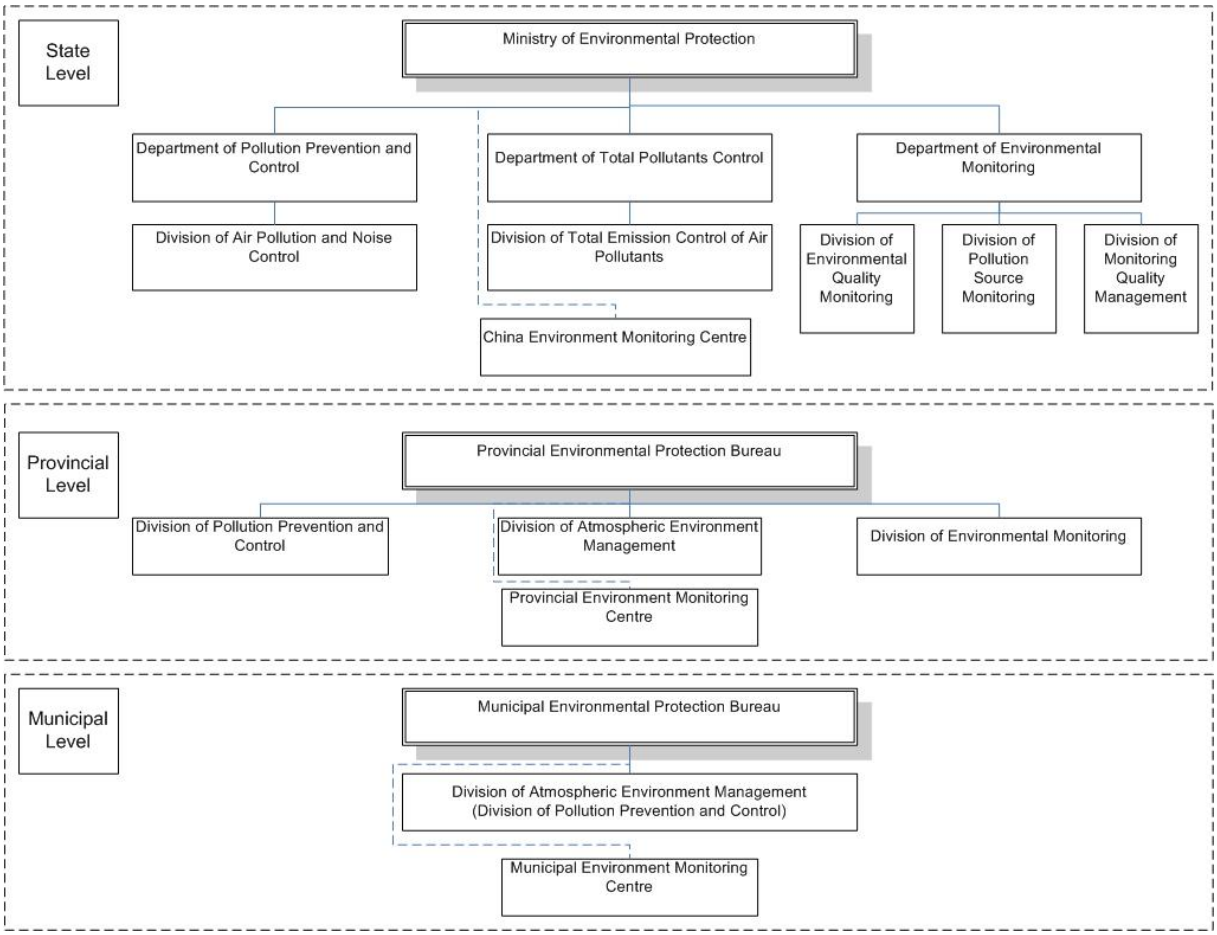

Figure 5. *Institutional arrangement of the Ministry of Environmental Protection in terms of air quality monitoring and pollution control. /20/*

At the sub-national level, there are about 2000 Environmental Protection Bureaus (EPBs). The EPBs play an essential role in implementing environmental policy. Their responsibilities include oversight of environmental impact assessment and other procedures for new projects; monitoring pollution released from industries, assessing fees for pollution discharges; initiating legal action against firms that have not met their environmental requirements; and conducting or organising relevant activities, such as environmental reporting, environmental education and a raising public awareness of environmental problems. /19/

Since the first enactment of the Environmental Protection Law in 1979, China now has altogether had 7 major laws concerning environmental protection. Four of these laws can be employed to regulate emissions from power sector including /19/:

- Environmental Protection Law,
- Air Pollution Prevention and Control Law ,
- Environmental Impact Assessment Law, and
- Law for Promoting Clean Production.

During the operation, power plants in China are charged with pollution fees for the air emissions and waste water disposal under the ‘‘Pollution Charge’’ regulations. However, the most pertinent policy to the introduction of emissions trading programmes is ‘‘Total Load Control’’ (TLC). This is because TLC is very similar to the ‘‘cap’ ’component of cap-and-trade emissions trading. The ‘‘cap’’ is usually set by the programme authority, referring to the maximum amount of the emissions of a particular pollutant. /19/

In 2004, MEP issued a proposal for regulations of emission permits, stipulating that emissions and discharges from polluting sources would be regulated through a permit system and the system would be implemented on an “area-by-area” and “step-by-step” basis (Change and Wang 2010, page 3361 /19/). “Pollution permit” systems do exist today in China and are administrated by the environmental protection bureaus at all levels. As part of the administrative and bureaucratic system, those permit systems, however, were never fully market-based. They mainly served the role of legitimising pollution fines and, to some extent, encouraged pollution control technology upgrading. /21/

6.2 Emission limits and monitoring methods

The emission limit values and the monitoring methods are defined in MEP’s standards. There are following type of standards available /22/:

- Quality Standard
- Emission Standard for Stationary-source Pollutants
- Emission Standard for Mobile-source Pollutants
- Method Standard
- Other Standards

Emission Standard for Stationary-source Pollutants consists emission limit values for different kind of activities. Available standards are presented in Appendix II. Available Method Standards for stationary sources are presented in Appendix III. Since 1983, MEP has published and revised 34 standards of vehicle-emitted pollutants control, covering light-duty vehicle, heavy-duty vehicle, heavy-duty engine, motorcycles, mopeds and tri-wheel & low speed vehicles (agriculture transport vehicles), etc. These standards cover new vehicles and in-use vehicles. /23/

In addition to the stationary source methods (Appendix III), numerous methods for ambient air are published for example SO_2, ozone, PM10, PM2.5, benzene, hydrogen chlorine and mercury.

Pöyry Consulting Co., Ltd has published in 2010 distinguished report “Air Pollution Control and Monitoring in China” where legislation, law enforcement and market are fully studied. Since then MEP has introduced new standard for thermal power plants (GB 13223-2011).

6.3 The Emission Standard of Air Pollutants for Thermal Power Plants

The Emission Standard of Air Pollutants for Thermal Power Plants (GB 13223-2011) (The Standard) was adopted by China’s Ministry of Environmental Protection (MEP) on July 18, 2011, and it will be effective starting January 1, 2012. The Standard stipulates limitations on concentrations of air pollutants in emissions from thermal power plants, including soot, SO_2, NO_x, mercury and mercury compounds. The Standard does not apply to thermal power plants using domestic waste or hazardous waste as fuels. /24,25/

The new Chinese law gives existing power plants a 2½ year grace period to meet the new standards, but then all existing plants will be subject to the new standard. Older plants will also see a tightened standard (and sometimes stricter than the US or the EU for existing plants, Table 18). /26/

Since most of China’s power generation comes from coal, the coal standards are the most relevant to addressing China’s air pollution challenges. Coal-fired power plants consume more than half of China’s annual coal production, and emit over 40% of China’s sulphur dioxide (SO_2) and nitrogen oxides (NO_X) pollutants./26/

Table 18. *The Emission Standard of Air Pollutants for Thermal Power Plants (GB 13223-2011) comparing to EU and U.S. emission limit values. /26/*

CHINA, EU, AND U.S. COAL-FIRED POWER PLANT STANDARDS (All units mg/m³)

		China	European Union	United States	
NO_x	**New Plants**	100	500 until 12/31/2015, then 200	117	
	Existing Plants (defined in China as built 1/1/04-12/3/11) (defined in US as built after 2/28/05)	100	500 until 12/31/2015, then 200	117	
	Existing Plants (defined in China as built before 1/1/04) (defined in US as built before 2/28/05)	200	500 until 12/31/2015, then 200	160 (built between 1997-2005)	640 (built between 1978-1996)
SO_2	**New Plants**	100	200	160 (built after 2005)	
	Existing Plants (28 provinces) (four provinces with high sulfur coal)[7]	200 400	400	160 (built between 1997-2005)	640 (built between 1978-1996)
Particulates	**New and Existing Plants**	30	50, with an exception of 100 for low quality coal (eg lignite)	22.5	
Mercury	**New and Existing Plants**	0.03	0.03 (A German standard only. No EU wide standard)	**New:** 0.001 (bituminous, gangue), 0.005 (lignite) **Existing:** 0.002 (bituminous, gangue), 0.006 (lignite)	

6.3.1 Key improvements /25/

Compared to the earlier version, which was established in 2003, the Standard makes the following major improvements:

- The standards for soot, SO_2, and NO_x have been tightened considerably.
- The Standard distinguishes existing and new sources for SO_2 and NO_x emissions; it provides a 2.5-year grace period for existing sources.
- Hg emissions will be controlled for the first time, starting January 1, 2015.
- The Standard stipulates special limitations which are more stringent over air emissions for key regions, where development is concentrated and environmental capacity is low. These areas are defined by their weak atmospheric environmental capacity, vulnerable ecological environment and major air pollution problems. However, the specific geographic scope and timeline of these special limitations is subject to MEP's further regulation.

6.3.2 Emission limit values or air pollutants for thermal plants /25/

I. Pollutant emission control requirements

- (Existing sources) From July 1, 2014, existing thermal power boilers and gas turbines must be controlled under the limits of soot, sulfur dioxide, nitrogen oxides emissions and blackness of smoke set forth in Table 19 below.
- (New sources) From January 1, 2012, new thermal power boilers and gas turbines must be controlled under the limits of soot, sulfur dioxide, nitrogen oxides emissions and blackness of smoke set forth in Table 19.
- (Mercury and mercury compound emissions) From January 1, 2015, coal-fired boilers must be controlled under the limits of mercury and mercury compound emissions as shown in Table 19.

Table 19. *Thermal Power Boiler and Gas Turbine Air Pollutant Emission Concentration Limits*

Unit：mg/m^3 (not for smoke blackness level) /25/

No.	Type of Energy Conversion Facility and Fuel	Pollutant	Conditions	Limits	Location of Emission Control
1	Coal-fired boilers	Soot	All	30	Stack or flue
		Sulfur Dioxide	New Boiler	100 200(1)	
			Existing Boiler	200 400(1)	
		Nitrogen Oxides (NO_2)	All	100 200(2)	
		Mercury and mercury compounds	All	0.03	
2	Oil-fired boilers or gas turbines	Soot	All	30	
		Sulfur Dioxide	New boilers and gas turbines	100	
			Existing boilers and gas turbines	200	
		Nitrogen Oxides (NO_2)	New oil-fired boiler	100	
			Existing oil-fired boiler	200	
			Gas turbine	120	
3	Gas-fired boilers or gas turbines	Soot	Natural gas boilers and gas turbines	5	
			Other gas-fired boilers and gas turbines	10	
		Sulfur Dioxide	Natural gas boilers and gas turbines	35	
			Other gas fired boilers and gas turbines	100	
		Nitrogen Oxides (NO_2)	Natural gas boiler	100	
			Other gas-fired boiler	200	
			Natural gas turbine	50	
			Other gas-fired gas turbine	120	
4	Coal-fired, oil-fired, gas-fired boilers or gas turbines	Smoke Degree (Ringelmann Smoke Chart)	All	1	Stack Vent

Notes:
(1) to be located in Guangxi Zhuang Autonomous Region, Chongqing Municipality, Sichuan Province and Guizhou Province, where the limits will be implemented with coal-fired boilers.
(2) Implementing limits on W-type thermal power generation boilers or furnace chamber flame boilers, circulating fluidized bed (CFB) boilers, and boilers put into operation as of December 31, 2003 or through the construction project's environmental impact report's approval of coal-fired power boilers.

II. Special Pollutant emission control requirements for key regions

Thermal power boilers and gas turbines located in key regions shall implement special air pollutant emission limits set forth in Table 20. The geographic scope of key regions, timeline of the special limits are subject to MEP's further regulation.

Table 20: *Special Limits of Air Pollutant Emission Concentration for Key Regions*

Unit：mg/m^3 （not for smoke blackness level）/25/

No.	Type of Energy Conversion Facility and Fuel	Pollutant	Conditions	Limits	Location of Emission Control
1	Coal-fired boilers	Soot	All	20	Stack or Flue
		Sulfur Dioxide	All	50	
		Nitrogen Oxides (NO_2)	All	100	
		Mercury and mercury compounds	All	0.03	
2	Oil-fired boilers or gas turbines	Soot	All	20	
		Sulfur Dioxide	All	50	
		Nitrogen Oxides (NO_2)	Oil-fired boiler	100	
			Gas turbine	120	
3	Gas-fired boilers or gas turbines	Soot	All	5	
		Sulfur Dioxide	All	35	
		Nitrogen Oxides (NO_2)	Gas boiler	100	
			Gas turbine	50	
4	Coal-fired, oil-fired, gas-fired boilers or gas turbines	Smoke Degree (Ringelmann Smoke Chart)	All	1	Stack Vent

III. Environmental departments' responsibilities over sensitive zones

The environmental departments are responsible for environmental quality monitoring in surrounding residences, educational institutions, hospitals and other sensitive areas during the operation of an existing thermal power boiler or gas turbine, and during environmental review upon the completion of a construction project and its subsequent operation.

- The range of the monitoring should be the surrounding sensitive zones defined in the Environmental Impact Assessment, EIA, of the construction project;
- If there has not been an EIA conducted on an existing thermal power plant, the environmental department should act in accordance with the characteristics and nature of the discharge company and the local natural weather conditions and factors, with reference to the environmental impact assessment guidelines.

The local government should be responsible for the environmental quality of its jurisdiction and should take measures to ensure meeting the ambient environmental quality standards.

6.4 Power sector environmental legislation and regulations /19/

China has approximately 40 legislative acts and regulations that regulate its power sector. Most of them have environmental provisions and some of them even particularly indicate how power plants should control pollution. Key legislation and regulations are introduced as below.

"Method of Environmental Governance in Power Sector" – the method was introduced in 1996. It stipulates (1) specific environmental responsibility of relevant institutions; (2) environmental governance on construction of power projects; (3) environmental governance associated with power production; (4) promotion of R&D, education and international exchange associated with environmental governance in power sector; (5) supervision and regulations on environmental protection activities; and (6) measures of encouragement and punishment. The former Ministry of Electric Power adopted the method and its environmental protection office was granted the authority to oversee the implementation of the method.

"Regulations of Environmental Monitory on Thermal Power Plants (1987)" – the regulations spell out many specific instructions in relation to environmental monitoring of the power industry, including (1) who has the responsibility to monitor power industry's discharges; (2) what kinds of equipment should be used; (3) which pollutants should be monitored; (4) the scope, timing and methods of carrying out the monitoring activities; and (5) the financial budget of monitoring activities, and so on.

"Regulations for Environmental Protection Design of Thermal Power Plant (1991)" – the regulations intend to integrate environmental concern into project design. It provides some requirements for thermal power plant projects, including: (1) at preliminary stage of project design, there should be a brief report on the environmental impact analysis of the project; (2) a full report of environmental impact analysis should be provided at the stage of feasibility study; (3) at the design stage, design planning should include a chapter particularly focusing on pollution control measures.

6.5 Emission monitoring in practice

Accurate emissions measuring system—the effectiveness of an emission trading scheme relies heavily on the accuracy and consistency in measurement of emissions. The current situation concerning measurement of emissions in China has neither of them in place. The current system is a combination of reports prepared by the enterprises themselves and occasional inspections by EPBs. The self-reporting system only requires regulated enterprises to report the information concerning their fuel inputs. For example, coal-fired power plants need to report the coal consumption and the sulphur content of the coal they used. The accuracy of this approach will not be sufficient especially when the fuel inputs and production processes are variable. With respect to the consistency, only a few enterprises have installed monitoring equipment for emissions data. Even for these enterprises, monitoring is not continuous, but operated on a

monthly, quarterly, or even annual basis. Legal system—an emissions trading scheme requires a solid. /19/

Obligation agreements between SEPA and power producers—In 2006, SEPA and China's six largest power producers signed obligation agreements regarding SO_2 emission reduction in the 11th Five-Year Plan. The agreements clearly state the specific reduction targets, emission reduction methods and emphasis the importance of overseeing the implementation of the agreements. It is seen as an innovative way to control the power sector's SO_2 emissions, although there still exists some uncertainties. For example, the compliance of the agreements is difficult to be monitored. In addition, the agreements only stipulate power producers' responsibility but do not set the responsibility for SEPA. This is because SEPA (its function is now replaced by MEP) was originally recognized as the environmental governance body at the national level, therefore, the policy measures launched by SEPA will become the only authority in China. On the other hand, it remains a fact that the Chinese government is good at stipulating new policies. Quite often, there is a huge gap between ideal and what happened in real practice. /19/

Based on a review of environmental regulation and emission trading experimentations in China over the past 20 years, Chang and Wang (2010) /19/ identified three main lessons learned:

- Accurate emission measurement is the foundation, and the current situation in China is far from satisfactory.
- The legal system is lagging behind. Emission rights and permits, trading rules, monitoring, collection of emission data, verification, enforcement and punishment for non-compliance – all those key aspects that enable a functioning emission trading scheme need to be backed up by and embedded in a solid legal system. Lack of legal support in two specific areas – accountability and permit allocation – were highlighted.
- There is a lack of administrative capacity, particularly in terms of the cross-level and cross-sectorial coordination

China does already have some existing infrastructure in place for measuring pollution such as sulphur oxides (SO_x) and energy consumption, including a handful of designated third-party verification companies (determined by the NDRC). /21/

6.6 Emission control and monitoring actions in China

As of July 2000, each city in China has been required to publish an Air Pollution Index measured for the urban region each day. Daily reports on the air quality in 47 major Chinese cities as well as on the water quality in the Huaihe River Basin are available on the Internet at China Environmental Protection, the environmental information center website of the State Environmental Protection Administration (SEPA). MEP says a new air quality index standard, including PM 2.5 and ozone measurements will be implemented nationwide in 2016. /27, 28/

It has been more than thirty years since Chinese began to study on odor pollution control at eighties last century. Triangle bags method which created by Tokyo institute of environment

protection, has been widely used in China during the twenty years, and has been written in China national emission standard of odor pollutants (GB14554-93) as the main odor measurement method recommended.

The Chinese government has set its 2011 target to reduce the emission of four major pollutants cutting them by 1.5 percent year-on-year. These main pollutants are Chemical Oxygen Demand (COD), sulfur dioxide, ammonia nitrogen, and nitrogen oxide. Ammonia nitrogen and nitrogen oxide were newly added to the country's major pollutants monitoring list in accordance with its environmental protection plan from 2011 to 2015. /30/

According to Zhou Shengxian, minister of environmental protection at a national meeting on 2010, China will impose higher pollutant emission standards for paper-making, textiles, leather, chemical plants and other heavy-polluting industries. More efforts will also be made to control emissions of motor vehicles, build sewage processing plants at the county level and continue research on developing technology to remove sulfur, saltpeter, nitrogen and other polluting materials during industrial manufacturing. In addition, the country will also issue more policies, such as providing financial support for processing pollutants and collecting charges over emissions from motor vehicles on a trial basis. /30/

China will invest more than 2 trillion yuan ($316 billion) in promoting energy-saving and low-carbon projects during the 12th Five-Year Plan period (2011-15), Xie Zhenhua, vice-minister of the National Development and Reform Commission, said. The country has set a goal of reducing its energy intensity by 16 percent and carbon intensity by 17 percent during the same period. Meanwhile, the country will step up efforts in eliminating outdated capacity in energy-guzzling industries, including electricity, iron and steel, electrolytic aluminium and cement, while it will further boost the service industry and strategic emerging industries. The strategic industries include alternative energy, biotechnology, new generation information technology, high-end equipment manufacturing, advanced materials, alternative-fuel cars and energy-saving and environmentally friendly technologies./31/

6.7 Transportation

Transportation has joined the power generation industry, as well as the steel and iron industries, among others, as one of the major CO_2 emission sectors. China has announced a national target of carbon intensity (tons/GDP) reduction by 40–45% based on 2005 levels by 2020. Hence, reducing CO_2 emissions in the transport sector is expected to make an important contribution to achieving this target. The expansion of the transportation sector has also caused tremendous local air pollutant emissions of carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), and particulate matter (PM), thereby becoming a serious environmental concern. To resolve the CO_2 reduction challenge, new regulations and standards have been initiated and/or discussed. For example, fuel tax was introduced in 2009, and new energy vehicle subsidy pilot schemes were initiated in 2010 for several cities. In Beijing, public transportation subsidy was implemented in the form of price deduction for bus and metro tickets. Carbon tax and energy tax are still under discussion. /32/

The Chinese capital is likely to adopt new vehicle emission permits which could be as strict as those in Europe, in response to concerns over the city's air pollution. The Beijing Municipal Environmental Protection Bureau has released a draft of new standard which specifies strict limits for a variety of vehicle emissions, including carbon monoxide, hydrocarbons, nitric oxide and particulate matter. Public opinions on the draft will be solicited until April 9 (2012), and the regulation is expected to be implemented within the year 2012. /33/

The Priorities in the future vehicle emission control /23/:

- Stricter control for diesel vehicles and engines, develop retrofit program
- Improve the fuel quality, especially sulphur and toxic content
- In-use Compliance and Recall program
- Develop incentive policy to promote the production and use of the Environmentally-Friendly Vehicle (EFV)
- Improve the assessment and modelling system for the policy making

7 The BRIC countries and international environment

The BRIC countries environmental legislation has taken quick steps last decade and various new monitoring methods have been introduced. Universal common challenge will be implementing these rules and guidelines in practice. As soon as the new environmental permits are granted and guidelines updated, need for better emission control technologies and reliable, accurate emission measurements arises. The BRIC countries will give important and specific contribution also in the future to the international environmental standards and monitoring development.

7.1 Pollution control markets and IPR risks

Large developing countries, such as China and India, have potentially large pollution control markets through which to spawn many domestic operators and fierce competition. Many low-carbon and pollution-control technologies have been commercialized with much knowhow. A caveat is that these large developing countries may not necessarily always have large domestic markets for pollution mitigation. These are partly determined by government policies and not just by the overall sizes of their economies. Their abilities to take on board foreign technologies might not be consistently strong. However, there is great potential for large developing countries to make use of markets for technology to build their industrial prowess with mature technologies. Though external financial support could further help these countries, their current strategies at international negotiations could be revised to better satisfy their urgent need of mature technologies for rapid development and environmental clean-up. China and India in particular may want to use climate negotiations as a platform to establish more effective markets to acquire technologies from developed countries. /34/

In international negotiation on transferring low-carbon technologies from developed to developing countries, developed countries generally argue for market-based solutions and adequate protection of intellectual property rights (IPR), whereas developing countries often demand nonmarket solutions at lower than market rates. The differing positions become an obstacle to the agreement of new and effective climate treaties.

Mr Yuan Xu studied 2010 SO_2 scrubber markets in China /34/. Interview questions were specified for each firm with different foci for licensors and licensees. Chinese firms have generally chosen to legally license, rather than to illegally acquire SO_2 scrubbing technologies. Legal licensing secures a complete package including systematic training, technical documentation and trade secrets in a relatively short time scale, without exposing the licensees to legal disputes. Good partnerships, strengthened by honest royalty payments, could also help licensees expand into new markets through future technology licensing. The market for SO_2 scrubbers at every unit scale was substantial and the unit scales escalated over time to require continuous technological support from licensors. Such dynamism favoured long-term partnerships between licensors and licensees for their mutual benefit and fostered honest royalty payments. /34/

7.2 Carbon trading schemes /21,35/

7.2.1 Established schemes

Kyoto Protocol: Established in 2005. The target is to reduce emissions by 5 percent below 1990 levels in 2008-2012, collectively, for the 37 countries with mandatory targets. Countries can reduce emissions at home, buy permits from one another, or buy carbon offsets from projects in developing countries under the Clean Development Mechanism (CDM).

European Union: Emissions Trading Scheme (EU ETS) Established in 2005, mandatory for all 27 EU members, plus Iceland, Liechtenstein and Norway, covering about half of total EU carbon emissions. The target is to reduce emissions by 21 per cent below 2005 levels by 2020. Under the scheme, member states allocate a quota of emission allowances to 11,000 industrial installations. Companies get most permits free during the second phase based on historical emissions, but many electricity generators will have to pay for all these from 2013 (third phase) . More than 3,000 airline operators will join the scheme in 2012. (Twenty-six national governments, China included, met in Moscow to discuss the airline industry's response to the aviation sector's inclusion into the EU ETS on 21 February 2012. The meeting aimed to affirm the role of the International Civil Aviation Organisation (ICAO) in addressing international aviation emissions and thereby urged airlines to take several alternative actions and measures in response to the EU ETS.)

New Zealand emissions trading scheme: Launched July 1, 2010. Mandatory, with the target to cut greenhouse gas emissions between 10 and 20 per cent by 2020 on 1990 levels. Under the scheme, emissions units are allocated based on an average of production across each industry. Sectors include forestry, electricity, industrial process emissions and transport, waste (start 2013), and agriculture (start 2015). From July 1, 2010, to Jan. 1, 2013, emitters have the option of paying a fixed price of NZ$25 per tonne of carbon, and will only have to surrender 1 unit for every 2 units of emissions.

Northeast U.S. Regional Greenhouse Gas Initiative (RGGI): Launched January 2009, covering carbon from power plants in 10 states in the U.S. Northeast. The target is to reduce emissions by 10 per cent below 2009 levels by 2018. Allows offsets from five different types of clean energy projects, including capturing methane from landfills and livestock manure, but only if a US$7 per tonne price trigger is hit.

Japan: Tokyo metropolitan trading scheme. Launched April 2010, covering around 1,400 top emitters in the metropolitan area. Japan aims to cut emissions by 25 per cent by 2020 from 1990 levels. Under the scheme, Tokyo sets emission limits for large factories and offices, which can be met by using technology such as solar panels and advanced fuel-saving devices.

7.2.2 Emerging schemes

Australia: Clean Energy Bill Adopted by the Australian Parliament, covers emissions from all sources except agriculture and land use, or the combustion of biomass, biofuels and biogas. The national target is to cut emissions by 5 per cent below 2000 levels by 2020. Under the scheme, 500 companies will pay a tax of A$23 per tonne of carbon from July 2012, rising by around 5 per cent a year, and move to a market based trading scheme in 2015.

California climate change law (AB32): To be launched in 2013, with the first permit auction in November 2011. Covers emissions from power plants, manufacturing and transportation fuels (starting in 2015). The target is to cut the state's emissions to 1990 levels by 2020. Most of credits will be allocated free in the early years, and emitters will be allowed to use offsets to fulfil up to 8 per cent of their compliance obligation.

Western Climate Initiative (WCI): To be launched in January 2013, covering California, Canada's British Columbia and Quebec, and possibly also Ontario. The target is to cut emissions by 15 per cent below 2005 levels by 2020. Under the scheme, emitters such as power plants will have to buy offsets to cover their emissions.

South Korea emissions trading scheme: Expected to start in 2015, covering about 470 companies from all sectors that together produce about 60 per cent of the country's emissions. The South Korean government has set a 2020 emissions reduction target of 30 per cent below projected "business as usual" levels.

India: Perform, Achieve and Trade system Trading is set to begin in 2014 after a three-year rollout period. It is a mandatory energy efficiency trading scheme covering eight sectors responsible for 54 per cent of India's industrial energy consumption. India has pledged a 20 to 25 per cent reduction in emissions intensity from 2005 levels by 2020. Under the scheme, annual efficiency targets will be allocated to firms. Tradable energy-saving permits will be issued depending on the amount of energy saved during a target year.

China: Pilot carbon trading schemes In November 2011, China approved pilot tests of carbon trading in seven provinces and cities – Beijing, Chongqing, Guangdong, Hunan, Shanghai, Shenzhen and Tianjin. Some of the pilot regions can start trading as early as 2013/2014. A national trading scheme is expected by 2016.

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Appendix I

INDIA: Standards for Emission (emission limit values) or Discharge of Environmental Pollutants from various Industries. /1/

Stn. No	Contents
01.	Caustic Soda Industry
02.	Man-Made Fibres (Synthetic)
03.	Petroleum Oil Refinery
04.	Sugar Industry
05.	Thermal Power Plants
06.	Cotton Textile Industries (Composite and Processing)
07.	Composite Woolen Mills
08.	Dye and Dye Intermediate Industry (New Revised Standard)
09.	Electroplating Industries
10.	Cement Plants
11.	Stone Crushing Unit
12.	Coke Ovens
13.	Synthetic Rubber
14.	Small Pulp and Paper Industry
15.	Fermentation Industry (Distilleries, Maltries and Breweries)
16.	Leather Tanneries
17.	Fertilizer Industry
18.	Iron Ore Mining and Ore Processing
19.	Calcium Carbide
20.	Carbon Black
21.	Copper, Lead and Zinc Smelting (New Revised Standard)
22.	Nitric Acid (Emission Oxides of Nitrogen)
23.	Sulphuric Acid Plant
24.	Iron & Steel (Integrated)
25.	Thermal Power Plants
26.	Natural Rubber Industry
27.	Asbestos Manufacturing Units (Including all ProcessesInvolving the use of Asbestos)
28.	Calor Alkali (Caustic Soda)
29.	Large Pulp and Paper
30.	Integrated Iron and Steel Plants (Omitted)
31.	Re-Heating (Reverberatory) Furnaces
32.	Foundries
33.	Thermal Power Plants
34.	Small Boilers
35.	Coffee Industry
36.	Aluminium Plants
37.	Stone Crushing Unit
38.	Petrochemicals (Basic & Intermediates)
39.	Hotel Industry
40.	Pesticide Manufacturing and Formulation Industry
41.	Tannery (After Primary Treatment)
42.	Paint Industry (Waste Water Discharge)
43.	Inorganic Chemical Industry (Waste Water Discharge)
44.	Bullion Refining (Waste Water Discharge)
45.	Dye & Dye Intermediate Industry (Waste Water Discharge)
46.	Noise Limits for Automobiles (Free Field) at One Meter indB(A) at the Manufacturing Stage to be achieved by the Year1992.
47.	Domestic appliances and Construction Equipments at the manufacturing stage to be achieved by the year, 1993

INDIA: Standards for Emission (emission limit values) or Discharge of Environmental Pollutants from various Industries. /1/

Stn. No	Contents
48.	Glass Industry
49.	Lime Kiln
50.	Slaughter House, Meat & Sea Food Industry
51.	Food and Fruit Processing Industry
52.	Jute Processing Industry
53.	Large Pulp & Paper News Print/Rayon Grade Plants of[Capacity above 24000 MT Per Annum]
54.	Small Pulp and Paper (Paper Plant of Capacity upto 24000 MT /Annum
55.	Common Effluent Treatment Plants
56.	Dairy
57.	Tanneries
58.	Natural Rubber Processing Industry(New Revised Standard
59.	Bagasse-Fired Boilers
60.	Man-made Fibre Industry (Semi-Synthetic)
61.	Ceramic Industry
62.	Viscose Filament Yarn
63.	Starch Industry
64.	Beehive Hard Coke Oven
65.	Briquette Industry (Coal)
66.	Soft Coke Industry
67.	Edible Oil & Vanaspati Industry
68.	Organic Chemicals Manufacturing Industry (New Revised Standard)
69.	Flour Mills
70.	Boilers (Small)
71.	Pesticides Industry
72.	Oil Drilling and Gas Extraction Industry
73.	Pharmaceutical (Manufacturing and Formulation) Industry
74.	Brick Kilns
75.	Soda Ash Industry (Solvay Process)(New Revised Standard)
76.	Emission Standard for SO From Cupola Furnace
77.	Specifications of Motor Gasoline for Emission Related Parameters
78.	Specification of Diesel Fuel for Emission related Parameters
79.	Coke Oven Plants
80.	Specifications of Two-Stroke Engine Oil
81.	Battery Manufacturing Industry
82.	Environmental Standards for Gas/Naptha-Based Thermal Power Plants
83.	Standards/Guidelines for Control of Noise Pollution From Stationary Diesel Generator (DG) Sets (Omitted)
84.	Temperature Limit for Discharge of Condenser Cooling Water from Thermal Power Plant
85.	Environmental Standards for Coal Washeries
86.	Water Quality Standards for Coastal Waters Marine Outfalls
87.	Emission Regulations for Rayon Industry
88.	Emission Standards for New Generator Sets(upto 19 KW run on Petrol and Kerosene with implementation Schedule
89.	Noise Standards for Fire Crackers
90.	Standards for Coal Mines
91.	Noise Limit for Generator Sets run with Petrol or Kerosene (New Revised Standard)
92.	Standards for Effluents from Textile Industry
93.	Primary Water Quality Criteria for Bathing Water
94.	Noise Limit for Generator Sets run with Diesel(New Revised Standard)

INDIA: Standards for Emission (emission limit values) or Discharge of Environmental Pollutants from various Industries. /1/

Stn. No	Contents
95.	Emission Limits for New Diesel Engines (up to 800 KW) for Generator Sets (Gensets) Applications
96.	Emission Standards for Diesel Engines (Engine Rating more than 0.8 MW (800 KW) for Power Plant, Generator Set applications and other Requirements
97.	Boilers using Agricultural Waste as Fuel
98.	Guidelines for Pollution Control in Ginning Mills
99.	Sponge Iron Plant (Rotary Kiln)
100.	Common Hazardous Waste Incinerator
101.	Incinerator for Pesticide Industry
102.	Refractory Industry
103.	Cashew Seed Processing Industry
104.	Plaster of Paris Industry

CHINA: Emission Standards (emission limit values) for stationary source pollutants and effective starting date. /4/

·Emission standard of air pollutants for thermal power plants	1.1.2012
·Emission standard of air pollutants for flat glass industry	1.10.2011
·Emission standard of pollutants for sulphuric acid industry	1.3.2011
·Emission standard of pollutants for nitric acid industry	1.3.2011
·Emission standard of pollutants for electroplating	1.8.2008
·Emission standard of pollutants for synthetic leather and...	1.8.2008
·Emission standard of pollutants for magnesium and titaniu...	1.10.2010
·Emission standard of pollutants for copper, nickel, cobal...	1.10.2010
·Emission standard of pollutants for lead and zinc industry	1.10.2010
·Emission standard of pollutants for aluminum industry	1.10.2010
·Emission standard of pollutants for ceramics industry	1.10.2010
·Emission Standard of Coal Bed Methane/Coal Mine Gas (on t...	1.7.2008
·Emission standard of pollutants for electroplating	1.8.2008
·Emission standard of pollutants for synthetic leather and...	1.8.2008
·Emission standard of air pollutant for gasoline filling s...	1.8.2007
·Emission standard of air pollutant for bulk gasoline term...	1.8.2007
·Emission standard for pollutants from coal industry	1.10.2006
·Emission standard of air pollutants for cement industry	1.1.2005
·Emission standard of air pollutants for coal--burning oil...	1.1.2002
·Emission standard of cooking fume (on trial)	1.1.2002
·Emission standard of air pollutants for coke oven	1.1.1997
·Integrated emission standard of air pollutants	1.1.1997
·Emission standard of air pollutants for industrial kiln a...	1.1.1997
·Emission standards for odor pollutants	15.1.1994

CHINA: Method Standard for stationary source emission and effective starting date.

·Determination of sulphur dioxide –NDIR absorption method	1.11.2011
·Standard for smoke metric tablet	1.5.2010
·Ambient air and waste gas Determ. of hydrogen chloride-Ion chrom.	1.4.2010
·Determination of hydrogen chloride - Silver nitratetitration	1.4.2010
·Determination of chlorine- Iodometric method	1.4.2010
·Determination of total gaseous phosphorus - Quimociac volumetric	1.4.2010
·Determination of sulfuric acid mist-Ion chromatography	1.4.2010
·Determination of mercury-Cold atomic absorption spectrophotom.	1.4.2010
·Ambient air and waste gas-Determination of arsenic-Silver diethyldithiocarbamate	1.4.2010
·Determination of lead-Flame atomic absorption spectrometry	1.4.2010
·Air and exhaust gas—Determination of ammonia—Nessler's reagent spetcrophotometry	1.4.2010
·Ambient air and waste gas Determination of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) Isotope dilution HRGC-HRMS	1.4.2009
·Determination of blackness of smoke plumes-Ringelmann smoke chart	1.3.2008
·Technical specifications for emission monitoring of stationary source	1.3.2008
·Technical Specifications of quality assurance and quality control for monitoring of stationary pollution source (on trial)	1.1.2008
·Limits and measurement methods for exhaust pollutants from diesel engines of non road mobile machinery	1.10.2007
·Specifications and Test Procedures for Continuous Emission Monitoring Systems of Flue Gas Emitted from Stationary Sources (on trial)	1.8.2007
·Specifications for Continuous Emissions Monitoring of Flue Gas Emitted from Stationary Sources(on trial)	1.8.2007
·Determination of exhauster anilines-Gas chromatography	1.11.2001
·Determination of nickel -Flame absorption spectrophotometric method	1.11.2001
·Determination of nickel -Graphitic furnace atomic absorption spectrophotometric method	1.11.2001
·Determination of nickel -Dimethylglyoxime with n-Butanol by spectrophotometry	1.11.2001
·Technical method for checking and ratifying the emission gross of soot and SO2 for coal-burning boiler-Method of balanced calculation between materials and products	1.11.2001
·Determination of cadmiun-Flame atomic absorption spectrophotometric method	1.11.2001
·Determination of cadmiun-Graphitic furnace atomic absorption spectrophotometric method	1.11.2001
·Determination of cadmiun-p-Azobenzenediazoaminazobenzene sulfonic acid spectrophotometric method	1.11.2001

CHINA: Method Standard for stationary source emission and effective starting date.

·Determination of tin-Graphite furnace atomic absorption spectrophotometric method	1.11.2001
·Determination of chlorobenzenes-Gas chromatography	1.11.2001
·Determination of fluoride-Ion selective electrode method	1.11.2001
Technical guidelines for fugitive emission monitoring of air pollutants	1.3.2001
Determination of sulphur dioxide from exhausted gas of stationary source Iodine titration method	1.3.2001
Determination of sulphur dioxide from exhausted gas of stationary source Fixed-potential electrolysis method	1.3.2001
Measuring method for exhaust pollutants from diesel engines of vehicles spectrophotometric method	1.9.2000
·Determination of chlorine-Methyl orange	1.1.2000
·Determination of acrylonitrile-Gas chromatography	1.1.2000
·Determination of acrolein-Gas chromatography	1.1.2000
·Determination of acetaldehyde-Gas chromatography	1.1.2000
·Determination of asphaltic smoke-Gravimetric method	1.1.2000
·Determination of vinyl chloride-Gas chromatography	1.1.2000
·Determination of carbon monoxide-Non-dispersive infrared	1.1.2000
·Determination of methanol-Gas chromatography	1.1.2000
·Determination of phenols-4-Amino-antipyrine spectrophotometric method	1.1.2000
·Determination of phosgene-Aniline ultraviolet spectrophotometric method	1.1.2000
·Determination of nitrogen oxide-N-(1-naphthyl)- ethylenediamine dihydrochloride spectrophotometric method	1.1.2000
·Determination of nitrogen oxide-Ultraviolet spectrophotometric method	1.1.2000
·Determination of asbestos dust-Microscopic count	1.1.2000
·Determination of benzo(a) pyrene-High performance liquid chromatography	1.1.2000
·Determination of chlorobenzenes-Gas chromatography	1.1.2000
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·Determination of chromate fog-Diphenyl carbazide spectrophotometric method	1.1.2000
·Determination of hydrogen cyanide-Iso-nicotinic-acid-3-methyl-1-phenyl-5-pyrazolone spectrophotometric method	1.1.2000
·Standard for smokemetric tablet	1.1.1997
·Determination of particulates and sampling methods of gaseous pollutants from exhaust gas of stationary source	6.3.1996
·Measurement method of smoke and dust emission from boilers	1.8.1992