A REVIEW OF THE PROCESS FOR SETTING INDUSTRY-SPECIFIC EMISSION STANDARDS IN INDIA

APPENDICES

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APPENDICES

Appendix I: List of industries for which standards have been developed

CPCB Ref.	Industry / Activity	Date of notification (if provided)
01.	Caustic Soda Industry (chlor alkali)	
02.	Man-Made Fibres (Synthetic)	
03.	Petroleum Oil Refinery	21st August, 2009
04.	Sugar Industry	14th January, 2016
05.	Thermal Power Plants	7th December, 2015
06.	Cotton Textile Industries (Composite and Processing)	
07.	Composite Woollen Mills	
08.	Dye and Dye Intermediate Industry	7th May, 2014
09.	Electroplating Industries	30th March, 2012
10.	Cement Plants	25 August, 2014
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	4th October, 2010
19.	Calcium Carbide	
20.	Carbon Black	
21.	Copper, Lead and Zinc Smelting	2nd May, 2011
22.	Nitric Acid (Emission: Oxides of Nitrogen)	
23.	Sulphuric Acid Plant	7th May, 2008
24.	Iron & Steel (Integrated)	31st March, 2012
25.	Natural Rubber Industry	
26.	Asbestos Manufacturing Units (Including all Processes involving the use of Asbestos)	
27.	Large Pulp and Paper	30th August, 2005
28.	Integrated Iron and Steel Plants (Omitted)	
29.	Re-Heating (Reverberator) Furnaces	
30.	Foundries	
31.	Small Boilers	
32.	Coffee Industry	6th August, 2008
33.	Aluminium Plants	
34.	Petrochemicals (Basic & Intermediates) Effluent	9th November, 2012
35.	Hotel Industry	4th November, 2009
36.	Pesticide Manufacturing and Formulation Industry	13th June, 2011
37.	Tannery (After Primary Treatment)	
38.	Paint Industry (Waste Water Discharge)	
39.	Inorganic Chemical Industry (Waste Water Discharge)	

40.	Bullion Refining (Waste Water Discharge)	
43.	Domestic Appliances and Construction Equipment at the Manufacturing Stage	
44.	Glass Industry	
45.	Lime Kiln	
46.	Slaughter House, Meat & Sea Food Industry	
47.	Food and Fruit Processing Industry	
48.	Jute Processing Industry	
51.	Common Effluent Treatment Plants	1st January, 2016
52.	Dairy	
54.	Natural Rubber Processing Industry	18th March, 2011
55.	Bagasse-Fired Boilers	
56.	Man-made Fibre Industry (Semi-Synthetic)	
57.	Ceramic Industry	
58.	Viscose Filament Yarn	
59.	Starch Industry	
60.	Beehive Hard Coke Oven	
61.	Briquette Industry (Coal)	
62.	Soft Coke Industry	
63.	Edible Oil & Vanaspati Industry	
64.	Organic Chemicals Manufacturing Industry	
65.	Flour Mills	

67.	Pesticides Industry	13th June, 2011
68.	Oil Drilling and Gas Extraction Industry	
69.	Pharmaceutical (Manufacturing and Formulation) Industry	9th July 2009
70.	Brick Kilns	22nd July 2009
71.	Soda Ash Industry (Solvay Process)	1st June, 2011
72.	Cupola Furnaces	
73.	Motor Gasoline for Emission Related Parameters	
74.	Diesel Fuel for Emission related Parameters	
76.	Two-Stroke Engine Oil	
77.	Battery Manufacturing Industry	
78.	Gas/Naphtha-Based Thermal Power Plants	
81.	Coal Washeries	
82.	Coastal Waters Marine Outfalls	
83.	Rayon Industry	
84.	New Generator Sets (up to 19 KW run on Petrol and Kerosene with Implementation Schedule)	7th August, 2013
86.	Coal Mines	
88.	Effluents from Textile Industry	
89.	Primary Water Quality Criteria for Bathing Water	
91.	New Diesel Engines (up to 800 KW) for Generator Sets (Gensets) Applications	7th August, 2013
92.	Diesel Engines (Engine Rating more than 0.8 MW (800 KW) for Power Plant, Generator Set Applications and other Requirements	

93.	Boilers using Agricultural Waste as Fuel	30th August, 2005
95.	Sponge Iron Plant (Rotary Kiln)	30th May, 2008
96.	Common Hazardous Waste Incinerator	26th June, 2008
97.	Incinerator for Pesticide Industry	13th June, 2011
98.	Refractory Industry	18th February, 2009
99.	Cashew Seed Processing Industry	1st January, 2010
100.	Plaster of Paris Industry	5th February, 2010

APPENDIX II: SECTOR REVIEWS

Thermal Power Plants (TPP)

India is experiencing a rapid growth in demand for electric power, and the majority of this is being met through thermal power plants. Many of these TPP are coal-based, to the extent that India is one the world's highest consumers of coal for power generation, behind only USA and China.

Figure 7: A Thermal power plant in Maharashtra

The power sector has grown from an installed capacity of 1,713 MW in the 1950's to 255,012.78 MW as of November 2014. 177,741.89 MW of this capacity is in the form of TPPs, where coal-based units account for 153,570.89 MW. This means that coal- based TPPs account for approximately 60% of power generation capacity in India.

The TPP sector is one of the most polluting sectors of Indian industry, accounting for 60% of industrial PM emissions (including the mining sector), 45% of industrial SO_2 emissions, 30% of industrial NOx emissions and more than 80% of industrial mercury (Hg) emissions[29].

Emission standards for TPP

Thermal power plants have been designated as a Red Category Industry under the CPCB developed classification system of polluting industries. The following emission standards for TPP were notified by the MOEFCC on 7th December 2015[30].

[29] CSE (2016) Overview of Air Pollution Standards in Emerging Economies via http://cseindia.org/userfiles/sweta.pdf

[30] MoEF (2015) The Gazette of India – Notification: Thermal Power Plant via http://www.moef.nic.in/sites/default/files/draft%20Notification%20forinviting%20the%20public%20comments%20for%20the%20Coal%20BTPP.pdf

Table 10: Notified emission standards for TPP

Age	Capacity	Pollutant	Standards
TPPs installed before 31st December 2003*	All	Particulate Matter	100 mg/Nm³
	<500MW	Sulphur Dioxide	600 mg/Nm³
	>500MW		200 mg/Nm³
	All	Oxides of Nitrogen	600 mg/Nm³
	>500MW	Mercury	0.03 mg/Nm³
TPPs installed after 31st December 2003 up to 31st December 2016*	All	Particulate Matter	50 mg/Nm³
	<500MW	Sulphur Dioxide	600 mg/Nm³
	>500MW		200 mg/Nm³
	All	Oxides of Nitrogen	300 mg/Nm³
	>500MW	Mercury	0.03 mg/Nm³
TPPs to be installed from 1st January 2017**	All	Particulate Matter	30 mg/Nm³
	All	Sulphur Dioxide	100 mg/Nm³
	All	Oxides of Nitrogen	100 mg/Nm³
	>500MW	Mercury	0.03 mg/Nm³

* TPPs (units) shall meet the limits within two years from date of publication of notification.
** Includes all the TPPs (units) which have been accorded environmental clearance and are under construction.

These new standards were an update on those previously notified for particulate matter, establishing norms for mercury, sulphur dioxide and oxides of nitrogen. At the time of writing this report a COINDs document for the TTP sector had not been published, nor had a sectoral background document been made available. As a result, it has not been possible to review any analysis carried out in preparation of the standards.

In order to achieve the most recent standards, new TPPs are expected to have emission-reduction technology fitted, such as flue gas desulphurisation (FGD). Since the new emission standards for TPPs were notified in 2015, media reports have estimated the cost of fitting the necessary abatement equipment to TPPs to be Rs 50 lakh-1.5 crore per megawatt, amounting to Rs 80,000 crore and Rs 2.4 lakh crore for the entire capacity of the country[31]. However, details of the methods and underlying assumptions for the estimation of these costs have not been made available so it is not possible to review what has been included or excluded from the calculations. In addition, the media reports estimate that within India there is only capacity to upgrade 10-15 GW per annum compared with a need of 80 GW per annum, just to comply with the SO_2 standards

Comparison with international approaches

The table and graph below provide a summary of how the new Indian standards for the TPP sector compare with those for China, the EU and USA, with an analysis of this comparison provided in the following Section (the EU standards are currently being revised with tighter standards expected to be adopted later in 2016).

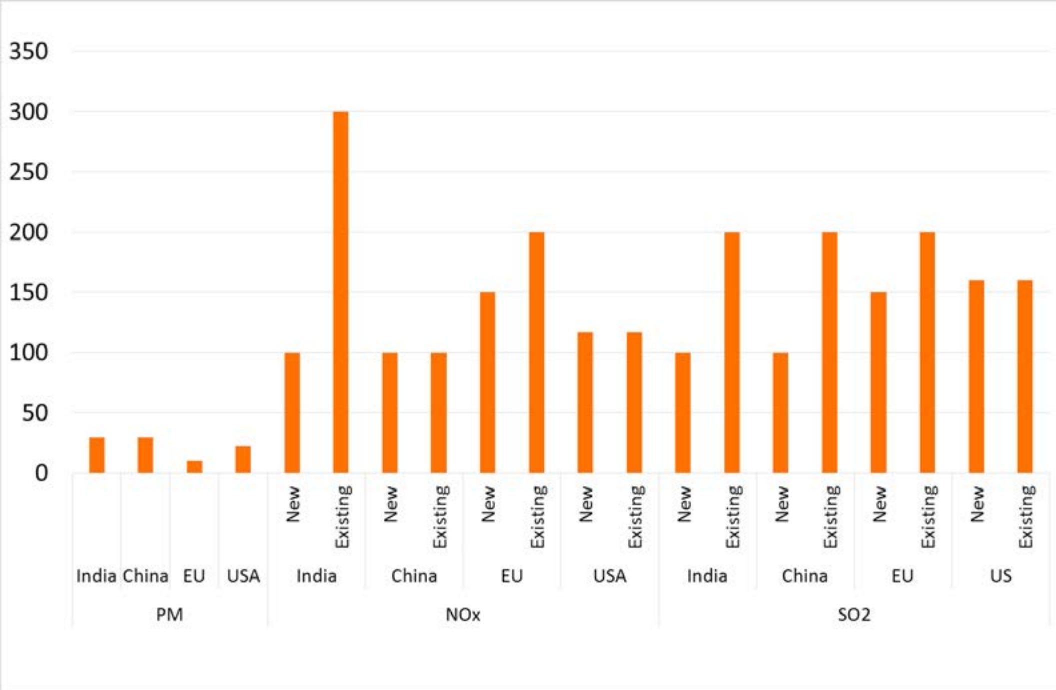
Table 11: International comparison of standards for the coal-fired TPP industry

Pollutant	Status	India (Dec 2015)	China	EU (>300 MWth)	US
SO_2	New	100	100	150	160
	Existing	200/600[1]	200/400[2]	200	160/640[3]
NO_x	New	100	100	150/200[4]	117
	Existing	300/600[5]	100/200[6]	200	117/160/640[7]
PM	New & Existing	30 (50/100)[8]	30	10	22.5
Mercury	New	0.03	0.03	-[9]	0.001
	Existing	0.03	0.03	-[9]	0.002

1) 200 for plant 500 MW capacity or higher, 600 for plant <500MW
2) 400 for four provinces with high-sulphur coal
3) 160 for plants built 1997-2005; 640 for plants built 1978-1996
4) 200 for lignite TPP
5) 600 for TPP pre 2004, 300 for TPP from 2004-2016
6) 100 for plants built 2004-2011; 200 for plants built before 2004
7) 117 for plants built after 2005; 160 for plants built 1997-2005; 640 for plants built 1978-1996
8) 100 for TPP pre 2004, 50 for TPP from 2004-2016
9) As part of the revision of the standards in the EU new standards for mercury will be included.

[31] The Financial Express (2016) Green norms: Govt to extend deadline for thermal plants via http://www.financialexpress.com/article/economy/green-norms-govt-to-extend-deadline-for-thermal-plants/218903/

Figure 8: Comparison of international standards for the TPP industry*



* Where a range of emissions was provided, the most stringent standard has been presented

Summary

The process adopted for the development of TPP emission standards notified in 2015 is not well-documented. As the new emission limits are broadly comparable to those in the USA, China and the EU, and for certain pollutants more stringent limits have been set (NOx and SO_2), it is reasonable to assume that the development process has given consideration to international standards. However, as a COINDs document/sectoral background report is not publicly available, it is not possible to confirm the techno-economic, social and environmental factors that have been taken into consideration.

Iron and Steel (I&S)

The iron and steel sector in India has experienced rapid expansion since the turn of the 21st century, and this rate of growth is anticipated to continue due to requirements for housing and infrastructure developments. In 2011-12, India's capacity for the production of crude steel was 72 million tons[32], while the National Steel Policy, 2012[33], aims to achieve crude steel capacity of 300 million tons by 2025-26.

[32] CPCB (2012) Cleaner Technology Options for Sintering Plant of Integrated Iron and Steel Plants via http://cpcb.nic.in/upload/NewItems/NewItem_208_SinteringPlant.pdf

[33] Ministry of Steel (2012) National Steel Policy – Draft via http://steel.gov.in/overview.htm

Figure 9: Blast furnace at an iron and steel facility

The two main methods for the production of steel are:

- **Primary production**, which utilises iron ore as a raw material and involves coke ovens, sinter plants, pellet plants and blast furnaces (BF)/basic oxygen furnaces (BOF).
- **Secondary production**, which involves the use of an electric arc furnace (EAF) and utilises sponge iron or steel scrap as the raw material.

Approximately 45% of the steel industry in India is accounted for by BF and BOF, with the remainder split between EAF and IF. Due to non-reporting by small facilities, it is not possible to determine the exact number of sponge iron facilities in India. Outside of the large integrated steel plants, many smaller facilities, in particular those using EAF/IF, form clusters. These are often in close proximity to raw materials and cheap labour.

Under CSE's Green Rating Project[34], the iron and steel industry was identified as having heavy pollution issues, as well as issues with non-compliance and failures in pollution monitoring and control. The primary pollutants of concern in the iron and steel sector are PM, NO_2, SO_2, VOCs and dioxins & furans arising from the sintering process.

Emission standards for iron and steel

Iron and steel plants have been deemed a Red Category Industry. Those with a production capacity of over 30,000 tons-per-annum, or sponge iron plants with a capacity over 200 tons-per-day, must receive environmental clearance from the MOEFCC. Plants with a capacity below these thresholds can be approved by SPCBs. The MOEFCC can also specify environmental norms for specific facilities, which must then be implemented by SPCBs.

The MOEFCC provides standards for various elements of the iron and steel manufacturing process, including coke ovens, sintering plant, blast furnaces, BOFs, rolling mills, EAFs, IFs, cupola foundries, calcination plants, lime kilns, dolomite kilns, refractory units and sponge iron plants. Various guidance documents have been published to assist SPCBs/PCCs in regulating these industries and in determining the most appropriate pollution control technologies.

[34] Further details available from: http://www.cseindia.org/taxonomy/term/20082/menu

This assessment has focussed on sponge iron plants, given their significant polluting potential and the reported difficulties in regulating the industry. The following table provides the current standards, which were notified in May 2008, for sponge iron plants.

Table 12: Indian emission standards for iron and steel plants: Sponge iron plants (rotary kiln)

Parameter	Fuel type	Limit value
Particulate matter	Coal	100 mg/Nm³
	Gas	50 mg/Nm³
Carbon monoxide (Vol/Vol)	Coal/gas	1%
Stack height (minimum)	Coal/gas	30 m (minimum) Stack height shall be calculated as $H = 14\ Q^{0.3}$ where Q is emission of Sulphur Dioxide (SO_2) in kg/hr

The standard also provides limit values for PM arising from de-dusting units and in ambient air at various locations within the facility. The standard specifies the required pollution control equipment and outlines the requirements for its installation and use, and provides additional restrictions for new facilities. The standard states that monitoring is required as per CPCB guidelines.

The COINDs document for the sponge iron industry[35] provides a detailed summary of the state of the industry in India, an overview of the potential environmental impacts associated with the manufacturing process, including information on environmental monitoring, an overview of current environmental management practices and a detailed breakdown of the technologies available for pollution control. The following stack emission results for a selection of coal-fired sponge iron plants of varying sizes using electrostatic precipitators are provided in the document.

Table 13: Stack emission results for coal-fired sponge iron plants

Plant capacity	Kiln monitoring (mg/Nm3) with ESP			
	Temp (°C)	PM	SO2	NOx
2x 100 tons-per-day kilns	172	302-727	65-90	80-112
2x 50 tons-per-day kilns	142	127-162	51-64	92-137
2x 50 tons-per-day kilns	148	43-47	54-77	45-60
2x 100 tons-per-day kilns	172	561-683	84-92	60-63
1x 500 tons-per-day kiln (before ESP)	165	24,960	-	-

[35] CPCB (2007) Comprehensive Industry Document: Sponge Iron Industry via http://www.cpcb.nic.in/upload/NewItems/NewItem_102_SPONGE_IRON.pdf

The COINDs document also specifies the minimum national standards and provides further details on monitoring requirements for the operator. It does not however provide an explanation of how the standards were determined. Neither does it explain why standards are not provided for SO_2 and NOx, despite the fact that monitoring results indicate significant emissions of both pollutants. Furthermore, the CPCB recommends operators of all facilities to monitor stack emissions for temperature, velocity, PM, SO_2, NOx, and CO once per month.

Comparison with international approaches

The sponge iron industry is not prevalent in USA or Europe, and although it is known to be established in China, it has not been possible to identify any directly comparable standards. A comparison table of international standards set for other stages of the iron and steel industry is provided in Appendix III.

Summary

Sponge iron plants have been identified as posing a significant risk to local communities and ecological habitats due to the high polluting nature of the industry, the tendency of facilities to form clusters, and non-compliance with emission standards. Although the COINDs document for sponge iron facilities provides detailed information on the environmental impacts of the industry and the pollution control technology available to treat emissions, it does not provide justification for the standards selected. It may be that this information is provided in the sectoral background document, however these are not made publicly available. Furthermore, the COINDs document does provide evidence to suggest that emissions of both NOx and SO_2 from sponge iron facilities may be hazardous to human health, and even recommends that operators undertake monitoring of both of these pollutants. Yet, standards for these substances have not been developed.

Brick Kilns (BK)

Figure 10: Brick kilns in India

Brick kilns in India manufacture an estimated 140 billion clay bricks per year for use in the construction sector. Installations are typically small in size, forming clusters in rural and peri-urban areas, and often operate seasonally. There are estimated to be over 100,000 brick kilns currently in operation.

Brick kilns are categorised as either intermittent or continuous. Intermittent kilns (e.g. clamps) have low energy efficiency and are typically used for small production operations, whereas continuous kilns (e.g. Bull's Trench Kilns (BTKs), high draught kilns) have higher energy efficiencies and larger capacities.

Brick kilns are also classified on the basis of their daily brick production capacity, as follows:

Small: <15,000 → **Medium:** 15,000 – 30,000 → **Large:** >30,000

The brick kiln industry is energy intensive, representing approximately 8% of India's total coal consumption. Brick kilns burn around 24 million tonnes of coal and 12.6 million tonnes of biomass per year[36]. The sector has been deemed a Red Category Industry due to the potential significance of pollutant emissions on human health and ecology[37].

Emission standards for brick kilns

Emission standards for brick kilns were first notified by the MOEFCC in April 1996. The notification set minimum stack heights, maximum emission concentration for suspended particulate matter (SPM), and proposed a ban on moving chimney BTKs. The notifications required moving chimneys to be changed to fixed chimneys by 30th June, 2002.

[36] CPCB (2007) Comprehensive industry document with emission standards, guidelines and stack height regulation for vertical shaft brick kilns (VSBK) vis-à-vis pollution control measures via http://cpcb.nic.in/Publications_Dtls.php?msgid=3

[37] Rajasthan State Pollution Control Board – Guidelines for Abatement of Pollution in Brick Kiln Industry via http://www.rpcb.rajasthan.gov.in/rpcbweb/Guidelines/Brick_TSR_2011.pdf?id=2

The original notification did not include standards for vertical stack brick kilns (VSBKs), which are a relatively new technology offering improved energy efficiency for the firing of bricks. As a result, the CPCB contracted The Energy and Resources Institute (TERI) to prepare a study to enable the development of emission standards and stack height regulation for VSBKs, which involved the monitoring of emissions from four pilot VSBKs, as well as analysis of pollution control technologies and best practices. The study included stack and fugitive emissions monitoring and ambient air quality monitoring. All of which were carried out in the presence of CPCB officials and in accordance with the standard procedures recommended by the CPCB. Stack emissions were monitored for PM, SO_2 and NOx. Ambient air quality monitoring of SPM, SO_2 and NO_2 was also carried out at three locations, at a distance of 50 – 100 meters from the kiln. An air dispersion model (PTMTP) was used to determine ground-level concentrations of particulate matter emitted from the stack.

A summary of the stack emission concentrations and ambient air quality recorded at each facility are provided in Table 14 and Table 15 respectively[36].

Table 14: Mean concentration of pollutants in the stacks of the four VSBKs

Parameter	VSBK - 1	VSBK - 2	VSBK - 3	VSBK – 4
Particulates (mg/Nm^3)	136 (93 – 176)	250 (232 – 272)	77 (67 – 84)	212 (170 – 234)
SO_2 (mg/Nm^3)	17 (13 – 25)	36 (27 – 44)	62 (39 – 118)	53 (48 – 62)
NOx (mg/Nm^3)	42 (36 – 50)	79 (57 – 91)	68 (55 – 81)	74 (70 – 78)

Table 15: Ambient air quality near the VSBKs

Parameter	VSBK - 1	VSBK - 2	VSBK - 3	VSBK - 4	NAAQS (24-hour standard)
SPM (µg/m^3)	192 – 346	189 – 352	95 – 147	70 – 129	500
RSPM (µg/m^3)	72 – 112	84 – 132	70 – 100	53 – 90	150
SO_2 (µg/m^3)	10 – 20	10 – 21	6 – 15	8 – 13	150
NO_2 (µg/m^3)	18- 32	25- 32	12- 32	13- 40	120

Based on the findings of the study an emission norm of 250 mg/Nm^3 without normalisation, was proposed at the CPCB meeting on April 20th, 2004, reflecting the average emissions recorded at VSBK – 2, which was the only fully commercial large-capacity VSBK covered by the study. The COINDs document recognises the limitations of the study, stating *"The proposed minimal* *emission standard is based on a limited amount of data collected from the first few pilot kilns operating in Madhya Pradesh and Maharashtra. The standard may require revision, once the technology spreads to other states in the country and more data on environmental performance of the technology becomes available."* The emission limit value of 250 mg/Nm³ for VSBKs has been retained in the draft notification of emission standards published in 2015. It is unclear whether any further research was undertaken to assess the suitability of this standard to protect human health and sensitive habitats. The draft emission standards for VSBKs are presented below[38].

Table 16: Draft emission standards for VSBKs

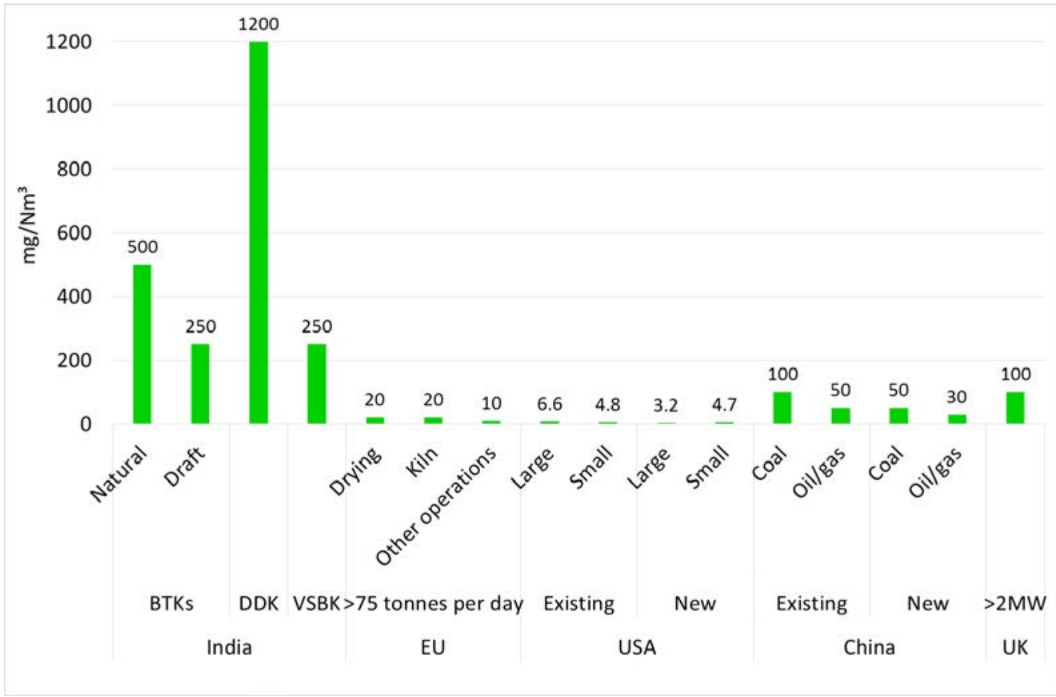
Pollutant	Standard
Particulate matter	250 mg/Nm³

Comparison with international approaches

An assessment of the emission standards for brick kilns (various types) set in other countries has been completed in order to provide comparison with the draft standards published for public comment by the MOEFCC in 2015. For the purposes of this analysis, data from the *Process Guidance Note 3/02(12) Statutory guidance for manufacture of heavy clay goods and refractory goods*[39], published by DEFRA in the United Kingdom, has also been included, as this is applicable to smaller facilities (>2MW thermal input) which are likely to more closely align with the small, localised brick kilns in India.

Full details of this assessment are provided in Appendix III. The following graph illustrates the emission standards for particulate emissions from the brick kiln sector, provided by each country.

Figure 11: Comparison of emission standards for particulate matter from brick kilns



It is clear from this assessment that the standards set by the MOEFCC are less stringent that those set in the UK, the EU, USA and China. Furthermore, as can be seen from the comparison table in Appendix III, all other regions considered in this assessment provide standards for other pollutants, besides particulate matter. These have been summarised below:

Table 17: Pollutants covered by standards for brick kilns

Country	Pollutants
India	PM
EU	PM, NOx, HCl, HF, SO_2
USA	PM, HF, HCl, HAP
China	PM, NO_2, SO_2, HCl, Pb, Ca, Ni
UK	PM, NO_2, SO_2, HF, HCl

It should be noted that in India emissions of SO_2 are addressed through the determination of an appropriate stack height. However, this does not provide the level of certainty offered through the use of a specific emission standard.

[38] MoEF (2015) Draft notification of emission standards for brick kilns via http://www.moef.nic.in/sites/default/files/Brick%20 Kilns.PDF

[39] Defra (2012) Process Guidance Note 3/02(12) Statutory guidance for manufacture of heavy clay goods and refractory goods via http://webarchive.nationalarchives.gov.uk/20141106091809/http:/www.defra.gov.uk/industrial-emissions/files/06092012-pgn-302.pdf

Summary

A number of potential areas for strengthening were identified in the process followed for the development of emission standards for VSBKs. The assessment was limited to just four facilities, only one of which was operating commercially at the time of the study. The assessment included the monitoring of SO_2 and NOx, though this data has not been used to formulate an emission standard for these pollutants. When compared with standards for brick kilns set around the world, the Indian standards were found to be less stringent for particulate emissions. Furthermore, all other countries reviewed were found to have standards for other pollutants, including NO_2 and SO_2. Despite the draft standards being published in 2015, they appear to be falling behind other parts of the world in both stringency and coverage.

Appendix III: Comparison of international emission standards

International emission standards – Iron and steel plant

Process	Pollutant	India	EU (BAT associated emission levels)	USA	China
Sinter plant	Dust / particulates	150 mg/Nm³	**Primary emissions:** <1 – 15 mg/Nm³ (bag filter) <20 – 40 mg/Nm³ (advanced electrostatic precipitator) **Secondary emissions:** <10 mg/Nm³ (bag filter) <30 mg/Nm³ (electrostatic precipitator) Daily mean.		**Pellet firing equipment:** 50 mg/m³ (existing) 80 mg/m³ (new) 40 mg/m³ (special) **Sinter machine, belt roasting machine and other production equipment:** 30 mg/m³ (existing) 50 mg/m³ (new) 20 mg/m³ (special)
	Mercury		<0.03 – 0.05 mg/Nm³ Spot samples for at least half an hour.		N/A
	Sulphur dioxide		<350 – 500 mg/Nm³ (BAT I – IV) 100 mg/Nm³ (BAT V) Daily mean.		**Pellet firing equipment:** 200 mg/m³ (existing) 600 mg/m³ (new) 180 mg/m³ (special)
	Nitrogen dioxide		<500 mg/Nm³ (process integrated measures) <250 mg/Nm³ (RAC) <120 mg/Nm³ (SCR) Daily mean.		**Pellet firing equipment:** 300 mg/m³ (existing) 500 mg/m³ (new) 300 mg/Nm³ (special)

Process	Pollutant	India	EU (BAT associated emission levels)	USA	China
	Polychlorinated dibenzodioxins / furans (PCDD/F)		<0.05 – 0.2 ng I-TEQ/Nm³ (bag filter) <0.2 – 0.4 ng-I-TEQ/Nm³ (advanced electrostatic precipitator) 6-8 hour random sample, steady-state conditions.		**Pellet firing equipment:** 0.5 ng-TEQ/m³ (existing) 1.0 ng-TEQ/m³ (new) 0.5 ng-TEQ/m³ (special)
Pelletisation plant	Dust / particulates		<20 mg/Nm³ (crushing, grinding and drying) <10 – 15 mg/Nm³ (all other process steps) Daily mean.		As above.
	Sulphur dioxide		<30 – 50 mg/Nm³ Daily mean.		
	Hydrogen fluoride & hydrogen chloride		<1 – 3 mg/Nm³ Daily mean.		
Coke oven plants	Dust / particulates	50 mg/Nm³ 25 mg/Nm³ (charging of stamp charging batteries)	**General:** <10 – 20 mg/Nm³ **Coke pushing:** <10 mg/Nm³ (bag filters) <20 mg/Nm³ (other cases) Coke dry quenching: <20 mg/Nm³ Discontinuous measurement, spot samples for at least half an hour. **Emission minimised conventional wet quenching:** <25 g/t coke Coke stabilisation quenching: <10 g/t coke		**Stove:** 50 mg/m³ (existing) 20 mg/m³ (new) 15 mg/m³ (special) **Feed system, coal system, high furnace cast-house and other production facilities:** 50 mg/m³ (existing) 25 mg/m³ (new) 10 mg/m³ (special)

Process	Pollutant	India	EU (BAT associated emission levels)	USA	China
	Hydrogen sulphide		<300 – 1,000 mg/Nm³ (BAT I) <10 mg/Nm³ (BAT II) Daily mean.		
	Sulphur dioxide	800 mg/Nm³	<200 – 500 mg/Nm³ Daily mean, oxygen content of 5%.		**Stove:** 100 mg/m³ (existing) 100 mg/m³ (new) 100 mg/m³ (special)
	Nitrogen dioxide	500 mg/Nm³	<350 – 500 mg/Nm³ (new or substantially revamped plants, less than 10 years old) 500 – 650 mg/Nm³ (older plants with well-maintained batteries and incorporated low-nitrogen oxides (NOx) techniques) Daily mean.		**Stove:** 300 mg/m³ (existing) 300 mg/m³ (new) 300 mg/m³ (special)
Blast furnaces	Dust / particulates	**BF stove:** 50 mg/Nm³ (existing) 30 mg/Nm³ (new) **Space de-dusting / other stacks of BF area:** 100 mg/Nm³ (existing) 50 mg/Nm³ (new)	<20 mg/Nm³ <1 – 15 mg/Nm³ (BAT II) <10 mg/Nm³ (cleaned blast furnace gas) Discontinuous measurement, spot samples for at least half an hour.		**Blast furnace:** 15 mg/m³ (special)
	Sulphur dioxide	250 mg/Nm³ (existing) 200 mg/Nm³ (new)	<200 mg/Nm³ Daily mean.		
	Nitrogen dioxide	150 mg/Nm³	<100 mg/Nm³ Daily mean.		
	Carbon monoxide	1% vol./vol.			

Process	Pollutant	India	EU (BAT associated emission levels)	USA	China
Basic oxygen furnace (BOF)	Dust / particulates	**Blowing lancing operation:** 300 mg/Nm³ (existing units) **Normal operation:** 150 mg/Nm³ (existing units) **Secondary emission stack:** 100 mg/Nm³ (existing units) 50 mg/Nm³ (new units)	**General:** 10 – 30 mg/Nm³ (BAT I) <50 mg/Nm³ (BAT II) **De-dusted off-gases:** <1 – 15 mg/Nm³ (bag filters) <20 mg/Nm³ (electrostatic precipitators) **Hot metal pre-treatment / secondary metallurgy:** <1 – 10 mg/Nm³ (bag filters) <20 mg/Nm³ (electrostatic precipitators) Daily mean. **On-site slag processing:** <10 – 20 mg/Nm³ Discontinuous measurement, spot samples for at least half an hour.	**Primary emissions from BOF for which construction is commenced after June 11, 1973:** 50 mg/dscm (0.022 gr/dscf / 52.8 mg/Nm³) 68 mg/dscm (0.030 gr/dscf / 72 mg/Nm³), as measured for the primary oxygen blow using closed hooding to control primary emissions **Secondary emissions from BOF for which construction is commenced after January 20, 1983:** 23 mg/dscm (0.010 gr/dscf / 24 mg/Nm³) Note: 0.05 grains/dscf = 120 mg/Nm³	
Electric arc furnace and steelmaking	Dust / particulates	**Rolling mills, arc furnaces, induction furnaces:** 150 mg/Nm³ **Re-heating (reverberatory) furnaces:** 150 mg/Nm³ (sensitive area) 250 mg/Nm³ (other area) **Cupola foundry:** 450 mg/Nm³ (melting capacity less than 3 TPH) 150 mg/Nm³ (melting capacity 3 TPH and above)	**Primary and secondary de-dusting:** <5 mg/Nm³ Daily mean. **Slag processing:** <10 – 20 mg/Nm³ Discontinuous measurement, spot samples for at least four hours.	**EAF constructed after October 21, 1974 and on or before August 17, 1983:** 12 mg/dscm (0.0052 gr/dscf / 12.5 mg/Nm³)	
		Calcination plant/lime kiln/ dolomite kiln: 500 mg/Nm³ (capacity up to 40 TPD) 150 mg/Nm³ (capacity above 40 TPD) **Refractory unit:** 150 mg/Nm³			
	Sulphur dioxide	**Cupola foundry:** 300 mg/Nm³			
	Mercury		<0.05 mg/Nm³ Discontinuous measurement, spot samples for at least four hours.		
	Polychlorinated dibenzodioxins / furans		0.1 ng I-TEQ/Nm³ 6 – 8 hour random sample during steady-state conditions.		

International emission standards – Brick kilns

Kiln type	Pollutant	India (Draft notifications of emission standards for brick kilns)	EU >75 tonnes per day UK (Process Guidance Note 3/02/(12))	USA (NESHAP for Brick and Structural Clay Products Manufacturing; and NESHAP for Clay Ceramics Manufacturing)	China (Emission standards for ceramics industry)
Bull's Trench Kilns (BTK)	Particulate matter	Natural draft kilns: 500 mg/Nm^3 Induced draft kilns: 250 mg/Nm^3			
Down-Draft Kilns (DDK)	Particulate matter	1,200 mg/Nm^3			
Vertical Shaft Brick Kiln (VSBK)	Particulate matter	250 mg/Nm^3			
General	Particulate matter		**EU BAT-AEL daily average for plant >75 tonnes per day** **1-20 mg/m^3 (drying)** **1-20 mg/m^3 (kiln)** **1-10 mg/m^3 (other operations)** **UK limits (smaller kilns)** **100 mg/m^3 (kilns with a net rated thermal input of 2MW or more)** **10 mg/Nm^3 (silos constructed since July 1st 2004)** 50 mg/m³ (arrestment equipment with exhaust flow >300 m³/min (other than from kilns and silo arrestment plant))	Existing large tunnel kiln: 6.6 mg/dscm (0.0029 gr/dscf) at 17 % O_2 Existing small tunnel kiln: 4.8 mg/dscm (0.0021 gr/dscf) at 17% O_2 New or reconstructed large tunnel kiln: 3.2 mg/dscm (0.0014 gr/dscf) at 17 % O_2 New or reconstructed small tunnel kiln: 4.7 mg/dscm (0.0021 gr/dscf) at 17 % O_2	Roller kiln, shuttle kiln, tunnel kiln: 100 mg/Nm³ (existing – coal fired) 50 mg/Nm³ (existing – oil/gas fired) 50 mg/Nm³ (new – coal fired) 30 mg/Nm³ (new – oil/gas fired)

Kiln type	Pollutant	India (Draft notifications of emission standards for brick kilns)	EU >75 tonnes per day UK (Process Guidance Note 3/02/(12))	USA (NESHAP for Brick and Structural Clay Products Manufacturing; and NESHAP for Clay Ceramics Manufacturing)	China (Emission standards for ceramics industry)
	Oxides of nitrogen (as NO_2)		EU BAT-AEL daily average for plant >75 tonnes per day <250 mg/m³ (kiln gas temp <1300 °C) <500 mg/m³ (kiln gas temp ≥1300 °C) UK (smaller kilns) 500 mg/m³ (all new or substantially changed processes (with a net rated thermal input of 2MW or more))		**Roller kiln, shuttle kiln, tunnel kiln:** **650 mg/Nm^3 (existing – coal fired)** **400 mg/Nm^3 (existing – oil/gas fired)** **450 mg/Nm^3 (new – coal fired)** **300 mg/Nm^3 (new – oil/gas fired)**
	Chloride (as hydrogen chloride)		**EU BAT-AEL daily average for plant >75 tonnes per day** **1-30 mg/m^3** **UK (smaller plant)** 50 mg/m³ (all new or substantially changed processes (with a net rated thermal input of 2MW or more))	26 kg/hr (57 lb/hr) (collection of all tunnel kilns at facility, including all process streams)	Roller kiln, shuttle kiln, tunnel kiln: 50 mg/Nm³ (existing) 25 mg/Nm³ (new)
	Fluoride (as hydrogen fluoride)		**EU BAT-AEL daily average for plant >75 tonnes per day** **1-10 mg/m^3** **UK (smaller plant)** **10 mg/m^3 (all kilns (with a net rated thermal input of 2MW or more))**		

Kiln type	Pollutant	India (Draft notifications of emission standards for brick kilns)	EU >75 tonnes per day UK (Process Guidance Note 3/02/(12))	USA (NESHAP for Brick and Structural Clay Products Manufacturing; and NESHAP for Clay Ceramics Manufacturing)	China (Emission standards for ceramics industry)
	Sulphur dioxide		**EU BAT-AEL daily average for plant >75 tonnes per day** **<500 mg/m³ (S ≤0.25%)** **500-2000 mg/m³ (S>0.25%)** UK (smaller plant) 500 mg/m³ (new or substantially changed plant (with a net rated thermal input of 2MW or more) where low sulphur clays are used (</= 0.12% w/w sulphur)) 2,000 mg/m³ (new or substantially changed plant (with a net rated thermal input of 2MW or more) where high sulphur clays are used (> 0.12% w/w sulphur))		**Roller kiln, shuttle kiln, tunnel kiln:** **500 mg/Nm³ (existing – coal fired)** **300 mg/Nm³ (existing – oil/gas fired)** **300 mg/Nm³ (new – coal fired)** **100 mg/Nm³ (new – oil/gas fired)**
	Mercury			**Existing large tunnel kiln:** 7.7 µg/dscm at 17 % O_2 Existing small tunnel kiln: 91 µg/dscm at 17% O_2 New or reconstructed large tunnel kiln: 6.2 µg/dscm at 17 % O_2 **New or reconstructed small tunnel kiln:** 91 µg/dscm at 17 % O_2	

Kiln type	Pollutant	India (Draft notifications of emission standards for brick kilns)	EU >75 tonnes per day UK (Process Guidance Note 3/02/(12))	USA (NESHAP for Brick and Structural Clay Products Manufacturing; and NESHAP for Clay Ceramics Manufacturing)	China (Emission standards for ceramics industry)
	Lead				**Roller kiln, shuttle kiln, tunnel kiln:** **0.5 mg/Nm³ (existing)** **0.1 mg/Nm³ (new)**
	Calcium				**Roller kiln, shuttle kiln, tunnel kiln:** **0.5 mg/Nm³ (existing)** **0.1 mg/Nm³ (new)**
	Nickel				**Roller kiln, shuttle kiln, tunnel kiln:** **0.5 mg/Nm³ (existing)** **0.2 mg/Nm³ (new)**

Appendix IV: Key process documents

Under the literature review completed for this study the following key guidance documents were identified that are used by Central and State Governments in the development of sector-specific emission standards:

- CPCB (1996) Rationale in Evolution of Standards for Industrial Effluents and Emissions: Outlines the work involved in the evolution of industrial effluents and emission standards, and identifies how to achieve the containment of pollution at source, in order to achieve emission standards in a techno-economically feasible manner.
- CPCB (2016) Final Document on Revised Classification of Industrial Sectors Under Red, Orange, Green and White Categories: Details the new system of industrial classification based on the Pollution Index, which is a function of the emissions (air pollutants), effluents (water pollutants), hazardous wastes generated and consumption of resources.
- CPCB (2009) Guidelines for Development of Location Specific Stringent Standards9: Provides comprehensive technical support to SPCBs/PCCs for the setting of more stringent standards, including the identification of areas with existing air pollution problems, and guidance on suggested methodologies for atmospheric dispersion modelling.

CPCB (1996) Emission Regulation – Part III: Details emissions monitoring requirements, including stack and ambient concentrations.

Appendix V: Prioritization of industries for standard development

In an effort to identify industrial emission sources that could potentially be prioritised for emission standard development/review, a review of the full list of standards provided on the CPCB website was carried out to confirm the most recent published standards. This information was then combined with the industry categorisations provided by the CPCB, to identify those which pose the greatest risk to the environment.

Of the 29 activities/sources for which the published date of the most recent standard is provided, 11 were found to have been notified prior to 2010. These are listed in the following table, which also includes the CPCB assigned industry categories.

Sources/activities with standards set prior to 2010

Industry / Activity	Date of notification	Industry Category
Petroleum Oil Refinery	2009	Red
Hotel Industry		Red
Pharmaceutical (Manufacturing and Formulation) Industry		Red
Brick Kilns		Orange
Refractory Industry		Orange
Sulphuric Acid Plant	2008	Red
Coffee Industry		Orange
Sponge Iron Plant (Rotary Kiln)		Red
Common Hazardous Waste Incinerator		Red
Large Pulp and Paper	2005	Red
Boilers using Agricultural Waste as Fuel		Unknown

The table above shows that there are a number of Red category industries, for which at least 5 years have passed since the last emission standard review occurred. Furthermore, given that the process for standard development typically takes between 2 to 3 years, it is reasonable to assume that the evidence used to support the emission standards, for those industries with standards set prior to 2009, will be around 10 years out of date.

This is of particular concern for the sponge iron plants, due to the rapid expansion of the industry over the last decade (as discussed earlier in the report), and common hazardous waste incinerators, which can often be located in heavily populated regions. The issue of pollutant emissions from waste burning activities was highlighted in the CPCB's *"Air quality monitoring, emission inventory and source apportionment study for Indian cities"*[40], with the source flagged as a significant issue for each of the cities considered in the study (Delhi, Bangalore, Pune, Mumbai, Chennai and Kanpur). Furthermore, it is unclear whether the standard for hazardous waste incinerators also applies to residual waste incinerators and more sophisticated units, such as gasifiers or pyrolysis systems. The combustion of waste is increasingly becoming a viable alternative to the landfilling of waste, and improvements in technology now enable the generation of heat and electricity for local communities, which can make them an attractive proposition. It is therefore important that India stays abreast of the technology as well as its implications for emission controls in this sector. Further, it is recommended that a full review of waste incineration technologies, including energy-from-waste systems, be undertaken, to ensure that appropriate standards are in place.

There are also several Red category industries for which the date of the standard could not be confirmed. These include the fertilizer industry, aluminium plants, oil drilling and gas extraction industry. The gas extraction industry is of particular importance if the Indian Government wishes to pursue opportunities for unconventional onshore oil and gas (e.g. shale gas). It is recommended these standards be reviewed to confirm whether the current standards are still appropriate.

Other sectors – based on expert judgement – that could be considered for standards development/revision include the following: Coke oven; Aluminium manufacturing units; Non-ferrous metallurgical industry; Asbestos manufacturing units; Pesticide manufacturing; Pharmaceutical industry; Mining industry; and Integrated paint industry.

[40] CPCB (2010) Air quality monitoring, emission inventory and source apportionment study for Indian cities via http://www.moef.nic.in/downloads/public-information/Rpt-air-monitoring-17-01-2011.pdf

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PHFI is a not-for-profit public private initiative working towards a healthier India. It is helping to build broadband public health capacity through education, research and training, with the purpose of enabling a sustained and holistic response to the significant public health challenges faced by India.

COUNCIL ON ENERGY, ENVIRONMENT AND WATER (CEEW)

The Council on Energy, Environment and Water (CEEW) is one of South Asia's leading policy research institutions. CEEW promotes dialogue and common understanding on energy, environment and water issues in India and globally through high quality research, partnerships with public and private institutions, and engagement with and outreach to the wider public.

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