A review report on new SO2 norms

Notified by MOEF&CC for Thermal Power Plant

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1. So far thermal power plants were required to meet the particulate emission norms only and there was no regulation for SO_2, NOx and Mercury emissions. Standards were specified only for the chimney height to ensure the emissions from flue gas were dispersed. On December 7, 2015, the Ministry of Environment, Forest and Climate Change (MoEF&CC) introduced stricter environmental standards for coal-based TPPs (**Table-1**) under the Environment (Protection) Act, 1986.

Table I

NEW ENVIRONMENTAL NORMS (wef DEC 2015)				
Date of Installation	**PM**	**SO2**	**NOx**	**Mercury (Hg)**
Before December 2003	100mg/Nm^3	600mg/Nm^3 < 500MW 200mg/Nm3 >= 500MW	600 mg/Nm^3	0.03mg/Nm^3 for >=500MW
January 2004 to December 2016	50mg/Nm^3	600mg/Nm^3 < 500MW 200mg/Nm3 >= 500MW	300 mg/Nm^3 (*)	0.03mg/Nm^3
January 2017 onwards	30mg/Nm^3	100 mg/Nm^3	100 mg/Nm^3	0.03mg/Nm^3

(*) NOx norms 300mg/Nm^3 revised to 450mg/ Nm^3 vide MOEF&CC notification G.S.R. 662(E) dated 19.10.2020.

2. After notification of new environmental norms in December, 2015, a detailed phasing plan, for installation of FGD to be completed till 2024 was prepared by CEA in consultation with all stake-holders and was sent to MoEF&CC in June,2017. However, subsequently, time line was squeezed by MoEF&CC to December, 2022.

3. The chemical equation pertaining to most prevalent Wet limestone FGD, DSI FGD and Sea water FGD technology are given as under for reference:

i. Wet lime FGD technology

a.CaCO3(s) + SO2(g) → CaSO3(s) + CO2(g)
b.Ca(OH)2(s) + SO2(g) → CaSO3(s) + H2O(l)
c.CaSO3(aq) + 2H2O(l) + ½O2(g) → CaSO4·2H2O(s) (Gypsum)

ii. Dry Sorbent Injection (DSI) FGD technology

a. 2NaHCO3(s) + heat → Na2CO3(s) + H2O(g) + CO2(g)
b. Na2CO3(s) + SO2(g) +1/2(O2)→ Na2SO4(s) + CO2(g)
c. Na2CO3(s) + SO3(g) → Na2SO4(s) + CO2(g)

iii. Seawater FGD technology

a. SO2(g) + H2O(l) + ½O2(g) → SO42−(aq) + 2H+
b. HCO3− + H+ → H2O(l) + CO2(g)

It is seen from the empirical calculation that one mole CO2 is being generated by absorption of one mole of SO2 in all desulphurization process. The Wet lime desulphurization process which is economical, produces additional 0.5% CO2 considering complete neutralization of SO2. The coal consumption is also expected to increase up to 1 % (due to APC) depending on the FGD technology and Green House Gas (CO2) will be released additionally due to increased coal consumption. **Global warming and Climate Change shall worsen further with the implementation of FGD due to this additional release of CO2 from all thermal power plants post FGD implementation.** The increased APC also reduces the efficiency of power plants.

4. CEA started monitoring the implementation of measures to comply with new norms. More than 90% TPPs are installing wet lime stone based FGD system as it is economical. Major issues/challenges being faced during the implementation of FGD system in thermal power plant are as under:

   a. Till the end of 2015 no SO_2 norms were applicable, thus FGD manufacturing capacity was almost nonexistent in the country.
   b. FGD technology being new to our country, there are at present limited vendors with limited capacity to supply FGD components. Therefore, there is an availability constraint.
   c. A sudden surge of demand has arisen as all thermal generating units, about 470 running units of 180 GW capacity, have to implement FGD system in one go. Proper planning was not there for development of infrastructure to meet the demand surge.
   d. Although India has the manufacturing capability of 70% FGD components, it depends on the imports from other country as manufacturing capacity is insufficient to cater to huge demand in a short period of time. To boost up the production for meeting huge demand as per required specifications, a few years' time is required.

   e. Balance 30% of FGD component is not manufactured in India. Thus, import from other countries is the only option and to create a manufacturing capability of these items in India would take few years.
   f. A huge foreign exchange for importing technology, equipment and skilled manpower from other countries shall be required.
   g. Placing order (Rupees one lahk thirty thousand cr.)for installation of FGD in all the plants simultaneously without ascertaining its performance in Indian condition may not be a correct decision.
   h. Thus, no time for fine tuning of the specification is possible, considering the implementation time of about 36 months and all the orders being placed in one go, targeting December 2022 deadline.
   i. Due to huge gap in demand and supply of FGD equipment, prices are escalating exorbitantly and it can also lead to market manipulation.
   j. Impact of Covid-19 pandemic on planning, placing of order, supply chain of equipment and installation of FGD is severe.
   k. Finally increasing cost of electricity.

5. To overcome all the above issues /challenges being faced by power industry, CEA prepared **a paper on location specific norms for thermal power plants** and suggested a graded action plan for FGD implementation in TPP which is summarized below. **The paper was approved by MOP and forwarded to MOEF&CC for consideration in January, 2021.**

   a. The target should be uniform ambient air quality across the country and not the uniform emission norms for thermal power plants. Implementation of uniform emission norms in TPPs located in different atmosphere may result in different ambient air quality.
   b. Thermal power plants located in an area, where quality of air is very good in terms of SO_2 level, can be exempted from immediate installation of additional equipment to control SO_2 emission from stack. A large number of thermal power stations are located in remote locations away from towns with little habitations around. Thermal power plants located in remote locations, ambient air quality (AQI) can be made as the guiding factor for formulating emission control. This may avoid installation of additional emission control equipment without compromising the ambient air quality.

   c. To explore such a feasibility, the 24hr avg.(max) SO_2 ground based measured levels (CPCB, 2018 data) were categorized into 5 distinct levels:

      i. Level I : >40 μg/m3
      ii. Level II : 31-40 μg/m3
      iii. Level III : 21-30 μg/m3
      iv. Level IV : 11-20 μg/m3
      v. Level V: 0-10μg/m3.

   d. To achieve tangible results, the SO_2 emission control equipment in the thermal power plants located in level-I should have to be installed on priority basis. The regions as identified under level-II can be covered subsequently under the next phases seeing the performance of FGD system in Level-I. Presently no action is required for the plant located in region under level III/IV/V as the SO_2 level in ambient air of these area is very less and as per CPCB the quality of air is good in regards to SO_2 level.
   e. The graded action will help in understanding the impact of these control equipment on their effectiveness and give a time for future course of correction. There are different technologies available to control the flue gas emissions and their suitability needs to be ascertained in the Indian conditions. An unworkable time schedule will create markets scarcity leading to import, jacked up prices unnecessary burden on power utilities thus on common person. Graded action plan will help in utilizing the resources in effective manner and it will help in fine tuning the technology for local conditions. If the process of emission control is completed in 10-15 years' time frame, and consider thermal power plants located in critically polluted areas in first phase, it will help in developing indigenous manufacturing base, skilled manpower in the country which shall take care of the local operating conditions.

6. Thereafter, MOEFF&CC notified G.S.R.243(E) dtd.31.03.2021, that the emission compliance would mean all the plant emission norms (2015) for PM/SO_2/NOx are to be met by the specified timeline (**Table II**), any deviation in the above norms beyond the timeline would be liable for the levy of emission compensation (EC) as detailed in **Table III.**

Table II

S.No.	Category	Location/Area	Timeline for Compliance	
			Non retiring Units	Retiring Units
(1)	(2)	(3)	(4)	(5)
1	Category A	Within 10 km radius of National Capital Region or cities having million plus population.	Upto 31st December 2022	Upto 31st December 2022
2	Category B	Within 10 km radius of Critically Polluted Areas or Non-attainment cities.	Upto 31st December 2023	Upto 31st December 2025
3	Category C	Other than those included in category A and B	Upto 31st December 2024	Upto 31st December 2025

7. Thermal power plant located in Category-A means if they are within 10 km from NCR/million plus population cities. Similarly, TPP in Category B means they are within 10 km from critically polluted area/ Non-attainment cities. **However, the presence of SO_2 or NOx level in the ambient air in the area has not been considered. It is well known that there is issue of PM10 or PM2.5 in many cities but there may not be any issue regarding level of SO_2 or NOx.** Thus ambient air quality (AQI) has not been made as the guiding factor for formulating the categorization. On the other hand the area where ambient air quality is actually critical in terms of SO2 or NOx level may not be located in cities/ areas as specified, there is a fair possibility that these areas may fall under category C.

8. Due to paucity of implementation time, any new technology which is being implemented in category A shall be repeated in category B without seeing its performance in category A. Therefore, sufficient time shall be required for fine tuning the performance of FGD already in operation. However, there is not enough time in between timeline of category A and B.

9. As per MOEF&CC March 2021 notification, December,2024 has been decided as the target date for compliance of TPP under category C (**Table II**), which shall allow a time period of 3.5 years for completion of FGD work for around 150 GW installed thermal capacity. Indigenous manufacturing capacity of FGD may not be available to cater to such an immediate demand of over 150 GW. This may be a very tight timeline considering the ground situation at present. Out of the 170 GW capacity comprising of 448 units which is being monitored by CEA, so far about 2 GW capacity comprising of 6 units have commissioned FGD system. Out of 6 units, 4 units adopted DSI technology which takes less time compared to wet limestone based technology and wet lime based FGD system was inbuilt in remaining 2 units which is made operational only. **Orders placed by a major central power utility as early as in 2018 for 26 FGD units for a total capacity of 15 GW have on an average completed a time period of over 33 months, and some units have completed 40 months since the award, and not a single FGD has been commissioned so far. These orders have been fairly distributed among five different major Indian vendors. The detailed evaluation of the progress of above orders shall help in understanding the roadblocks and estimating the existing capability of the EPC contractors in the country. Based on which a realistic time schedule for installation of FGD for 180 GW installed capacity can be planned.**

10. About 150 GW plus capacity of TPPs is under Category C (exact number of units and capacity will be known only after completion of categorization work by A Task Force constituted for this purpose) and sufficient time will be required so that they can modify the order seeing the performance of FGD in category A. After commissioning of FGD system almost 2-3 years are required for stabilization. Thus minimum 6 years' time may be given from commissioning of TPP under Category A. **Therefore timeline for category C shall be 2028 (considering 3 years for stabilization and 3 year for implementation). Further, there will be huge demand of FGD equipment in 2028 which may create crisis in the FGD market in India. Therefore, it is suggested that all these units timeline may be spread in four years i.e. 2028, 2029, 2033 & 2034 according to their distance from million plus city/ critically polluted area/ Non Attainment city. If distance is 11-40 km, 41-70 km, 71-100 km and more than 100 km, timeline will be 2028, 2029, 2033 and 2034 respectively.** This will help in understanding the performance of the emission control equipment, their effectiveness and give a time for course of correction.

    An unworkable time schedule is creating market scarcity leading to import, jacked up prices unnecessary burden on power utilities. **The project cost for wet lime based FGD technology is varying between rupees 0.39 crore to 1.10 crore per MW, which is quite high, around 2.8 times.** Graded action plan especially for category C will help in utilizing the resources in economic manner and will help in fine tuning the technology for local conditions. If the process of emission control is completed in 10-15 years' time frame, and considering thermal power plants located in critically polluted areas (category A & category B) in the first phase, it will help in developing indigenous manufacturing base, skilled manpower in the country and in turn shall take care of the local operating conditions and reduce the financial burden. A workable timeline based on realistic manufacturing capability of 30-40 GW per year can be adopted. Likewise, in other countries in the world, where SO_2 and NOx emission standards for coal fired power plants were proposed more than two decades back giving them sufficient time for adoption of the new emission control technology. A larger timeline would be beneficial to salvage the present situation faced by the industry. It would also allow proper gestation of the new technology for its efficacy.

11. The environmental compensation (EC) max. per unit (Table III) of 20 paisa (Category A), 15paisa (Category B) and 10paisa (Category C) which shall be levied for noncompliance beyond assigned time limit , takes into the consideration that the impact of thermal power plant emissions is location specific. The merchant plants which are not operating in pass through regime may have the option, whether to go for the compliance or alternatively pay the EC. It can also happen, when generating station and the power procurer/user are owned by the same entity, the generating station may continue to operate without meeting the emission norms by paying a penalty in case it is lower than the cost of compliance.

Table III

Non-Compliant operation beyond the Timeline	Environmental Compensation (Rs. per Unit electricity generated)		
	Category A	Category B	Category C
0-180 days	0.10	0.07	0.05
181-365 days	0.15	0.10	0.075
366 days and beyond	0.20	0.15	0.10

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It may be noted that CERC (Terms and Conditions of Tariff) Regulations, 2019 has provision for additional capitalization for installation of additional equipment for meeting new emission norms/ standards. However, these regulations do not include pass through of penalty levied on generating companies on account of the non – compliance of emission norms. Further, the responsibility of complying with environmental emission norms lies with the generating companies and the expenditure to be incurred on account of installation of additional emission control equipment is being passed on to beneficiaries. However, it is opined that the penalty levied by CPCB is unlikely to be allowed as pass through by the Appropriate Commission in tariff, as delay seems to be attributable to the generating company concerned. Therefore, the entire penalty is likely to be borne by TPP concerned. Environment compensation for a typical 500 MW unit operating at 60% PLF is calculated in table-IV. It can be seen from table that EC is increasing after six months and further increasing in 2nd year. Environment compensation is 13 cr. in 1st six months, 20 cr. in next six months and 33 cr. in 2nd year for thermal plants under category A.

Table-IV

Non- Compliant Operation beyond the timeline	Environment compensation					
	Category A		Category B		Category C	
	Rs./ Unit	Rs. Cr.*	Rs./ Unit	Rs. Cr.*	Rs./ Unit	Rs. Cr.*
0-180 days	0.1	13.0	0.07	9.1	0.05	6.5
181-365 days	0.15	20.0	0.1	13.3	0.075	10.0
One year delay total		**32.9**		**22.4**		**16.5**
366 days and beyond	0.2	52.6	0.15	39.4	0.1	26.3
Two year delay total		**85.5**		**61.8**		**42.8**

In Rs. Cr. for 366 days & beyond calculation is for one full yer (i.e. 365 days)

The amount 33 cr in 1st year and 52,6 cr in 2nd year onwards is quite high compared to the profit of a thermal power plant as EC will not be passed through in tariff instead may have to be borne by generating utilities.

Further, EC should not be made unending/perpetual. Instead it should be allowed for a limited period beyond which the plant may be asked to shut down. Otherwise the definite purpose of EC will be defeated.

It may be noted that CEA, representative of thermal generating utilities, equipment manufacturers and suppliers/ vendors were not consulted during preparation of new environment norms 2015 about status/ requirement of the basic infrastructure for meeting SO2 norms by all TPP in one go which might be the main reason for missing the target 2017 or 2022. The kind of infrastructure required for 180000 MW thermal capacity (470 units) can easily be understood from Table-V where the requirement (in Metric Tonnes) of materials for a typical FGD system for a 2x500 MW TPS is estimated.

Even after submitting the ground reality, issue & challenges of FGD implementation, CEA's apprehension was undermined by not considering proposed graded action plan which may be the reason for missing target 2024 again. To achieve the huge target of installation of about 470 FGD systems, proper roadmap has to be prepared by ensuring availability of FGD technology, equipment, skilled man power, supply of FGD component and sufficient time for implementation. Imposition of environment

compensation without creating infrastructure will not serve any purpose. Instead, it may cause disruption of power supply in the country as more than 70% of country's energy demand is being met from thermal power plants.

Table-V

Sl. No.	Major Materials	Materials Requirement
i	Cement	25000
ii	Structural Steel	15000
iii	Reinforcement steel	5750-6000
iv	Stainless steel & plates	350-400
v	Aluminum	50-70
vi	Casting and Forgings	200
vii	Casting and Forgings special alloy / Duplex stainless steel	50
viii	Tube & Pipes	600-800
xi	BQ Plates	30
x	C276 clad/sheet for absorber	350-375
xi	Titanium Gr2 for ducting	300-350

12. Way forward

a. **There should be longer duration plan (up to 2035) for adopting the new emission norms (2015), especially for power plants falling under category C of the MoEF&CC notification** (Table II) for the followings:

   i. This will help in understanding the performance of the emission control equipment, their effectiveness and give a time for course correction.
   ii. There are different technologies available to control the flue gas emissions of thermal power plants and their suitability needs to be ascertained in the local conditions.
   iii. This will help in developing indigenous manufacturing facility,
   iv. Reducing import of equipment from foreign companies,
   v. Avoiding price escalation exorbitantly or market manipulation.

b. **A Task Force may be constituted compromising representative of MOP, MOEF&CC, NITI Aayog, CEA, CPCB, Generating Utilities/Manufacturers/Vendors for smooth implementation of new environment norms considering phased Manufacturing Program (PMP) of FGD equipment under Atma Nirbhar Bharat.**

   1. Task Force should review the category or create separate category for controlling SO2 emission from chimney.

   2. Prepare a realistic timeline for FGD system implementation and then, environment compensation (EC) considering following:

i. Availability constraint of FGD equipments.
ii. Vendor's constraint.
iii. Present manufacturing capabilities
iv. Time to enhance indigenous production
v. Time for manufacturing of 30% equipment indigenously (which is being imported presently) under PMP.
vi. Target for zero or minimum import.
vii. Stop price escalation / market manipulation due to huge gap in demand and supply of FGD equipment.
viii. Impact of Covid-19 on supply chain of FGD equipment and ground reality of FGD implementation.
ix. Least increase of electricity tariff thus least burden on common person.

3. **To study the SO2-reduction against CO2 increase in flue gas emission by FGD system. Accordingly exemption may be given to few units where SO2 level in ambient air is very less compared to permissible limit.** Thus avoiding following by not implementing FGD system aimlessly:
   i. Increase of CO2 emission by FGD system
   ii. Increase of water consumption by thermal plant
   iii. Increase of auxiliary consumption thus burning more coal means further increasing CO2 emission.
   iv. Increase of limestone consumption means more mining, more transportation, thus more consumption of electricity and diesel. Therefore more coal burning and more dust pollution & CO2 emission.
   v. Increase of transportation of Gypsum byproduct thus, further increasing CO2 emission.
   vi. Issue of low grade Gypsum disposal as no buyer for the same
   vii. Increasing cost of electricity thus more burden on common person.