Centre for Science and Environment

MILESTONE TRACKER

for

Installation of Emission-Control Technologies

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1. INTRODUCTION

The Ministry of Environment, Forest and Climate Change (MoEF&CC) revised the environmental standards for coal-based thermal power stations in 2015. The deadline to comply with the standards expired in 2017; no progress was however made by the industry. The Ministry of Power (MoP) and Central Electricity Authority (CEA) prepared a phasing plan for implementation of emission control technologies. The plan however was heavily back loaded with about 70 per cent capacity achieving compliance only in 2021-22. The MoP claimed that the revised deadline was determined by assessing the time required to install pollution control equipment.

Early this year, the Supreme Court of India took notice of non-compliance of coal-fired thermal power plants with the 2015 environmental norms. Power plants within 300 km of the Delhi-NCR region were identified as a key source of air pollution. The Supreme Court noted the deliberate pushback from the industry on the issue of compliance with the norms, and directed the MoP and MoEF&CC to submit action plans to implement the standards. In December 2017, the Central Pollution Control Board (CPCB) sent Section 5 directions to all coal-based power plants, allotting timelines for compliance as per the CEA's phasing plan. CPCB's notices, however, accelerated the timeline for compliance till December 2019 for plants based within a radius of 300km of Delhi-NCR.

There is little clarity, however, on the monitoring mechanism that should be adopted by the MoEF&CC and CPCB to track implementation progress. Part of the problem lies with the complexity of the project management process, and any perusal would be time consuming in its present form. It is hence necessary to identify appropriate and clear milestones in the process of implementation. This can ensure that the bottlenecks are swiftly identified and the process runs in a timely fashion. It will also allow the regulators to take any remedial/ enforcement action in case of delays during implementation as against waiting till the end.

Centre for Science and Environment (CSE) in consultation with industry experts and manufacturers has prepared this milestone document to aid the process. This is an attempt to capture the key steps which, when verified on the ground, can give a good picture of the progress made by the power stations towards compliance. While the identified milestones would not be definitive, they would simplify the supervision and enable efficient oversight of the various projects.

It is advisable that regulators ensure that projects are monitored at least every two months in the case of short projects, every three months in medium-duration projects and once in four months in long-duration projects. Short-duration projects are those with work allocation for six to eight months, such as minor ESP modification, low-NO_x burner and OFA installation, and combustion optimization. Medium-duration projects are those with work allocation for at least a year, such as ESP upgradation, dry sorbent injection (DSI); and long-duration projects with about two years work allocation like FGD installation. Identification of about four to five critical stages can help regulators monitor the installation of pollution-control technology and assess its progress.

2. CONTROLLING PARTICULATE MATTER (PM)

CPCB through their Section 5 directions have asked 163 GW of capacity to comply with the particulate matter standards. According to RPC plans, 121 GW of capacity is compliant with the PM norms; 13 GW of capacity requires upgradation of their electrostatic precipitators (ESPs). About 40 GW of capacity plans to achieve the PM norms by installing sulphur dioxide control measures, particularly flue gas desulphurization (FGD) systems. However, that is not an advisable strategy as it can damage the internal FGD system such ducting and absorber tank and may affects quality of gypsum (a useful byproduct of FGD). Plants should instead look at upgrading their ESPs. These minor upgradations needed for ESPs can be done in the following two ways:

1) Conversion to the Switch Mode Power Supply (SMPS) system or
2) Adding filtering channels

Minor upgradations can generally be completed in six months (see *Table 2.1: Milestone for ESP retrofit for compliance with PM standards*). These can be assessed every two months by regulators to oversee progress at the power station.

For 13 GW of capacity, which needs major upgradation work for ESPs, the upgradations would involve:

1) Addition of more fields in existing ESPs or
2) Converting a few fields to hybrid filters.

While the process of retrofits has milestones similar to the minor upgradations, they require much more time. In such a case, the regulator should opt for a monitoring frequency of six months to observe the progress.

Power plants have had more than two years to comply with the norms. Hence, power stations should have at least completed prefeasibility studies to identify the ESP upgrades/retrofits that are required. Regulators should ask for such reports from the power stations.

Any ESP upgradation/retrofit project can be monitored by checking for activity at the following major stages:

1. **Vendor/manufacturer selection:** Power stations usually select the appropriate vendor through bidding though the pace of the process may vary (e.g. NTPC finalized tenders for Dadri and Aravalli-Jhajjhar within a month). Once a vendor is selected, the station issues a 'note to proceed' and pays an advance amount.
   Regulators should therefore check and insist at the start of the monitoring plan (at the beginning of Month 1) for details on the vendor selected by the station and the note to proceed.
2. **Detailed engineering report:** Once the vendor has been selected, discussions are held about the equipment to be purchased, sub-vendor availability etc. This culminates in the generation of a Detailed Engineering Report. The regulator may ask at this stage (after two to six months, depending on the project) for the Detailed Engineering Report with information on sub-vendors, shortlisted material, and their pricing.
3. **Supply of equipment at the site:** Once the Detailed Engineering Report is generated, site mobilization starts. Equipment is supplied usually around month 3–6. The regulator can take the following steps:

- Inspection of equipment such as collector/emitter electrode, transformer, and civil construction materials available at the site. These can be verified against the list of shortlisted materials identified previously in the pre-feasibility/detailed engineering.
- Inspection of the attendance registers to verify the presence of the manufacturers working at the site.

4. **Erection:** This stage marks the completion of the retrofit/upgradation work. In the case of minor upgradation, the work ideally is complete within two months. Major works, however, take around 18 months.
5. **PG test results:** A performance guarantee (PG) test is conducted by the manufacturer to ascertain the performance of the equipment as per the contract orders. The regulator can ask for a copy of the performance and guarantee test report to ensure if the equipment is complying with the norms.

TABLE 2.1: MILESTONES FOR ESP RETROFIT FOR COMPLIANCE WITH PM STANDARDS

S. no.	Major milestone	Start month	Stop month	Months taken
1	**Conventional method for each pass**			**14**
a)	Basic engineering	1	2	2
b)	Detailed engineering	1	6	6
c)	Manufacture and delivery of equipments	3	12	10
d)	Dismantling and erection	5	13	9
e)	Trial and PG test	14	14	1
2	**Conversion to hybrid filters**			**18**
a)	Basic engineering	1	4	4
b)	Detailed engineering	3	6	4
c)	Manufacture and delivery of equipments	5	13	9
d)	Erection (civil and structural work)	12	16	5
e)	Trial and PG test	17	18	2
3	**Conversion to SMPS system**			**4**
a)	Basic engineering	1	1	1
b)	Detailed engineering	1	2	2
c)	Manufacture and delivery of equipments	2	4	3
d)	Erection (civil and structural work)	4	4	1
e)	Trial and PG test	4	4	1
4	**Adding filtering channel system**			**5**
a)	Basic engineering	1	1	1
b)	Detailed engineering	1	2	2
c)	Manufacture and supply of equipments	2	3	2
d)	Erection (civil and structural work)	4	5	2
e)	Trial and PG test	5	5	1

It is important to note that the timeline for upgrading one pass has been listed here. However, retrofit of subsequent passes takes less time. Almost all these activities for the second pass can be taken up in parallel, and get completed about four to six months after the upgradation of the first pass has been completed.

3. CONTROLLING SULPHUR DIOXIDE

As per the roadmap identified under CPCB's Section 5 directions, 163.4 GW of thermal power capacity will instal sulphur dioxide control measures, with the focus on flue gas desulphurization systems. The roadmap is divided over a period of five years, with a significant capacity being asked to comply only by 2021–22 (see *Table 3.1: FGD Installation Roadmap Identified by the CPCB*). CSE believes that the FGD requirement is excessive, especially for units of less than 500 MW capacity; these smaller units should be opting for alternatives such as dry sorbent injection, which require less investment and time. Therefore, the milestones to be tracked should differentiate between the technologies to be installed. These are discussed below.

TABLE 3.1: FGD INSTALLATION ROADMAP IDENTIFIED BY THE CPCB

The timeline is heavily backloaded—120 GW has to comply by 2021 and 2022

Timeline	No. of units	Capacity (GW)
Immediately	30	3.6
2018	1	0.5
2019	33	14.4
2020	43	22.3
2021	162	59.7
2022	171	62.2
No comments given by CPCB	4	0.6
Total	**444**	**163.4**

Source: Centre for Science and Environment, 2018

Flue Gas Desulphurization (FGD)

As per our assessment, about 111 GW of capacity, comprising unit sizes over 500 MW, may require installation of FGD systems to meet the new standards. FGD retrofit is the most expensive retrofit. The process is time consuming as there are a large number of equipments involved. The FGD system requires civil foundation—a major reason for the construction to be time consuming. In ideal situations, the construction of FGD takes two years (see *Table 3B: FGD construction*). A close oversight by regulators would be necessary at each four-month interval to ascertain progress and speed up implementation. Key component installations and other works should be monitored at various stages.

During the documentation phase, power stations undertake the necessary paperwork that can enable the construction of an FGD. At this juncture, the following milestones can be tracked:

1. At the beginning of Month 1, details of 'award of contract' and token advance to the Original Equipment Manufacturer (OEM) can be asked.
2. Site mobilization and draft of the detailed engineering report with information on layout, construction of Gantt chart etc. should be available at the end of Month 7.

While these preconstruction activities are expected to take up to seven months, companies can innovate to reduce this time period by using their in-house project management. NTPC awarded the FGD contract for its Dadri Power station in a very short span of time—other companies could be asked to employ NTPC's best practices.

Post the documentation and mobilization, civil work starts. It takes a total of 24 months to instal and commission FGD system. The key milestones, which can be physically verified at the site, to be considered at such a stage are as follows:

1. By the end of Month 6, civil foundation should be completed.
2. At the end of the Month 15, Control and Instrumentation and electrical works are completed.
3. At the end of Month 17, the installation of the various components of the FGD system (like absorber tank, pumps, GGH etc.) is completed (refer to *Table 3.3: Breakup of equipment erection*). The work is complex and has multiple parts, with several of them executed in parallel. These parts are visible during the course of construction only after a few months; it therefore makes sense to oversee work only after some of it has been completed. Duct installation should be complete by the end of Month 9, and the absorber tank should be erected by the end of Month 15.
4. At the end of Month 24, the regulator can ask for the performance guarantee (PG) test report of the FGD system to ascertain its appropriate functioning. This can also provide information on the commissioning status.

Dry Sorbent Injection (DSI)

As per our assessment, only 49 GW of capacity, comprising of units less than 500 MW capacity, need to take measures to meet the emission standard of 600 mg/Nm^3. This can be achieved with alternative SO_2 control measures, such as partial FGDs, lime injection in boilers, etc. Dry sorbent injection (DSI) is the most cost-effective and least time-consuming amongst these options. NTPC Dadri has already placed tenders to instal DSI systems. Inspection can be carried out every three months to ascertain work progress (refer to *Table 3.4: Dry sorbent injection (DSI) method*):

1. Award of contract to the vendor (beginning of Month 1).
2. Availability of detailed engineering report at the end of third month, with details on the sub-vendor, break-up of activity, pricing, etc.
3. Completion of civil foundation works for storage and site mobilization at the end of the Month 6.
4. At the end of Month 9, the regulator can view the assembled equipment like storage silo, sorbent carrying pipeline etc.
5. At the end of the year, a performance guarantee test report can be collected from the power station to ensure compliance with the revised environmental emission standards.

MILESTONES FOR SULPHUR DIOXIDE CONTROL METHODS

TABLE 3.2: FGD DOCUMENTATION AND PROCUREMENT

S. no.	Major milestone	Start month	Stop month	Months taken	Remarks
1	Letter of Award (LoA)	1	1	0	Documentation
2	Basic and detail engineering	1	5	5	
3	Procurement	5	7	3	Equipment mobilization to site

TABLE 3.3: FGD CONSTRUCTION

S. no.	Major milestone	Start month	Stop month	Months taken	Remarks
1	Civil foundation	1	7	7	Construction period
2	Electrical and C&I work	4	15	12	
3	Equipment erection*	2	17	16	
4	Trial operation	18	23	6	
5	Performance guarantee test	23	24	2	

*BREAKUP OF EQUIPMENT ERECTION

S. no.	Major milestone	Start month	Stop month	Months taken
a)	Gas-to-gas heater	5	7	3
b)	Limestone handling system	5	8	4
c)	Duct support and installation	4	9	6
d)	Gypsum dewatering house	2	13	12
e)	Booster fan	6	13	6
f)	Absorber and its internal installation	3	15	12
g)	Painting and insulation	13	16	4
h)	FGD control room	9	17	9

TABLE 3.4: DRY SORBENT INJECTION (DSI) METHOD

S. no.	Major milestone	Start month	Stop month	Months
1	Letter of Award (LoA)	1	1	0
2	Planning and detail engineering	1	3	3
3	Civil foundation	4	6	3
4	Equipment erection	6	11	6
5	Trial operation and PG test	11	12	1

4. CONTROLLING OXIDES OF NITROGEN

As per CPCB directives, 163 GW will require upgradation to meet the oxides of nitrogen standards. CPCB has identified the installation and/or upgradation of low-NO_x burners (LNBs) and overfire air (OFA) systems alongside automated Combustion Optimization among other technology options for achieving this. These are rigorous studies involving modifications to the existing boiler. Time taken to achieve compliance through implementation varies with the complexity of the system adopted.

Combustion optimization is a highly preferred option, as it incurs minimal cost and requires very little time—in a span of three months, the work can be completed (see *Table 4.1: Process and timelines for combustion optimization)*. The regulator may choose to monitor it at the end of Month 3, or seek an update on the progress at regular intervals in the following manner:

1. Beginning of Project: Ensure plant has awarded the contract to the vendor with a certain token advance.
2. End of Week 6: the sensors necessary to monitor—temperature, coal flow, air flow, etc. would have been installed.
3. End of Week 8: Computational fluid dynamics report—analysing various scenarios and action plans to reduce NO_x will be available with the plant.
4. End of Week 12: Necessary retrofit and adjustments to the combustion systems take place. Subsequently, a plant performance guarantee (PG) report can be collected from the plant to ascertain compliance.

TABLE 4.1: PROCESS AND TIMELINES FOR COMBUSTION OPTIMIZATION

S. no.	Description	Total time taken (in weeks)	End time (in weeks)
1	Note to proceed given to the vendor by power plant (this is a prerequisite for initiating the process)	0	0
2	Planning and engineering completed • Schedules are prepared • Targets determined	2	2
3	Installation of boiler combustion optimization sensors (coal flow, air flow, O_2, CO, and loss of ignition or unburnt carbon sensors)	4	6
4	Baseline testing before the retrofit (which will include – specifications of existing equipment, boiler operating and performance data, stack sampling for current emissions, and proximate and ultimate analysis of coal)	1	7
5	Furnace modelling (CFD analysis)	1	8
6	Retrofit of coal mills and burner pipes with damper systems, retrofit of burners with individual flow controls	3	11
7	Total hot commissioning of the system	1	12
8	Boiler tuning including all necessary changes to combustion control loops in the DCS	1	13
9	Training of plant personnel and documentation	1	14
	Total time	**14 weeks (3–4 months)**	

Installation of LNB and OFA system takes more time as it involves modification of the burner system. In general it takes about eight months to install and commission LNB and OFA system (see *Table 4.2: Processes and Timelines of LNB and OFA*). The regulators can monitor progress at the site on a bi-monthly basis in the following manner:

1. Beginning of project: The 'note to proceed' letter has been issued to the vendor with the payment of a certain advance amount, receipt for which can be furnished.
2. End of Week 6: Computation fluid dynamic (CFD) report is available with the plant, which analyses various scenarios. A work schedule to reduce NO_x from the plant is drawn up, which can be furnished on request.
3. End of Week 12: Detailed engineering report containing information such as design of LNBs is generated. Based on this, manufacturing orders are placed. Copy of the order can be requested.
4. End of Week 24: Installation of the actual components takes place at the plant. Verification can be done by checking for the availability of the equipment at the plant.
5. End of Week 30: System has been commissioned post a PG test. Reports can be collected to ensure successful installation and compliance. It is advisable that the regulators collect information on the capacity-building efforts by the power station officials. This will ensure proper functioning and longevity of the equipment.

TABLE 4.2: PROCESS AND TIMELINES FOR INSTALLATION OF LNB AND OFA

S. no.	Description	Total time taken (weeks)	End time (weeks)
1	Note to proceed given to the vendor by power plant (this is a prerequisite for initiating the process)	0	0
2	Planning and engineering completed • Schedules are prepared • Targets determined	2	2
3	Installation of boiler combustion optimization sensors (coal flow, air flow, O_2, CO, and loss of ignition or unburnt carbon sensors)	4	6
4	Gathering baseline data before the retrofit (which will include specifications of existing equipment, boiler operating and performance data, stack sampling for current emissions, and proximate and ultimate analysis of coal)	1	7
5	Furnace modelling (CFD analysis)	1	8
6	Basic engineering followed by detailed design of low-NO_x combustion system (either designing a new LNB or modifying the existing burner system)	4	12
7	Manufacturing and prefabrication of low-NO_x burners	10	22
8	Burners and allied components supplied to the power plant	1	23
9	Actual installation of low-NO_x burners and OFA system (This stage involves actual down time of plant) • Burner installation • Modifications to the existing pulverized coal piping • OFA duct work and injectors • Control dampers	4	27
10	System commissioning • Cold commissioning • Hot commissioning	1	28
11	Boiler tuning including all necessary changes to combustion control loops in the DCS	1	29
12	Training of plant personnel and documentation	1	30
	Total time	**30 weeks (6–8 months)**	

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