Recommendations on

Operation Norms for Thermal Power Stations

Tariff Period -2014-19

Government of India
Ministry of power
Central electricity authority

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Recommendations to CERC On
Operation Norms for Thermal Power Stations for Tariff Period 2014-19
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Section -1 Background

1. *Introduction*

1.1 The Tariff Policy notified by the Central Government under the Electricity Act 2003, provides that The Central Commission would, in consultation with the Central Electricity Authority, notify operating norms from time to time for generation and transmission. The Central Electricity Regulatory Commission (CERC) has initiated the process of deciding terms and conditions of tariff for the tariff period commencing from 1.4.2014 and have requested CEA, vide letter No. **CERC/Engg/T&C/2014-19 dated 7-05-2013** for recommendations on operation norms for station heat rate, auxiliary energy consumption, specific fuel-oil consumption, target PLF and target availability. The recommendations of CEA for "**Operation Norms for Thermal Power Stations"** are furnished in this report.

2. *Prevailing Norms*

2.1 The norms for the tariff period 2009-14 (prevailing norms) notified by CERC vide their order No.**L-7/145(160)/2008-CERC Dated 19th January, 2009** provide for the following normative parameters:-

Table-1 Prevailing norms by CERC

Parameter and Units Size	Normative value
Coal Fired Units	
Unit Heat Rate	
200/210/250 MW Units	2500 kcal/kWh
500 MW and above Units	2425 kcal/kWh
New Thermal Generating Station achieving COD on or after 1.4.2009	1.065 X Design Heat Rate (kcal/kWh)
Secondary Fuel Oil Consumption*	1.0 ml/kWh

Auxiliary Energy consumption** 200 MW series 500 MW & above (Turbine BFP) --do--------(Motor Driven BFP)	 8.5 % 6.0 % 8.5 % For stations with induced draught cooling towers, the norms shall be further increased by 0.5 %.
Lignite Fired Units	
Unit Heat Rate (except for NLC TPS-I and TPS-II (stage I&II) *New Thermal Generating Station achieving COD on or after 1.4.2009*	4 to 10% higher than coal fired units based on correction factors with respect to moisture content of lignite 1.065 X Design Heat Rate (kcal/kWh)
Secondary Fuel Oil Consumption* (except NLC TPS-I) Non CFBC Units CFBC Units	 2.0 ml/kWh 1.25 ml/kWh
Auxiliary Energy consumption** All generating stations with 200 MW sets and Stations with CFBC Technology	0.5 percentage point more than the auxiliary energy consumption norms of coal based generating stations 1.5 percentage point more than the auxiliary energy consumption norms of coal based generating stations
CCGT Stations	
Unit Heat Rate Existing Stations (Prior to 1-4-09) *New Thermal Generating Station achieving COD on or after 1.4.2009* With Natural Gas and RLNG With Liquid Fuel **Auxiliary Energy consumption** Combined Cycle Open Cycle	 Most Stations covered under station specific norms for heat rate for both OC and CC mode 1.05 X Design Heat Rate of the unit/block 1.071 X Design Heat Rate of the unit/block 3.0 % 1.0 %

Note:
* The savings in SFC in relation to norms shall be shared with beneficiaries in the ratio of 50:50)
**The Auxiliary Energy Consumption indicated is for plants with once through or natural draught cooling tower based CW system.
The above norms are the general norms and stations specific relaxed norms have been provided for certain specific stations

2.2 For the above norms, CERC had requested for CEA recommendations vide letter no. **CERC/Engg./Tariff/T&C from 1.4.09 dated 3rd April, 2008**, and the CEA recommendations were furnished to CERC vide our report of **September-2008**. A copy of the above report is enclosed as Appendix-I

3. *Significant changes introduced in 2009*

3.1 The CEA recommendations for operation norms for 2009-14 introduced a large number of significant changes in the approach for setting the normative parameters – which are briefly enumerated as follows

3.2 The concept of setting normative heat rate on the basis of design heat rate of the units was introduced so as to enable the benefits of technology advancements or favourable input conditions to be automatically passed on to the consumers. The single value norms based on units' sizes prevalent earlier allowed same normative heat rate to all stations irrespective of the ambient conditions, coal quality or equipment design efficiency thus putting some of the stations to a relative disadvantage. The reasons for this changeover have been discussed in detail in the CEA report for norms for 2009-14 enclosed as Appendix-I.

3.3 However, it was suggested that the above concept of norms based on design heat rate may be adopted only for the future units to be commissioned after 1.4.2004. For existing units commissioned before 1.4.2004, the prevailing norms of CERC (based on single value concept) were allowed to continue and it was suggested that as and when these units undergo major R&M/LE works, fresh norms for these units should be prescribed with reference to the efficiency achieved after implementation of R&M/LE works. CERC however made the new system applicable for "***New Thermal Generating Station achieving COD on or after 1.4.2009"***

3.4 The normative Auxiliary Energy Consumption for units of 500 MW or higher sizes with turbine driven Boiler feed pumps was reviewed and the prevalent reduction of 1.5 % (one and half percent points) being allowed to units with TBFPs over the units with motor driven BFP was increased to 2.5 % (two and half percent points) thus reducing the normative AEC of TBFP units by 1 % (one percent point). This was done to have more realistic Auxiliary energy consumption of BFPs and was made applicable to all units with Turbine driven BFPs.

3.5 Also, the additional auxiliary energy consumption of 0.5%, which was earlier being allowed to units with both Natural Draught Cooling Towers (NDCT) and Induced Draught Cooling Towers (IDCT) was reviewed and was allowed only to the units having IDCT for cooling of condenser cooling water. This was made applicable to all existing and future units.

3.6 The Specific Secondary Fuel Oil Consumption (SFC) was reviewed and it was suggested that secondary fuel oil consumption should be provided only to cover the start-up fuel requirements, as average unit loading for most NTPC stations had been very high thus eliminating the need of secondary fuel support for flame stabilization. It was brought out that considering the actual operating data of NTPC and other good operating stations in the country, the normative SFC for NTPC stations could be limited to 0.25 ml/kWh; however, to start with, a normative SFC of 0.75 ml/kWh was recommended. CERC allowed a normative SFC of 1 ml/kWh with the proviso that savings on secondary fuel oil consumption in relation to norms shall be shared with beneficiaries in the ratio of 50:50.

3.7 Norms for Auxiliary energy consumption of units with CFBC boilers and for lime stone consumption of CFBC boilers were incorporated for the first time.

4. Approach adopted for the current study

4.1 The approach followed for the current study is similar to the approach followed for the past study for 2009-14. Detailed discussions on the possible approaches and general principles for setting norms have already been made in the CEA report for the norms of 2009-14 and can be referred at Appendix-I.

4.2 The principle of setting normative heat rate on the basis of design heat rate adopted in 2009 has been continued to be followed. However, the operating margin of 6[1] % has been reviewed. The old units shall however continue to be covered by the single value norms.

4.3 The norms of Auxiliary energy consumption have been reviewed based on the prevalent trends for new units; and the concept of providing SFC largely on the basis of start-ups has been examined further.

4.4 The principles of working normative parameters for lignite fired units based on appropriate differential with respect to coal fired units has been

[1] CERC allowed a margin of 6.5 % in the tariff regulations notified.

continued and the additional Auxiliary energy consumption for CFBC units has been allowed as prevalent.

4.5 Some of the new systems like air cooled condensers (ACC) are likely to come up in some of the stations and normative parameters for ACC based units have also been covered.

4.6 Also the concept of station specific relaxed norms adopted by CERC for specific stations in wake of their lower performance may continue; however these norms could be suitably reviewed by CERC based on the actual performance of these stations.

4.7 Operating data and design data made available from the stations by CERC has been the basis of computations and analysis made in the report.

5. Data Received

5.1 The operating data for the last five years (2008-09 to 2012-13) for the central sector generating stations was received from CERC vide their letter no. **Nil dated 16-08-2013**. CERC also directed the stations vide their letter no. **CERC/Engg/ T&C/2014-19** dated **11-09-2013** to furnish the design data to CEA and the same was received from the utilities. Names of the stations from where data was received are furnished in Table-2.

Table-2 Details of stations furnishing data

S.No	Station	Utility	Capacity (MW)
	Coal/Lignite Based Stations		
1	Bhilai (2x250 MW)	NTPC -JV	500
2	Singrauli (5x200+2x500)	NTPC	2000
3	Rihand (5x500)	NTPC	2500
4	Tanda TPS (4x110)	NTPC	440
5	Unchahar (5x210)	NTPC	1050
6	Korba (3x200+4x500)	NTPC	2600
7	Vindhyachal (6x210+2x500+2x500+2x500)	NTPC	4260
8	Sipat (3x660+2x500)	NTPC	2980
9	Ramagundam (3x200+4x500)	NTPC	2600
10	Simhadri (2x500+2x500)	NTPC	2000
11	Farakka (3x200+2x500+1x500)	NTPC	2100

12	Kahalgaon (4x210+3x500)	NTPC	2340
13	Talcher (4x60 +2x110 MW)	NTPC	460
14	Talcher SPTS (2x500 MW+4x500 MW)	NTPC	3000
15	Badarpur TPS (3x95+2x210)	NTPC	705
16	NCTPS Dadri (4x210+2x490)	NTPC	1820
17	INDIRAGANDHI -Jhajjar (3x500 MW)	NTPC JV	1500
18	Neyveli Station -1 (6x50 +3x100)	NLC	600
19	Neyveli -I EXPANSION (2x210 MW)	NLC	420
20	Neyvelli -TPS-II (Stage-I) (3x210 MW)	NLC	630
21	Neyvelli -TPS-II (Stage-II) (4x210)	NLC	840
22	Barsingsar 2x125 MW	NLC	250
23	Maithon Power Ltd. (2x525)*	MPL	1050
	Gas Based Stations		
1	Anta (3x88.71 GTs + 1x153.2 ST)	NTPC	419.33
2	Auraiya (4x111.19 GT+2x 109.3 ST)	NTPC	663.66
3	Dadri (4x 130.19 GT+ 2 X 151.54 ST)	NTPC	829.78
4	Faridabad (2X137.758 GT+1X156.07 ST)	NTPC	431.58
5	Kawas (4x106 GT+2x116.1 ST)	NTPC	656.2
6	Gandhar (3x x 144.3 GT+ 1x224.49 ST)	NTPC	657.39
7	kayamkulam (2x115 GT+1x129 ST)	NTPC	359
8	Kathalguri , (6x33.5 GT+3x30 ST)	NEEPCO	291
9	Agartala (4x21 GT)	NEEPCO	84

* Units commissioned during terminal years of norms period – Not considered for analysis

5.2 The operating data received contains gross and net generation, coal and oil consumption alongwith GCVs of fuels, schedule and forced outages and start-up details (cold, warm and hot startups). The design data received is steam parameters, turbine cycle heat rate alongwith corresponding backpressure/CW temperature, boiler efficiency & design coal quality and start-up fuel consumption per start-up for each type of start-up.

5.3 Based on the above data, the following details have been computed

- Station PLF & Unit loading
- Station heat rate
- Variation of heat rate from design heat rate
- Station auxiliary energy consumption
- Station secondary fuel oil consumption
- Break up of SFC for startups and other than start up

The above computations have been made for year to year basis as well as average of last 5 years

5.4 In addition to the data received from utilities, the performance/design data from the CEA data base and publications have also been used and where used, the same has been indicated.

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Section -2 Analysis and Recommendations

6. Target Availability–Coal fired stations

6.1 As per the present norms, the Normative Annual Plant Availability Factor for all thermal stations is **85** % barring stations with relaxed norms. However Lignite-fired Generating Stations with CFBC boilers have been prescribed the normative availability of **75%** for the first three years from COD and **80 %** thereafter.

6.2 The availability factors for the last five years computed from the data received from stations are given in table-3.

Table-3 Availability* of Stations

S.No	Stations	2008-09	2009-10	2010-11	2011-12	2012-13	Average	Remarks
1	Bhilai		97.0%	98.2%	99.2%	99.2%	98.4%	
2	Singrauli	89.3%	90.6%	95.0%	89.7%	91.1%	91.1%	
3	Rihand	95.7%	92.5%	92.5%	93.6%	90.0%	92.9%	U#5- 11/2012
4	Tanda	89.2%	90.9%	91.8%	88.6%	82.9%	88.7%	
5	FGUTPP,	91.7%	94.3%	94.7%	93.5%	95.2%	93.9%	
6	Korba	92.2%	94.6%	90.3%	82.9%	94.9%	91.0%	U#7- 3/2011
7	Vindhyachal	92.3%	93.0%	94.5%	91.8%	93.2%	93.0%	U#11- 3/2013
8	Sipat	96.3%	93.0%	94.2%	90.4%	86.6%	92.1%	6/08,1/09,10/11,5-8/12
9	Ramagundam	93.6%	93.7%	92.3%	95.5%	87.1%	92.4%	
10	Simhadri	94.7%	94.5%	94.2%	96.4%	92.8%	94.5%	9/2011, 9/2012
11	Farakka	85.9%	82.3%	89.1%	81.8%	78.9%	83.6%	U#6- 4/2012
12	Kahalgaon	90.9%	78.1%	83.0%	77.3%	85.8%	83.0%	U#5-7- 8/8,10/08, 3/10
13	Talcher	93.2%	90.7%	92.2%	90.5%	93.8%	92.1%	
14	Talcher STPS	91.8%	94.5%	90.7%	87.5%	88.9%	90.7%	
15	Badarpur	93.0%	86.6%	81.1%	86.3%	84.4%	86.3%	
16	NCTPS Dadri	96.5%	94.5%	89.4%	93.8%	90.8%	93.0%	U#5&6- 1&7/2010
17	Indiragandhi				67.3%	80.8%	74.0%	3/2011, 4/12,4/13
	Overall NTPC	**92.4%**	**91.3%**	**91.4%**	**88.6%**	**89.2%**	**90.0%**	
18	Neyveli 1	68.1%	88.1%	85.5%	87.6%	87.6%	83.4%	
19	Neyveli -1 Expn	85.0%	84.3%	84.1%	85.6%	92.0%	86.2%	
20	Neyvelli II (St-I)	67.6%	81.6%	85.8%	88.2%	88.9%	82.4%	
21	Neyvelli -II (St-II)	72.5%	86.9%	86.0%	88.6%	89.9%	84.8%	
22	Barsingsar					70.2%	70.2%	
	Overall NLC	**73.3%**	**85.2%**	**85.4%**	**87.5%**	**85.7%**	**81.4%**	

Note: *The availability factors have been worked out based on data of generation and outages received from the stations and may vary slightly from CEA published data on availability. Remarks indicate periods of addition of new units in the stations.

6.3 As may be seen that barring few instances, the availability for all the stations has been well above the normative availability. The instances of low availability have been mainly in stations where new units were commissioned during the specific year and could be due to lower availability for the new units initially. The availability of stations had been lower during 2008-09 but improved considerably during the later years. Barsingsar TPS shows lower availability than the target of 75 %.

6.4 **Recommendation 1- Availability Factor**

> **Recommendation** - Thus the present norms of **Availability Factor** are considered adequate and may be retained

7. Station Heat Rate–Coal fired stations

Brief Recap of 2009-14 Recommendations on SHR

7.1 As brought out above at Para **3.2** above, CEA recommendations for operation norms for 2009-14 introduced the *"concept of specifying normative heat rate in terms of the design heat rate"* for the new units and was made applicable by CERC for the units attaining commercial operation from 1.4.2009. Detailed discussion on the concept is given in Paras **5.1 &5.2** of the 2009-14 report enclosed at Appendix -1. Some of the salient findings of that report in respect of operating heat rate were as under:-

7.1.1 Deviation of operating heat rate (vis-à-vis design heat rate) for some of the NTPC stations and for several other stations having only large sized units (210 & 500 MW units) was very low at about 4% indicating that considerable improvements in operating heat rate are possible with good operating practices. (Para 8.1 to 8.16 of 2009-14 report –Appendix-I)

7.1.2 The operating practices are by far and large, the single most important factor responsible for the heat rates achieved and deviation of 2 to 4% from design unit heat rate are being achieved in actual operation in many stations some of them having even very old units. (Para 8.16)

7.1.3 Thus, the report concluded that there was a case to prescribe a unit heat rate of **2-3%** over the respective design heat rate for the existing as well as future units. However, it was suggested that as a first step, normative unit heat rate of 6% over the design unit heat rate may be prescribed, which corresponded to average deviation of operating heat rate from design heat rate for all NTPC stations for last 3 years (2004-05 to 2006-07), which could be further reviewed in the next revision of norms.

7.2 Thus in the above backdrop, an operating margin of 6 % over design heat rate was recommended for future units with the suggestion that it may be reviewed in the next revision of norms. Finally a margin of 6.5% was allowed by CERC.

Analysis of operating heat rate

7.3 The operating heat rates for the last 5 years, computed on the basis of data provided by the stations are given in Table-4.

Table-4 Operating Heat rate – Coal fired Stations

Stations	Yearly Operating Heat rate (kcal/kWh)					Average 2008-13
	2008-09	2009-10	2010-11	2011-12	2012-13	
Bhilai		2494	2370	2348	2349	2390
Singrauli	2393	2393	2393	2393	2390	2392
Rihand	2347	2347	2346	2350	2357	2349
Tanda	2728	2727	2732	2770	2759	2743
Unchahar	2387	2383	2403	2417	2405	2399
Korba	2369	2375	2381	2383	2384	2378
Vindhyachal	2375	2372	2372	2370	2380	2374
Sipat	2360	2349	2349	2340	2343	2348
Ramagundam	2372	2371	2371	2371	2370	2371
Simhadri	2351	2348	2348	2364	2365	2355
Farakka	2415	2407	2400	2399	2403	2405
Kahalgaon	2372	2378	2390	2405	2398	2389
Talcher	2867	2859	2851	2843	2823	2849

Talcher SPTS	2356	2357	2353	2360	2385	2362
Badarpur	2773	2750	2750	2749	2755	2755
NCTPS Dadri	2389	2393	2392	2400	2396	2394
Indira Gandhi			2434	2440	2402	2425
Overall NTPC	**2394**	**2393**	**2394**	**2398**	**2399**	**2396**

7.4 As may be seen that the overall average of the operating heat rate for all stations for the last five years has been **2396** kcal/kWh, which is lower than even the current SHR norm of 2425 kcal/kWh for 500 MW units. Considering that about 9000 MW of the capacity out of total capacity of 33000 MW in these stations comprises of 200/210/250 MW (and lower size) units with normative SHR of 2500 kcal/kWh, the composite normative heat rate for the above stations under the prevailing single value norms works out to about 2450 kcal/kWh and the operating heat rate is significantly lower than the above norm.

7.5 The deviation of operating heat rate from the design heat rate for the stations with 200 MW and higher size units is given in table-5.

Table- 5 Deviation of Operating Heat rate from Design heat rate

Stations	Deviation of OHR from Design Heat rate (%)					Average 2008-13
	2008-09	2009-10	2010-11	2011-12	2012-13	
Bhilai		11.10%	5.57%	4.57%	4.64%	**6.47%**
Singrauli	3.51%	3.49%	3.49%	3.49%	3.37%	**3.47%**
Rihand	5.06%	5.05%	5.03%	5.20%	5.49%	**5.16%**
FGUTPP,	4.01%	3.85%	4.70%	5.33%	4.77%	**4.53%**
Korba	3.97%	4.21%	4.37%	4.48%	4.50%	**4.31%**
Vindhyachal	4.83%	4.68%	4.66%	4.60%	5.02%	**4.76%**
Sipat	3.06%	2.56%	2.56%	4.69%	4.83%	**3.54%**
Ramagundam	5.43%	5.38%	5.39%	5.39%	5.33%	**5.38%**
Simhadri	5.51%	5.40%	5.38%	3.38%	3.41%	**4.62%**
Farakka	5.58%	5.24%	4.94%	4.91%	4.63%	**5.06%**
Kahalgaon	1.58%	1.84%	2.38%	3.00%	2.72%	**2.30%**
Talcher STPS	5.04%	5.09%	4.89%	5.24%	6.34%	**5.32%**
NCTPS Dadri	5.04%	5.39%	5.34%	5.67%	5.49%	**5.39%**
Indiragandhi				7.93%	6.25%	**7.09%**
Weighted Avg.	**4.40%**	**4.47%**	**4.41%**	**4.77%**	**4.81%**	**4.57%**

7.6 As may be seen, the deviation of operating heat rate from the design heat rate has been in the range of 4 to 5% for most of the stations. Some stations show much lower deviation of 2.5 to 3 % and one station (Kahalgaon) has even shown a deviation of 1.5- % to 2 % in 2008-09 and 2009-10. The overall deviation for all stations works out to **4.57 %.**

7.7 It is important to note that these deviations are on station basis (for the whole station) as separate generation from the units commissioned after 1.4.2009 were not available and even where available in some cases, the coal consumption for those units were not available separately.

7.7.1 Most of the units in these stations are old units – out of total capacity of 31,000 MW, ~ 10,000 MW is over 20 years old and ~13000 MW capacity is 15 years old; only ~8000 MW capacity has been installed after 1st April 2009. Thus even with combination of considerable share of old capacity, the overall operating deviation of heat rate has been around 4.5 %.

7.7.2 It is also seen that **some of the stations where all the units are quiet old like Singrauli and Korba TPS have shown quiet low deviation in operating heat rate.** This highlights that O&M practices are the single most important factor determining efficiency; and with due care and efforts, consistently high level of operating efficiency can be achieved even in the old units.

7.8 Though the deviation of heat rate for units commissioned after 1-4-2009 is not available separately, it is very clear; from the table-5 that the operating deviation is respect of these units would be much lower. This is evident from the performance of stations like Sipat, Simhadri and Kahalgaon where all the units (or many of the units) have been added around 2009 or later. Details of deviation of operating heat rate and units added at these stations are given in table-6. As may be seen, all the three stations have significant capacity additions after 2008 and show very low deviation of OHR from design after addition of new units.

Table- 6 OHR of select stations with Capacity addition after 2008

Station & Capacity (MW)	Commissioning Details		Deviation of OHR from Design (%)					Average 08-13
	< 2008	After 2008	08-09	09-10	10-11	11-12	12-13	
Sipat 2980 MW (2x500+3x660)	**0**	**2980** June-08, Jan-09, Oct-11, May-12, Aug-12	3.06%	2.56%	2.56%	4.69%	4.83%	**3.54%**
Kahalgaon 2340 MW (4x210+3x500)	**4x210**	**3x500** Aug-08, Dec-08, Mar-10	1.58%	1.84%	2.38%	3.00%	2.72%	**2.30%**
Simhadri 2000 MW (2x500+2x500)	**2x500**	**2x500** Sep-11, Sep-12	5.51%	5.40%	5.38%	3.38%	3.41%	**4.62%**

Sipat TPS has shown higher heat rate deviation in 2001-12 and 12-13 mainly because the new units commissioned here were supercritical units of 660 MW which appear to be facing initial stabilization problems as also seen from lower PLF of the station during the above period.

Trend of operating heat rate 2003-2013

7.9 The trend of deviation of OHR from design heat rate during the last norms period (2002-03 to 2006-07) and the current norms period (2008-09 to 2012-13) is given in table-7. As may be seen, the operating deviation has come down in all cases, implying that operating heat rate has improved at all stations due to improvement in O&M practices and/or improved equipment design. The average of the operating deviation for 5 years (2002-03 to 2006-07) for all NTPC stations was **6.44** % and it came down to **4.61** % for the 5 year period for current norms (2008-09 to 2012-13). For the above comparison, stations which have come up entirely after 2006-07 and for which no data was available for the period 2002-03 to 2006-07 have not been considered. Thus three stations (Sipat, Bhilai and Indiragandhi) have not been considered for the above analysis.

7.10 It may also be seen from table-7 that, the stations where new units have been added show marked reduction in deviation of OHR from design heat rate; as compared to stations where fresh capacities were not added during the period. As may be seen, Dadri, Kahalgaon, Simhadri and Vindhyachal where significant share of capacity was added after the first norms period (2006-07) show very high improvement in deviation of OHR thus indicating that the deviation of OHR in respect of newly installed units have been much lower. Also several stations like Farakka, Ramagundam and Unchahar have also shown significant improvements with no capacity additions (or minor capacity additions) attributable mostly to the improvement in O&M practices.

7.11 It may thus be concluded that the improvement in O&M practices over the years coupled with induction of new units of modern design has led to significant improvement in OHR as is evident from falling deviation of OHR from design and the improvements are more pronounced in the stations with new units which indicates significantly lower deviation in OHR from design heat rate for the new units.

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Table- 7 Deviation of operating heat rate from Design heat rate (2002-03 to 2006-07) Vs. (2008-09 to 2012-13)

Stations	Cap	Deviation of OHR from Design HR (%)						Cap	Deviation of OHR from Design HR (%)						Avg. (02-07) – Avg. (08-13)	Cap Addition
		2002-03	2003-04	2004-05	2005-06	2006-07	Average		2008-09	2009-10	2010-11	2011-12	2012-13	Average		
Dadri	840.00	8.41%	8.27%	7.06%	6.47%	6.15%	7.22%	1820	5.04%	5.39%	5.34%	5.67%	5.49%	**5.39%**	**-1.83%**	2x490
Farakka	1600.00	8.22%	8.42%	10.68%	6.82%	6.46%	8.02%	2100	5.58%	5.24%	4.94%	4.91%	4.63%	**5.06%**	**-2.96%**	1x500
Kahalgaon	840.00	7.78%	6.93%	6.61%	6.22%	5.73%	6.59%	2340	1.58%	1.84%	2.38%	3.00%	2.72%	**2.30%**	**-4.29%**	3x500
Korba	2100.00	5.85%	6.16%	5.38%	4.41%	4.08%	5.18%	2600	3.97%	4.21%	4.37%	4.48%	4.50%	**4.31%**	**-0.87%**	1x500
Ramagundem	2600.00	8.55%	8.56%	7.81%	8.60%	7.11%	8.10%	2600	5.43%	5.38%	5.39%	5.39%	5.33%	**5.38%**	**-2.72%**	
Rihand	2000.00	7.08%	6.75%	6.34%	5.13%	5.57%	6.03%	2500	5.06%	5.05%	5.03%	5.20%	5.49%	**5.16%**	**-0.87%**	1x500
Simhadri	1000.00	9.40%	7.90%	6.58%	5.99%	5.69%	6.74%	2000	5.51%	5.40%	5.38%	3.38%	3.41%	**4.62%**	**-2.12%**	2x500
Singrauli	2000.00	4.23%	4.24%	4.37%	3.84%	3.84%	4.11%	2000	3.51%	3.49%	3.49%	3.49%	3.37%	**3.47%**	**-0.64%**	
Talcher STPS	3000.00	7.33%	7.68%	7.06%	6.00%	5.62%	6.43%	3000	5.04%	5.09%	4.89%	5.24%	6.34%	**5.32%**	**-1.11%**	
Unchahar	1050.00	7.13%	7.09%	6.78%	5.90%	5.03%	6.33%	1050	4.01%	3.85%	4.70%	5.33%	4.77%	**4.53%**	**-1.80%**	
Vindhyachal	3260.00	8.14%	8.23%	7.00%	5.66%	5.38%	6.81%	4260	4.83%	4.68%	4.66%	4.60%	5.02%	**4.76%**	**-2.05%**	2x500
Weighted Average	**20290**	**7.33%**	**7.29%**	**6.84%**	**5.83%**	**5.46%**	**6.44%**	**26720**	**4.55%**	**4.56%**	**4.60%**	**4.60%**	**4.73%**	**4.61%**		

Observations

1. **T**he operating deviation has come down in all cases, implying that operating heat rate has improved at all stations due to improvement in O&M practices.
2. Generally, the stations where new units have been added show marked reduction in deviation of OHR from design as compared to stations where fresh capacities were not added during the period. Thus indicating that the deviation of OHR in respect of newly installed units have been much lower.

7.12 Further, a study on analysis of performance of equipment installed during 11th Plan was conducted by CEA recently and the data in respect of the units commissioned during the 11th Plan was sought from various stations including NTPC stations. The deviation of operating heat rate from design heat rate observed for some of the very well performing stations are given in table-8. As may be seen, with good O&M practices, the newly installed units are capable of very good performance as reflected in very low deviation of OHR from DHR.

Table- 8 Deviation of OHR of select new units – inputs from recent CEA study

S.No	Station	Utility	2008-09	2009-10	2010-11	Total	Remarks
1	Station-1	Private			2.35%	**2.35%**	
2	Station-2	Private			1.22%	**1.22%**	Imported Coal
3	Station-3	Private	4.79%	3.25%	3.11%	**3.52%**	
4	Station-4	State			3.25%	**3.25%**	
5	Station-5	Central	2.34%	2.32%	2.59%	**2.41%**	
6	Station-6	Central	1.60%	0.45%	0.81%	**0.83%**	

Conclusion - The newly installed units are capable of very good performance. With good O&M practices, the **Operating heat rate (OHR) of 2 % to 3 % higher than Design Heat rate (DHR)** can be achieved by these units on sustained basis.

Heat Rate provisions in Case-II SBD

7.13 Ministry of Power have recently brought out Standard Bidding Documents (SBD) for case-II/UMPP projects. The heat rate provisions in the above SBDs are as follows:-

Table- 9 Heat rate Provisions in SBDs

Parameter	Allowable Provisions	Remarks
Net Operating Heat rate	1.02 x tested **net** unit heat rate subject to maximum of 2300 kcal/kWh	Only Supercritical units envisaged
Heat rate Degradation factor	0.16% increase in heat rate allowed every year after first year	
Compensation for part loading/ low dispatch	Provision for additional heat rate for part loading provided as per table- 9A	Only when actual dispatch is low as indicated

Table- 9A Additional Heat rate Provisions for Part load in SBDs

S.No.	Dispatch as proportion of Dedicated Capacity (%)	Increase in SHR (for super-critical turbine)	Increase in SHR (for sub-critical turbine)
1	85-100	Nil	Nil
2	75-84.99	1.25	2.25
3	65-74.99	2	4
4	55-64.99	3	6
5	45-54.99	4.5	9
6	35-44.99	7	13.5
7	25-34.99	10.5	21
8	15-24.99	14	30
9	5-14.99	19	40
10	Below 5	25	50

7.14 It may be seen that, the above provisions allow operating deviation of 2 % over the **tested heat rate** (and not the quoted heat rate as in CERC norms. The tested heat rate could be about 0.5 % to 1 % lower than the quoted heat rate and thus margins allowed in terms of quoted heat rate (as in CERC norms) would be around 1 % higher than the margins computed over the tested heat rate. Thus a 6.5 % margin over quoted heat rate allowed in present CERC norms would work out to around 7.0 to 7.5 % margin over the tested heat rate as against 2 % allowed in the SBDs.

7.15 As regards Additional heat rate allowed for part loading provided in the SBD, it may be seen that no part load compensation would be applicable for the units under consideration for norms with the present loading pattern of these units. The PLF and unit loading for the coal fired stations during the norms period are given in table-10. As may be seen the average unit loadings have been very high in the range of 90 % to over 100 % for most stations (barring specific cases where induction of new units might have led to lower PLF in specific years).

Table- 10 PLF and Unit loadings – coal fired stations

Stations	Plant Load Factor (%)						Average Unit Loading (%)					
	2008-09	2009-10	2010-11	2011-12	2012-13	Over all	2008-09	2009-10	2010-11	2011-12	2012-13	Over all
Bhilai		55.2	91.7	90.8	92.0	82.4%		56.9	93.4	91.6	92.8	83.7%

Singrauli	90.7	92.8	96.5	89.0	92.4	92.3%	101.6	102.4	101.7	99.2	101.5	101.3%
Rihand	97.2	95.6	93.1	92.4	75.0	90.7%	101.6	103.3	100.7	98.7	83.3	97.5%
Tanda	89.4	92.2	92.6	88.3	83.6	89.2%	100.3	101.5	100.9	99.7	100.9	100.7%
FGUTPP,	93.7	97.3	93.3	90.0	92.7	93.4%	102.3	103.2	98.5	96.2	97.4	99.5%
Korba	96.2	97.6	75.7	79.2	90.1	87.8%	104.3	103.2	83.8	95.5	95.0	96.4%
Vindhyachal	93.1	96.6	94.6	90.6	91.1	93.2%	101.0	103.9	100.1	98.7	97.7	100.3%
Sipat	48.6	93.3	96.5	41.2	67.2	69.4%	50.5	100.4	102.5	45.5	77.6	75.3%
Ramagundam	94.5	94.8	90.3	93.3	91.3	92.8%	100.9	101.2	97.8	97.7	104.8	100.5%
Simhadri	97.4	97.3	96.1	58.8	72.3	84.4%	102.9	102.9	102.0	61.0	77.9	89.3%
Farakka	76.8	73.1	79.1	71.2	63.1	72.7%	89.4	88.8	88.8	87.0	80.0	86.8%
Kahalgaon	44.4	53.4	68.4	65.6	71.7	60.7%	48.9	68.4	82.4	84.9	83.6	73.6%
Talcher	92.7	90.9	94.2	92.8	96.3	93.4%	99.4	100.2	102.2	102.6	102.7	101.4%
Talcher STPS	85.8	90.4	85.7	83.2	81.6	85.4%	93.5	95.6	94.5	95.1	91.8	94.1%
Badarpur	89.1	82.7	73.7	77.3	73.8	79.3%	95.9	95.5	91.0	89.6	87.4	91.9%
NCTPS Dadri	99.4	48.9	75.6	89.2	82.1	79.0%	103.0	51.7	84.5	95.1	90.5	85.0%
Indiragandhi				55.4	56.5	56.0%				82.4	70.0	76.2%
Overall	**85.9**	**84.5**	**87.3**	**79.3**	**80.8**	**82.5%**	**93.0**	**92.4**	**95.3**	**89.4**	**90.3**	**91.4%**

New Units Inducted: Rihand-11/2012, Korba-3/2011, Sipat- 6/2008,1/2009,10 /2011,5/2012,8/2012, Simhadri-9/2011, 9/2012, Farakka-4/2012, Kahalgaon-10/2008,12/2008,3/2010, NCTPS Dadri-1/2010,7/2010, Indiragandhi- 3/2011, 4/2012,4/2013

7.16 The heat rate provisions in SBDs allow no part load compensation for dispatch from 100 % to 85 % and thus no part load compensation would be applicable in case of above stations.

7.17 As brought out above, the heat rate provisions in SBD also allow an operating degradation factor of **0.16%** each year after the first year of operation. The actual operating degradation however is expected to be much less and almost negligible with proper O&M practices as is evident from very low deviation of operating heat rate from design in respect of stations like Singrauli and Korba with units over 25-30 year old. However, even if an operating margin as per above SBD provisions were to be considered for the new units installed after 1-4-2009, the overall applicable margin for the additional capacity installed between 2009-2013 (being considered for norms) works out to about 0.5 %. If the capacity to be installed between 2014-2019 is also considered (on similar pattern as in 2009-13), the applicable operating margin for the overall capacity (from 2009-2019) would work out to about **0.3 %.**

Conclusion – Thus, applying the provisions of heat rate as per the Standard bidding documents (SBD) for case-II bidding of MoP, the **Operating heat rate (OHR) allowed** for units installed after 2009, for the norms period 2014-19 would be about **2.3 % higher than tested unit heat rate or about 1.8 % higher than the quoted Design Heat rate (DHR)**

Recommendation 2- Station Heat rate

Recommendation –

The normative Gross Operating heat rate (OHR) allowed for units installed after 2009, may be taken as about **3 % (three percentage points) higher than Design Heat rate (DHR)**.

Considering the operating heat rate of stations, it is felt that the existing single value heat rate norms for 500 and 200/210/250 MW units may also be **reduced by 50 kcal/kWh**

Alarming Trend of Falling Boiler Efficiency

7.18 While reviewing the design data received from stations, it is seen that, the boiler efficiency for many of the recent units inducted are **substantially lower** than the boiler efficiency of the older units at the same station or other stations with almost comparable coal quality. The details are given in table-11. As may be seen, in most of the stations the boiler efficiency for subsequent units installed later has been much lower than the boiler efficiency for the previous units. <u>In some of the cases, the boiler efficiency has been alarmingly lower</u>

Table- 11 Trend of Falling Boiler Efficiency

S.No	Station	Units	Period of Installation	Boiler Efficiency %	Design Coal Parameters				
					FC (%)	VM (%)	Ash (%)	Moisture (%)	GCV (kcal/kg)
1	Singrauli	1-5 (5x200)	1982 to 1984	87.49	32.4	21.6	30	16	4050
		6-7 (2x500)	1987 to 1988	86.63	32.4	21.6	30	16	4050
2	Korba	1-3 (3x200)	1983 to 1984	87.50	26	18	44	12	3500
		4 -6 (3x500)	1998 to 1990	86.69	28	22	40	10	3500
		Unit-7 (1x500)	2011	84.91	25	22	40	13	3300
3	Farakka	1-3 (3x200)	1986 to 1988	85.18	27.5	16.9	42.6	13	3200
		4 -5 (2x500)	1995 to 1996	87.51	27.5	16.9	42.6	13	3200
		Unit-6 (1x500)	2012	83.39	24.5	16.9	43.6	15	3000
4	Ramagundam	1-3 (3x200)	1984 to 1985	88.60	35.1	28.8	29	7.1	4850
		4 -6 (3x500)	1988 to 1991	87.30	35.1	28.8	29	7.1	4850

		Unit-7 (1x500)	2005	86.88	24	22	42	12	3400
5	Unchahar	1-2 (2x210)	1992	84.67	40	16	34	10	4320
		3-4 (2x210)	2000 to 2001	87.51	24	23	41	12	3300
		Unit-5 (1x210)	2007	85.28	25	22	40	13	3400
6	NCTPP, Dadri	1-4 (4x210)	1993 to 1995	87.30	24	23	41	12	3500
		5 -6 (2x490)	2010	85.34	25	21	41	13	3500
7	Rihand	1-2 (2x500)	1990 to 1991	86.99	29.67	24.33	33	13	4000
		3-4 (2x500)	2005 to 2006	87.12	28	22	30	20	4000
		Unit-5 (1x500)	2012	84.05	24	22	34	20	3500
8	Kahalgaon	1-4 (4x210)	1995 to 1996	87.70	28	17	42	13	3200
		5 -6 (2x500)	2008	82.73	23.5	17	43	16.5	2850
		Unit-7 (1x500)	2010	82.38	23.5	17	43	16.5	2850
9	Vindhyachal	1-6 (6x210)	1988 to 1992	87.58	30.68	18.32	35	16	3700
		7 -8 (2x500)	2000	87.77	26.5	23	30	20.5	3700
		9 -10 (2x500)	2006 to 2007	85.14	29	21	30	20	3700
		Unit-11 (1x500)	2013	84.00	29	21	32	20	3600
10	Sipat	1-3 (3x660)	2011 to 2012	86.27	24	21	43	12	3300
		4 -5 (2x500)	2008 to 2009	84.91	25	22	40	13	3300
11	Simhadri	1-2 (2x500)	2002 to 2003	87.27	25	21	40	14	3300
		3-4 (2x500)	2011 to 2012	84.50	24	21	41	14	3300
12	Talcher	1-2 (2x500)	1997	87.43	23.67	24.33	40	12	3500
		3-6 (4x500)	2003 to 2005	85.59	22	33	42	15	3300

7.19 **There appears to be no justification for such reduction in boiler efficiency when the earlier units have higher boiler efficiency with same/comparable coal quality**. Technology must progressively lead to efficiency improvements and not the other way and thus improvements in technology over the years are expected to lead to higher boiler efficiency for subsequent units installed later.

7.20 In some of the cases it is seen that utilities in their recent specifications have specified that a minimum carbon loss of 1 to 1.5% would be considered for quoting boiler efficiency - thus, leading to corresponding reduction in boiler efficiency (and consequent increase in design heat rate).

7.20.1 **Such practices defeat the purpose of specifying the normative heat rate in terms of the design heat rate.** It needs to be understood that the operating margin (over the design heat rate) provided in the norms is intended to cover the variations over a certain base line, and the quantum of variation allowed has been fixed considering this base line as the design heat rate at design CW temperature/back pressure, zero percent makeup etc. as specified in the norms.

7.20.2 Contrary to the above, the provisions of minimum carbon loss etc. lead to artificially inflating or jacking up the base line (design heat rate) itself. Thus such a practice by the utilities is seen as an attempt to build up certain margin upfront in the design heat rate thus leading nto a higher design heat rate and consequently leading to a higher normative heat rate value ultimately.

7.20.3 **It is, therefore, recommended that such practices by the utilities should be discontinued forthwith**. **A review of all Specifications should be undertaken by CERC** and where such provisions leading to build up of margin upfront in the design heat rate are found, **the operating margin provided in norms should be correspondingly lowered to the extent that such build up in terms of additional losses etc. have been provided in the specifications**. Only then would the true spirit of allowing intended operating margin over DHR for normative purposes would be realized.

7.21 Also with a view as to prevent abnormally lowered figures of boiler efficiency by the bidders/utilities, It is suggested that, the minimum boiler efficiency to be considered for the boilers based on Indian subbituminous coal as indicated in the Table in Clause **26 (ii)B of** the norms notified by CERC may be increased to **87** %. Thus the allowable minimum boiler efficiency for the purpose of design heat rate shall be as follows:-

Fuel	Minimum Boiler Efficiency (%)
Sub -bituminous Indian coals	**87%**
Bituminous Imported coal	**89%**

Also the maximum allowable Turbine Cycle Heat Rate for different steam parameters as indicated in Table in Clause **26 (ii)B of the present norms** shall be applicable subject to modification that THR for all supercritical units shall be maximum 1810 kcal/kWh with Motor driven BFP and 1850 kcal/kWh with Turbine driven Boiler Feed Pump, thereby deleting the Supercritical steam parameters of 537/565 provided earlier.

Recommendation 3- Safeguards for Design Heat rate

Recommendation –

Design parameters – Turbine Cycle Heat Rate and Boiler efficiency should be realistic and attempts to build margin upfront by the utilities to jack up design heat rate by specifying minimum carbon loss etc. or other such losses should be discontinued forthwith.

A review of all Specifications may be undertaken by CERC and where such provisions leading to build up of margin upfront in the design heat rate are found, **the operating margin provided in norms should be correspondingly lowered** to the extent of such build up in terms of additional losses etc. provided in the specifications.

Minimum boiler efficiency for Sub -bituminous Indian coals may be taken as **87**% and lower figures may be allowed only after proper justification by the utilities.

Maximum Turbine Cycle Heat Rate for all supercritical units may be taken as 1810 kcal/kWh with Motor driven BFP and 1850 kcal/kWh with Turbine driven Boiler Feed Pump as required by CEA Regulations or lower.

8. Auxiliary Energy Consumption–Coal fired stations

8.1 In the CEA Report on operation norms for 2009-14, the reduction in AEC on account of turbine driven BFP was increased from 1.5% to 2.5% thus lowering the AEC for 500 MW units with TBFP to **6.0** % from then prevailing **7.0** %. However, no changes were made in the allowable AEC as such; and thus the prevailing norms for AEC have been continuing for the last 20 years. Improvements in equipment/systems design have occurred over the years like introduction of axial fans having lower power consumption, introduction of variable frequency drives, overall design optimization etc. Further, the auxiliary consumption may not increase proportionately with unit size and higher sized units are expected to have lower auxiliary consumption in terms of percentage of unit size.

8.2 The operational data of AEC for the stations are given in table- 12. The table shows yearly AEC and average AEC for five years. Also shown are the normative AEC (worked out on the basis of unit size and type of CW systems) and difference between normative and average operating AEC. The table also shows share of capacity constituted by 500 and higher sized units in the total station capacity.

Table- 12 Details of Auxiliary Energy Consumption

Stations	2008-09	2009-10	2010-11	2011-12	2012-13	Average	Norms	Norms-Average	*Share _500	Remarks
Bhilai		8.7	8.5	8.5	8.6	8.58%	9.00%	**0.42%**	0%	
Singrauli	7.0	7.0	7.1	7.0	7.0	7.01%	7.25%	**0.24%**	50%	Note-1
Rihand	6.3	6.5	6.5	6.5	6.5	6.45%	7.30%	**0.85%**	100%	Note-2
FGUTPP,	7.9	7.8	8.3	8.2	8.1	8.06%	9.00%	**0.94%**	0.%	
Korba	5.7	6.1	6.1	6.2	6.2	6.05%	7.08%	**1.02%**	77%	Note-3
Vindhyachal	6.1	6.0	6.1	6.1	6.3	6.11%	7.11%	**1.00%**	86%	
Sipat	5.0	5.6	5.5	5.8	6.3	5.64%	6.50%	**0.86%**	100%	
Ramagundam	5.6	5.6	5.6	6.0%	5.9	5.74%	7.08%	**1.34%**	77%	
Simhadri	5.2	5.4	5.4	5.5	5.9	5.47%	6.50%	**1.03%**	100%	
Farakka	6.7	7.2%	6.4	6.7	6.7	6.73%	6.83%	**0.10%**	71%	
Kahalgaon	7.6	7.8	7.5	8.0	7.7	7.69%	7.40%	**-0.30%**	64%	
Talcher STPS	5.5	5.7	5.8	5.9	6.5	5.88%	6.50%	**0.62%**	100%	
NCTPS Dadri	7.5	7.9	6.9	6.3	6.5	7.02%	7.65%	**0.64%**	54%	
Indiragandhi				6.8	6.0	6.42%	6.50%	**0.08%**	100%	Note-4

Notes: - Site specific features indicated by the stations with respect to AEC

1. CW Pumping distance of 1.5km; New Ash Dyke distance 20km
2. CHP Conveyer system. First stage units have motor driven BFP
3. Additional booster pump house at 15 Km from plant for ash disposal system
4. Radial Stacker Reclaimer in CHP, Raw Water Siphon System, Reverse Osmosis (RO) system, Oxygenated Treatment, Pressurized ash evacuation system provided.

* Shows share of capacity constituted by 500 and higher sized units in total capacity.

8.3 Barring one, all stations show auxiliary energy consumption lower than the normative auxiliary energy consumption, however, stations with 500 MW units have shown much lower auxiliary consumption as compared to their respective normative auxiliary consumption. Barring Indiragandhi TPS, all stations with solely 500 MW units show an AEC of about 1 % lower than the normative AEC. Indiragandhi TPS has several additional systems leading to higher AEC. Sipat and Simhadri TPS show an AEC of 5.5 % - both these stations are new stations and comprise of 500 MW and higher size units only. The slightly higher overall AEC of Sipat appears due to the commissioning of two units in the year 2012-13 leading to higher yearly consumption for 2012-13.

8.4 A review of guaranteed Auxiliary Energy Consumption data of various projects available with CEA shows that the guaranteed AEC for boiler for 500 MW units is about 0.6 % points lower than the boilers' AEC for 200/210 MW units. Besides, higher unit size also leads to savings in AEC in BoP systems.

8.5 An attempt has also been made to compute AEC for 500 MW units from the data of stage wise generation furnished by some stations and the details of computed auxiliary energy consumption of 500 MW units worked out are indicated in table-.12A

Table- 12A Auxiliary Energy Consumption of 500 MW units

S.No	Item	Auxiliary energy consumption (%)						PLF (%)					Remarks
		2008-09	2009-10	2010-11	2011-12	2012-13	Average	208-09	2009-10	2010-11	2011-12	2012-13	
Korba	St-3 (1x500)				5.6%	5.5%	**5.5%**				76%	93%	
Vindh-yachal	St- 2 (2x500)	5.7%	5.7%	5.9%	5.9%	6.0%	**5.8%**	93%	96%	94%	88%	90%	2000
	St- 3 (2x500)	4.9%	4.7%	4.5%	4.6%	4.93%	**4.7%**	94%	98%	96%	93%	93%	2007
Sipat	St- 2 (2x500)	5.0%	5.6%	5.6%	5.8%	6.3%	**5.7%**	49%	93%	97%	99%	79%	
Ramag-undam	St-3 (1x500)	4.6%	4.6%	4.7%	5.3%	5.0%	**4.8%**	95%	101%	92%	94%	87%	
Simhadri	St- 1 (2x500)	5.3%	5.5%	5.4%	5.6%	6.0%	**5.5%**	97%	97%	96%	93%	88%	
	St- 2 (2x500)				5.5%	5.9%	**5.7%**				49%	57%	
Farakka	St-3 (1x500)					6.4%	**6.4%**					59%	
Kahalgaon	St- 2 (3x500)	6.2%	6.7%	6.6%	6.6%	6.4%	**6.5%**	35%	67%	65%	60%	68%	
Talcher STP	St- 1 (2x500)	6.7%	7.0%	6.8%	6.8%	7.4%	**6.9%**	89%	88%	85%	79%	81%	**2002**
	St- 2 (4x500)	5.0%	5.1%	5.4%	5.6%	6.2%	**5.4%**	84%	92%	86%	85%	82%	2011
Dadri	St- 2 (2x490)			6.0%	5.6%	5.8%	**5.8%**			60%	89%	77%	

Note: (1) All the above units have closed cycle CW system.
(2) Figures in the Remarks indicate year of COD

8.6 From the above table it may be seen that AEC of all the 500 MW units is considerably lower than the prevailing norm of 6.5 % (for closed cycle CW system). In fact several stations have achieved AEC of less than 5 %. The only exceptions are Kahalgaon and Farakka where the AEC is higher due to very low PLF. Further, the AEC of new 500 MW units is considerably lower than the older 500 MW units.

8.7 Thus considering the above, there is a case for lowering of AEC by 1 % (one percentage point) for 500 MW and higher size units installed after 1-4-2009. However, with a view to allow some operational flexibility to the stations, it is suggested that normative AEC for 500 MW and higher size units installed after 1-4-2009 may be reduced by 0.75 % (three fourth percentage points)

Recommendation 4- Auxiliary Energy Consumption

Recommendation –

AEC for 500 MW and higher size units installed after 1-4-2009 **may be reduced by 0.75 %** (three fourth percentage points). Thus the normative AEC for 500 MW and higher size units installed after 1-4-2009 may be taken as **5.25 % for units with Turbine driven BFPs and 7.75 % for motor driven BFPs.** Additional AEC of **0.5 %** may be allowed for units with induced draught cooling towers (IDCT) for condenser water cooling.

9. *Specific Secondary Fuel Oil Consumption (SFC)–Coal fired stations*

9.1 The SFC for coal fired stations is given in Table 13. As may be seen, the overall SFC for all stations for the period 2008-09 to 2012-13 works out to **0.37** ml/kWh. However, there are very large variations in SFC – both interstation (in SFC amongst various stations) as well as in intra-station (SFC for various years in the same station). These are highlighted in the table. It is also seen that few stations have substantially higher SFC as compared to other stations.

Table- 13 Details of Specific Secondary Fuel Oil Consumption

SFC ml/kWh

Stations	2008-09	2009-10	2010-11	2011-12	2012-13	Average
Bhilai		1.49	0.39	0.17	0.19	**0.56**
Singrauli	0.29	0.24	0.24	0.65	0.21	**0.33**
Rihand	0.16	0.20	0.21	0.25	0.51	**0.27**
Tanda	0.70	0.44	0.70	0.48	0.59	**0.58**
FGUTPP,	0.27	0.17	0.33	0.76	0.40	**0.39**
Korba	0.08	0.09	0.12	0.22	0.10	**0.12**
Vindhyachal	0.20	0.18	0.12	0.21	0.21	**0.19**
Sipat	0.53	0.20	0.21	0.11	0.50	**0.31**
Ramagundam	0.16	0.10	0.13	0.12	0.22	**0.15**
Simhadri	0.10	0.22	0.09	0.21	0.42	**0.21**
Farakka	1.21	0.83	0.39	0.60	1.53	**0.91**
Kahalgaon	1.19	1.00	0.72	0.83	0.66	**0.88**
Talcher	0.33	0.63	0.52	0.44	0.38	**0.46**
Talcher STPS	0.64	0.63	0.45	0.40	0.59	**0.54**

Badarpur	0.59	0.75	0.81	1.00	1.51	**0.93**
NCTPS Dadri	0.14	0.35	0.53	0.16	0.22	**0.28**
Indiragandhi				3.74*	0.44	**2.09**
Weighted Avg	**0.38**	**0.34**	**0.29**	**0.34**	**0.45**	**0.37**

Note: Stations with high SFC and instances of high yearly SFC Highlighted.
* Not considered for averages (Indiragandhi SFC for 2011-12)

9.2 The SFC for high and low oil consumption stations have been analysed separately in table-14. The stations with 200 MW and higher size units only have been considered for the above analysis.

Table- 14 SFC of High and Low Oil Consumption Stations

SFC- ml/kWh

S.No	Stations	2008-09	2009-10	2010-11	2011-12	2012-13	Average	Capacity (MW)
1	Bhilai			0.39	0.17	0.19	**0.25**	500
2	Singrauli	0.29	0.24	0.24	0.65	0.21	**0.33**	2000
3	Rihand	0.16	0.20	0.21	0.25	0.51	**0.27**	2500
4	FGUTPP,	0.27	0.17	0.33	0.76	0.40	**0.39**	1050
5	Korba	0.08	0.09	0.12	0.22	0.10	**0.12**	2600
6	Vindhyachal	0.20	0.18	0.12	0.21	0.21	**0.19**	4260
7	Sipat	0.53	0.20	0.21	0.11	0.50	**0.31**	2980
8	Ramagundam	0.16	0.10	0.13	0.12	0.22	**0.15**	2600
9	Simhadri	0.10	0.22	0.09	0.21	0.42	**0.21**	2000
10	NCTPS Dadri	0.14	0.35	0.53	0.16	0.22	**0.28**	1820
11	INDIRAGANDHI					0.44	**0.44**	1500
Wtd Avg. Low Cons Stations		**0.21**	**0.19**	**0.20**	**0.26**	**0.30**	**0.24**	**23810**
1	Farakka	1.21	0.83	0.39	0.60	1.53	**0.91**	2100
2	Kahalgaon	1.19	1.00	0.72	0.83	0.66	**0.88**	2340
3	Talcher STPS	0.64	0.63	0.45	0.40	0.59	**0.54**	3000
4	Badarpur	0.59	0.75	0.81	1.00	1.51	**0.93**	705
Wtd Avg. High Cons Stations		**0.97**	**0.78**	**0.53**	**0.61**	**0.93**	**0.75**	**8145**

9.3 As may be seen from the table,

9.3.1 The overall SFC for 11 stations with total capacity of 24,000 MW is **0.24 ml/kWh**. Stations like Korba, Ramagundam and Vindhyachal show very low SFC of **0.12 to 0.15 ml/kWh** and there are several instances of extremely low yearly SFC of **0.08 to 0.10 ml/kWh at several stations**.

9.3.2 Even amongst the stations with low overall SFC, there are instances of high SFC in specific years (highlighted in the table) which could be due to specific instances like commissioning of new units in the stations etc.; and the SFC would be even lower if these instances are not considered. The extremely low consumption have also been highlighted in colour.

9.3.3 On the contrary, 4 stations with total capacity of 8000 MW have an overall SFC of **0.75 ml/kWh,** which is more than **3** times the SFC of 11 low consuming stations. Few instances of low yearly SFC (highlighted green) are also seen in these stations; however, generally the SFC has been high.

9.4 Such extremely large variations in SFC between the stations (with only few stations having very high SFC) suggests, that it may not be appropriate to have a common approach or philosophy for normative SFC for all stations; and the few stations having large SFC may need a different approach.

9.5 The past trends of SFC (2002-03 to 2006-07) have also been compared with the present trend and the details are furnished in table-15. For the above comparison, stations which have come up entirely after 2006-07 and for which no data was available for the period 2002-03 to 2006-07 have not been considered.

Table- 15 Trends of SFC (2002-07 vs. 2008-13)

SFC- ml/kWh

Station	2002-03	2003-04	2004-05	2005-06	2006-07	Average	2008-09	2009-10	2010-11	2011-12	2012-13	Average
Farakka	1.78	1.94	2.42	0.94	0.9	**1.60**	1.21	0.83	0.39	0.60	1.53	**0.91**
Kahalgaon	0.63	0.54	0.53	0.41	0.61	**0.54**	1.19	1.00	0.72	0.83	0.66	**0.88**
Dadri	0.44	0.17	0.16	0.21	0.11	**0.22**	0.14	0.35	0.53	0.16	0.22	**0.28**
Korba	0.24	0.21	0.11	0.11	0.1	**0.15**	0.08	0.09	0.12	0.22	0.10	**0.12**
Ramagundam	0.21	0.23	0.17	0.24	0.19	**0.21**	0.16	0.10	0.13	0.12	0.22	**0.15**
Rihand	0.22	0.22	0.17	0.25	0.17	**0.21**	0.16	0.20	0.21	0.25	0.51	**0.27**
Simhadri	1.10	0.66	0.23	0.19	0.19	**0.47**	0.10	0.22	0.09	0.21	0.42	**0.21**
Singrauli	0.18	0.23	0.3	0.31	0.44	**0.29**	0.29	0.24	0.24	0.65	0.21	**0.33**
Talcher STPS	0.46	0.83	0.65	0.5	0.27	**0.54**	0.64	0.63	0.45	0.40	0.59	**0.54**
Unchahar	0.64	0.5	0.43	0.36	0.27	**0.44**	0.27	0.17	0.33	0.76	0.40	**0.39**
Vindhyachal	0.21	0.18	0.16	0.15	0.14	**0.17**	0.20	0.18	0.12	0.21	0.21	**0.19**

As may be seen from the table, there have been very large variations in SFC between the two norms period for the high oil consumption stations. The average SFC of Farakka decreased sharply from 1.60 ml/kWh to 0.91 ml/kWh while the average SFC of Kahalgaon increased from 0.54 ml/kWh to 0.88 ml/kWh. The SFCs for the other stations remained almost same during the two norms period.

9.6 Thus it is felt that the high SFC at these few stations could be due to station specific reasons. The fact that these stations have achieved low SFC in the past (or in specific years), indicates that they can also achieve low SFC through proper identification and analysis of the specific factors leading to high SFC and remedial measures.

Correlation of Start-ups and SFC

9.7 An attempt has been made to correlate the SFC with the number of start-ups. The details of yearly start-ups and SFCs are given in Table 16. Similar analysis was also made in the 2009-14 report; however, the details of start-ups were worked out from CEA internal records, while in the current analysis, the details of start-ups (total start-ups and type of startup -hot, warm and cold) have been sought from the stations and are as per the data furnished by the stations.

Table- 16 SFC and Start-up Details

Stations	SFC (ml/kWh)						Over all_ PLF	Startups per unit (nos)					
	2008-09	2009-10	2010-11	2011-12	2012-13	Average		2008-09	2009-10	2010-11	2011-12	2012-13	Average
Bhilai		1.49	0.39	0.17	0.19	0.56	82.4		29.5	14.5	7.5	5.0	**14.1**
Singrauli	0.29	0.24	0.24	0.65	0.21	0.33	92.3	7.4	8.6	6.4	10.1	8.4	**8.2**
Rihand	0.16	0.20	0.21	0.25	0.51	0.27	90.7	6.0	7.8	7.0	7.3	17.0	**9.0**
Tanda	0.70	0.44	0.70	0.48	0.59	0.58	89.2	15.8	14.3	12.5	8.8	10.3	**12.3**
FGUTPP,	0.27	0.17	0.33	0.76	0.40	0.39	93.4	9.6	5.6	8.4	7.4	8.2	**7.8**
Korba	0.08	0.09	0.12	0.22	0.10	0.12	87.8	3.9	5.6	7.3	10.0	5.7	**6.5**
Vindhyachal	0.20	0.18	0.12	0.21	0.21	0.19	93.2	7.5	6.4	5.4	6.8	6.1	**6.4**
Sipat	0.53	0.20	0.21	0.11	0.50	0.31	69.4	4.8	3.4	4.0	3.2	14.8	**6.0**
Ramagundam	0.16	0.10	0.13	0.12	0.22	0.15	92.8	6.6	4.1	5.0	4.6	7.3	**5.5**
Simhadri	0.10	0.22	0.09	0.21	0.42	0.21	84.4	1.0	2.8	2.0	5.0	7.5	**3.7**
Farakka	1.21	0.83	0.39	0.60	1.53	0.91	72.7	9.3	7.8	6.2	9.5	20.2	**10.6**
Kahalgaon	1.19	1.00	0.72	0.83	0.66	0.88	60.7	7.4	6.1	9.9	8.7	7.0	**7.8**

Talcher	0.33	0.63	0.52	0.44	0.38	0.46	93.4	7.3	12.8	8.7	7.2	8.0	**8.8**
Talcher STPS	0.64	0.63	0.45	0.40	0.59	0.54	85.4	5.7	8.0	9.2	10.8	8.8	**8.5**
Badarpur	0.59	0.75	0.81	1.00	1.51	0.93	79.3	9.4	10.4	18.0	17.8	22.8	**15.7**
NCTPS Dadri	0.14	0.35	0.53	0.16	0.22	0.28	79.0	4.2	5.3	12.0	10.2	10.7	**8.5**
Indiragandhi				3.74	0.44	2.09	56.0				8.3	15.0	**11.7**

Figures in Red indicate addition of new units during the year. Instances of very high start-ups have been highlighted

9.8 As may be seen from table-16, there are large variations in number of startups amongst the stations – the startups per unit vary from 2-3 on the low side to 14-15 on the high side. The normal trend is 7-9 start ups per units per year.

9.8.1 Large year to year variations in start-ups are also seen in some stations – in some cases the high yearly start-ups can be correlated to commissioning of new units in the station. High yearly start-ups in Korba (2011-12) and Rihand, Sipat and Farakka in 2012-13 can be correlated to entry of new units in the stations in these years.

9.8.2 While the inter-year SFC for individual stations generally co-relate well with the number of yearly start-ups, considerable variation in the SFC amongst stations are seen for similar start-ups profile. Ramagundam and Simhadri show very low start-ups as well as very low SFC. Korba, Vindhyachal and Sipat show start-ups of about 6-6.5 and generally low SFC of 0.12 to 0.31; the higher SFC of Sipat mostly during years of induction of new units. However, Singrauli, Rihand, Unchahar, Kahalgaon, Talcher STPS and Dadri show considerable variation in SFC from 0.28 to 0.88 for similar start-ups of around 8. Farakka and Badarpur show very high SFC as well as very high start-ups.

9.8.3 Normally in the well performing stations (with generally low SFC), comparatively higher SFC and higher start-ups are seen in only/mostly in the years when new units have been inducted.

Break-up of SFC for Start-ups

9.9 An assessment has also been made to work out the breakup of total SFC of the station into the SFC for start-ups and SFC for flame support etc. For the above assessment, standard oil consumption per startup for each type of startup (hot, warm and cold) for each unit size (200/210 and 500) has been considered. The details of assessed oil consumption for start-ups and other than start-ups are given in table-17

Table- 17 Breakup of SFC - Start-up and Other

Stations	Parameter	2008-09	2009-10	2010-11	2011-12	2012-13
Bhilai	Total SFC (ml/kWh)		**1.49**	**0.39**	**0.17**	**0.19**
	SFC For startups (%)		46%	61%	78%	40%
	SFC other than startups (%)		54%	39%	22%	60%
Singrauli	Total SFC (ml/kWh)	**0.29**	**0.24**	**0.24**	**0.65**	**0.21**
	SFC For startups (%)	53%	79%	61%	35%	79%
	SFC other than startups (%)	47%	21%	39%	65%	21%
Rihand	Total SFC (ml/kWh)	**0.16**	**0.20**	**0.21**	**0.25**	**0.51**
	SFC For startups (%)	49%	61%	50%	43%	42%
	SFC other than startups (%)	51%	39%	50%	57%	58%
FGUTPP,	Total SFC (ml/kWh)	**0.27**	**0.17**	**0.33**	**0.76**	**0.40**
	SFC For startups (%)	72%	62%	48%	18%	36%
	SFC other than startups (%)	28%	38%	52%	82%	64%
Korba	Total SFC (ml/kWh)	**0.08**	**0.09**	**0.12**	**0.22**	**0.10**
	SFC For startups (%)	89%	87%	84%	58%	54%
	SFC other than startups (%)	11%	13%	16%	42%	46%
Vindhyachal	Total SFC (ml/kWh)	**0.20**	**0.18**	**0.12**	**0.21**	**0.21**
	SFC For startups (%)	55%	51%	67%	55%	46%
	SFC other than startups (%)	45%	49%	33%	45%	54%
Sipat	Total SFC (ml/kWh)	**0.53**	**0.20**	**0.21**	**0.11**	**0.50**
	SFC For startups (%)	37%	60%	54%	78%	42%
	SFC other than startups (%)	63%	40%	46%	22%	58%
Ramagundam	Total SFC (ml/kWh)	**0.16**	**0.10**	**0.13**	**0.12**	**0.22**
	SFC For startups (%)	52%	56%	54%	52%	42%
	SFC other than startups (%)	48%	44%	46%	48%	58%
Simhadri	Total SFC (ml/kWh)	**0.10**	**0.22**	**0.09**	**0.21**	**0.42**
	SFC For startups (%)	28%	28%	53%	38%	30%
	SFC other than startups (%)	72%	72%	47%	62%	70%
NCTPS Dadri	Total SFC (ml/kWh)	**0.14**	**0.35**	**0.53**	**0.16**	**0.22**
	SFC For startups (%)	100%	38%	41%	100%	86%
	SFC other than startups (%)	0%	62%	59%	0%	14%
High Consumption Stations		**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**
Farakka	Total SFC (ml/kWh)	**1.21**	**0.83**	**0.39**	**0.60**	**1.53**
	SFC For startups (%)	19%	24%	35%	39%	25%
	SFC other than startups (%)	81%	76%	65%	61%	75%
Kahalgaon	Total SFC (ml/kWh)	**1.19**	**1.00**	**0.72**	**0.83**	**0.66**
	SFC For startups (%)	18%	18%	33%	27%	24%

	SFC other than startups (%)	82%	82%	67%	73%	76%
Badarpur	Total SFC (ml/kWh)	**0.59**	**0.75**	**0.81**	**1.00**	**1.51**
	SFC For startups (%)	37%	35%	68%	48%	45%
	SFC other than startups (%)	63%	65%	32%	52%	55%
Talcher STPS	Total SFC (ml/kWh)	**0.64**	**0.63**	**0.45**	**0.40**	**0.59**
	SFC For startups (%)	13%	17%	34%	42%	28%
	SFC other than startups (%)	87%	83%	66%	58%	72%

9.10 As may be seen from the table, stations with low SFC have most of their oil consumption incurred in the start-ups and have very little oil consumption for flame support; while, the high consuming stations have most of the oil consumption for the flame support purposes. Low yearly SFC of 0.1 to 0.2 ml/kWh at Korba, Sipat, Singrauli, Rihand, Dadri are mostly associated with 70 % to 90 % of SFC for startups. In certain cases, even 100 % SFC has been for startup purposes. On the contrary, high oil consuming stations have very low share of start-ups' SFC - 20 to 30 % and even lower.

9.11 It is also seen that, high oil consumption for flame support occurs despite very high average unit loadings at the stations. As may be seen from table-10, the unit loading of the high consumption stations have been quiet high ranging from 85 % to 95 % most of the time. Similarly instances of high yearly SFC occur in other stations despite high unit loadings. Thus there appears to be no justifiable reasons for such high SFCs as fuel oil support is normally envisaged for low unit loadings (below 30-40%).

Approach for Normative SFC

9.12 From the discussions in the foregoing Paras – 9.1 to 9.11, the following key observations emerge regarding Specific Secondary Fuel Oil Consumption:-

9.12.1 **Most stations have very low SFC-** Overall SFC is **0.24 ml/kWh** for about 75 % of the capacity considered and **0.75 ml/kWh** for balance 25 % capacity**.** Extremely low yearly SFC of **0.08 to 0.10 ml/kWh** are seen in many stations.

9.12.2 High SFC in select few stations appears to be due to station specific factors and can be lowered through proper identification and analysis of these factors and remedial measures. These stations have achieved low SFC in the past and in specific years).

9.12.3 Stations with low SFC have most of their oil consumption incurred in the start-ups and have very little oil consumption for flame support. About 60 % to 80 % of SFC (and even higher) in these cases is attributable to startups.

9.12.4 In cases of high SFC, large share of SFC is for other than start-ups (flame support etc.). Further in most cases, this high SFC occurs despite very high unit loadings and there appears to be no justifiable reasons for the same.

9.13 In the above context, it is felt that different approaches or philosophies for normative SFC are necessary for the two categories of stations viz- majority of stations having generally low SFC and select few stations having very high SFC. It is thus felt that norms for SFC may be provided separately for the high consuming stations in terms of station specific norms which could be progressively lowered as steps are taken by the utilities to address station specific issues leading to high oil consumption. For the rest of the stations, the SFC norms should be representative of their actual consumption level and very high SFC may not be allowed for these stations

9.14 **The present normative provisions allowing SFC of 1 ml/kWh with provisions of 50:50 sharing are not considered appropriate** in the prevailing situation as even in the case of very low actual SFC of 0.1 ml/kWh, it allows a normative SFC of about 0.5 to 0.6 ml/kWh which is considered far too liberal and unrealistic.

9.15 **Thus the following approach is suggested for normative SFC –**

9.15.1 Barring select few high oil consumption stations, other stations may be allowed a normative SFC of **0.25 ml/kWh** inclusive of about **7** startups per unit in a year. In case of additional start-ups, additional oil consumption be allowed based on the standard criteria (in terms of kilolitre per startup) being recommended in subsequent Paras.

9.15.2 The few high consuming stations may be covered under station specific norms with targets for progressive reduction of SFC each year as steps are taken by the utilities to address station specific issues leading to high oil consumption. To begin with these stations may be allowed a SFC of 1 ml/kWh SFC with provisions of 50:50 sharing for the first year with targets for progressive yearly reduction.

9.15.3 New units commissioned may be allowed a higher SFC of 1 ml/kWh during the first six months after commissioning. However this would cover all startups requirements of the unit and no additional oil consumption be allowed for additional startups of these units during the above period.

9.16 Such an approach is also considered necessary as, the changing grid conditions may necessitate considerably higher number of start-ups in future; and providing a fixed SFC may lead to reluctance on the part of the utilities to incur start-ups. Thus correlating the normative/allowable SFC with the start-ups so as to adequately compensate the generators for additional start-ups is considered necessary.

Allowable oil consumption for Additional startups

9.17 The details of oil consumption for each type of start-up (hot, warm and cold) were called from the stations and wide variations have been noticed in the consumption per start-up indicated by the utilities/ station. The details of same are furnished in Table-18.

Table- 18 Oil consumption per startup – received from stations

S.No	Name of the Station	Unit size (MW)	Capacity (MW)	Start Up Oil Consumption (Kl) per start		
				Hot	Warm	Cold
1	Neyveli TPS -1	6x50+3x100	600	6	14	25
2	Neyveli TPS I Expn	2x210	420	50	90	200
3	Neyvelli TPS-II (Stage-I)	3x210	630	22	61	83
4	Neyvelli TPS-II (Stage-II)	4x210	840	22	40	60
5	Barsingsar TPS	2x125	250	30	45	60
6	NTPC	200	7000	20-40	40-60	150-200
		500	21480	30-50	50-100	350-400
		660	1980	85-100	120-150	350-400

Note-NTPC have not furnished stations wise details of start-up consumption

9.18 As may be seen, there are wide variations in the consumption indicated by different stations for same unit sizes. The figures indicated by NTPC are much higher especially for the cold startups. Considering the consumption figures indicated by NTPC, the SFC required for meeting startup requirements (based on the generation and start-ups furnished by the stations) have been computed, and compared with the actual SFC reported by the stations in table-19. The values indicated are in terms of percentages of actual total SFC of the stations.

Table- 19 Actual SFC vs. Startup SFC computed as per NTPC estimates

Stations	SFC Details	2008-09	2009-10	2010-11	2011-12	2012-13
Bhilai	Actual SFC (ml/kWh)		1.49	0.39	0.17	0.19
	S-UP SFC (% of total SFC) NTPC HIGH		124.54%	187.46%	244.01%	107.09%
	S-UP SFC (% of total SFC) NTPC LOW		81.92%	130.58%	174.29%	72.28%
Singrauli	Actual SFC (ml/kWh)	0.295	0.237	0.242	0.653	0.209
	S-UP SFC (% of total SFC) NTPC HIGH	194.36%	302.78%	243.32%	136.30%	279.71%
	S-UP SFC (% of total SFC) NTPC LOW	150.82%	238.22%	193.44%	107.27%	214.77%
Rihand	Actual SFC (ml/kWh)	0.160	0.204	0.205	0.251	0.506
	S-UP SFC (% of total SFC) NTPC HIGH	159.97%	236.24%	182.30%	143.84%	125.12%
	S-UP SFC (% of total SFC) NTPC LOW	125.77%	198.68%	151.22%	113.35%	95.04%
FGUTPP, Unchahar	Actual SFC (ml/kWh)	0.273	0.175	0.327	0.759	0.405
	S-UP SFC (% of total SFC) NTPC HIGH	245.65%	206.81%	153.89%	52.87%	107.72%
	S-UP SFC (% of total SFC) NTPC LOW	174.25%	146.17%	106.87%	35.83%	73.55%
Korba Super	Actual SFC (ml/kWh)	0.081	0.085	0.121	0.224	0.101
	S-UP SFC (% of total SFC) NTPC HIGH	258.08%	238.59%	235.69%	170.14%	132.95%
	S-UP SFC (% of total SFC) NTPC LOW	186.80%	168.19%	166.71%	119.20%	87.19%
Vindhyachal	Actual SFC (ml/kWh)	0.200	0.181	0.122	0.214	0.211
	S-UP SFC (% of total SFC) NTPC HIGH	130.07%	120.26%	172.79%	160.06%	120.92%
	S-UP SFC (% of total SFC) NTPC LOW	84.63%	78.45%	117.73%	115.35%	83.03%
Sipat	Actual SFC (ml/kWh)	0.531	0.197	0.206	0.106	0.505
	S-UP SFC (% of total SFC) NTPC HIGH	66.32%	198.91%	129.36%	229.05%	108.35%
	S-UP SFC (% of total SFC) NTPC LOW	37.14%	157.26%	83.94%	169.14%	74.04%
Ramagundam	Actual SFC (ml/kWh)	0.162	0.100	0.130	0.117	0.220
	S-UP SFC (% of total SFC) NTPC HIGH	126.53%	142.35%	143.37%	140.94%	100.60%
	S-UP SFC (% of total SFC) NTPC LOW	83.06%	95.57%	99.67%	99.87%	65.66%
Simhadri	Actual SFC (ml/kWh)	0.100	0.223	0.089	0.210	0.418
	S-UP SFC (% of total SFC) NTPC HIGH	81.97%	65.78%	133.33%	81.05%	90.64%
	S-UP SFC (% of total SFC) NTPC LOW	58.55%	41.57%	88.00%	50.02%	69.12%
Farakka	Actual SFC (ml/kWh)	1.215	0.832	0.390	0.605	1.530
	S-UP SFC (% of total SFC) NTPC HIGH	49.93%	75.49%	109.16%	118.21%	67.14%
	S-UP SFC (% of total SFC) NTPC LOW	34.24%	56.70%	81.95%	87.89%	47.70%
Kahalgaon	Actual SFC (ml/kWh)	1.193	0.999	0.716	0.834	0.658
	S-UP SFC (% of total SFC) NTPC HIGH	48.77%	60.15%	109.69%	93.18%	79.13%
	S-UP SFC (% of total SFC) NTPC LOW	33.75%	46.17%	84.18%	72.53%	60.14%
TSPTS	Actual SFC (ml/kWh)	0.637	0.633	0.450	0.404	0.592
	S-UP SFC (% of total SFC) NTPC HIGH	44.92%	51.52%	119.80%	124.00%	106.71%

	S-UP SFC (% of total SFC) NTPC LOW	36.63%	38.16%	95.94%	91.61%	89.38%
Badarpur TPS	**Actual SFC (ml/kWh)**	0.595	0.752	0.809	1.000	**1.514**
	S-UP SFC (% of total SFC) NTPC HIGH	89.17%	83.27%	**173.75%**	**121.52%**	**116.60%**
	S-UP SFC (% of total SFC) NTPC LOW	55.88%	52.30%	**113.48%**	76.68%	75.27%
NCTPS Dadri	**Actual SFC (ml/kWh)**	0.14	0.35	0.53	0.16	0.22
	S-UP SFC (% of total SFC) NTPC HIGH	**327.46%**	**109.84%**	**124.02%**	**336.36%**	**282.90%**
	S-UP SFC (% of total SFC) NTPC LOW	**244.19%**	78.09%	90.34%	**252.12%**	**212.88%**
INDIRAGANDHI TPS	**Actual SFC (ml/kWh)**				3.740	0.435
	S-UP SFC (% of total SFC) NTPC HIGH				39.64%	**507.65%**
	S-UP SFC (% of total SFC) NTPC LOW				30.50%	**424.20%**

Note: For each station, the first row shows actual SFC reported by the station
Second and third rows show SFC for startups computed as per oil consumption per startup indicated by NTPC (upper and lower limits of range indicated by NTPC) and expressed as % of total SFC reported by the respective station.

9.19 As may be seen from the above table, **start-up fuel requirement worked out on the basis of the oil consumption figures furnished by NTPC far exceed the total oil consumption in most of the stations,** thus indicating that the figures furnished by NTPC are excessively high and are not realistic.

9.20 The oil consumption per start-up has also been computed on the basis of standard start startup curves of the manufacturers after allowing liberal margins. Feedback has also been taken from the other utilities on the actual oil consumption being incurred normally for each type of startups. Based on the above information, the following start-up fuel requirements per start-up are proposed to be adopted.

Table- 20 Recommended SFC per Startup

Unit size (MW)	**Start Up Oil Consumption (Kl) per start**		
	Hot	**Warm**	**Cold**
200/210/250	20	30	50
500	30	50	90
660	40	60	110

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Recommendation 5- Specific Secondary Fuel Oil Consumption

Recommendations –

1. Most stations have very low SFC and most of their oil consumption incurred in the start-ups. Select few stations have very high SFC due to station specific factors. Thus different approaches or philosophies for normative SFC are necessary for the two categories of stations

2. Normative SFC of (except for select high consumption stations) may be taken as **0.25 ml/kWh** inclusive of 7 startups per unit. In case of additional start-ups, additional oil consumption be allowed based on the standard criteria (in terms of kilolitre per startup) as follows:-

Unit Size (MW)	Oil Consumption per startup (Kl)		
	Hot	Warm	Cold
200/210/250	20	30	50
500	30	50	90
660	40	60	110

3. **High consuming stations may be covered under station specific norms** with targets for progressive reduction of SFC each year as steps are taken by the utilities to address station specific issues leading to high oil consumption.

   To begin with these stations may be allowed a SFC of **1 ml/kWh** for the first year with provisions of **50:50** sharing and with targets for progressive yearly reduction.

4. New units commissioned may be allowed a higher SFC of 1 ml/kWh during the first six months after commissioning. However this would cover all startups requirements and no additional oil consumption be allowed for additional startups of these units during the above period

5. The present normative SFC of 1 ml/kWh is considered too liberal for most stations having very low SFC. Further, correlating the normative/allowable SFC with the start-ups is considered necessary to adequately compensate the generators for additional start-ups as, the changing grid conditions may necessitate considerably higher number of start-ups in future; and providing a fixed SFC may lead to reluctance on the part of the utilities to incur start-ups.

10. *Lignite fired stations*

10.1 As may be seen from table-1, the present Station Heat Rate (SHR) norm for lignite based stations are based on SHR for coal based stations with 4 to 10% higher SHR than coal fired units based on correction factors with respect to moisture content of lignite. Similarly the normative AEC allowed is 0.5 % higher than the normative AEC for coal fired units. Further, most of the lignite stations are covered under relaxed station specific norms.

10.2 The operating heat rate of lignite stations are given in table-21. As may be seen all Neyvelli stations covered under relaxed norms have operating heat rate within the prescribed normative heat rate. The operating heat rate of Barsingsar is 6.68 % higher than the design heat rate, which is slightly higher than the normative heat rate (6.5% over DHR); however the station became operational in 2012-13 and had a low PLF of 58 %.

Table- 21 Operating Heat rate –Lignite Stations

Stations	Item	2008-09	2009-10	2010-11	2011-12	2012-13
Neyveli TPS -1	Heat Rate (kcal/kWh)	3924	3933	3944	3960	3897
	Deviation from Design (%)	50.17%	50.51%	50.94%	51.55%	49.13%
Neyveli TPS I EXPN.	Heat Rate (kcal/kWh)	2739	2743	2751	2745	2737
	Deviation from Design (%)	9.46%	9.63%	9.96%	9.70%	9.40%
Neyvelli TPS -II (Stage-I)	Heat Rate (kcal/kWh)	2947	2917	2894	2883	2874
	Deviation from Design (%)	12.59%	11.46%	10.58%	10.16%	9.84%
Neyvelli TPS -II (Stage-II)	Heat Rate (kcal/kWh)	2950	2893	2877	2880	2871
	Deviation from Design (%)	14.82%	12.63%	11.99%	12.11%	11.74%
Barsingsar TPS	Heat Rate (kcal/kWh)					2601
	Deviation from Design (%)					6.68%

10.3 The Auxiliary energy consumption and Specific Secondary Fuel Oil Consumption of lignite fired stations are given in table-22.

Table- 21 Lignite Stations – AEC and SFC

Stations	2008-09	2009-10	2010-11	2011-12	2012-13	AEC/SFC
Neyveli TPS -1	12.19%	11.76%	12.32%	11.96%	11.55%	Auxiliary Energy Consumption (%)
Neyveli TPS I EXPN.	8.56%	8.70%	8.46%	7.65%	8.56%	
Neyvelli TPS-II (Stage-I)	9.67%	9.61%	9.88%	9.60%	9.67%	
Neyvelli TPS -II (Stage-II)	9.97%	9.53%	9.51%	9.66%	9.66%	
Barsingsar TPS					12.68%	

Neyveli TPS -1	2.27	1.21	2.09	1.33	1.21	Specific Secondary Fuel Oil Consumption (ml/kWh)
Neyveli TPS I EXPN.	1.29	1.21	1.79	0.90	0.69	
Neyvelli TPS-II (Stage-I)	1.35	1.32	0.81	0.65	0.48	
Neyvelli TPS -II (Stage-II)	1.48	0.48	0.58	0.59	0.49	
Barsingsar TPS					0.56	

10.4 The Neyvelli stations are covered under relaxed norms for AEC. AEC for Barsingsar TPS is 12.68 % which is slightly higher than the normative AEC of 11.5 %; however, as brought out above, the station became operational in 2012-13 and had a low PLF of 58 % and performance is likely to improve in subsequent years. The SFC of Barsingsar is however, very low at 0.56 ml/kWh as against a normative SFC of 1.25 ml/kWh. This is despite very high start-ups of about **28.5** per unit. Also, almost all the SFC has been on account of start-ups. In view of the above, the SFC norm for CFBC units could be revisited.

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Recommendation 6- Lignite fired Stations

Recommendation –

1. **Stations under Specific/Relaxed Norms**

Several Neyvelli stations (TPS-I & Expn, TPS-II) are covered under relaxed station specific norms and may continue with the station specific norms. CERC may however review based on the actual performance achieved.

2. **Other stations**

(a) SHR - For other Neyvelli stations the present system of normative SHR, and AEC based on respective norms for coal based units plus additional margins is considered adequate and may continue.

SHR for New units (COD) after 01-04-2009

The normative Gross Operating heat rate (OHR) allowed may be taken as about 3 % (three percentage points) higher than Design Heat rate (DHR) similar to recommendations for coal fired stations.

(b) AEC – Present AEC norms of 0.5 % higher than coal based units with PC technology and 1.5 % higher for CFBC technology are considered adequate and may continue.

(c) SFC - The present SFC norm of 2 ml/kWh may be reviewed considering very low SFC of 0.5 to 0.8 achieved by the stations. On similar lines as suggested for coal fired stations, normative SFC of **0.75 ml/kWh** inclusive of 7 startups per unit may be prescribed and in case of additional start-ups, additional oil consumption be allowed based on the standard criteria (in terms of kilolitre per startup) as indicated

CFBC units – SFC for CFBC units could also be taken as **0.75 ml/kWh** inclusive of 7 startups per unit

Additional Oil Consumption for Startups

Unit Size (MW)	Oil Consumption per startup (Kl)		
	Hot	Warm	Cold
210/250 PC	20	30	50
210/250 CFBC	65	75	100
125 CFBC	35	40	50

11. Gas Based stations

11.1 The operational performance of gas based stations – PLF, heat rate and AEC are given in table-22.

Table- 22 Operational Performance- Gas Based Stations

Station	Cap.	2008-09	2009-10	2010-11	2011-12	2012-13	Average
Plant Load Factor (%)							
Anta	419.33	68.48%	81.72%	67.73%	73.30%	59.25%	**70.10%**
Auraiya	663.36	64.41%	77.93%	75.19%	66.75%	47.75%	**66.40%**
Kawas	656.2	60.60%	75.28%	67.53%	62.77%	50.45%	**63.33%**
Gandhar	657.39	72.07%	77.93%	70.47%	63.97%	60.41%	**68.97%**
Faridabad	431.586	62.96%	84.96%	83.46%	81.14%	63.56%	**75.21%**
Dadri Gas	829.78	72.74%	77.13%	74.29%	73.96%	60.77%	**71.78%**
Rajiv Gandhi	359	64.31%	76.88%	60.51%	22.46%	49.24%	**54.68%**
Assam GBP	291	69.33%	68.63%	72.00%	69.24%	65.91%	**69.02%**
Agartala	84	89.76%	90.05%	87.52%	90.52%	85.98%	**88.77%**
Operating Heat Rate							
Anta	419.33	2067	2050	2081	2042	2080	**2064**
Auraiya	663.36	2167	2113	2091	2100	2105	**2115**
Kawas	656.2	2054	2070	2093	2029	2037	**2057**
Gandhar	657.39	2018	2047	2026	2035	2029	**2031**
Faridabad	431.586	1974	1920	1933	1940	1988	**1951**
Dadri Gas	829.78	1978	1988	1976	1983	2005	**1986**
Rajiv Gandhi	359	1958	1957	1973	1986	1963	**1967**
Assam GBP	291	2665	2565	2666	2733	2817	**2689**
*Agartala (OC)	84	3771	3763	3762	3833	3476	**3721**
Auxiliary Energy Consumption. (%)							
Anta	419.33	**2.23%**	**2.16%**	**2.58%**	**1.93%**	**2.22%**	**2.23%**
Auraiya	663.36	**2.27%**	**2.39%**	**2.53%**	**2.56%**	**2.81%**	**2.51%**
Kawas	656.2	**1.52%**	**1.70%**	**1.87%**	**1.80%**	**2.06%**	**1.79%**
Gandhar	657.39	**1.83%**	**1.43%**	**1.67%**	**1.77%**	**1.85%**	**1.71%**
Faridabad	431.586	**2.46%**	**2.27%**	**2.30%**	**2.24%**	**2.47%**	**2.35%**
Dadri Gas	829.78	**2.53%**	**2.35%**	**2.38%**	**2.40%**	**2.40%**	**2.41%**
Rajiv Gandhi	359	**1.49%**	**1.44%**	**2.37%**	**3.26%**	**2.52%**	**2.22%**
Assam GBP	291	**1.66%**	**1.69%**	**1.42%**	**1.15%**	**2.55%**	**1.69%**
Agartala	84	**0.47%**	**0.47%**	**1.65%**	**1.76%**	**1.56%**	**1.19%**

* Open Cycle

11.2 A sharp reduction in PLF is seen in all stations (except stations in Assam) during the last year because of shortage of gas. All the above gas based stations fall under the station specific heat rate norms and the operating heat rate for most of the NTPC stations fall in the range of the prescribed norms.

However Assam and Agartala stations of NEEPCO have higher heat rate than the normative heat rate.

11.3 It is therefore suggested that Station specific norms already been prescribed by CERC for the existing gas fired stations (about 6-8% higher than the design heat rate) may continue for these stations.

11.4 The AEC of all stations is in the range of 2 to 2.5 % and even lower despite low PLF. The overall AEC works out to **2.15 %** which is much lower that the normative AEC of 3 % (for combined cycle) and several stations show much lower AEC. Thus the allowable AEC could be lowered by **0.5 %** for combined cycle mode. However, the prevailing AEC norms of 1 % for open cycle are considered adequate.

11.5 As may be seen, no new gas based stations have been added after 01-04-2009 and thus feedback of actual operating heat rate with respect to design for the new units are not available. From the CEA report on operation norms for the tariff period 2009-14, it is seen the operating heat rate for NTPC gas stations was about 2% to 5% higher than the design heat rate. The same trend is seen from the operational data for the current period (2007-08 to 2012-13). Thus for the current tariff period the prevailing norm of **5 %** over the Design heat rate (7.1 % with liquid fuel) in respect of new units (COD after 01-04-2009) may continue for the CCGT stations with COD after 01-04-2009.

Recommendation 7- Gas based stations

Recommendation –

Station specific norms for Heat rate already prescribed by CERC for the existing gas fired stations may continue.

Also the prevailing norm of **5 %** over the Design heat rate (**7.1** % with liquid fuel) in respect of new units (COD after 01-04-2009) may continue.

AEC norms of **3 %** for combined cycle may be reduced to **2.5**%. For open cycle the prevailing norm of 1 % is considered adequate and may continue.

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Section -3 Other Issues

12. Air Cooled Condensers

12.1 In view of the difficulties being faced in siting thermal power plants due to non-availability of water, particularly in some coal bearing areas like Orissa, Jharkhand and Chhattisgarh, use of dry cooling system for condenser cooling are understood to being explored; and large thermal power stations with air cooled condensers or dry cooling systems may come up in future. Thus the normative parameters to be adopted for dry cooling systems are being discussed in subsequent Paras.

12.2 Dry cooling systems can be broadly classified in two categories viz. direct dry cooling systems and indirect dry cooling systems. In the direct dry cooling system, exhaust steam from LP turbine is directly cooled in a system of finned tubes by ambient air using mechanical draft fans or natural draft hyperbolic tower. In an indirect dry cooling system, exhaust steam from the turbine is cooled by water in a surface or jet condenser and hot water is cooled by air in finned tube bundles using mechanical draft fans or natural draft hyperbolic tower

12.3 The use of air cooled condensers or dry cooling systems leads to increase in Auxiliary Energy Consumption as well as reduced output or increase in station operating heat rate.

12.4 A techno- economic study was carried out by CEA on impact of application of dry cooling system in thermal power plants in India. Requisite data on dry cooling system was obtained from the manufacturers of dry cooling systems. The salient finding of the study are as under:-

12.4.1 As compared to wet cooling system, the dry condenser cooling system are likely to result in reduction of unit output by about 7%. <u>Thus the heat rate of the unit with dry cooling system is expected to be higher by about 7%.</u>

12.4.2 The auxiliary power consumption for different type of dry cooling systems considering the base AEC for conventional wet cooling system (Once through or NDCT type) taken as 6 % are expected to be as follows:-

Type of Dry Cooling System	Expected AEC (% of gross output)
Direct cooling air cooled condensers with mechanical draft fans.	**6.8 %**
Indirect cooling system employing jet condensers with pressure recovery turbine and natural draft tower	**6.2 %**

12.5 Considering the above, it is suggested that **Additional Auxiliary Energy Consumption of 0.5 % may be allowed for plants with Indirect cooling type dry cooling system and 1.0 % for direct cooling type air cooled condensers** with mechanical draft fans.

12.6 No change in station heat rate for plants with air cooled condensers or dry cooling systems is envisaged as the present system of specifying normative heat rate in terms of design heat rate would automatically take care of higher heat rate of dry cooling systems. However, the maximum allowable Turbine Cycle Heat Rate prescribed may have to be correspondingly increased for plants using dry cooling systems.

Recommendation 8- Air Cooled Condensers/Dry Cooling Systems

Recommendation –

AEC: Additional Auxiliary Energy Consumption as follows may be allowed for plants with dry cooling systems

Type of Dry Cooling System	Additional AEC (% of gross output)
Direct cooling air cooled condensers with mechanical draft fans	**1.0 %**
Indirect cooling system employing jet condensers with pressure recovery turbine and natural draft tower	**0.5 %**

SHR: No change in heat rate for plants with air cooled condensers/dry cooling systems is envisaged as the impact of higher heat rate automatically gets incorporated in design heat rate.

However, the maximum allowable Turbine Cycle Heat Rate may be increased by **7 %** for plants using dry cooling systems

13. GCV used for computations of Station Heat rate (SHR)

13.1 It is also important to ensure that the computations of SHR are made in accordance with the spirit of the CERC tariff Regulations and the Regulations appropriately define the principles of computation of SHR.

13.2 From the Pro-forma for furnishing "Actual annual performance/operational data" prescribed by CERC it is seen that the following data regarding coal consumption and GCV is required to be submitted by the utilities/stations.

14.1	**Consumption :**
14.1.1	Domestic Coal (Linked mine/ Other mines/e-auction/spot)
14.1.2	Imported Coal*
14.2	**Gross Calorific Value (GCV):**
14.2.1	Domestic Coal (As received)
	(As fired)
14.2.2	Imported Coal (As received)
14.2.3	Spot market/e-auction coal (As received)
14.2.4	Weighted Average Gross Calorific value (As received)
14.2.5	Weighted Average Gross Calorific value (As fired)

Thus the utilities/stations are required to furnish the details of GCV on "***as received basis***" as well as ***"as fired basis"*** in respect of domestic coal as well as for the weighted average of domestic and imported coal.

13.3 However, the stations have furnished only the GCV "***as received***" for imported coal and Weighted average ***GCV "as fired" (***for the blend of domestic and imported coal combined) <u>and have not furnished the data for ***"as received GCV"*** of domestic coal</u>**.** Thus in the absence of details of "***as received GCV"*** from the stations, both in respect of domestic coal as well as for the weighted average, it is not possible to determine the basis of computation of Station heat rate (SHR) or verify the correctness of the same; as <u>difference between the ***as fired*** and ***as received*** GCV increases the coal consumption correspondingly.</u> For instance taking the "***as fired GCV"*** as 100 kcal/kg lower than the ***"as received GCV"*** understood to be followed by some utilities would project around 3 % increase in the coal consumption for typical 3500 GCV coal.

13.4 It may be pertinent to mention that the billing of coal would be on the basis of dispatch GCV by the coal suppliers (which should be approximately same as *"as received GCV").* Considering the issues of coal quality being faced by some of the stations with CIL, there could be variations between the dispatch GCV and ***as received GCV***; however, difference between the ***as received GCV*** vis-à-vis ***"as fired GCV"*** would be very marginal and would be solely on account of marginal loss of heat during the coal storage.

13.5 From the data received from stations, it is seen that most stations have very low storage of about 7-10 days coal requirements. The loss of heat value during storage depends on the type of coal and the period of storage. Some International publications indicate a loss of heat value of about 1 % for 1 year storage for high rank coals and 3 % for low rank coals. Thus considering a 3 % heat loss for Indian coals, the average loss of heat value for 10 days storage would be about 0.08% or about 3 kcal/kg for a typical coal with 3500 kcal/kg GCV. The intent of this illustration is to just highlight that the storage losses of coal are almost negligible especially for low storage periods as in the Indian stations. Thus the SHR computations could be based on "***as received GCV"*** basis; and if considered necessary CERC may provide for appropriate quantum of storage heat loss separately to account for heat loss due to storage. Any arbitrary practice of using ***as fired GCV*** for SHR computations without proper guidelines for determining the same would only lead to inflated claims of coal consumption.

13.6 It is thus felt that all SHR computations may be made on ***as received*** GCV basis, and the marginal difference between ***as received*** and ***as fired*** GCV could be compensated by providing a **coal storage loss** in terms of % of total coal on similar lines as coal transit loss. This will be in line with gate to gate energy accounting concept generally practiced Internationally and also envisaged under the PAT (Perform Achieve and Trade) mechanism under the National Mission on Enhanced Energy Efficiency.

14. Compliance of CEA Technical Standards Regulations - 2010

14.1 One of the functions assigned to Central Electricity Authority under Section 73 of the Electricity Act 2003, is to "*specify the technical standards for construction of electrical plants, electric lines and connectivity to the grid"* (Sec 73(b)). Also under Section 177 of the Act, CEA has been vested with the powers to make such Regulations.

14.2 Accordingly, CEA has notified the ***Technical Standards for Construction of Electric Plants and Electric Lines Regulations 2010*** vide gazette notification dated **20-8-2010**. The Regulations cover key Operating Capabilities viz. fuel quality, grid conditions, cooling water temperature etc. for the thermal generating units and also prescribe salient sizing & construction criteria, minimum efficiency levels, protection systems etc. These are mandatory to be followed by the project developers/generating companies.

14.3 The Investigation and Enforcement provisions of the Electricity Act 2003 have been laid down in Part -12 of the Act and under this part, in Section 128, the Regulatory Commissions have been empowered as follows:-

14.3.1 To take cognizance of failure to comply with any of the provisions of the Act, including Regulations made under the Act, by any generating company, and order to investigate the affairs of any generating company by an Investigating Authority

14.3.2 Direct the generating company to produce all books of account, registers and other documents in his custody or power and furnish any statement and information relating to the affairs of the generating company, to said Investigating Authority

14.3.3 On receipt of report of the Investigating Authority, the Appropriate Commission may Enforce Penalties including cancellation of licence or direction to cease to carry on the business of generation of electricity to the generating company.

14.3.4 Appropriate Commission may specify the minimum information to be maintained by the licensee or the generating company, necessary to enable investigation by the Investigating Authority

14.3.5 Where the Appropriate Commission, is satisfied that a generating company has contravened or is likely to contravene any of the provisions of this Act, it is empowered to give directions necessary for securing compliance with that condition or provision

14.4 Thus a request was made by CEA to the "**Forum of Regulators**" (Forwarded to FOR vide Ministry of Power Letter **24th January 2012**) to device an implementation mechanism for the CEA Technical Standards Regulations by directing the generating companies making Tariff Application to the commissions to furnish information related to key efficiency, and operation parameters prescribed in the CEA Regulations alongwith certification/undertaking of compliance in respect of these provisions of the Regulations while making tariff application. Copy of the CEA communication to the Forum of Regulators is enclosed at Appendix-II.

14.5 CEA has requested CERC also for incorporation of the salient provisions of the CEA Regulations in the application for tariff made by the Generating companies to CERC and has indicated/ suggested changes required in the (Appendix-I Part-I Form-2 "Plant Characteristics") of the CERC Tariff Regulations. Copy of the CEA communication enclosed at Appendix-III.

14.6 Meanwhile, CERC have issued Draft Tariff Regulations 2014-19 vide notification dated 6th December, 2013. The above Regulations propose that before declaration of commercial operation (COD), *it shall be mandatory for the generating company to obtain a certificate from Central Electricity Authority or any agency designated by Authority to the effect that the generating station meets all the technical standards of Central Electricity Authority (Technical Standards for Construction of Electrical plants and electric lines) Regulations, 2010 and Grid Code*

14.7 Thus under the proposed CERC Regulations, a certification by CEA regarding compliance to CEA Technical Standards Regulations would be a precondition for declaration of commercial operation of any thermal unit. Such a provision is **NOT considered desirable** due to the reasons discussed in following Paras

14.8 As per the Electricity Act 2003, "*Any generating company may establish, operate and maintain a generating station without obtaining a licence under this Act if it complies with the technical standards relating to connectivity with the grid referred to in clause (b) of section 73"* (Sec-7 of the Act)

14.9 Thus the Spirit of the Act is to decontrol by moving away from direct Controls. The enforcement provisions brought out at Para **14.3** above granted to the Regulatory Commissions, are envisaged only as **EXCEPTIONS** where violations are noticed - providing for powers to Commissions for stringent action including cancelation of licence or directing closure. On the contrary, the provisions proposed by CERC in the draft Tariff Regulations would require every generating company to approach CEA for certification regarding compliance of CEA Technical Standards Regulations in respect of each generating unit before the unit can be declared to be in commercial operation. Thus such a provision would be in total contravention of the Spirit of the Act.

14.10 Further, certification of compliance of the Regulations by CEA as proposed by CERC does not appear to be feasible due to the following reasons:-

14.10.1 The CEA Technical Standards Regulations lay down detailed construction Standards and many a times these Standards are in terms of other standards like BIS, International standards etc. Any exercise for certification of compliance would necessitate detail review of design and sizing documentation, test reports, etc. for each unit being installed. Such an exercise would be almost impossible to implement without seriously jeopardizing the execution of such large numbers of projects being implemented in the country.

14.10.2 Certain provisions of the CEA Technical Standards Regulations are of continuous nature like maintainance of documents at the site by the owner (for making available as and when required for any investigation etc**.),** compliance to applicable environmental emission standards etc. **and one time compliance of such provisions is neither intended nor would serve the purpose.**

14.10.3 The Regulations contain provisions on operating capability – like design for highest CW temperature, worst fuel quality, grid frequency variations, loading/unloading capabilities etc. which can be ascertained only with sustained plant operation.

14.10.4 The efficiency provisions stipulated in the Regulations would require detailed performance guarantee tests which require very elaborate preparation and testing as per International codes and it may not be feasible/advisable to hold back commercial operation on this account.

14.11 It may thus be seen that the intent of the CEA Technical Standards Regulations is to provide a framework for construction of plants based on prevalent good engineering practices, especially in the wake of sudden expansion of the Indian power sector involving large number of players; many of whom without adequate previous experience of the sector. This coupled with the enforcement provisions to ERCs under section 128 provide a sound legal framework for construction of sound and efficient plants. It needs to be kept in view that, with the rapid pace of capacity addition in the country, almost 4-5 thermal units are being commissioned in a month and may go up further in future. **It is not feasible to conceive of any process of detailed examination and certification of compliance to the Regulations before allowing commercial operation of such large number of units**.

14.12 Thus in keeping with the Spirit of decontrol of the Electricity Act 2003, a system of self-certification/undertaking by the project proponents for key provisions of the CEA Technical Standards Regulations-2010, as has been suggested by CEA to the FOR and CERC may be adopted. Adoption of such process by the Regulatory Commissions could ensure that there is no non-compliance either deliberate or due to oversight of the key provisions of CEA technical Regulations. Any non-compliance despite such process in place could be penalized by the Regulatory Commissions as per the prevalent provisions of the Act.

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Section -4 Next Page

Section -4 Summary of Recommendations

Summary of Recommendations

The various recommendations made in this report are summarized as follows:-

Availability Factor

The present norms of **Availability Factor** are considered adequate and may be retained

Station Heat rate

Existing Stations (Prior to 01-04-2009)

1. The stations covered under relaxed station specific norms may continue under such norms. CERC may however like to review the same for progressive improvement based on actual operational performance.
2. Normative SHR for lignite stations based on respective norms for coal based units plus additional margins (based on moisture content of lignite) is considered adequate and may continue.
3. Considering the operating heat rate of stations, it is felt that the existing single value heat rate norms for 500 and 200/210/250 MW units may be **reduced by 50 kcal/kWh.**
4. Gas based stations have been prescribed station specific norms and may continue under such norms with review by CERC for progressive improvement based on actual operational performance.

Stations with COD after 01-04-2009

5. The normative **Gross Operating heat rate (OHR) allowed** for coal and lignite based units installed after 2009, may be kept as **3 % (three percentage points)** higher than Design Heat rate (DHR) **instead of the prevailing norm of 6.5 %** higher than Design Heat rate.
6. The prevailing norms for **Gas Based Stations** with (COD after 01-04-2009) may continue. Thus the normative SHR of these stations would be **5 % higher than the Design heat rate for natural gas as fuel and 7.1 % with liquid fuel.**
7. No change in heat rate for plants with air cooled condensers or dry cooling systems is envisaged as the impact of higher heat rate automatically gets incorporated in design heat rate. Thus the SHR norms for ACC based plants shall same as the norms for respective fuel.

   However, the maximum allowable Turbine Cycle Heat Rate may have to be increased for plants using dry cooling systems.

Safeguards for Design Heat rate

8. The following is suggested to ensure realistic Design Heat rate (Turbine Cycle Heat Rate and Boiler efficiency) and prevent attempts to jack up design heat rate by the utilities, by specifying minimum carbon loss etc.

    a. Practices of specifying such losses should be discontinued forthwith

    b. Minimum boiler efficiency for Sub -bituminous Indian coals may be taken as **87 %** and lower figures may be allowed only after proper justification.

    c. A review of all Specifications may be undertaken by CERC and where such provisions leading to build up of margin upfront in the design heat rate are found, the operating margin provided in norms should be correspondingly lowered to the extent of such build up in terms of additional losses etc. has been provided in the specifications.

Auxiliary Energy Consumption

1. The stations covered under relaxed station specific norms may continue under such norms. CERC may however like to review the same for progressive improvement based on actual operational performance.
2. Existing AEC norms for coal fired units are considered adequate and may continue.
   However, AEC for 500 MW and higher size units installed after 1-4-2009 **may be reduced by 0.75 %** (three fourth percentage points). Thus the normative AEC for 500 MW and higher size units installed after 1-4-2009 may be taken as **5.25 % with Turbine driven BFPs and 7.75 % for motor driven BFPs.** Additional AEC of **0.5 %** may be allowed for units with induced draught cooling towers (IDCT) for condenser water cooling.
3. Lignite based PC and CFBC units may be allowed additional AEC over coal fired stations as per prevalent norms.
4. The prevailing AEC norms of 1 % for Gas based stations in open cycle are considered adequate and may continue. However, AEC norms of 3 % for Gas based stations in combined cycle may be reduced to 2.5 %.
5. Additional Auxiliary Energy Consumption as follows may be allowed for plants with **Dry Cooling Systems**

Type of Dry Cooling System	Additional AEC (% of gross output)
Direct cooling air cooled condensers with mechanical draft fans	**1.0 %**
Indirect cooling system employing jet condensers with pressure recovery turbine and natural draft tower	**0.5 %**

Specific Secondary Fuel Oil Consumption

1. Different approaches or philosophies for normative SFC are necessary for normal stations and select stations with very high SFC. Also a system of correlating SFC with startup is considered necessary to allow reasonable compensation for additional grid imposed startups

2. Normative SFC of (except for select high consumption stations) may be taken as **0.25 ml/kWh** inclusive of 7 startups per unit. Additional start-ups, may be allowed additional oil consumption as follows:-

Unit Size (MW)	Oil Consumption per startup (Kl)		
200/210/250	20	30	50
500	30	50	90
660	40	60	110

3. **High consuming stations may be covered under station specific norms** with targets for progressive reduction of SFC each year. To begin with these stations may be allowed a SFC of **1 ml/kWh** for the first year with provisions of **50:50** sharing and with targets for progressive yearly reduction.

4. Newly commissioned units may be allowed a higher SFC of 1 ml/kWh **during the first six months after commissioning**. However this would cover all startups requirements and no additional oil consumption be allowed for additional startups of these units during the above period

5. The present normative SFC of 1 ml/kWh is considered too liberal for most stations having very low SFC. Further, correlating the normative/allowable SFC with the start-ups is considered necessary to adequately compensate the generators for additional start-ups as, the changing grid conditions may necessitate considerably higher number of start-ups in future; and providing a fixed SFC may lead to reluctance on the part of the utilities to incur start-ups.

6. The present SFC norm of **2 ml/kWh** for **Lignite Fired stations may be reviewed** considering very low SFC of 0.5 to 0.8 achieved by the stations. On similar lines as suggested for coal fired stations, normative SFC of **0.75 ml/kWh** inclusive of 7 startups per unit may be prescribed. The SFC for CFBC units could also be taken as **0.75 ml/kWh** inclusive of 7 startups per unit.

   Additional start-ups, may be allowed oil consumption as follows

Unit Size (MW)	Oil Consumption per startup (Kl)		
210/250 PC	20	30	50
210/250 CFBC	65	75	100
125 CFBC	35	40	50

Other Issues

Air Cooled Condensers

1. Impact of ACC/dry cooling systems on SHR and AEC have already been covered in the recommendations for SHR and AEC respectively.

GCV used for computations of Station Heat rate (SHR)

2. Stations have furnished only the "***as fired GCV"*** and have not furnished the ***"as received GCV***" thus it is not possible to determine the basis of computation of Station heat rate (SHR) or verify the correctness of the same, as difference considered between the as fired and as received GCV increases the projected coal consumption correspondingly.

3. Thus the Regulations should appropriately define the criteria for "***as received GCV"*** to ensure SHR computations in accordance with the spirit of the CERC tariff Regulations.

4. Considering very low storage period of 7-10 days by most stations, the heat loss due to storage is expected to be extremely low leading to very marginal difference between ***as received*** and ***as fired*** GCV.

5. It is thus felt that all SHR computations may be made on "***as received GCV"*** basis, and the marginal difference between ***as received*** and ***as fired*** GCV could be compensated by providing a coal storage heat loss in terms of % of total coal on similar lines as coal transit loss

Compliance of CEA Technical Standards Regulations - 2010

6. The mechanism of certification regarding compliance to CEA Technical Standards Regulations by CEA before declaration of commercial operation of any thermal unit, as proposed in the CERC draft tariff Regulations of 6th December, 2013 is NOT considered desirable as such a provision would be in contravention of the Spirit of the Electricity Act 2003, which seeks to completely decontrol thermal generation; and the enforcement provisions by Regulatory Commissions, are envisaged only as EXCEPTIONS in case of violations.

7. Further, considering the rapid pace of thermal generation capacity addition in the country, any process of detailed examination and certification of compliance to the Regulations before allowing commercial operation of the units is not considered feasible and may jeopardize the execution of large numbers of projects being implemented in the country.

8. Thus in keeping with the Spirit of decontrol of the Electricity Act 2003, a system of self-certification/undertaking by the project proponents regarding key provisions of the CEA Technical Standards Regulations-2010 may be adopted as already suggested by CEA to the FOR and CERC in the past – Details at Appendix-II and Appendix-III.

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ANNEXURE-I

केन्द्रीय विद्युत विनियामक आयोग

CENTRAL ELECTRICITY REGULATORY COMMISSION

सत्यमेव जयते

D.O. No. CERC/ Engg/T&C/2014-19 **Dated: 07.05.2013**

Dear Sir,

The Commission has initiated the process of finalising Terms & Conditions of tariff for the tariff period commencing from 1.4.2014.

The Tariff Policy notified by the Government of India dated 6.1.2006 provides for notifying of operating norms by the Central Commission in consultation with the CEA.

I shall, therefore, be grateful if CEA could give their recommendations on operational norms for various types of hydro & thermal generating stations including Target Availability, Target PLF, Gross Station Heat Rate, Specific Fuel Oil Consumption and Auxiliary Energy Consumption, etc.

It would be appreciated if CEA could convey its recommendations latest by 31.07.2013.

With regards,

Yours sincerely

(Rajiv Bansal)
Secretary

Shri A.S. Bakshi
Chairman,
Central Electricity Authority
Sewa Bhawan, R.K. Puram
New Delhi-110066

Urgent

Member (Thermal) / Member (HE)

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ANNEXURE-2

केन्द्रीय विद्युत विनियामक आयोग

CENTRAL ELECTRICITY REGULATORY COMMISSION

सत्यमेव जयते

के. वि. वि. आयोग
C.E.R.C.

Date 16.08.2013

Chief Engineer I/C
Thermal & Engineering Technology Division
Central Electricity Authority
Sewa, Bhawan, R.K. Puram
New Delhi

Subject: Terms and Conditions of Tariff for the tariff period starting from 01.04.2014 – regarding.

Sir,

Please refer to your DO No. CEA/TETD-TT/2013/N-14/1269 dated 31.05.2013 addressed to Secretary CERC on the above cited subject in response to his letter of even no. dated 7.5.2013. The operational data for the last five years along with salient design data has been received for the thermal power stations of the following generating companies:

1. NTPC Sail Power Company Ltd.
2. Ratnagiri Gas and Power Pvt. Ltd.
3. NTPC Limited
4. Neyveli Lignite Corporation Ltd.
5. North Eastern Electric Power Corporation Ltd.
6. Maithon Power Ltd.
7. Aravali Power Company Pvt. Ltd.

The same is sent herewith for recommending operational norms. Operational data in respect of other thermal generating companies shall be furnished as soon as the same is received.

Yours faithfully,

Sd/- 16/8/13
(A.K. Saxena)

Encl : As above

Copy for information to:
Secretary, CEA – alongwith a copy of our letter dated 7.5.2013.

तीसरी और चौथी मंजिल, चन्द्रलोक बिल्डिंग, 36, जनपथ, नई दिल्ली–110001
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RECOMMENDATIONS ON OPERATION NORMS FOR THERMAL POWER STATIONS FOR TARIFF PERIOD BEGINNING 1st APRIL, 2009

1 INTRODUCTION

1.1 The Electricity Act 2003 provides that The Central Government shall, from time to time, prepare the "National Electricity Policy" and "Tariff Policy", in consultation with the State Governments and the Central Electricity Authority (CEA) for development of the power system based on optimal utilization of resources such as coal, natural gas etc. It also provides that, the Central Commission, in discharge of its functions shall be guided by the National Electricity Policy, National Electricity Plan and Tariff Policy. The Tariff Policy notified by the Central Government provides that The Central Commission would, in consultation with the Central Electricity Authority, notify operating norms from time to time for generation and transmission.

1.2 The Central Electricity Regulatory Commission (CERC) has initiated the process of deciding terms and conditions of tariff for the tariff period commencing from 1.4.2009 and have requested CEA, vide letter No. CERC/Engg./Tariff/T&C from 1.4.09 dated 3rd April, 2008, to give recommendations on operation norms for station heat rate, auxiliary energy consumption, specific fuel oil consumption, target PLF and target availability. The recommendations of CEA for Thermal Power Stations are furnished in this report.

1.3 The report is divided into following Sections:

Section 1	General Principles
Section 2	Coal fired stations
Part A	Future and existing stations covered under general Norms
Part B	DVC and NTPC stations covered under relaxed norms
Section 3	Lignite fired stations
Section 4	Gas turbine stations
Section 5	Summary of recommendations

SECTION- 1: GENERAL PRINCIPLES

2 PREVAILING NORMS AND THEIR EVOLUTION

2.1 The prevailing norms for the tariff period 2004-2009 notified by CERC in respect of NTPC and NLC stations, vide their order dated 26th March 2004, as amended till date, are as under:-

Table-1 Prevailing Norms by CERC

Parameter	Units/Stations	Normative value	Remarks
Unit Heat Rate	**Coal Fired Units**		
	200/210/250 MW Units During Stabilization period Subsequent period	 2600 kcal/kWh 2500 kcal/kWh	Relaxed norms provided during stabilization period stand withdrawn w.e.f. 1.4.2006
	500 MW and above Units During Stabilization period Subsequent period	 2550 kcal/kWh 2450 kcal/kWh (Heat rate to be lower by 40 kcal/kWh for units with motor driven Boiler Feed Pumps)	
	Lignite fired units except for TPS-I and TPS-II (stage I&II)	4 to 10% higher than coal fired units based on correction factors with respect to moisture content	
Secondary Fuel Oil Consumption	**Coal Fired Units** During Stabilization period Subsequent period	 4.5 ml/kWh 2.0 ml/kWh	
	Lignite Fired Units During Stabilization period Subsequent period	 5.0 ml/kWh 3.0 ml/kWh	

Auxiliary Energy consumption	**Coal Fired Units** *200 MW series* With cooling Tower Without cooling Tower	 9 % 8.5 %	Additional AEC of 0.5 % allowed during stabilization period (withdrawn w.e.f. 1.4.2006)
	Coal Fired Units *500 MW series* With cooling Tower Without cooling Tower	**TBFP** **MBFP** 7.5 % 9.0 % 7 % 8.5 %	
	Lignite Fired units except for TPS-I and TPS-II (stage I&II)	0.5 % higher than coal fired units	

Notes:

1. In addition, station specific norms have been stipulated for Gas turbine based stations which have been brought out in Section- 4.
2. Stabilization period of 180 days provided with effect from date of commercial operation. Relaxed norms provided during stabilization period stand withdrawn w.e.f. 1.4.2006

2.2 It may thus be seen that the prevailing norms are single value norms prescribed for most commonly prevailing unit sizes viz. 200/210/250 and 500 MW units. Also specific relaxed norms have been provided for some stations like Talcher, Tanda & Badarpur of NTPC, TPS –I & II of NLC and DVC stations which could not meet the general norms due to various reasons.

2.3 A brief history of evolution of these norms is as follows :

a) Till the entry of central sector in the power generation in 1975, most of the generation was with the State Electricity Boards (SEBs) which were vertically integrated entities having generation, transmission and distribution under common fold and unified accounting. Thus, the issue of transfer pricing from generation to transmission did not exist. With the entry of Central Public Sector Undertakings (CPSUs) the Central Govt.

had to determine the tariff of generating stations set up in the central sector and need was felt for prescribing the normative parameters for generation unit heat rate, secondary fuel consumption, auxiliary energy consumption to work out the price of power to the beneficiary States. Thus, K.P Rao committee was set up which prescribed operation norms for the stations under the CPSUs.

b) With the entry of private sector in power generation, the States started entering into Power Purchase Agreements (PPAs) with the Independent Power Producers (IPPs). With a view to maintain uniformity regarding operational parameters in the PPAs and also to guide the States in this regard, comprehensive financial and operation norms were notified by the Government of India (GOI) in March, 1992. The operation norms prescribed by this notification were as under:-

Table-2 Norms notified by GOI in 1992

Parameter	Units/Stations	Normative value	Remarks
Unit Heat Rate	**All Coal fired Units** During Stabilization period Subsequent period	 2600 kcal/kWh 2500 kcal/kWh	To be reduced by 40 k Cal/ kWh for 500 MW units with electrically operated boiler feed pumps
Secondary Fuel Oil Consumption	**All Coal fired Units** During Stabilization period Subsequent period	 5.0 ml/kWh 3.5 ml/kWh	
Auxiliary Energy consumption	*200 MW series* With cooling Tower Without cooling Tower	 9.5 % 9 %	
	500 MW series With cooling Tower Without cooling Tower	 8 % 7.5 %	9.5% & 9 % for motor driven BFPs

c) Later these norms were clarified to be ceiling norms and states could negotiate better norms with the IPPs.

d) Central Electricity Authority in 1997 prepared operation norms which prescribed a framework to identify all the site specific and equipment specific factors and incorporate them in the norms. These norms specified:-

- Turbine heat rates corresponding to different PLF (100, 80, 60 & 50 percent)
- Working out boiler efficiency based on fuel quality, etc.

These norms were adopted by CERC as draft norms for central sector stations and were circulated for public comments. Considering the diverse opinion expressed by the generating utilities, CERC inter-alia directed the prevailing norms of 1992 be allowed for next 3 years with effect from 1.4.2001.

e) Subsequently in 2004, CERC notified the revised norms which are presently in vogue upto 31.3.2009.

3 RECENT DEVELOPMENTS

3.1 The prevailing norms are single value norms uniformly adopted for all stations with few exceptions. Most of the units to which these norms are applicable have been of similar design supplied mainly by BHEL and had similar operating steam parameters. However, during the last decade several developments have taken place.

a) Considerable improvements have been made in turbine designs due to improved blade profiles thus leading to lower heat rates. For the same steam parameters, the turbine cycle heat rate have been reduced by 30-40 kcal/kWh as compared to earlier design due to use of more efficient blade designs.

b) While the turbine cycle heat rate of 210 MW turbine supplied by BHEL earlier were about 1980 kcal/kWh, the turbine cycle heat rate of 250 MW machines being supplied now is about 1950 kcal/kWh. Similarly for 500 MW machines, turbine heat rates have improved from 1980 kcal/kWh to 1945 kcal/kWh. It may be added here that heat rates indicated above for 210/250 MW sets are with motor driven BFP whereas same for 500 MW machine corresponds to turbine driven BFP. Thus the heat rates for both 210 and 500 MW units have reduced appreciably.

c) Units from several inter-national manufacturers have been inducted in the Indian power sector and the share of such units is gradually increasing.

d) Apart from 210/250 & 500 MW units mostly prevailing earlier, units of other sizes like 300 MW, 600 MW and higher size supercritical units (660 & 800 MW) are being introduced. The turbine heat rate for 300 MW Units is about 1920 kcal/kWh which is much lower than prevailing heat rates of comparable size units in the country of 250 MW capacity.

e) Even for the same unit size, different steam parameters are being adopted – for example, instead of 150 kg/cm^2 535/535 deg.C parameter normally being adopted for 250 MW units, NLC for their recent 250 MW units have adopted 170 kg/cm^2 537/537 deg.C steam cycle. Higher reheat temperature of 565 deg.C is being adopted in some new 500 MW units like Dadri thermal power project of NTPC. The 300 MW units also have 170 kg/cm^2 steam parameters.

f) In the recently held bids for 800 MW supercritical units, there is a difference of over 25-30 kcal/kWh in the guaranteed turbine cycle heat rates quoted by the two bidders

g) Also, imported coal is increasingly being used by many of the stations and its use is likely to increase further in future. Imported coal may lead to a higher boiler efficiency by 2-3 percentage points, thus lowering the unit heat rate of about 50-75 kcal/kWh.

3.2 Huge thermal capacity additions are envisaged in the next decade. The existing thermal capacity is expected to be more than doubled in the next 10 years. Thus the implication of norms becomes even more important at this stage as the CERC norms would either directly or indirectly (thru SERCs) be applicable to this huge capacity being inducted. Thus it is imperative that better efficiency norms are adopted with a view to conserve scarce fuel resource and infuse efficiency in power generation.

3.3 The private sector is poised for rapid development and its share in generation would increase considerably. The CERC norms would also be applicable to the private sector stations, albeit indirectly and must, therefore, reflect the reasonable efficiency levels achievable.

3.4 NTPC & other Central utilities would also be required to compete with private sector in the long run and the cost plus tariff regime is to be ultimately replaced by tariff based competitive bidding. The norms must, therefore, reflect higher levels of efficiency to induce a sense of competition and promote efficient operation. More efficient operation would also lead to less CO_2 emission which is the current focus of global efforts for lower GHG emissions.

4 PRINCIPLES GOVERNING OPERATION NORMS

4.1 The basic objective of operation norms is to lay down the benchmarks or standards of operation efficiency to be followed by the generating companies (GENCO) for the purpose of determination of tariff. It is thus an exercise towards balancing the interests of consumers and the GENCOS allowing for reasonable constraints faced during plant operation.

4.2 The tariff policy provides that "*Suitable performance norms of operations together with incentives and dis-incentives would need be evolved along with appropriate arrangement for sharing the gain of efficient operations with the consumers".* It also provides that "*In cases where operations have been much below the norms for many previous years the initial starting point in determining the revenue requirements and the improvement trajectories should be recognized at "relaxed" levels and not the "desired" levels".*

Thus, in keeping with the objective of the tariff policy, the operation norms should progressively provide for more efficient operation barring select cases of relaxations where the desired norms cannot be applied.

4.3 The operation efficiency or heat rate and other performance parameters of a thermal power station depend on a number of factors which can be broadly classified as follows:-

a) Technology and Equipment
b) Ambient conditions
c) Fuel quality
d) Plant operation and maintainance practices.

Thus any benchmarking exercise has to consider these factors for normative operational performance. As brought out above at Para 3.1, considerable variations exist in the unit sizes, steam parameters for similar unit sizes and fuel quality amongst various operating units and units likely to be inducted in future. Super-critical units of 660/800 MW are being introduced where the heat rates are considerably better than the 500 and 600 MW units and thus, the present norms of 500 MW units would not be applicable for these units. The benchmarking exercise has to adequately provide for all these variations.

5 APPROACH FOR SPECIFYING NORMS

Possible approaches for specifying operation norms could be

(i) Uniform single value norm for all stations
(ii) Norm in terms of % of design value

5.1 Uniform single value norm for all stations

The single value norms have presently been prescribed by CERC for station heat rate, auxiliary energy consumption and secondary fuel oil consumption. The single value may be expressed as either as absolute number as done in case of station heat rate and SFC or as a percentage as done for AEC. Such norms are appropriate for parameters like secondary fuel oil consumption (SFC) and auxiliary energy consumption (AEC) which do not vary significantly with the unit size or other technological parameters.

However, the single value concept has limitations when applied to operating parameters like the unit heat rate. As explained at Para 3 above, a large variations in heat rate exist due to different equipment design, steam parameters, design fuel quality etc. Even for same unit size & steam parameters, the heat rates vary due to improvements affected by the suppliers progressively over time and therefore, considerable variations exist in heat rates offered by different manufacturers for same unit size-steam parameters.

Also even with the same turbine generator, the unit heat rate could vary significantly at two different sites due to large variations in coal quality, cooling water temperature, etc. Thus even with the same equipment efficiency, a station could have considerably higher design unit heat rate due to site specific factors beyond his control and the normative heat rate based on single value concept would provide much lower operational margin to such a station.

Thus, while adopting a single value norm for heat rate covering such large variations, considerations are invariably required to be made to accommodate the worst combinations of turbine cycle heat rate, boiler efficiency. This leads to considerable variation in the margin available to different utilities between the operating heat rate and design heat rate.

Thus, the single value concept provides very high cushion for operational variation (or leads to high savings to units with lower design heat rates) and leads to undue penalty to those with higher design heat rates which could be for reasons beyond the control of utility like coal quality and cooling water temperature. Thus, instead of rewarding operational efficiency, which should be the aim of any good benchmarking exercise, it rewards better designs or better site inputs where the operator reaps the benefits of intrinsic advantages of the equipment or site environment or coal quality without major operational efforts. However, this approach provides incentive to the project developer to go for more efficient design and technologies which may result in higher capital cost. In the cost plus approach this will result in higher fixed charges for such units which will be passed on to the beneficiaries of the project. However, the benefit of higher efficiency in operation may not be passed on to the beneficiaries and may be retained by the project developer.

5.2 Norm in terms of % of design value

The other approach could be to specify the normative parameter as a certain percentage above the design parameters of the unit. The design heat rate indicates the intrinsic capability or the best achievable efficiency of any generating unit**.** Such an approach automatically provides for consideration of variations in design/technology, ambient conditions and fuel quality in the norms and thus provides more rational basis for operation norms specially in the developing scenario with large variations in design of the units. It also provides for incentive to the project developers to achieve better operational efficiencies. However, in this approach there is no incentive to the developer to adopt more efficient designs/technologies as the entire benefit of having more efficient designs/technologies is passed on to the beneficiaries. **Thus, it is suggested that while single value approach may be continued for specifying norms for AEC and SFC, the % over design approach may be followed for specifying Unit Heat Rate with some benchmark values for different unit sizes to ensure minimum efficiency standards in the future units by the project developers**

6 DATA RECEIVED

6.1 CERC vide their order dated 7.1.2008 directed the generating companies to furnish details of performance and operation parameters for the years 2002-03 to 2006-07 on annual basis. These details were furnished by NTPC, DVC and NLC to CERC in respect of their operating stations and CERC forwarded the data to CEA vide letter nos. CERC/Engg/Tariff/T&C from 1.4.09/ dated 12^{th} May 2008 and CERC/Engg/Tariff/T&C from 1.4.09/ dated 12^{th} June 2008.

6.2 Along with the data for operating stations, NTPC also furnished guaranteed parameters (design values) for 660 MW supercritical units at Sipat TPS and Barh TPS along with correction curves with respect to various operational parameters.

6.3 Design details regarding steam parameters, design coal analysis, guaranteed turbine cycle heat rate and boiler efficiency, guaranteed auxiliary energy consumption were also called for by CEA from NTPC, DVC and NLC. The design data for upcoming stations of NLC viz. NLC TPS-II Expn. (2x250 MW) and Barsingsar TPS (2x125 MW) was also received from CERC vide letter no. 98/2007 and 99/2007 dated 4th December 2007. Both these projects are envisaged with CFBC boilers. Design details for DVC stations were received from DVC vide their letter no. Director(T)/DCE(GM)/10(A)/87 dated 13th June 2008. The design data for NTPC stations was received vide NTPC letter No. 01:C D:701 dated 21.8.2008.

6.4 In addition to the data received from utilities, the performance data of heat rate, SFC and AEC for other stations in the country and the shut down details of the units have been made use of from the CEA data base and publications.

6.5 Based on the above data, the following details have been computed :

- Station PLF
- Station heat rate
- Station auxiliary energy consumption
- Station secondary fuel oil consumption
- Variation of auxiliary energy consumption from normative auxiliary energy consumption.
- Variation of heat rate from normative and design heat rate
- Different types of startups for units

The above computations have been made for year to year basis as well as average of last 5 years.

Similar data available in CEA for state owned and private utility thermal power plants have been used to analyze wider spectrum of data of both state and central sector power plants and for comparison with stations following good industry practices for operation and maintenance of their plants.

Based on the General Principles enunciated above and data received, the recommendations for operating norms for various types of Thermal Power Stations are worked out in subsequent sections in the report.

SECTION- 2: COAL FIRED STATIONS

PART- A – FUTURE AND EXISTING STATIONS COVERED UNDER GENERAL NORMS

7 STATIONS COVERED

7.1 This part covers all future stations and the existing stations that are required to meet the general norms prescribed by CERC. There are 11 existing stations of NTPC which are covered under the general norms.

Stations	Capacity
Dadri	4x210 MW
Farakka STPS	3x200 + 2x500 MW
Kahalgaon	4x210 MW+1x500 MW
Korba STPS	3x200 + 3x500 MW
Ramagundem STPS	3x200 +4x500 MW
Rihand	4x500 MW
Simhadri	2x500 MW
Singrauli STPS	5x200 + 2x500 MW
Talcher STPS	6x500 MW
Unchahar	5x210 MW
Vindhyachal STPS	6x210 +4x500 MW

The following units at these stations have been commissioned during the current norms period of 1.4.2004 onwards.

Stations	Capacity
Kahalgaon	Units 5- 500 MW
Ramagundem STPS	Units 7- 500 MW
Rihand	Units 3&4- 2x500 MW
Talcher STPS	Units 5&6- 2x500 MW
Unchahar	Unit 5 - 210 MW
Vindhyachal STPS	Units 9&10 - 2x500 MW

8 PERFORMANCE ANALYSIS & RECOMMENDATION

PLF and Unit Loadings

8.1 Most NTPC stations have been operating at a very high PLF of over 85 % during the last 2-3 years and some of the stations have even operating at PLF of 90 to 95 %. Details of PLF for these stations have been given in Table-3 below. The average outage of the stations have been in the range of 8% to 10% and the average unit loadings worked out excluding the period of outages are even higher and in the range of 92 to 99 %. Details of outages and unit loadings are given in Tables 3(a) and 3(b) below.

Table 3 *PLF of NTPC stations

Station	2002-03	2003-04	2004-05	2005-06	2006-07	Average
Dadri	82.06%	83.77%	92.97%	91.98%	95.69%	89.29%
Farakka	63.84%	67.12%	69.21%	81.79%	81.33%	72.66%
Kahalgaon	67.81%	80.91%	82.65%	89.32%	89.41%	82.02%
Korba	89.48%	88.55%	92.69%	86.98%	89.69%	89.48%
Ramagundem	92.29%	88.54%	90.32%	86.46%	88.90%	89.30%
Rihand	88.48%	90.58%	91.19%	84.86%	91.90%	89.40%
Simhadri	87.21%	87.91%	92.73%	88.37%	92.10%	89.66%
Singrauli	92.28%	89.04%	90.28%	88.49%	83.83%	88.78%
Talcher STPS	73.50%	82.25%	78.59%	84.15%	90.02%	81.70%
Unchahar	83.58%	87.44%	92.16%	95.69%	95.54%	90.88%
Vindhyachal	85.52%	82.50%	90.07%	92.46%	92.61%	88.63%

* PLF has been taken from CEA Records (Performance Review of Thermal Power Stations)

Table 3(a) Outages of NTPC stations

Stn	Badarpur	2002-03	2003-04	2004-05	2005-06	2006-07	Average
Badarpur	Scheduled Outages (%)	5.43%	3.92%	4.77%	7.86%	8.05%	6.01%
	Forced Outages (%)	2.41%	0.25%	2.57%	1.70%	3.26%	2.04%
	Total Outages (%)	**7.84%**	**4.17%**	**7.33%**	**9.56%**	**11.32%**	**8.04%**
Dadri	Scheduled Outages (%)	6.64%	5.03%	3.55%	6.02%	4.19%	5.09%
	Forced Outages (%)	0.80%	1.98%	0.62%	0.51%	0.29%	0.84%
	Total Outages (%)	**7.44%**	**7.01%**	**4.17%**	**6.53%**	**4.48%**	**5.93%**
Farakka	Scheduled Outages (%)	9.50%	7.45%	8.23%	6.82%	7.94%	7.99%
	Forced Outages (%)	12.78%	10.18%	8.45%	4.41%	5.36%	8.24%
	Total Outages (%)	**22.28%**	**17.63%**	**16.68%**	**11.23%**	**13.30%**	**16.23%**
Kahalgaon	Scheduled Outages (%)	5.52%	6.86%	6.62%	4.98%	6.45%	6.09%
	Forced Outages (%)	9.25%	2.96%	1.90%	1.83%	1.36%	3.46%
	Total Outages (%)	**14.77%**	**9.82%**	**8.52%**	**6.81%**	**7.80%**	**9.54%**
Korba	Scheduled Outages (%)	5.81%	7.37%	5.32%	5.97%	10.74%	7.04%

	Forced Outages (%)	1.34%	0.90%	1.32%	7.34%	1.07%	2.39%
	Total Outages (%)	**7.15%**	**8.27%**	**6.63%**	**13.32%**	**11.81%**	**9.44%**
Ramagundem	Scheduled Outages (%)	4.79%	6.93%	7.38%	7.72%	5.45%	6.45%
	Forced Outages (%)	2.50%	2.11%	1.62%	1.33%	3.98%	2.31%
	Total Outages (%)	**7.29%**	**9.05%**	**9.00%**	**9.05%**	**9.43%**	**8.76%**
Rihand	Scheduled Outages (%)	6.92%	6.91%	6.22%	4.06%	4.32%	5.69%
	Forced Outages (%)	0.96%	0.76%	1.51%	10.20%	3.98%	3.48%
	Total Outages (%)	**7.88%**	**7.67%**	**7.73%**	**14.26%**	**8.30%**	**9.17%**
Simhadri	Scheduled Outages (%)	4.11%	3.67%	5.27%	4.53%	6.24%	4.76%
	Forced Outages (%)	4.23%	4.70%	1.50%	1.75%	1.32%	2.70%
	Total Outages (%)	**8.34%**	**8.37%**	**6.76%**	**6.28%**	**7.56%**	**7.46%**
Singrauli	Scheduled Outages (%)	4.37%	7.28%	6.33%	8.72%	12.77%	7.89%
	Forced Outages (%)	1.31%	2.47%	1.98%	3.54%	3.79%	2.62%
	Total Outages (%)	**5.68%**	**9.75%**	**8.31%**	**12.26%**	**16.56%**	**10.51%**
Talcher STPS	Scheduled Outages (%)	7.58%	8.43%	2.68%	6.99%	6.81%	6.50%
	Forced Outages (%)	4.52%	7.32%	5.68%	4.40%	2.33%	4.85%
	Total Outages (%)	**12.10%**	**15.76%**	**8.36%**	**11.39%**	**9.14%**	**11.35%**
Unchahar	Scheduled Outages (%)	7.25%	6.09%	6.21%	4.02%	4.11%	5.53%
	Forced Outages (%)	5.15%	4.00%	1.54%	1.28%	1.20%	2.63%
	Total Outages (%)	**12.40%**	**10.08%**	**7.75%**	**5.30%**	**5.31%**	**8.17%**
Vindhyachal	Scheduled Outages (%)	8.92%	2.44%	8.37%	4.43%	6.36%	6.10%
	Forced Outages (%)	2.44%	12.19%	1.12%	2.92%	1.39%	4.01%
	Total Outages (%)	**11.36%**	**14.64%**	**9.49%**	**7.36%**	**7.75%**	**10.12%**
Average	Scheduled Outages (%)	**6.40%**	**6.03%**	**5.91%**	**6.01%**	**6.95%**	**6.26%**
	Forced Outages (%)	**3.97%**	**4.15%**	**2.48%**	**3.44%**	**2.44%**	**3.30%**
	Total Outages (%)	**10.38%**	**10.18%**	**8.40%**	**9.45%**	**9.40%**	**9.56%**

Table 3(b) Average Unit Loading of NTPC stations

Station	2002-03	2003-04	2004-05	2005-06	2006-07	Average
Dadri	89.04%	87.42%	100.33%	101.70%	107.90%	97.28%
Farakka	68.97%	72.18%	72.22%	87.50%	85.14%	77.20%
Kahalgaon	87.25%	98.22%	99.20%	100.62%	103.13%	97.69%
Korba	104.99%	98.19%	101.33%	93.33%	97.28%	99.02%
Ramagundem	99.40%	96.53%	96.73%	99.74%	100.80%	98.64%
Rihand	95.43%	99.59%	100.21%	93.31%	101.47%	98.00%
Simhadri	94.67%	95.21%	100.50%	103.07%	100.44%	98.78%
Singrauli	100.68%	97.17%	96.83%	94.42%	90.68%	95.96%
Talcher STPS	77.93%	91.13%	85.71%	95.91%	107.88%	91.71%
Unchahar	95.08%	103.79%	100.57%	107.99%	105.15%	102.52%
Vindhyachal	97.63%	91.75%	97.63%	97.64%	97.80%	96.49%
Average	**92.29%**	**93.51%**	**94.73%**	**96.68%**	**99.40%**	**95.32%**

Average Unit Loading =PLF/(100% -total outages in %)

Station Heat Rate

Heat Rate for NTPC stations

8.2 Based on the data of gross generation, coal consumption and average GCV of coal reported by NTPC, the gross stations heat rate has been worked out. A comparison of station heat rate has then been made with the normative heat rate and the design station heat rate (the normative station heat rate and design station heat rate have been worked out taking weighted average of the normative/design heat rate for the individual units). The deviation of operating heat rate from design heat rates and normative heat rate are given in Table 4 and 6 respectively.

Table-4 Operating Vs. Design Heat Rate - NTPC Stations

Stations	Design Heat rate	2002-03	2003-04	2004-05	2005-06	2006-07	Average
Dadri	2274	8.41%	8.27%	7.06%	6.47%	6.15%	7.22%
Farakka	2287	8.22%	8.42%	10.68%	6.82%	6.46%	8.02%
Kahalgaon	2301	7.78%	6.93%	6.61%	6.22%	5.73%	6.59%
Korba	2279	5.85%	6.16%	5.38%	4.41%	4.08%	5.18%
Ramagundem	2250	8.55%	8.56%	7.81%	8.60%	7.11%	8.10%
Rihand	2234	7.08%	6.75%	6.34%	5.13%	5.57%	6.03%
Simhadri	2228	9.40%	7.90%	6.58%	5.99%	5.69%	6.74%
Singrauli	2312	4.23%	4.24%	4.37%	3.84%	3.84%	4.11%
Talcher STPS	2243	7.33%	7.68%	7.06%	6.00%	5.62%	6.43%
Unchahar	2295	7.13%	7.09%	6.78%	5.90%	5.03%	6.33%
Vindhyachal	2266	8.14%	8.23%	7.00%	5.66%	5.38%	6.81%
Weighted Average	**2267**	**7.33%**	**7.29%**	**6.84%**	**5.83%**	**5.46%**	**6.44%**

8.3 As may be seen from Table-4 the average deviation of operating heat rate from design heat rate for the last five years (2002-03 to 2006-07) has been in the range of 5.46 – 7.33 %. For individual years, the deviation has been from 4 % to 7 % for most stations. The average deviation for all stations in 2004-05 and 2006-07 has been below 6%.

The deviation has consistently been coming down for all the stations. The weighted average deviation for all stations was 7.33% in 2002-03 and has progressively come down to 5.46% in 2006-07.

8.4 Also, the deviation has been similar for all the stations and shows no correlation with age or make etc. Stations like Korba where no units have been added for the last 15 years has shown variations similar to Simhadri where both the units have been added recently or Talcher and Vindhyachal where a number of units have been recently added. The operating heat rates for individual units are not available. However, if these were available, the deviation of operating heat rate from design heat rate is likely to have yielded similar results.

8.5 Table 6 shows the deviation of operating heat rate from normative heat rate for NTPC stations. As may be seen, the operating heat rates are lower than the normative heat rate for all these stations. The average deviation for individual stations in the last 5 years has been in the range of (-) 3.32% to (-)1.25 %, except Farakka, while for individual years the deviation has been (-) 4 % to (-) 0.5 % . This shows that there is considerable variation in operating efficiency achieved from year to year and with due care and efforts, consistently high level of operating efficiency can be achieved. There is also considerable improvement in operating efficiency over the last 5 years in all the stations. The average deviation of operating heat rate from normative heat rate for all these stations taken together was (-) 1.42% in 2002-03, which has improved to (-) 3.14% in 2006-07.

Table-5 Operating Vs. Normative Heat Rate NTPC Units

Station	Normative HR	Operating Heat rate (kcal/kWh)					
		2002-03	2003-04	2004-05	2005-06	2006-07	Average
Dadri	2500	2465	2462	2434	2421	2414	2438
Farakka	2469	2474	2478	2530	2442	2434	2469
Kahalgaon	2500	2480	2460	2453	2444	2433	2453
Korba	2464	2412	2419	2402	2379	2372	2397
Ramagundem	2462	2441	2442	2425	2442	2409	2431

Rihand	2450	2392	2385	2376	2349	2358	2369
Simhadri	2450	2438	2404	2375	2361	2355	2378
Singrauli	2475	2410	2410	2413	2401	2401	2407
Talcher STPS	2450	2406	2414	2400	2376	2368	2386
Unchahar	2500	2459	2458	2451	2430	2410	2440
Vindhyachal	2478	2456	2458	2430	2400	2393	2426
Wtd. Average	**2468**	**2433**	**2432**	**2422**	**2399**	**2391**	**2413**

Table-6 Deviation of Operating Heat Rate from Norm -NTPC Units

Station	**Normative HR**	**Deviation of Operating Heat rate from Normative Heat Rate (%)**					
		2002-03	**2003-04**	**2004-05**	**2005-06**	**2006-07**	**Average**
Dadri	2500	**-1.39%**	**-1.52%**	**-2.62%**	**-3.16%**	**-3.44%**	**-2.47%**
Farakka	2469	**0.19%**	**0.38%**	**2.48%**	**-1.10%**	**-1.43%**	**0.01%**
Kahalgaon	2500	**-0.80%**	**-1.58%**	**-1.88%**	**-2.24%**	**-2.69%**	**-1.90%**
Korba	2464	**-2.10%**	**-1.81%**	**-2.53%**	**-3.43%**	**-3.73%**	**-2.72%**
Ramagundem	2462	**-0.84%**	**-0.83%**	**-1.51%**	**-0.80%**	**-2.16%**	**-1.25%**
Rihand	2450	**-2.36%**	**-2.66%**	**-3.04%**	**-4.14%**	**-3.74%**	**-3.32%**
Simhadri	2450	**-0.51%**	**-1.88%**	**-3.08%**	**-3.61%**	**-3.89%**	**-2.93%**
Singrauli	2475	**-2.63%**	**-2.62%**	**-2.50%**	**-3.00%**	**-3.00%**	**-2.75%**
Talcher STPS	2450	**-1.78%**	**-1.46%**	**-2.03%**	**-3.00%**	**-3.35%**	**-2.61%**
Unchahar	2500	**-1.66%**	**-1.69%**	**-1.98%**	**-2.79%**	**-3.59%**	**-2.39%**
Vindhyachal	2478	**-0.89%**	**-0.81%**	**-1.94%**	**-3.16%**	**-3.42%**	**-2.11%**
Wtd. Average		**-1.42%**	**-1.45%**	**-1.87%**	**-2.79%**	**-3.14%**	**-2.24%**

Heat rates for other stations in State and Private sector

8.6 The deviation of operating heat rate from design heat rate for the last four years has also been worked out for a large number of stations from various state and private sector utilities based on data available in CEA. It is seen that the deviation ranges from extremely low of 2 % to very high of 50-55 %. Out of total of 55 stations, 8 stations had deviation of about 5 % and 26 stations had the deviation less than 20 %. The range of deviation significantly narrows when stations with only 210/500 MW units are considered. Though deviation upto 40 to 45 % have also been incurred by some of the stations with units of 210/500 MW series, most stations have deviation within 20 %. Out of total of 26 non -NTPC coal fired stations having only 210/500 MW units, 7 to 8 stations had the deviation of operating heat rate from design as about

5%. Details of number of stations and the range of deviation of operating heat rate from design heat rate are furnished in Table- 7.

Table-7 Deviation of operating heat rate from design- Non-NTPC stations with 200/500 MW units

Deviation Range	2003 - 04	2004-05	2005-06	2006-07
Total Stations	**26**	**26**	**26**	**26**
Data Available	**15**	**18**	**19**	**22**
0% to 2%	0	1	1	0
2% to 4%	1	0	5	5
4% to 6%	2	3	1	3
6% to 8%	1	1	3	2
8% to 10%	2	3	0	2
10% to 15%	3	2	6	3
15% to 20%	1	3	1	3
20% to 25%	3	1	0	1
>25%	2	4	2	3

8.7 Complete details of design and operating heat rate for the stations having only 200/210/250 and 500 MW units are given in table 7(a) and deviation of operating heat rate from design for select high performing non-NTPC stations is given in table 7(b)

Table-7(a) Heat rate of Non-NTPC stations with 200 and 500 MW units

S. No	Station	Cap MW	Design H.R.	Operating Heat Rate (Kcal/Kwh)				Deviation from Design Heat Rate (%)			
				2003 - 04	2004-05	2005-06	2006-07	2003 - 04	2004-05	2005-06	2006-07
1	GGS Ropar	1260	2277	2551	2543	2541	2702	12.01%	11.64%	11.55%	18.66%
2	Lehra Mohabat	420	2238	2422	2424	2407	2439	8.23%	8.33%	7.54%	9.01%
3	Obra B ----5*200	1000	2636	3142	3055			19.19%	15.88%		
4	Anpara 'A' & 'B'	1630	2395		2907				21.37%		
5	Wanakbori	1470	2344	2513	2539			7.24%	8.34%		
6	Korba West (I&II)	840	2312	2861	2685	2650	2780	23.72%	16.11%	14.62%	20.25%
7	Satpura(Ph-II&III)	830	2364	2944	2968			24.53%	25.55%		
8	Birsingpur (II)	420	2293	2806	2885		3063	22.37%	25.82%		33.59%
9	Kaparkheda-	840	2254	2516	2641	2600	2602	11.58%	17.16%	15.34%	15.45%
10	Chandrapurpur	2340	2278	2385	2600	2611	2600	4.71%	14.15%	14.61%	14.14%
11	K'gudem Stage-V	500	2234			2312	2365			3.49%	5.90%
12	Vijaywada	1260	2302	2495	2435	2402	2378	8.39%	5.79%	4.35%	3.32%
13	Rayalseema	420	2250	2304	2288	2323	2331	2.39%	1.68%	3.27%	3.61%
14	Tuticorin 5*210	1050	2344	2474	2493	2502	2494	5.54%	6.36%	6.72%	6.41%

15	N.Chennai 3*210	630	2348		2456	2440	2454		4.60%	3.92%	4.53%
16	Mettur 4*210	840	2386	2656	2622	2537	2522	11.34%	9.88%	6.32%	5.73%
17	Bokaro 'B' 3*210	630	2399	3665	3710	3336	3267	52.74%	54.63%	39.05%	36.14%
18	Mejia 4*210	840	2227	3231	2923	2541	2473	45.06%	31.25%	14.09%	11.04%
19	IB TPS 2*210	420	2350		2445	2426	2422		4.04%	3.23%	3.08%
20	Suratgarh 5*250	1250	2260			2490	2469			10.16%	9.25%
21	Dahanu 2*250	500	2227			2298	2271			3.18%	2.01%
22	Trombay Coal Based	500	2414			2387	2482			-1.13%	2.82%
23	Raichur	1470	2288			2571	2585			12.37%	12.99%
24	Bakreshwar	630	2250			2834	3057			25.96%	35.88%
25	Budge Budge	500	2314				2468				6.67%
26	Kolaghat	1260	2644				3126				18.27%
	Weighted Average Excluding Extreme Values (>20%)							**8.82%**	**10.55%**	**9.47%**	**10.21%**
27	Neveli(II Stg I &II)	1470	2590	2935	2871	2878	2891	13.35%	10.85%	11.14%	11.67%
28	NEYVELI FST EXT (2*210)	420	2476			2760	2742			11.46%	10.78%

Table-7(b) Heat rate Deviation for high performing non-NTPC stations

Station	Capa city MW	Design heat rate kcal/kWh	**Heat rate Deviation from design**				**Remarks**
			2003-04	**2004-05**	**2005-06**	**2006-07**	
Kothagudem Stage V (2x250 MW)	500	2234			3.48%	5.90%	
Vijaywada (6x210 MW)	1260	2301		5.80%	4.36%	3.33%	
Rayalseema (2x210 MW)	420	2250	2.38%	1.67%	3.26%	3.60%	
Tuticorin (5x210 MW)	1050	2344	5.54%	6.36%	6.72%	6.41%	
N.Chennai (3x210 MW)	630	2348		4.60%	3.92%	4.53%	
Mettur (4x210 MW)	840	2386			6.32%	5.73%	
IB TPS (2x210 MW)	420	2350		4.03%	3.21%	3.06%	
Dahanu, (2x250 MW)	500	2227			3.21%	2.03%	Stations use imported coal for blending.
Trombay Coal Based (1x500 MW)	500	2414				2.83%	
Weighted Average			**7.54%**	**5.97%**	**4.22%**	**4.37%**	

8.8 From Table-7(b), it may be seen that the stations where the deviation is about 5 % are not confined to any specific utility or sector but are fairly widespread covering stations from private sector and state sector utilities. Nor are these stations restricted to any particular age group and include stations where most units are fairly old to stations with middle aged and new units.

Similar analysis carried out by CEA in the year 2004 (while working out norms for the operating period 2004-09) based on 3 years operating data collected from large number of stations also yielded similar results and showed that the deviation of operating heat rate from design showed no correlation with the age or make of the units and old units from some of the utilities showed very low deviations.

Estimation of Heat rate deviation due to conditions beyond control of utilities

8.9 An estimation of impact of heat rate due to grid conditions shows that very little deviation from the design heat rate is incurred due to grid conditions beyond the control of the utilities. The factors that affect operating heat rate and are beyond the control of utilities are:-

- Coal quality
- Grid Frequency
- Cooling water temperature
- Unit loading or dispatch instructions

8.10 The impact of these factors on the operating unit heat rate are worked out as under:-

- From the details of coal qualities furnished by NTPC it is seen that the coal quality is almost consistent during the last 5 years for all the stations. Thus there is no significant degradation in the operating heat rate on account of variations/deteriorations in coal quality.
- The impact on heat rate on account of grid frequency for coal based thermal units is very low. The degradation in turbine cycle

heat rate for operation at 49 Hz is 3 kcal/kWh (0.15%) and considering operation at low frequency of upto 49 Hz for 25% of the total operation period, the impact on heat rate due to low frequency operation would be merely 0.05%.

- The design cooling water temperatures are so chosen that they are met more than 90% of the time and thus average degradation due to higher temperatures for the rest of 10 % time is of the order of 0.07 %. The overall impact when seen over long operation period of a year would be even lower as part of the increase due to higher temperatures gets compensated due to lower than design temperatures in winter months thus leading the better heat rates and thus reduces the overall impact.
- As discussed in earlier paras, the unit loading are already near full loads and do not lead to any degradation in heat rate. The PLF of most stations covered under the prescribed norms has been in the range of 85 to 90% during the preceding 2-3 years. Also the total outages (scheduled + forced outages) for most stations have been in the range of 8% to 10%. Thus PLF of 90% corresponds to a unit loading of 100% and a PLF of even 80% corresponds to unit loading of 89%. The average unit loading for all stations taken together have been in the range of 93% to 99% in the last 3 years. The degradation of heat rate at 90% loading would be about 1% in the old machines with constant pressure operation and would be about 0.5 % in the new machine with sliding pressure operation. Thus at the prevailing level of unit loadings the degradation for part load would be about 0.3% to 0.7 % for the old machines and 0.25% for the new machines.
- **Thus the overall impact of factors beyond the control of the generators is about 0.12% and even after considering the impact of minor part loadings incurred it would be about 0.4% to 0.8% for old machines and 0.4% for new machines.**

8.11 Interaction with European utilities has indicated that the deviation of operating heat rate from design heat rate of the order of 0.5 – 1% all through the life of the plant. It can thus be concluded that quality of operation is by far the most important factor affecting the station heat rate and there is ample scope to improve the deviation of station heat rate from design heat rate.

Recommended Normative Heat rate

8.12 As discussed in Para 3 above, there is a strong case for change over from the present system of single value norm for station heat rate to percentage margin over the design heat rate system with a view to accommodate large range of unit heat rates likely to be seen in future for reasons discussed in the said para.

8.13 As may be seen from Table 1 & 2, the norm for station heat rate has remained at 2500 kcal/kWh from the year 1992 onwards (except for a minor reduction of 50 kcal/kWh made for 500 MW units in the year 2000). The K.P Rao Committee had also prescribed heat rate of 2500 kcal/kWh except for units in eastern region. Thus, the normative heat rate has remained 2500 kcal/kWh practically for last 3 decades, notwithstanding numerous technological developments in equipment design and operation.

8.14 During the KP Rao committee era, most units were 210 MW units of LMZ design having a Turbine cycle heat rate of 2060 kcal/kWh. Thus, the normative unit heat rate of 2500 kcal/kWh provided an operating margin of about **5.5%** over the design unit heat rate. Continuance of this norm of 2500 kcal/kWh beyond the year 1984 where KWU design units were inducted provided an operating margin of about **9.5%** over the design heat rate to the KWU units as they had lower design turbine cycle heat rate. With further lowering of turbine heat rates due to improved design blades, the margin available between design and normative heat rate has increased further.

8.15 Presently, the turbine cycle heat rate of a typical 500 MW unit is about 1945 kcal/kWh and the unit heat rate corresponding to boiler efficiency of 87% works out to 2236 kcal/kWh. Thus the prevailing norm of unit heat rate of 2450 kcal/kWh allows a margin of about **9.5%** between the design unit heat rate and Normative unit heat rate for a typical unit.

8.16 As seen from operating data of NTPC stations (Tables 4 & 5) and select stations in the country (Table 7), the operating practices is by far the single most important factor responsible for the heat rates achieved and deviation of 2 to 4% from design unit heat rate are being achieved in actual operation in many stations some of them having even very old units. Internationally, the operating heat rates within 1% of the design heat rates are also being maintained. Thus, there is a case to prescribe a unit heat rate of 2-3% over the respective design heat rate for the existing as well as future units. However, at present the operating heat rate of NTPC units are about 6% higher than the design heat rates and the prevailing normative heat rate are about 9 to 10 % higher than design heat rate. Further, going by the past experience, utilities have cited various operational constraints in the past in implementing improved norms and have desired gradual improvements in norms. Thus the following methodology is suggested for implementation:-:

- **As a first step, normative unit heat rate of 6% over the design unit heat rate (guaranteed unit heat rate by the supplier at conditions of 0% make up, design coal, and design cooling water temperature) may be prescribed for all future units to be commissioned after 1.4.2009.** This corresponds to average deviation of operating heat rate from design heat rate for all NTPC stations for last 3 years (2004-05 to 2006-07). This could be further reviewed in the next revision of norms.
- **For existing units commissioned before 1.4.2004, the prevailing norms of CERC may be allowed to continue as most of the units are old units likely to go in for major renovation & modernization**

(R&M)/ life extension (LE). After R&M/LE, fresh norms for the units should be prescribed with reference to the efficiency achieved after implementation of R&M/LE works. Here, it may be added that as per the current trends, many R&M/LE schemes envisage capacity uprating and/or efficiency improvement. In view of the fact that such expenditure incurred gets capitalized while working out the tariff, there is need to evolve a suitable mechanism for sharing of benefits with the discoms/buyer. A comprehensive approach towards sharing of cost-benefit needs to be evolved after interaction with various stake holders including regulators, generating companies, discoms & SEBs

- However, a large number of 500 MW units have been installed after 2004 and many more are likely to be commissioned by 2009 when the new norms would become applicable. While the older existing units have been recommended to be kept under the prevailing norms as most of them are quiet old, **it is felt that these new units commissioned after 1.4.2004 may be brought under the new normative regime and thus the normative heat rate for these units may be kept as 6% over their design heat rate.**

8.17 As the design heat rate of generating unit is to be considered as the basis for working out normative heat rate recommended in the report, it is very important that the proper design heat rates are adopted. The relevant conditions to be considered for design heat rate as well as minimum design heat rate are mentioned in Para 18. It is, however, seen that design heat rate for many of the recent units being inducted by NTPC are substantially higher than the design heat rate of the older units due to substantially low boiler efficiency for these units. Boiler efficiency rate for 500 MW units at Korba STPS stage-III are about 2 % lower than that for stage –II units. Similarly for , Farakka STPS Stage-III the boiler efficiency is about 4% lower than that for stage-II units. In Kahalgaon 500 MW units the boiler efficiency indicated by NTPC is 5% lower than that for earlier 210 MW units. There appears to be no justification for such reduction in boiler efficiency when the earlier units have higher boiler efficiency with same coal. Technology must progressively lead to efficiency improvements and not the other way. This needs clarification from NTPC.

8.18 With a view to ensure that minimum efficiency standards are adopted by the project developers in the future units, the following minimum benchmark turbine cycle heat rate and boiler efficiency shall be met by all future coal/lignite based thermal generating units. :-

a) Maximum turbine cycle heat rate

Steam parameters at Turbine inlet		**Maximum Turbine cycle heat rate (kcal/kWh)**
Pressure kg/cm2	**Main/Reheat Steam temperature (deg C)**	
150	535/535	1955
170	537/537	1910 (with MD-BFP) 1950 (with TD-BFP)
170	537/565	1895(with MD-BFP) 1935(with TD-BFP)
247	537/565	1860(with MD-BFP) 1900(with TD-BFP)
247	565/593	1810(with MD-BFP) 1850(with TD-BFP)

MD-BFP means motor driven BFP

TD-BFP means turbine driven BFP

b) Minimum Boiler Efficiency

Fuel	**Minimum Boiler Efficiency (%)**
Sub -bituminous Indian coals	85%
Bituminous Imported coal	89%

In case higher heat rate/lower boiler efficiencies are proposed, the utility may be asked to furnish detail justification for review by CERC.

Auxiliary Energy Consumption

8.19 Details of auxiliary consumption of NTPC stations is given in Table-8 below :

Table 8 Auxiliary Energy consumption for NTPC stations

Station	2002-03	2003-04	2004-05	2005-06	2006-07	Average	Normative	Deviation Average Vs Norm (% Points)
Dadri	7.99%	8.05%	7.34%	7.35%	7.41%	7.61%	9.00%	**-1.39%**
Farakka	8.02%	8.16%	8.50%	7.00%	6.67%	7.60%	7.56%	0.04%
Kahalgaon	9.56%	9.64%	8.82%	8.41%	8.34%	8.91%	8.44%	0.47%
Korba	6.15%	6.68%	6.59%	6.52%	6.11%	6.41%	7.93%	**-1.52%**
Ramagundem	6.48%	6.61%	6.60%	6.40%	6.21%	6.45%	7.85%	**-1.40%**
Rihand	8.03%	7.65%	7.98%	7.30%	6.49%	7.32%	7.25%	0.07%
Simhadri	6.01%	6.18%	5.65%	5.65%	5.56%	5.77%	7.50%	**-1.73%**
Singrauli	6.86%	6.92%	6.96%	7.11%	7.24%	7.01%	7.75%	**-0.74%**
Talcher STPS	7.11%	7.02%	6.58%	5.63%	5.50%	6.32%	7.50%	**-1.18%**
Unchahar	8.76%	8.93%	8.68%	8.48%	8.34%	8.62%	9.00%	**-0.38%**
Vindhyachal	7.00%	7.29%	7.00%	6.93%	6.77%	6.98%	8.08%	**-1.10%**

The average auxiliary energy consumption for these stations for the last 5 years (2002-03 to 2006-07) varies from 5.8% to 9%. Most stations have incurred auxiliary energy consumption lower than the normative auxiliary energy consumption (worked out on the basis of weighted average of normative AEC for individual units). The stations with 500 MW units have shown much lower auxiliary consumption as compared to their respective normative auxiliary consumption. Simhadri TPS having 2 nos. 500 MW units has shown an average auxiliary consumption of 5.77%, which is 1.73 percentage points lower than its normative consumption of 7.5%. Similarly, Talcher STPS with 6x500 MW units has shown average consumption of 6.32% which is 1.18% percentage points lower than its normative auxiliary consumption. Dadri TPS despite having all 210 MW units has shown an average auxiliary consumption of 7.61% which is 1.39% percentage points lower than its normative auxiliary consumption of 9%.

8.20 The present norms of auxiliary energy consumption are comfortable being met by most of the stations. Further, there seems to be no technical development leading to significant lowering of auxiliary energy consumption barring slight reduction in AEC for stations using imported coal. However, as discussed at Para 8.19 above, the stations with 500MW units have shown appreciably low power consumption as compared to the normative auxiliary energy consumption. This discrepancy seems to have arisen on account of a reduction of 1.5% allowed in the auxiliary energy consumption for 500 MW units with turbine driven boiler feed pumps. The AEC on account of boiler feed pump power in case of motor driven BFPs is in the range of about 3% including the motor efficiency and coupling losses. The installed motor ratings of BFPs in 210/250 MW units where motor driven BFPs are provided is in the range of 4% of the unit rating. Similarly installed motor rating of 50% capacity motor driven BFP for 500 MW is 10 MW (2%). Against this back drop, a reduction of 1.5% in auxiliary energy consumption provided for 500 MW units with T-BFP on account of elimination of motor drives for BFPs seems to be quite less and contributing to appreciably low auxiliary energy Consumption for 500 MW units as compared to their respective norms.

8.21 Estimation of AEC for the turbine driven BFP has also been made from the heat balance diagram (HBD) for a typical 500 MW unit of BHEL. From the HBD it is seen that the steam extraction for BFP is 68.7 tons per hour which is equivalent to turbine power of 11.39 MW or 2.23% of unit rating. Considering the same pump power and after accounting for the motor efficiency and losses in hydraulic coupling, equivalent power consumption for a motor driven BFP will be about 2.75%.

Estimates of BFP power have also been made using plant design modeling softwares. These computations also show a difference of 2.5% to 3% in auxiliary energy of units with TBFP Vs MBFP.

8.22 Thus, the reduction of 1.5% in the normative AEC of 500 MW presently being adopted for units with turbine driven BFPs is too low and needs to be increased to 2.5 - 3%. Thus the normative AEC for 500 MW & higher size units with turbine driven BFPs may therefore be taken as 2.5% less than corresponding normative AEC for units with motor driven BFPs. This may be made applicable to all existing and future units.

8.23 Further, the additional power consumption of 0.5% allowed for the cooling towers is primarily intended for stations with induced draught cooling towers (IDCT). It is, however, seen that this benefit of additional auxiliary energy consumption is being availed of by stations having natural draught cooling towers (NDCT), there being no justification for the same as no additional auxiliary energy consumption is incurred in the NDCT. Further, NDCT are invariably provided only when the techno-economics justify the additional capital cost as compared to life time additional auxiliary energy consumption for the draught towers in the IDCT. Thus, the additional auxiliary energy consumption of 0.5% should be allowed only to the units having IDCT for cooling of condenser cooling water. This may be made applicable to all existing and future units.

Specific Secondary Fuel Oil Consumption (SFC)

8.24 Specific secondary fuel oil consumption is directly related to the number of start ups of the units and average unit loading. As brought out in Para 8.1 above, average unit loading for most NTPC stations have been in the range of 95 to 100%, thus eliminating the need of secondary fuel support for flame stabilization which is normally required at unit load below 40%, except for start up. This is amply demonstrated by very low SFC shown by most of the stations. Details of SFC for these stations are given in Table-9.

Table 9 Secondary Fuel Oil consumption - NTPC

Station	2002-03	2003-04	2004-05	2005-06	2006-07	Average
Dadri	0.44	0.17	0.16	0.21	0.11	0.21
Farakka	1.78	1.94	2.42	0.94	0.90	1.56
Kahalgaon	0.63	0.54	0.53	0.41	0.61	0.54
Korba	0.24	0.21	0.11	0.11	0.10	0.15
Ramagundem	0.21	0.23	0.17	0.24	0.19	0.21
Rihand	0.22	0.22	0.17	0.25	0.17	0.20
Simhadri	1.10	0.66	0.23	0.19	0.19	0.37
Singrauli	0.18	0.23	0.30	0.31	0.44	0.29
Talcher STPS	0.46	0.83	0.65	0.50	0.27	0.50
Unchahar	0.64	0.50	0.43	0.36	0.27	0.44
Vindhyachal	0.21	0.18	0.16	0.15	0.14	0.17
Weighted Average	**0.47**	**0.50**	**0.46**	**0.33**	**0.28**	**0.39**

8.25 As may be seen from Table-9. average SFC for the last 5 years (2002-03 to 2006-07) has been in the range of 0.2 to 0.3 ml/kWh for most stations. Korba and Vindhyachal TPS have incurred still lower SFC of 0.15 ml/kWh. The only exception is Farakka TPS which has shown an average SFC of 1.56 ml/kWh. However even for Farakka, the average SFC is higher on account of very high SFC in 2003-04 and 2004-05 and for the last two years the SFC of this station is also in the range of 0.90 ml/kWh.

8.26 It is, therefore, recommended that for all existing and future units, secondary fuel oil consumption should be provided only to cover the start up fuel requirements. However, prescribing a norm based on actual fuel consumption per start up may be too cumbersome to actually implement in practice. Thus, for the sake of convenience, a normative SFC has been worked out in terms of ml/kWh on the basis of typical start ups being made in various NTPC stations for the last few years.

8.27 A detailed analysis of the total start ups of NTPC units during the year 2005-06 and 2006-07 have been made from the operation monitoring data available in Central Electricity Authority. The details of total startups on NTPC units in the years 2005-06 to 2006-07 are given in Table-10.

Table-10 Unit start-ups 2005-06 & 2006-07- NTPC units

Stations	Units	Capacity MW	Total Starts		Start ups per Unit	
			2005-06	2006-07	2005-06	2006-07
Dadri	4	840	27	13	6.75	3.25
Farakka	5	1600	54	76	10.80	15.20
Kahalgaon	4	840	25	29	6.25	7.25
Korba	6	2100	21	30	3.50	5.00
R-Gundem	7	2600	45	43	6.43	6.14
Rihand	*3/4	1500/2000	21	33	7.00	8.25
Simhadri	2	1000	9	12	4.50	6.00
Singrauli	7	2000	31	78	4.43	11.14
Talcher STPS	6	3000	38	55	6.33	9.17
Unchahar	*4/5	840/1050	20	27	5.00	5.40
Vindhyachal	*8/9	2260/2760	36	45	4.50	5

*Units considered for the year 2005-06

8.28 It is seen that taking all NTPC stations together the average start up per unit works out to 6 per unit in the year 2005-06 (2 hot starts and 4 cold starts) and 8 per year in 2006-07 (2 hot, 1 warm and 5 cold starts). It may be seen that there is large variation in the start ups per unit among the individual stations with very low start ups of 3.5 per unit in case of Korba on one hand to 10.8 in case of Farakka on the other in the year 2005-06. In the year 2006-07 too while Dadri had a low start up of 3.25 per unit, Farakka TPS had average start up of 15.2 and Singrauli had an average start up of 11.4.

<u>An estimation of the fuel oil consumption for the start ups and comparison with the actual SFC incurred by the stations has been made in Table 11.</u>

Table 11 Startup vs. Total SFC – NTPC units

Stations	No. of Units	Total Cap (MW)	SFC 2005-06 ml/kWh			SFC 2006-07 ml/kWh		
			Computed SFC for Startups in the Year		Actual SFC for the Year	Computed SFC for Startups in the Year		Actual SFC for the Year
			Optimal	Liberal		Optimal	Liberal	
Dadri	4	840	0.07	0.12	0.21	0.04	0.08	0.11
Farakka	5	1600	0.14	0.24	0.94	0.22	0.38	0.90
Kahalgaon	4	840	0.11	0.19	0.41	0.12	0.22	0.61
Korba	6	2100	0.06	0.10	0.11	0.07	0.12	0.10
R-Gundem	7	2600	0.08	0.13	0.24	0.09	0.15	0.19
Rihand	4	2000	0.11	0.17	0.25	0.11	0.17	0.17
Simhadri	2	1000	0.05	0.08	0.19	0.09	0.14	0.19
Singrauli	7	2000	0.08	0.14	0.31	0.19	0.32	0.44
Talcher STPS	6	3000	0.08	0.14	0.50	0.09	0.15	0.27
Unchahar	5	1050	0.07	0.13	0.36	0.08	0.14	0.27
Vindhyachal	9	2760	0.07	0.12	0.15	0.06	0.11	0.14

Optimal: worked out on basis of standard start up procedures.

Liberal : worked out with relaxed considerations- about twice the optimal

8.29 The start up fuel consumption estimates have been made for two scenarios namely:- **Optimal** where the start up fuel consumption has been worked out on basis of standard start up procedures and **Liberal** where the start up fuel consumption has been worked out with relaxed considerations since operators may not follow recommended start up procedures strictly and may continue to engage oil for longer periods. The start up consumption under liberal scenario considered is approximately twice the oil consumption worked out under optimal scenario. Based on the above analysis it is seen that the actual SFC in many of the stations like Vindhyachal, Korba, is almost equal to the start up SFC under liberal scenario, while it is higher for others indicating that the oil consumption per start up is still higher.

Even considering higher oil consumption for start ups (liberal scenario), the SFC for start ups works out to below 0.25 ml/kWh for all the stations and for most of the stations it is in the range of 0.15 ml/kWh.

Also the actual oil consumption for all the NTPC stations has been in the range of 0.2 to 0.3 ml/kWh. **The overall SFC for all NTPC stations taken together for 2005-06 and 206-07 works out to about 0.3 ml/kWh**.

SFC for other stations in State and Private Sector

8.30 The SFC for stations from various state and private sector utilities in the country having solely 200/210/250 and 500 MW units is shown in Table 12. **From this table it may be seen the average SFC for year 2006-07 for all the 26 coal fired stations is 0.95 ml/kWh.** Also barring exceptional cases where some stations have incurred higher SFC of upto 4 ml/kWh in specific years, the SFC for most stations has been within 1 ml/kWh.

Table 12 SFC of Non NTPC Stations with 200 and 500 MW units

S.No	Name of Station—Units* Capacity	Installed Capacity (MW)	SFC 04-05	SFC 05-06	SFC 06-07
1	Ropar	1260.00	0.97	0.61	0.44
2	Lehra Mohabat2*210	420.00	0.24	0.27	0.33
3	Obra B ----5*200	1000.00	4.04	3.92	
4	Anpara 'A' & 'B' –3*210+2*500	1630.00	0.67		
5	Wanakbori - 7*210	1470.00	0.71		0.76
6	Korba West (I&II) 4*210	840.00	1.17		
7	Satpura(Ph-II&III)1*200+3*210	830.00	1.06	1.48	
8	Birsingpur 2*210	420.00	1.04		1.17
9	Kaparkheda- 4*210	840.00	2.082	2.84	0.65
10	Chandrapurpur 4*210+3*500	2340.00	0.84	1.16	0.89
11	K'gudem Stage-V (Unit ! & 2: 2*250)	500.00	0.43	0.59	0.38
12	Vijaywada - 6*210	1260.00	0.33	0.27	0.38
13	Rayalseema -2*210	420.00	0.22	0.8	0.49
14	Tuticorin 5*210	1050.00	0.64	0.94	1.97
15	N.Chennai 3*210	630.00	3.75	1.88	0.79
16	Mettur 4*210	840.00	0.36	0.4	0.38
17	*Bokaro 'B' 3*210	630.00	3.59	3.14	2.39
18	*Mejia--4*210	840.00	4.85	3.25	3.92
19	IB TPS 2*210	420.00	0.65	0.4	0.41

20	Suratgarh (5*250)	1250.00	0.78	0.73	0.53
21	Dahanu (2*250)	500.00	0.14	0.18	0.12
22	Trombay Coal Based Unit 1*500	500.00			2.46
23	RAICHUR (7*210)	1470.00	0.6	0.73	0.46
24	Bakreshwar3*210	630.00	0.56	0.4	
25	Budge Budge 2x250	500.00	0.22	0.12	0.12
26	Kolaghat-6*210	1260.00	1.68		1.26
	Weighted Average		**1.23**	**1.24**	**0.95**

*Separate relaxed norms have been prescribed by CERC for these Stations

8.31 Further, the SFC for select high performing stations amongst these 26 stations is shown in Table 12(a**).** It is seen that out of 12 stations, SFC of 11 stations was less than 0.5 ml/kWh in the year 2006-07. The overall SFC of these 12 stations was 0.5 ml/kWh in 2005-06 and was 0.4 ml/kWh in the year 2006-07.

Table 12(a) SFC of select high performing Non– NTPC stations

S.No	**Name of Station--Units*Capacity**	**Installed Capacity (MW)**	**SFC 04-05**	**SFC 05-06**	**SFC 06-07**
1	Ropar	1260.00	0.97	0.61	0.44
2	GHTP, Lehra Mohabat-2*210	420.00	0.24	0.27	0.33
3	Suratgarh (5*250)	1250.00	N/A	0.73	0.53
4	Dahanu, (2*250)	500.00	0.14	0.18	0.12
5	K'gudem Stage-V (Unit ! & 2: 2*250)	500.00	0.43	0.59	0.38
6	Vijaywada 6*210	1260.00	0.33	0.27	0.38
7	Rayalseema 2*210	420.00	0.22	0.8	0.49
8	Mettur 4*210	840.00	0.36	0.4	0.38
9	Raichur (7*210)	1470.00	0.6	0.73	0.46
10	IB TPS-2*210	420.00	0.65	0.4	0.41
11	Bakreshwar (3*210)	630.00	0.56	0.4	N/A
12	Budge Budge 2x250	500.00	0.22	0.12	0.12
	Weighted Average		**0.49**	**0.50**	**0.40**

8.32 As brought out in Para 8.26, the normative SFC should be provided only to cover the startup fuel requirements of the units as oil requirement for low load flame stabilization is totally eliminated in view of very high unit loadings. The foregoing discussion at Para 8.26 to

8.29 conclusively establishes that the SFC for startups even with very liberal assumptions of consumption would be less that 0.25 ml/kWh. Thus considering the actual operating data of NTPC and other good operating stations in the country there is a case for limiting the SFC for NTPC stations to 0.25 ml/kWh barring exceptional cases like Farakka and Kahalgaon which have higher SFC.

8.33 **However to start with a normative SFC of 0.75 ml/kWh may be prescribed for all the existing stations and future coal fired stations.**

Target PLF and Availability

8.34 The prevailing norms for target availability for full reimbursement of fixed charges for coal fired units is 80%. The target for incentives which are presently based on PLF (not on availability) is also 80 %.

8.35 The present target availability for reimbursement of fixed charges have been worked out after careful consideration of the interest of the generators and the consumers and may be retained at the present level of 80% for all future and existing coal fired stations except for stations covered under relaxed norms.

8.36 The utilities have been arguing in past that criteria of granting incentive should also be changed to the availability and not the PLF as PLF is linked to actual station dispatch which in turn depends upon grid considerations. Also in the guidelines for tariff based competitive bidding, availability based criteria has been stipulated for this purpose. It is felt that criteria for incentive may be based on availability rather than PLF. It is suggested that the target availability for the purpose of incentive should be fixed by CERC taking into consideration the current operational profile and level of incentive envisaged.

Stabilization Period

8.37 The present norms provide for stabilization period of 180 days for coal/lignite fired units. As the commissioning procedures have been significantly improved and very high PLF are being sought by the utilities to be demonstrated during the trial operation by the suppliers, there appears to be no need of such a stabilization period. Further, the CERC tariff notification of 2004 also stipulated that the stabilization period and relaxed norms applicable during the stabilization period shall cease to apply from 1.4.2006. In view of the above the provision of stabilization period existing in the present norms may be withdrawn and the usual norms be made applicable from the date of commissioning (completion of trial operation) of the unit.

Supercritical Units

8.38 NTPC is in the process of installing 660 MW super-critical units at Sipat TPS and Barh TPS. A large number of supercritical units are likely to be inducted at various NTPC stations in future. NTPC have submitted the details of guaranteed parameters (turbine cycle heat rate, boiler efficiency, auxiliary energy consumption) and correction curves with respect to various operating parameters.

8.39 In view of the suggested methodology of specifying the unit heat rate in terms of a certain percentage above the design value, the supercritical units do not need any specific consideration. Thus, the recommended norms of Unit Heat Rate, Auxiliary Energy Consumption and Secondary Fuel Oil consumption as recommended for future coal fired stations in the preceding Paras above may be adopted for all the supercritical units.

8.40 It is, however, seen that in the design data furnished by NTPC to CERC, the turbine cycle heat rates furnished are for the operating conditions of 89 mmHg back pressure and 3 % make up. It is not clear as to why NTPC have furnished turbine cycle heat rate corresponding to 89 mmHg back pressure and 3 % make up conditions as reference turbine cycle heat rate when it is a standard practice that reference conditions for turbine cycle heat rate guaranteed by the supplier are at design cooling water temperature/backpressure (normally 33 deg C or 76 mmHg) and 0% make up conditions. It is suggested that CERC may like to specifically mention the reference conditions for indicating heat rate, boiler efficiency and other parameters which are affected by change of reference conditions.

8.41 In the design data furnished by NTPC to CEA vide their letter No. 01:C D:701 dated 21.8.2008, the turbine cycle heat rate at guarantee conditions of 0 % make up and design back pressure have been furnished for Sipat and Barh TPS as under:

Sipat TPS	1904 kcal/kWh
Barh-I TPS	1889 kcal/kWh

The above turbine cycle heat rate may be taken for determining norms for these stations.

PART – B STATIONS COVERED UNDER RELAXED NORMS

9 STATIONS COVERED AND PREVAILING NORMS

9.1 This part relates to coal fired stations where the performance has been much below the prescribed norms and hence the general norms could not be applied and station specific relaxed norms have been prescribed by the CERC.

9.2 There are three coal fired stations of NTPC for which relaxed station specific norms have been prescribed by CERC. In addition, relaxed station specific norms have also been prescribed for all the four coal fired stations of DVC. Thus, the stations covered under the relaxed station specific norms are as under:

Stations	Capacity
NTPC Stations	
Badarpur	3x100/95 + 2x210 MW
Tanda	4x110 MW
Talcher	4x60 +2x110 MW
DVC Stations	
Bokaro TPS	3X210 MW
Chandrapura TPS	3X130 MW
Durgapur TPS	1X140 +1X210 MW
Mejia TPS	4x210 MW

9.3 The prevailing norms for the NTPC stations prescribed by CERC vide order of 26/3/2004, as amended till date, are as under:-

Table-13 Relaxed Norms for Specific NTPC stations

Parameter	Station Heat Rate	Secondary Fuel Oil Consumption	Auxiliary Energy consumption
Badarpur 3x100/95+2x210 MW	2885 kcal/kWh	2.6 ml/kWh	11 %
Talcher 4x62.5+2x210 MW	2975 kcal/kWh	2 ml/kWh	10.5 %
Tanda 4x110 MW	2850 kcal/kWh	2 ml/kWh	12 %

9.4 Also CERC vide their order on petition 66/2005 notified the following norms for DVC stations which stipulates gradual improvement over the years.

Table-14 DVC Norms notified by CERC

Operational Parameter	2006-07	2007-08	2008-09
Bokaro TPS "B" (3x 210 MW)			
Target Availability (%)	55	65	75
Target PLF (%)	55	65	75
SHR (kcal/kWh)	3250	2900	2700
AEC (%)	10.5	10.25	10.00
SFC (ml/kWh)	3.5	2.75	2
Chandrapur TPS (3x130 MW)			
Target Availability (%)	55	55	60
Target PLF (%)	55	55	60
SHR (kcal/kWh)	3100	3100	3100
AEC (%)	11.5	11.5	11.5
SFC (ml/kWh)	3	3	3
Durgapur TPS (350 MW)			
Target Availability (%)	60.5	67	74
Target PLF (%)	60.5	67	74
SHR (kcal/kWh)	3100	2940	2820
AEC (%)	11.5	10.7	10.55
SFC (ml/kWh)	4.4	2.85	2.4
Mejia TPS (3x 210 MW)			
Target Availability (%)	78	80	80
Target PLF (%)	78	80	80
SHR (kcal/kWh)	2625	2550	2500
AEC (%)	11	9.6	9
SFC (ml/kWh)	3.5	2.5	2

10 PERFORMANCE ANALYSIS

PLF and Unit Loadings

10.1 The PLF of the stations covered in this section are given in Table-15. PLF of Talcher and Tanda has improved significantly from about 55% in 2002 -03 to >87% in 2006-07. Badarpur TPS has been consistently operating at PLF above 85%.

10.2 PLF of DVC stations have been consistently improving and in the last year (2006-07), Bokaro and Chandrapura recorded a PLF of about 60 %, Durgapur TPS had a PLF of 67 % and Mejia TPS had a PLF of 85 %.

Table-15 PLF of coal fired stations with relaxed norms

Station	2002-03	2003-04	2004-05	2005-06	2006-07
NTPC stations					
Badarpur	85.49%	87.91%	88.45%	87.12%	85.92%
Talcher	55.95%	67.97%	79.33%	87.60%	88.10%
Tanda	55.07%	72.24%	82.33%	82.64%	87.18%
DVC Stations					
Bokaro	55.80%	48.99%	44.71%	48.34%	59.88%
Chandrapura	32.98%	38.26%	55.43%	59.54%	62.78%
Durgapur	36.15%	54.38%	47.97%	58.70%	67.31%
Mejia	45.37%	54.71%	62.99%	79.96%	85.16%

Station Heat Rate

10.3 A comparison of operating station heat rate has been made with the design station heat rate (the design station heat rate have been worked out taking weighted average of the normative/design heat rate for the individual units). NTPC have not furnished the design heat rate for their units. Thus for NTPC stations the comparison has been made with normative heat rate.

10.4 Table 16 shows the deviation of operating heat rate from normative heat rate for NTPC stations covered in this Part-B. As may be seen, the operating heat rate are lower than the normative heat rate for all the stations. There is also considerable improvement in operating efficiency over the last 5 years. The operating heat rate were 5 to 10 % higher than the normative heat rate in 2002-03 but have consistently improved and are 2 to 3 % lower than normative heat rate in 2006-07

Table-16 Operating Vs. Normative Heat Rate NTPC Units with relaxed norms

Station	Norm	Devation from Normative heat rate (%)				
		2002-03	2003-04	2004-05	2005-06	2006-07
Badarpur	2885	**-2.84%**	**-3.32%**	**-3.36%**	**-4.17%**	**-4.63%**
Talcher	2975	**5.69%**	**0.85%**	**-1.71%**	**-2.07%**	**-2.38%**
Tanda	2850	**10.06%**	**-0.13%**	**-3.24%**	**-3.41%**	**-3.53%**

10.5 In respect of DVC stations the average deviation of operating heat rate from design heat rate for the last 5 years has been in the range of 25 % to 50 %. However the deviation has been showing a consistent downward trend and for Mejia TPS, the deviation during last two years (2005-06 and 2006-07) has been 15.73 % and 12.99 % respectively.

Table-17 Operating Vs. Design Heat Rate DVC Units

Station	Design Heat Rate	Deviation from Design Heat Rate					
		2002-03	2003-04	2004-05	2005-06	2006-07	Average
Bokaro	2461	48.37%	50.46%	52.15%	36.78%	33.68%	43.84%
Chandrapura	2327	92.34%	59.29%	45.19%	42.82%	38.72%	51.40%
Durgapur	2346	51.56%	52.14%	48.80%	35.06%	30.82%	42.24%
Mejia	2225	44.57%	47.64%	33.44%	15.73%	12.99%	27.72%

10.6 The operating heat rate of DVC stations are given in Table-18 . As may be seen, in 2006-07, Durgapur and Mejia TPS have already achieved stations heat rate lower than the prescribed normative heat rate and Bokaro and Chandrapura were operating above the normative heat rate. Also progressively improving heat rate norms have already been prescribed by CERC for these stations as given in Table-14 above.

Table-18 Operating Heat Rate DVC Units

STATION	2002-03	2003-04	2004-05	2005-06	2006-07	Average	*Norm
Bokaro	3651	3703	3744	3366	3290	3540	3250
Chandrapura	4476	3707	3378	3324	3228	3523	3100
Durgapur	3556	3569	3491	3169	3069	3337	3100
Mejia	3217	3285	2969	2575	2514	2842	2625

*Norm are in respect of the year 2006-07

Auxiliary Energy Consumption

10.7 Details of auxiliary consumption of DVC units is given in Table-19 below :

Table 19 AEC for Stations with Relaxed Norms-NTPC & DVC

Station	2002-03	2003-04	2004-05	2005-06	2006-07	Normative
NTPC Stations						
Badarpur	9.97%	10.21%	10.00%	9.57%	9.48%	11.0%
Talcher	11.47%	10.73%	10.58%	10.07%	10.19%	10.5%
Tanda	13.48%	13.50%	12.00%	11.91%	8.78%	12.0%
DVC Stations						
Bokaro	11.01%	11.30%	10.81%	10.70%	10.55%	10.5%
Chandrapura	17.27%	14.66%	11.47%	10.84%	10.54%	11.5%
Durgapur	13.20%	11.29%	12.20%	11.07%	10.53%	11.5%
Mejia	12.63%	10.83%	10.91%	10.49%	10.39%	11.0%

From the table it may be seen that, most stations have incurred auxiliary energy consumption lower than the normative auxiliary energy consumption prescribed by CERC. The auxiliary energy consumption for DVC stations in 2006-07 is 0.5 % to 1 % lower than their norm for the year. Thus these stations are already geared up for achieving the more stringent norms prescribed by CERC for the years 2007-08 and 2008-09.

Specific Secondary Fuel Oil Consumption (SFC)

10.8 Specific fuel oil consumption of stations covered in this part is given in Table-.20

Table-20 SFC for Stations under relaxed Norms- NTPC & DVC

Station	2002-03	2003-04	2004-05	2005-06	2006-07	Average
NTPC stations						
Badarpur	0.42	0.30	0.33	0.34	0.42	0.36
Talcher	1.60	1.55	0.78	0.40	0.44	0.94
Tanda	2.12	0.99	0.74	0.62	0.40	0.94
DVC Stations						
Bokaro	5.93	4.01	3.59	3.14	2.39	3.88
Chandrapura	0.35	16.50	2.61	0.95	1.83	3.85
Durgapur	13.19	9.57	7.29	3.36	3.15	6.64
Mejia	6.29	5.20	4.85	3.25	3.92	4.56

10.9 As may be seen from Table-20, SFC for Badarpur during the last 5 years (2002-03 to 2006-07) has been in the range of 0.3 to 0.4 ml/kWh. Talcher and Tanda had very high SFC during the earlier years but in 2006-07 they have also achieved a SFC of 0.4 ml/kWh. As brought out earlier in Part A of the report, the very high operating PLF of the stations have almost obviated the need of SFC for load support purpose thus drastically reducing the SFC.

10.10 The SFC for DVC stations is in the range of 3.82 to 6.64 ml/kWh. The SFC has consistently been coming down for the last 5 years and the weighted average for 2006-07 is 2.99 ml/kWh as against 6.23 ml/kWh In the year 2002-03. Also all DVC stations except Mejia have achieved the SFC lower than the normative SFC prescribed for the year.

11 RECOMMENDATIONS

11.1 The stations covered under this Part have been given relaxed station specific norm with a specific target for improvement and such regime may continue with further targets for improvement in the coming years.

11.2 However as Badarpur TPS has already achieved an average SFC of 0.36 ml/kWh over the last 5 years, it could be taken out of the purview of relaxed norms in respect of SFC and the normative SFC of 0.75 ml/kWh recommended for existing and future stations may be prescribed for Badarpur TPS. Similarly Tanda and Talcher TPS have already achieved very high PLF of over 85 % and SFC of 0.94. The normative SFC for these stations may be lowered to 1.25 ml/kWh.

SECTION- 3: LIGNITE FIRED STATIONS

12 STATIONS COVERED

Neyvelli Lignite Corporation has three operating stations namely TPS-I (6x50+3x100) MW, TPS II Stage- I (3x210MW), TPS II Stage-II (4x210 MW) and TPS I Expn (2x210 MW). Also two new stations are being set up by NLC namely TPS II Expn (2x250) MW and Barsingsar TPS (2x125) MW. Both TPS II Expn and Barsingsar TPS are being provided with circulating fluidized bed combustion (CFBC) boilers with provision to fire limestone powder for control of SOX emissions. The prevailing norms for lignite fired stations are given in Table – 21

Table-21 Prevailing Norms by CERC for Lignite Stations

Parameter	Units/Stations	Normative value	Remarks
Unit Heat Rate	Lignite fired units except for TPS-I and TPS-II (Stage I & II) .	4 to 10% higher (based on correction factors with respect to moisture content) than coal fired units which are as under: *2600 kcal/kWh 2500 kcal/kWh	* 2600 kcal/kWh applicable only during stabilization period. (withdrawn wef 1.4.2006)
	TPS-I	3900 kcal/kWh	
	TPS-II	2850 kcal/kWh	
Secondary Fuel Oil Consumption	During Stabilization period Subsequent period	5.0 ml/kWh 3.0 ml/kWh	(Additional SFC during stabilization withdrawn wef 1.4.2006)
Auxiliary Energy consumption	Stations except for TPS-I and TPS-II (Stage I & II) With cooling Tower Without cooling Tower	9.5 % 9.0 %	
	TPS-I	12 %	
	TPS-II	10 %	

13 PERFORMANCE ANALYSIS

13.1 The PLF of operating stations is given in Table- 22. As may be seen from Table 22, TPS-I has been operating at a high PLF of 80 % from 2002-03 to 2004-05. However, it has been operating at lower PLF of about 75 % for last two years. TPS II has also achieved high PLF of 80-83 % from 2002-03 to 2003-04 but is operating at lower PLF of 70 % for last 3 years. However, TPS I Expn station has been operating has been operating at very high PLF of 88 % during 2004-05 and 2006-07.

Table 22 PLF of NLC Stations

Station	Normative PLF	Operating PLF during the Year					Average PLF
		2002-03	2003-04	2004-05	2005-06	2006-07	
TPS I (6x50+3x100 MW)	75%	83.31%	83.72%	81.03%	75.92%	75.89%	79.97%
TPSII Stage I (3x210 MW)	75%	83.45%	74.47%	71.54%	69.87%	56.83%	71.23%
TPSII Stage II (4x210 MW)	75%	80.15%	80.11%	72.03%	72.27%	73.40%	75.59%
TPS Expn I (2x210 MW)	75%		53.90%	88.01%	83.78%	88.76%	78.61%

13.2 The deviation of operating heat rate of NLC stations from normative heat rates are given in Table 23. TPS I &II stations are covered under relaxed operating norms and the operating heat rate is slightly higher than the normative heat rate. For TPS-I Expn the normative heat rate (worked out assuming moisture content of 50 % in lignite) is almost equal to the operating heat rate from the year 2005 onwards.

Table 23 Normative Heat rate and Deviation of operating heat rate from norm for last 5 years –NLC stations

Stations	Norm	2002-03	2003-04	2004-05	2005-06	2006-07	Average
TPS I (6x50+3x100 MW)	3900	0.64%	0.85%	2.08%	2.36%	0.51%	1.29%
TPSII Stage I (3x210 MW)	2850	13.70%	5.65%	1.28%	1.20%	1.59%	4.69%
TPSII Stage II (4x210 MW)	2850	1.03%	1.17%	0.35%	0.85%	1.43%	0.97%
TPS Expn I (2x210 MW)	2750		9.08%	3.58%	0.71%	0.04%	3.35%

13.3 The secondary fuel oil consumption (SFC) for NLC stations is given in Table 24. As may be seen from the Table, barring TPS I, other stations (TPS II and TPS I Expn) show a SFC of less than 1.5 ml/kWh for most periods and have even shown very low SFC of 0.5 to 1.0 ml/kWh in specific years. Thus there is a scope to reduce the normative SFC for lignite fired stations as well.

Table 24 SFC for NLC Stations

Stations	Norm	2002-03	2003-04	2004-05	2005-06	2006-07	Average
TPS I (6x50+3x100 MW)	3.0	3.62	1.42	3.03	3.46	3.43	2.99
TPSII Stage I (3x210 MW)	3.0	3.66	0.79	1.21	0.92	1.53	1.62
TPSII Stage II (4x210 MW)	3.0	2.73	0.41	1.05	1.08	0.89	1.23
TPS Expn I (2x210 MW)	3.0		5.42	1.57	1.38	1.07	2.36

13.4 The average number of start ups (starts per unit per year) in NLC I & II stations have been about 12 in the year 2005-06 and 14 in the year 2006-07 as against 6 start ups per unit per year for NTPC coal fired units in the year 2005-06 and 8 in the year 2006-07. Thus the fuel consumption for on start up for NLC units would be higher. However even after considering the higher SFC on account of higher start ups, the overall SFC especially for TPS I Expn station appears to be very high as the station has been operating at very high PLF and thus the need of oil support for flame stabilization would be negligible. Also the start ups for NLC Expn I station are high at 18.5 and 20 start ups per unit in the years 2005-06 and 2006-07 respectively. However there is a marked variation in the numbers of start ups between units 1 and 2 and the start ups on unit 1 are almost twice of unit 2 in both the years.

13.5 The auxiliary energy consumption of NLC stations is given in table 25. As may be seen the AEC of TPS I & II stations is in the range of their relaxed AEC norm of 12% and 10% respectively. The AEC of TPS-I Expn station is in the range of 8.5 % to 9 % which corresponds well with the prevailing norms for lignite fired units.

Table 25 AEC for NLC Stations

Stations	Norm	2002-03	2003-04	2004-05	2005-06	2006-07	Average
TPS I (6x50+3x100 MW)	12%	11.57%	11.51%	11.41%	11.27%	11.55%	11.46%
TPSII Stage I (3x210 MW)	10%	9.70%	9.69%	9.85%	9.68%	9.40%	9.66%
TPSII Stage II (4x210 MW)	10%	9.63%	9.40%	9.74%	9.75%	9.73%	9.65%
TPS Expn I (2x210 MW)	9.5%		9.78%	9.05%	9.08%	8.47%	9.09%

14 RECOMMENDATIONS

Keeping the above in view it is recommended that:-

Target PLF and Availability

14.1 The performance of recent lignite fired stations have improved considerably and as seen for TPS I Expn, very high PLF of over 85% has been achieved from the 2nd year of installation. Thus, the present practice of providing a lower target availability for lignite based stations may be done away with and uniform target availability may be prescribed for future and existing coal and lignite fired stations except for NLC TPS I & II where lower target availability have been prescribed on account of station specific reasons.

Another exception to this could, be the upcoming CFBC based stations of NLC TPS II Expansion (2x250 MW) and Barsingsar TPS (2x125 MW). The PLF of existing CFBC stations has also been lower and being the first CFBC based units of NLC, the desired performance level may not be attained during initial years. Thus, it is suggested that target availability for reimbursement of fixed charges in respect of TPS - II Expn (2x250 MW) and Barsingsar TPS (2x125 MW) may be kept lower at 75%.

14.2 The target availability for the purpose of incentive may be fixed by CERC taking into consideration the current operational profile and level of incentive envisaged.

Heat Rate

14.3 Considering the principles adopted for determination of norms in this report and for reasons as brought in Para 8.16 **the normative unit heat rate of 6% over the design unit heat rate (guaranteed unit heat rate by the supplier at conditions of 100% load, 0% make up, design fuel and design cooling water temperature) may be prescribed for all future units to be commissioned after 1.4.2009.** This could be further reviewed in the next revision of norms.

14.4 **The existing norms of CERC applicable to TPS-I, TPS-II (Stage I&II and TPSI Expn are already covered under the relaxed norms for station specific reasons. The prevailing norms may be allowed to continue for these stations**. However, in case major R&M/LE is taken up by these stations, fresh norms for the units should be prescribed with reference to the efficiency achieved after implementation of R&M/LE works and suitable provisions for sharing of cost-benefits also may be evolved..

Specific secondary fuel oil consumption (SFC)

While the prevailing normative SFC of 3 ml/kWh may be continued for TPS I station, a lower SFC norm of 2.0 ml/kWh may be adopted in respect of TPS II station (Stage-I&II) in line with its actual past performance. Also for all future lignite stations with pulverized fuel technology and the TPS I Expn station, the normative SFC may be limited to 1.25 ml/kWh which provides liberal margin for oil support after meeting the startup requirements. Also the CFBC boilers being installed at TPS-II Expn and Barsingsar station do not need oil support for low load support. However being CFBC units installed by NLC for the first time there could be a possibility for higher start ups during initial few years. Thus the SFC for stations with CFBC boilers may also be taken as **1.25 ml/kWh** which would correspond to start up requirements of about 20 cold starts per unit per year at a PLF of 75%.

Auxiliary Energy Consumption

14.5 The prevailing AEC norm of 9.0% and 9.5% may be continued for TPS I Expn and all future lignite stations with pulverized fuel technology. However the additional AEC of 0.5 % may be allowed only to units with Induced Draught Cooling Towers (IDCT) and not to units with Natural Draught Cooling Towers (NDCT). Prevailing relaxed norms for AEC may be continued for TPS-I and TPS-II with specific targets for gradual improvement.

14.6 The CFBC boilers involve higher auxiliary consumption due to higher pressure drops and consequently higher fan power as compared to the pulverized fuel fired units. Also, these units involve additional power consumption for lime stone handling, crushing and firing for control of SOx emissions. However, CFBC units do not require pulverizers as the fuel is fed in crushed form and thus there is a corresponding saving in the power consumption in pulverizers as compared to the pulverized fuel technology.

14.7 NLC have asked for an additional AEC of 1% on account of CFBC boiler technology and additional 0.5% on account of uncertainty etc that may be faced as the CFBC units are being implemented by them for the first time and past operation data is not available. Thus they have asked for an AEC of 11% for TPS Expn II and 12% for Barsingsar TPS on account of additional AEC of 0.67% for cooling water pumping from a distant source (60 kms)

An assessment of incremental auxiliary consumption for CFBC units has been made and it is found that the CFBC units entail higher auxiliary energy consumption of 0.7% to 1%. However, in the present case of NLC stations, the limestone is being procured in the powder form and consequently the power consumption for limestone crushing is eliminated and thus the incremental consumption should be on the lower side. Thus, an additional auxiliary energy consumption of 1.0% may be allowed to NLC stations with CFBC boilers.

14.8 As regards additional AEC asked by NLC for Barsingsar on account of long lead for water system, it is felt that sufficient margins exist in the prescribed norms for AEC to account for minor station specific AEC and as such demands for such station specific additional consumptions may not be acceded too. Also the quantum of additional power asked for by NLC appears to be very high. The estimated AEC for such pumping requirements may be in the range of about 400 kW (equivalent to 0.15 %)

Limestone Consumption

14.9 NLC have asked for a lime stone consumption of 16 tons/hr and 6 tons/hr respectively for TPS II Expn and Barsingsar TPS. It is not clear whether NLC have been mandated to control SOx emissions under the environmental approval granted for the project. It is noted that the sulphur content in lignite for these stations is comparable that for existing stations as may be seen from Table- 26.

Table-26 Sulphur content in existing and future stations of NLC

Station	Sulphur content in lignite (%)	
	Design	Range
TPS II Expn	0.7 %	Worst 1%
Barsingsar	0.80%	Worst 1.7 %
TPS I	0.68 %	
TPS II	0.50%	0.4% to 0.81%

Thus there appears to be no need to fire limestone unless it is required specifically by the environment authorities. Also the quantum of reduction of SOx (in terms of % removal of SOx required) would have to be known to assess the limestone consumption. However, consumption of lime stone for the stations has been estimated on the basis of 90% SOx removal, 90% lime stone purity and 100% unit loading which is given below:

TPS-II Expn (2x250 MW)	11.5 T/hr
Barsingsar TPS (2x125 MW)	7.0 T/hr

Corresponding limestone consumption on per unit basis would be 0.046kg/kWh for TPS II Expn and 0.056kg/kWh for Barsingsar TPS. The consumption would reduce proportionately with reduction in SOx removal efficiency and would increase proportionately with reduction in limestone purity.

SECTION- 4: GAS TURBINE STATIONS

15 STATIONS COVERED

15.1 Operating data has been received from the gas turbine stations of NTPC and NEEPCO. The details of the stations are as under:-

Table- 27 List of Gas Based Stations

Station	Capacity
NTPC Stations	
Kawas	4x 106 MW GT+ 2 X 116.1 MW ST= 656.2 MW
Dadri	4x 130.19 MW GT+ 2 X 151.54 MW ST= 829.78 MW
Faridabad	2x137.758 MW GT+ 1x156.06 MW ST = 431.586 MW
Anta	3x88.71 MW GT + 1x153.28 MW ST=419 MW
Auraiya	4x 111.19 MW GT+ 2x 109.3 MW ST=663 MW
RGCCP (Kayamkulam)	2x115.2GT+ 1x129.177 MW ST=359.577 MW
Gandhar	3x x 144.3 MW GT+ 1x224.49 MW ST=657.39 MW
NEEPCO Stations	
Kathalguri	6 x 33.5 MW GT + 3 X 30 MW ST = 291MW
Agartala	4 x 21MW Gas turbine = 84 MW

15.2 The prevailing norms for the GT stations prescribed by CERC vide order of 26/3/2004 (as revised) are as under:-

Table-28 Prevailing Norms for GT Stations

Station	Heat Rate (kcal/kWh)		AEC (%)	
	Comb Cycle	Open Cycle	Comb Cycle	Open Cycle
Kawas	2075	3010	3%	1%
Dadri	2075	3010	3%	1%
Faridabad	2000	2900	3%	1%
Anta	2075	3010	3%	1%
Auraiya	2100	3045	3%	1%
Kayamkulam	2000	2900	3%	1%
Gandhar	2000	2900	3%	1%
Kathalguri	2250	3225	3%	1%
Agartala	-N/A-	3580	3%	1%

16 PERFORMANCE ANALYSIS

PLF

16.1 The PLF of the GT stations are given in Table-29 . NTPC stations have been operating at PLF of 70 to 80 % for the last 3 years except Kawas and RGCCP stations. RGCCP has shown very low PLF of 11 to 36% in the last 3 years. Agartala GT station has operated at PLF of over 85 % for the last two years.

Table 29 PLF of GT stations

Station	2002-03	2003-04	2004-05	2005-06	2006-07
Kawas	74.59%	69.01%	50.05%	51.13%	63.13%
Dadri	72.82%	70.73%	76.26%	75.37%	76.98%
Faridabad	71.60%	74.12%	83.94%	78.39%	74.88%
Anta	76.29%	76.76%	76.98%	77.64%	80.13%
Auraiya	74.80%	74.75%	72.13%	74.96%	79.39%
RGCCP	69.37%	69.08%	20.24%	11.69%	36.11%
Gandhar	59.40%	56.76%	71.04%	78.89%	79.11%
Kathalguri	40.21%	62.41%	63.36%	67.60%	70.82%
Agartala	76.24%	76.92%	77.62%	86.73%	88.85%

*Agartala is an open cycle station.
PLF for years 2002-03 to 2005-06 taken from CEA records

Station Heat Rate

16.2 The operating heat rate of Gas turbine stations and their comparison with normative and design heat rates are given in Tables 30, 31 &32. As may be seen from the tables, some GT stations (GTS) of NTPC have been operating at 3 to 7% lower than their normative heat rate. The operating heat rate of Gandhar GTS has been about 1% higher than the normative heat rate for the last 2 years. Kathalguri GTS has been operating consistently above the normative heat rate, the operating heat rate for the last 4 years being 3 to 7 % higher than norm.

Table-30 Operating Heat Rate of GT Stations

Station	Norms	2002-03	2003-04	2004-05	2005-06	2006-07	Average
Kawas	**2075**	1998	2018	2001	2010	1989	2003.2
Dadri	**2075**	1970	1998	1982	1967	1947	1972.8
Faridabad	**2000**	1935	1909	1875	1885	1904	1901.6
Anta	**2075**	2017	2085	2058	2067	2032	2051.8
Auraiya	**2100**	1983	1971	1978	1953	1992	1975
RGCCP	**2000**	1977	1980	1972	1986	1960	1975
Gandhar	**2000**	1934	1958	1997	2018	2026	1986.6
Kathalguri	**2250**	2736	2329	2417	2322	2376	2436
*Agartala	**3580**	3454	3637	3582	3437	3370	3496

*Agartala is open cycle station.

Note: Operating heat rate of Auraiya has been worked out after correcting the GCV of Naphtha furnished by NTPC on per kg basis to per litre basis.

Table 31 Deviation of Operating Heat Rate From Norms GT Stations

Station	Norms	2002-03	2003-04	2004-05	2005-06	2006-07	Average
Kawas	**2075**	-3.71%	-2.85%	-3.67%	-3.25%	-4.28%	-3.55%
Dadri	**2075**	-5.06%	-3.91%	-4.65%	-5.45%	-6.51%	-5.12%
Faridabad	**2000**	-3.25%	-4.70%	-6.55%	-6.13%	-5.09%	-5.15%
Anta	**2075**	-2.80%	0.50%	-0.82%	-0.39%	-2.08%	-1.12%
Auraiya	**2100**	-5.55%	-6.50%	-6.20%	-7.42%	-5.53%	-6.24%
RGCCP	**2000**	-1.15%	-1.01%	-1.41%	-0.71%	-2.01%	-1.26%
Gandhar	**2000**	-3.30%	-2.17%	-0.15%	0.90%	1.29%	-0.69%
Kathalguri	**2250**	21.60%	3.51%	7.42%	3.20%	5.60%	8.27%
*Agartala	**3580**	-3.52%	1.59%	0.06%	-3.99%	-5.87%	-2.35%

*Agartala is open cycle station.

16.3 The comparison of operating heat rate with the design heat rate for NTPC stations is furnished in Table 32. There are also considerable variations in the fuel mix from year to year and from station to station. Stations like Gandhar, Faridabad, have operated mostly on gas while Kawas, Anta, Auraiya have been operating on liquid fuel for considerable period due to non-availability of gas. RGCCP has been running completely on liquid fuels and its design heat rate is presumed to be with liquid fuel. The correction factor for liquid fuel has also been applied on the design heat rate while working out deviation from design heat rate in table 32. The details of these correction are given in Table 33.

Table 32 Deviation of Operating Heat rate from Design Heat Rate- GT Stations

Name of Stations	Design Heat rate Gas	2002-03	2003-04	2004-05	2005-06	2006-07	Average
Kawas	*	1.08%	2.05%	0.84%	2.27%	1.66%	1.58%
Dadri	*	1.86%	3.23%	2.45%	1.57%	0.69%	1.96%
Faridabad	*	4.94%	3.87%	2.28%	3.85%	3.84%	3.76%
Anta	*	3.22%	6.55%	5.21%	5.62%	3.99%	4.92%
Auraiya	*	1.63%	0.88%	1.31%	-0.06%	2.12%	1.17%
RGCCP	**1928**	2.54%	2.63%	2.22%	2.94%	1.61%	2.39%
Gandhar	**1894**	2.11%	3.31%	5.26%	6.21%	6.54%	4.69%
Weighted Average		**1.42%**	**2.17%**	**1.86%**	**2.14%**	**1.99%**	**1.92%**

Note: 1* Design Heat rate corrected with respect to liquid fuel used in the year as indicated in Table 33.

2 For Gandhar the design heat rate worked out based on open cycle design heat rate available in CEA, as the design heat rate of 1995 furnished by NTPC is too high.

Table 33 Impact of Liquid Fuel on Design Heat rate - GT Stations

Name of Stations	Design Heat Rate on Gas	Gen. Liquid Fuel (% of total Gen) Design Heat rate on Gas+ Liquid Fuel (kcal/kWh)	2002-03	2003-04	2004-05	2005-06	2006-07
Kawas	**1952**	Gen. Liquid Fuel	67.53%	70.35%	89.41%	41.69%	15.65%
		Design HR Gas+ Liquid	1978	1979	1987	1968	1958
Dadri	**1928**	Gen. Liquid Fuel	15.45%	19.53%	17.33%	22.12%	14.46%
		Design HR Gas+ Liquid	1934	1936	1935	1937	1934
Faridabad	**1850**	Gen. Liquid Fuel	0.99%	5.48%	7.83%	10.69%	5.19%
		Design HR Gas+ Liquid	1850	1852	1853	1854	1852
Anta	**1951**	Gen. Liquid Fuel	7.98%	15.06%	12.88%	15.65%	7.95%
		Design HR Gas+ Liquid	1954	1957	1956	1957	1954
Auraiya	**1946**	Gen. Liquid Fuel	10.42%	14.83%	11.89%	16.25%	8.89%
		Design HR Gas+ Liquid	1950	1952	1951	1952	1949

16.4 As may be seen from the table, the operating heat rate for NTPC gas stations is about 2% to 5% higher than the design heat rate.

16.5 The PLF for most NTPC stations being in the range of 70% to 80%, thus considerable variations in heat rate are possible on account of operation practices followed by the stations, the extent of part loading on individual gas turbines etc.

Auxiliary Energy Consumption

16.6 Details of auxiliary energy consumption of GT stations are given in Table-33. From the table it may be seen that, most GT stations have incurred auxiliary power consumption lower than the normative auxiliary power consumption prescribed by CERC. The only exception is RGCCP station where the AEC is higher at 4% and 6% during the years 2004-05 & 2005-06, due to extremely low PLF of 22% & 11% for the station in these years. AEC for Agartala is also high during 2002-03 & 2003-04 as the normative AEC for this station is 1% as it is an open cycle station.

Table 34 AEC for GT Stations

Station	2002-03	2003-04	2004-05	2005-06	2006-07
Kawas	1.76%	2.22%	2.40%	2.19%	1.74%
Dadri	2.72%	2.57%	2.52%	2.32%	2.20%
Faridabad	2.11%	2.19%	1.97%	2.31%	2.27%
Anta	2.87%	2.56%	2.70%	2.52%	1.91%
Auraiya	1.89%	1.91%	1.81%	1.80%	1.80%
RGCCP	2.17%	2.31%	4.06%	6.24%	2.62%
Gandhar	2.22%	2.33%	2.03%	1.95%	1.95%
Kathalguri	3.23%	2.83%	2.95%	2.88%	2.86%
***Agartala**	1.77%	1.42%	0.89%	0.38%	0.58%

*Agartala is open cycle station.

17 RECOMMENDATIONS

17.1 The pace of installation of new gas fired stations has slowed down considerably over the years because of low availability of gas and very few new gas stations are coming up now. Station specific norms have already been prescribed by CERC for the existing gas fired stations as given in the Table 28. These norms for heat rate correspond to about 6-8% higher than the design heat rate of the stations. Besides, the guaranteed heat rate for GT stations are dependent on site specific factors like site altitude and ambient temperature.

17.2 It is thus recommended that for existing GT stations, the station specific normative heat rates prescribed may continue to be adopted. However, for future GT stations the normative station heat rate may be taken as 5% above the design heat rate. Also in case of operation with liquid fuels a higher heat rate of 2% over the normative heat rate with natural gas may be prescribed.

17.3 As regards norms for the auxiliary energy consumption, the prevailing norms of 1% and 3% AEC for open cycle and combined cycle GT stations may continue to be adopted for existing as well as future stations and are adequate for both natural gas as well as liquid fuel operation.

SECTION- 5 SUMMARY OF RECOMMENDATIONS

The various recommendations made in the preceding paras in this report have been summarized in Table- 35(a) for existing units and in Table 35 (b) for future units for ease of reference and understanding. **However, following points may be kept in view while fixing the norms:**

18.1 As may be seen, a new methodology of describing heat rates in terms of design heat rates has been suggested in the report for future units. It is, therefore, essential that the design heat rate is properly defined so as to eliminate variations arising on account of different practices of specifying design heat rate by different utilities. Thus, for the purpose of application of operation norms **recommended in this report, following criteria of adopting design heat rate be followed** :

a) In case the design heat rate is guaranteed separately for boiler and turbine then:

- The design turbine heat rate shall be the guaranteed value at 100% MCR unit loading, with design cooling water temperature and zero percent make up conditions and
- The boiler efficiency as guaranteed by supplier for design coal and based on Gross calorific value of coal. Any minimum limits of unburnt carbon loss or any other loss specified by the utilities shall NOT be considered.

b) In case the design heat rate is guaranteed for the unit then:

The design heat rate of the unit shall be the guaranteed heat rate at 100% MCR unit loading, with design coal, design cooling water temperature and zero percent make up conditions and based on gross calorific value of coal. Any minimum limits of unburnt carbon loss or any other loss specified by the utilities shall NOT be considered.

18.2 With a view to ensure that minimum efficiency standards are adopted by the project developers in the future units, the following minimum benchmark turbine cycle heat rate and boiler efficiency shall be met by all future coal/lignite based thermal generating units. :-

a) Maximum turbine cycle heat rate

Steam parameters at Turbine inlet		**Maximum Turbine cycle heat rate (kcal/kWh)**
Pressure kg/cm2	**Main/Reheat Steam temperature (deg C)**	
150	535/535	1955
170	537/537	1910 (with MD-BFP) 1950 (with TD-BFP)
170	537/565	1895(with MD-BFP) 1935(with TD-BFP)
247	537/565	1860(with MD-BFP) 1900(with TD-BFP)
247	565/593	1810(with MD-BFP) 1850(with TD-BFP)

MD-BFP means motor driven BFP

TD-BFP means turbine driven BFP

b) Minimum Boiler Efficiency

Fuel	**Minimum Boiler Efficiency (%)**
Sub -bituminous Indian coals	85%
Bituminous Imported coal	89%

In case higher heat rate/lower boiler efficiencies are proposed, the utility may be asked to furnish detail justification for review by CERC.

Table – 35(a) Summary of Recommended Normative Operating Parameters (Existing Units)

	Target PLF/availability		Heat Rate (kcal/kWh)		Auxiliary Energy Cons. (%)		SFC (ml/kWh)	
	Prevailing Norm	**Recommended Norm**	**Prevailing Norm**	**Recommended Norm**	**Prevailing Norm**	**Recommended Norm**	**Prevailing Norm**	**Recommended Norm**
COAL FIRED UNITS UNDER GENERAL NORMS								
200/210/250 MW Units	**Fixed charges:** 80% availability	**Fixed charges:** 80% availability	**During Stabilization**: 2600 **Subsequent Period:** 2500	**No change**	**With cooling tower** 9% **W/o Cooling Towers** 8.5% (Additional AEC of 0.6% allowed during stabilization period)	**With IDCT cooling tower** 9% **With NDCT cooling tower** 8.5% **W/o cooling tower** 8.5%	**During Stabilization** 4.5 **Subsequent Period** 2.0	0.75
500 MW Units with TD-BFP	**Fixed charges:** 80% availability	**Fixed charges:** 80% availability	**During Stabilization**: 2550 **Subsequent Period:** 2450	**Units with COD Bef 1.4.2004** 2450 **Units with COD After 1.4.2004** 6% over the design heat rate	**With cooling tower** 7.5% **W/o Cooling Towers** 7% (Additional AEC of 0.6% allowed during stabilization period)	**With IDCT cooling tower** 6.5% **With NDCT cooling tower** 6% **W/o cooling tower** 6%	**During Stabilization** 4.5 **Subsequent Period** 2.0	0.75
500 MW units with MD-BFP	**Fixed charges:** 80% availability	**Fixed charges:** 80% availability	**During Stabilization**: 2510 **Subsequent Period:** 2410	**Units with COD Bef 1.4.2004** 2410 **Units with COD After 1.4.2004** 6% over the design heat rate	**With cooling tower** 9% **W/o Cooling Towers** 8.5% (Additional AEC of 0.6% allowed during stabilization period)	**With IDCT cooling tower** 9% **With NDCT cooling tower** 8.5% **W/o cooling tower** 8.5%	**During Stabilization** 4.5 **Subsequent Period** 2.0	0.75
COAL FIRED UNITS UNDER RELAXED NORMS								
Talcher TPS NTPC	**Fixed charges:** 80% availability	**Fixed charges:** 80% availability	2975	Station Specific Relaxed norms may be continued with targets for progressive improvements	10.5 %	Station Specific Relaxed norms may be continued with targets for progressive improvements	2.0	1.25
Tanda TPS NTPC			2850		12.0 %		2.0	1.25
Badarpur TPS NTPC			2885		11.0%		2.6	0.75
<u>**DVC Stations**</u> Bokaro B Chandrapur Durgapur Mejia		Station Specific norms may be continued with targets for progressive improvements	(For the year 2008-09) 2700 3100 2820 2500	Station Specific norms may be continued with targets for progressive improvements	10.0 % 11.5 % 10.55 % 9.0 %	Station Specific norms may be continued with targets for progressive improvements	2.0 3.0 2.4 2.0	Station Specific Relaxed norms may be continued with targets for progressive improvements

LIGNITE FIRED UNITS UNDER GENERAL NORMS									
NLC TPS-I Expn	**Fixed charges:** 75% availability	**Fixed charges:** 80% availability	Prevailing Normative heat rate for coal fired units corrected for moisture content in lignite using multiplying factors specified by CERC.	No change	**With cooling tower** 9.5% **W/o Cooling Towers** 9% (Additional AEC of 0.6% allowed during stabilization period)	**With IDCT cooling tower** 9.5% **With NDCT cooling tower** 9% **W/o cooling tower** 9%	**During Stabilization** 5.0 **Subsequent Period** 3.0	1.25
LIGNITE FIRED UNITS UNDER RELAXED NORMS									
NLC TPS -I NLC TPS –II (Stage I & II)	**Fixed charges:** 75% availability	**Fixed charges:** 75% availability	3900 2850	Station Specific Relaxed norms may be prescribed with targets for progressive improvements	12% 10 %	Station Specific Relaxed norms may be prescribed with targets for progressive improvements	3.0 3.0	3.0 2.0
GAS BASED STATIONS									
All Existing stations of NTPC and NEEPCO	**Fixed charges:** 80% availability	**Fixed charges:** 80% availability	Station Specific norms have been prescribed	No Change	**Open Cycle Opn.** 1.0% **Combined Cycle Opn** 3.0%	No change	Not Applicable	Not Applicable

Table – 35(b) Summary of Recommended Normative Operating Parameters (Future Units)

	Target PLF/Availability		**Heat Rate kcal/kWh**		**Auxiliary Energy Cons. (%)**		**SFC (ml/kWh)**	
	Prevailing Norm	**Recommended Norm**	**Prevailing Norm**	**Recommended Norm**	**Prevailing Norm**	**Recommended Norm**	**Prevailing Norm**	**Recommended Norm**
COAL FIRED UNITS								
Units with Motor driven BFPs including supercritical units		**Fixed charges:** 80% availability		6% over the design heat rate		**With IDCT cooling tower** 9% **With NDCT cooling tower** 8.5% **W/o cooling tower** 8.5%		0.75
Units with Turbine driven BFPs including supercritical units		**Fixed charges:** 80% availability		6% over the design heat rate		**With IDCT cooling tower** 6.5% **With NDCT cooling tower** 6% **W/o cooling tower** 6%		0.75
LIGNITE FIRED UNITS								
Lignite fired units with pulverized fuel technology		**Fixed charges:** 80% availability		6% over the design heat rate		**With IDCT cooling tower** 9.5% **With NDCT cooling tower** 9% **W/o cooling tower** 9%		1.25
Lignite fired units with CFBC Technology Boilers		**Fixed charges:** 75% availability		6% over the design heat rate		**With IDCT cooling tower** 10.5% **With NDCT cooling tower** 10% **W/o cooling tower** 10%		1.25
GAS BASED STATIONS								
Gas Turbine Stations		**Fixed charges:** 80% availability		5% over the design heat rate		**Open Cycle Opn.** 1.0% **Combined Cycle Opn** 3.0%	Not Applicable	Not Applicable

APPENDIX - II

No.23/21/2005-R&R (Vol-II)
Government of India
Ministry of Power
**

Shram Shakti Bhawan, Rafi Marg,
New Delhi, 24th January, 2012

To

The Secretary,
Forum of Regulators,
Chanderlok Building,
Janpath, New Delhi

Subject: Implementation mechanism for "CEA Technical Standards for Construction of Electric Plants and Electric Lines Regulations 2010".

Sir,

I am directed to forward herewith a copy of the D.O. letter No. CEA/TETD-TT/2011/S-1/1420 dated 26.12.2011 on the above subject. It is requested that the matter may be taken up with SERCs for effective implementation of the above regulations of CEA.

Yours faithfully,

Encl: As above

(Pranay Kumar)
Director
Tel: 2371 5250

Copy to: Chairman, CEA w.r.t letter No. CEA/TETD-TT/2011/S-1/1420 dated 26.12.2011.

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25/1/12

A.S. BAKSHI

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रामकृष्ण पुरम्

CHAIRPERSON & EX-OFFICIO SECRETARY
TO THE GOVERNMENT OF INDIA
CENTRAL ELECTRICITY AUTHORITY
SEWA BHAWAN, R. K. PURAM

नई दिल्ली–110066
NEW DELHI-110066

D.O. No.CEA/TETD-TT/2011/S-1/ 1420

23.12.2011

Subject: **Note for the "Forum of Regulators" regarding implementation mechanism for "CEA Technical Standards for Construction of Electric Plants and Electric Lines Regulations 2010"**

Dear Sir,

Kindly refer to the discussions held on the above subject in the meeting taken by Chairman, NMCC on 12.12.2011, wherein it was brought out by CEA that existing provisions under the Act empower the Regulatory Commissions to take cognizance of the failure to comply with the Act (including the regulations made under the Act) and order investigation in the matter. In case failure of compliance is established through investigation, the Appropriate Regulatory Commission is empowered to enforce penalties including *directing the generating company to cease to carry on the business of generation of electricity.*

It was suggested in the meeting that these provisions may be used for implementing these Regulations and the issue may be taken up with Regulatory Commissions for making necessary arrangements in this regard. A note for the "Forum of Regulators" suggesting creation of implementation mechanism for the above Regulations is enclosed for your kind perusal and consideration.

With warm regards

Yours sincerely,

Encl: (A.S Bakshi)

Shri P. Uma Shankar
Secretary
Ministry of Power
Shram Shakti Bhawan
Rafi Marg
New Delhi-110001

Implementation of
"CEA Technical Standards for Construction of Electric Plants and Electric Lines Regulations 2010"

Note for the Forum of Regulators

Background

1. The Electricity Act 2003 provides that *"Any generating company may establish, operate and maintain a generating station without obtaining a licence under this Act if it complies with the technical standards relating to connectivity with the grid referred to in clause (b) of section 73"*

   As a part of its functions and duties prescribed under Section 73 of the Act, the Central Electricity Authority has been assigned the duty to *"specify the technical standards for construction of electrical plants, electric lines and connectivity to the grid"* (Sec 73 (b)).

2. Further, under Section 177 of the Act , CEA has been vested with the powers to make Regulations
   "The Authority may, by notification, make regulations consistent with this Act and the rules generally to carry out the provisions of this Act." (Sec.177 (1)). Without prejudice to the generality of the power so conferred vide Sec 177(1), one of the matter specifically listed for making such regulations is the technical standards

   "the technical standards for construction of electrical plants and electric lines and connectivity to the grid under clause (b) of section 73" Sec 177 (2)(e)

3. Accordingly, CEA has notified the Technical Standards for Construction of Electric Plants and Electric Lines Regulations 2010 vide gazette notification dated 20-8-2010. These Regulations were prepared by a task force in consultations with utilities and manufacturers; the draft Regulations were pre published before Publication and were notified on 20.8.2010 after vetting by the Ministry of Law.

Scope of Technical Standards Regulations

4. These Regulations cover thermal power stations, hydro power stations, sub stations and transmission lines. All type of thermal power stations. Viz. – Coal and lignite fired Stations, Gas Turbine Stations and Diesel generating sets have been covered. Sub stations of all type viz. Air Insulated Substation, Gas Insulated Substation, Hybrid Substation, Distribution Sub Stations have been covered.

   The Regulations cover key Operating Capabilities viz. fuel quality, grid conditions, cooling water temperature etc, salient sizing & construction criteria, minimum efficiency levels for turbine and boiler, typical protection systems etc.

Implementation of the Regulations

5. A need for effective implementation of these Regulations has been raised at various forums by the manufacturers and Govt. agencies. Apprehensions have also been expressed by some manufacturers that certain foreign equipment being supplied may not conform to these Regulations and is thus posing unfair competition. The issue was also raised in the Maira Committee set up to look into the disadvantages being faced by the domestic manufacturers of power equipment and in the Workshop on India-China Trade & Economic Relations organized by National Security Council Secretariat in Augusr-2011. Chairman National Manufacturing Competitiveness Council (NMCC) had also taken a meeting on 12-12-2011 to discuss the implementation of these Regulations wherein Secretary (Power) and Secretary (Heavy Industry) also participated.

Enforcement Provisions under the Electricity Act 2003

6. Part XII of the Electricity Act 2003 provides for Investigation And Enforcement of the Act. The provisions made in this part under Section 128 of the Act read as follows:-

   - *128(1) The Appropriate Commission may, on being satisfied that a generating company or a licensee has failed to comply with any of the provisions of this Act or rules or regulations made there under, at any time, by order in writing, direct any person (hereafter in this section referred to as "Investigating Authority") specified in the order to investigate the affairs of any generating company or licensee and to report to that Commission on any investigation made by such Investigating Authority*

   - *128(2) Notwithstanding anything to the contrary contained in section 235 of the Companies Act, 1956, the Investigating Authority may, at any time, and shall, on being directed so to do by the Appropriate Commission, cause an inspection to be made, by one or more of his officers, of any licensee or generating company and his books of account; and the Investigating Authority shall supply to the licensee or generating company, as the case may be, a copy of his report on such inspection*

   - *128(3) It shall be the duty of every manager, managing director or other officer of the licensee or generating company, as the case may be, to produce before the Investigating Authority directed to make the investigation under subsection (1), or inspection under sub-section (2), all such books of account, registers and other documents in his custody or power and to furnish him with any statement and information relating to the affairs of the licensee or generating company, as the case may be, as the said Investigating Authority may require of him within such time as the said Investigating Authority may specify*

   - *128(5) The Investigating Authority, shall, if it has been directed by the Appropriate Commission to cause an inspection to be made, and may, in any other case, report to the Appropriate Commission on any inspection made under this section*

- *128(6) On receipt of any report under sub-section (1) or sub-section (5), the Appropriate Commission may, after giving such opportunity to the licensee or generating company, as the case may be, to make a representation in connection with the report as in the opinion of the Appropriate Commission, seems reasonable, by order in writing—*
    - *(a) require the licensee or the generating company to take such action in respect of any matter arising out of the report as the Appropriate Commission may think fit; or*
    - *(b) cancel the licence; or*
    - *(c) direct the generating company to cease to carry on the business of generation of electricity*

- *128(8) The Appropriate Commission may specify the minimum information to be maintained by the licensee or the generating company in their books, the manner in which such information shall be maintained, the checks and other verifications to be adopted by licensee or the generating company in that connection and all other matters incidental thereto as are, in its opinion, necessary to enable the Investigating Authority to discharge satisfactorily its functions under this section*

- *129(1) Where the Appropriate Commission, on the basis of material in its possession, is satisfied that a licensee is contravening, or is likely to contravene, any of the conditions mentioned in his licence or conditions for grant of exemption or the licensee or the generating company has contravened or is likely to contravene any of the provisions of this Act, it shall, by an order, give such directions as may be necessary for the purpose of securing compliance with that condition or provision*

7. Thus under the above provisions of enforcement under the Electricity Act 2003, the Appropriate Regulatory Commission has the powers to

    a. take cognizance of failure to comply with any of the provisions of this Act and order to investigate the affairs of any generating company by an Investigating Authority

    b. The generating company is bound to produce all books of account, registers and other documents in his custody or power and furnish any statement and information relating to the affairs of the generating company, to said Investigating Authority

    c. On receipt of report of the Investigating Authority, the Appropriate Commission may Enforce Penalties including cancellation of licence or direct the generating company to cease to carry on the business of generation of electricity

    d. Appropriate Commission may specify the minimum information to be maintained by the licensee or the generating company, necessary to enable investigation by the Investigating Authority

e. Where the Appropriate Commission, is satisfied that a generating company has contravened or is likely to contravene any of the provisions of this Act, it is empowered to give directions necessary for securing compliance with that condition or provision

8. As the above provisions relate to *"the provisions of this Act or rules or regulations made there under"*, the same can be exercised by the Appropriate Regulatory Commission to implement the "Technical Standards for Construction of Electric Plants and Electric Lines Regulations 2010".

Regulations made by CERC

9. Under Section 178 of the Act, the CERC has been vested with the powers to make Regulations - *"The Central Commission may, by notification, make regulations consistent with this Act and the rules generally to carry out the provisions of this Act."* (Sec.178 (1)). Without prejudice to the generality of the power so conferred vide Sec 178 (1), matters specifically listed for making such regulations are

   - *178 (s) the terms and conditions for the determination of tariff under section 61;*
   - *178 (t) details to be furnished by licensee or generating company under sub-section (2) of section 62*

10. CERC have made regulations under Section 178 of the Act viz. *Central Electricity Regulatory Commission (Procedure for making of application for determination of tariff, publication of the application and other related matters) Regulations, 2004.* These Regulations require the generating companies to furnish information on technical details of the plants and have prescribed forms for furnishing of such information. The details called for already include steam parameters, guaranteed design heat rate and conditions of guarantee (make up, cooling water temperature etc). The "CEA Technical Standards for Construction of Electric Plants and Electric Lines Regulations 2010" also prescribe efficiency criteria in terms of maximum allowed turbine cycle heat rate and boiler efficiency which can thus easily be verified from the details already being sought by the Regulatory Commissions vide CERC Regulations mentioned above.

Suggested Enforcement Mechanism

11. As per the prevailing provisions of tariff under the Act, every generating company is required to get its tariff **determined** by the Appropriate Regulatory Commission under section 62 of the Act or **adopted** if such tariff has been determined through transparent process of bidding in accordance with the guidelines issued by the Central Government under Section 63 of the Act. Thus all generating companies are required to approach the Appropriate Regulatory Commission for determination/adoption of their tariff.

12. As stated above, the CERC has already made Regulations for filing tariff applications by the generating companies and these Regulations are to be followed

by all Regulatory Commissions. These Regulations call for technical details of the plant including steam parameters, guaranteed design heat rate and conditions of guarantee and these can be used to verify compliance to CEA Regulations.

13. Thus the above mechanism may be used by the Regulatory Commissions to enforce compliance to key provisions of the Regulations on Technical Standards like minimum efficiency levels. The generating companies while making Tariff Application may be asked to furnish key efficiency parameters, Guaranteed Design Heat rate and Conditions of guarantee and any other information considered relevant on oath alongwith certification of compliance to "CEA Technical Standards for Construction of Electric Plants and Electric Lines Regulations 2010".

14. Insistence on such a process by the Regulatory Commissions would ensure that there is no non compliance either deliberate or due to oversight and the generating companies will make due diligence in ensuring that prescribed minimum efficiency levels are met. Any non compliance despite such process in place could be penalized by the Regulatory Commissions.

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APPENDIX-III

GOVERNMENT OF INDI1A
MINISTRY OF POWER
CENTRAL ELECTRICITY AUTHORITY
SEWA BHAWAN, R.K.PURAM
NEW DELHI-110066
Website : www.cea.nic.in
(आई .एस .ओ. 9001:2008)

To
The Secretary,
Central Electricity Regulatory Commission,
Chanderlok Building,
36, Janpath,
New Delhi- 110 001.

Subject: **Advice to CERC for incorporation of provisions of CEA Technical Standards Regulations in the CERC Tariff Regulations**

Dear Sir,

During a study made by a Committee set up by CEA for analyzing the performance of Chinese equipment vis-à-vis Indian equipment (BHEL), It was seen that there were lot of inconsistencies in the data on design turbine cycle heat rate, steam flows, flow margins etc. furnished by some of the utilities. Large variations in steam flows were seen for similar turbine cycle heat rate and similar cycle configurations. There was lack of co-relation between heat rate and steam flows by some suppliers and in some cases, the turbine cycle heat rate indicated was very high and unrealistic. Some of the units did not reflect adequate flow steam margins.

The Authority feels that such anomalies/discrepancies in the design Turbine Cycle Heat Rate, Steam flows, design margins is indicative of lack of due diligence by the suppliers and utilities/generating companies on the above aspects. The Authority feels that the key design/efficiency parameters should be furnished by the Generators while making an application for determination of tariff either under Section 62 of the Act or under adoption of tariff under Section 63 of the Act, so that they are transparently displayed for examination by the Utility.

The CEA has notified the ***Technical Standards for Construction of Electric Plants and Electric Lines Regulations 2010*** vide gazette notification dated **20-8-2010**. The Regulations cover key Operating Capabilities viz. fuel quality, grid conditions, cooling water temperature etc. for the thermal generating units and also prescribe salient sizing & construction criteria, minimum efficiency levels, protection systems etc. These are mandatory to be followed by the project developers/generating companies. It is seen that presently many of the stations/project developers have not been paying adequate attention to these aspects covered under the Regulations.

A need for effective implementation of these Regulations is thus being felt and the issue has also been raised at various forums by the manufacturers and Govt. agencies. Apprehensions have also been expressed by some manufacturers that certain foreign equipment being supplied may not conform to these Regulations and is thus posing unfair competition.

For the above mentioned reason, it is felt that an additional clause needs to be inserted after sub-Section (1) under Section 5 "Application for determination of Tariff" of the existing CERC (Terms Conditions of Tariff) Regulations 2009 :

"The generating companies while making the Tariff Application shall give an undertaking certifying compliance to CEA (Technical Standard for Construction of Electric Plants and Electric Lines) Regulations 2010."

This may be suitably incorporated in the Tariff Regulations being finalized for the period 2014-19. In addition, suggested changes to CERC formats (Appendix-I Part-I Form-2 "Plant Characteristics"), shown in track changes mode, for incorporation of information/certification regarding salient provisions of the CEA Regulations are enclosed at Annex-I. An explanatory note on importance of provisions proposed to be incorporated in CERC tariff process is also enclosed for reference.

This issue may also be taken up in the Forum of Regulators for information of the SERCs. Insistence on such a process by the Regulatory commissions would ensure that there is no non-compliance either deliberate or due to oversight and the generating companies will, as a result, do proper due diligence in ensuring that prescribed minimum efficiency levels are met.

सदस्य/ता के.वि.प्र.
डायरी 04
दिनांक 2-1-14

P. Batra 2/1/2014

(Pankaj Batra)
Chief Engineer (I/C)
RA Division

CEA/RA/CERC/2013/386-88

02/01/14

Copy for kind information to :

(1) Chairperson, CEA.
(2) Member (Thermal), CEA.

Plant Characteristics

Name of the Company						
Name of the Power Station						
Unit(s)/Block(s) Parameters	**Unit-I**	**Unit-II**	**Unit-III**			
Name of Boiler Manufacturer						
Name of Turbine generator Manufacturer						
Main steam Pressure at Turbine inlet(kg/cm2) abs[1]						
Main Steam temperature at turbine inlet(deg C)[1]						
Reheat Steam pressure at turbine inlet (kg/cm2) abs[1]						
Reheat Steam temperature at turbine inlet(deg C)[1]						
Main Steam flow at Turbine inlet under MCR condition (tons/hr)[2]						
Main Steam flow at Turbine inlet under VWO condition (tons/hr)[2]						
Unit Gross electrical output under MCR/Rated condition (MW)[2]						
Unit Gross electrical output under Turbine VWO condition (MW)[2]						
Design Condenser backpressure (kg/cm2 (a))						
Design Cooling Water temperature (deg C)						
Guaranteed Design Gross Turbine cycle heat rate (kcal/kWh)[3]						
Conditions on which guaranteed						
% MCR						
% Makeup						
Design Fuel						
Design cooling water Temperature						
Back Pressure						
Steam flow at Superheater outlet under BMCR condition (tons/hr)						
Steam pressure at superheater outlet at BMCR condition (kg/cm2) abs						
Steam temperature at superheater outlet at BMCR condition (degC)						
Steam temperature at Reheater outlet at BMCR condition (degC)						
Design/Guaranteed Boiler Efficiency (%)[4]						
~~Pressure (kg/cm2)~~						
~~Temperature 0C~~						
~~Guaranteed Design Heat rate (kCal/kWh)~~						

~~Note: In case guaranteed unit heat rate is not available then furnish the guaranteed turbine cycle heat rate and guaranteed boiler efficiency separately along with condition of guarantee.~~

Type of cooling Tower						
Installed Capacity (IC)						

Date of Commercial Operation (COD)						
Type of cooling system[5]						
Type of Boiler Feed Pump[6]						
Fuel Details[7]						
Special Features/Site Specific Features[8]						
Special Technological Features[9]						
Environmental Regulation related features[10]						
Any other special features						

1 - At Turbine MCR condition
2- with 0% (Nil) make up and design Cooling water temperature
3-at TMCR output based on gross generation, 0% (Nil) makeup and desing Cooling water temperature
4 - With Performance coal based on Higher Heating Value (HHV) of fuel and at BMCR output
5 Closed circuit cooling, once through cooling, sea cooling, natural draft cooling, induced draft cooling etc.
6 Motor driven, Steam turbine driven etc.
7 Coal or natural gas or naptha or lignite etc.
8 Any site specific feature such as Merry-Go-Round, Vicinity to sea, Intake /makeup water systems etc. scrubbers etc. Specify all such features
9 Any Special Technological feature like Advanced class FA technology in Gas Turbines, etc.
10 Environmental regulation related features like FGD, ESP etc.
Note1: In case of deviation from specified conditions in Regulation, correction curve of manufacturer may also be submitted.
Note2: Heat Balance Diagrams has to be submitted along with above information incase of new stations.
Note3 : The Terms - MCR, BMCR, HHV, Performance coal, are as defined in CEA Technical Standards for Construction of Electric Plants and Electric Lines Regulations - 2010 notified by the Central Electriticy Authority

Certified that

All documents as prescribed in Reg-3(8) of the CEA Technical Standards for Construction of Electric Plants and Electric Lines Regulations - 2010 have been retained at site and are available at site
All requirements as per Reg-5 of the CEA Technical Standards for Construction of Electric Plants and Electric Lines Regulations - 2010 have been complied
The unit operating capability shall be in conformity to Reg-7(1),7(2),7(3) and 7(4) of the CEA Technical Standards for Construction of Electric Plants and Electric Lines Regulations - 2010
All requirements as per Reg-8 of the CEA Technical Standards for Construction of Electric Plants and Electric Lines Regulations - 2010 have been complied for the Steam Generator
All requirements as perReg-9(2), 9(4), 9(9),9(15), 9(16), 9(18) of the CEA Technical Standards for Construction of Electric Plants and Electric Lines Regulations - 2010 have been complied for the Steam Turbine generator

Petitioner

Explanatory note on provisions of CEA Regulations proposed to be incorporated in CERC tariff process

The important provisions of the Regulations proposed to be incorporated in the tariff application process are as follows:

a. **Turbine Cycle Heat Rate and Boiler Efficiency** – The Regulations prescribe the maximum allowable Turbine Cycle Heat Rates for various unit sizes and Boiler Efficiency for various coal qualities. The intent is to prescribe minimum efficiency criteria through these parameters so as to ensure that only modern technology efficient units are installed. The Regulations prescribe maximum Turbine Cycle Heat Rate of 1850 kcal/kWh for super-critical units. Compliance to the above is considered essential to promote efficient technology so as to ensure lower Greenhouse gas emissions and long term fuel conservation.

b. **Flow margins (VWO and BMCR margins)**- Flow margins are considered essential to ensure long term operating capability of the units at their rated capacity and to compensate/offset for the impact of degradation that may occur with time. These margins also aid and facilitate grid operation in exigencies by allowing certain operating reserve which could be utilised for short term exigencies. The Grid Code also requires that units should be capable of instantaneously picking up additional load of about 5% MCR.

   With the above objectives, the Regulations prescribe a VWO margin of 5% (the turbine VWO flow shall be 5 % more than the MCR flow) and a BMCR margin of 2% over the turbine VWO capacity. Provision of these margins is considered essential to prevent sub-optimally sized units that could face capacity constraints in the long run.

c. **Condenser Back pressure/design cooling water temperature** – It is necessary to ensure that the units are designed for Indian ambient conditions of cooling water temperature/ambient air temperature. The units not designed for specifically Indian conditions may face capacity constraints.

d. **Grid frequency variations, ramp rates and start-ups** – The Regulations prescribe grid frequency and ramp rates suitable for Indian operating conditions and compliance to the above is considered necessary for proper operation under Indian ambient conditions.

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