CENTRAL ELECTRICITY REGULATORY COMMISSION
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4th November, 2008

NOTICE

Sub: Recommendations on Operation Norms for Thermal Power Stations for Tariff Period beginning 1st April, 2009

The advice of CEA on "Norms of operation for the tariff period 2009-14" is enclosed.

Suggestions/comments if any on the norms suggested by CEA may be sent to the Commission by 12.11.2008. It is proposed to consider the advice of CEA before finalizing the regulations on Terms and Conditions of Tariff for 2009-14.

Sd/-
Alok Kumar
Secretary

Table of Contents

1 INTRODUCTION 1

SECTION- 1: GENERAL PRINCIPLES 2

2 PREVAILING NORMS AND THEIR EVOLUTION 2

3 RECENT DEVELOPMENTS 5

4 PRINCIPLES GOVERNING OPERATION NORMS 8

5 APPROACH FOR SPECIFYING NORMS 9

5.1 UNIFORM SINGLE VALUE NORM FOR ALL STATIONS 9
5.2 NORM IN TERMS OF % OF DESIGN VALUE 10

6 DATA RECEIVED 11

SECTION- 2: COAL FIRED STATIONS 13

PART- A – FUTURE AND EXISTING STATIONS 13

7 STATIONS COVERED 13

8 PERFORMANCE ANALYSIS & RECOMMENDATION 14

PLF AND UNIT LOADINGS 14
STATION HEAT RATE 16
HEAT RATES FOR OTHER STATIONS IN STATE AND PRIVATE SECTOR 18
ESTIMATION OF HEAT RATE DEVIATION DUE TO CONDITIONS BEYOND CONTROL OF UTILITIES 21
RECOMMENDED NORMATIVE HEAT RATE 23
AUXILIARY ENERGY CONSUMPTION 27
SPECIFIC SECONDARY FUEL OIL CONSUMPTION (SFC) 29
SFC FOR OTHER STATIONS IN STATE AND PRIVATE SECTOR 33
TARGET PLF AND AVAILABILITY 35
STABILIZATION PERIOD 36
SUPERCRITICAL UNITS 36

PART – B STATIONS COVERED UNDER RELAXED NORMS **38**

9 STATIONS COVERED AND PREVAILING NORMS **38**

10 PERFORMANCE ANALYSIS **40**

PLF AND UNIT LOADINGS 40
STATION HEAT RATE 40
AUXILIARY ENERGY CONSUMPTION 42
SPECIFIC SECONDARY FUEL OIL CONSUMPTION (SFC) 42

11 RECOMMENDATIONS **43**

SECTION- 3: LIGNITE FIRED STATIONS **45**

12 STATIONS COVERED **45**

13 PERFORMANCE ANALYSIS **46**

14 RECOMMENDATIONS **48**

TARGET PLF AND AVAILABILITY 48
HEAT RATE 49
SPECIFIC SECONDARY FUEL OIL CONSUMPTION (SFC) 49
AUXILIARY ENERGY CONSUMPTION 50
LIMESTONE CONSUMPTION 51

SECTION- 4: GAS TURBINE STATIONS **53**

15 STATIONS COVERED **53**

16 PERFORMANCE ANALYSIS **54**

PLF 54
STATION HEAT RATE 54
AUXILIARY ENERGY CONSUMPTION 57

17 RECOMMENDATIONS **57**

SECTION- 5 SUMMARY OF RECOMMENDATIONS **59**

MAXIMUM TURBINE CYCLE HEAT RATE (KCAL/KWH) 60

MINIMUM BOILER EFFICIENCY (%) 60

Table – 35(a) Summary of Recommended Normative Operating Parameters (Existing units) **61**

Table – 35(b) Summary of Recommended Normative Operating Parameters (Future units) **63**

List of Tables

Table-1 Prevailing Norms by CERC 2
Table-2 Norms notified by GOI in 1992 4
Table 3 PLF of NTPC stations 14
Table 3(a) Outages of NTPC stations 14
Table 3(b) Average Unit Loading of NTPC stations 15
Table-4 Operating Vs. Design Heat Rate - NTPC Stations 16
Table-5 Operating Vs. Normative Heat Rate NTPC Units 17
Table-6 Deviation of Operating Heat Rate from Norm -NTPC Units 18
Table-7 Deviation of operating heat rate from design- Non-NTPC stations with 200/500 MW units 19
Table-7(a) Heat rate of Non-NTPC stations with 200 and 500 MW units 19
Table-7(b) Heat rate Deviation for high performing non-NTPC stations 20
Table 8 Auxiliary Energy consumption for NTPC stations 27
Table 9 Secondary Fuel Oil consumption - NTPC 30
Table-10 Unit start-ups 2005-06 & 2006-07- NTPC units 31
Table 11 Startup vs. Total SFC – NTPC units 32
Table 12 SFC of Non NTPC Stations with 200 and 500 MW units 33
Table 12(a) SFC of select high performing Non– NTPC stations 34
Table-13 Relaxed Norms for Specific NTPC stations 39
Table-14 DVC Norms notified by CERC 39
Table-15 PLF of coal fired stations with relaxed norms 40
Table-16 Operating Vs. Normative Heat Rate NTPC Units with relaxed norms 41
Table-17 Operating Vs. Design Heat Rate DVC Units 41
Table-18 Operating Heat Rate DVC Units 42
Table 19 AEC for Stations with Relaxed Norms-NTPC & DVC 42
Table-20 SFC for Stations under relaxed Norms- NTPC & DVC 43
Table-21 Prevailing Norms by CERC for Lignite Stations 45
Table 22 PLF of NLC Stations 46
Table 23 Normative Heat rate and Deviation of operating heat rate from norm for last 5 years –NLC stations 46
Table 24 SFC for NLC Stations 47
Table 25 AEC for NLC Stations 48
Table-26 Sulphur content in existing and future stations of NLC 51
Table- 27 List of Gas Based Stations 53
Table-28 Prevailing Norms for GT Stations 53
Table 29 PLF of GT stations 54
Table-30 Operating Heat Rate of GT Stations 55
Table 31 Deviation of Operating Heat Rate From Norms GT Stations 55
Table 32 Deviation of Operating Heat rate from Design Heat Rate- GT Stations 56
Table 33 Impact of Liquid Fuel on Design Heat rate - GT Stations 56
Table 34 AEC for GT Stations 57

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	**<u>All Coal fired Units</u>** 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	**<u>All Coal fired Units</u>** 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 12th May 2008 and CERC/Engg/Tariff/T&C from 1.4.09/ dated 12th 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	Capacity 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 2005-06	Total Starts 2006-07	Start ups per Unit 2005-06	Start ups per Unit 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.

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.

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