PART LOAD OPERATION- EFFICIENT AND INNOVATIVE APPROACHES

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1. ABSTRACT

India's Prime Minister has vowed to go **"above and beyond"** the Paris Agreement on climate change and with the US withdrawal from the agreement India is poised to utilize the opportunity to fill the leadership void in the global climate change governance. India is moving toward a clean energy revolution and is well on course to achieve the targets of Paris Agreement. India has upscaled the target of National Solar Mission, recently became the fourth largest producer of wind energy and announced the plans to cancel 14 GW of coal based plants.

In the current scenario of a global push towards clean energy, reliable and economical operation of coal fired power plants with frequent start-ups/shut-downs, large variation of load in a short interval of time and part load operation for a sustained period will be a challenge in future.

Operating the coal fired units at part load up to 55% of MCR for a sustained period due to the new **CERC guidelines**, large ramp-ups/ramp-downs due to RRAS and frequent start-ups/shut-downs due to low schedule are new norms at NTPC Dadri. We are already facing the challenges which other power stations are envisaging in future and we at NTPC Dadri are reliably and efficiently steering through this volatile period of energy demands.

This paper discusses various challenges faced during part load operation at NTPC Dadri and various effective and innovative solutions such as **"Single BFP Operation"** and **"Single CEP Operation"**. Total savings because of adopting these approaches has also been presented.

The share of renewable energy will grow in future therefore the fossil fuel power plants will have to be run even **below the current technical minimum of 55% of MCR.** In the end of this paper we have suggested a few processes and modifications which will enable the running of our thermal power plants below the 55% capacity, reliably and efficiently

2. PART LOAD OPERATION AT NTPC DADRI

2.1 INTRODUCTION

Due to new **CERC** norm, the technical minimum schedule for operation of central generating stations and inter-state generating stations was revised **to 55% of MCR loading**. Increased share of renewable energy, **RRAS** requirements, and the new norm for technical minimum have lead to variable scheduling with the quantum of variation in schedule revision being quite high. This has lead to large variation in load generation and units being run at around 55% of capacity for a considerable period at NTPC Dadri. Figure-1 shows the load generated at Dadri Stage II in the month of October. We can clearly see that the unit was run at part load (Load<300MW, blue coloured curve) for a considerable period of time.

Figure-1

2.2 CHALLENGES AND STRATEGIES FOR RELIABLE OPERATION

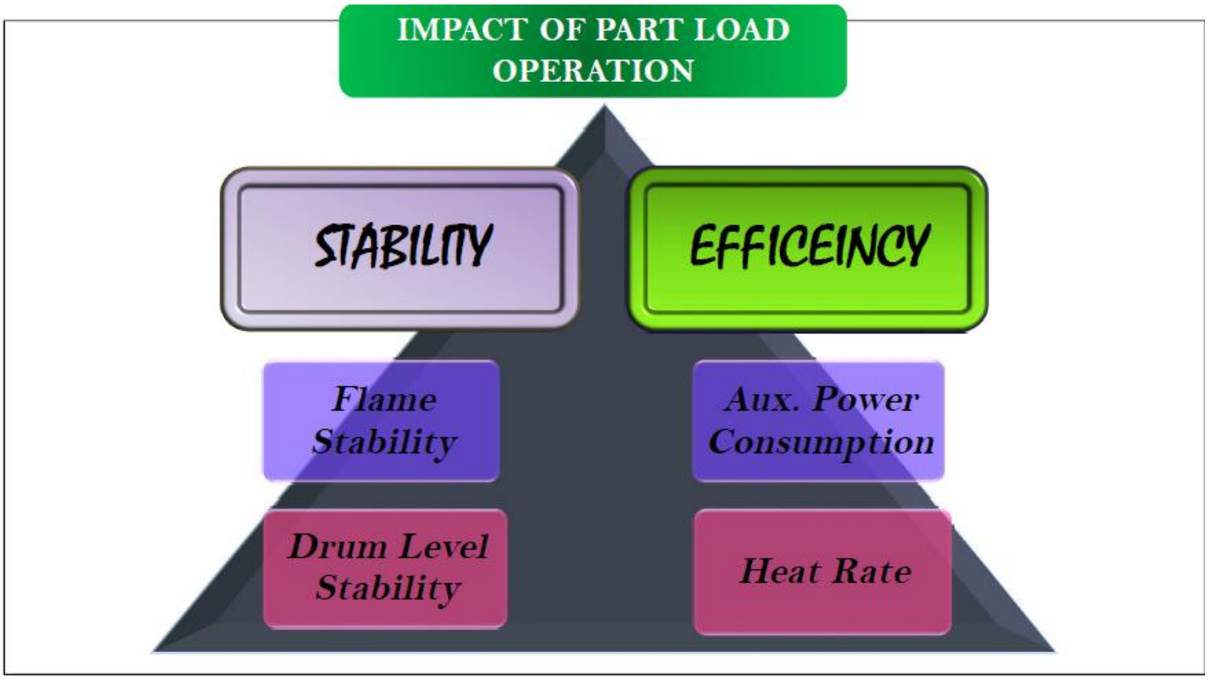
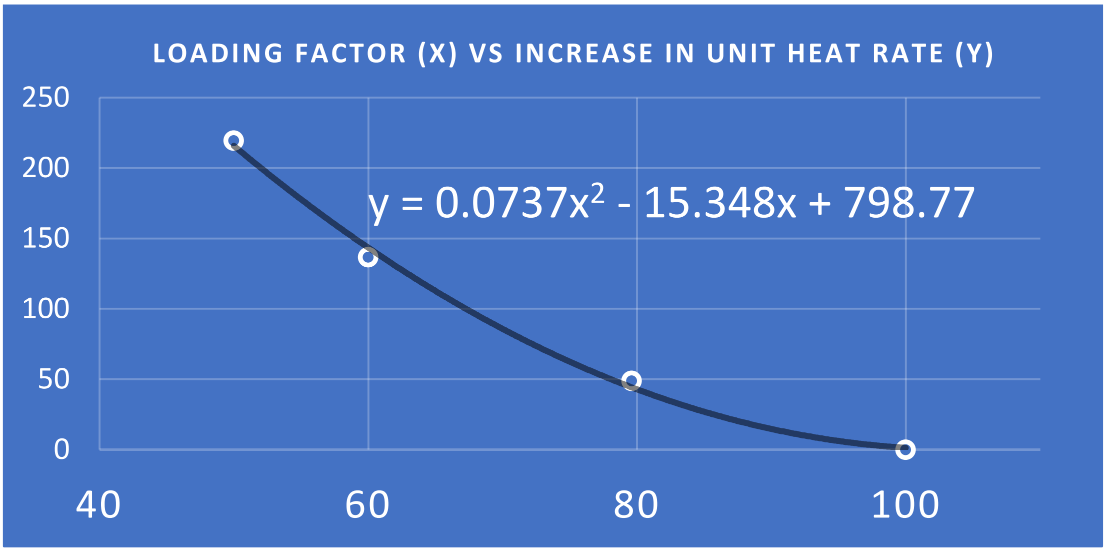


Figure-2

1. **Deterioration in Unit Heat Rate**. The following graph and table shows the increase in unit heat rate with unit loading factor of Dadri Stage II units.

$$\textit{Unit Heat Rate} = \frac{GTCHR}{\textit{Boiler efficiency}} \times 100$$



Stage-II Units (2X490MW)		
Loading Factor Reduction		Increase in Heat Rate/ % Loading factor decrease
From	**To**	**kCal/kWhr**
100%	80%	2.44
80%	60%	4.39
60%	50%	8.28
100%	50%	4.39

2. **Increase in % APC**, which leads to financial losses. We have already adopted various practices to reduce APC at part loads such as:

   a) Single TGECW operation

   b) Single ACW operation or all ACWs stopped at lower CW temperature during winters.

   c) Intermittent operation of raw water and clarified water pumps according to forebay level.

d) Three CWs operation during winters.

e) Two BCWs operation at all loads.

3. **Boiler flame stability:** At part loads, decrease in coal flow accompanied by bad grade coal leads to flame getting unstable. The following figure-3 shows the flame condition at part load operation for a sample period:

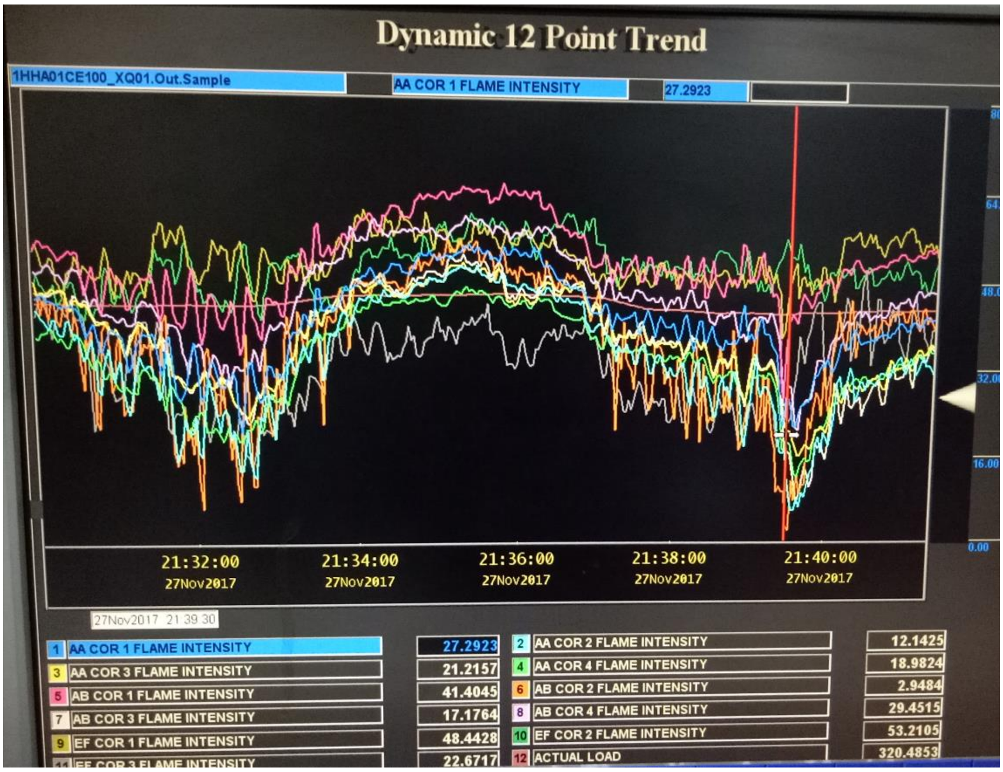


Figure-3

To stabilize the flame condition we run four **continuous** Mills, do Mill changeover and run lower Mills if required, and reduce burner tilt to 50% or lower but it sacrifices HRH temperature.

4. We have fine tuned a few auto loops like superheater spray control and reheater spray control. Drum level control and CMC may further be tuned for better response at part loads.

5. MS temperature excursion due to low throttle pressure which leads to large variation in super heater spray and loss of efficiency which restricts sliding pressure operation. We have to run the unit at higher throttle pressure even at part load.

6. Due to large variation in schedule, achieving a large ramp rate from part load condition becomes difficult. To overcome this difficulty SPAA-P3000 Condensate throttling and unit control module have been commissioned in Unit#6, showing good results.

7. RGMO influence is always kept ON which causes large pressure variations at part loads, this leads to drum level fluctuations and flame instability.

8. TDBFPs recirculation getting opened at part loads which leads to large fluctuation in drum level. Figure-4 shows the fluctuation in drum level and feed water flow at part load for a sample period.

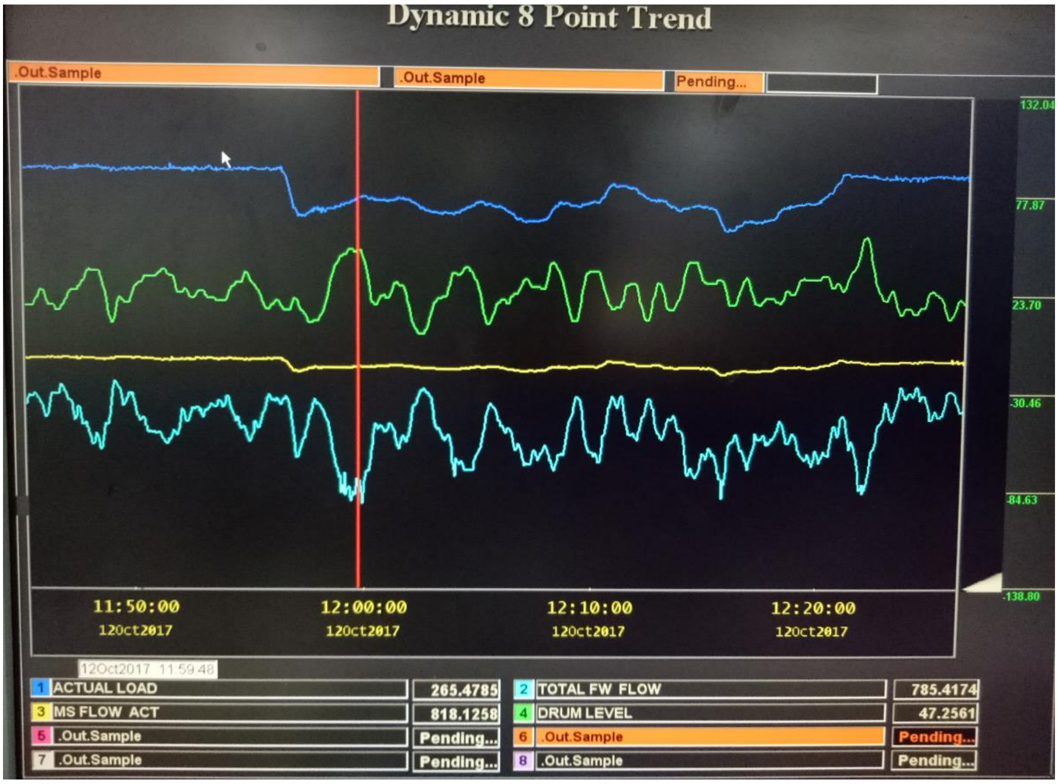


Figure-4

In order to overcome this hurdle we have proposed “Single TDBFP Operation” which is explained later in this paper.

9. Thermal fatigue in boiler and turbine due cyclic variation in temperature.

10. Deterioration in HRH temperature which leads huge financial losses. 1˚C loss in HRH temperature leads to a loss of 0.6 MW. We have proposed to do LRSB operation in re-heater area even at part loads also to improve HRH temperature.

11. Less opportunities for Boiler surface cleaning (Wall Blowing and LRSB operation). We do Wall Blowing and LRSB operation whenever we get opportunity at higher schedule.

12. DSM issues at technical minimum load (AG >=SG).

3. INNOVATIVE APPROACHES FOR BETTER AND STABLE PART LOAD OPERATION AT NTPC DADRI

3.1 SINGLE BFP OPERATION

NTPC Dadri has adopted an innovative practice of running only one BFP at part loads (Load <126 MW for Stage I & Load<300 MW for Stage II)

NTPC Dadri Stage-I has three MDBFPs in each unit with an original scheme of running two MDBFPs and keeping one in standby. As the part load operation has become common at NTPC Dadri so the original logics have been modified for single BFP operation. The following table-1 shows the reduction in APC and financial gains due to this:

Date	Unit Load MW	Total feed water power KW	Total BFP suction flow TPH	SEC KW/TPH	ECI KW/MW	Feed water flow TPH
10/2/2017	116.5	3026.6	362.4	8.4	26.0	351.3
10/24/2017	117.5	2376.2	361.3	6.6	20.2	348.5
	Saving of BFP power by Single BFP operation				**700 KW**	
	Saving per day				0.0189 MU	
	Saving per day				**Rs 0.5376 Lac**	
	Reduction in Unit APC				0.40 %	

Table-1

NTPC Dadri Stage II has two TDBFPs and one MDBFP design in each unit. There was a practice to run one TDBFP and MDBFP together whenever the other TDBFP was under permit.

Dadri Stage II has now adopted an innovative approach to reduce the auxiliary power consumption when one TDBFP is under shutdown. We run only one TDBFP till 300 MW load with MDBFP in standby. This practice has helped to reduce the total APC. Table-2 shows a comparison of power consumption by BFPs (Steam consumption equivalent in MW for TDBFPs) in Unit#5 during the shutdown of TDBFP-5B on 18/11/2017. We can see that there is a considerable saving of auxiliary power during single TDBFP operation.

BFPs POWER CONSUMPTION DATA

(Steam consumption in TDBFP has been converted into MW equivalent)

Date	Time	Unit#5 Load	TDBFP-5A	TDBFP-5B	MDBFP	Total
18-11-17	0455hrs	267 MW	4.1 MW	3.96 MW	0 MW	8.06 MW
18-11-17	2320hrs	290 MW	4.2 MW	0 MW	5.93 MW	10.13 MW
19-11-17	0330hrs	266 MW	6.33 MW	0 MW	0 MW	6.33 MW
19-11-17	0700hrs	278 MW	6.4 MW	1.4 MW (rolled @ 3000rpm)	0 MW	7.8 MW

Table-2

1. Total Saving while running only one TDBFP in comparison to running two TDBFPs at part Load: 8.06 MW-6.33 MW= **1.73 MW**

2. Total Saving while running only one TDBFP in comparison to running one TDBFP and one MDBFP.

SUGGESTION

Dadri Stage II units runs below 300 MW load for a considerable period in 24 hours as shown earlier in Figure-1. After analyzing various parameters associated with the BFPs power consumption we have come to the conclusion that it is always efficient to run only one TDBFP and the other TDBFP in ready to load condition (rolled @ 3000rpm) till 300 MW unit load. Total gain in power consumption by following this approach is shown in Table-2 Last row.

3.2 SINGLE CEP OPERATION:

We have adopted an innovative approach to reduce APC during part load operation of Dadri Stage II units by running only one CEP at Load<300 MW. Following steps were taken to achieve single CEP operation:

1. De-aerator level controller pressure control mode set point reduced to 23 ksc.
2. If load set point is increased above 300 MW with one CEP in service then alarm will be generated.
3. Alarm is generated if De-aerator level controller shifts to pressure control.

A detailed investigation of various parameters with only one CEP in service at unit Load<300 MW was done. We found out that by running one CEP a total of **300KW power** was saved.

4. SUGGESTIONS FOR FUTURE:

As the share of renewable energy will increase in future, the thermal power plants will have to be run at loads even further below the 55% of the capacity. There is a scope to run these units at even 40% of the capacity with new approach and modifications. In this paper we are proposing few modifications and processes in order to run the units reliably and efficiently at loads even lower than 55% capacity.

1. Three continuous Mills operation.
2. One BCW operation.
3. Single TDBFP operation on sustained basis.
4. Maintaining De-aerator pressure and temperature from APRDS/CRH.
5. Single ID/FD/PA operation.
6. Installation of Boiler Stress Monitoring system
7. Blade Vibration Monitoring System.
8. Advanced Flame Scanners.
9. Improved automation (control loops & logics) and instrumentation.
10. Better blending for maintaining consistent quality of coal
11. Online GCV monitoring
12. Online Coal sampling

REFERENCES

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3. *Power Plant Performance by A.B Gill*
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AUTHORS:

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