System Improvement in Super Thermal Power Stations by Distributed Control System (DCS) – KSTPS Stage-I 2x110 MW: A Case Study

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ABSTARCT

A thermal power plant is run with an objective to reduce - tube failures, un-burnt coal, plant down time, operating cost as well to increase the production. It is desirable to have minimal maintenance and Plant Load Factor (PLF) achieved is better than 90%. To achieve these goals higher, recently at Kota Super Thermal Power Station (KSTPS) the plant control system was upgraded at unit – 1 & 2 from Trans-data technology to Distributed Control System (DCS) technology. The Unit – 1 & 2 represent 2 X 110 MWs capacity. The up gradation was carried out in 2010. The objective was achieved with remarkable improvement in the Un-burnt coal, Boiler Tube leakage and plant availability > 95%. This paper aims to present the salient features of this up gradation along with overall results as a case study. It also indicates the significance in cost and environmental saving achieved.

Keywords

DCS, SADC, Local Pneumatic Controllers.

1. INTRODUCTION

1.1 General Plant details

Kota Super Thermal Power Station (KSTPS) is the first major coal based thermal power station in the state of Rajasthan in India, located on the left bank of Chambal River at Kota. Its present installed capacity is 1240 MW. Since inception KSTPS has always adopted use of better technologies and engineering practices to achieve higher efficiency, more production, minimal down time and minimisation of environmental hazards. As a result, KSTPS could establish a record of excellence and has earned meritorious productivity awards from the Ministry of Power, Govt. of India during 1984, 1987, 1989, 1991 and every year since 1992-93 onwards. In 2008-09 its Gross Generation was 8874 MU at 94.76% PLF with Auxiliary Power consumption 9.37% and Sp. Oil consumption 0.43 ml/kWh. Table – 1 exhibits the abstract of its last 5 years performance at a glance:

Table – 1 : PERFORMANCE of KSTPS

Year	Generation achieved (MU)	P LF (%)	Aux. Power Consp. (%)	Spcfc. Coal Consp. Kg/Kwh	Spcfc. Oil Consp. ml/Kwh	Cost of Power sent out (Paisa/Kwh)
2005-06	8294.15	90.60	9.27	0.650	0.48	161.60
2006-07	8162.63	89.17	9.36	0.675	0.57	165.51
2007-08	8395.46	91.46	9.37	0.684	0.50	175.17
2008-09	8674.16	94.76	9.37	0.674	0.43	213.98
2009-10	8584.32	89.65	9.54	0.681	0.70	236.80
2010-11(up to Feb'11)	7691.79	90.14	9.76	0.677	0.57	

1.2 Distributed Control System (DCS)

DCS is the state-of art technology for power plant control systems. DCS initiates, monitors, regulate and control every activity in the plant. The operators can also monitor the plant from a centrally located place. Under DCS all the controls and parameters are so distributed that even failure of any of the part/subassembly in the control system cannot affect the operation of the plant. The DCS apart from controlling the plant, generates various data/information and analyse the parameters to predict the best possible performance of plant.

2. WEAKNESS IN OLD SYSTEM AND PROBLEM AREAS

With an objective to achieve higher performance, a detailed study of the old control system was carried out and bottle necks of the system were identified. All the sources causing problems in control system areas at Stage-I of the plant were identified as under :

(i) Auto Control and Measurement System :
Original control system was designed over Trans-data technology based Mini cards (George Kent Range) in 1983 for the KTPS Unit # 1 & 2 (2X110 MW). The complete system was

envisaged for controls and Measurement system etc. The Trans-data Mini card system technology concentrated only on the voltage based sensing and measurement techniques and thus has several limitations and deficiencies.

(ii) Secondary Air Damper Control System (SADC) : The SADC System was installed in year 1983. It made use of Pneumatic Signals from controllers installed in the Control Room, which were connected to various SADC Power Cylinders at Wind Box through 180 meter to 250 meter long plastic tubing. This length was a cause for further signal transportation lag/delay. Wind Box DP signals were transmitted from Pneumatic Transmitter installed in the field. The connection was through plastic tube to SADC Panels and that was prone to leakages. Limitations / problems in carrying the pneumatic signal from field to control room and than to SADC dampers affected the process such that it was cumbersome to achieve fine Damper control & desired level of Boiler Performance.

(iii) Local Pneumatic Controllers :
Under old system, Local Pneumatic Controllers were installed for Close Loop Control of various parameters related to Pressure, Level and Temperature. These Local Pneumatic Controllers had been installed in the field and were operative only from the field itself. Under field conditions, round the clock continuous exposure and higher temperatures in its operating zone were source of frequent outages. That made gradually difficult to achieve the performance of controlled parameters on regular basis.

3. SOLUTIONS & REMEDIES ENVISAGED:

(i) Auto Control and Measurement System : After detailed study of the existing Control system, present-day trends and hierarchy followed in the new Units of Rajasthan Vidhyut Utpadan Nigam Ltd (RVUNL), the adoption of Distributed control system for Kota Super Thermal Power Station Stage-I was examined. It was adjudged most suitable solution available and also an easier solution, which could have been adopted by the Operation and Maintenance personnel working for the plant.

(ii) Secondary Air Damper Control System (SADC)
During the study of the SADC system, two major defects were observed. First, travel of pneumatic signal from control room to the field through PVC pipes of 250 m long length. Due to aging they had become prone to air leakage and caused decrease in air pressure at the Actuator level. The probable solution was to replace the pneumatic signal with Electric signal. For arranging electric signal Microprocessor based Electronic Controllers were required. It was the advantage of the DCS that the same was in-built in the DCS making system simple to integrate and reliable. Second, it was also observed that Pneumatic Actuators installed in the field had already lived their useful life and needed replacement.

(iii) **Local Pneumatic Controllers**
The local controllers were also having same delay problem, needing either Microprocessor based Electronic Controller or to have DCS and interface the signal with DCS. Selection of DCS made it an automatic choice to adopt the DCS for replacing Local Controllers.

3. OBSERVATION AND MEASUREMENT

To adjudge the net effect of new system over the old one, the following data/statistics were observed and measured. Table – 2 exhibits various parameters for plant performance apriori to up gradation at the KSTPS Stage-I.

Table – 2 : Aprioi performance parameters

S.No.	Parameter	Data/Statistical range/averages
1	Un- Burnt Carbon in Fly Ash	3.0 % to 3.7%
2	Un-Burnt Carbon in bottom Ash	3.5% to 4.0%
3	Turbine I/L Pressure	Varies with Coal Quality
4	SH/RH Out Let Temperatures	Varies with Coal Quality
5	Unit Load	Varies with Coal Quality
6	Heat Rate	3050 kcal/kwh

The upgradation was completed in 2010, and post up gradation data were logged and analysed. Table – 3 summarises the various parameters for plant performance posteriori up gradation at the KSTPS Stage-I.

Table – 3 : Posteriori performance parameters

S.No.	Parameter	Data/Statistical range/averages
1	Un- Burnt Carbon in Fly Ash	0.6 % to 0.9%
2	Un-Burnt Carbon in bottom Ash	0.9% to 1.2%
3	Turbine I/L Pressure	$130\ kg/cm^2 \pm 1\ kg/cm^2$
4	SH/RH Out Let Temperatures	535 °C ± 5 °C
5	Unit Load	110 MW ± 2 MW
6	Heat Rate	2850 kcal/kwh

4. RESULTS AND DISCUSSIONS

Table-2 & 3 reveals and clearly establishes significant improvements in plant performance after commissioning of DCS. It has improved significantly in respect of parameters 1, 2, 6 directly, while it could bring performance under norms and predicted range which was varying earlier due to coal quality. We present the advantages and cost benefits below.

(i) Major Advantages
Under the old control system SADC and Secondary Air control (O_2 control) were done manually and a change in air was totally dependent on operating personnel. Under the new system, both the control loops are automated and thus frequent changes with the change in load is regulated by the auto system instead of operating personnel. It is evidenced by reduction in "un-burnt coal" parameter, which has got reduced to 0.6 to 0.9% in fly ash and 0.9 to 1.2% in bottom ash. Prior to DCS, these parameters were more than 3%. This is a major saving on account of reduction in un-burnt coal and will give recurring benefits to the plant.

Implementation of Steam Temperature control of SH & RH, has achieved reduction in the number of tube failures at both the units, in comparison to old system. Under old system SH & RH temperature control was done manually, as there was no provision and performance depended upon alertness of operators.

(ii) Other Advantages

Under the old system Header Pressure, Mill out-let temperature control and Feeder Speed controls were performed manually due to no provision in the control system. This resulted in sluggish response of control system. DCS has improved the performance of auto loops and it has resulted in better and smoother performance of control loops easier for operation staff and better monitoring of parameters for ultimate analysis. Now machine is running in Boiler Pressure control mode with constant load and stable boiler parameters.

(iii) Cost savings

The following calculations present an estimate of Per Day Saving on account of Un-Burnt coal and resultant saving annually for one plant.

Total Coal Consumption - 2000 tons / Unit
Ash content - 35%
=> Total Ash – 2000 X .35 = 700 tons
=> Fly ash in Total Ash 80% = 560 tons
=> Bottom ash in total Ash 20% = 140 tons
Improvement in Fly Ash Carbon – Avg. 3.35% to 0.75%
Improvement in Bottom Ash Carbon - Avg. 3.75% 1.05%
Current approx. Rate of Coal - @ Rs. 2,353 / ton
=> Saving in Fly Ash - 560 X 0.026 X 2353 = @ Rs. 34,259=68 per day
=> Saving in Bottom Ash - 140 X0.027X2353= @ Rs. 8,894=34 per day
=> Total Saving per day = Rs. 43,154=02
=> Total Saving per year = Rs. 1,57,51,217=30

5. CONCLUSION

The above study and measurement establishes that adoption of DCS has brought in significant technical performance advantages, cost savings and environmental advantages for KSTPS stage I & II. The cost spent can be recovered in short span of time.

6. REFERENCES

[1] Technical Specification of Stage-I, KSTPS documentation of plant-I design.

[2] Daily Log sheets of various Parameters (Stage-I) for last six years, KSTPS, Kota.