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Vibration Analysis of Turbo Generator in Kota Super Thermal Power Station

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Abstract: ***Super Thermal Power Stations (STPS) or Super Power Station are a series of ambitious power projects planned by the Government of India. With India being a country of chronic power deficits, the Government of India has planned to provide 'power for all' by the end of the plan, The capacity of thermal power is 1000 MW and above. This paper presents an analysis of steam turbine vibration monitoring system of kota super thermal power plant. In this paper, a detailed concept and techniques used in turbine vibration monitoring, monitoring equipments and vibration analysis of turbo generator of 195 MW, UNIT-7 has been discussed to evaluate performance of turbine. A detailed report on vibrations of bearings corresponding to the bearing temperatures of turbo generator has been done by using IRD 880 instruments.***

Keywords: power generating plant, steam turbine, shaft vibration, bearing, turbo generator**.**

1. Introduction

Energy consumption in India is become very important aspect to improving the power production by using different input energy resources. To improve the power production we have many ways that are useful for fulfill the demand of energy. Condition monitoring and analysis of turbine vibration of power plants has another way to minimize unnecessary shut down and reduce maintenance cost the of turbo generator. Reducing maintenance and shut downs use reduces energy costs and may result in a financial cost saving to consumers. Preventive maintenance is most important aspect to reduce the unwanted failure of turbo generator .condition monitoring of turbine vibration with fluctuating load has been measured by using different equipments and sensing devises continuously with time. This monitoring system used to check out the real time vibration occurs in turbine shaft and bearings during operation. This solution is cost effective as maintenance can be planned without influencing the total availability of the plant. Condition characteristics of the machine such as bearing damage, unbalance, alignment or cavitations enable a differentiated evaluation of mechanical stress which will keep all on track for when to have the shut down and the process is ongoing without any manual interruption. Hence we will be able to protect the equipment from expensive consequential costs. The machines can be taken for maintenance, without dismantling, just by knowing the health of the machine which is possible by online monitoring. Implementing predictive maintenance leads to a substantial increase in productivity of up to (35%). Preventing unpredicted shutdowns on one hand and anticipating corrective operations on the other can be carried out under the best conditions. Knowledge of the root cause of the malfunctioning of the machine can help expedite the actions that are needed to be taken instead of shutting down the whole system. This is nothing but predictive maintenance for prediction of the health of the machine. Here the performance level is decided with the help of the reports taken at intervals. There is rapid notification and fast error detection. Diagnostics feature give the root cause of the failure of machinery.

2. Causes of Vibration in Turbine

There are several reasons for vibration in machines. They can be due to:

- Unbalance of shaft
- Bearing of the rings
- Fluid coupling problem
- Shaft misalignment
- Oil whirl and other dynamic instabilities problem
- Cracking of the ring

These problems can gradually become very severe and result in unplanned shut downs. To avoid this, shutdowns are planned. Time Based Maintenance System (TBM) is called preventive maintenance. One can extend the life of the machines by monitoring these online in a cost effective way. Vibration Monitoring and Analysis is the easiest way to keep machines healthy and efficient in the long run and increase the overall efficiency of the plant. It reduces the overall operating cost as well as the down time period. Vibration sensors are used to predict faults in a running machine without dismantling it and give a clear indication of the severity by showing the amplitude of vibration.

2.1. Vibration Instrument (IRD 880)

The IRD Model 880 Spectrum Analyzer/Dynamic Balancer is a portable instrument designed for industrial use in detecting and resolving machinery vibration problems. Using the Model 880, an operator can perform many analysis techniques that are essential to obtain comprehensive vibration data. Also, precision in-place balancing can be performed using the single plane or two plane methods. Pressing a single switch generates a completely annotated hard-copy frequency spectrum from 600-600,000 cpm in only 25 seconds. You can also obtain low frequency measurements down to 60 cpm. A single

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sensor measures machinery vibration in displacement, velocity, acceleration, and Spike Energy units.

Features:

- Digital amplitude or frequency display provides a high precision readout for balancing and analysis.
- Analog amplitude and frequency meters supplement the digital displays and aid in analyzing unsteady signals.
- Automatic tabular listing of spectrum frequency peaks and amplitudes.
- Chart speed selector with three time-plot speeds records short transients and slowly changing vibration over a number of hours.
- Automatic "order" indication of the spectrum frequency peaks to show harmonic relationships of frequency peaks to rpm.
- Diagnostic capability includes hard-copy tabular readout of the most likely causes of vibration.
- Prints out AVERAGE, MINIMUM, and MAXIMUM overall values tor both spectrum and amplitude vs. time plots.
- Event marking feature prints a short vertical line to indicate the precise time of events on amplitude vs. time plots.

3. Observation

My observations are related to the measuring and analysis of vibrations corresponding to the bearing temperature of turbo generator at unit-7 in kota super thermal power station. Vibrations in bearings corresponding to bearing temperature of turbo generator are taken by using mechanalysis instrument IRD 880. I have observed and measured bearing vibrations as well as bearing temperature on 09-03-2015. Number-1, 3, 4,5,6,7 are Radial Journal Bearings and Number-2 is Thrust Bearing and Radial Journal Bearing.

The vibrations of these bearings of turbo generator are taken in three ways

1. Vertical Displacement
2. Horizontal Displacement
3. Axial Displacement

Table 1: Turbine Parameter

S. No.	*Parameter*	*Pressure (Kg/Cm^2)*	*Temperature (°C)*
1.	Main Steam	117	531
2.	C.R.H.	32.3	380
3.	H.R.H.	31.4	531
4.	Curts Wheel	99	_
5.	Thrust Bearing	_	59
6.	LP Exhaust Hood	_	59

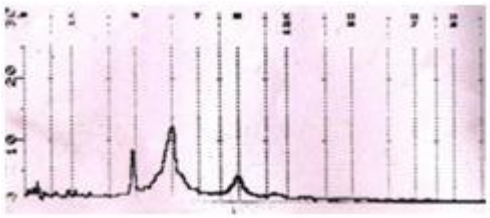
- Lube oil temperature before cooler (c) - 44 .1
- Lube oil temperature after cooler (c) - 99

Table 2: Generation Parameter

S. No.	*Miscellaneous*	*HP*	*IP*	*LP*
1.	Eccentricity	13.31	24.41	24.7
2.	Expansion O.A	27.1	1.65	_
3.	Expansion Diff.	2.10	2.07	2.07

4. Analysis and Results

- The following plots are generated by IRD 880 instrument. These plots are between the displacement amplitude of vibration and frequency in cpm (k).
- The maximum displacement amplitude observed in bearing no. 4,5,and 6.



Figurer 1(a): Frequency (K) – Vertical Displacement (V)

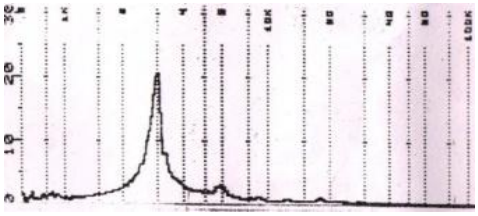


Figure 1(b): Frequency (K) – Horizontal Displacement (H)

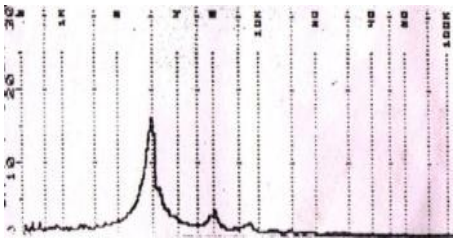


Figure 1(c): Frequency (K) – Axial Displacement (A)

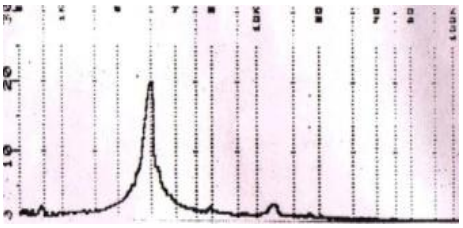


Figure 2(a): Frequency (K) – Vertical Displacement (v)

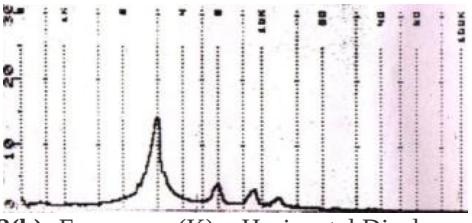


Figure 2(b): Frequency (K) – Horizontal Displacement (H)

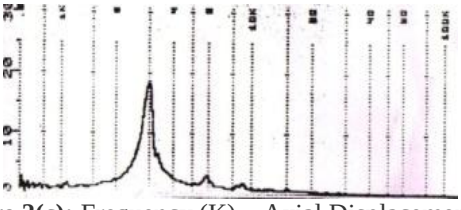


Figure 2(c): Frequency (K) – Axial Displacement (A)

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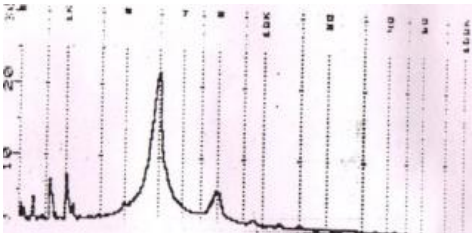


Figure 3(a): Frequency (K) – Vertical Displacement (V)

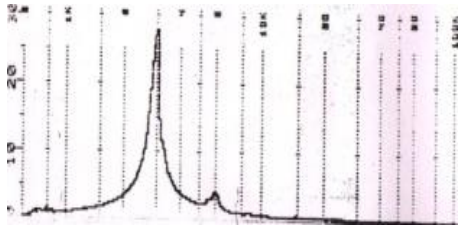


Figure 3(b): Frequency (K) – Horizontal Displacement (H)

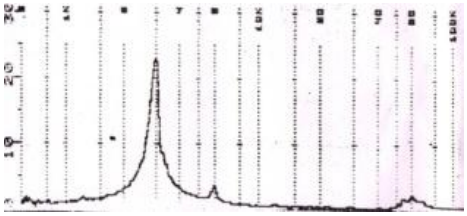


Figure 3(c): Frequency (K) – Axial Displacement (A)

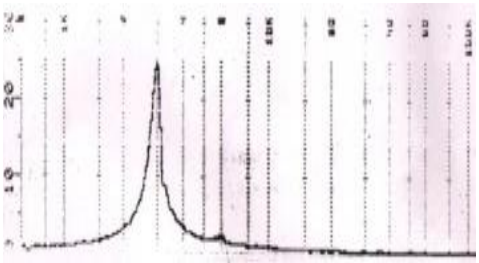


Figure 4(a): Frequency (K) – Vertical Displacement (V)

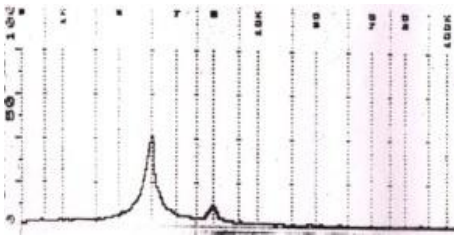


Figure 4(b): Frequency (K) – Horizontal Displacement (H)

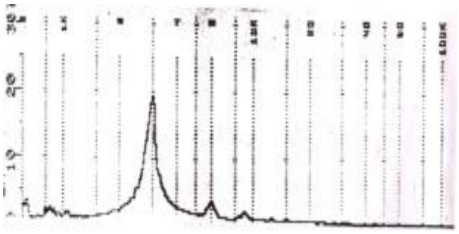


Figure 4(c): Frequency (K) – Axial Displacement (A)

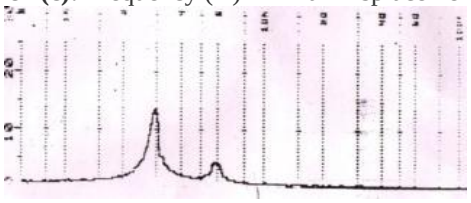


Figure 5(a): Frequency (K) – Vertical Displacement (V)

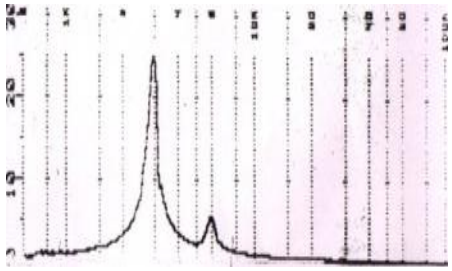


Figure 5(b): Frequency (K) – Horizontal Displacement (H)

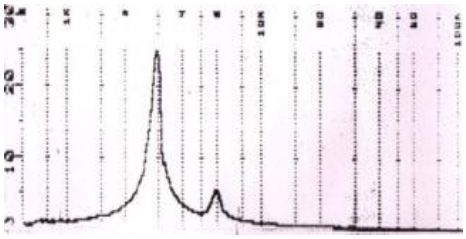


Figure 5(c): Frequency (K) – Axial Displacement (A)

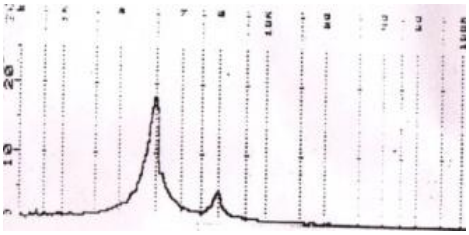


Figure 6(a): Frequency (K) – Vertical Displacement (V)

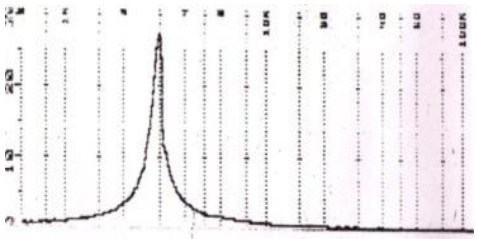


Figure 6(b): Frequency (K) – Horizontal Displacement (H)

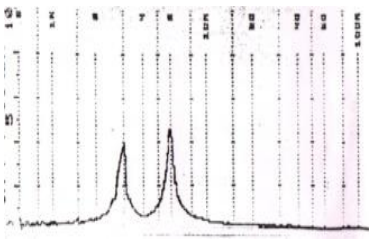


Figure 6(c): Frequency (K) – Axial Displacement (A)

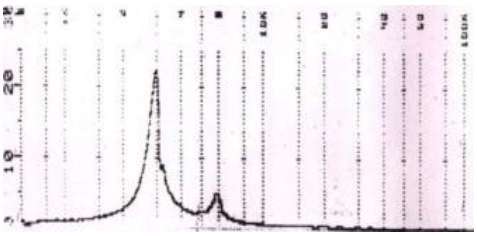


Figure 7(a): Frequency (K) – Vertical Displacement (V)

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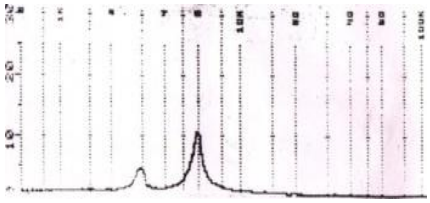


Figure 7(b): Frequency (K) – Horizontal Displacement (H)

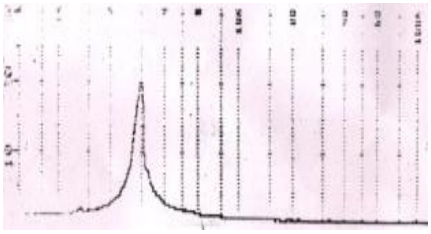


Figure 7(c): Frequency (K) – Axial Displacement (A)

4.1. Analysis of Datas

Standard values for different parameters are as follows:-

Radial vibration displacement –

- 100 micron peak to peak unit shut down limit.
- 35 micron rms value alarming limit.
- 50 micron peak to beak alarming limit.
- Radial Vibration velocity - 6.4 mm/ Sec., rms value - 8 mm/ sec. peak to peak.
- Absolute shaft vibration - 120 micron peak to peak alarming limit
- 200 micron peak to peak Unit shut down limit.

Axial vibration amplitude –

- ½ of highest radial vibration (displacement & Velocity) i.e. 25 micron alarming limit.

Table 3: Results from the figures.

Bearing No.	*Vibration (Micron / Mm Per Sec.)*			*Bearing Tempera-ture (°C)*
	Vertical	*Horizontal*	*Axial*	
1.	12/1.2	20/1.6	16/1.2	68
2.	20/1.8	15/1.2	16/1.1	67
3.	22/2.1	28/1.7	22/1.4	72
4.	25/2.1	30/1.2	20/1.2	77
5.	12/4.3	25/1.6	28/1.4	75
6.	18/7.4	30/4.2	5/2.1	53
7.	20/4.3	22/3.8	10/4.0	51

5. Conclusion

- The maximum vertical displacement measured in bearing no. 4.
- The maximum horizontal displacement measured in bearing no. 4 and 6.
- The maximum axial displacement measured in bearing no. 5.
- The maximum bearing temperature measured in bearing no. 4.
- The maximum vertical velocity measured in bearing no. 6.
- The maximum horizontal velocity measured in bearing no. 6.
- The maximum axial velocity measured in bearing no. 7.

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