FAILURE OF HP CONTROL VALVE IN 210 MW STEAM TURBINE

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ABSTRACT:

At NTPC Dadri Stage-I Turbines (4X210MW) are of KWU make. It consists of two sets of HPCV, which regulate the steam flow to the turbines. Recently a problem was faced in which the Unit load was not increasing beyond a particular value, which was due to the failure of HPCV. The paper covers the root cause analysis of the problem.

INTRODUCTION:

Turbine control valves regulate the flow of steam to the steam turbine so as to control its speed or increase or decrease load as per requirement. The variation in load during the operation of a steam turbine can have a significant impact on its performance. In a practical situation the load frequently varies from the designed or economic load and thus there always exists a considerable deviation from the desired performance of the turbine by varying HP control valve opening. In 210 MW machine there are two sets of HP control valves and IP control valves.

FUNCTION AND WORKING OF CONTROL VALVES:

HP control valves are operated through hydraulic servomotor. HP control valve is coupled with hydraulic servomotor which is used for operating the control valve. Valve opening and closing is done by governing system of the Turbine. Control valve (Fig. 1) consists of valve cone with spindle (item No.04) which moves inside valve cover bush (item no. 3) to regulate the steam flow by varying the gap between valve cone and valve seat.

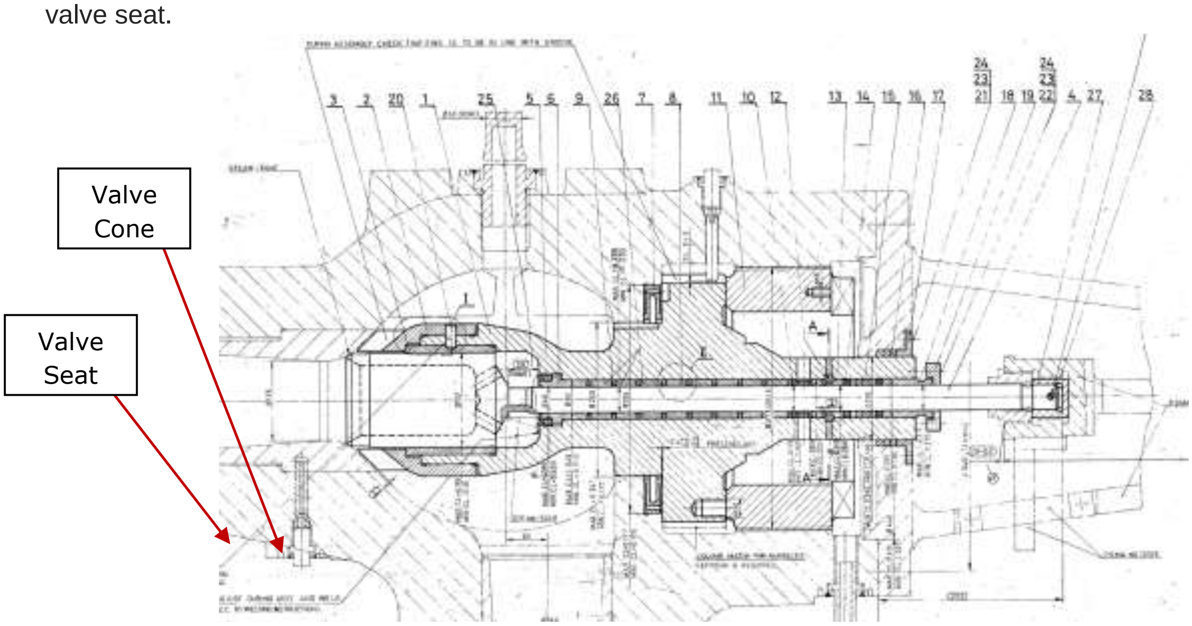


Fig. 1:-HP CONTROL VALVE

PROBLEM FACED:

It was observed that Unit load was not increasing beyond 203MW.

Following observations were made:

Parameters at 203 MW - Drum pr-163.3 ksc, Selected throttle pr-145.8ksc, MS Pr(HPBP) - 152.1ksc, 1st stage pr- 125.3ksc, EHC/HPCV-1,2/IPCV-1,2 - 100%, HRH pr 33.61ksc; Vacuum - 0.93ksc.

1. Boiler side MS pressure-L/R were matching before synchronization, however 2-3ksc pressure difference developed at load and maximum difference was approx. 6ksc.
2. HPBP and LPBP passing checked in local and found normal.
3. On raising load beyond 170 MW, **HPT shaft F/R** vibrations were increasing and hunting as well (Fig.2). Maximum value of HPT Front shaft vibrations (1x/1y) reached up to 150/202 Microns at 197 MW.(At 140 MW vibration were 1X/1Y-37/58 microns.

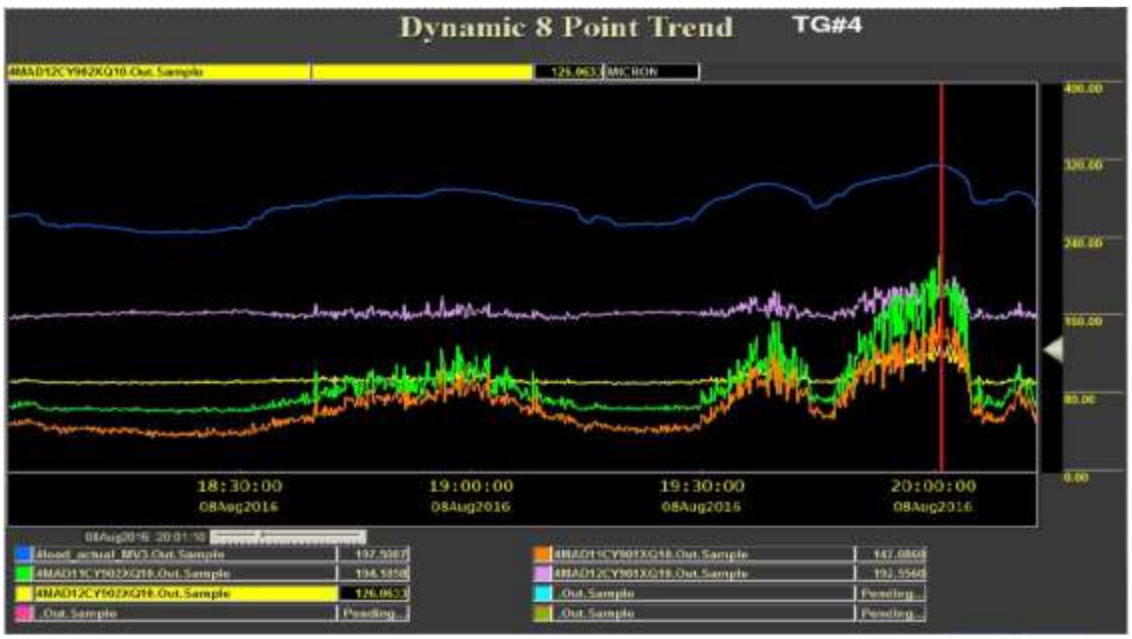


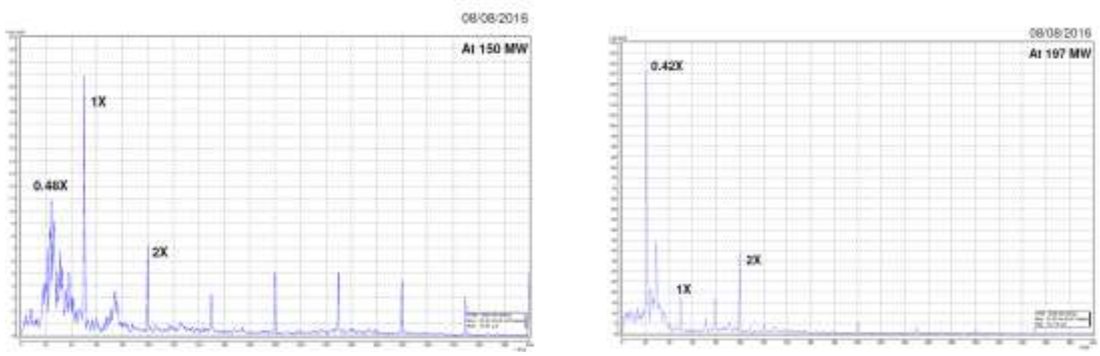
Fig 2:- Vibration trend

4. MS line Temperature downstream of HPCV's were measured with non contact type instrument and found to be almost matching (460 deg C).

ANALYSIS

Vibration Spectrum taken for bearing-1 at different load

TG#4 – Turbine Brg.-1 Shaft Vibration Spectrum



Spectrum showed vibration frequency of 0.42X to 0.48 X (X-rotating speed).It was suspected to be related to flow induced instability.

To identify the reason for the flow, disturbance following exercise and observations were made:

1. Master pressure gauges were mounted in the impulse line before the MS strainer. The measurements of Pressure after MS strainer were taken from the Pr .Transmitter readings available in the control room.

Load (MW)	Pr gauge value (before strainer)	Pr Transmitter value (after strainer)
147	126.9 (left)	127.1 (left)
166	130.9 (left)	131.1 (left)
155	126.5 (right)	126.1 (right)
142	122.0 (right)	121.25 (right)

The above readings indicate that there is marginal pressure drop across the MS strainer.

2. Pressure survey report at 205 MW:

Description	1st stage pr	CRH-Pr	HRH-Pr	Ext-5-Pr	Ext-4-Pr	Ext-3- Pr	Ext-2-Pr	Cond Back Pr.
Design	135.21	40.57	36.52	16.7	7.14	2.37	0.91	0.10
Actual	126.9	36.6	33.3	16.3	7.4	2.4	1.022	0.093

MS Pr before ESV-2 146.7

MS Pr before ESV-1 153.4

MS pressure difference was observed upstream of ESV left and right side, which was increasing with load. Same pressure difference pattern was observed at Boiler outlet as well.

3. Sound level was measured downstream of HPCV's at various loads and at different control valve openings. The sound level in left side (HPCV1) varied from 83 to 89 db, whereas in right side (HPCV2) it varied from 95 to out of scale.

INFERENCE:

1. There is no choking in any of MS strainer.
2. There is unequal steam flow in left and right MS lines at turbine inlet.
3. Based upon the sound level it seems that there is flow restriction in HPCV 1.
4. Based upon the pressure difference in left and right side it seems that the restriction is in HPCV-1.

OBSERVATIONS ON CLOSING OF CONTROL VALVES DURING RUNNING:

1. When HPCV-2 was gradually closed manually from local (ATT), it was observed that there was sharp fall in steam flow (BLI) & load while the MS Pr. before ESV increased and the HPCV-1 position increased to 100%.

HPCV-2	LOAD	HPCV-1	MS FLOW	Pr. ESV-1	Pr. ESV-2
%	MW	%	TPH	KSc	KSc
71	146	59	440	129	125
47	124	84	363	132	130

2. Similarly when HPCV-1 was gradually closed from local (ATT), closed upto 2% position there was no change in HPCV-2 position, BLI, load & MS Pr before ESV.

HPCV-1	LOAD	HPCV-2	MS FLOW	Pr. ESV-1	Pr. ESV-2
%	MW	%	TPH	KSc	KSc
52	139	66	425	131	127
2	140	66	426	131	127

CONCLUSION:

So it was concluded from the above observations that HPCV-1 path was restricted and the steam flow was diverted towards HPCV-2. Due to high steam flow through HPCV-2, sound intensity was also found on the higher side (95 db). The steam flow imbalance in HPT was also causing increase in HPT Front shaft vibrations with increase in steam flow/load.

RESOLUTION OF PROBLEM:

HPCV 1 dismantled to check the cause. Valve spindle and cone were found broken (Fig. 3). HPCV Spindle and cone assembly replaced with new one and assembled. Unit brought back smoothly.

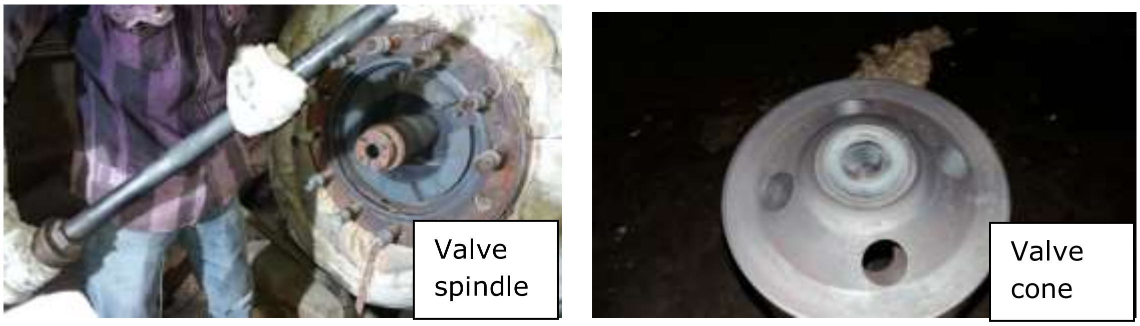


Fig. 3