FAILURE OF ELECTRO HYDRAULIC CONVERTER (EHC) FOLLOW UP PISTON

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ABSTRACT:

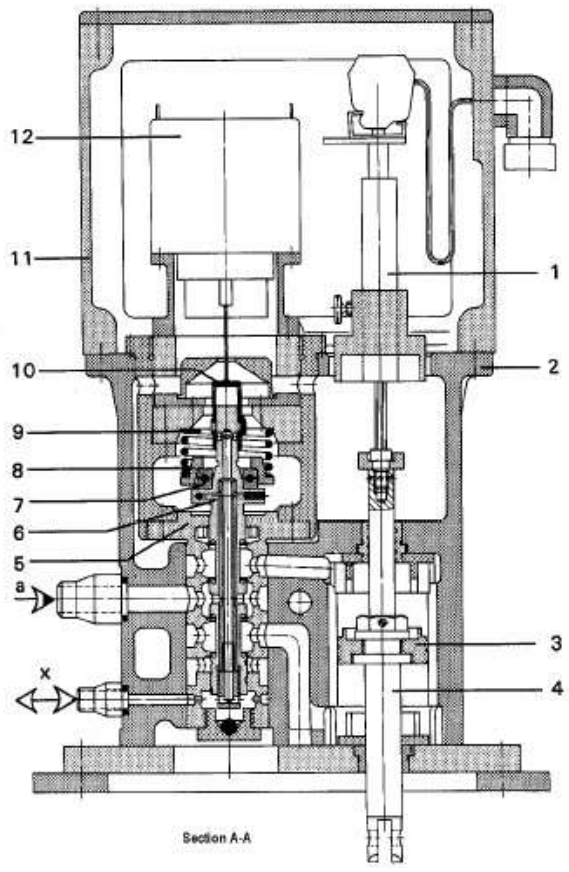
At NTPC Dadri Stage-I Turbines (4X210MW) are of KWU make. It consists of two sets of HPCV, which regulate the steam flow to the turbines. In a particular Unit during Synchronization the Unit load suddenly reduced from 30 MW to 5 MW, which in turn resulted in the forced manual tripping of Unit. The paper covers the root cause analysis of the problem.

INTRODUCTION:

BHEL Steam Turbines are equipped with Electro-Hydraulic Governing system (EHG) backed up hydro-mechanical system to facilitate the smooth operation of the KWU turboset in an interconnected grid system ensuring stable operation under grid fluctuations and load throw off conditions. It permits governed run up to rated speed.
The electrical equipment of the electro hydraulic governing system comprises of measuring devices, the electronic controllers, electro-hydraulic converter (EHC), etc and the mechanical equipment comprises of pilot valve, amplifier piston, compression springs, follow up pistons, etc.

FUNCTION AND WORKING OF ELECTRO-HYDRAULIC CONVERTER:

The Electro-hydraulic converter (EHC) is a vital device which acts as an interface between the electronic controller circuit and the hydraulic devices. The plunger coil in EHC receives the electric signal from the control circuit in the form of voltage and converts it into a mechanical up and down movement of a sleeve connected to it. The sleeve which slides over a pilot valve makes the trip oil pressure to vary thus causing a deflection, up and down, of the pilot valve from its neutral position. The deflection of the pilot valve directs the control oil either to top or bottom of the amplifier piston and facilitates draining of control oil from the other side in order to move the amplifier piston up and down. This movement of the amplifier piston, through links, makes the sleeves of the follow-up pistons thus varying the HP and IP secondary oil pressure which are responsible for operation of the steam control valves of the turbine.



1 Differential transformer
2 Amplifier casing
3 Amplifier piston
4 Piston rod
5 Valve bushing
6 Pilot valve
7 Grooved ball bearing
8 Spring disc
9 Compression spring
10 Sleeve
11 Casing support
12 Moving coil system
a Control fluid
x Trip fluid

Fig-1: Electro-hydraulic Converter

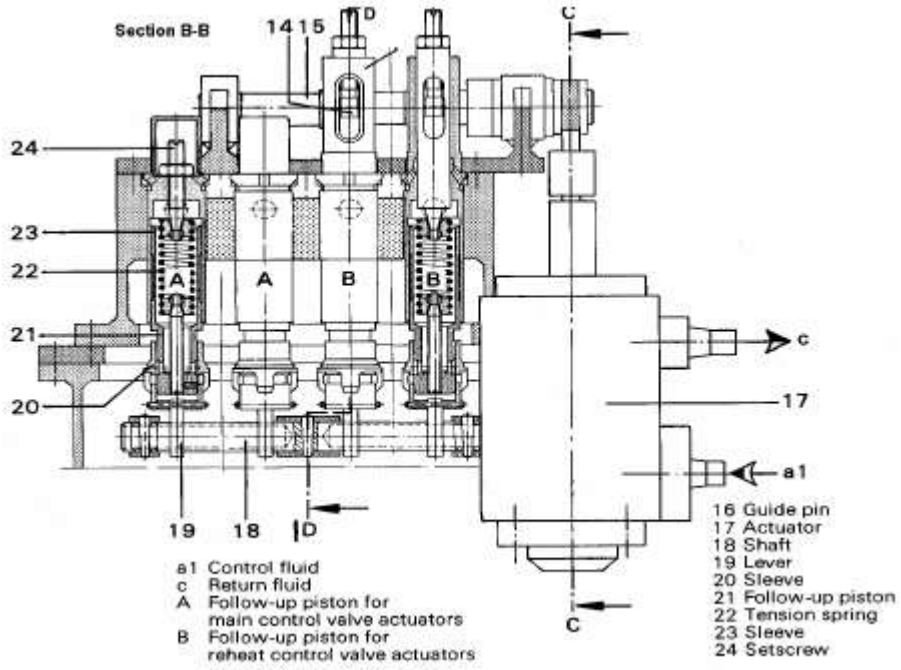
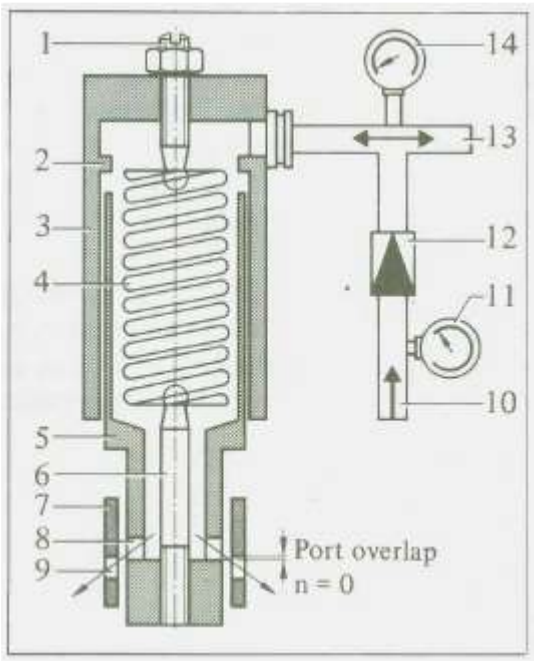


Fig-2: Follow-Up Pistons (EHC)

Follow Up Pistons

Follow-up pistons are used to convert the governor movement into oil pressure changes. The follow up pistons respond to the smallest actuating forces and therefore allow the use of low-force low-mass governors.



1 Adjusting screw
2 Stop
3 Body
4 Tension spring
5 Hollow piston
6 Threaded rod
7 Sleeve
8 Piston drain port (5)
9 Sleeve drain port (7)
10 Trip oil (6–8 kgf/cm²
11 Pressure gauge
12 Restrictor
13 Secondary oil
14 Pressure gauge

Fig-3: Follow-Up Piston

MODE OF OPERATION:

At zero pressure the tension spring (4) holds the piston (5) against the stop (2). There is no port overlap at (8,9). When secondary oil from the trip oil circuit (10) passes the restrictor and enters the follow up piston it builds up a pressure which pushes down the piston (5) against the force of the spring (4). When there is minimum overlap at the drain ports (8,9) the pressure present in the piston is the maximum attainable. Any further increase in oil pressure in the follow-up piston gives rise to increased drain port overlap allowing surplus oil in the follow up piston to escape to drain. The dimension 'n' of the port overlap can therefore be equated to zero.
The restrictor (12) before the follow-up piston limits the flow of inlet oil and reduces its pressure. The requirement for zero drain port overlap cannot be fulfilled without the restrictor.
Secondary oil pressure can be varied by:

1. Moving the sleeve
2. Changing the pre-tension of the spring

PROBLEM FACED:

Dadri Unit-4 (210 MW) was operating at 31 MW and following were the various governing oil pressure as recorded in control room:
Trip Oil Pr.- 9 ksc
HPCV-1,2 position -90 %
HP Sec Oil Pr - 4.46 ksc
IPCV-1,2 position - 100 %
IP Sec Oil Pr. Pr.- 7.08 ksc
EHC position- 69 %

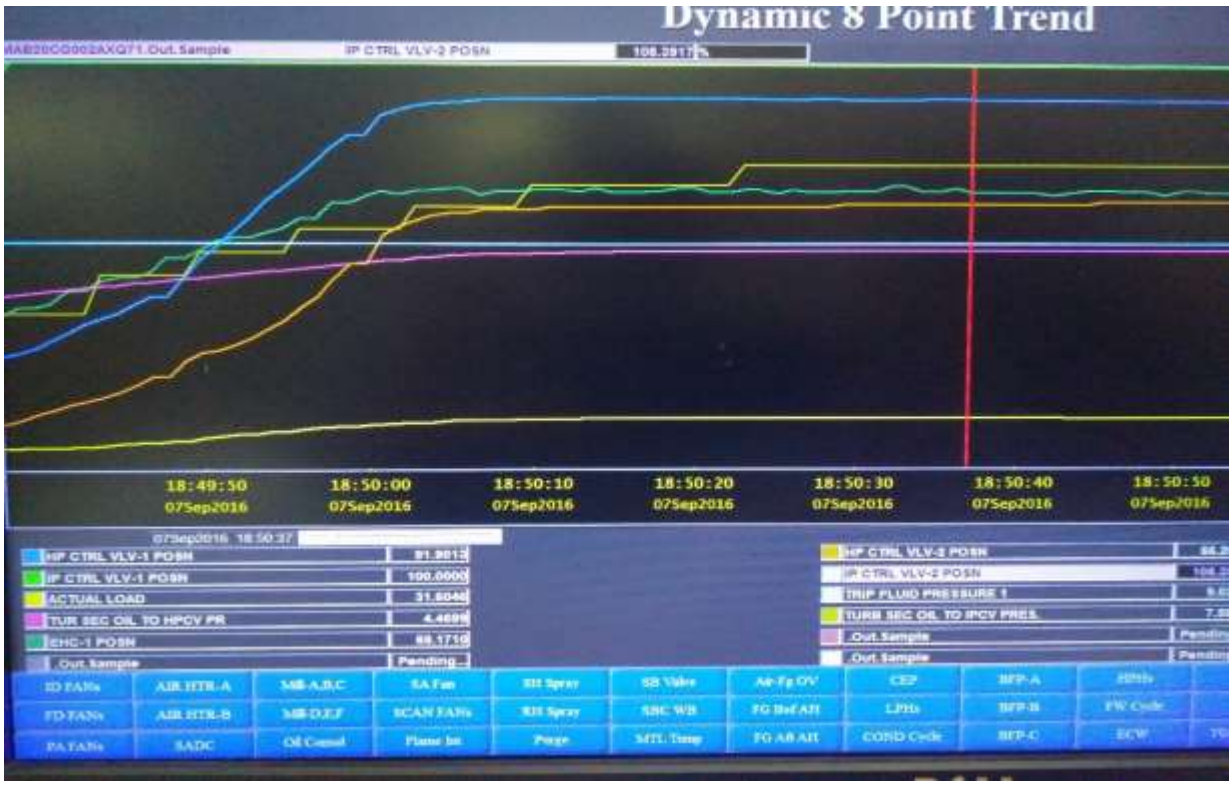


Fig-4: Pressure and Load Trends before the incidence

Suddenly load throw off occurred and load reduced to 5 MW. At 5 MW following were the various governing oil pressure as recorded in control room:

Trip Oil Pr. - 9 ksc
HPCV-1,2 position-100 %
HP Sec Oil Pr.- 5.0 ksc
IPCV-1,2 position - 0 %
IP Sec Oil Pr.- 0 ksc
EHC -command increased from 69 to 100 %

Fig-5: Pressure and Load Trends after the incidence

ANALYSIS OF THE PROBLEM:

- Machine was hand tripped because IP secondary oil pressure reduced to zero and was not increasing even though EHC command increased and got saturated.
- All ESVs were gagged to diagnose the problem.
- During checking of governing characteristic it was found that IP Sec Oil pressure was not generating.
- Machine was then put in hydraulic mode for checking governing characteristics. HP/IP secondary oil pressure was developing in hydraulic mode. So it was clear that problem is in EHTC module.
- EHC follow up piston inspection window was opened and it was found that one of IP follow up piston split pin (item no:43) had got detached and cylindrical pin (item no:25) came out from the position. Due to this the sleeve of the follow up piston fell down thereby leading to complete draining of trip oil and in turn no IP sec oil pressure was generating.

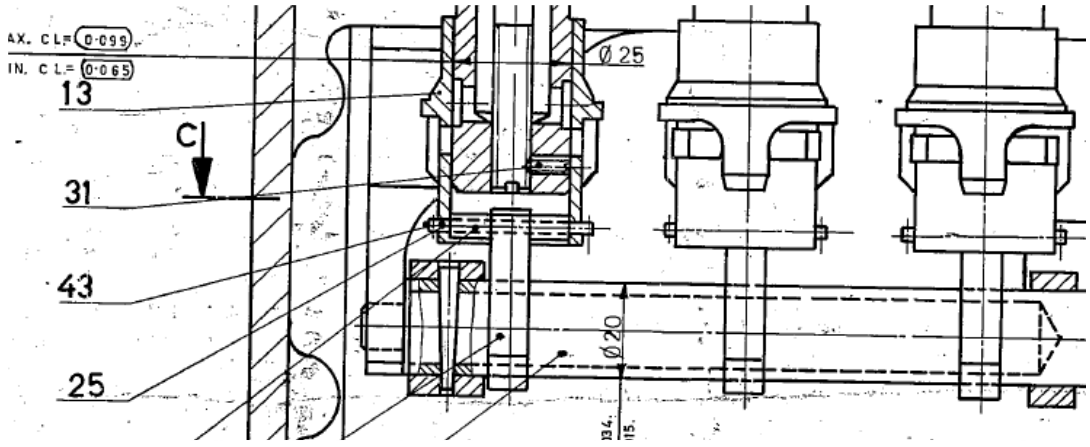


Fig-6: Follow-up piston drawing

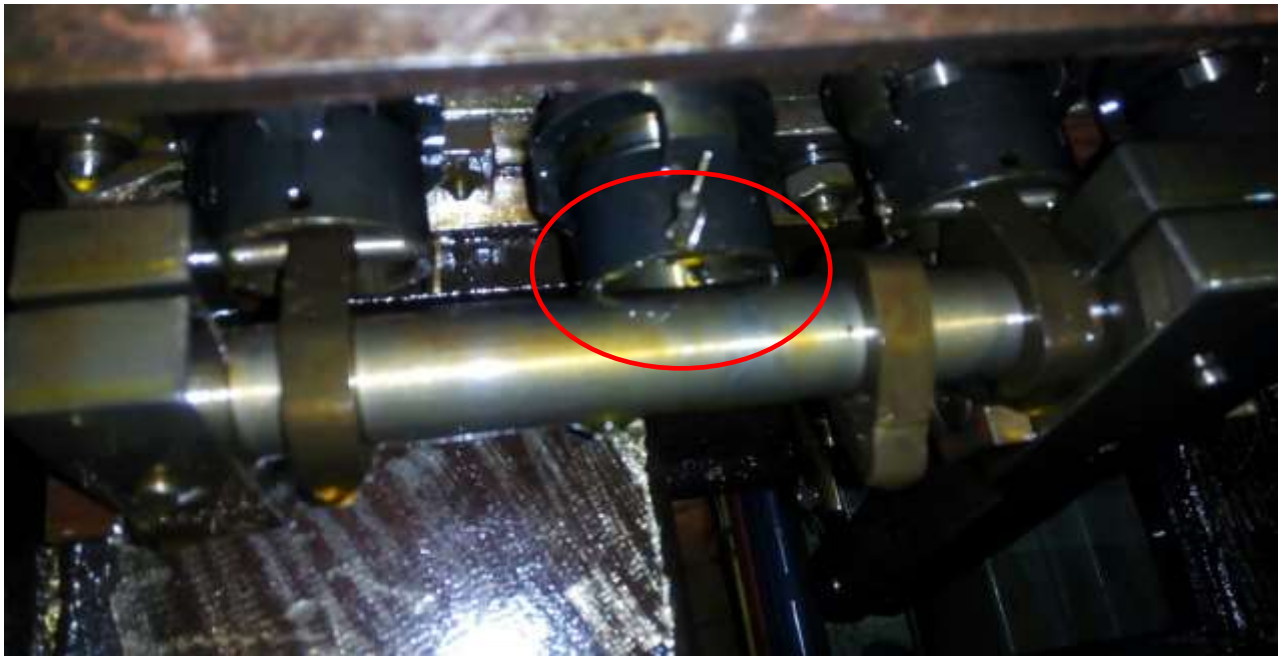


Fig-7: Dislodged split pin and cylindrical pin of IP follow-up piston in EHC

RESOLUTION OF PROBLEM:

New cylindrical and split pin were installed and EHC governing characteristics setting was done. Unit was brought back to load smoothly.

Fig -8: Split pin and cylindrical pin of IP follow-up piston in EHC after replacement

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