COMMISSIONING AND MAINTENANCE EXPERIENCE ON MECHANICAL EQUIPMENTS IN STEAM GENERATORS OF CAPTIVE POWER PLANT AT H W P, MANUGURU

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1. Introduction:

Heavy Water Project (Manuguru) is having a Captive Power Plant to cater to the demands of steam and power for main plant of HWP(M). There are three steam generators each of 265 Te/Hr. of steam generating capacity (at 105 bar and 485^{o}C) and three turbogenerators of 30 MW capacity each. The saturated steam requirement of 375 Te/hr. at 32 bars and 40 Te/Hr. at 8 bar are generally met through the HP and LP extractions of the turbines. In case of problems, the steam can be sent through HP and LP pressure reducing and desuperheating station.

The steam generators and their auxiliaries have been supplied on turn-key basis by M/s. ACC-Babcock Ltd. and turbo generators by M/s. BHEL. The consultant for the design / supply / erection / commissioning of the complete captive power plant is M/s. Tata consulting engineers / Tata Projects Ltd.

During the commissioning and initial run of the steam generators and their auxiliaries, teething / initial problems were encountered in nearly all the equipments of the steam generators. The problems were analysed by us in consultation with the engineers of M/s. ABL, M/s. TPL and M/s TCE and hopefully, it would be possible to come out of the problems through our constant efforts. The commissioning of the steam generators has given us a valuable experience which in turn has developed confidence in solving the problems. Some of the major problems faced by us during commissioning of the steam generators are briefly discussed below :

2. Failure of tubes :

Failure of tubes had taken place in SG-1 on two occasions. Sectional drawing of the steam. Generators showing the tubes is given in fig-1. In the first occasion, water wall tube of the furnace rear wall (material carbon steel) below the goose neck (tube no. 119 from the left) had failed as a result of crack (fig-2). Filler blocks are welded with the rear wall tubes which in turn, are welded with a horizontal buckstay channel, supporting the economiser ash hopper from one side. The crack appeared to be initiated from the weld-zone of the particular failed tube with the filler block. This welding was done by M/s. ABL at site. In order to avoid such failures in future it was thought to do the random checking at the time of next overhaul of SG-1. The tube-repair was carried out by welding insert.

On the second occasion, 4 nos. of furnace roof tubes (Tube no. RF 14,47,48 and 66 from left side) had failed (Ref. Fig-

1) and started leaking profusely specially from tube no. 47 and 48. Apart from this, tube no. 46 had shown signs of external erosion. 'D' meter survey was done for adjacent tubes in the failed region. In tube no. 46, thickness was found to be 3.6 to 3.8 mm in that region as against the desired thickness of 4.5 mm. The roof tubes are meant for carrying saturated steam from the roof inlet header to the primary superheater inlet header. The roof inlet header is getting saturated steam directly the drum-top. The material for the tube is BS-3059-1978-620 commonly known as 1 cr. 1/2 MO steel.

On careful examination of the failures, it was suspected that the tube no. 48 might have failed initially at the panel welding area of the tube, probably this would have caused steam-jet impinging on the tube no.47 resulting in heavy erosion of the tube and finally resulting in rupture. Due to this, heavy leakage had taken place from tube no.47 & 48, further secondary damages might have taken place for tube no 14 and 66 and also, thinning of tube no. 46. However, it is difficult to visualise how secondary tube-failure can take place for tube no 14, 66 so much away from tube no. 47 & 48. Another possibility is of independent leakage in tube no.14 & 66. If this is so, detailed examination of thickness for all the roof-tubes need to be carried out during the next annual overhauling. In view of the urgency, the repair was carried out immediately.

3. Failure of P.F. Mills:

4 nos. of P.F. mills are supplied for each steam generator (8.5 E 10 Ball and race type mill) with a capacity to grind coal upto 30 Te/hr. with a fineness of 70% passing through 200 mesh (fig. no. 3). The major failures which came up during commissioning/initial run are failure of coupling, loading unit, loading cylinder and stir-up.

Coupling had failed in two of the mills namely, 2 C and 3 B. Both the failures were exactly of the similar nature. These couplings are bibby type. The mill side coupling cover in both the cases had sheared off from the right angle joint area-subsequently, the bolted covers had moved to the motor side and the grid springs had fallen. As a result of this, the motor alone was running with coal mill being stationery. On further checking, it was found that the mill-alignment got disturbed badly. The probable reason could be of the entry of foreign material coming alongwith coal, which might have caused heavy shock load to the mill, resulting in movement of the gearbox (confirmed by the coupling alignment readings). Afterwards, a thorough survey was done for all the mills regarding fixing of spring-washers in foundation bolts of mill gearbox. Wherever the spring washers were found missing, the same were replaced.

The loading on the top grinding ring (stationary ring) for proper grinding is arranged through hydro-pneumatic loading cylinders, loading unit and stir-up. The force is applied

through 8 nos. of loading cylinders (all around the mill) with the help of Nitrogen gas at a pressure of around 32 bars. Nitrogen is sealed in the loading cylinder through the seal oil pressurised through a hand-pump to 36 bars. The force is transmitted over the top grinding ring on four sides through external levers, spindle, internal lever. During two years of mill operation, 16 loading cylinders have failed. With the failure of loading cylinders, the seal oil starts leaking through the same. In almost all loading cylinders, the ram was found to have heavy erosion marks, thus apart from replacement of the seals (11 seals in one loading cylinder), the polishing and chrome-plating of the ram requires to be done. Brass bush also requires replacement in most of the cases.

Failure of the loading units (8 nos.) and failure of stir-ups (6 nos.) had also taken place in the different mills. In almost all the loading units, the inner lever got broken. In case of such failures, complete loading unit assembly requires to be changed. The repair of the loading unit assembly is being carried out by disassembling, replacement of the broken inner lever and again assembling of the components. This is quite a tedious exercise in absence of hydraulic press. The stir-up (U-bolts) also frequently got broken in the mills. The replacement of the stir-ups is not a time consuming work but still for attending to this work, the mill has to be cooled down for a minimum period of 24 hrs. which in turn reduces mill availability. Besides the above major failures, minor problems like blockage of foreign material in the pilot reject gate, main reject gate, damage of the vertical/inclined brush ploughs etc. were also faced frequently, which are normal in case of mills.

In addition, due to the wear of the balls, in one mill, fill-in-ball was added after 2000 operating hours. The upper/lower grinding rings, balls have not been replaced in any of the mills which are operating for the last 1 to 2 years. Most of the major failures of the mills are caused by the broken crusher rings. The failure rates of the crusher rings have been abnormally high and the metal detectors located on the downstream conveyor had been working erratically, thus the crusher rings had escaped through the metal detector and reach the mills. Considering the seriousness of the problem, manual picking arrangements for broken crusher ring/foreign material has also been carried out. The root problem of the crusher ring failure is also tried by changing the material of crusher rings and by picking up stones both from the yard and also from the conveyor belt.

4. Air Register failure :

Air registers which are the secondary air dampers provided in the wind box (fig no. 4) for each coal / oil burners. Thus there are 12 numbers of Air-registers in each steam generator for 12 coal / oil burners.

The two Air Registers of SG-2 and one Air Register of SG-1 got badly damaged / burnt due to the fire reaching the Air

Registers. This Air register frames, vanes, SS cones, Actuator-lever/rings, igniter-guide pipe, throat plate, front plate etc. got badly damaged. As the Air Register was never expected to be damaged so soon, there was no spare available, thus some time was lost in its procurement. Two air registers assembly have already been replaced in SG-2 with all other components mentioned above. The wind box fire probably caused due to the clinker formation at the burner-mouth. In case of clinker at the burner mouth, the coal/primary air mixture in place of going into the furnace might, after hitting the clinker, reflect back into the wind box through the air register-opening thus causing fires. Care is being taken not to allow spreading of the clinker in the burner-mouth. Wind box pressure is also maintained a little higher (around 60 mm Hg.). Dripping of the oil from the gun is also attended promptly through regular cleaning of the guns and preventive replacement of copper washers near the gun-tips etc.

5. Failure of conical impellers : (fig.no 5)

Conical impellers are provided at the end of the coal pipe / nozzle. The impellers are assisting in the movement of coal and primary air in divergent manner so that the secondary air coming to the furnace through the air registers, causes enough turbulence of coal and primary air mixture. The life of the impellers has been found to be 3-4 months. The failure may be even earlier if there is clinker at mouth. Though as per M/s. ABL, this should last for a minimum period of six months. We are rotating the impellers regulating rod / impeller by 120° at frequent intervals to have uniform erosion of the impeller all around and thus increasing the life of impeller. But this has not helped much.

6. Problems of fans :

The basic problems faced by the primary air fans are failure of bearings, high vibrations etc. The common problems discussed for all these fans are as under.

6.1 Water mixing with lubricating oil in fan bearings :

This problem was existing more in PA fans (fig.no.6). However, it was also occurring in forced draft / induced draft fans. All these fans are supported by white metal sleeve bearings (fig. no 7). Water mixing is more serious in case of PA fans as it was provided by external lubrication system with cooling arrangement. Complete quantity of lubricating oil tank gets contaminated with the mixing of water and the quantity of oil to be changed in such cases is very high. The leakage of cooling water into the lubricating oil circuit is taking place due to cooling water flowing from top half to the bottom half of the bearing and again to the top half through the failed parting-plane 'O' ring joint. This problem has been overcome to a great extent by getting good quality 'O' rings and applying annabond 678 at the 'O' ring joint with proper curing time.

6.2 Failure of lubricating oil rings :

The lubricating oil rings with lap joints were frequently failing on all the ID/FD/PA fans. It is difficult to monitor the movement of the rings all the time and a few failures of the bearings had taken place due to the failure of the lap joint of the ring. It was modified with groove type joint having two screws. Periodic monitoring of these rings alongwith the above modification has helped there after in reducing failures of the bearings.

6.3 High vibrations of PA fans :

These PA fans were run in the presence of manufacturers, consultant. Most of them were showing high vibrations of the order if 200 microns / 20 mm per sec. (axial). The foundation bolts of these fans were required tightening very frequently. Similarly, the alignment-checking had to be done at regular intervals for most of fans to reduce vibration-levels. In some cases, the in site-balancing of the PA fan had to be carried out at the time of commissioning. In one case; 3.4 kg balancing weight had to be added. As per the manufacturer the storage had not been done properly. Hence, such problems had to be faced. Inspite of all efforts from our side, still the vibrations appeared high in some PA fans. (150 microns/10 mm per sec.) Foundation on non-drive end is inadequate and hence reinforcement of the NDE side of the foundation is being strengthened in one of the PA fans.

6.4 Axial unbalance problems of PA fans :

The failure of the bearing thrust pads were eliminated by welding suitable anti-thrust vanes on impeller by trial and error. Since the gap is narrow, the anti-thrust vanes are unable to reduce hot air leak on the discharge end of the fan through the gland.

6.5 Hot air leakages :

Hot air leak of PA fan is existing due to lack of approach problem. The casing joint leak was controlled by using flat gaskets instead of rope which M/s. ABL were using earlier. Heavy hot air leakage was existing from the gland through the carbon rings. This was set right by providing cooling discs and also by correcting the gland housing. In some cases where eccentricity was found in the housing of the carbon ring causing gap on one side, hot air was found leaking from the gap.

6.6 Bearing housing modification of PA fans :

To prevent overflow of lubricating oil through parting planes of bearings, it was suggested to enlarge the outlet hole. Feasibility of such enlargement was not possible for

existing housings and new housings were installed for SG-2 & SG-3. Replacement of the housing is to be done in SG-1.

CONCLUSION :

It is needless to state that the quality of design, the extent of quality control and shop testing, the kind of attention meant during erection, the nature of pre-commissioning checks to be carried out, and understanding of the operational personnel about the equipment should be of high degree and need to involve the coordination of all concerned.

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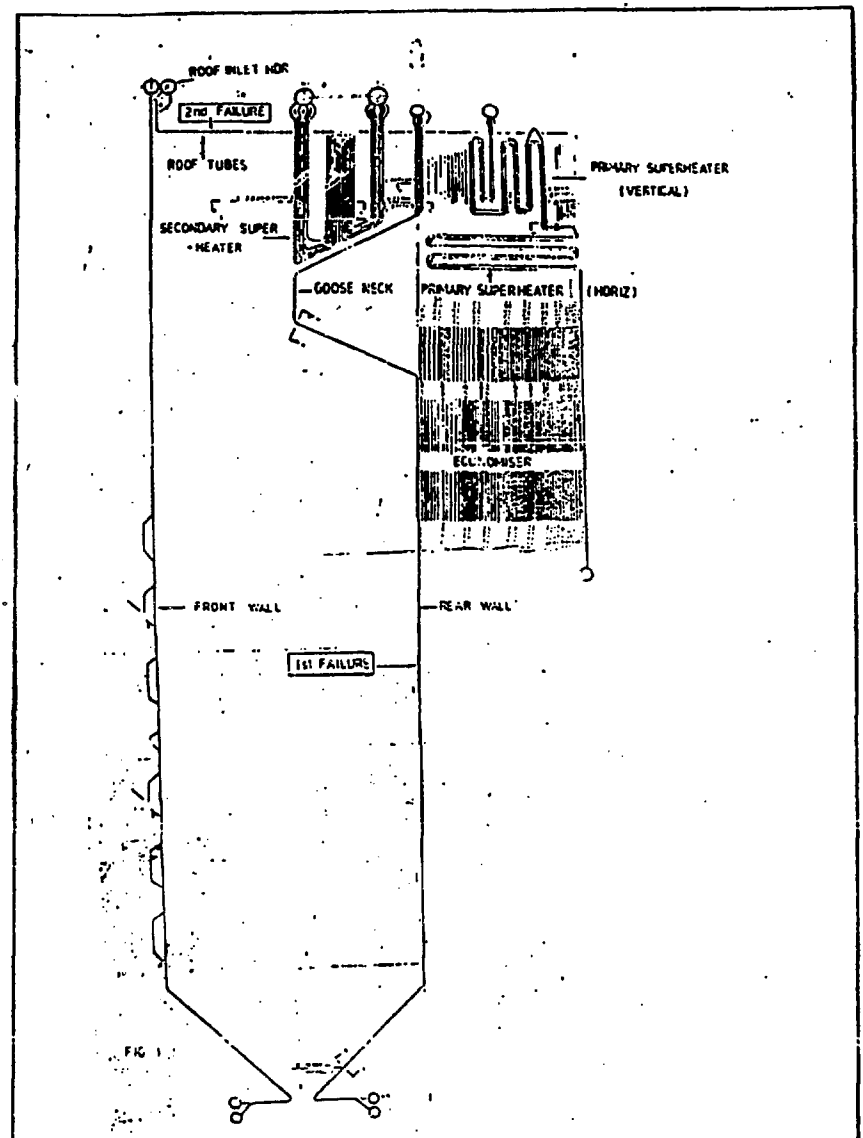
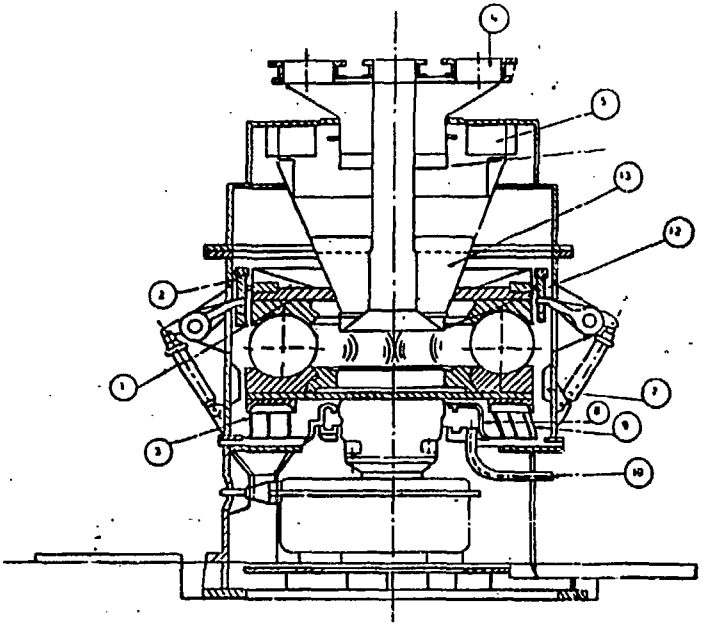


FIG NO 1	SECTIONAL DRG OF STEAM GENERATOR	CAPTIVE POWER PLANT
		HEAVY WATER PLANT (M)



NO	DESCRIPTION
13	OVER SIZE PARTICLE RETURN CHUTE
12	MACE TYPE STRIKE
11	FLAT COVER PLATE
10	SEAL AIR INLET
9	INCL INED BRUSH PLOUGH
8	AIR SEAL HOUSING
7	THRUST PLATE
6	ADJUSTABLE SLEE
5	RADIAL VANE CLASSIFIER BLADE
4	DISCHARGE COAL DUCT
3	STRAIGHT BRUSH PLOUGH
2	STIRRUP
1	SPIDER

FIG NO 3	85E PULVERISER	HEAVY WATER PLANT (M)
		CAPTIVE POWER PLANT

(A) OBSERVATION PIPE.
(B) AIR REGISTER.
(C) REGULATING ROD PACKING COLLAR.
(D) PEEP HOLE.
(E) ELBOW COVER PLATE.
(F) BURNER THROAT.
(G) ELBOW WEAR PLATE.
(H) CENTRE PIPE.
(J) SUPPORT VANES.
(K) IMPELLER REGULATING ROD.
(L) IMPELLER.
(M) STAINLESS STEEL TIPS.
(N) STAINLESS STEEL CONE.
(O) INLET ELBOW
(P) FLAME SPREADING RING.

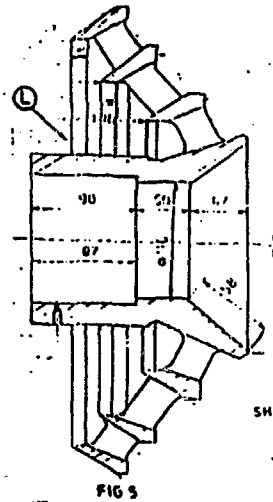


FIG 5

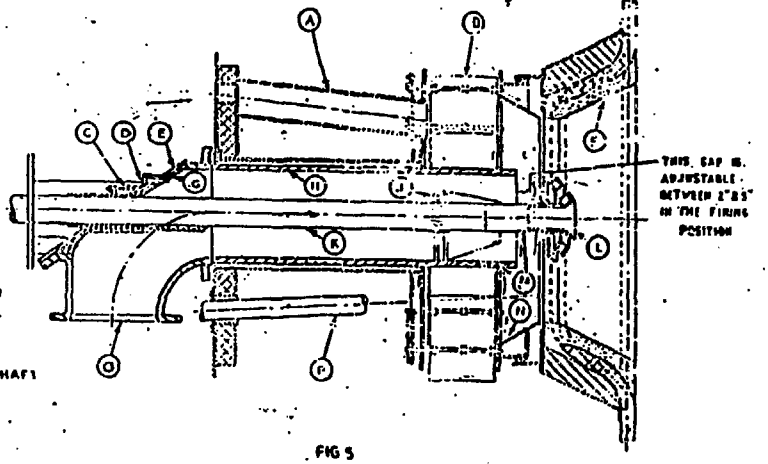


FIG 5

FIG 4&5	CIRCULAR PULVERISED FUEL BURNER	HEAVY WATER PLANT (M)
		CAPTIVE POWER PLANT

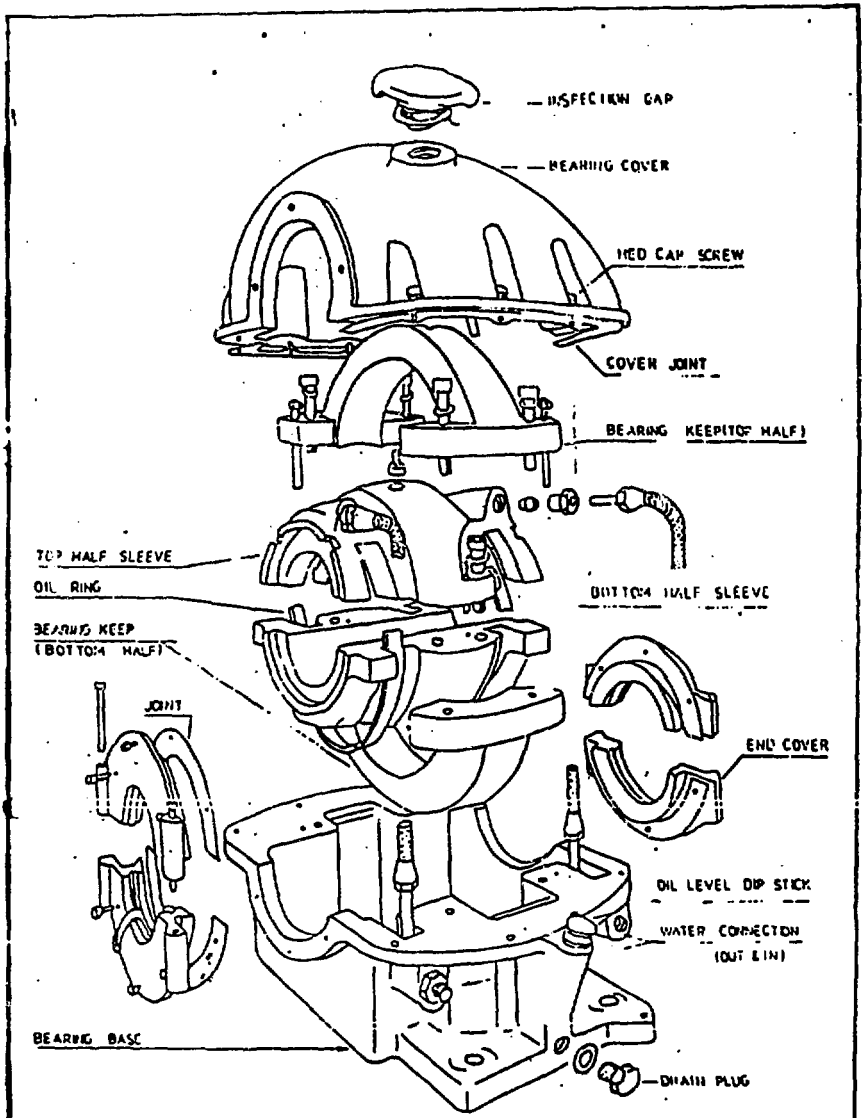


FIG - 7	GENERAL ARRANGEMENT OF FAN BEARING. (FD, ID, PA)	CAPTIVE POWER PLANT
		HEAVY WATER PLANT (M)