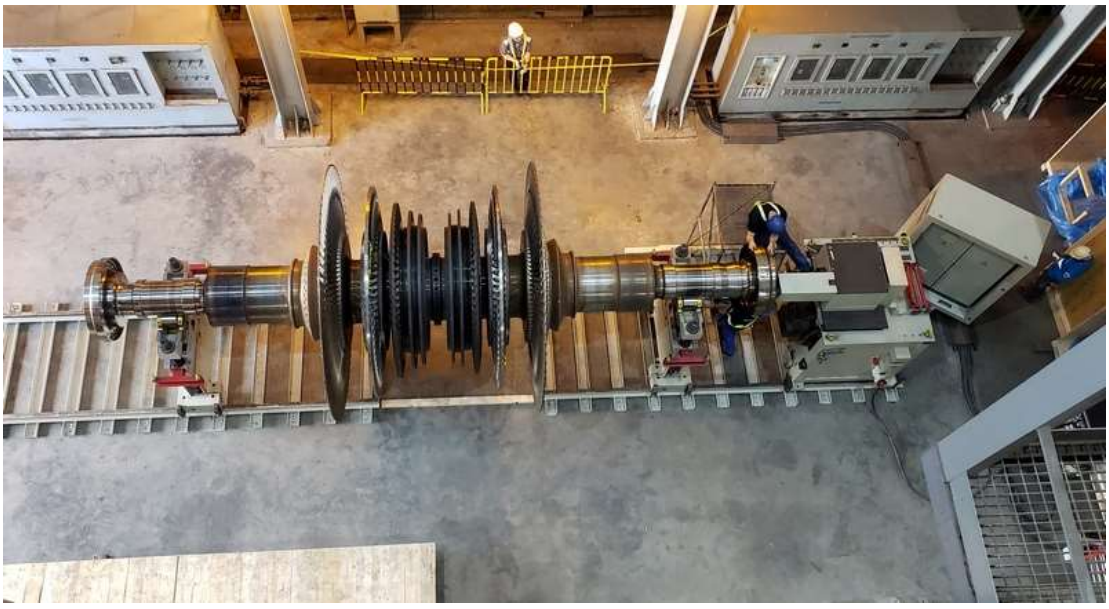
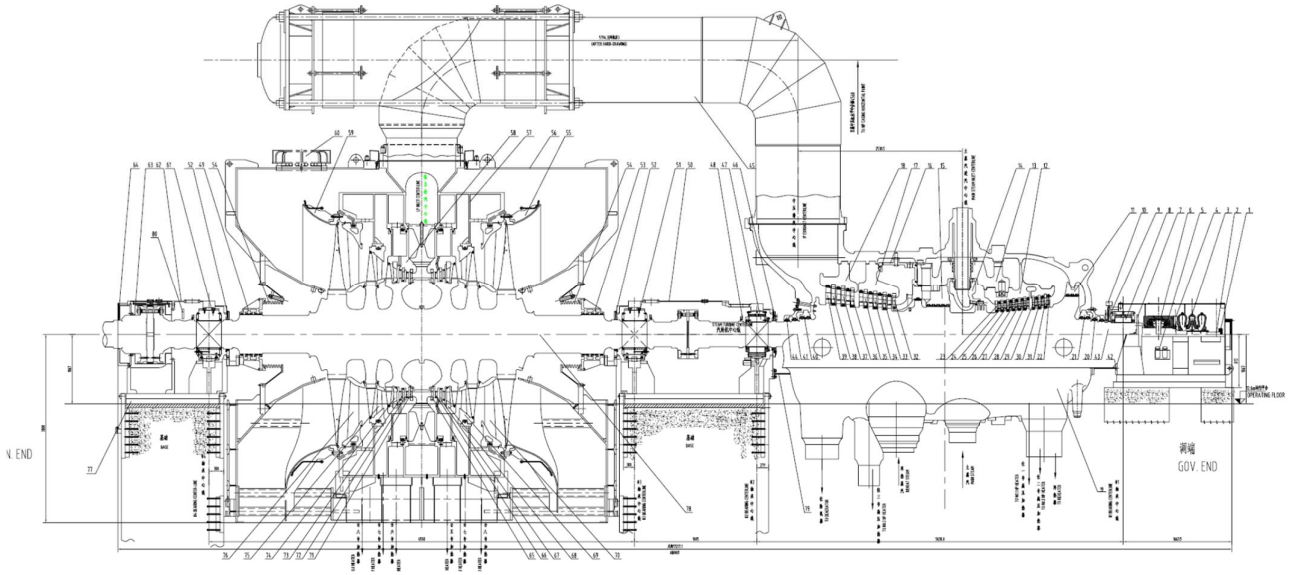
320MW Thermal Steam Turbine – Case Study

2016 - 2019



EXECUTIVE SUMMARY



320mW STG

The Coal-Fired Thermal Power Station (Philippines) was shut down annually to undertake maintenance and repairs to the 320MW Steam Turbine Generator (STG), Boilers and ancillary Balance of Plant (BOP) equipment. ProGen was contracted over the last four Overhauls (2016 to 2019) to undertake the Client technical support function relating to work on the STG and of its boiler feed pumping plant.

Pre-overhaul ProGen undertook the following preparation work

- Review the scope of work and equipment manuals.
- Mobilise to site and review preparation work undertaken by the Client and their directly-employed Contractors.

Key work Overhaul work undertaken by ProGen for the STG and Generator area entailed the:

- Undertake shift work as required. This involved day, night or split shift work.
- Provide hands-on expert technical support and advice during the steam turbine mechanical overhauling works.
- Provide local-based Turbine Supervisors to directly monitor Contractor work quality and progress.
- Undertake the work to meet the Client-developed schedule of work and procedure.
- Monitor the overhauling work of the turbine and generator following the work details and approved schedule.
- Monitor the recording of the “as-found” and “as-left” data and provide advice as required.
- Conduct inspection, record and report observation, and make recommendations for correction.
- Perform quality control of the overhauling work.
- Provide assistance during the repair of defects in the steam turbine parts found during the mechanical overhaul.
- Prepare a final report.

THE PROJECT

The work on the turbine was scheduled to be undertaken on day and night 12 hr shifts - seven days a week. The overhaul was scheduled for durations ranging from 30 to 45 days (each year's plan duration was dependent on scheduled work scope).

Notable findings and recommendations during the overhauls included:

- Close attention and supervision to every task has been required to minimise the negative aspects of poor workmanship by contractor staff due to low skill and experience of staff.
- The checking and setting process for the operating clearances of the turbine and generator bearing is not completely suitable for the bearings employed on these machines. Currently the process has the potential for errors to be made in the calculation of the correct clearance.
- The effective coordination of work effort during the overhaul proved difficult on occasions due to the variety of resources required for progressing tasks. Particular issues that arose consistently throughout the term of the overhaul across all work parties. Confident decision-makers within the contractor and client organisation supplemented by experienced "Expat" supervisors were essential to facilitating effective progress,
- Redesign required for the shaft raising equipment to allow for the safe execution of the tasks on any of the bearings from #1 through to #4 bearing.
- Residual Magnetism was noted in multiple components (Stationary and Rotating). Gauss readings higher than 15 were noted.
- The TBFP internal stationary blade ring did not have sufficient lifting points to allow for safe lifting of the upper halves.
- Review the coupling fit criteria and adopt a workable set of tolerances for each of the bolt sizes. Ensure that tight bolts are not fitted until they (or the holes) have been relieved to remove interference fit. The increasingly regular seizing of the coupling bolts and the resultant condition of many of the coupling bolt hole bores. Technical support from either the OEM or a third party needs to be sought to resolve why the bolt and coupling materials are so prone to galling.
- The difficulties with the bolting and unbolting of the couplings are becoming more prevalent with each turbine inspection due to the different combinations of rotors that are now being used in each machine. E.g. Unit 2 now has a second-hand refurbished generator rotor ex Unit 1 attached to a new LP rotor and the existing HIP rotor. It is noticeable that there are small differences and imperfections in each of the coupling bolt bores that are having to be addressed with each reassembly. The variations in the coupling combinations make it extremely difficult to achieve reliable coupling concentricity's within the required tolerances. The normal process for the coupling of a new combination of rotor couplings is to expect to bore or ream out holes that are mismatched after confirmation of the coupling concentricity.
- The seat insert in the body of the RH #3 MCV Valve body was found to have material spalled from the thin intersection of the steam chest forging. It appears that several chunks of the seat material have spalled off and have been carried into the nozzle area and beyond if this has occurred during operation or since commissioning. Some of the missing pieces are likely to have been substantial enough to cause damage to the rotating and stationary elements of the HP steam path.
- There have been reported issues with vacuum leakage around the gland sections of the LP cylinder. The LP cylinder was removed for inspection so the half joint was able to be inspected for evidence of leakage. The joint area had been generously covered with red RTV gasket sealant. This sealant coverage looked to be secure with only a small area tainted with penetrating oil that would have been used during the removal of difficult bellows bolts. The gland housings were not disturbed during the inspection however it was noted that there is considerable clearance on some of the outer segments, both radially and at the butt gaps of the adjoining segments
- The current set up for installing and measuring the H2 Seal components is not able to provide the full range of data required to ensure that the seals are installed to the correct tolerances. Seal ring axial and radial distortion cannot be measured fully.

The combined fit of the seals cannot be assessed over the full circumference of the seal and housing. Axial and radial clearances cannot be tested effectively when mounted on the shaft journals.

- The Generator H2 seals were found to be badly damaged during strip-down. The seal babbitt metal was burnt and had runs indicating material loss. There was also evidence of arcing damage from pitting and tracking.
- The TBFP HP glands have been reported as problematic prior to the overhaul resulting in excessive steam leakage from the gland into the front bearing pedestal. The implemented modification is a temporary solution which should improve the steam leakage issue. The preferred solution to this issue would be to address the issues with the gland steam controls / condenser to ensure all is operating correctly.
- There were two of the turbine casing studs on “A” turbine that had to be drilled out and replaced. One of the studs on the upper casing was completely wrenched off with the Hytorc. The other had to be severed by a grinder in order to preserve the remaining thread in the casing.
- Consider making or purchasing two floor cranes for use with chain blocks to aid the safe handling of heavy items without having to rely on the overhead crane. These small mobile cranes are on heavy duty castors and provide an effective means of safely handling the smaller items too heavy for manual movement. They would be ideal for handling the bearing pads for adjustment and also the completed bearings around the mandrels for clearance checking.
- The turbine hall cranes are required to have operators stationed in the cab for the duration of the assignments. This requirement leads to a considerable amount of lost time and productivity during the course of an overhaul or maintenance activity. Consideration should be given to the option of fitting the cranes with remote controls to lessen the impact of the losses as outlined.

Post overhaul ProGen developed and issued the Client a full and detailed overhaul report with recommendations to improve reliability and future outages.

DIAGRAMS AND PHOTOS

Turbine LP rotor repositioning after reblading.

Row L-1 blade root inspection – Prior to reblading

LP Inner Cylinder

Turning Gear bull gear inspection

No4 Bearing Reassembly inspection

TBFP Rotor installation