From relocation to commissioning of a Frame 5 gas turbine unit

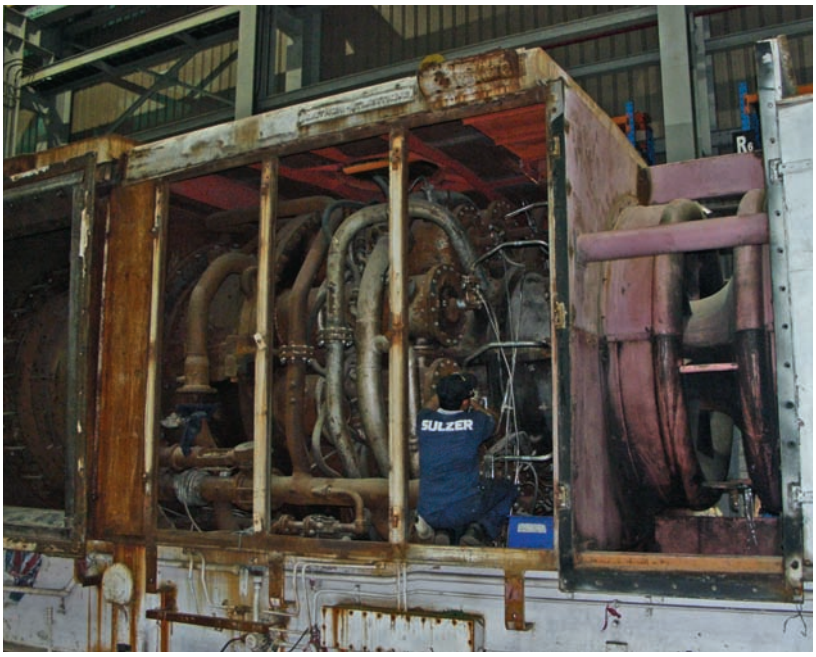
Second life

A discarded gas turbine unit for power generation was impressively restored by Sulzer Turbo Services Indonesia. The company carried out all the individual steps—from relocation to commissioning. The unit was put into commercial operation on December 14, 2009 and has been running since then without any major problems.

After Sulzer Turbo Services Indonesia had successfully installed two used Japanese steam turbine generator sets (17 MW and 18 MW) and completed a major overhaul of three Japanese 37 MW steam turbine generator units, a pulp and paper company based in Sumatra, Indonesia, awarded another challenging job to the company. The task was to supply a secondhand gas turbine generator unit.

This project was initiated in order to optimize the company's pulp production capacity of 2600 air-dry tons per day and increase its tissue production capacity. The plan was supported by the initiative to have a gas supply to that geographical area in the near future.

After consideration of various options, a gas turbine was selected to supplement the available multifuel and recovery boilers. The heat recovery from the gas turbine exhaust system will be put to further use in the future in the steam boiler—increasing the plant steam capacity for both power generation (combined cycle) and processes requirements. A Frame 5001P European gas turbine met the customer's power needs. For Sulzer Turbo Services Indonesia, this was the first turnkey project for a complete relocation, refurbishment, installation, and commissioning of a Frame 5 gas turbine with limited data, drawings, and without a manual for this unit. A small team from the engineering department developed all the required drawings as well as an operation manual.



1 The incoming fully corroded gas turbine unit was stripped down for refurbishing.

Relocation to Indonesia

Sulzer Turbo Services Indonesia located a suitable gas turbine generator set in Shenzhen, China. The next step was to build a team to dismantle and relocate the unit to Purwakarta, Indonesia. Instead of having a full team from Indonesia, two well-experienced field service engineers were assigned to work with local personnel to dismantle, preserve, and pack the units for shipment.

The main equipment was packed and shipped to Indonesia. Some other parts, i.e., exhaust system and inlet air system, were fully corroded and considered too costly to ship for repair to Indonesia; thus, they had to be redesigned and fabricated locally in Indonesia.

The shipment to Jakarta took about one month. Sulzer Turbo Services Indonesia's premises were well prepared, and there was enough space for the gas turbine unit to be positioned directly in the big bay of the workshop for refurbishment.

2 Coated turbine wheels.

Repair in the workshop

The unit was stripped down for inspection and repair recommendation 1. The gas turbine rotor was removed, and the unit was completely disassembled. The compressor and turbine section were unstacked for a thorough inspection of the individual parts. Defects due to FOD (foreign object damage) were found on several compressor blades, and these underwent minor repairs. An aluminum coating (HI-Coat A08) was applied on an individual turbine wheel for corrosion protection 2. Both rotor-bearing journals were too small due to medium radial rubbing and minor pitting corrosion. In general, no indications of cracking were found on the rotor. Therefore, the rotor was restacked, all through-bolts were replaced, and new turbine buckets were installed.

All turbine and compressor casings were cleaned, inspected, and reconditioned as necessary. The engineers determined that all combustion parts were fully corroded, and they found some cracks on transition pieces and combustion liners. Welding repair was performed and, as a final step, thermal-barrier coatings (TBC) were applied. After major repair of the stage nozzles, they were also coated with TBC.

The generator rotor was dismantled. Indications of cracking on the retaining rings (which are high-stress components) made them unsafe for further service. Sulzer Turbo Services Indonesia manufactured and replaced these rings with rings made of a better material.

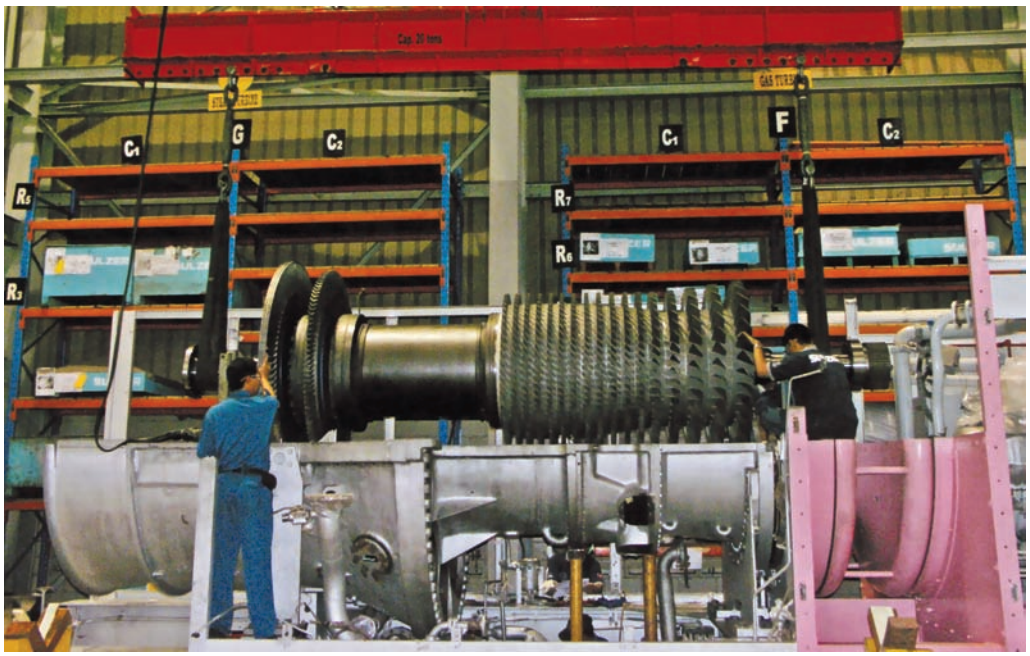
Based on the stator wedge tightness result, the stator of the generator was rewedged. The 84 slots wedges with eight wedges per slot were replaced with new G10 packers of dielectric material that ensured a tight radial fit. All electrical tests of the generator rotor and stator were acceptable, and the rotor was reinstalled with new bearings 3 4 5.

The load gear was dismantled. The journal shafts of the bull gear and pinion gear were found to have medium pitting corrosion, evidence of radial rubbing, and some dents; these shafts were repaired with a HVOF spray coating (high-velocity oxygen fuel spraying). The quill shaft of the bull gear was excessively bent and needed to be straightened. Five bearings had to be exchanged because of medium pitting corrosion and radial rubbing on their inside diameter. The accessory gear shafts had minor rubbing on the bearing journals. They were polished and reassembled with the new bearings set.

Parts Fabrication

The gas turbine exhaust system and the inlet air system were fabricated by local vendors to technical specifications from Sulzer Turbo Services Indonesia. The gas turbine exhaust system comprises structural steel plus three major

3 Installation of the rotor.



4 Reassembly of the turbine at the shop.

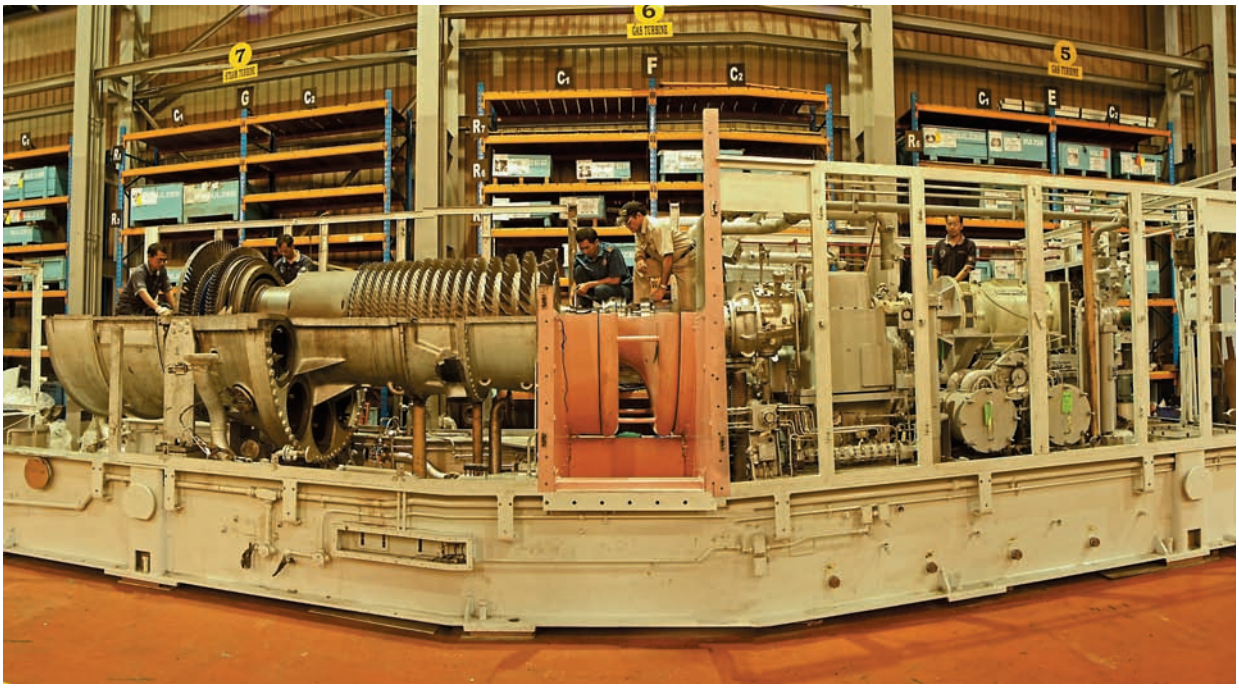
subassemblies, namely, a 90° elbow and two silencer pack modules. The exhaust stack, which is installed on top of the exhaust plenum, is a normal configuration for a simple cycle type Frame 5001P model. The exhaust silencer modules are all welded carbon steel constructions with external seal welds; they have a thermal interior that allows for thermal expansion. All fabrication descriptions and prefabrication instructions were included in the technical specifications.

The inlet air system consisted of an inlet silencer, an inlet duct, and an inlet elbow. The inlet silencer consisted of a painted carbon steel duct shell and a type 304 stainless steel perforated liner and baffles. The walls were acoustically treated and had vertical parallel baffles. The air filter system was a single-stage filter that used unique conical and cylindrical filter cartridges for the lowest operating-pressure loss. It consisted of three filter modules that were bolted together and/or assembled around a collecting plenum. While the inlet duct consisted completely of painted carbon steel, duct shell and inlet elbow consisted of a painted carbon steel duct shell completed with a carbon steel cladding.

Targeted upgrading

Because the unit needed gas fuel to operate, dual fuel conversion was required on the fuel nozzle system. Therefore, a new set of dual fuel nozzles was purchased and installed on the unit. A gas ring manifold was fabricated and installed on the unit together with the fabricated gas fuel line and its accessories.

Furthermore, fire protection system of the original unit used halon, which has since been prohibited by law, so the fire protection setup was upgraded to a system using CO_2. All fire detectors, all nozzles, and gas bottles in the system were replaced.



5 Turbine, compressor and turbogenerator.

6 The gas turbine unit was directly loaded onto the foundation, and prealignment checks were continued.

7 The exhaust silencer modules were fabricated according to specifications from Sulzer Turbo Services.

New control system

A new control system was supplied and installed, which has the benefit of triple modular redundancy. All existing instruments on the skid were listed, identified, tagged, and then tested to establish which could be utilized in the new control system. When necessary, new instrumentation was purchased. The control system commissioning included recalibration of all the instrumentation, loop checking, and function testing.

On-site work

Preparation work was carried out on-site starting from the foundation. Pre-engineering work included a check of the civil work of the fundament. The anchor bolt locations were measured and compared with the original foundation drawings. Upon completion of the foundation work, the unit was delivered to the site to be directly loaded onto the foundation so that prealignment checks could be continued 6.

All fabricated parts of the exhaust 7 and inlet air system were packed and delivered to site. The exhaust system was ready for direct installation onto the unit; however, the inlet air system required reassembly work on-site before installation onto the unit 8. The engineers carried out a great deal of welding and grinding work, including much heavy lifting. This work was considered hazardous. Thus, safety precautions were reviewed each morning at the toolbox meeting prior to starting work.

The lube oil pipeline was ready before oil flushing started. The final alignment was conducted at the end phase of the reassembly work. Because the gas supply was not yet ready, the unit was put into operation using heavy oil fuel.

8 The inlet air system was reassembled on-site.

The unit was put into commercial operation as of December 14, 2009, and a performance test of 72 hours was conducted without any major problems.

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