

Effective Project Management Results in Successful Rerate of Compressor String at Thailand Refinery

Customer

Petroleum refinery
Map Ta Phut, Thailand

Equipment

Steam turbine and hydrogen
recycle compressor

Challenge

Rerate a non-Elliott steam turbine and modify a non-Elliott compressor to achieve new process requirements.

Solution

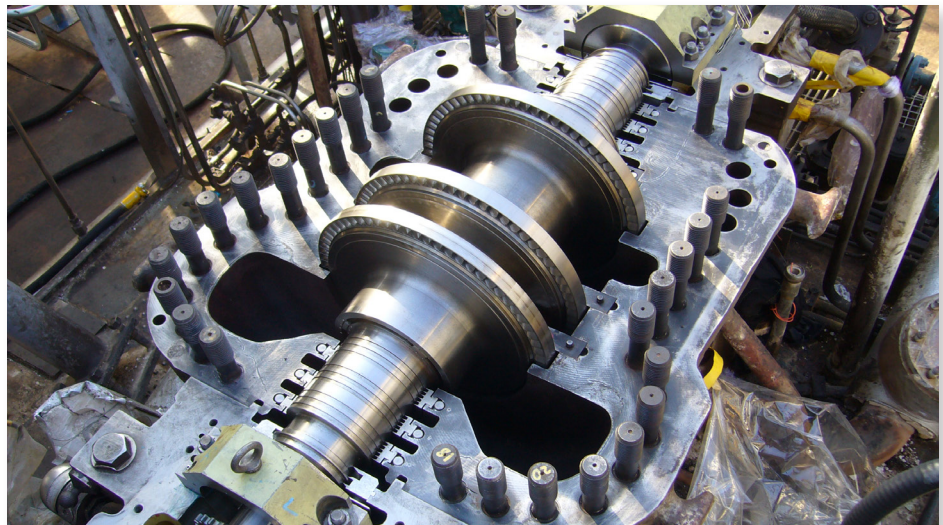
Elliott coordinated several teams around the world and used state-of-the-art reverse engineering tools to execute the turbine rerate and compressor modifications within the customer's schedule.

In preparation for a transition to Euro 4 low sulfur fuel standards, one of Thailand's most modern petroleum refineries needed to change the process on a compressor string in its diesel production unit. The upgrade required the steam turbine to produce increased power at a higher speed without a change to the existing steam conditions or exhaust pressure. The driven hydrogen recycle compressor also needed to operate at a higher speed.

The original equipment manufacturer recommended replacing the installed string with new equipment. Elliott Group proposed a faster and more cost-effective solution that included rerating the existing steam turbine and modifying the compressor. Elliott began the project in November 2010, with a delivery deadline of July 2011.

The project's success required flawless coordination and execution among several Elliott teams throughout the world. Engineering and manufacturing took place primarily in Jeannette, Pennsylvania, with assistance from the Elliott service centers in Pittsburgh, Pennsylvania and Taichung, Taiwan. The Taichung facility also provided critical engineering support. Field Service operations were provided by Elliott's regional office in Singapore. Dedicated project managers from Elliott's Engineered Solutions team in Jeannette and Asia Pacific Field Service group in Singapore oversaw every detail of the complex project.

To rerate the steam turbine and upgrade the compressor, Elliott required precise measurements in order to reverse engineer, modify, and manufacture the necessary components. However, the refinery did not plan to shutdown the equipment string until a scheduled outage in September 2011. This posed a major challenge for Elliott. The team had to find a way to obtain the necessary measurements without access to the equipment.



Steam turbine rotor before the rerate.

Turbine Rerate

A steam turbine, identical to the unit that Elliott would rerate, was shut down during a planned outage at the refinery. The Elliott project team used this opportunity to inspect and measure the turbine's internal components. Using a portable coordinate measuring machine (CMM) with a hand-held laser scanner, Elliott engineers gathered the data to reverse engineer the required parts.



Elliott engineers on the turbine deck at the refinery, measuring rotor dimensions with a portable CMM and hand-held laser scanner.

Although most of the reverse engineering was completed at the customer's site in Thailand, Elliott also requested that the refinery ship the turbine's spare parts to the Taiwan service center to further aid in the reengineering process.

Elliott needed to use a combination of modified spare parts from the refinery's operating turbine and newly manufactured parts to complete the rerate and meet the increased power and speed requirements. The scope of work included:

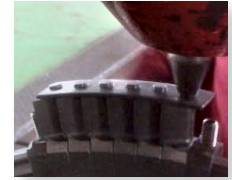
- Modifying the existing spare rotor, converting it from three stages to two stages
- Installing new blades on the rotor assembly
- Performing at-speed balancing of the rotor
- Manufacturing new stationary parts, including a set of spare parts

Expert technicians at Elliott's Taiwan service center machined the blades off of the spare rotor, built up the disc using sub-arc welding, and installed new blades supplied from Jeannette.



Blades being removed from rotor shaft.

The team used a tenon peening process to secure the blades to the shroud. The Materials Engineering group – certified to perform the blade tenon peening process – trained and qualified the Taiwan service center technicians to perform this operation at their facility. Once the blades were installed, blade shrouds were peened, and final machining was complete, the rotor was shipped to Jeannette for at-speed balancing.



Tenon peening process.



Elliott engineer measuring a journal bearing with a portable CMM and hand-held scanner.

Simultaneous to the work on the rotor, the Jeannette team manufactured the new stationary parts, including segmented nozzle rings, journal and thrust bearings, second-stage diaphragm, diaphragm seals, internal steam seals, tip seals, and inlet valves and valve seats.

Reverse Engineering a Segmented Nozzle Ring

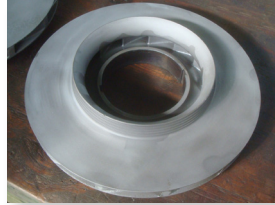


Typical nozzle rings are one piece. The nozzle ring in the refinery's diesel unit's steam turbine was comprised of individual segments that fit into a channel, making it difficult to measure. Elliott manufactured the fixture pictured on the left to hold the nozzle segments in their arc formation for accurate measurement.

Compressor Modifications

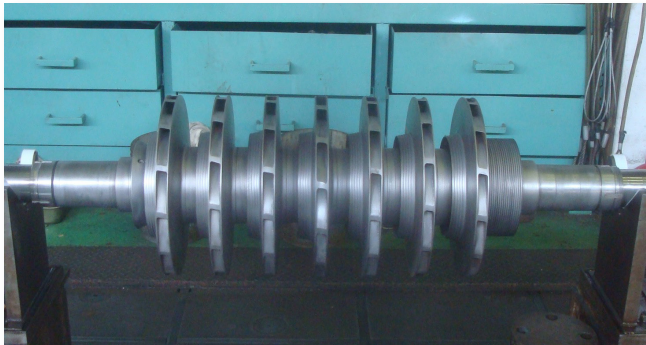
The increase in turbine power and speed required Elliott to modify the compressor to ensure it would operate at the required speed. After receiving the spare compressor components from the refinery, Taiwan service center engineers and technicians inspected the rotor and components.

All impellers were removed from the rotor and spin tested to uncover any potential issues. Considering impeller manufacturing lead time, Elliott reengineered two new impellers prior to performing the tests as a precaution. Elliott's analysis indicated that the original impellers would have no issues operating at a higher speed, but some new components were needed.



New impeller manufactured at Elliott's Jeannette manufacturing facility.

In addition to the two new impellers, Jeannette manufacturing reengineered and manufactured a rotor shaft and shaft sleeves, and the Pittsburgh service center manufactured new journal bearings. Elliott also provided a second set for spare parts. All components were shipped to the Taiwan service center for final assembly. The rotor was reassembled and low-speed balanced in the Taiwan service center, then it was returned to Jeannette for an at-speed balance.

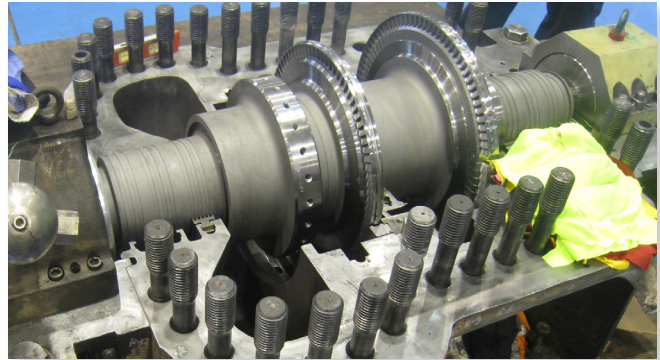


Modified compressor rotor assembly, ready for installation.

Turbine and Compressor Installation

Elliott delivered the turbine and compressor components to the Thailand refinery in advance of the July 2011 deadline.

Elliott's Field Service team installed the new turbine and compressor hardware within a 10-day window during the September shutdown. The team removed the original internal components from the turbine casing and installed the rerated rotor and new stationary parts. A new nameplate on the turbine identifies it as an Elliott machine. The Field Service crew also opened the compressor casing and installed the modified rotor and new components.



Rerated turbine rotor in the refinery's workshop where the turbine was rebuilt and then installed on the turbine deck.

In November 2011, the customer conducted a successful field performance test of the steam turbine with assistance from Elliott's Technical Service group based in Switzerland.

The refinery was pleased and impressed with the coordination of Elliott teams around the world to ensure the success of the project. The turbine rerate and compressor modification were completed on time and delivered the performance improvements that the refinery needed to meet the new clean fuel standards.

Customers everywhere turn to Elliott for engineering expertise, superior project management, and effective solutions for their complex projects.

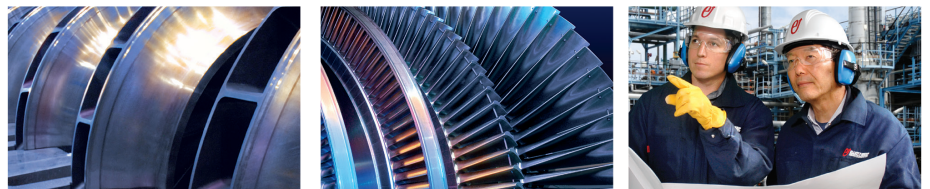


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