

**Customer:**

Ethylene Plant, Iowa

Equipment:

Elliott multi-stage turbines
Elliott multi-stage compressors
Various Elliott and non-Elliott equipment

Problem:

Improve the efficiency and reliability of five different equipment strings during a 40-day turnaround.

Solution:

Advanced planning and coordination ensured that strategic upgrades and modifications were successfully completed within the turnaround schedule.

Thorough preparation leads to improved equipment performance and a successful turnaround

An ethylene processor in Iowa had a 40-day turnaround scheduled in 2013 to increase the efficiency, reliability, and safety of the installed Elliott equipment. Elliott began working with the customer's dedicated turnaround team in 2010 to ensure that there was adequate time to complete the necessary work. The customer planned to overhaul and upgrade two process gas trains, two ethylene refrigeration trains, and a propylene refrigeration train.

Elliott's scope of work included:

- Efficiency upgrade of the process gas turbine
- Rerate of the propylene compressor
- Upgrade of the propylene turbine valve rack
- Multiple turbine brush seal upgrades
- General overhaul of gears, lube systems, turbines, and compressors.

The scope of work required the involvement of many parts of Elliott's organization, including Field Service, Service Parts, Engineered Solutions, and Elliott's Chicago service center. Field Service served as the primary point of contact, coordinating and simplifying the customer's interaction with Elliott and keeping the customer informed of the overall progress before, during, and after the turnaround.

Prior to the turnaround, Elliott's Chicago service center inspected six spare rotors to verify that they were suitable for use. During the same period, the service center also disassembled, inspected, and rebuilt six sets of valve racks, servos, and steam admission valves.

Elliott also conducted a parts audit of the customer's spare parts inventory well in advance of the turnaround. Having the right spare parts on hand during a turnaround is a critical success factor. The audit identified specific parts that would be needed but were not in inventory. Additionally, some parts had longer lead times than others, so it was important to identify and order them immediately following the audit.

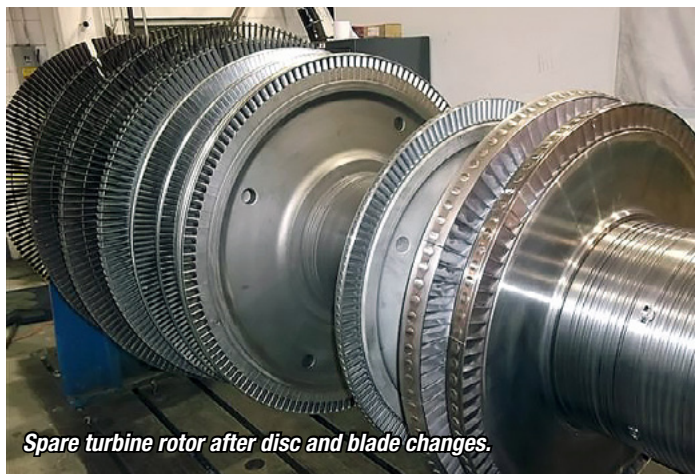
Process Gas Steam Turbine

The customer's objectives were to improve efficiency, increase horsepower, and extract as much flow as possible from the eight-stage process gas turbine. Elliott met each of the customer's goals by rerating the turbine's high pressure section. The nozzle ring and first-stage disc were replaced while the second-stage disc and diaphragm were re-bladed. These changes increased efficiency by 6%.

Elliott modified the spare rotor prior to the turnaround. After the turnaround, Elliott modified the unit rotor and returned it to the customer along with a new set of spare diaphragms and a spare nozzle ring.

Propylene Refrigeration Steam Turbine

The multi-stage propylene refrigeration turbine began to experience intermittent vibration on the extraction lift



Spare turbine rotor after disc and blade changes.

rod in 2009. Elliott worked closely with the customer to troubleshoot the problem and determine the root cause. Operational data indicated that the vibration occurred when the valve rack was more than 75% open. Elliott's analysis determined that the vibration was a result of the moment force on the lift rod, caused by significant pressure drop across the valve. Elliott concluded that a change in the opening sequence of the valves would decrease the pressure drop, reduce the moment force, and eliminate the vibration problem.

Elliott modified the valve stem lengths and the nozzle ring to achieve these changes without sacrificing performance. The spare extraction diaphragm was modified in advance, reducing the amount of work required during the turnaround.

Propylene Refrigeration Compressor Rerate



Spare extraction diaphragm after modification.

The customer wanted to improve the efficiency of the compressor while also converting a sideload connection to an extraction connection, capable of passing 178,000 lb/ hr. After considering multiple options of varying complexity, they decided upon a complete rerate of the rotating and stationary components. Elliott manufactured new unit and spare rotors, new diaphragms, seals, and spare seals for installation on-site by Elliott Field Service. The new components improved compressor efficiency while addressing the customer's other requirements.



At-speed balance of new 60M rotor.

Ethylene Refrigeration Steam Turbine

Many different options were presented to the customer to increase the power of this single valve, multi-stage turbine. After review of the new process conditions, a power increase of only 10% met their needs. This made relatively inexpensive modifications a feasible solution.

A new nozzle ring provided the required power increase, but also created higher internal pressure. The increased pressure exceeded the casing rating and required a re-hydrotest of the turbine's first-stage casing. Removing the turbine from the facility for the test would have been a costly and time consuming process, so Elliott manufactured new hydrotest plates in advance and delivered them to the site. The customer successfully conducted the hydrotest with the equipment in place under Elliott supervision.

No changes were required to the integrally forged rotor. The cost effectiveness of the turbine modifications allowed the customer to invest in a spare rotor and a complete set of spare diaphragms.

Turbine Brush Seal Upgrades

To provide the customer with additional cost-effective turbine efficiency gains, Elliott proposed upgrading the turbine seals to brush seals. Brush seals are up to 2% more efficient on high pressure sections and 0.5% more efficient on low pressure sections. Brush seals also reduce steam leakage to the gland system and reduce the amount of sealing steam required for operation. Elliott installed brush seal upgrades on two process gas turbines, two ethylene turbines, and one propylene turbine, and supplied a spare set of brush seals for each of the three processes. Field machining was performed on each turbine to accommodate the new seals.

Turnaround Execution

Elliott's extensive preparations in advance of the turnaround included: component inspections and modifications to rotors, valve racks, servos, and admission valves; manufacturing of new components including spare rotors, seals, nozzle rings, diaphragms, and hydrotest plates; and the on-site parts audit. Four Elliott technical representatives supervised the work of customer personnel during the turnaround and of the sub-contractors for field machining and welding.

When plant operations resumed as scheduled, each modified piece of equipment met the new performance requirements. The customer was pleased with the performance upgrades on the equipment and with Elliott's overall planning and execution.

While the plant startup was the primary objective, Elliott's work on this project began well in advance of the turnaround, and continued after the turnaround was completed. All rotors and diaphragms removed during the turnaround were shipped to Elliott's Chicago service center and subjected to the same inspections as the spare components.



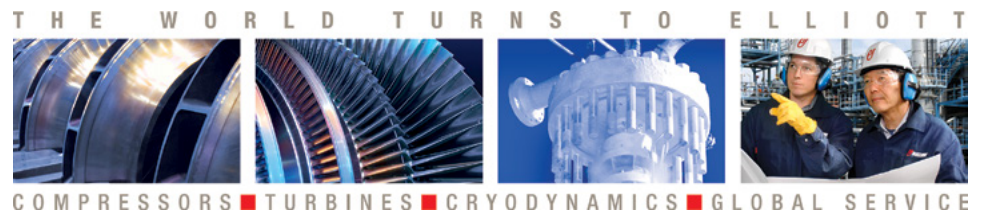
Elliott understands the critical nature of our customer's equipment. We are completely invested in meeting our customers' needs and schedules while exceeding their expectations for quality and professionalism. With more than a century of turbomachinery experience, the world turns to Elliott for engineering expertise, qualified personnel, and a continued commitment to excellence.



901 North Fourth Street
Jeannette, PA 15644-1473
Phone: 724-527-2811
Fax: 724-600-8442
Email: info@elliott-turbo.com

www.elliott-turbo.com

© 2020 Elliott Group



SVS.4204.0520