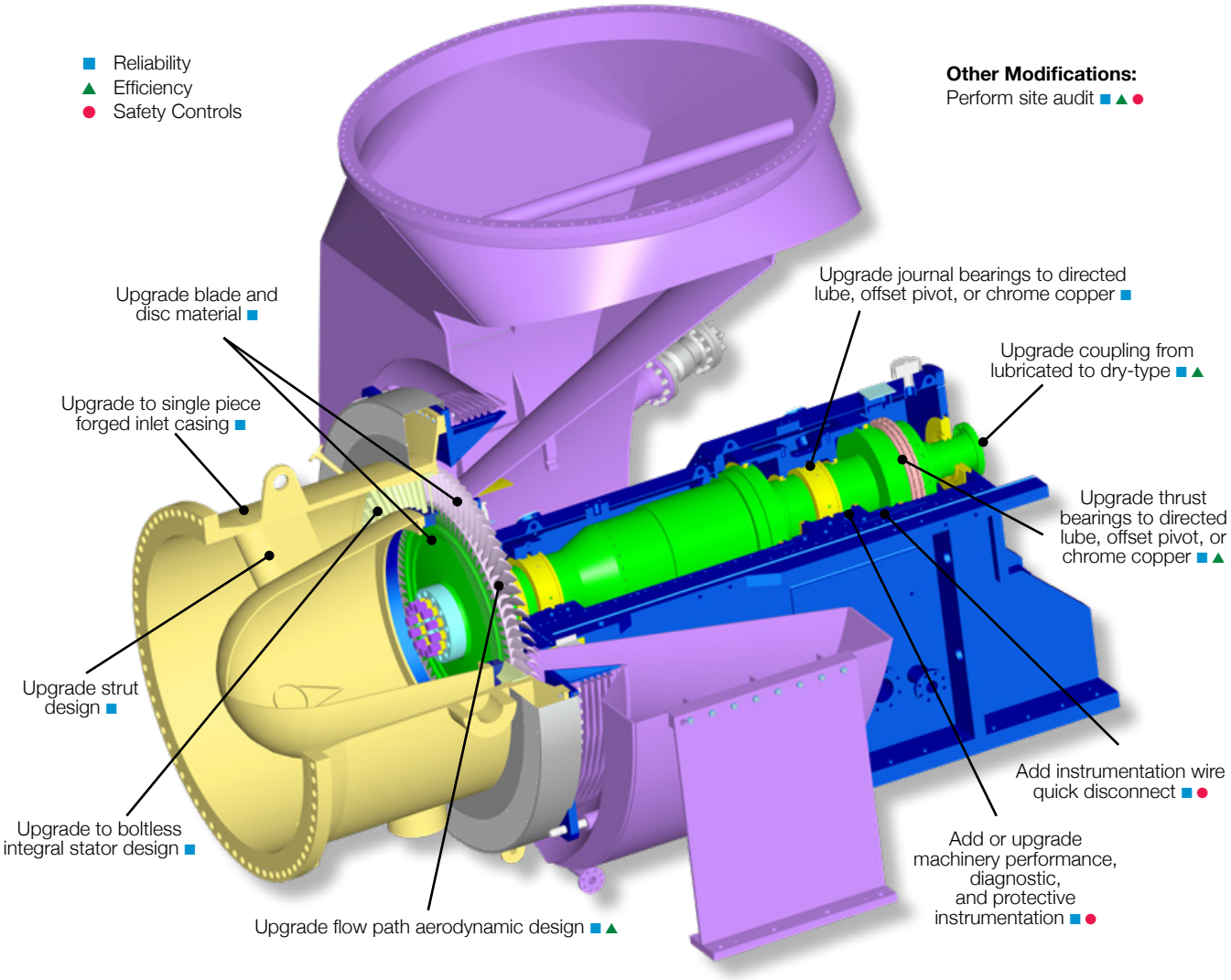
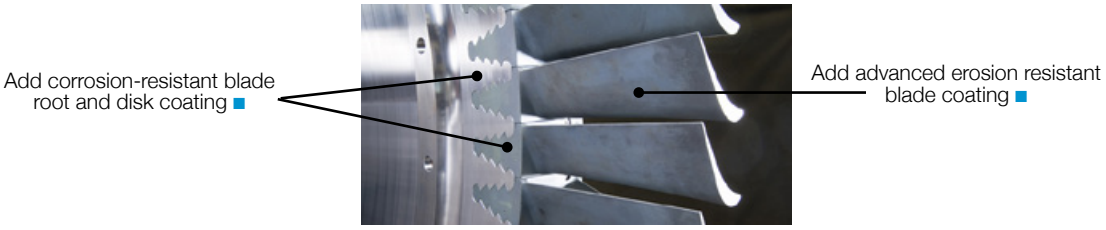
Power Recovery Expander Modifications and Rerates

Elliott power recovery expanders produce power from the valuable thermal energy in the waste gas stream of the fluid catalytic cracking (FCC) process. A hot gas expander typically drives either the main FCC air compressor train or an electric generator, reducing a refinery's power consumption and carbon footprint. Elliott introduced the first commercial hot gas expander in 1963, and in the decades since this engineering breakthrough, has continued to enhance its expander design. Today, Elliott's fourth-generation expanders recover up to 60,000 horsepower (45 MW) from FCC flue gas streams and regularly exceed required run times between planned outages.

Upgrading a power recovery expander has multiple, immediate benefits. Working closely with the customer, Elliott conducts site audits to evaluate expander performance and identify upgrades that will keep performance high and maintenance costs low. An upgrade by Elliott Engineered Solutions of an Elliott expander or a machine from another manufacturer, will enhance performance, lower operating costs, increase reliability, reduce unplanned outages, and extend the time between planned shutdowns. Elliott expander upgrades also contribute to refinery environmental compliance initiatives, while maintaining or improving overall plant safety and efficiency.





The harsh FCC operating environment requires expert knowledge of materials and extreme accuracy when replacing or upgrading expander components. Elliott's Materials Engineering Laboratory leads the industry in research in expander applications. Elliott engineers use FARO® coordinate measuring machine (CMM) technology together with calibrated hand-measurement tools, to determine the precise dimensions of expander components, regardless of the original manufacturer. Elliott accurately replicates components and provides mechanical and metallurgical enhancements to improve the reliability of any hot gas expander. Elliott parts are manufactured by our ISO 9001 registered Service Parts organization, using computer-controlled multi-axis machine tools.

Elliott Engineered Solutions

Elliott Engineered Solutions has one focus – to help customers obtain the highest value from their critical rotating equipment. Elliott has more than 100 years of experience in engineering, manufacturing repairing, and modifying all types of turbomachinery. Elliott Engineered Solutions specializes in the following areas:

- Modifications and rerates of turbomachinery to increase the operational life and value of your investment by optimizing performance and reducing downtime.
- Reverse engineering and comprehensive analytical studies such as lateral and torsional rotor analysis, root-cause failure analysis, mechanical evaluation analysis, finite element analysis (FEA), and aerodynamic analysis.
- On-site audits to evaluate turbomachinery efficiency and determine potential reliability improvements to maximize your return on existing equipment.

Enhancement	Category	Benefit
Add advanced erosion resistant blade coating	Reliability	Reduce the effect of catalyst wear on airfoils
Add corrosion-resistant blade root and disk coating	Reliability	Prevent sulfidation corrosion in partial combustion atmospheres
Add instrumentation wire quick disconnect	Reliability. Safety	Reduce chance of oil leak; reduce maintenance time
Add or upgrade machinery performance, diagnostic, and protective instrumentation	Reliability. Safety	Improve machinery performance, health monitoring and protective instrumentation
Perform site audit	Reliability. Safety. Efficiency	Identify areas to upgrade for peak performance
Upgrade blade and disc material	Reliability	Improve high temperature corrosion resistance in partial combustion atmospheres
Upgrade coupling from lubricated to dry-type	Reliability. Efficiency	Eliminate oil requirements; improve rotor dynamics
Upgrade flow path aerodynamic design	Reliability. Efficiency	Minimizes catalyst erosion on the rotating blades and increase efficiency
Upgrade journal bearings to directed lube, offset pivot, or chrome copper pads	Reliability	Improve rotor stability at operating speed
Upgrade strut design	Reliability	Reduce the potential for nose cone strut cracking
Upgrade thrust bearings to directed lube, offset pivot, or chrome copper pads	Reliability. Efficiency	Reduce oil requirements, bearing temperature, and bearing heat loss
Upgrade to boltless integral stator design	Reliability	Eliminate the high-temperature hardware required to mount the integral stator assembly
Upgrade to single piece forged inlet casing	Reliability	Eliminate the potential for weld cracking/flue gas leaks

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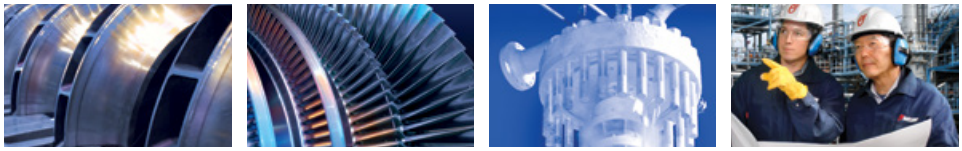
THE WORLD TURNS TO ELLIOTT



COMPRESSORS ■ TURBINES ■ CRYODYNAMICS ■ GLOBAL SERVICE