Elliott Engineered Solutions

Elliott Engineered Solutions has one clear focus – to help customers derive additional value from their critical turbomachinery. Elliott has more than 100 years of experience in engineering, manufacturing, repairing and modifying all types of rotating equipment. Elliott's depth and breadth of experience translates into expertise that few companies can match and none surpass.

Maximizing the value of your turbomachinery investment

Elliott Engineered Solutions rerates and upgrades can maximize a company's investment in rotating equipment. Over time, operational requirements change as plants expand and new technologies are introduced. An equipment rerate is often a cost-effective, time-saving answer to increasing throughput without the expense of investing in new equipment. A comprehensive Elliott site audit can also identify a wide range of opportunities for performance improvements within a production facility.

Extending the life of your rotating equipment

The availability and reliability of turbomachinery can have a critical affect on revenue. Each day that a piece of rotating equipment is off-line can result in millions in lost revenue and serious disruption of the downstream supply chain. Equipment upgrades by Elliott Engineered Solutions can increase reliability and reduce planned and unplanned outages that disrupt production and reduce revenue. Upgrades to bearing, seals, couplings and controls improve efficiency and reliability, reduce operating costs, and extend the equipment's operating life.

Hundreds of companies throughout the world rely on Elliott to keep their turbomachinery operating efficiently, reliably and at peak performance, regardless of the original manufacturer.

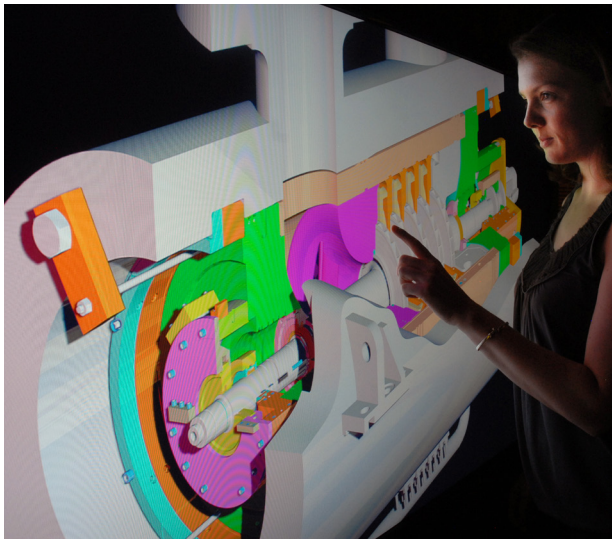
The world turns to Elliott for the experience, expertise and resources of Elliott Engineered Solutions.

Rerates

Turbines, compressors, expanders and other rotating equipment are significant capital assets. Equipment engineered, manufactured and serviced by Elliott typically operates reliably and efficiently for many years. But even well maintained turbomachinery in good working order can become obsolete through advances in technology, design, materials, or plant capacity. Elliott Engineered Solutions can maximize the value of rotating equipment from any manufacturer by re-engineering the equipment to meet enhanced performance specifications within the same casings and with minimal changes to foundations, piping and other connections.

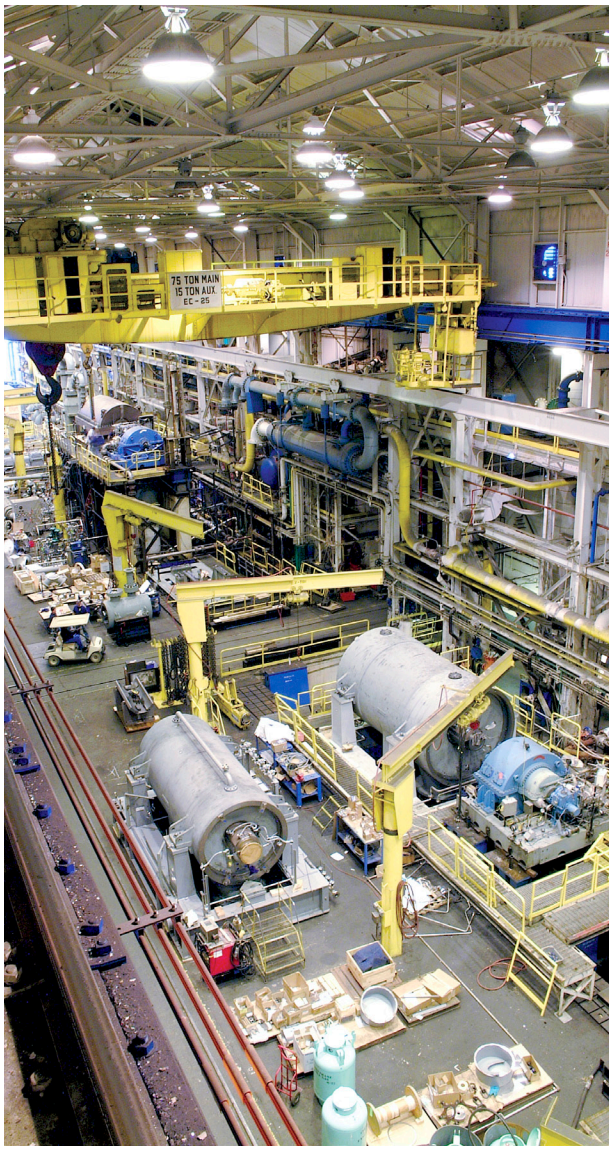
Comprehensive engineering studies

A rerate can be as simple as redesigning a nozzle ring or as complex as reviewing all mechanical limits and replacing all aero components. An engineering study is often necessary to determine how the equipment should be modified. A thorough mechanical and aerodynamic evaluation can include performance and efficiency analysis, flow path definition, material analysis, rotor dynamics analysis, finite element analysis, and gas analysis. Using computer-aided design (CAD) and computational fluid dynamics software (CFD), Elliott engineers develop design specifications that meet or exceed new application requirements. Elliott can then re-engineer and manufacture virtually any component from any manufacturer through the use of state-of-the-art digital shape sampling and processing technology along with coordinate measuring machines, laser measurement, and traditional manual dimensioning.



Facilities throughout the world

Elliott has manufacturing and full-service repair facilities in North America, Europe and Asia capable of completing the most complex rerate projects. Elliott's facilities are equipped to conduct the full spectrum of machinery testing including impeller mechanical tests, assembled rotor at-speed balance testing, casing hydro-testing, materials verification, and performance testing.

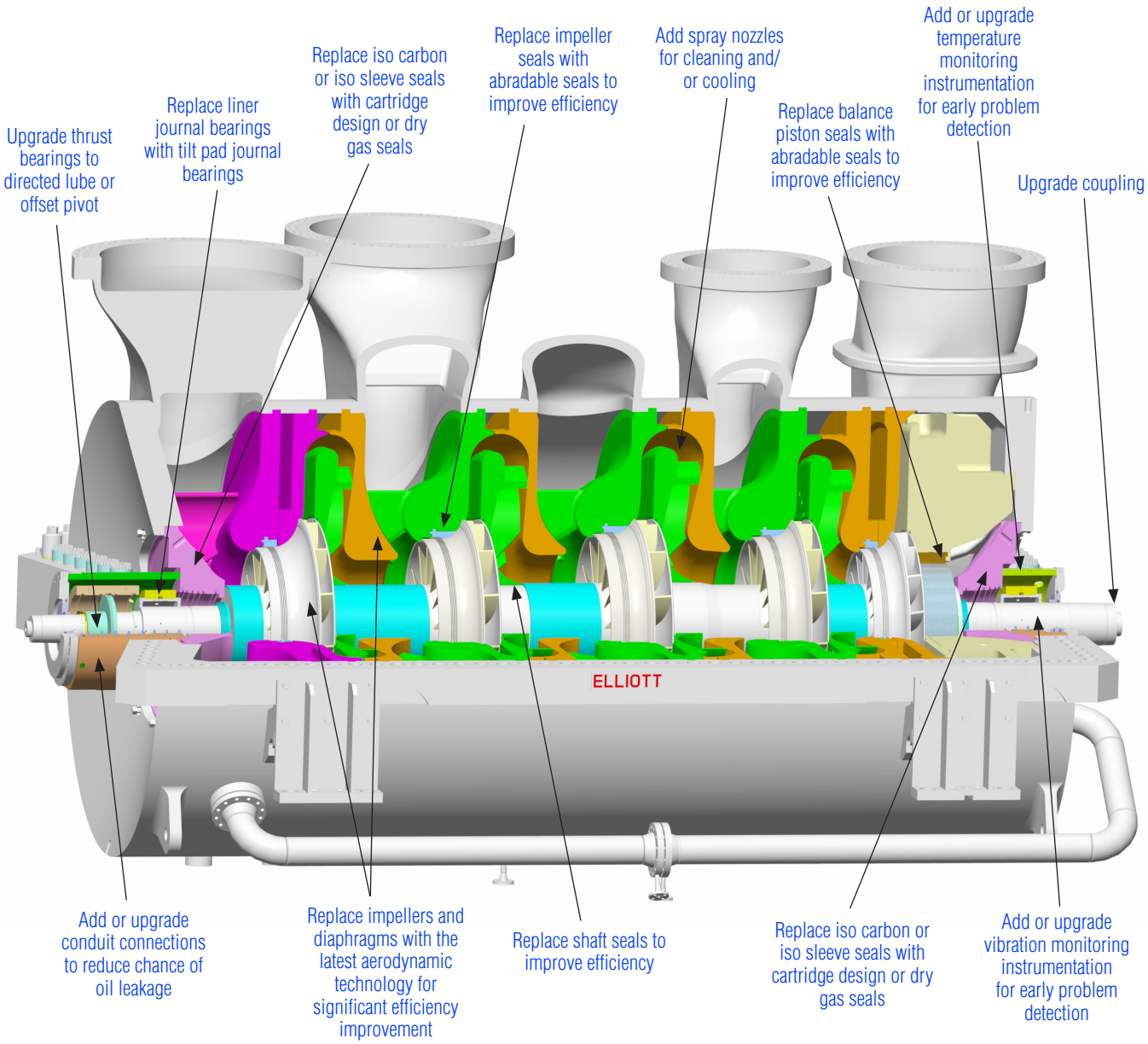


Equipment Upgrades

Every minute that critical process machinery such as compressors and steam turbine drivers are shut down – whether planned or unplanned -- means a significant loss of revenue. An Elliott Engineered Solutions Equipment upgrade can significantly can increase reliability, which can extend the time between shutdowns, abbreviate turnarounds and reduce unplanned outages. Elliott site audits also can identify upgrades that improve efficiency, boost performance, lower operating costs, reduce maintenance expenses, improve plant safety, and enhance environmental compliance.

Compressor Upgrades

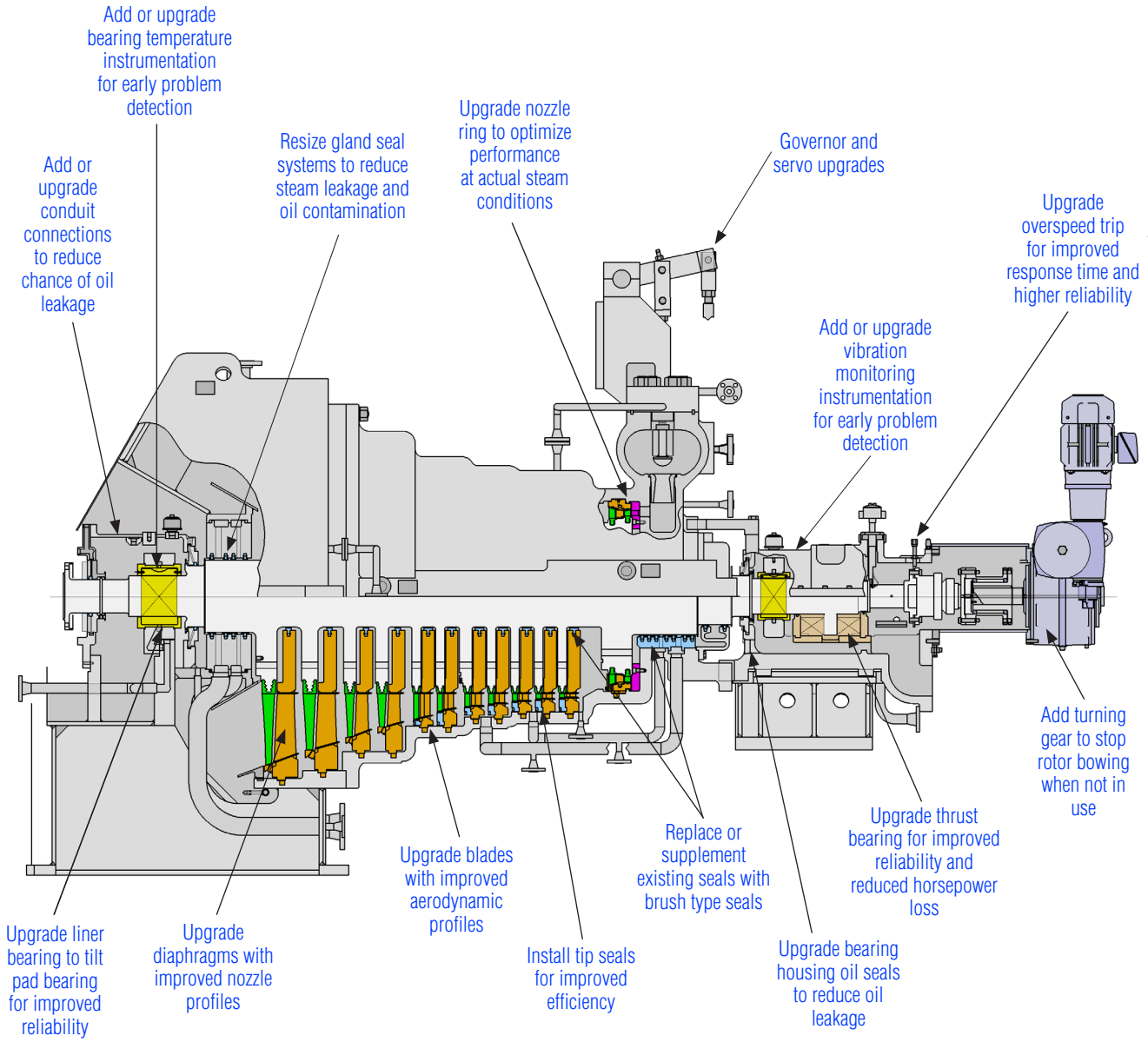
Elliott is a leader in improving the design, materials, manufacturing techniques and components associated with turbomachinery. Illustrated below are examples of some of the reliability and efficiency upgrades that Elliott can apply to centrifugal compressors from any manufacturer.



Turbine Upgrades

Steam turbine performance can often be improved with simple procedures and modifications. The installation of pneumatically operated automatic hand valves on single valve turbines can minimize throttling losses and boost efficiency when manually adjusting hand valves is not feasible.

The performance of multivalve multistage turbines can be improved by addressing individual stage efficiency. The inlet stage, for example, might actually be operating below the most efficient point on its operating curve. Because the inlet stage typically uses the most energy and produces the most power of any stage, improving inlet stage efficiency can significantly improve overall efficiency. Other common turbine upgrades include the addition of stage tip seals, installing new diaphragms with improved nozzle profiles, and more efficient blade designs.



Site Audits

When it comes to evaluating the efficiency and operating performance of rotating equipment, Elliott Engineered Solutions stands alone. Elliott engineers are responsible for many of the developments in design, materials and manufacturing that define the state-of-the-art in turbomachinery today.

Expert Performance Appraisal

With an Elliott site audit, equipment operators can draw upon Elliott's experience and expertise to evaluate the performance of their installed turbomachinery. An Elliott site audit engineer will assess the turbomachinery installed in a facility and identify opportunities for enhancement. An on-site review can uncover a variety of performance issues. Are actual compressor RPMs near the design RPM? Is compressor outlet temperature higher than the original specification? Is a turbine valve rack wide open or in a throttled position during operation? Are all pressures, temperatures and flows reasonably close to design? Many turbines, for example, do not operate in their designed performance range, resulting in low efficiency. Elliott can recommend appropriate measures to increase efficiency and improve other operational metrics such reliability, ease of maintenance and lower operating costs.

Quantifying Costs and ROI

A key consideration of a site audit is to identify the critical costs associated with each piece of equipment. In addition to basic operating costs, such as cost of steam and the frequency and cost of replacing wearing parts such as bearings and seals, critical considerations include the daily cost of planned and unplanned shutdowns. A realistic understanding of the cost of having critical equipment off-line is essential when considering a turbomachinery rerate or upgrade. Elliott uses Value Analysis Models to project the cost-benefit of a specific rerate or upgrade and to determine the return on investment (ROI) the customer can expect. With Value Analysis Models available for a number of typical compressor and steam turbine modifications, Elliott can quickly run "what if" scenarios to show customers the affect a modification will have on their bottom line.

Tools

Elliott Engineered Solutions ensures the precision and accuracy of every rerate and upgrade with state-of-the-art tools for analysis, design and fabrication.

Materials testing can include chemical analysis, optical and scanning electron microscopy, fracture mechanics analysis, comprehensive non-destructive testing and much more. Mechanical testing and design entails lateral and torsional critical analysis, critical speed map analysis, finite element analysis, 3D modeling and geometry definition.

The accurate measurement and definition of new components is essential to ensure that a modification achieves its objectives. Elliott uses the digital shape sampling and processing technology of a FARO coordinate measuring machine equipped with a laser scanner to provide accurate dimensioning of components, whether originally manufactured by Elliott or another manufacturer. Elliott fabricates new components with the same computer-controlled multi-axis machine tools it uses to manufacture new equipment.

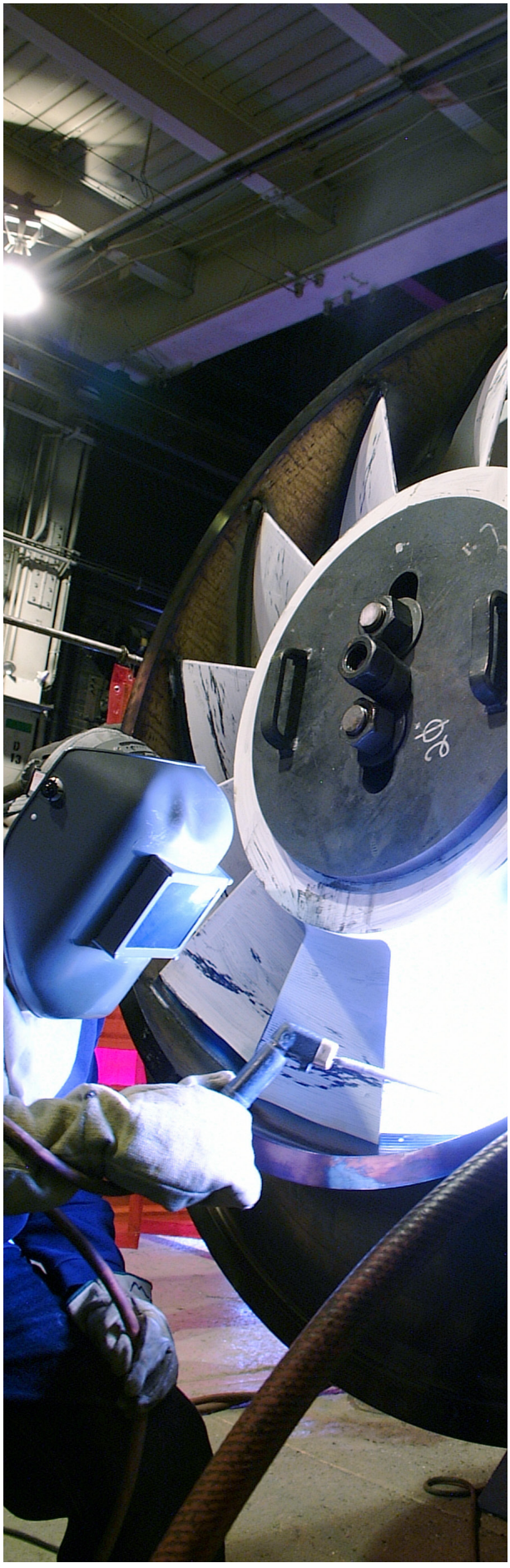
Remanufacturing

Elliott can extend the useful life of turbomachinery and restore its efficiency by remanufacturing it to its original condition. Usually, remanufacturing results in an immediate performance benefit simply due to restoration of flow passages through the aero components. Remanufacturing can be a much more cost-effective solution with shorter lead time than investing in new equipment.

The remanufacturing process begins with a thorough inspection for wear, erosion and corrosion, and analysis of all components at an Elliott facility. Components are repaired or replaced as necessary, and appropriate reliability and efficiency upgrades, such as aero flow path coatings, are applied. Elliott covers equipment remanufactured to its standards with its new equipment warranty. Elliott also remanufactures equipment from other OEMs, using the latest design software and measurement technology to re-engineer components.

Equipment Reapplication

When a critical piece of machinery fails suddenly and completely, the results can be truly catastrophic – in terms of operations, infrastructure, contractual obligations, and revenue. In these circumstances, extended down time is not an option. In many cases Elliott can quickly locate and reapply a used or "retired" machine for the affected service while the original machine is repaired or replaced. Reapplied equipment can also prove to be a cost-effective permanent alternative to new machinery in mature operating environments.



Elliott Group is a global leader in the design, manufacture and service of technically advanced centrifugal compressors, steam turbines, power recover expanders and axial compressors used in the petrochemical, refining, oil & gas and process industries, as well as in power applications. Elliott Group is a wholly owned subsidiary of Ebara Corporation, a major industrial conglomerate headquartered in Tokyo, Japan.

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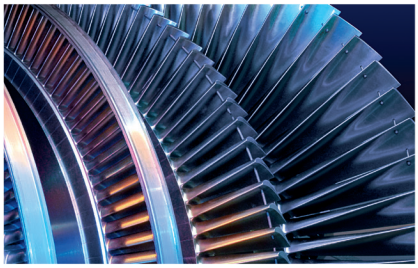


COMPRESSORS ■ TURBINES ■ GLOBAL SERVICE