



**ELLIOTT GROUP**  
EBARA CORPORATION

# Elliott Engineered Solutions



## ■ 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*

As technology, materials, and plant capacity evolve, Elliott Engineered Solutions is dedicated to helping customers enhance the performance of their centrifugal compressors, steam turbines, hot gas expanders, and other critical turbomachinery. Modifications and rerates by Elliott Engineered Solutions can maximize a company's investment in rotating equipment. An equipment rerate is often a cost-effective, time-saving answer to increasing throughput without the expense of investing in new equipment.

### *Extending the life of your rotating equipment*

Even well maintained turbomachinery in good working order can become obsolete through advances in technology, design, materials, or plant capacity. The availability and reliability of turbomachinery can have a critical effect 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. Elliott Engineered Solutions equipment modifications and rerates can increase reliability and reduce planned and unplanned outages that disrupt production and reduce revenue. A comprehensive Elliott site audit can identify a wide range of opportunities for performance improvements within a production facility.

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.

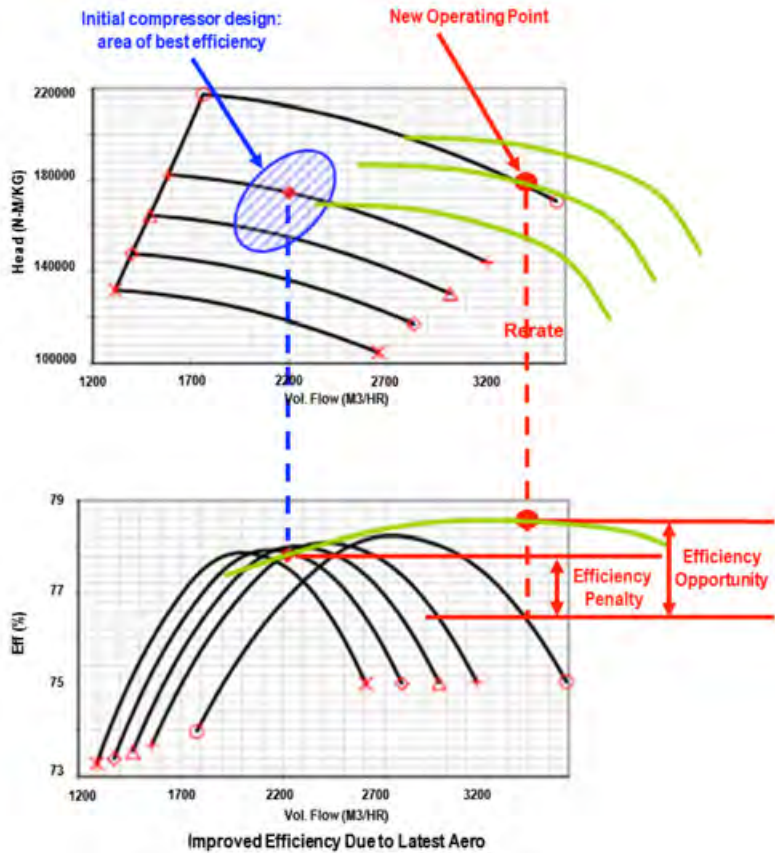


## EQUIPMENT SERVICES

### Rerates

Expansion and modernization of processing plants often increase the production demands on critical turbomachinery. Advances in flow path design, stage performance, aerodynamics, manufacturing technology, and materials science make it possible to achieve new process parameters within existing casings, minimizing changes to foundations, piping, and other connections. A rerating of existing equipment can meet new production requirements more quickly and cost-effectively than an investment in new equipment. With careful planning and skillful execution, Elliott regularly rerates equipment during normal maintenance shutdowns. Elliott begins a rerate project with a thorough evaluation that includes performance and efficiency analysis, flow path definition, material analysis, rotor dynamic analysis, finite element analysis (FEA), and a gas analysis.

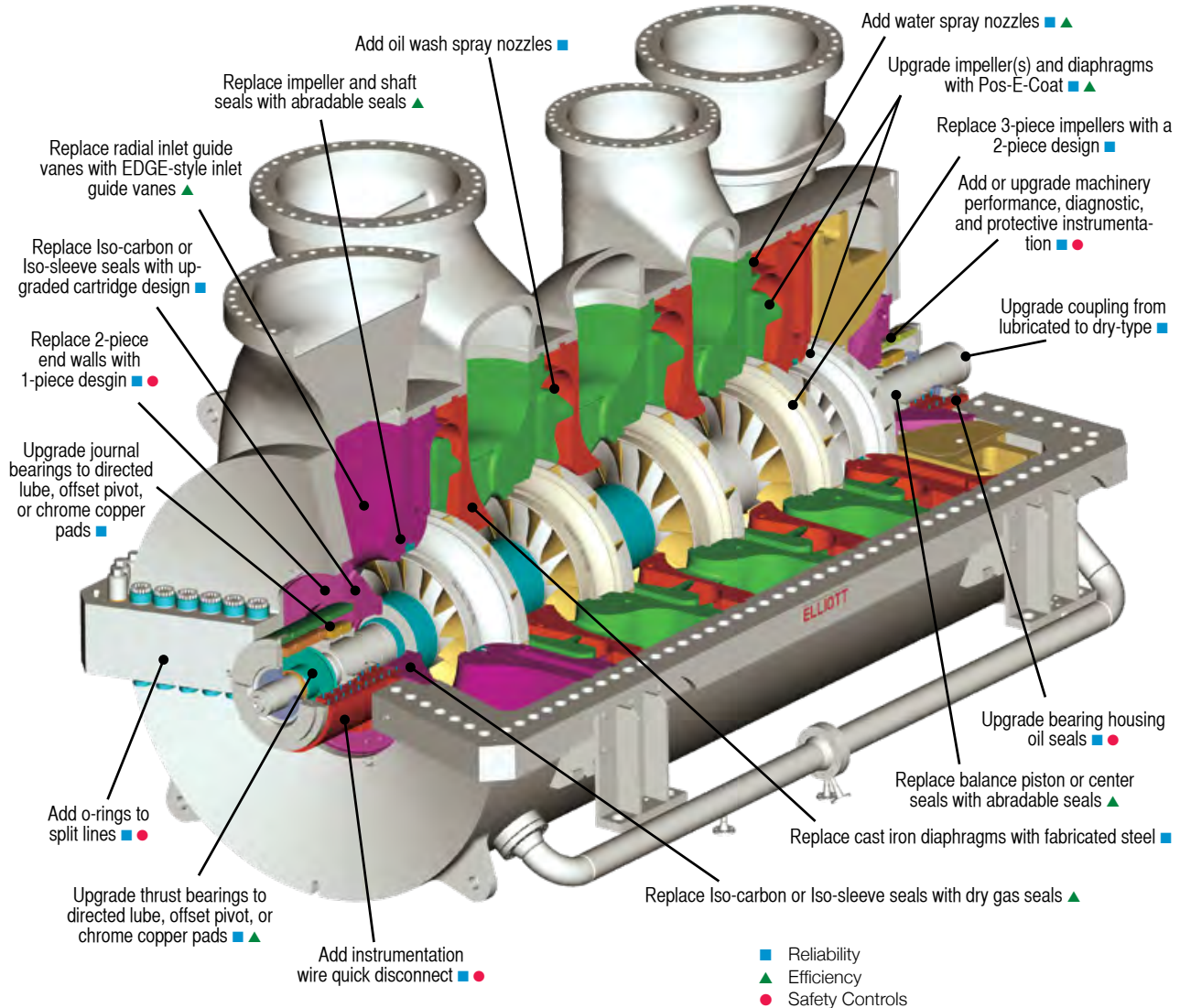
Elliott uses value analysis models of typical compressor and steam turbine rerates and modifications to demonstrate to customer the cost-benefit of a specific rerate and the return on investment (ROI) the customer can expect.





## Modifications

Turbomachinery modifications by Elliott Engineered Solutions can increase the operational life and value of your critical rotating equipment by enhancing performance and reducing downtime. A modification can range from a simple bearing upgrade to a complete modernization project which may include dry gas seals, wash systems, couplings, material upgrades, modern instrumentation, controls, and more. Production resumes with a more reliable machine at a fraction of the cost of new equipment. Increased equipment reliability means extended time between shutdowns, shorter turnarounds, and fewer unplanned outages.

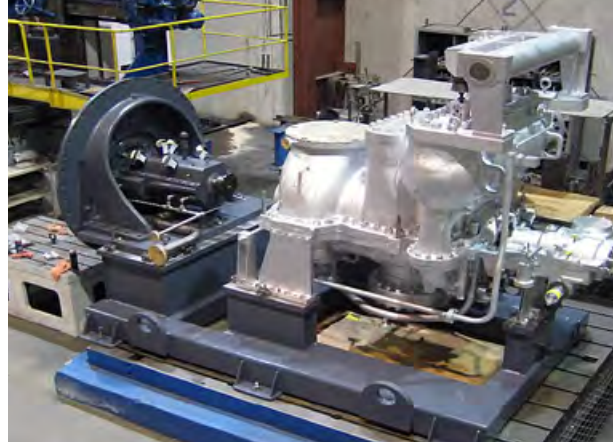


## Remanufacturing

Elliott can restore a unit's efficiency and extend its useful life by remanufacturing it to its original condition. Remanufacturing typically results in immediate performance improvement due to restoration of flow passages through the aero components. Elliott remanufactures turbomachinery from any original equipment manufacturer, using the latest design software and measurement technology to re-engineer components. Remanufacturing is usually a much more cost-effective solution with a shorter lead time than an investment in new equipment. Customers benefit from increased reliability and Elliott's long-term support.

## Reapplication

The sudden, complete failure of a critical piece of machinery can be catastrophic in terms of operations, infrastructure, contractual obligations, and revenue. In these circumstances, extended down time is not an option. Elliott can often quickly locate and reapply a used or “retired” machine for the affected service until the original machine is replaced. Reapplied equipment can also be a cost-effective permanent solution to new machinery in mature operating environments. Elliott engineers can present the best technical solutions for any operating condition or application.



## Drop-Ins

There are a number of situations when customers might require a “drop-in” replacement for a critical piece of equipment. Operational requirements might have changed significantly, or new equipment must be tested before installation, or turnaround time must be shortened and modifications to piping and foundation minimized. Elliott offers complete drop-in replacement equipment for situations like these. A drop-in unit can reduce discovery repair work and eliminate disassembly, installation, and alignment of new internal parts. When choosing a drop-in unit, Elliott can also upgrade and enhance bearings, seals, and instrumentation to improve a unit’s reliability, control, and safety. Complete drop-in units can be tested before installation at Elliott’s facilities in Jeannette, PA and Sodegaura, Japan.



*Assembly of a drop-in replacement for a 30-year old compressor. Design enhancements for this machine included solid end walls, abrasable seals, and improved diaphragm and impeller materials.*



## ■ ANALYTICAL CAPABILITIES

An engineering study is often necessary to determine how rotating equipment should be modified. Elliott engineers review design specifications, drawings, instruction manuals, overhaul history, and service reports to ensure a full understanding of a machine's history. Thorough mechanical and aerodynamic evaluation can include reverse engineering and comprehensive analytical studies such as lateral and torsional rotor analysis, root-cause failure analysis, mechanical evaluation analysis, FEA, and aerodynamic analysis.



### *Reverse Engineering*

Using portable, coordinate measuring machines (CMM), Elliott engineers precisely map the geometry of equipment from any manufacturer. Using CMM tools to record internal component geometry during service outages, we can recommend redesigns, rerates, or reliability upgrades of internal components. When operating machinery cannot be dismantled for measurement and evaluation, we can map the installation footprint and provide a replacement “drop-in” unit with upgraded internal components. This is a timely and cost-effective way to meet changes in production requirements or provide spare components for your rotating equipment.

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, regardless of the manufacturer. Elliott fabricates new components with the same computer-controlled multi-axis machine tools it uses to manufacture new equipment.

### *Advanced Engineering Studies*

Using solid-modeling techniques, computational fluid dynamics (CFD), finite element analysis (FEA), and proprietary performance and rotor dynamic software, Elliott engineers design solutions using the latest materials, aerodynamic designs, and reliability advancements to meet or exceed new application requirements. Engineering studies can also evaluate equipment for increased output, revised operating conditions, or extended-life requirements.

### *Remaining Life Assessment*

Elliott conducts remaining life assessment evaluations using metallurgical and fracture-mechanics methodologies. These techniques predict the remaining operating life of components and structural elements that have been in service for an extended period of time. Life assessment is an important tool for scheduling replacement and avoiding premature scrapping of parts.



## Site Audits

Site Audits performed by Elliott consulting engineers provide an objective analysis of the condition of equipment from any manufacturer. Site audits target cost-effective equipment upgrades for improved reliability, peak efficiency, and ease of maintenance. Typical audits consider site utility costs, equipment operating history, and potential upgrades. Elliott prepares a detailed report with improvement recommendations and value analysis.

## ■ VALUE & EXPERTISE

When process changes, environmental regulations, or increased capacity requirements demand enhanced performance from your critical process machinery, Elliott Engineered Solutions is at your service. Elliott maximizes the value of your investment in turbomachinery by providing cost-effective alternatives to new equipment. We routinely rerate, modify, remanufacture, and re-engineer Elliott and non-Elliott rotating equipment to improve operating efficiency, reduce operating costs, and support increased plant capacity, anywhere in the world.

Engineered Solutions is part of Elliott Group's Global Service organization, which provides comprehensive service and support to customers around the world for Elliott and non-Elliott rotating equipment. With a global network of full-service repair centers and regionally-based field service crews, Elliott's expertise and resources are close at hand for fast emergency response, scheduled installations, turnarounds and overhauls, or routine maintenance, parts, and repairs. Customers everywhere turn to Elliott because our resources are global and our response is local.







Elliott Group is a global leader in the design, manufacture, and service of technically advanced centrifugal compressors, steam turbines, power recovery expanders, cryogenic pumps and expanders, and axial compressors used in the petrochemical, refining, oil & gas, liquefied 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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T H E W O R L D T U R N S T O E L L I O T T



COMPRESSORS ■ TURBINES ■ CRYODYNAMICS ■ GLOBAL SERVICE