

# Steam Turbines

Steam turbines are designed for long life but, after many years of service, wear may reduce their performance; or the process conditions for which they were originally designed may have changed. In either case, design re-evaluation and revamping to align them with current process requirements is usually a cost-effective means of adding additional years of productive service.

## What we do

GE has an expert engineering team, state-of-the-art design and analysis tools, modern shop and test facilities, and the years of experience needed to restore optimum performance to steam turbines.

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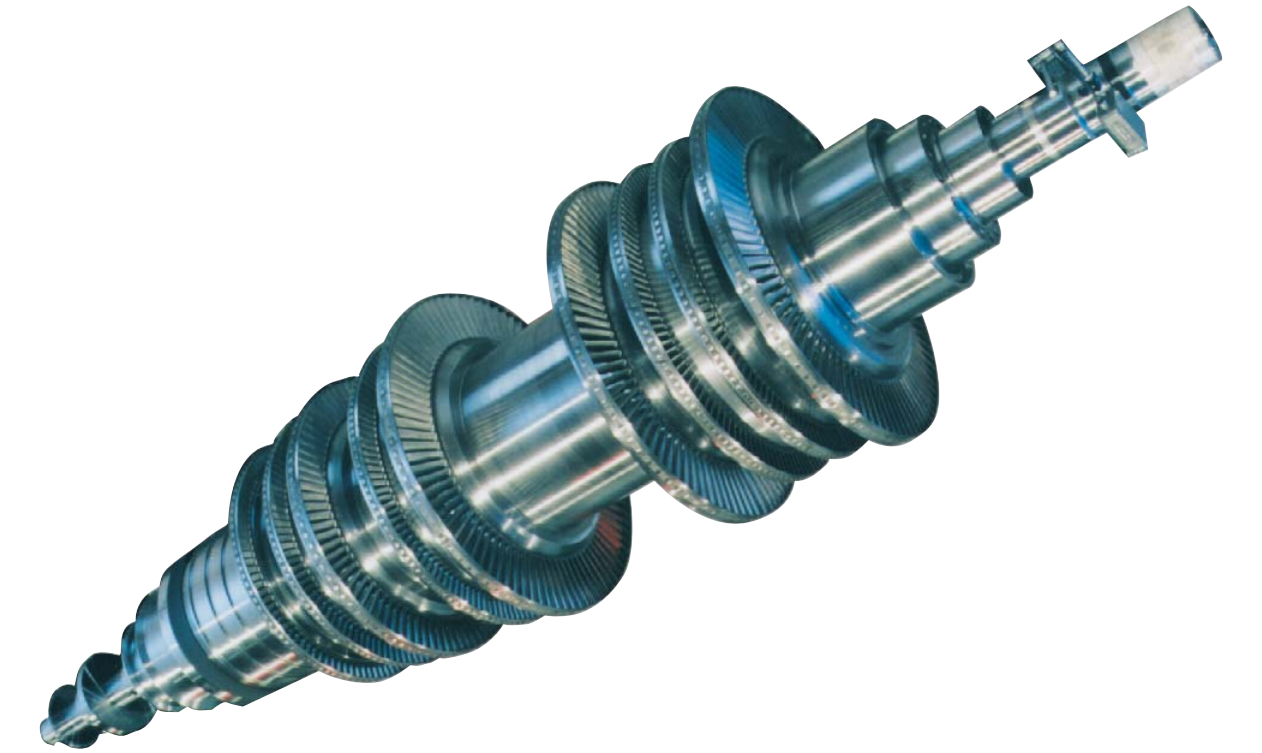
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# Steam Turbines

A full range of engineering, repair  
and uprate services



## Solutions for every steam turbine

GE's Conmec steam turbine service provides single-source access to a complete range of aftermarket solutions. We have an experienced team of engineering specialists, a highly qualified field-service staff, and a fully equipped overhaul facility. This combination of expertise and infrastructure gives us the unique ability to perform comprehensive services on components and full units from any original equipment manufacturer.

We help customers improve the efficiency and prolong the productive life of their equipment, allowing them to realize significant savings over the cost of new replacement machinery. Our experienced engineers have enhanced every feature of steam turbines and solved a wide range of operational problems – including solid particle and moisture erosion, corrosion, performance deficiencies and mechanical difficulties. Our design upgrades include rotor blades, diaphragms, nozzle plates and casing components.

### Repairs and overhauls

GE's state-of-the-art overhaul capabilities give customers the maximum performance possible from existing equipment. Whether supervising a simple rotor-replacement project or managing complete turnkey restorations, all our solutions are backed by proven design capabilities, strict quality control measures and experienced field-service personnel. Our overhaul services span the full range of machine types.

Customers around the world rely on our industry-leading restoration capabilities to extend the operating life of their aging turbines. Starting with a complete analysis of all critical components, we return entire turbines to as-new condition for significantly less than the cost of new equipment. With our thorough inspection techniques and metallurgical evaluations, our 'zero time' overhauls are unsurpassed for engineering excellence.

### Replacement parts and manufacturing support

One of the major reasons our repair and overhaul work meets such exceptional standards is the high quality of our replacement parts, all of which meet or exceed OEM specifications. All GE parts are manufactured at a competitive price with delivery tailored to each customer's specific requirements.

Replacement parts available include:

- Turbine nozzles, buckets and blades
- Diaphragms
- Fasteners, bearings and seals
- Solid and built-up rotors
- Complete casings
- Control and T&T valves

## Higher performance at a lower cost

GE delivers improved reliability, decreased maintenance costs, and increased horsepower through upgraded designs for a broad range of equipment – including rotor blades, diaphragms, nozzle plates and casing components. Engineered upgrades can be provided in the following areas:

### Mechanical upgrades

After analyzing the potential for enhanced performance, we replace existing steam turbine components with state-of-the-art upgraded parts to improve reliability and maintainability.

Common upgrades include:

- Steam seal system
- Bearing conversion
- Rotor redesign
- API instrumentation

### Performance rerates

We rerate existing steam turbines for increased power or efficiency. By applying modern metallurgical advances and specialized design techniques to redesign the steam path, we offer customers the opportunity to significantly improve the performance of older units for new steam and load conditions.

### Governors

By performing a thorough evaluation of the steam turbine's governor control systems, we identify areas where operations can be improved. We offer both electronic and PLC-based governor controls to provide optimum system integration. System upgrades also include electronic overspeed protection.

### Re-application of turbomachinery

Through our worldwide network of customer contacts our turbine experts can locate previously owned steam turbines and rerate them to meet the specific operating conditions of a new plant. Re-applying a refurbished steam turbine expedites the installation and increases the financial return for our customers since they realize significant cost savings versus new equipment and earlier plant production. Sourced equipment is always thoroughly assessed with our detailed engineering analysis and stringent testing protocols.

## Analytical tools and experience

We continuously develop and invest in our analytical capabilities, tools and engineering skills. These provide an edge in solving the difficult aerodynamic, mechanical, stress and structural design challenges encountered when rerating or re-applying steam turbines – and give extra value to our customers.

### Finite Element Analysis (FEA)

With analytical tools such as ANSYS® and Pro/MECHANICA®, we optimize components to safely expand the design envelope of existing equipment. Areas of analysis range from transient heat transfer analysis of casings to steady state stress analysis of rotor blades and disc attachment areas.

### Computational Fluid Dynamics (CFD) Analysis

We use CFD analysis to design more efficient flow path components while decreasing the effects of solid particle and moisture erosion. In conjunction with laboratory test stand analysis, CFD facilitates the correlation between field data and that of predictive models. By optimizing the flow path, we enhance performance, reduce erosion and increase reliability.

## Comprehensive analysis tools

Other engineering tools commonly used by our teams include:

### Design

- AutoCAD®
- Pro/Engineer – Solid Modeling

### Rotor dynamics

- ROMIG®

### Aerodynamics

- Northern Research® TAXIG®

### Axial turbine performance

- AEA® – Tascflow® Computational Fluid Dynamics

### Structural analysis

- ANSYS® – Mechanical/Structural
- Pro/Mechanica®

### Vibration analysis

- ANSYS – Finite Element
- Northern Research – Viblade

### Performance analysis

- STEAM – proprietary program developed in-house

### Performance and design

- Turboflow International Steam Turbine Performance

## Case study

### Rerate of a mechanical drive steam turbine in refinery service, West Coast USA

New plant process requirements demanded an increase in performance from the refinery's main air blower train. We rerated the existing 12-stage steam turbine driver from 10,000 HP at 2,650 RPM to 15,900 HP at 2,910 RPM – increasing output by 59%.

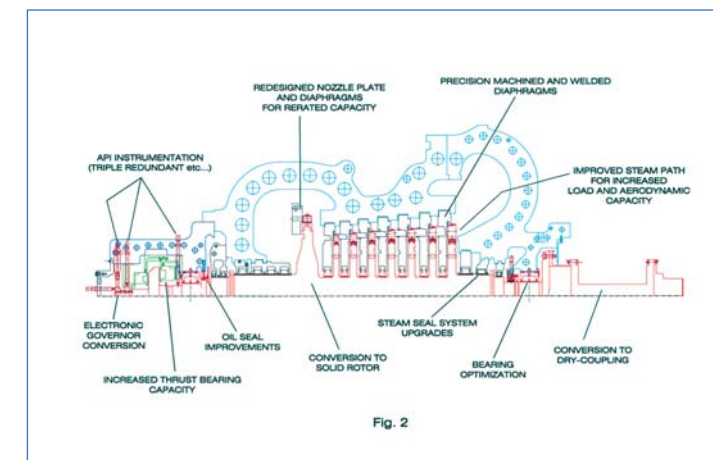
To achieve such a substantial increase in performance, our engineers made significant changes to the turbine's internal structure. The number of stages was reduced from 12 to 11 and the two final stages were completely redesigned. Integral to this redesign was the development of a free-standing, tapered and twisted airfoil mounted on a straddle root attachment. Blade stresses and frequencies were analyzed using FEA techniques and verified through modal testing.

Additional redesigned components included the ninth stage diaphragm for nozzle passing frequency, rotor shaft for high shaft end stress considerations, radial bearings for unit synchronous response, active thrust bearings for adequate thrust margin and the train coupling to meet the requirements of API 671.

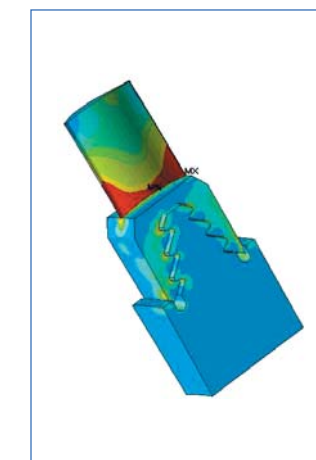
# Exceed expectations



State-of-the-art free-standing blade conversion



Typical unit rerate layout



Finite element analysis of a bladed disk



Major rerate from 10,000 HP to 15,900 HP for US refinery