

Industrial Steam Turbines

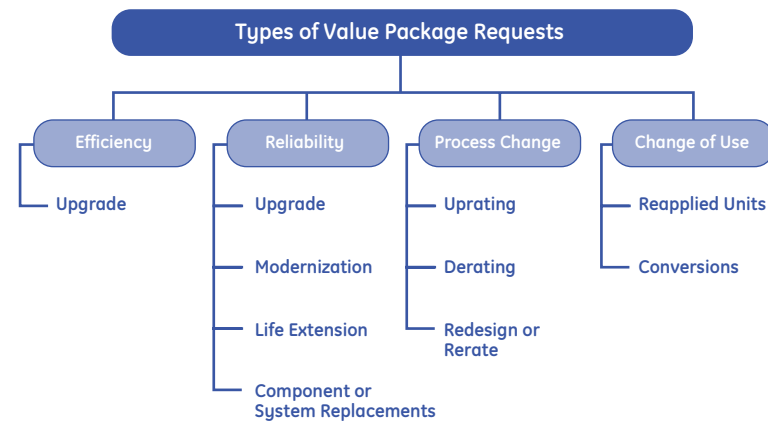
Advanced Technology for Improved Output and Reliability



OEM Expertise and Integration Tailored to Your Specific Operating Needs

GE Energy has created a full range of value packages to help achieve optimum performance from your existing steam turbine system. Drawing on GE's advanced technology and worldwide resources, our Industrial Steam Turbine application engineers have the required expertise to re-evaluate and reconfigure your unit to meet your current or future operating needs.

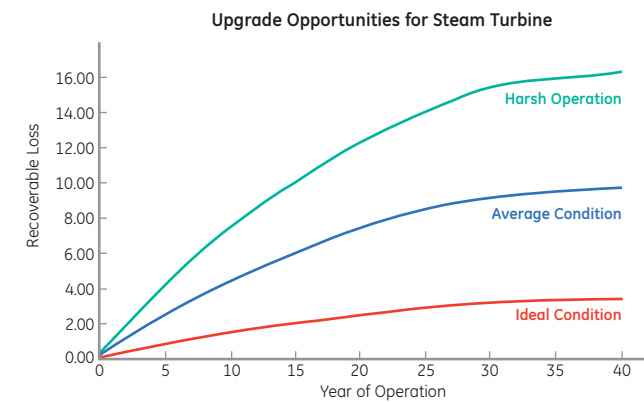
Which One Fits Your Needs?



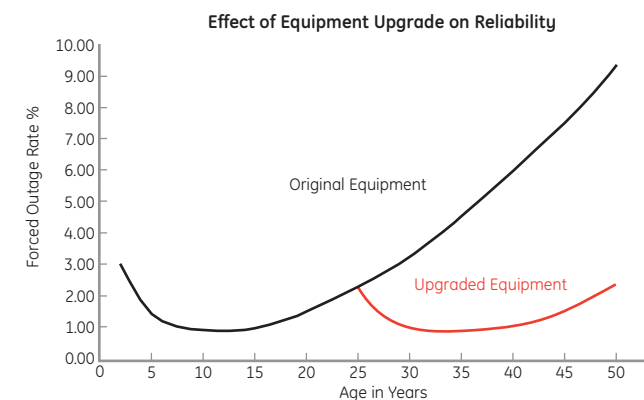
Value Packages

GE's skilled team of application engineers work closely with you to determine the value package that best suits the needs of your plant. Offerings include:

- Efficiency Upgrades.** Many older units experience performance losses as a result of changes in nozzle and bucket throat areas and blade profiles, as well as deterioration of finishes and increased clearances. By rebuilding the turbine with modern high efficiency components—usually nozzles, buckets, valves, and seals—our efficiency upgrade recovers the degradation, while improving efficiency levels by 4-6% above original unit performance. For a unit running over 30 years, these efficiency features can recover 10% degradation and increase performance 5% beyond its original level.



- Reliability Upgrades.** History has shown that steam turbine reliability decreases after 20 years of service. For a typical unit the forced outage rate can increase by 3-4% every 10 years. To arrest this trend, GE's reliability upgrade rebuilds your turbine with high reliability components that modernize your unit—while providing



significant life extension and operational reliability well into the future. This upgrade usually involves steam path replacement using new generation nozzle, bucket and rotor components or other engineered systems.

- Plant or Process Changes.** Plant changes may require the turbine to be redesigned or re-rated to accommodate changes in plant or process parameters, such as new throttle, extraction, admission and/or exhaust conditions. GE will evaluate the new requirements to determine modifications required for optimal operation at the new conditions. Specific conversions include:

- *Up-rates.* Modifying the steam path for increased power or flow
- *Derates.* Optimizing steam path performance for reduced power or flow needs
- *New process condition.* Modifying the turbine for new throttle flow, extraction demand, steam conditions, or speed

- Reapplication or Change of Use.** GE will evaluate if an existing turbine can be re-applied at a different site or to a different plant application. Our dedicated team of specialists will determine if the existing turbine can be reapplied without modifications—or identify all the necessary changes required for the new application.

GE's experienced Industrial Steam Turbine engineers can customize a value package to meet the specific needs of your plant.

Extend the Life of Your Steam Turbine

Advanced Technology Component Packages for Enhanced Performance

To restore aging industrial steam turbines to modern standards—even after 20 to 40 years of operation—GE's Industrial Steam Turbines team developed Engineered Advanced Technology Component Packages that can be adapted to your specific plant needs.

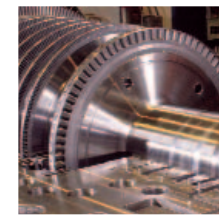
From individual components to turbine sub-systems or total machine redesigns, GE can provide you with reliable and efficient plant operation at the new process conditions, ratings, or applications your system requires.

Modernize Your Turbine with GE Advanced Technology Upgrade Packages



Head End Buckets

- Advanced SCHLICHT cylindrical profiles for performance and reliability improvements
- Flat skirt for more strength; round skirt for more efficiency
- Locking buckets where applicable
- SPE-protection plasma spray coatings



Rotor - Rebuild of Existing Rotor

- Factory inspection and refurbishment
- Wheel dovetail inspection
- Rotor welding: dovetail, wheel, shaft end, fine-line welding
- Shrunk-on wheel refurbishment
- Low speed and high-speed balance

Rotor - Use New Rotor Forging

- Enables new staging with modern buckets
- Solid rotor construction eliminates shrunk-on wheels, thrust collar, and coupling hubs for higher reliability
- New forgings with modern materials and NDT standards



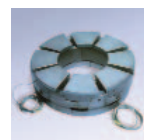
TSI Monitoring

- Complete range of vibration, temperature and displacement sensors and monitors



Control System Upgrades

- Convert mechanical hydraulic controls (MHC) or early generation electrohydraulic controls (EHC) to modern microprocessor-based type
- Electronic controllers and hydraulic interfaces available for significant performance and reliability benefits
- Convert mechanical bolt overspeed trips to high reliability electronic type



Thrust Bearings

- Tapered land to tilt pad conversions for higher load capability and misalignment tolerance

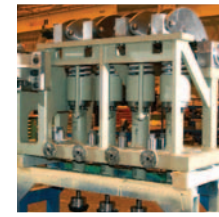


Journal Bearings

- Convert to tilt pad design for improved load capacity and rotor stability

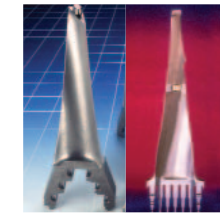
Steam Valves - Cam-Lifted

- Higher efficiency valve conversions; upgraded designs for valve seats, disks/systems/bushings; cam shaft, sector gear, no-maintenance DU bearing replacements; and improved clevis design



Steam Valves - Bar-Lifted

- Conversion from multi-piece to solid valves with split lift beam to reduce wear and vibration
- Valve seat, disk, stem and bushing upgrades



Condensing End Buckets

- New SCHLICHT twisted/tapered Vortex bucket designs for improved section reliability and performance
- Generator drives - LP and section upgrades featuring new generation SCHLICHT bucket and nozzle forms
- Mechanical drives - variable speed buckets with harmonically-tuned nozzles, larger setbacks, and long bands to reduce low frequency vibration stress
- Flame-hardened or solid material tall buckets replace brazed strips for improved erosion resistance

Exhaust End Improvements

- Cast iron to fabricated steel conversions
- Temperature-controlled exhaust hood sprays
- Refurbished or new turning gears for controlled startup and shutdown
- Gear couplings to modern disk type couplings
- Grinding brush upgrades and shaft voltage monitors for improved reliability



Casing - Modifications as Needed to Support Turbine Upgrades

- Add/modify extraction openings
- Condensing to non-condensing conversions
- Add borescope ports for inspection of steam path
- Casing and diaphragm inlays for erosion repair



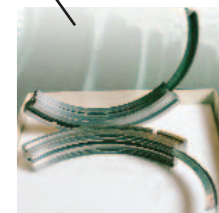
Auxiliary Turbine Systems - Reliability Upgrades

- Nozzle spray chamber replaces gland leakage condenser
- Gland exhaust vacuum pump replaces steam ejector
- Mechanical-hydraulic to pneumatic steam seal operator
- Converts NRVs to pneumatic operation



Lube and Hydraulic System - Component or Complete System Upgrade Packages

- Refurbished, uprated, or new oil hydraulic systems
- High pressure hydraulic unit (HPU) and valve actuators for faster valve response
- Replace shaft or steam turbine drive oil pumps with motor-driven pumps
- Oil-pump rebuilds or capability upgrades
- Add full flow duplex filters, dehydrators, vapor extractors



Brush Seal

- Advanced brush seals to minimize leakage
- Based on GE's successful aircraft engines and gas turbine seal evolution
- Compliant bristle design reduces typical leakage by 70%

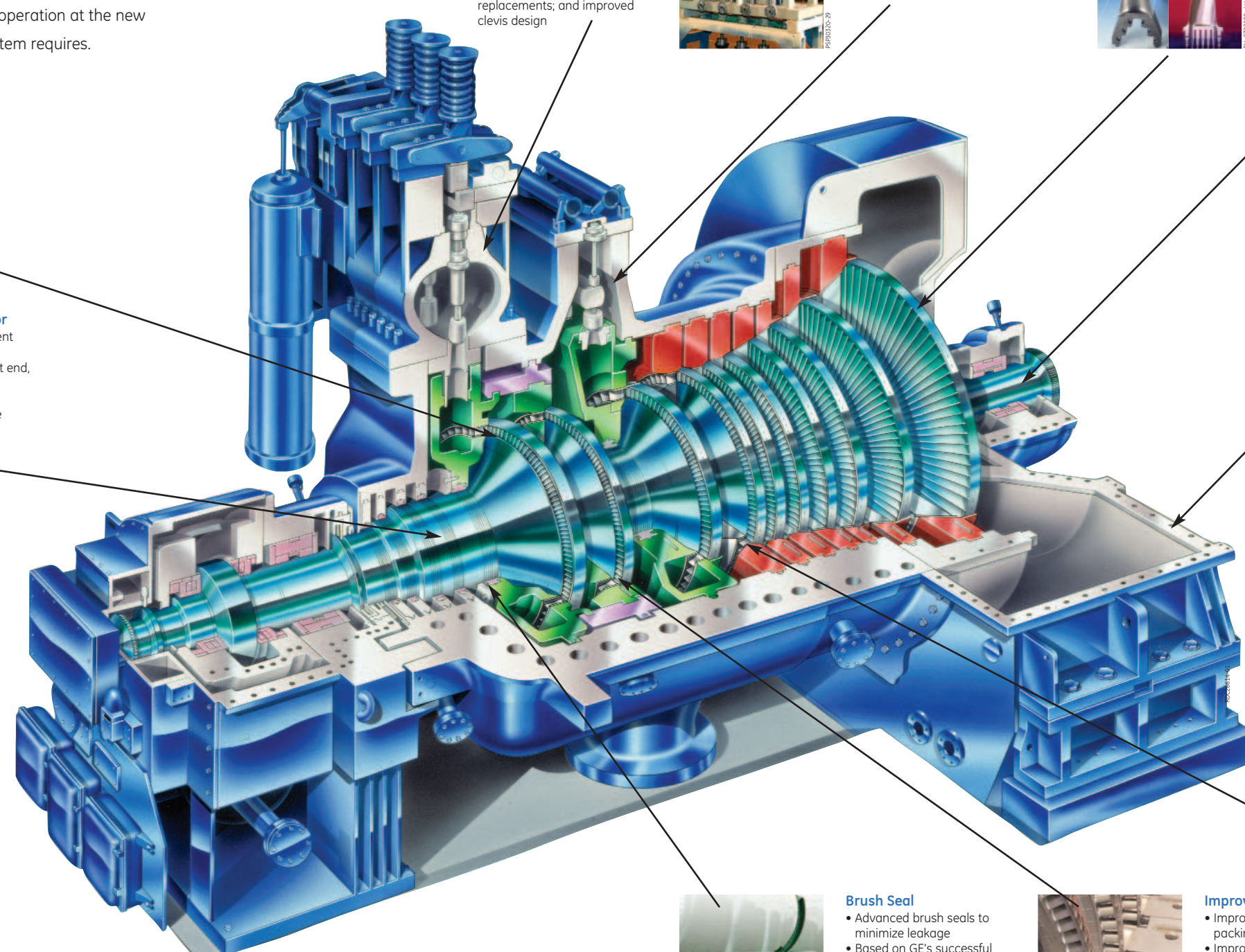


Improved Leakage Control

- Improved hi-lo labyrinth shaft packing to reduce leakage
- Improved HP nozzle box packing for higher reliability
- Advanced buckets and spill strips for improved efficiencies

Nozzles and Diaphragms

- Modern designs with advanced nozzle profiles and improved structural design
- Enhanced reliability and performance
- Welded nozzle plate replacements
- Solid Particle Erosion (SPE) hard facing nozzle protection



GE's Industrial Steam Turbine Application Center

A Dedicated Technology Center Focused Entirely on Maximizing Your Plant Value

To provide a dedicated technology group which serves only our steam turbine customers, GE Energy has developed an Industrial Steam Turbine Application Center staffed by a team of highly-skilled innovators—supported by industry-leading technology and a continually growing knowledge base.

With a core team of 20 engineers drawn from every technical turbomachinery discipline (for a total of over 600 man-years of experience on GE industrial steam turbines), the Application Center has the resources to serve all of your turbine needs. This veteran team is further reinforced by their access to the original OEM drawings, design and history data, and analytical tools—which enable us to provide you with the highest quality solutions.

Integrated Design System (IDS) Analysis Program

Our engineering team utilizes GE's proprietary Integrated Design System (IDS) to provide them with the most effective turbine design. This automated design program uses selection criteria and algorithms to "assemble" components into a complete turbine. Performing stage-by-stage thermal and mechanical analysis, the IDS is calibrated to forty-four (44) ASME field tests and eighteen (18) laboratory-tested sections for accuracy.

The IDS program also runs "real" operating points and establishes maximum stage conditions—as well as performing mechanical analysis of the total steam and generating performance curves and stress summaries. Supported by OEM drawings and design records, proposed turbine designs are thoroughly analyzed to ensure that resulting modifications will correctly fit the turbine the first time.

Our engineering expertise—combined with the Application Center's innovative design tools, computer aided design and solid modeling facilities—enable us to evaluate solutions across your total turbine system. By working closely with the customer, GE's Industrial Steam Turbine specialists can optimize reliability, capacity, maintainability and plant life-cycle costs.



Integrating Turbomachinery Expertise, Tools, and Data

EXPERTISE:

- Plant and Process Studies
- Thermodynamics Analysis
- Mechanical Design
- Heat Transfer
- Machinery Design
- Noise and Vibration
- Fracture Mechanics
- Strength of Materials
- CAD/CAM
- FEA - Static/Dynamic
- Control Systems
- Solid Modeling
- Rotor Dynamics Analysis

DESIGN TOOLS and DATA:

- Integrated Design System
- Maintenance History
- Electronic Records and Drawings
- Bill of Material
- Original Design Records
- Six Sigma Methodology
- ISO 9001 Procedures
- Unigraphics 3-D CAD

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