Performance Improvement and Uprates

for Reaction and Impulse Steam Turbines

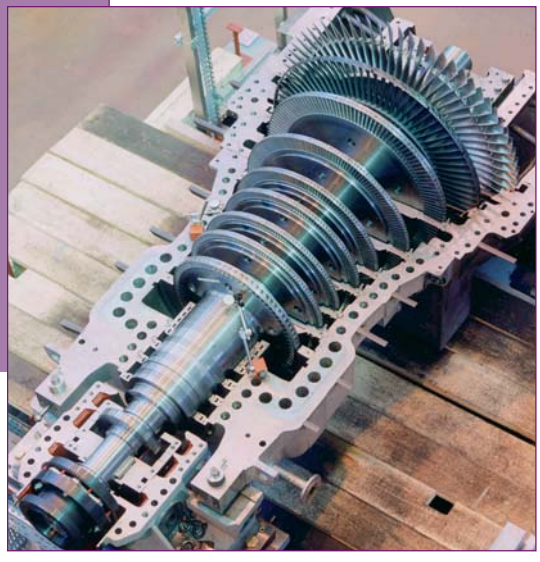
Benefits

■■■ **Increased production**
■□□ **Higher efficiency**
□□□ Compliance with environmental regulations
■■■ **Availability and Reliability**
■■■ **Life extension**

The GE Oil & Gas steam turbine product line includes both impulse and reaction technology as well as steam turbines for geothermal applications. All products are based on a modular turbine design that ensures reliability and a high level of performance.
We have also an extensive experience in the re-rating of steam turbines.
Customer can benefit from implementing the latest design improvements and leveraging our experience in new machine technology prior to retrofit installations.

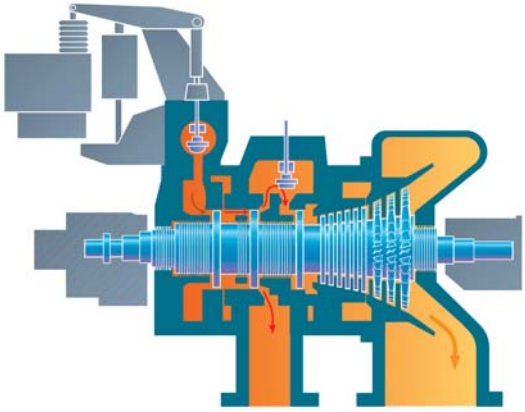
Re-rating provides substantial benefits, including:

- Improved profits by increasing plant production
- Increased plant capacity
- Increased efficiency
- Improved reliability
- Lower operating costs as a result of increased plant efficiency
- Extension of operating life
- Re-use and optimization of existing assets
- Re-use of the same spare parts previously used



What it is

Re-rating a steam turbine with new internals components and a new rotor can increase its performance, which typically increases efficiency and flow rate. Efficiency and steam flow capability can usually be significantly increased (up to 5% efficiency improvement and from 20 to 30% increase in steam inlet mass flow). New stator blade carriers and a new rotor can be designed to optimize the new operating points.



Typical cross-section drawing of an extraction condensing turbine equipped with a control stage in both high and low pressure sections

How it works

Selection of Internals Components

Based on our broad experience we select the steam turbine blading. Rotor blades and stator blades are chosen from our standardized families of pre-designed and verified stages.
All components are designed in compliance with API standards and codes, as well as our our internal standards.

Design Standards

Components that are not already regulated by codes are designed to meet the highest engineering standards. Component designs are verified by the application of FEA (Finite Element Analysis), CFD (Computational Fluid Dynamics), and model testing for NPI (New Product Introduction) projects.
The following list shows the standard activities included in a revamping study:

Bundle Selection

- Identification and axial and radial spacing available within the casing
- Selection of rotor blades and stator blades to optimize performance and reliability
- Mechanical layout check

Steam Velocity Check

- Inlet nozzles
- Discharge nozzle
- Extraction/Injection nozzles

Auxiliaries Check

- Lubricating oil system
- Oil system control
- Main condenser and condensing system

Aero/Rotordynamic Check

- Goodman and Campbell diagram
- Lateral/torsional analysis

Material Selection

- Identify the most suitable for new duty

We have experience in highly successful re-bundling projects for reaction Steam Turbines:

Urea Synthesis:

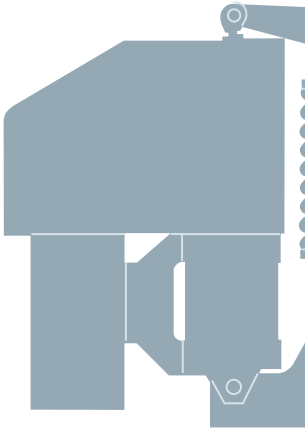
Compressor train:
ST+2MCL607+2BCL306/A

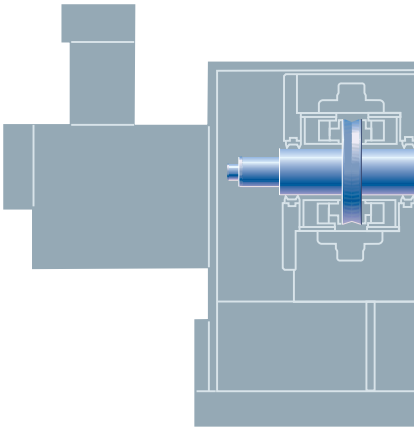
- Design flow: 27,000 NMC/H
- Upgraded flow: 34,000 NMC/H
- Flow increase: 25% accommodated through improved compressor efficiency and available driver power - no driver modification required

Ammonia Synthesis:

Compressor train:
ST+2BCL508+BCL407/A+2BCL406/B

- Design flow (make up/recycle): 135,000/585,000 NMC/H
- Upgraded flow (make up/recycle): 185,000/730,000 NMC/H
- Flow increase (make up/recycle): 35/25 accommodated through improved compressor efficiency and available driver power - no driver modification required





How it works

We have experience in highly successful re-bundling projects for action Steam Turbines:

Power Generation:
ST Unit: ST + Gearbox reductor + Generator
- Adaptation to new inlet pressure: from 18 bar abs to 10.5 bar abs

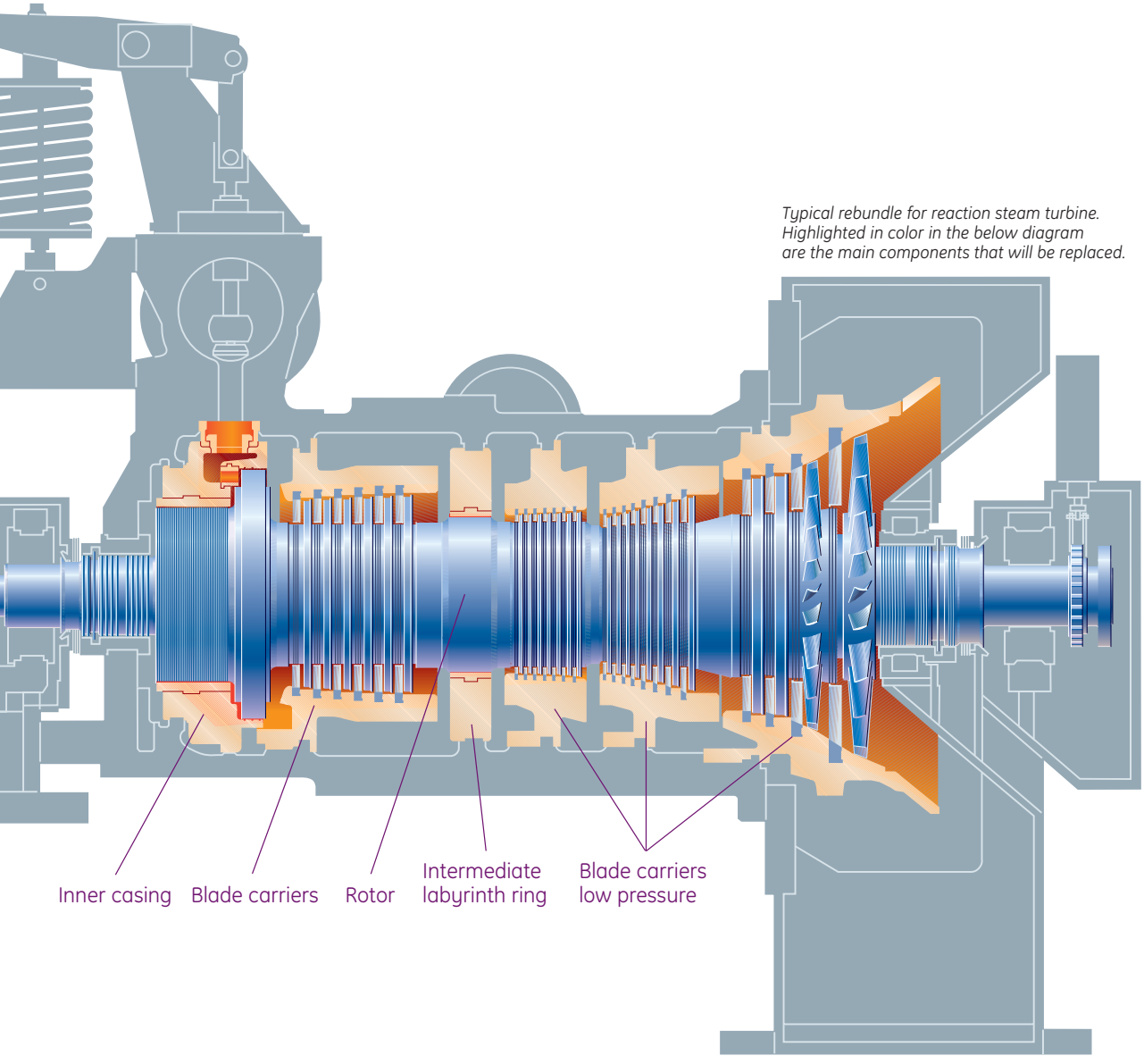
Power Generation:
ST Unit: ST + Gearbox reductor + Generator
- Design power: from 13.1MW to 16.5MW
- Upgraded Power: 26%

Butadiene Unit
Compressor train: ST+ non GE centrifugal compressor
- Design power: from 9.3MW to 11MW
- Upgraded power: 18%

Scope of Work for Standard Steam Turbine Rebundle
This scope of work identifies the main steps required to perform the subject installation only.
It assumes that turbine disassembly is for no other purpose than the installation.

- New set of complete blade carriers or diaphragms
- New set of labyrinth rings with gland condenser
- New set of tilting-pad journal and thrust bearings
- New set of seal oil rings with buffer chamber

Typical rebundle for reaction steam turbine. Highlighted in color in the below diagram are the main components that will be replaced.



GE imagination at work

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