Siemens Gas Turbine
SGT5-4000F

Advanced performance

Answers for energy.

SIEMENS
Increasingly fierce competition fueled by deregulation and privatization is dictating ever lower power generation costs. One approach to cost-cutting is economical plant operation centering on low investment costs and in particular on lowest life-cycle costs.

The SGT5-4000F – Designed for competitive power generation

The SGT5-4000F – Siemens Gas Turbine (SGT™) – our high-performance workhorse is tailored to meet these requirements. With its innovative design, materials and thermodynamic processes, the SGT5-4000F ensures you a strong position in a competitive market.

The machine is characterized by the use of a proven concept:
- Two rotor bearings
- Cold-end generator drive
- Built-up rotor with Hirth serrations and central tie bolt

The combination of this proven design and innovative features results in:
- Low investment costs per installed kilowatt
- High efficiency
- Low maintenance expenditure
- Long service life
- Fast payback on invested capital

Based on the standard design concepts of our modular reference power plants for single-shaft and multi-shaft application we have defined several scope of supplies around the SGT5-4000F. These packages from component through SGT-PAC to the full Turnkey scope support all your needs. The intelligent with a range of modules and options brings you benefits in terms of deadlines and quality.
The SGT5-4000F gas turbine concept builds on more than 40 years’ experience with heavy-duty gas turbines at Siemens and Siemens Westinghouse. This is the solid technical foundation, on which innovative technology is based. Consistent application of the accumulated know-how on a wide range of disciplines was implemented. For instance, development and manufacture of this technology involved not only aeroengine manufacturers but also precision casting specialists, research institutes and technical universities.

The task in hand was to ensure maximum operating economy. The first crucial questions we had to answer were:
- Does an appropriate technical platform for this development already exist?
- Where do new solutions have to be found?

The key technical starting points:
- Compression and combustion. We had to push forward into new thermodynamic ranges and higher combustion temperatures, while still fulfilling the requirements for an easy-to-service design and long intervals between major overhauls.

Today, the SGT5-4000F is proof that it is possible to reconcile ambitious economic and environmental targets – through:
- Effective use of resources
- Low NOx content of exhaust gas
- Lowest CO₂ emissions

---

### Siemens Gas Turbine *

<table>
<thead>
<tr>
<th></th>
<th>SGT5-4000F</th>
<th>SGT5-3000E</th>
<th>SGT-1000F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid frequency (Hz)</td>
<td>50</td>
<td>50</td>
<td>50/60</td>
</tr>
<tr>
<td>Gross power output (MW)</td>
<td>292</td>
<td>191</td>
<td>68</td>
</tr>
<tr>
<td>Gross efficiency (%)</td>
<td>39.8</td>
<td>36.8</td>
<td>35.1</td>
</tr>
<tr>
<td>Gross heat rate (kJ/kWh)</td>
<td>9,038</td>
<td>9,794</td>
<td>10,265</td>
</tr>
<tr>
<td>Gross heat rate (Btu/kWh)</td>
<td>8,567</td>
<td>9,283</td>
<td>9,730</td>
</tr>
<tr>
<td>Exhaust temperature (°C/F)</td>
<td>577/1,071</td>
<td>575/1,068</td>
<td>583/1,081</td>
</tr>
<tr>
<td>Exhaust mass flow (kg/s)</td>
<td>692</td>
<td>512</td>
<td>192</td>
</tr>
<tr>
<td>Exhaust mass flow (lb/s)</td>
<td>1,526</td>
<td>1,129</td>
<td>422</td>
</tr>
<tr>
<td>Pressure ratio</td>
<td>18.2</td>
<td>13.3</td>
<td>15.7</td>
</tr>
<tr>
<td>Length x width x height (m)**</td>
<td>13x6x8</td>
<td>13x6x8</td>
<td>11x4x4.8**</td>
</tr>
<tr>
<td>Weight (t)</td>
<td>308</td>
<td>308</td>
<td>53 + 20***</td>
</tr>
</tbody>
</table>

---

* Standard design; ISO ambient conditions
** Length incl. transmission
*** Weight main frame + transmission
The compressor

The compressor with optimized flow path and controlled diffusion airfoils for more efficient operation. Ruggedized compressor design to withstand underspeed and overspeed conditions, ensuring reliable operation of the SGT5-4000F in grids with major frequency fluctuations.

The turbine blades

The blades of the first and second turbine stages have to withstand thermal stresses and are therefore fabricated from a heat-resistant alloy which is allowed to solidify as a single-crystal structure. They also have an additional ceramic coating. They are cooled internally through a complex array of air channels and externally by film cooling. These measures combine to ensure a long blade service life.

The SGT5-4000F –
Innovative design on a proven basis

Optimized flow, combustion and cooling systems as well as new materials add up to a gas turbine efficiency of nearly 40%. To highlight a few features:

- Very compact casing
- 15-stage high-efficiency compressor
- Optimized design point for compressor pressure ratio and boundary-zone-corrected compressor blades (controlled diffusion airfoils)
- Annular combustion chamber with 24 hybrid burners for uniform flow and temperature distribution
- Compact design and fully ceramic heat shields to minimize cooling air requirements
- Single-crystal blades made of high-grade alloys with additional ceramic coating
- High-efficiency vortex and convection cooling in the blade interior with film cooling of the blade surface
- The latest vintage SGT5-4000F also features fail-safe hydraulic turbine blade tip clearance control for optimized radial clearances and hence maximum performance
- Easy-to-service design thanks to an annular walk-in combustion chamber, which enables inspection of hot-gas-path parts without cover lift
The rotor

The rotor is designed as a disk-type rotor with Hirth serrations and central tie bolt. This proven design principle combines low weight with high stiffness and ensures smooth running and low thermal stresses under all operating conditions, resulting in the familiar short run-up times of Siemens gas turbines.

The annular combustion chamber

The enhanced hybrid burner (HR3) with its cylindrical burner extensions and modified flow path results in stable, low noise combustion.

Proven design features at a glance

The SGT5-4000F is based on the SGT5-2000E/SGT6-2000E, our reliable runners. These gas turbines are of proven ruggedness, as attested by more than 380 machines sold and more than 8.8 million cumulative operating hours. Main features include:

- Horizontally split casing
- Two rotor bearings
- Disk-type rotor with Hirth serrations and a central tie bolt
- All blades removable with rotor in place
- Multi-stage axial-flow compressor with variable-pitch inlet guide vanes, four-stage axial-flow turbine, all moving blades free-standing
- Hybrid burners for premix and diffusion mode operation with natural gas and fuel oil
- Combustion chambers lined with individually replaceable ceramic heat shields
- Generator coupled to compressor (cold-end drive)
- Axial exhaust gas flow

The enhanced hybrid burner

The dual-fuel hybrid burner for premix and diffusion combustion of gas and oil consists of a system of rugged individual burners. This configuration permits flexible, stable, clean – and therefore economical – operation.
The SGT5-PAC 4000F

The Siemens Gas Turbine Package (SGT-PAC) comprises the gas turbine and generator, and all major mechanical, control and electrical equipment required for safe and reliable operation of these components.

We deliver our Siemens Gas Turbine Packages largely pre-assembled, including piping and wiring to a major extend. The auxiliary systems are combined in groups and installed as prefabricated packages. This reduces installation and commissioning expenditures and durations.

Pre-engineered options are available to meet project- and site-specific requirements or to increase operating flexibility and performance of the power generating system.

Scope of SGT5-PAC 4000F

<table>
<thead>
<tr>
<th>Base scope</th>
<th>Options (selection)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas turbine</td>
<td>Liquid fuel system</td>
</tr>
<tr>
<td>Electrical generator</td>
<td>Dual-fuel operation</td>
</tr>
<tr>
<td>Fuel gas system</td>
<td>NOx water injection system for liquid fuels</td>
</tr>
<tr>
<td>Hydraulic oil system</td>
<td>Inlet air evaporative cooling</td>
</tr>
<tr>
<td>Instrument air system</td>
<td>Inlet air anti-icing system</td>
</tr>
<tr>
<td>Lube oil system</td>
<td>Inlet air self-cleaning pulse filter</td>
</tr>
<tr>
<td>Compressor cleaning system</td>
<td>Gas turbine stack for simple cycle</td>
</tr>
<tr>
<td>Air intake system</td>
<td>Diverter damper and bypass stack for combined cycle</td>
</tr>
<tr>
<td>Exhaust gas diffuser</td>
<td>Further noise abatement</td>
</tr>
<tr>
<td>Instrumentation &amp; Control</td>
<td>Fin-fan cooling systems for generator and lube oil</td>
</tr>
<tr>
<td>Electrical equipment</td>
<td></td>
</tr>
<tr>
<td>Power Control Centers</td>
<td></td>
</tr>
<tr>
<td>Noise enclosures</td>
<td></td>
</tr>
<tr>
<td>Fire protection</td>
<td></td>
</tr>
<tr>
<td>Starting frequency converter</td>
<td></td>
</tr>
</tbody>
</table>
World experience

The SGT5-4000F has been in service since 1997. We have sold nearly 290 gas turbines of the SGT-1000F series, SGT5-4000F and SGT6-4000F with more than 3.6 million cumulative operating hours and a fleet reliability exceeding 99%.**

** Status December 2007

---

Didcot 8, England
National Power plc. operates the combined cycle power plant with two multi-shaft 2x1 units that has a total capacity of 1390 MW and nearly 220,000** operating hours for V94.3A (new: SGT5-4000F).

Mainz-Wiesbaden, Germany
Kraftwerke Mainz-Wiesbaden AG operates the combined cycle cogeneration power plant with one multi-shaft 1x1 unit that has a total capacity of 410 MW, featuring the latest vintage V94.3A (new: SGT5-4000F) design already with over 52,000** operating hours.

Seabank 1&2, England
Seabank Power Ltd./Scottish & Southern Energy operate one multi-shaft 2x1 and one single-shaft combined cycle power plant with a total capacity of 1,140 MW and nearly 150,000** operating hours.

Genelba, Argentina
PECOM ENERGIA S.A. operates the combined cycle power plant with a multi-shaft 2x1 unit that has a total capacity of 660 MW and over 133,000** operating hours.
SGT5-4000F adjustment to site conditions

Power Output and Efficiency at Generator Terminals

Ambient temperature [°C]

Power Output at Generator Terminals

Altitude [m]

Power Output at Generator Terminals

Relative humidity [%]

Efficiency at Generator Terminals

Efficiency at Generator Terminals

Efficiency at Generator Terminals