Ansaldo Energia Group

Ansaldo Energia is a leading provider of services and equipment for power plants, offering expertise at all levels of complexity for our own and third party machinery for heavy-duty Steam and Gas turbines, Generators, Nuclear, Micro turbines and Shaft Line. We provide global services including Repairs and Spare Parts, Field Service work including overhauls and upgrades, Plant Support with Remote Monitoring and Diagnostics, with transactional as well as comprehensive Long Term Service Agreements.

We are a global supplier of turn-key power plants, with a broad offering of the most reliable and best performing solutions available today, backed up by a dedicated Research and Development group and a global Service organization that assists customers with continuous product improvements, combined with the traditional reliability and robustness of Ansaldo Energia products.

The result is a unique and balanced value package based on innovation and reliability. Ansaldo Energia’s solutions combine the company’s proven designs, manufacturing capabilities and commissioning skills with its well-known flexibility in matching customer needs with tailored solutions.

At Ansaldo Energia, we recognize that the power market continues to be dynamic and challenging to our Customers. To remain profitable, operators expect global service organizations to offer solutions that improve the efficiency, operational flexibility, emissions, reliability and life-cycle maintenance costs of their power production assets.

Today, 160 years of Ansaldo Energia history are combined with a strategic assemblage of complementary service acquisitions. Not only can our Team provide advanced technology service solutions for your installed Ansaldo equipment, but our uniquely positioned OSP™ (Original Service Provider) technologies enable value-based offerings for any large frame GE, Siemens and Mitsubishi gas turbine, steam turbine or generator. This industry-first combination result? A flexible, multi-platform, full-scope service provider that can deliver competitive and proven answers to improve your equipment’s life cycle maintenance costs.

With major operations in Genoa, Italy; Rheden, Netherlands; Jupiter, Florida, USA; Abu Dhabi, UAE; and field offices throughout Europe, Asia/Pacific, the Middle East, South and Central America, and the US, Ansaldo Energia offers customers localized service and global capacity to bring the highest level of value and capability to your plant.

We look forward to working with you as we create Power Together!
Steam Turbine Shaft Line

Ansaldo Energia has over 100 years of experience in the design, manufacturing and installation of Steam Turbines, and is a worldwide leader in the power generation industry. We have a comprehensive capability to supply new plants, as well as offer spare parts and complete maintenance services, with an ability to supply and repair capital parts, modify existing turbines and retrofit most turbines installed around the world, regardless of the original designer or manufacturer. Our capability covers multi-technology turbines (both impulse and reaction) and a large range of power sizes (up to 1000 MW for a single unit).

We have the flexibility to work in most world regions, due to an availability of portable machines and dedicated tool sets, used by skilled personnel, to offer you the highest level of quality of service.

Ansaldo Energia services a wide range of steam turbines:
- fossil fired steam cycles
- combined cycles
- combined heat and power
- desalination plants
- solar plants
- industrial plants
- geothermal cycles

Drawing on years of Ansaldo Energia’s OEM experience, and our highly developed capabilities, we work with you as a partner to manage planned outages and quickly deal with unexpected failures or unconventional service outages. Our goal is to improve reliability, availability and increase the capacity of your turbine, while reducing future maintenance costs.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>POWER RANGE [MW]</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reheat</td>
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<td></td>
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<tr>
<td>RT30</td>
<td>150-1000</td>
<td>■ Thermal Fossil-fired Steam Cycles</td>
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<tr>
<td>MT15</td>
<td>100-300</td>
<td>■ Combined Cycles</td>
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<tr>
<td>Non reheat</td>
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<td></td>
</tr>
<tr>
<td>MT20</td>
<td>100-350</td>
<td>■ Cogeneration Plants</td>
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<td>MT10</td>
<td>40-250</td>
<td>■ Solar Plants</td>
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<tr>
<td>Geothermal</td>
<td></td>
<td>■ Geothermal Cycles</td>
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<tr>
<td>GT</td>
<td>40-150</td>
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We Know Our Job

Ansaldo Energia know-how and experience derives from:
- supply and installation of 30 geothermal units for a total power of 1000 MW
- supply and installation of 15 non reheat reaction steam turbines for a total power of 2200 MW (according to ABB technology)
- supply and installation of 67 reheat reaction steam turbines for a total power of 13800 MW (according to ABB technology)
- supply and installation of 525 impulse (according to GE technology) and reaction (according to W technology) steam turbines for a total power of 73600 MW
- a total of 637 steam turbines and 90600 MW installed around the world
Ansaldo Energia’s OSP™ Team Offers the High Technological Knowledge of an OEM on Every Type of Technology

Merging a flexible approach, a pro-active structure and highly specialized competencies over different technologies, we build upon our OEM knowledge and leverage our organizational expertise, to achieve the know-how to work both on the OEM fleet and on non-OEM steam turbines.

Ansaldo Energia’s Portfolio of Services for Steam Turbine Shaft Line

Ansaldo Energia’s Service Organization provides worldwide technical assistance in the fields of maintenance, high technology solutions and repairs, with a preventive maintenance program to ensure that customers are in the best position to achieve optimum operation. Diagnostic tools and procedures are available to monitor and check steam turbine parameters continuously, in order to prevent forced outages, detect aging trends and address maintenance activities. Ansaldo Energia’s Service Organization can also provide clients with in-house personnel training, supported by dedicated instructional materials.

Steam Turbine Shaft Line offers service in the following areas:
- Solutions/Upgrades
- Repair
- On Site capabilities
- Maintenance
- Diagnostics
- LTSA
- Parts

Solutions/Upgrades
- steam turbine capacity enhancement (upgrades)
- maintenance and operation optimizations
- entire unit replacement
- steam turbine rehabilitation
- auxiliaries renovation
- control systems improvement (from analog to digital)

Repair
The majority of repairs and field activities are completed on-site at the customer’s location. Necessary repairs and/or improvements are completed at our Genoa, Italy repair and manufacturing facility.

We offer the following on-site capabilities:
- Machining repairs
- Balancing and alignment assessment
- Blading path assessment and repairing
- Blades replacement
- Rotor straightening
- Hot part assessment
Machining, such as rotor journals lathing, including metal spray to recreate original diameters, main valves machining (seat), and coupling holes honeying, is possible thanks to fully skilled mechanics/operators and a wide set of portable equipment, such as:

- Drilling machine
- Lathe
- Vertical Turning Lathe
- Line boring
- Horizontal boring and milling

In addition to the above, a special diagnostic tool (Phased Array) designed and developed by Ansaldo, allows us to get a fast evaluation of rotor free standing last stage blades, to guarantee safe operation or replace blades before failures should occur.

**Maintenance**

Steam Turbine Shaft Line provides every type of maintenance: from a short inspection to a major overhaul, covering the machine, its auxiliaries (steam seal system, lube oil system) and the control systems, regardless of the technology and the manufacturer.

Pre-outage activities:
- SOW- Scope of Works - Elaboration
- ITP - Inspection and Test Plan - Elaboration
- Planning Elaboration
- Pre-outage meetings
- Method Statement
- Risk assessment
- Tools preparation
- Spares definition

On-site activities:
- On-site mobilization
- Turbine dismantling
- Fact Finding / NDT – Non Destructive Tests
- NC – Non Conformances - report and resolution
- Failure analysis / Trouble shooting
- Remedials implementation
- Turbine re-boxing
- Start-up assistance (including balancing)
- On-site demobilization
Post-outage activities:
- Final Report issue
- RCA- Root Cause Analysis - in case of fault
- Engineering feedbacks
- TIL – Technical Information Letters

In case of fault, fast intervention to diagnose the extent of the fault, repair, a troubleshooting analysis and root cause identification are part of the services offered.

Diagnostics
Ansaldo Energia is a leader in developing tools and methods to check the operation of steam turbines and assess the state of mechanical components. Different checks aimed to minimize maintenance cost and increase availability of the plant, avoiding the risk of unplanned outage, are in Ansaldo’s portfolio:
- Non Destructive Testing
- Life Assessment
- Remote Monitoring

Non Destructive Testing: We continuously develop specifically tailored non destructive testing of steam turbine components. We offer high reliability and repeatability of the tests, as well as reducing the testing time and avoiding long and expensive dismantling of components. Phased Array testing, applied on Free Standing Last Stage Blade, is a typical example of our effort: this kind of test has been fully developed and qualified in the Ansaldo laboratory.

Life Assessment: We provide a number of tests to analyze the expected remaining life of capital and strategic components, such as steam turbine casings and rotors, as well as the characterization of material exposed to high temperature and thermal cycles.

Remote Monitoring:
Ansaldo Energia monitors the health of steam turbine cycles 24/7 by the remote acquisition of vital parameters (typically steam pressure, temperature, and vibrations). The data acquired and specific feedback is returned to the Operator to provide for planning and predictive intervention and optimize the list of necessary spare parts. In particular, DIAGEN®, is an integrated diagnostic system designed and developed by Ansaldo Energia that can be installed on existing units, both turbo and hydro, regardless of the size, model and OEM. DIAGEN® allows real-time measurements, evaluation of trends and Fast Fourier Transit (FFT) analysis, all of them with the possibility to be remotely connected to our head office in Genoa, Italy and Florida, US. DIAGEN® is a modular package that can be installed with the Generator in operation, and is based on the following four modules:
- CORALB for the shaft current and voltage monitoring - can be installed in standstill conditions
- CORTROT for the air gap flux probe monitoring is installed during a major overhaul
- SCAPAR for the stator winding partial discharge monitoring - can be installed in standstill conditions
- TEMAV for the stator winding overhangs vibration monitoring and can be installed in a minor overhaul

Several Benefits can be achieved by Customer:
- Easy Data Reading with only one instrument and Assessment (trend)
- Supported by Ansaldo generator specialists
- Predictive diagnostics to reduce fault risks
- Easy implementation to connect already equipped with Ansaldo Energia or other OEM sensors
- Cost saving
  - no specialist travel to Power Plant
  - no generation interruption for measurements
  - reduced risk of outage
  - reduced insurance premiums
Long Term Service Agreements
Steam Turbine Shaft Line, as part of the Ansaldo Energia Maintenance strategy, provides long term service agreements that incorporate state-of-the-art technologies, skilled permanent monitoring and swift best-in-class expertise in a customizable format which allows:

- Anticipation of technical issues
- Optimization of scheduled and unscheduled interventions and inspections
- Optimization of spare parts management
- Supply, install and commission upgrades
- Maintenance and operation day-by-day

Parts
As the Steam Turbine OEM and based on our extensive experience in the Service and Maintenance of our own fleet, Steam Turbine Shaft Line manufactures and continually develops capital parts and all other spares, including new blades and welded rotors of large size. Leveraging today’s capacities with a history of experience and technological agreements with different manufacturers, Ansaldo Energia is able to supply a wide spectrum of parts for third parties’ machines.

As necessary, Steam Turbine Shaft Line is able to rapidly implement a Reverse Engineering process, based on a team of well-proven experts in the design of generator parts equipped with up-to-date tools for 3D scanning.

For more information and to reach our sales Team, please go to www.AnsaldoEnergia.com