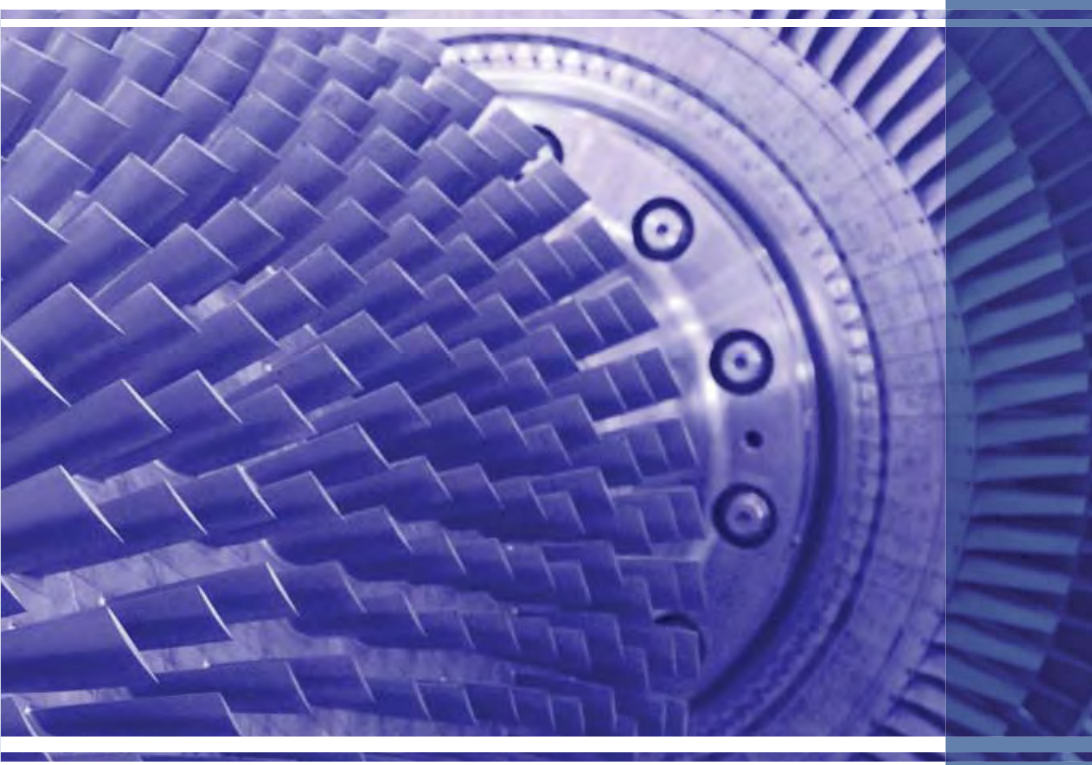
Turbine Services™

Delivering a world of
Turbine Solutions



Gas turbine | Maintenance | Repairs | Spares | Parts

a CHROMALLOY company

Turbine Services™

Introduction

TURBINE SERVICES is a global maintenance services provider to owners and operators of gas turbines, offering an employee skill base in excess of 2,000 man-years experience delivering gas turbine maintenance solutions. With our heritage in John Brown Engineering, our primary specialization is in the heavy duty range of General Electric designed gas turbines.

Our business is founded on the strength of our technical and engineering capability, reinforced by our commitment to quality and customer satisfaction that is demonstrated by our accreditations (ISO 9001:2000) and registrations (Achilles, Supply Line, FPAL and Repro).

In addition to our extensive experience, our customers also benefit from the high-tech capabilities of our parent company, Chromalloy. Leading the industry in advanced technology derived from 50 years of aero and industrial gas turbine component experience, we offer state-of-the-art component; repair, coating and manufacturing technologies.

1. Gas Turbine Spares & Replacement Parts
2. Component Repair Services
3. Combustion Inspection Elimination Kit
4. Gas Turbine Rotor Overhaul Services
5. Field Support & Engineering Services
6. Gas Turbine Refurbishment
7. Long Term Service Agreements
8. Sentinel C – Gas Turbine Control System
9. Condition Monitoring for Gas & Steam Turbines
10. Training Courses for Gas Turbine Technologies

Turbine Services

Gas Turbine Spares & Replacement Parts

Turbine Services maintains a substantial computerised inventory of spare parts for the General Electric design of heavy duty gas turbine equipment, and also other OEM turbine manufacturers.

Our parts inventory is continually monitored to ensure that the customer requirements are satisfied ex-stock for both scheduled and unscheduled maintenance.

Spare Parts

Turbine Services supplies the critical components necessary to return your equipment to full service. Components include stationary and rotating blades, shroud blocks, combustion equipment and auxiliary spare parts. We stock a full range of capital and consumable components covering the following:

- MS3002
- MS5002
- MS5001
- MS6001
- MS7001
- MS9001

Engineered non-OEM Components

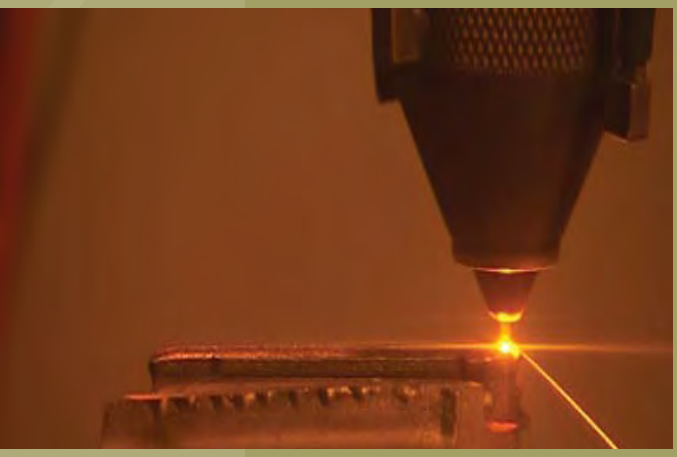
Our new component parts offerings are developed, managed and monitored within Turbine Services and our related Chromalloy divisions. Our advanced reverse engineering programs utilize the latest technology in; finite element analysis, high resolution scanning technologies, Equiax, DS and Single crystal castings, machining, ECM, laser drilling and protective coatings. Critical hot section parts are redesigned with original OEM integrity as well as the addition of design modifications based on component condition from service.

Logistics

Turbine Services work closely with our customers to develop new supply chain solutions. We also offer a variety of material support systems including:

- Logistics management
- Full warranties
- Regional stockholding
- Emergency service
- Installation service
- Component exchange
- Parts repair
- Scheduled just-in-time inventory
- Consignment stocks
- Long term service agreements

Turbine Services™



Component Repair Services

Turbine Services offers the most comprehensive independent gas turbine repair service in the world. Supported by state-of-the-art-technologies and capabilities of our parent Company, Chromalloy, Turbine Services has extensive experience in repairing and refurbishing all component parts associated with gas turbines and related power equipment.

Specialised Repairs & Coatings

Our repair services include the refurbishment of all critical; compressor, combustion and hot section parts. Our regional workshop capabilities include:

- Specialised vacuum furnace for super alloys
- Metallurgical laboratory and Component Life Evaluations
- Full NDT testing and conditional reporting
- Advanced alloy welding
- Laser welding
- Induction welding
- Chamber welding
- Advanced braze repairs
- Hydrogen Fluoride Ion cleaning
- Hot isostatic pressure (HIP) rejuvenation heat treatment
- Fuel nozzle test & flow matching
- Flow divider, pump & valve testing
- Bearings & associated deflectors

Before

For more specialised repairs, Turbine Services offers a complete range of high technology coating processes, including many developed and patented by our parent company Chromalloy:

- Electron beam physical vapour deposition coating (EBPVD)
- Platinum aluminide coatings
- Low pressure plasma spray coatings (LPPS)
- High velocity oxy fuel coatings (HVOF)
- Pack cementation coatings
- Plasma spray thermal barrier coating (TBC)
- Advanced protective hard face and anti-fretting coatings

After

Turbine Services™

Combustion Inspection Elimination Kit

Turbine Services offers a high-tech process to eliminate the requirement for combustion inspection outages. Gas turbines can therefore be operated up to and inspected at 24Khrs – hot gas path and 48Khrs – major inspection interval thereby reducing gas turbine downtime and increasing availability.

The Problem

Stress, wear and creep growth are very common problems with the following consequences:

- Thermal stresses leading to cracking of critical components
- Excessive wear due to vibration caused by the combustion dynamics
- Creep growth in areas such as the transition piece picture frames, which leads to distortion and incorrect power distribution in the critical gas path.

The Solution

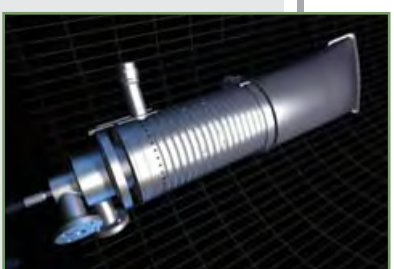
By the application of thermal barrier coatings, local "hot spotting" of the parent materials is reduced, as is the thermal stress, thus preventing cracking of critical components. By applying hard-face coatings and wear resistant materials, and by reducing clearances, wear due to vibration is minimised.

Nimonic material, which has better creep resistant characteristics in the area of the picture frame, is now used extensively – in fact complete transition pieces can be supplied in Nimonic material.

The Benefits

By employing the latest technology in this way:

- Availability is increased by reducing the number of overhauls
- Spare parts requirements are reduced



...all of which allow the owners and operators to achieve their objective of increasing the overall profitability of their plant.

Turbine Services™

Gas Turbine Rotor Overhaul Services- Stripdown-Reblading-Rebuild-Balancing

Turbine Services offers complete gas turbine compressor rotor and power section overhauls for heavy duty gas turbines. Staffed and resourced by customer-focused engineers with over 2,000 man years of gas turbine experience, customers can benefit from a comprehensive quality service. All rotors are returned to a fully refurbished condition with minimal turnaround time.

Gas Turbine Rotor Overhaul

Turbine Services offers, in association with our sister company Masaood John Brown, a competitive alternative for gas turbine owners and operators in the overhaul of rotors. Dedicated rotor overhaul engineers offering knowledgeable advice, experience of commercial operation, and an ex-stock supply of necessary components and rotating parts, ensure a committed response in returning users equipment to commercial operation as fast as possible with appropriate documentation and reports.

- Pre–stripdown balance and inspection
- Rotor disassembly
- NDT facilities
- Individual blade and wheel coating
- Latest coating technologies
- Individual wheel balancing
- Rotor re-blade
- Rotor reassembly
- Rotor balance and run-outs
- Rotor storage containers
- Comprehensive customer reports

Customers can also take advantage of Turbine Services rotor exchange programme. We always have available sufficient new or refurbished components to assemble turbine and compressor rotors at short notice. Customers are invited to benefit from this service. For cost-effective maintenance, customers may consider exchanging their operating rotor for a previously overhauled fully refurbished rotor which can be pre-delivered to site awaiting the next overhaul commencement

Turbine Services™

Field Support & Engineering Services

Turbine Services employ a wide range of experienced gas turbine mechanical, instrumentation and control, commissioning field engineers, technical advisors and project managers.

We provide our customers with expert personnel to undertake and deliver both on-site and remote engineering services, meeting their needs for planned and unplanned plant maintenance.

Field Support

Turbine Services engineering services include:

- Scheduled outages (e.g. CI, HGPI & MI)
- Unscheduled outages
- Comprehensive QHSE programs
- Site management
- Control systems and retrofits
- Electrical engineering
- Fuel conversions
- Technical support
- Generator overhauls
- Plant commissioning
- Plant upgrades
- Control retrofits
- Plant relocation
- Contractual maintenance agreements
- Auxiliary plant services
- Condition monitoring and diagnostics

Turbine Services™

Gas Turbine Refurbishment- Total Power Generating Package Overhaul Service

Turbine Services offers, in association with our sister company Power Development International, fully refurbished and customised gas turbines by purchasing used units. The turbines types are MS3001, MS5001, MS5002, MS6001, MS7001 and MS9001.

Gas Turbine Refurbishment

Each turbine can be overhauled to any specification required by a client. In many cases, gas turbines are available overhauled and ex-stock ready for onward sale. Customers can therefore expect a quality service and rapid turnaround time as turbines are returned to a fully refurbished condition. Turbine Services service includes:

- Full “major” overhaul
- Rotor refurbishment
- Availability of new and refurbished component parts
- Gear box inspection and overhaul
- Generator inspection, maintenance and overhaul
- Turbine Re-wiring
- Control Panel Upgrade
- Control Cab refurbishment or replacement
- Inlet and exhaust plenum engineering and procurement
- Engineer, Procure & Construct (EPC)

Turbine Services offers a competitive alternative to purchasing new gas turbines on extended lead times. A resident core of field engineers and an ex-stock supply of rotating parts and components, ensure minimum response time in returning users equipment to service and commercial operation as fast as possible.

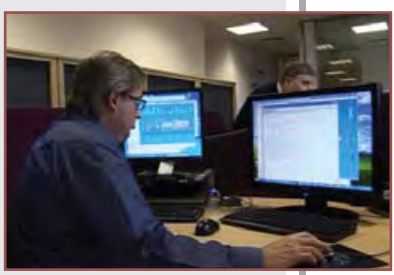
Turbine Services

Long Term Service Agreements

Turbine Services conceptual approach to Long Term Service Agreements (LTSA) is one of a partnership arrangement with our customers. Our Contract Executives are the customers single point of contact and are all technically qualified to provide an immediate response to gas turbine operational issues and have many years of experience in running such contracts.

LTSA Framework

- Scheduled and unscheduled maintenance
- Technical support
- Spare parts and parts repair services
- Plant reliability, availability and performance
- OEM qualified engineers



LTSA Support Services

- Contract management and support team
- Engineering support
- 24 hour / 7 day emergency cover
- Remote monitoring and diagnostics
- Logistics support
- Training
- Troubleshooting

LTSA Benefits

- Established contract terms and conditions
- Agreed pricing structure over mutually agreed time period
- Year-to-Year budget visibility
- Guaranteed availability of contracted services
- Single point contact for outages, planning, mobilization, QHSE and engineering
- Guarantee/warranty by a single source provider
- Inspection support container fleet available for scheduled and unscheduled outages at a moment's notice

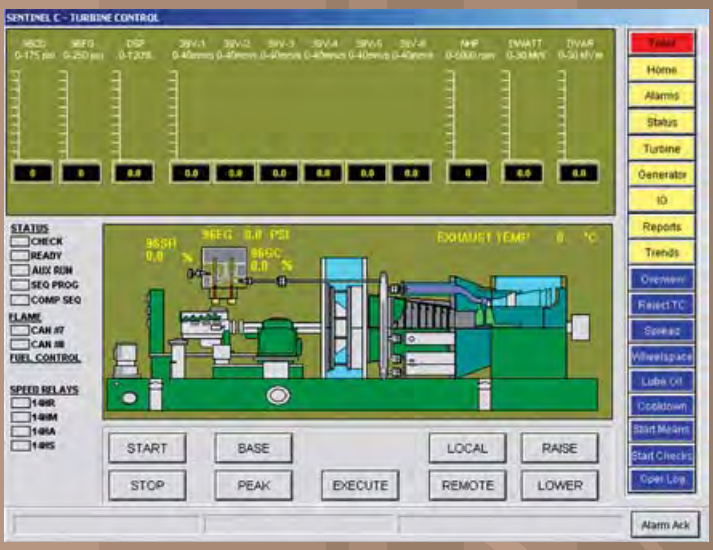
Turbine Services™

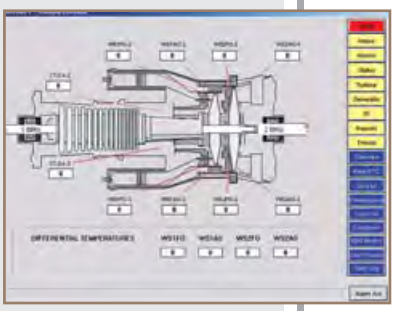
sentinel™ C
advanced gas turbine control system

Sentinel C™ Advanced Gas Turbine Control System

The Sentinel-C series of turbine control systems were designed specifically for the retrofit of heavy duty gas turbine controls; in particular, the Speedtronic and LA families of turbine controllers.

It is a competitive alternative solution for the replacement of older control technology. The turbine control philosophy of the original system is maintained and it is easily adapted to site-specific requirements.





Sentinel C™

System Features

- PLC system architecture
- Hot backup PLC redundancy
- Fuel governor
- Auto synchronisation & power monitor
- Gas turbine protection
- Automatic start-up, auxiliaries sequencing
- Combustion monitor

User Benefits

- Minimise GT downtime
- Increase availability and reliability
- Readily available spares-worldwide support
- SCADA interface, all parameters visible to operator
- Ease of maintenance/set up
- Networking capability
- Easy access and export of GT data
- Non-dependence on OEM spares (Speedtronic cards)
- Buy-back of existing control systems option (e.g. Mk I – Mk IV)

Turbine Services

TIGER®

Condition Monitoring

For Gas and Steam Turbines

Condition Monitoring for Gas and Steam Turbines

TIGER® continuously evaluates the state of gas and steam turbines by automating the knowledge of the best turbine engineers. By diagnosing the state of the turbine every second, a complete picture is built-up of the condition of the turbine. TIGER® performs several thousand fault detection steps every second.

Higher-level diagnostic rules are then used to interpret these faults into a simple-to-read diagnostic summary. A quick check of this gives an overview of what has happened with the turbine in the last shift, day, or week.

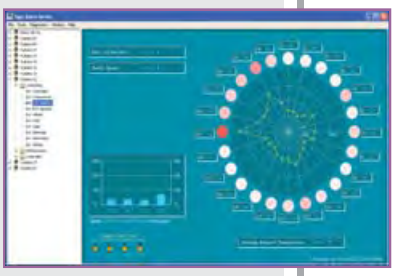
TIGER®

System Features

- Sophisticated diagnostics
- Patented temporal pattern matching of faults
- Performance models
- Factored hours and starts calculations
- Vibration diagnostics and display
- Comprehensive graphing
- Replaying of data
- Remote access
- Automated reports
- Email and SMS notifications

User Benefits

- Detect the first symptoms of a developing problem
- Troubleshoot and bring the turbine back quickly
- Enable condition-based maintenance
- Identify operational and warranty issues
- Assess insurance risk
- Assist in commissioning
- 24 hour remote monitoring
- Reduce travel—diagnose problems from your laptop
- Pool expertise—your engineers contribute remotely
- Reduce costs—increase availability



Turbine Services™

Training Courses for Gas Turbine Technologies

Turbine Services offers, in association with our sister company Osborne Training Services, training courses which are delivered by engineers with extensive experience in the operation and maintenance of gas turbines and associated equipment.

Training

Customer training is an important element within Turbine Services range of integrated turbo machinery products and services. Together with our joint venture companies we have delivered training to over 1,000 engineering personnel, educating and enhancing the technical skills of our customers plant operators. Training programs are available to suit operational, mechanical, electrical and instrumentation disciplines covering functions such as inspection, maintenance and trouble shooting. These are complemented by classroom tuition and hands-on training. Modular courses are available to offer flexibility in course content:

- Introduction to Power Plant
- Gas and Steam Turbine Operations and Maintenance
- Combined Cycle Power Plant
- Power Plant Safety
- Generator Control and Maintenance
- Gas Turbine Control Systems
- Power System Protection

Gas Turbine Training Courses

Our courses are designed to focus on improving personal knowledge and awareness, to give operators confidence in carrying out their assigned tasks and to improve turbine reliability with reduced unscheduled outages.

The Turbine Services Companies are divisions of the Chromalloy Gas Turbine Corporation, who's interests are in the global Aero and Industrial Gas Turbine Market sector. Masaood John Brown is a Joint Venture between Turbines Services and Al Masaood (UAE) offering shared technology with the Middle East, Indian and African regions.

Turbine Services

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MASAOOD JOHN BROWN
GAS TURBINE SERVICES

CHROMALLOY

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