The world turns to Elliott

Elliott Global Service Network
PRODUCTS & SERVICES

Portfolio of services for both Elliott and Non-Elliott Equipment
Equipment Serviced

- Compressors
- Steam Turbines
- Power Products
- Cryodynamic Products
- Auxiliary Equipment

Regardless of the OEM

And more.....

Approximately 40% serviced equipment is non-Elliott

The world turns to Elliott
Compressors

- **Centrifugal Compressors**
  - API 617
  - State-of-the-art aerodynamics
  - Horizontally & vertically split casings
  - Flows to 270,000 cfm (458,700 m³/hr)
  - Pressures to 10,000 psig (690 barg)

- **Axial Compressors**
  - API 617
  - High flow capacity, low pressure
  - Flows to 396,000 cfm (673,000 m³/hr)
  - Pressures to 100 psig (7.0 barg)
Steam Turbines

• Multi-Stage Steam Turbines
  – API 612 specifications
  – Pressures to 2,000 psig (138 barg)
  – Temperatures to 1,005 deg F (540 deg C)
  – Powers to 135,000 HP (100,000 kW)
  – Speeds to 14,000 RPM

• Single-Stage Steam Turbines
  – API 611 specifications
  – Pressures to 900 psig (62 barg)
  – Temperatures to 900 deg F (480 deg C)
  – Powers to 3,500 HP (2,600 kW)
  – Speeds to 7,000 RPM
Power Equipment

• Power Recovery Expanders
  - Reliable and durable
  - Over 30 successful installations
  - 4 frame sizes
  - Powers to 60,000 HP (45,000 kW)
  - 3,000-6,700 rpm
Cryodynamic Equipment

- Submerged Liquefied Gas Pumps
  - Retractable (In-Tank)
  - Suction Vessel Mounted
  - Marine Cargo Handling
  - Aggressive Fluid

- Cryogenic Liquid Expanders
  - Used as a bypass loop to Joule-Thompson valve
  - Lowers pressure of liquefied gas to allow for suitable transport
  - Reduces vaporization in the let down process, resulting in higher liquid production.
Packaged Systems

• Turbine-Generator Sets
  – 50 kW – 30,000 kW
  – Pressures to 900 psig (62 barg)
  – Temperatures to 900 deg F (480 deg C)

• Auxiliary Systems
  – API 614 specifications
  – Lube oil systems
  – Control oil systems
  – Seal oil systems
  – Fuel gas and fuel oil manifolds
  – Dry gas and buffer gas seal packages
  – Accumulators and draining packages
  – Interconnecting process piping
Global Service Products and Services

- **Service Centers**
  - Repairs for Elliott and Non-Elliott Equipment

- **Field Service**
  - Technical Advisors and Service Engineers
  - Project Managers and Labor

- **Service Parts**
  - Entire Elliott Product Range

- **Rerates, Engineering Services & Modifications**
  - Redesign equipment to change flow, horsepower, etc.
  - Reaplication of Used Equipment
  - Engineering Studies
  - Modifications and Upgrades
SERVICE CENTERS

Repair of Elliott and Non-Elliott equipment
Service Center Locations

Click a location for specific Service Center details.
Service Centers

• 18 global service centers
• Experienced service teams
  – Engineers
  – Metallurgists
  – Technicians
  – Welders
  – Machinists
  – Mechanics
• Wide-range of repair services
• Rotor storage
• At-speed balance
# Service Centers

## Services
- Inspection, repairs, overhauls
- Component restoration/replacement
- Custom parts manufacturing
- Specialty machining
- Heat treatment / Stress relieving
- Full non-destructive testing
- Dynamic rotor balancing
- Vibration Analysis
- Coatings
- Rotor Storage
- ISO 9001:2000 certified

## Typical Repair Scope
- Unit disassembly, inspection, repair, and re-assembly
- Component repairs/reconditioning, modifications, parts replacement
- Repair using welding, machining, chrome plating, metal spray, and mechanical fix techniques
- Balancing
Service Centers - Welding

• Weld Repair Technology
  – Impeller blades, covers, hubs
  – Diaphragms, diffusers
  – Turbine disks, blades
  – Casings
  – Shafts

• Weld Processes
  – Tungsten Inert Gas (TIG)
  – Submerged Arc (SAW)
  – Plasma Transfer Arc (PTA)
  – Shielded Metal Arc (SMAW)
  – Gas Metal Arc (GMAW)
Service Centers - Rotor Storage

• Vertical storage (hanging)
• Climate-controlled environment
• Storage locations
  – Baton Rouge
  – Brazil
  – Edmonton
  – Houston
  – New Orleans
  – San Francisco
Service Centers - Rotor Balancing

• At Speed Balance
  – Contracted through the service center
  – Service provided in our Jeannette facility
  – Verification of mechanical integrity over entire speed range
  – Corrections made on multiple balancing planes
  – Guarantees smooth operation at rated speed
FIELD SERVICE

Service of Elliott and Non-Elliott equipment
Field Service

- Experienced Field Service teams
  - Project Managers
  - Engineers
  - Technicians
  - Technical Advisors

- Field Service operations
  - Bundled Services
  - Turnkey Projects
  - New Installation/Start Up
  - Equipment Relocation
  - Customer Point of Contact
Field Service

- Installation and commissioning
- Routine maintenance and repairs
- Comprehensive overhauls
- Spare parts inventory audits
- Plan outage management
- Turnaround planning
- Troubleshooting
- Resident engineers
- Maintenance contracts
- Field Machining
- Emergency call-out service
- Operator and maintenance training
- Technical support
The world turns to Elliott

Field Service

- Technical assistance
  - Problem analysis and diagnosis
  - Repair recommendations
  - Technical direction for routine maintenance
    - Keep turbomachinery running more efficiently and for longer periods
  - Planned maintenance programs
    - Consultation and implementation
SERVICE PARTS

OEM and Replacement Parts for Elliott and Non-Elliott Equipment
Service Parts

• Parts sales and customer service
  – Engineering and technical support
  – Site audits
  – Spare parts kit boxes
  – Quick action center
    • Emergency response
    • Stock a wide variety of raw material
    • Manufacture a variety of small parts/assemblies
    • Supports Elliott manufacturing facilities and service centers worldwide
Service Parts - Audits

• Provided at no cost to the customer
  Verify physical inventory against the customer’s electronic records
  – Compare inventory with Elliott’s maintenance parts list (MPL)
  – Inspect inventory condition to ensure parts are suitable for installation
  – Confirm that sealants and elastomers have not expired
  – Identify obsolete inventory
  – Evaluate parts storage locations to ensure protection from damage or corrosion

Download the **Elliott Parts Audits** brochure to learn more.
Spare Parts Kits

• Standardized packages for routine maintenance spare parts
  – Optimizes spare parts inventory
  – Complimentary parts audit
  – Customized to meet your needs
  – Convenient for maintenance outages and turnarounds

• Kit box features
  – High-strength, industrial grade plastic box designed for your needs
  – Unit-specific parts, organized according to equipment configuration
  – Precision-cut foam to hold parts in place
  – Stackable trays to maximize space
  – Nameplate with kit box part number, short description of contents, and Elliott contact information
  – Labels identify specific parts
  – Reordering instructions included

Download the *Elliott Spare Parts Kits* brochure to learn more.
Rotor and Diaphragm Storage

• Protection for vital components
  – Rotors (horizontal or vertical storage)
  – Diaphragms
• Designed for long-term storage and shipping
• Requires no maintenance
• Corrosion resistant
• Protects against ambient conditions
• Suitable for nitrogen purging
• Can be lifted by forklift or crane
• Desiccant packs for moisture absorption
ENGINEERED SOLUTIONS

Re-rates and Modifications of Elliott and Non-Elliott Equipment
Engineered Solutions

• Experienced Engineered Solutions team
  – Product Engineers
  – Project Engineers
  – Application Engineers
  – Project Managers
  – Drafters

• Engineered Solutions goals
  – Maximize a customer’s investment
  – Improve reliability
  – Reduce operational costs
  – Simplify maintenance
  – Shorten turnarounds and reduce unplanned outages

Download the Engineered Solutions brochure to learn more.
Engineered Solutions Services

• Rerates
  – Achieve new process parameters within existing casings
  – Minimal changes to foundations, piping and other connections
  – Site audits to evaluate efficiency and performance

• Modifications and Upgrades
  – Modernize the equipment
  – Enhance equipment performance
  – Control System Conversions (governors, over-speed trip, anti-surge)
  – Component Upgrades (Couplings, Seals, Bearings)

Download the Turbomachinery Modifications and Rerates brochure to learn more.
Engineered Solutions Services

• Reaplication
  – Cost-effective, permanent alternative to new machinery in mature operating environments
  – Cost-effective, permanent alternative to new machinery in mature operating environments
  – Shorter delivery than new equipment
  – Reduced outage expense
  – Reconditioned to “like-new” condition
  – Re-engineered to improve design
Engineered Solutions Services

• Drop-in replacement equipment
  – Reduces discovery repair work
  – Eliminate disassembly, installation, and alignment of new internal parts

• Analytical capabilities
  – Site audits
  – Advanced engineering studies
  – Remaining life assessment
  – Rotor dynamics
  – Stress analysis
  – Failure analysis
  – Reverse engineering
  – Repair and welding technology
The world turns to Elliott

Compressor Rerates and Modifications

- Replace impeller eye and shaft seals with abradable seals
- Replace cast iron diaphragms with fabricated steel and modern construction
- Add oil or water liquid injection nozzles and system
- Add Pos-E-Coat to impellers, complete rotor assembly, and diaphragms
- Replace Iso-carbon or Iso-sleeve seals with dry gas seals
- Upgrade thrust bearings to self-leveling or leading edge groove (LEG)
- Upgrade liner and tilt pad journal bearings to spherical seat journal bearings with instrumentation
- Replace impellers with modern materials and two-piece construction
- Add o-rings to split endwalls or upgrade to solid endwalls
- Upgrade coupling from lubricated to dry type
- Replace balance piston seals with abradable seals
- Add or upgrade temperature, vibration, and position monitoring instrumentation
- Upgrade or add windback seal
- Add or upgrade conduit and wiring quick disconnects
- Add Pos-E-Coat to impellers, complete rotor assembly, and diaphragms

Click on the compressor image to link to the interactive graphic on elliott-turbo.com.

- Reliability
- Efficiency
- Safety/Environmental
MSMV Turbine Rerates and Modifications

- Upgrade packing case seals to stationary labyrinth seals or brush seals
- Upgrade liner and tilt pad journal bearings to spherical seat journal bearings with instrumentation
- Upgrade or add windback seals
- Upgrade tip seals to reduce steam loss around the blades for improved efficiency
- Upgrade to an electronic governor and modern servo motor for more precise speed control
- Upgrade thrust bearings to self-leveling or leading edge groove (LEG)
- Upgrade the nozzle ring
- Replace the nozzle ring
- Upgrade or replace the rotor assembly with modern design and materials
- Upgrade or add monitoring instrumentation
- Upgrade to a modern design bar lift or cam lift valve rack
- Upgrade to a modern design bar lift or cam lift valve rack
- Upgrade to an electronic governor and modern servo motor for more precise speed control
- Upgrade to a modern design bar lift or cam lift valve rack
- Upgrade coupling from lubricated to dry type
- Upgrade to an electronic overspeed trip device
- Upgrade to a hydraulic trip block
- Add exhaust spray nozzles
- Upgrade to a modern trip and throttle (T&T) valve
- Upgrade to modern digital controls
- Additional Upgrades (not pictured):
  - Upgrade coupling from lubricated to dry type
  - Upgrade to an electronic overspeed trip device
  - Upgrade to a hydraulic trip block
  - Add exhaust spray nozzles
  - Upgrade to a modern trip and throttle (T&T) valve
  - Upgrade to modern digital controls

Click on the steam turbine image to link to the interactive graphic on elliott-turbo.com.

The world turns to Elliott
YR Turbine Modifications

- Add or upgrade monitoring instrumentation
- Add an insulation blanket
- Upgrade gland packing
- Add a remote trip solenoid
- Upgrade to a pneumatic trip system (with or without partial stroke)
- Upgrade to bearing isolators
- Add a gland evacuation system
- Add a pressure lubrication system
- Upgrade to an electronic overspeed trip system
- Upgrade to an electronic governor
- Add a microswitch
- Add a remote trip solenoid
- Upgrade to a pneumatic hand valve

Click on YR Turbine image to link to the interactive graphic on elliott-turbo.com.

The world turns to Elliott
Off-Design YR Turbine Rerates

- **Sentinel valve** (not pictured) provides a warning of over pressurization for improved safety.
- **Gland packing** minimizes steam leakage along the rotor shaft and prevents air from entering the turbine casing.
- **Governor valve and stem assembly/valve seat** increases or decreases steam flow while providing header pressure control.
- **Overspeed trip pin assembly** increases trip accuracy and dependability.
- **Bearing liners** support the rotor based on radial position.
- **Nozzle ring** improves performance and increases capacity.

**Legend:**
- ▲: Power Change
- △: Speed Change
- ▼: Steam Condition Changes
TECHNICAL SERVICE

Customer Technical Support
Technical Service Global Network

Technical expertise and resources located around the world to support our customers with rotating equipment products and services.
Technical Service

• Installation and Commissioning Support
  – Expertise to support on-site Elliott Field Service personnel for trouble free commissioning
  – Expertise to remotely support customer coordinated activities
  – Controls engineering capabilities for start up support and performance tuning

• Advanced trouble shooting & root cause failure analysis of field issues
  – On-site process reviews & machinery investigations
  – Vibration data acquisition and advanced analysis
  – Structural and Modal finite element analysis (FEA)
  – Complete metallurgical analysis

• Development of specialized repair procedures to be executed by Elliott Field Service and Service Centers
  – Repair & extend equipment lifecycle without sacrificing reliability or performance

• Management of Elliott Technical Service Letters
  – Online technical content about Elliott products available for customer use

• Management & administration of critical quality processes
  – Warranty process for all products & services
  – Feedback process to drive continuous improvement to Elliott’s products & services
OTHER GLOBAL SERVICE PROGRAMS
Training Programs

• Professional Elliott Training
  – On-site and factory training
  – Training facilities in Jeannette, PA and Tuggen, Switzerland
  – Hands-on YR turbine workshops
  – Promotes a safer work environment
  – Improves operating efficiency
  – Reduces maintenance costs

• Available training programs
  – YR turbines
  – Multi stage, multi valve steam turbines
  – Centrifugal compressors
  – Lube and seal systems
  – Customized on-site or factory training
Long-Term Service Agreements (LTSA)

• Predictable and affordable monthly expense for fleet
• Improved reliability through periodic equipment inspections from an experienced Elliott Service Engineer
• Routine maintenance parts included
  – Other parts provided at discounted rate
• Extended warranty opportunities
• Semi-annual, 5, or 10 year terms
• Global agreements preferred, site specific available
Bearing Manufacturing

• Types
  – Tilt Pad Journal
  – Thrust

• Services
  – Centrifugal casting with ASTM B-23 babbitt
  – In-house re-babbitting and bearing repair
  – Lead sealing and repair
  – Fully certified ultrasonic and dye penetrant testing
  – Coordinate measuring machine (CMM) inspection
  – CNC and manual machining of parts up to 120 inches