Industrial Gas Turbines
Aftermarket Parts, Repairs and Services

New Industrial Gas Turbine Parts
Industrial Gas Turbine Repair
Aftermarket Field Services
PW Power Systems

About Us

PW Power Systems, Inc. (PWPS) is a world leader in developing and manufacturing energy solutions for power generation, offering products for aeroderivative and industrial gas turbines. PWPS offers a full range of maintenance, overhaul, repair and spare parts for other manufacturers’ gas turbines with specific concentration on the high-temperature “F” class industrial machines. PWPS also offers quick turnaround for parts and repair services utilizing the latest in component repair technology integrated from Pratt & Whitney® Global Aftermarket Service expertise.

PWPS is committed to providing high-quality solutions for the distributed energy market that increase energy productivity, energy reliability and operational savings for its customers.
New Industrial Gas Turbine Parts

PW Power Systems (PWPS) designs, reengines and manufactures components for use in land-based industrial gas turbine (IGT) applications. As part of the portfolio of components and services available, PWPS produces and repairs replacement parts for the hot gas path (HGP) from other OEMs of large-frame gas turbines.

PWPS components are manufactured using Pratt & Whitney® proprietary alloys and coatings. These materials, coupled with aerospace technology, industrial design technology and quality systems, enable users to install these components and operate their equipment with no degradation in machine performance while realizing improved durability of the HGP components.

PWPS solutions allow customers to develop a degree of confidence that is unparalleled in the industry.

PWPS experience with HGP parts and repairs is based on comparisons of distress modes observed in the fleet.

PWPS goal is to provide value-based gas turbine solutions for customers by incorporating customer feedback, component optimization and the advantage of over 80 years of technological development from our extensive high-temperature aviation heritage.

PWPS is leveraging Pratt & Whitney® world-renowned hot section engineering to address the needs of the IGT customer.

PWPS has an extensive proven history of producing industry-leading technological solutions. We utilize this advantage by applying proprietary technology to create new and innovative solutions for our industrial customers.
New Industrial Gas Turbine Enhanced Parts

Advanced Proprietary Technology Includes:

- High-temperature technology
- Proprietary alloys
- Metallic coatings
- Ceramic coatings
- Film cooling
- Multidisciplinary optimization
- Tip clearance material systems
- Advanced computational modeling techniques

60 Hertz Portfolio Offering:

- Frame 7FA.03 1st, 2nd, and 3rd stage buckets, nozzles and shroud blocks
- Frame 7FA.03 compressor parts
- Frame 7FA.03 DLN 2.6 transition pieces, liners, flow sleeves, liner end cap assemblies and fuel nozzles
- Frame 7EA 1st, 2nd, and 3rd stage buckets
- Frame 7EA 1st, 2nd, and 3rd stage buckets and shroud blocks

50 Hertz Portfolio Offering:

- High-temperature-class hardware
- STG5-4000F (V94.3A4x) HGP components
  - 1st, 2nd, 3rd, 4th stage blades and vanes
  - Blade outer air seals (BOAS)

PWPS has surpassed over 2.4 million hours of accumulated run-time on its Frame 7FA.03 (7FA+e) HGP components.
Product Development Process
Robust Intellectual Property (IP) Strategy Integrated into Reengineering Design

- Project Launch
- Metrology
- Preliminary Design
- Detailed Design
- Production

Flowchart:
- Project Launch: Engineering Analysis, Prelim IP Assessment
- Metrology: Features List
- Preliminary Design: IP Risk Identification
- Detailed Design: IP Due Diligence Process
- Production: Final Clearance
**PW Power Systems Experience and Technology**
Differentiating from the Competition

**Copying vs. Redesigning**

- Market Data and Source for Parts
- Reverse Engineer Existing Parts and Engine Equipment
- CMM Technology
- Optical Technology
- Wax Molding
- SOAPP Analysis
- IP Risk Analysis
- Enhance Design and System Integration
- Manufacturing Development
- Validation
- Manufacturing and Sourcing
- Production

**PW Power Systems Design Toolbox:**
- Multiple disciplinary optimization allows for extensive exploration of design options while monitoring many design constraints
- Iterations effectiveness maximized
Industrial Gas Turbine Repair

Overview

PW Power Systems IGT repair activities are directed to our San Antonio Center of Excellence. Originally intended as an aero engine repair facility supporting military and commercial customers, this facility is now solely dedicated to IGT repair. At this facility, PWPS characteristic level of rigor and competency is extended to the efficient repair of industrial gas turbine components. Each component repair is driven by documented repair procedures, process controls, and inspection methods ensuring the highest quality levels.

A significant investment in equipment and facility improvements has been made over the last several years as PWPS transformed this facility into a dedicated industrial gas turbine facility. These investments in the facility will continue to expand capabilities and retain the best technical talent in the industry.
The vast majority of all repair processing is performed in-house with minimal vendor-supported operations. This helps ensure the highest levels of quality and schedule control. On-site process capabilities include, but are not limited to:

- Elevated-temperature Weld
- Manual TIG Weld
- Laser Weld
- Vacuum Heat Treat
- Braze Crack Repair
- CNC Shot Peen
- Robotic HVOF Plasma Coat
- Robotic APS Coat
- Grit Blast
- Blending
- Airflow
- Water Flow
- Digital 450 kV X-ray
- Heat Tint
- FPI
- CMM
- Bridgeport Machining
- EDM Plunge and Hole Drill
- Submerged Ultra-sonic Inspection System
- FSET (Frequency Scanning Eddy Current Test) System
- 5-axis CNC Grinding

The technical expertise required to develop and execute advanced IGT repairs resides on-site at PWPS San Antonio facility, fortified by the depth and technical resources of over 80 years of turbine engine expertise.
PWPS has successfully repaired over 650 sets of “F” class components.

**Gated Repair Process**

**INDUCT**

**STRIP AND INSPECT**

**REPAIR**

**COAT AND FINISH**

**PACK AND SHIP**

**CUSTOMER REVIEW GATE**

**Strip and Inspect Process Steps:**
- Mark ID and Incoming VIS
- Incoming Photo Document
- Metallurgical Assessment
- Disassembly
- X-ray
- Airflow
- Removal of External Coat
- Chemical or Waterjet Strip
- Heat Tint
- Blend Residual Coating
- Dimensional FPI
- Post Strip Photo Document
- Generate Report
- Customer Review Gate

**Repair Process Steps:**
- Machine and Rout Defects
- Solution Vacuum Heat Treat
- FPI
- Weld Repair
- Blend Repair
- Hot Isostatic Press (HIP)
- Machine and CNC
- Vacuum Heat Treat
- EDM Cooling Holes
- Blend and Deburr
- Grit Blast Clean
- FPI
- Heat Tint
- X-ray
- Airflow
- Water Flow
- Dimensional
- Pre-coat VIS
- Customer Review Gate

**Coat and Finish:**
- Heat Tint
- Internal Aluminum Coat
- Mask for Coat
- HVOF
- Diffusion Vacuum HT
- APS TBC Coat
- Diffusion and Age Vacuum HT
- Deburr Cooling Holes
- Heat Tint
- Shot Peen
- Rail Coat
- Cosmetic Clean
- Airflow
- Water Flow
- X-ray
- Dimensional Inspection
- Final Visual Inspection
- Moment Weigh and Sequence
- Customer Review Gate
Standardized Repair Methodology

**TWP - Technical Work Package:**
- Technical requirements
- Defines key characteristics

**Router (Traveler):**
- Sequenced operational process steps
- Piece-by-piece traceability

**Work Instructions:**
- Instructions for performing a specific type of operation (blending, welding, moment weight, airflow, etc.)

**Technique Sheet:**
- Detailed parameters and specific instructions within a work instruction group unique to a specific operation or part

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**Engine Types with Repair Experience:**
- Frame 7B/7EA
- Frame 6FA
- Frame 7FA.03
- Frame 9FA+e
- Frame 9E
- V84.2
- V94.2
- V84.3A
- V94.3A2/A4
State-of-the-art Coatings Extend Part Life

PW Power Systems (PWPS) creates advanced coating systems to refurbish hot section components, provide oxidation and hot-gas-corrosion protection, and aid temperature reduction through the use of advanced coating ceramics.

These coatings represent state-of-the-art proprietary materials tailored to meet the unique challenges of industrial gas turbine environments.

<table>
<thead>
<tr>
<th>Engine Models</th>
<th>Blades/ Buckets</th>
<th>Nozzles/ Vanes</th>
<th>Liners</th>
<th>Transition Pieces</th>
<th>Shrouds</th>
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</thead>
<tbody>
<tr>
<td>Frame 7FA.03</td>
<td>•</td>
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<td>Frame 6B</td>
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<td>Frame 9E</td>
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<td>V84.3A</td>
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<td>V94.3A2 / A4</td>
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<tr>
<td>Frame 9FA+e</td>
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*heat shields

Metallic Coatings

<table>
<thead>
<tr>
<th>Oxidation Resistance</th>
<th>TMF Cracking Resistance</th>
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<tr>
<td>Proprietary Coating</td>
<td>Proprietary Coating</td>
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<tr>
<td>GT29 (baseline)</td>
<td>GT29 (baseline)</td>
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<tr>
<td>GT29 Plus</td>
<td>GT29 Plus</td>
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<tr>
<td>GT33 Plus</td>
<td>GT33 Plus</td>
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</tbody>
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Improved Survivability

Relative Durability of TBC Systems

Proprietary Thermal Barrier Coatings (TBC) Offer More Design Flexibility
Gas Turbine Services

Through its partnership with Mechanical Dynamics & Analysis (MD&A), PW Power Systems now provides these specialized field services.

Power plant owners and operators have entrusted their turnkey turbine-generator overhauls to MD&A for over three decades. Our project managers and technical directors are seasoned professionals with a broad range of experiences whose skill sets cover both common and unique makes and models of turbo machinery from around the world. Our reputation for providing objective advice, effective project management and high quality repairs has enabled MD&A to become one of the most recognized and trusted names in the power generation industry.

An abbreviated list of services provided by our Gas Turbine Services team includes:

- Combustion, Hot Gas Path and Major Inspections
- Generator Inspection and Repair
- New and Used Capital and Consumable Parts
- Hot Gas Path, Combustion and Compressor Repairs
- Technical Direction, Consultation and Controls Engineers
- Labor and Supervision
- Control System Upgrades
- Full Suite of Specialty Services

Fleet Support for:
Frame 3, 5, 6B, 7EA, 7FA, 9E, 9FA
V84, V94

Facility Locations:
- Latham, NY
- Clifton Park, NY
- Fort Collins, CO
- St. Louis, MO
- Houston, TX
- Willoughby, OH
- Ocala, FL
- Anoka, MN
- Mandan, ND