

A photograph of an industrial facility, likely a refinery or chemical plant, at night. The scene is illuminated by numerous bright orange and yellow lights, creating a high-contrast image against a deep blue sky. Several tall, cylindrical distillation columns are visible, along with a complex network of pipes, walkways, and structural steel. The lights create a warm, industrial glow. A large, faint, light-colored circular graphic is overlaid on the left side of the image, partially obscuring the text.

PSM

a Hanwha company

Thomassen Energy
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9F Product Offering

We continue to focus on the timely market introduction of our own innovative, targeted, high quality design solutions to emerging 9F fleet issues.

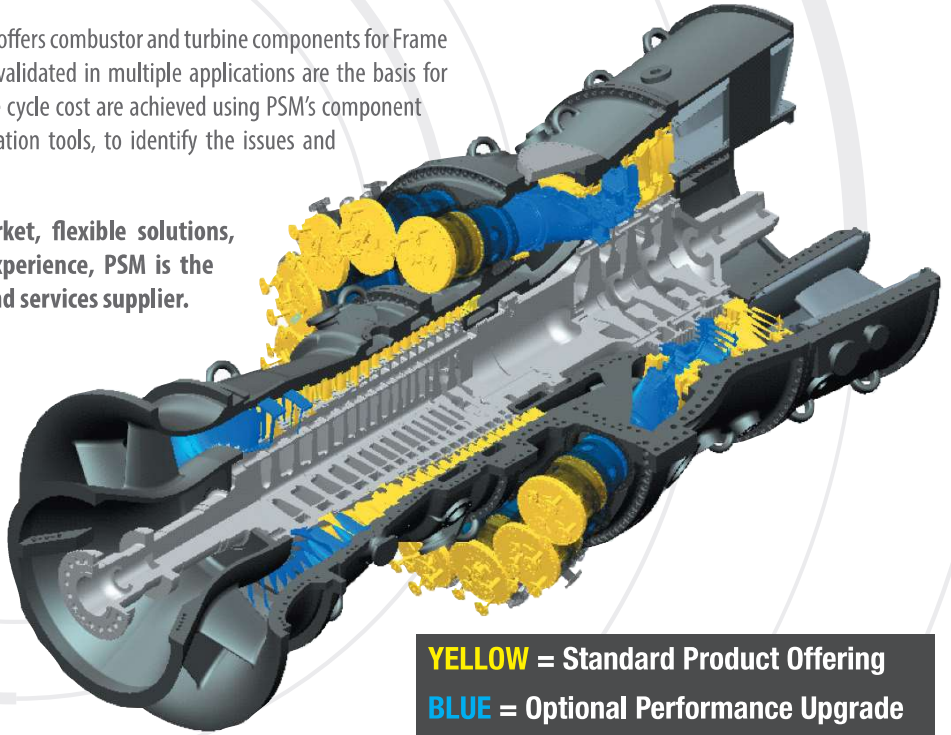
PSM 9F PRODUCTS

Built on our successful products for the Frame 7F, PSM offers combustor and turbine components for Frame 9F. Design improvements developed for the 7F and validated in multiple applications are the basis for PSM's 9F portfolio. Improved durability and lower life cycle cost are achieved using PSM's component and system level product modeling and data evaluation tools, to identify the issues and failure modes in current OEM designs.

Combining technical expertise, speed to market, flexible solutions, tools, and multi-OEM gas turbine platform experience, PSM is the industry leading F-Class alternative products and services supplier.

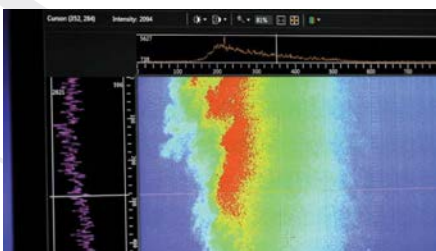
Design Improvements

- + Interchangeability with OEM hardware
- + ≤ 9 ppm NOx & CO emissions over normal premix operating load range
- + All parts are designed to deliver 32,000 Factored Hours (FH) and 900 Factored Starts (FS) inspection intervals or better



YELLOW = Standard Product Offering
BLUE = Optional Performance Upgrade

Creating longer lasting, more dependable parts for your 9F gas turbine provides better power plant availability and profitability in the marketplace. PSM's line of Frame 9F compatible parts have redesigned the original parts where necessary to address the life-limiting elements of existing designs. PSM's hot gas path components utilize advanced materials, coatings, cooling schemes, and design features to maximize durability and reliability.



Components are upgraded by PSM following a proven design approach:

- + Identify the current component issues/failures
- + Use state-of-the-art analytical tools, metallurgical evaluations, and engine test data where possible to determine the root cause of the issues/failures

- + Use this data to design and fabricate new hardware with design features that better maximize durability and reliability

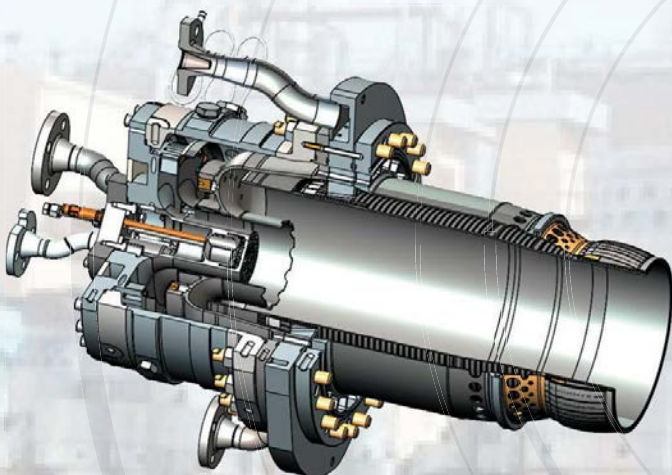
Co-locating R&D engineering with the PSM repair workshop, our design engineers collect continuous feedback on the performance of PSM's and competitors' designs and proactively address emerging fleet issues. With these capabilities PSM has introduced designs that can align combustion and hot gas path inspections and reduce repair scopes, providing customers with reduced lifecycle costs.



FLAMESHEET

Superior Turndown, Fuel Flexibility, and Emissions Capability

Future-Proof your engine today! FlameSheet™ is the ultimate combustor solution to meet any new conditional operational needs. As the power generation market continues to be impacted by renewable penetration, low natural gas prices from fracking, and dynamic financial market changes, users are forced to reevaluate their fleets in order to remain relevant. FlameSheet™ provides the ultimate in flexibility including the ability to perfectly poise your engine to be prepared for anything from the operational flexibility needed today to the Hydrogen economy!



Cross Section view. FlameSheet™ is now available on most engine models

FlameSheet™ Benefits

- + Up to a 30% increase in GT operating load range with single digit NOx and CO
- + Optional low load HRSG protection setting
- + Superior Fuel Flex
 - 30% Modified Wobbe Index
 - Ideally suited for alternate fuel operation, including hydrogen, ethane, and propane
 - + Up to 60% Hydrogen mix (demonstrated 80% in rig testing conditions!)
 - + Up to 40% Ethanes (C2)
 - + Up to 10% Butanes (C4-C6)
 - + Up to 20% Propane (C3)
 - PSM is on our way to 100% Hydrogen capability!
- + NOx as low as 5ppm
- + Peaking power at constant NOx emissions
- + Dual fuel capable
- + Up to 32K / 1250 start inspection intervals
- + Compatible with plant's existing GT controller and fuel skids

FlameSheet™ = TWO Combustors in ONE

FlameSheet™ employs a simple, two-stage radially-inflow “combustor-within-a-combustor” concept that allows the staged operation of each at various load conditions. While at high loads, both combustors are used, with the outer combustor flame structure looking like an annular “sheet of flame” around the inner combustor. At low loads, the outer combustor is predominantly used. Leveraging trapped vortex stabilization aerodynamics, the outer combustor operates with excellent stability and remains sufficiently hot at very low loads to consume CO (CO typically limits low load operation).



DIGITAL PRODUCTS

Maximizing Plant Performance

Before, during or after large equipment upgrades PSM's Digital Technology Portfolio maximizes the potential performance of your plant. Very often combining several engineered systems together, there are some layers of overlapping redundancy, which if fully understood provides significant optimization potential. Over the last decade, PSM has been combining our domain expertise in GT technology, combustion system design, engine upgrades, engine operation from our M&D Center, as well as controls logic experience, together with balance of plant operations and advanced controls methods, to create innovative optimization tools. Using propriety and patented controls blocks we can offer multiple optimization features offered to suit your individual needs.



FlexSuite and AutoTune

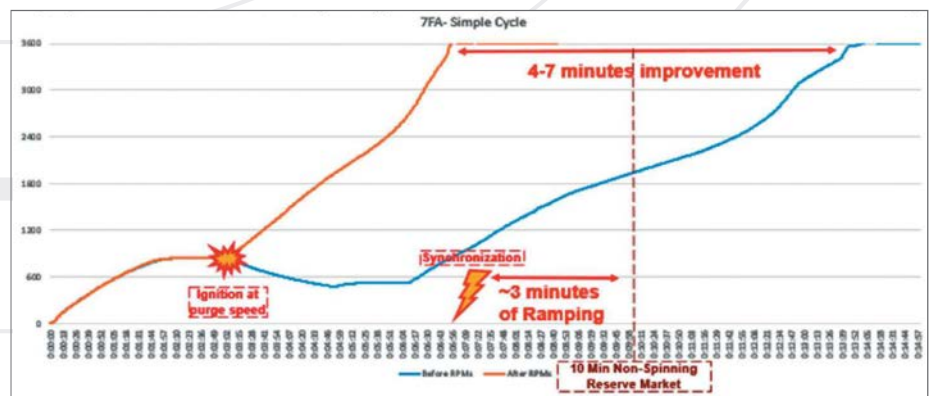
A portfolio of applications for your existing controller FlexSuite from PSM provides Digital Optimization for your power plant operations. No matter if you are looking for operational reliability improvements or increases operational flexibility there are multiple optimization features offered to suit your individual needs.

FlexSuite Building Blocks

- + Combustion Optimization
- + Start-up / Shut-down Optimization
- + Enlarged Load Range
- + Efficiency and Lifetime
- + Fuel Flexibility
- + Grid Support
- + Service Flexibility

Start-Up Optimization

FlexStart & FlexRamp: Increase Reliability and Availability through control logic improvements and adaptations that allow your GT's to better meet your performance needs. No matter if you are in a 10 minute start-up market or auxiliary services, being able to start faster and subsequently ramp fast both before and after heat soak can provide significant monetary value.



Example 7F rotor RPM with FlexStart controls logic optimization, gets SCGT to grid synchronization 7 minutes faster than originally commissioned allowing plant to operate in 10 minute spinning reserve market

AutoTune

Intelligent GT combustion optimization for emissions and combustion dynamics, while maximizing operational range and fuel variation. Utilize in conjunction with FlexSuite, FlameSheet™ and GTOP™ to maximize the optimization potential.

System Features

AutoTune is an expert advisory system that provides extra level of intelligent protection to your existing controller

- + External to control system
- + HMI screen seamlessly integrated

Patented learning algorithms eliminate the need for seasonal tunes and provide significant system enhancement:



Tuning Optimization

- + Dynamics - providing improved hardware life and Lean Blow Out mitigation
- + Emissions – avoiding excursions, providing consistent emissions even with atmospheric/climate/seasonal changes, @ varying load points
- + Learning – intelligent learning of known operational points allows for less tuning and therefore less chance for error
- + Transient tuning - adapts to cycling of units and provides response to dynamics changes
- + Trip Avoidance: provides ultra-fast reaction if combustor is flaming out to prevent a trip

AutoTune Learns

Patented learning algorithm captures information from successful and unsuccessful tuning events.

Overtime, AutoTune learns and the need for tuning reduces drastically whenever the same operating conditions are experienced.

FlexSuite – Flexibility Building Blocks

In addition to the below, PSM's FlexSuite offers additional controller modules compatible with the majority of control systems and designed to optimize your plant's performance.

Extended Turndown

- + Dynamic optimization of unit minimum load
- + AutoTune monitors emissions and combustion dynamics to safely meet load target or hold at lowest safe point of operation
- + Integrated with both manual load control or AGC drive load targets
- + Learns over time by saving ambient condition profiles to allows for quicker load ramp when revisiting safe operating points

Operational Flexibility

With PSM's patented algorithms, it is possible to maximize the GT output according to the climate conditions and actual system performance, for example do you want to maximize season peak power potential? Peak+ continuously seeking to maximize load range while maintaining emissions and dynamics, three optional modes are available:

- + Power+ @ current firing temperature range with no impact to hardware life
- + Peak+ @ option for increase peak firing mode to achieve greater improvements, with some hardware lifetime debit
- + Turndown - minimizing low load point by maintaining output just above premix transfer

While running on AGC or remote dispatch: Peak+/Power+, Turndown & Transient Tuning all active during Automated Generation Control and do not require stable load conditions before optimizing.

9F TURBINE SECTION: HOT GAS PATH

Design improvements leveraged from 15 years of 7F Experience

Buckets

1st Stage Bucket

- + Directionally Solidified (DS) casting for improved capability
- + Latest design features cast-in, TBC coated tip plate for enhanced reliability and reduced repair scope
- + Advanced cooling technology to address tip and platform durability issues
- + Full platform TE (trailing edge) undercut to eliminate TE cracking
- + Includes attachment relief cuts to address turbine wheel cooling air slot and lockwire tab cracking
- + Externally coated with durable Strain Tolerant Micro Cracked Thermal Barrier Coating STMC-TBC® and internally aluminide coated



2nd Stage Bucket

- + Conventionally cast from patented PSM 116 material for improved LCF & Creep durability and repairability
- + Improved cooling scheme with fully turbulated cooling holes
- + Tip shrouds feature several design upgrades to eliminate shroud lifting and localized creep cracking
- + Buckets are externally TBC coated and internally aluminide coated
- + Includes attachment relief cuts to address turbine wheel cooling air slot and lockwire tab cracking



3rd Stage Bucket

- + Conventionally cast from patented PSM 116 material for improved durability and repairability
- + Features scalloped shrouds to counteract shroud lifting
- + Z-Notch features larger hard face surface area to reduce wear and fretting
- + Externally MCrAlY coated



9F DROP-IN REPLACEMENT COMBUSTION SYSTEMS

For over 20 years PSM has been manufacturing combustion systems with improved durability and reliability for direct replacement of OEM equivalents. Our hardware is designed to deliver at least 24,000 Factored Hours (FH) & 900 Factored Starts (FS) inspection intervals or better and also provides ≤ 9 ppm NOx & CO emissions over normal premix operating load range

DLN2.0+ and DLN2.6+

Directly compatible with OEM combustion systems, PSM Drop-In replacements can be interchanged with existing OEM systems without the need for conversion or modification. Both DLN2.0+ and DLN2.6+ share many of the following features:

Transition Piece

- + Improved durability through PSM design features
- + Patented cooling features reduce metal temperature
- + Thermally free mount to 1st stage nozzle



Nozzles

1st Stage Nozzle and Outer Retaining Ring

- + Fully externally coated with MCrAlY metallic bond and TBC for oxidation resistance and reduced metal temperatures
- + Cooling air is redistributed to the platform and sidewalls for improved durability
- + ID rail redesigned to reduce stiffness that contributes to high airfoil stresses and cracking
- + Parallel chordal hinge to seal between nozzle ID and support ring
- + PSM 109 alloy provides a proven reduction in Thermo-Mechanical Fatigue (TMF) cracking when compared to cobalt based alloys



2nd Stage Nozzle

- + Fully externally coated with MCrAlY metallic bond coat and TBC for oxidation resistance and reduced metal temperatures
- + Upgraded trailing edge cooling design
- + Furnished with attached diaphragms made from 310 SS, an upgraded alloy, to address field oxidation issues



3rd Stage Nozzle

- + Furnished with attached diaphragms



Liner

- + Improved durability with conical design and upgraded material
- + Improved impingement cooling for enhanced durability
- + Improved assembly and sealing with double-ply, forward facing hula seal design

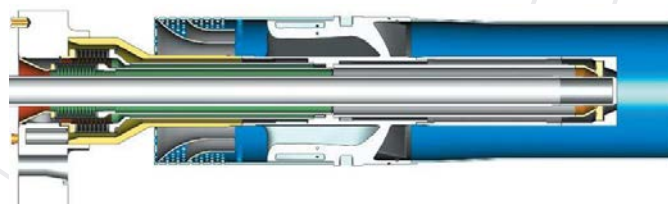


Liner Cap

- + Improved durability through PSM design features
- + Upgraded Effusion plate material to Haynes 282 for increased LCF capability

Cover Assembly, inc Swozzles

- + All machined and welded design – no brazed inserts, eliminating recurrent braze joint failures in brazed designs
- + Compatible with PSM and OEM fuel nozzles
- + PSM Swozzle matches OEM flow and emissions characteristics, also available as scrap replacement to cover fallout during repair



9F COMPRESSOR RELIABILITY SOLUTIONS

Common fleet stator issues include:

- + **Shim migration and liberation** that can result in significant downstream compressor hardware impact damage
- + **S0-S4 carrier ring corrosion and lock-up** that can cause high cycle fatigue (HCF) failures. Maintainability is also negatively impacted, since the corroded carriers can be very difficult to remove, sometimes requiring a rotor lift and destructive removal.
- + **Excessive case hook fit wear** that can result in stator rock or stepping that can lead to forced outages. Wear issues are most pronounced in the aft compressor stages.
- + **Tip rubs** can cause tip crack initiation and pieces of stator tips to liberate, that can cause compressor hardware impact damage.

To address these fleet issues, enhanced stator reliability design features are incorporated as standard across the S0 thru EGV product offering:

- + **100% Shimless**, to eliminate shim liberation risk
- + **Squealer tips standard**, to minimize the potential for tip cracks and stator material liberation due to rubs against the rotor during operation
- + **Full radial machining geometry**, for optimum part damping
- + **Shotpeen**, for enhanced material capability
- + **Passivation**, for corrosion resistance
- + **Interchangeable** with OEM design by sets
- + **Complete offering** for flared and unflared compressor flowpaths available

Common fleet rotor blade issues include:

- + **R0 HCF failures** that can cause significant downstream damage
- + **Attachment fretting and crack initiation**
- + **Tip rubs** that cause material degradation that can result in tip crack initiation and material liberation, leading to downstream compressor hardware impact damage

To address these fleet issues, enhanced rotor blade reliability design features are incorporated as standard for our R0 thru R17 product offering:

- + **Squealer tips standard**, to minimize the potential for tip cracks and blade material liberation due to rubs against the case during operation
- + **Shotpeen**, for enhanced material capability
- + **Passivation**, for corrosion resistance
- + **Attachment undercuts** to avoid fretting and potential cracks
- + **All required spacers available**
- + **Interchangeable** with OEM design by sets
- + **In-situ blade tip grinding capability** to ensure tip clearance requirements are achieved
- + **Complete offering** for flared and unflared compressor flowpaths available



1st to Market with a Proven R0 Design Solution

Since its introduction, the 7F.03 R0 compressor blade has been a major maintenance issue for end users. PSM completely redesigned this component, delivering a design solution to the customer that met design requirements in only 10 months. This solution has been operational since 2008. The same design solution is also available for the 9F.03.

- + Erosion and corrosion tolerant design
- + Material upgraded to a higher strength alloy
- + Compound variable conical fillet introduced to reduce stresses

- + Airfoil restacked to reduce steady stresses along the leading edge
- + Retuned airfoil to reduce vibratory stress response
- + PSM has a patented R0 Blade retention design that replaces the OEM "Biscuit Mod" retention feature and does not rely on staking to retain R0
- + No IGV modifications required for install
- + No requirements for replicas or extraordinary inspections

ROTOR MANAGEMENT SOLUTIONS

Capitalizing on a portfolio of rotor and blading design upgrades and full 3D steady state and transient analysis models enables PSM a full exchange rotor service available, with a PSM LTE rotor minimizing your downtime and optimizing your capital investment.

Capabilities

- + Unstack and deblade
- + Reblade and tip grind new blades
- + R0 retention plug modification
- + Compressor clocking optimization
- + Patch ring repairs
- + Complete rotor structural analysis to support repairs
- + Own design flared and unflared compressor blading with reliability improvements
- + Seed rotor to support rotor exchange program

PSM Rotor Exchange

- + Seed rotor to support rotor exchange program
- + In-situ Blend / Polish / Peen of first turbine disk cooling slot, with additional life-enhancing solutions available upon full destack



PSM SEED ROTOR DURING DISASSEMBLY AND LIFE TIME EXTENSION ASSESSMENT

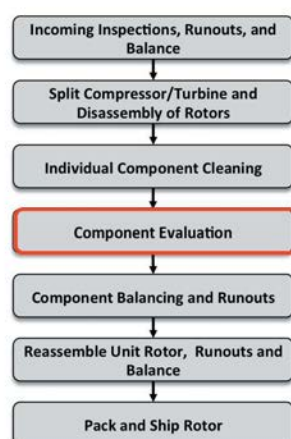
Rotor Lifetime Extension (LTE)

PSM's Rotor LTE program can extend the useful lifetime of your rotor. With the advancements in computing power, material properties, fracture mechanic methodologies, and inspection techniques, it is now possible to assess the potential to run rotors beyond their original published limits. Rotor LTE is enabled by:

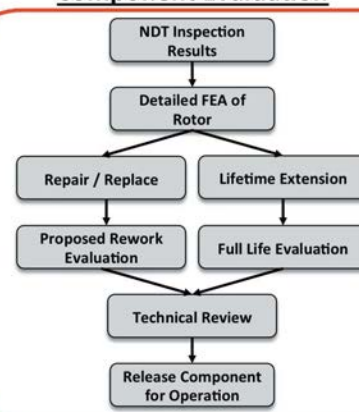
- + Advanced non-destructive inspection techniques, utilized to detect surface and volume flaws
- + Full rotor material characterization
- + Full 3D Finite Element Analysis (FEA) models for thermal & structural analysis
- + Inspection results and operational history fed back to the FEA Model

Any problematic flaws identified are analyzed, and a report detailing the predicted remaining rotor capability is generated, empowering owners to make informed decisions about their rotor

assets. Optional rotor modifications can be applied, that are designed to extend rotor lifetime in known life limiting locations.



Component Evaluation



LONG TERM AGREEMENTS

Summary of Offerings

As a leading parts provider in the industry, PSM is offering comprehensive and flexible Long Term Agreements for 7F, 501F, 6B, and 7E aimed at decreasing lifecycle costs to the end user. Our PSM engineered part design enables us to increase the component life and extend the program intervals, eliminating inspections and providing the customer with significant price reduction over the life of the contract.

In addition, through our experience with component performance, PSM is able to reduce the fallout of hot gas parts due to the improvements made to the OEM design and reconditioning process. PSM has also assembled a highly skilled and experienced field service organization capable of industry leading outage performance.

Flexible Agreements — to fit the customer needs

Types of PSM Service Agreement Offerings			
Included Product Offerings	Long Term Agreement (LTA)	Long Term Maintenance Agreement (LTMA)	Frame Agreement
Parts Supply	✓	✓	✓
Reconditioning	✓	✓	✓
Field Services	✓	✓	Optional
Monitoring & Diagnostics (Remote Monitoring)	✓	Optional	Optional
Contract Manager	✓	Optional	Optional
Inventory Management	✓	✓	Optional

PSM has designed a flexible concept for the Long Term Agreements focused on your requirements. We understand the frequent change in market conditions, and PSM is willing to accommodate the changing conditions based on your needs. The intention of each agreement is to provide the customer with competitive pricing while taking advantage of the entire PSM portfolio of offerings. Our agreements can be structured to not only include the gas turbine, but also the generator, steam turbine, and respective auxiliaries.

In summary, the various agreement offerings are structured to optimize your maintenance budget by offering competitive parts life guarantees, minimal parts fallout, coverage during unscheduled inspections, control of inventory, and proactive contract management to ensure total coverage.

Scope of Supply — based on the customer requirements

The customer determines the level of scope for the Long Term Agreements, ranging from full service offerings to a pricing agreement. Service offered by PSM within a Long Term Agreement include, but are not limited to, the following:

- Parts Supply
- Reconditioning
- Field Services — including craft labor
- Monitoring & Diagnostics (e.g. Remote Monitoring)
- Contract Management
- Inventory Management
- Parts Tracking
- Engineering Assessments
- System Technical Support
- Emergency Response



SERVICE CAPABILITIES INCLUDING MONITORING & DIAGNOSTICS

PSM services a diverse portfolio of GT components, control and combustion system platforms

- + Reliable coverage ranging from basic support through Complex Root Cause Analysis
- + Service Engineering goes beyond traditional support to provide best practices from across all platforms & systems
- + Strong Processes & Infrastructure positions PSM to further grow capabilities

Engineering Assessment

- + Experienced and dedicated team supporting our Field Service, Project Management, Sales & Tendering, R&D, Fleet Management, Global Execution Centers, and Customers
- + Over 400 events per typical outage season evaluated and answered
- + Team can reach into all parts of PSM organization to ensure quick event disposition

Tuning and Commissioning

- + 200+ tunes per year
- + Wide variety of combustion technology and control systems
- + Strong expertise in OEM & PSM Combustion systems
- + In house knowledge base and access to combustion design engineers
- + Tuning events completed across 7 platforms

Monitoring and Diagnostics

- + Over 50 units and 10 GW monitored
- + Global cloud-based infrastructure with redundancy
- + Follow-the-sun approach with manpower support
- + Monthly Operational Assessment Reports (OAR's) included monitoring of customer selected parameters

Controls Design and Development

- + Controls-related services across 7 different platforms
- + Support customers and PSM technology initiatives
- + PSM Virtual Plant available
 - A full tie-back simulator
 - Built to support controls replacement and expansion projects or technology development
 - Assesses operational and protective schemes and communications protocols



Additional Services and Product Offerings: Servicing GE, SW, MHI: B, E & F Class Fleets for 50Hz & 60Hz

Field Services & Outage Management including on-staff bladders and supply of labor for gas turbines, steam turbines and generators worldwide for GE B,E & F-class, SW & MHI F-class.

Reconditioning & Repair of all turbine airfoils and combustion system components, including fuel nozzle overhaul using advanced techniques for improved life cycle cost and incorporating new make design improvements during repair

Combustion System Engine Tuning including Monitoring & Diagnostics
Support for all rotating equipment (e.g. remote monitoring) of gas turbines worldwide.

Rotor Rebuild & Inspection including seed rotors, new replacement compressor and turbine disks, disk repairs, full volumetric NDE inspection and rotor lifetime extension.

R&D, Engineering Assessments, Root Cause Analysis and system technical support for gas turbines.

Flexible Long-Term Parts and Service Agreements (LTSA) combine all of PSM's products and services for a custom solution that meets your needs.

Power Plant Solutions provide integrated services and upgrades for all your critical power plant components and systems. PSM provides a single point of contact for maximizing your plant's performance potential, increasing operational flexibility, and outage management.

FlexSuite provides plant optimization tailored to your exact needs, offer on multiple OEM control systems, from FastStart & FastRamp to Part Load Performance

AutoTune offers autonomous, real-time combustion system control tuning packages for optimizing combustion dynamics/pulsations, emissions and output on the GE 7F gas turbines.

GTOP Upgrade Packages increase output and reduce heat rate, while extending component lifetime and inspection intervals.

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