FT4000™ Gas Turbine SWIFTPAC® Package
FT8® Gas Turbine SWIFTPAC® Package
FT8® Combined-Cycle Gas Turbine SWIFTPAC® Package
FT8® Gas Turbine MOBILEPAC® Package

Gas Turbine Packages

PW Power Systems

a group company of MITSUBISHI HEAVY INDUSTRIES, LTD.
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About Us

Mitsubishi Heavy Industries, Ltd.

Mitsubishi Heavy Industries, Ltd. (MHI), a diversified Fortune “Global 150” company with more than $30 billion in annual revenues and 40,000 employees worldwide. MHI is an international leader in the design and supply of energy, aerospace, machinery, transportation, and environmental systems and equipment.

PW Power Systems

PW Power Systems, Inc. (PWPS) formerly Pratt & Whitney® Power Systems, now a subsidiary of Mitsubishi Heavy Industries, Ltd. has leveraged the advanced technology of Pratt & Whitney® proven aircraft engines and uniquely applied it to intricate power system solutions to become a leader in power generation solutions.

PW Power Systems is a world leader in developing and manufacturing energy solutions for power generation offering products for aero-derivative and industrial gas turbines. PWPS has more than 2,000 industrial gas turbines installed in over 50 countries worldwide and prides itself on being superior in the gas turbine repair and overhaul sector. The PWPS™ gas turbine engine portfolio offers competitive, efficient, and flexible products at 25 MW to 120 MW of power.

PW Power Systems is committed to providing high-quality solutions for the distributed energy market that increase energy productivity, energy reliability, and operational savings for our customers.
FT4000™ Gas Turbine SWIFTPAC® Package

The FT4000™ simple-cycle gas turbine SWIFTPAC® package offers a greater than 41% simple cycle efficiency and a nominal 120 megawatts of power within a modular design that is built on over fifty years of aero-derivative packaging experience. Utilizing the core technology derived from the proven Pratt & Whitney® PW4000™ turbofan engines, the all-new SWIFTPAC® package is designed to provide reliable peaking and base-load power with a relatively compact footprint.

This is accomplished by coupling two FT4000™ engines to one electric generator. The modular design includes proven features of the successful FT8® gas turbine SWIFTPAC® package and MOBILEPAC® package designs.

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Features
- One (1) aero-derivative engine (60MW)
- Two (2) aero-derivative engines (120MW)
- Modular design
- Maximum factory assembly
- Optimized shipping sizes
- Proven industrial components
- Integrated ancillary systems
- Control enclosure with power distribution
- Pre-fabricated field piping
- Interconnecting quick-disconnect cables
- Standard option packages

Benefits
- Reduced transportation time and cost
- Limited on-site inventory
- Minimal installation time
- Efficient commissioning
- Low installed cost/high overall value
- Operating flexibility
- High part-load efficiency
- <10-minute start-up time
- Quick engine change-out
- Design flexibility to meet customer needs

Performance
- 120 Megawatt nominal output in twin-engine configuration
- Wet compression for improved performance above ISO conditions
- Highest power output by any aero-derivative GT package
- Single or dual engine operation
- 50- or 60- hertz performance with no penalty
- >41% thermal efficiency without external cooling
Scope of Supply
FT4000™ Gas Turbine SWIFTPAC® Package

Driver Packages
(Two per SWIFTPAC® Package)
• Gas generator, GG4000-1
• Power turbine, PT4000-1 (CW/CCW)
• Diaphragm-type coupling
• Engine base
• Structural base frame w/ drip pan
• Acoustic/weather enclosure
• Combustion air inlet plenum
• Engine removal system
• Fuel control module
• Ignition system
• Synthetic lube oil system
• Hydraulic start system
• Hydraulic control oil system
• Bleed air system
• Buffer air system
• Ventilation air system
• Off-line water wash system
• Vent and drain system
• Fire protection system

Electric Generator Assembly
• Open ventilated, air-cooled double-end drive generator
• Brushless excitation system
• Line-side cubicle
• Neutral cubicle
• Rotor ground detection system
• Acoustic/weather enclosure
• Inlet and exhaust cooling air silencers
• Generator instrumentation
• Remote I/O modules

Auxiliary Skid Assemblies
• Mineral-oil-lubricating oil skid
• Gas fuel filter skids
• Liquid fuel boost pump skids
• Water injection boost pump skids
• Fire suppression skids
• Water wash pump cart

Control Enclosure
• Turbine control cabinets
• Gas turbine digital control system
• Remote I/O modules
• Vibration monitoring system
• Multifunction protection relays
• Motor control centers
• Auxiliary power distribution
• Battery systems
• Fire protection cabinet

Standard Options
• Air-cooled heat exchangers
• Evaporative cooler system
• Inlet fogging system
• Wet compression system
• Modular exhaust stacks
• Reduced far field noise
• Control enclosure fire suppression

Available Services
• Permitting support
• Balance of plant (BOP) engineering and procurement
• Installation technical support
• Construction management and labor
• Operation and maintenance

Major Field Assemblies
• Inlet filter houses, two-stage
• Combustion and ventilation air inlet silencers
• Ventilation air exhaust silencer
• Prefabricated field piping
• Quick-disconnect electrical cables
• Modular cable tray system

Fuel System Configurations
• Gas fuel
• Dual fuel
• Liquid fuel
• Water injection NOx control

GT Exhaust Assembly
• Exhaust diffuser/collector box
• Acoustic/weather enclosure
FT8® Gas Turbine SWIFTPAC® Package

The FT8® Gas Turbine SWIFTPAC® Power Plant Provides Quick, Reliable Power. Installation Takes Less Than 30 Days

The SWIFTPAC® gas turbine package offers 30 or 60 MW of power. Utilizing proven FT8® technology, derived from a Pratt & Whitney JT8D™ derivative gas generator, the SWIFTPAC® power plant is designed to provide quick, reliable power.

The package design includes an enclosed driver assembly incorporating the gas generator, power turbine, exhaust collector box, inlet plenum and lube system. These factory-assembled modules allow the SWIFTPAC® power plant to generate power less than 30 days after arriving on site.
Typical Performance

SWIFTAC® 60 Gas Turbine Package 50Hz, 11.0kV, 09Pf.

Estimated Gross Power Output vs Ambient Temperature and Heat Rate vs Ambient Temperature SWIFTAC® 60 Gas Turbine Package, Natural Gas, WI - 25 ppm NOx.

Sea Level, 60% RH, 63.5 mm W.C. Inlet Loss, 38.1 mm Exhaust Loss.

Gas Fuel 50 Hz Water Injected

![Graph showing estimated gross power output vs ambient temperature and heat rate vs ambient temperature for SWIFTAC® 60 Gas Turbine Package.]

Simple-Cycle Performance - Natural Gas

<table>
<thead>
<tr>
<th></th>
<th>30 MW</th>
<th>60 MW</th>
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<tbody>
<tr>
<td>Output (kW)*</td>
<td>30446</td>
<td>61196</td>
</tr>
<tr>
<td>Heat rate* (BTU/kW-hr)</td>
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<tr>
<td></td>
<td>(KJ/kWh)</td>
<td>9825</td>
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<tr>
<td>Thermal Efficiency (%)*</td>
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<td>37</td>
</tr>
<tr>
<td>Exhaust flow (lb/sec)*</td>
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<td>402</td>
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<tr>
<td>Exhaust temp. (°F)*</td>
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<td>895</td>
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<tr>
<td>U.S. transport time</td>
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<td>6 days</td>
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<td>3 ft. concrete</td>
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<td>Installation</td>
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<td>NOx</td>
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<td>25</td>
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<td>Fuel</td>
<td>Dual</td>
<td>Dual</td>
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<tr>
<td>Frequency</td>
<td>50/60 HZ</td>
<td>50/60 HZ</td>
</tr>
</tbody>
</table>

*Also available with DLN and/or inlet fogging.

Enhancements

- Factory-assembled modules
- Integrated lube oil system
- Factory-tested quick-disconnect cables
- Prefabricated field piping
- Factory-flushed lube oil systems
- Combined GT and exhaust enclosure
- Factory checkout
- Simple, flat foundation with minimal embedments
- Compact layout

Benefits

- Best-in-class part-load efficiency
- Reduced site setup time
- Lower site cost
- Less expensive shipping
- Reduced field flushing
- Minimal field wiring terminations utilizing quick-disconnect cables
- Prefabricated piping needs no field welding
- Less site labor
- Standard and repeatable manufacturing process
- Standard and repeatable installation process
- Preassembled and tested
- Reduced field inventory
- Ease of engine checkout and maintenance
- Operating flexibility
- Ease of transportation and relocation
Scope of Supply
SWIFT® Gas Turbine Package: Dual Fuel, Water Injection

Gas Turbine Package (2)
- Gas generator (GG8-3 core engine)
- Power turbine
- Diffuser
- Collector box
- Exhaust transition
- Fabricated gas turbine base and mount assembly
- Coupling connecting power turbine and generator
- Hydraulic starting motor
- Ignition system
- Off-line compressor internal water wash system
- Lube oil system
- Fuel supply system
- Buffered air system
- Water injection NOx control system
- Gas turbine enclosure
- Two-stage inlet air filter with weather protection
- Inlet silencing
- Exhaust stack
- Quick disconnect electrical interface

Generator Package
- Brush open ventilated; air-cooled, double ended, synchronous generator or equivalent
- Brushless exciter assembly
- Stator heaters
- Neutral ground transformer/resistor
- Current transformers
- Stator RTDs
- Vibration probes
- Bearing drain RTDs
- Bearing metal RTDs
- Hot and cold air RTDs
- Rotor ground detection
- Generator lube oil system
- Enclosure
- Quick disconnect electrical interface

Control Enclosure with HVAC
- Operator control cabinet
- Monitoring cabinet
- Instrument cabinet
- Unit control cabinet
- Generator protective relay panel
- Motor control center
- Master terminal cabinet
- Rack-mounted, sealed, lead, acid cell batteries
- Battery chargers
- Switchgear module 15 kV class
- CTG auxiliary transformer
- FM200 fire suppression

Hydraulic Starting Package

Field Installation Hardware
- Interconnecting piping and hoses
- Interconnecting quick disconnect electrical cables for power and signal
- Foundation embedded material
- Special maintenance tools

General Arrangement Diagram  SWIFT® 60 Gas Turbine Package
Owner-Supplied Services and Responsibilities

Project and Site Development
- Adequate title and interest, permanent facility permits, construction permits and licensing
- Equipment mounting and mounting hardware
- Provisions of local communication facilities
- Temporary construction staging & secure inventory area
- Access road(s), interior roads and parking areas
- Site prep, leveling and compaction

Engineering and Construction
- Site engineering
- Site Organization during construction
- Emissions and acoustic testing
- Worker’s Compensation, employer’s liability or any other local insurance required
- All supervision and craft labor for complete off-loading, inventory, inventory control, storage, erection, installation, checkout, testing and start-up of all non-PWPS™ supplied equipment and material
- Consumable material for erection works
- Required test prior to startup
- Construction equipment, tools and aids
- Phasing and synchronizing the generator to purchaser’s system

Interface Requirements and Responsibilities
- Natural gas for start-up, testing and operation 475 psig (33 bar), approximately 4700 scfm (2.2m³/sec) per gas turbine
- Injection water for NOx control 5-50 psig (0.3-3.4 bar), approximately 25 gpm (115 L/min) per gas turbine
- Potable water for gas turbine off-line water wash 50 psig (3.4 bar) min, approximately 300 gallons (1150 liters) per gas turbine water wash at 35 gpm (133 L/min)
- Liquid fuel for start-up testing and operation 30-75 psig (2.0-5.1 bar) approximately 36 gpm (136 L/min) per gas turbine
- Electrical ground grid interconnections grounding pads are provided by PWPS™ on each trailer and aux skid
- Vent and drain maximum flow on oily waste drain is 35 GPM for water wash. Total waste water per wash is 300 gal.
- High-voltage power
- Control system interface/grid signals
- Alternate electrical power supply 255 kW per power island, 380V, 50 Hz, 3-phase for lighting, heating and intermittent auxiliaries

Other Responsibilities
- Site survey/plot plan
- Excavation for foundations, pipes, roads, cabling & grounding grid
- Site leveling
- Backfill
- Finish grading
- Surface drainage to and including any collection pond
- Oily water separator
- Sanitary waste disposal
- Plant lighting
- Plant fire protection systems-hydrants, panels and extinguishers
- Intra-communication system
- Site fencing and gates
- Construction water
- Builder’s all risk insurance (BAR)
FT8® Combined-Cycle Gas Turbine SWIFTPAC® Package
The FT8® Combined-Cycle Plant Provides High Efficiency, Low-Cost Power and Low Emissions

Features
- All the advantages of an aero-derivative prime mover
- High availability
- High reliability
- Excellent full- and part-load efficiency
- Reduced installation times
- State-of-the-art plan-distributed control systems
- Available with air-cooled condenser
- Can be configured for cogeneration
- Available on full turnkey basis

Full-Load Performance
Gross output—165 MW*
Gross heat rate—6883 BTU/kWh (7262 KJ/kWh)
*2 SWIFTPAC®, 1 steam turbine

Part-Load Performance
Gross output—81 MW**
Gross heat rate—7041 BTU/kWh (7429 KJ/kWh)
**1 SWIFTPAC®, 1 steam turbine
FT8® Gas Turbine MOBILEPAC® Package

25 MW of Mobile Power

The MOBILEPAC® gas turbine package was introduced more than 30 years ago with the FT4 engine. After many successful years of operation, the MOBILEPAC® gas turbine package now utilizes the FT8® engine and offers 25 MW of moveable power. Utilizing the proven SWIFTPAC® gas turbine package technology, this package is designed to provide quick, reliable power and is especially useful in emergency situations.

The MOBILEPAC® gas turbine package design includes two trailers. The first contains the gas turbine, electric generator, exhaust collector, diffuser and engine lube oil system. The second trailer carries the 15 kV switchgear, control system, operation panel, protective relays, batteries and charger, motor control center and the hydraulic start package. A pre-commissioned MOBILEPAC® gas turbine package can be driven to a site and begin generating power in less than one day.
The MOBILEPAC® gas turbine package requires the smallest footprint in the industry, utilizing as little as 25-foot by 60-foot space. Very little advance site preparation is required for the sighting, and no foundation or concrete pad is necessary for installation of the unit. The unit is transportable by land, sea or air to anywhere in the world, allowing worldwide delivery of the MOBILEPAC® gas turbine package within 24 hours.

**Typical Performance**

MOBILEPAC® Gas Turbine Package 50Hz, 11.0kV, 09Pf.

Estimated Gross Power Output vs Ambient Temperature and Heat Rate vs Ambient Temperature FT8® MOBILEPAC® Gas Turbine Package, Natural Gas, WI-25 ppm NOx.

Sea Level, 60% RH, 63.5 mm W.C. Inlet Loss, 25.4 mm Exhaust Loss.

**Gas Fuel 50 Hz Water Injected**

**Benefits**

- Ready for emergency power within one day (site ready)
- Environmentally compatible
- Dual fuel/Dual frequency
- Optional black start capability
- Flexible trailer sighting
- Highway compatible
- Three-point support and structural rigidity to maintain generator alignment
- Remote operation
- Leasing options available

**Product Facts**

- **Output (kW)**: 25000
- **Base engine**: FTB®
- **Number of Trailers**: 2
- **Installation** (site ready and previously commissioned): 8 hours
- **Noise**: 95 dba at 1 meter
- **NOx/CO**: 50/100 mg/m³
- **Grid**: 50 or 60 Hertz
- **Fuel**: Liquid or Gas
Scope of Supply
FT8-3 MOBILEPAC® Gas Turbine Package: Dual Fuel, Water Injection

Power Trailer
Gas Turbine Package
- Gas generator (GG8-3 core engine)
- Power turbine
- Difuser
- Collector box
- Exhaust transition
- Fabricated gas turbine base and mount assembly
- Coupling connecting power turbine and generator
- Hydraulic starting motor
- Ignition system
- Off-line compressor internal water wash system
- Lube oil system
- Fuel supply system
- Buffered air system
- Water injection NOx control system
- Gas turbine enclosure with three point jacking and leveling system
- Two-stage inlet air filter with weather protection
- Inlet silencing
- Exhaust stack
- Quick disconnect electrical interface

Generator Package
- Brush open ventilated; air-cooled synchronous generator or equivalent
- Brushless exciter assembly
- Stator heaters
- Neutral ground transformer/resistor
- Current transformers
- Stator RTDs
- Vibration probes
- Bearing drain RTDs
- Bearing metal RTDs
- Hot and cold air RTDs
- Rotor ground detection
- Generator lube oil system
- Enclosure
- Quick disconnect electrical interface

Control Trailer
Control Enclosure with HVAC
- Operator control cabinet
- Monitoring cabinet
- Instrument cabinet
- Unit control cabinet
- Generator protective relay panel
- Motor control center
- Master terminal cabinet
- Rack-mounted, sealed, lead, acid cell batteries
- Battery chargers
- Switchgear module 15 kV class
- CTG auxiliary transformer
- FM200 fire suppression

Hydraulic Starting Package
Field Installation Hardware
- Interconnecting piping and hoses
- CO2, fuel
- Interconnecting quick disconnect electrical cables for power and signal
- Access stairs and platforms for power trailer and control trailer
- Piping interfaces
- Special maintenance tools

Options Available
- Equipment erection
- Equipment demolition
- Balance of plant (BOP) design and supply
- BOP design, supply, and install
- Freight
- Leasing through APR Energy

General Arrangement Diagram  FT8-3 MOBILEPAC® Gas Turbine Package
Owner-Supplied Services and Responsibilities

Project and Site Development
- Adequate title and interest, permanent facility permits, construction permits and licensing
- Equipment mounting and mounting hardware
- Provisions of local communication facilities
- Temporary construction staging & secure inventory area
- Access road(s), interior roads and parking areas
- Site prep, leveling and compaction to meet at least 191,521 Pa (4000 lbs per square foot) compressive strength
- Transmission system

Engineering and Construction
- Site engineering
- Site Organization during construction
- Emissions and acoustic testing
- Worker's Compensation, employer's liability or any other local insurance required
- All supervision and craft labor for complete off-loading, inventory, inventory control, storage, erection, installation, checkout, testing and start-up of all non-PWPS™ supplied equipment and material
- Consumable material for erection works
- Required test prior to startup
- Construction equipment, tools and aids
- Phasing and synchronizing the generator to purchaser’s system

Other Responsibilities
- Site survey/plot plan
- Excavation for foundations, pipes, roads, cabling & grounding grid
- Site leveling
- Backfill
- Finish grading
- Surface drainage to and including any collection pond
- Oily water separator
- Sanitary waste disposal
- Plant lighting
- Plant fire protection systems-hydrants, panels and extinguishers
- Intra-communication system
- Site fencing and gates
- Construction water
- Builder’s all risk insurance (BAR)

Interface Requirements and Responsibilities
- Natural gas for start-up, testing and operation 475 psig (33 bar), approximately 4700 scfm (2.2m³/sec) per gas turbine
- Injection water for NOx control 5-50 psig (0.3-3.4 bar), approximately 25 gpm (115 L/min) per gas turbine
- Potable water for gas turbine off-line water wash 50 psig (3.4 bar) min, approximately 300 gallons (1150 liters) per gas turbine water wash at 35 gpm (133 L/min)
- Liquid fuel for start-up testing and operation 30-75 psig (2.0-5.1 bar) approximately 36 gpm (136 L/min) per gas turbine
- Electrical ground grid interconnections grounding pads are provided by PWPS™ on each trailer and aux skid
- Vent and drain maximum flow on oily waste drain is 35 GPM for water wash. Total waste water per wash is 300 gal.
- High-voltage power
- Control system interface/grid signals
- Alternate electrical power supply 255 kW per power island, 380V, 50 Hz, 3-phase for lighting, heating and intermittent auxiliaries
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