

Aero-derivative Gas Turbine Packages



PW Power Systems

a group company of  **MITSUBISHI HEAVY INDUSTRIES, LTD.**

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FT8® SWIFTPAC® Gas Turbine Package





About our company

Mitsubishi Heavy Industries, Ltd.

Mitsubishi Heavy Industries, Ltd. (MHI) is a diversified Fortune Global 500 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 complex power system solutions to become a leader in power generation.



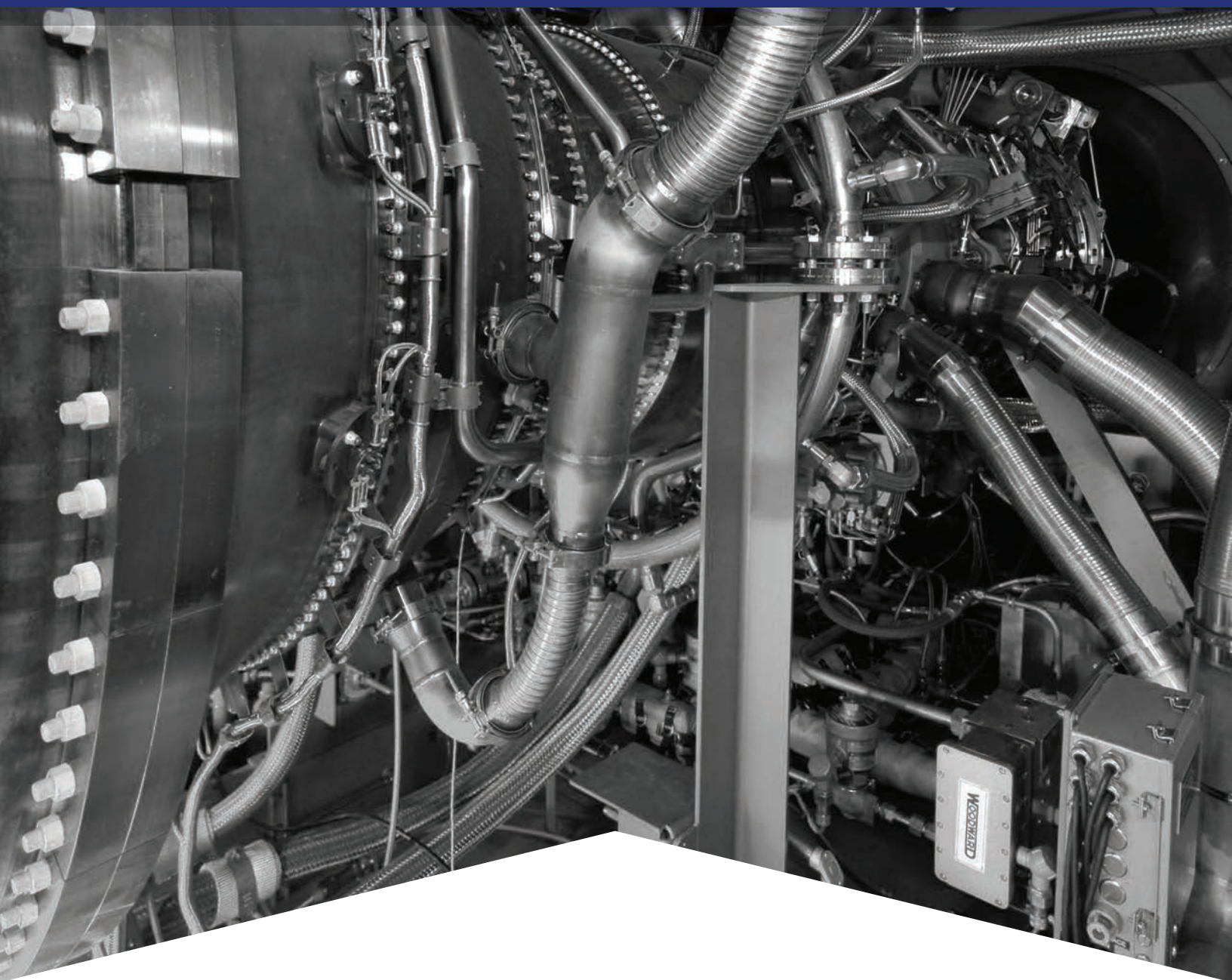
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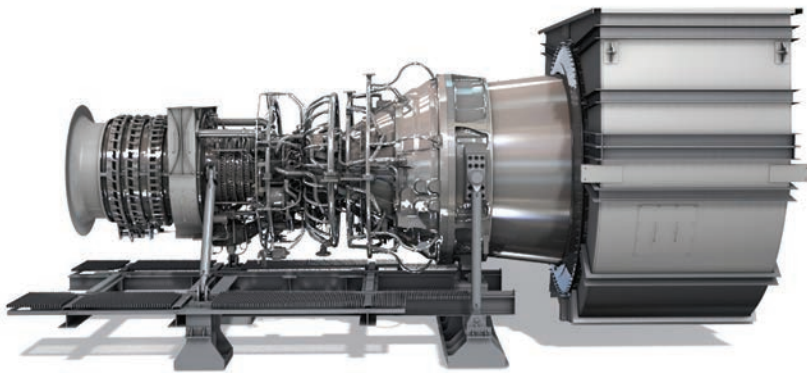
PW Power Systems offers products for aero-derivative and industrial gas turbines. PWPS has more than 2,000 industrial gas turbines installed in over 50 countries worldwide and prides itself on being superior in the gas turbine repair and overhaul sector. The PWPS gas turbine engine portfolio offers competitive, efficient, and flexible products from 30 to 140 megawatts 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 its customers.

FT4000® SWIFTPAC® Gas Turbine Package

The FT4000® SWIFTPAC® gas turbine package is available in both single and twin engine configurations, which offer greater than 41 percent simple-cycle efficiency and a nominal 60-70 or 120-140 megawatts of power within a modular design that is built utilizing over 50 years of aero-derivative design and packaging experience.





FT4000

Utilizing the core technology derived from the proven Pratt & Whitney® PW4000™ turbofan engines, the all-new SWIFTPAC® gas turbine packages are designed to provide reliable peaking and base load power with a relatively compact footprint. This is accomplished by coupling either one or two FT4000® engines to one electric generator. The modular design includes proven features of the successful FT8® SWIFTPAC® and MOBILEPAC® gas turbine package designs.

Features

- One (1) aero-derivative engine (60-70 MW) or two (2) aero-derivative engines (120-140 MW)
- Single or dual engine configuration
- Modular design
- Maximum factory assembly
- Optimized shipping sizes
- Proven industrial components
- Integrated ancillary systems
- Control enclosure with power distribution
- Prefabricated field piping
- Interconnecting quick-disconnect cables
- Standard option packages

- Efficient commissioning
- Low installed cost/high overall value
- Operating flexibility
- High part load efficiency
- 10-minute start-up time
- Quick engine changeout
- Design flexibility to meet customer needs

Performance

- 140 MW nominal output in twin-engine configuration
- Wet compression for improved performance above ISO conditions
- Highest power output by any aero-derivative gas turbine package
- Single or dual engine operation
- 50 or 60 Hz performance with no penalty
- >41% thermal efficiency without external cooling

Benefits

- Reduced transportation time and cost
- Limited on-site inventory
- Minimal installation time



FT4000® SWIFTPAC® Gas Turbine Package

Scope of Supply

GT Enclosure Assembly

One (1) per aero-derivative engine

- Gas generator, GG4000-1
- Power turbine, PT4000-1
- Exhaust diffuser and collector box
- Diaphragm-type coupling
- Engine base
- Structural base frame with 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
- Offline water wash system
- Vent and drain system
- Fire protection system

Fuel System Configurations

- Gas fuel
- Liquid fuel
- Dual fuel
- Water injection NOx control

Electric Generator Assembly

One (1) per package

- Open-ventilated, air-cooled generator
- Brushless excitation system
- Lineside cubicle
- Neutral cubicle
- Rotor ground detection system
- Acoustic/weather enclosure
- Inlet and exhaust cooling air silencers
- Generator instrumentation

Control Enclosure

One (1) per package

- Turbine control cabinets
- Gas turbine digital control system
- Vibration monitoring system
- Multifunction protection relays
- Motor control centers
- Auxiliary power distribution
- Fire protection cabinet

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

Auxiliary Skid Assemblies

- Mineral lubricating oil skid
- Gas fuel filter skids
- Liquid fuel boost pump skids
- Water injection boost pump skids
- Battery skid
- Fire suppression skids
- Water wash pump cart

Options

- Evaporative cooler system
- Inlet fogging system
- Wet compression system
- Modular exhaust stacks
- Reduced far-field noise
- Fire suppression: electric generator enclosure, power control enclosure, and gas turbine enclosure
- 15 kV generator breaker
- Auxiliary transformer

Available Services

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

FT4000® SWIFTPAC® Combined-cycle Plants

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 plant-distributed control systems
- Available with air-cooled condenser
- Can be configured for cogeneration
- Available on full turnkey basis

FT8® MOBILEPAC® Gas Turbine Package

30 Megawatts of Mobile Power

The FT8® MOBILEPAC® gas turbine package requires a small footprint, utilizing a 72 by 53 foot area*. Very little advanced site preparation is required, and no foundation or concrete pad is necessary for installation of the unit. The unit is transportable by land, sea or air, allowing worldwide delivery of the MOBILEPAC® gas turbine package within 24 hours.

*Compact footprint installed in parallel or in-line. This footprint allows equipment access and necessary clearance.



FT8® MOBILEPAC® Gas Turbine Package: Dual Fuel, Water Injection

Scope of Supply

Power Trailer

Gas Turbine Package

- 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 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

- 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
- FM-200 fire suppression

Hydraulic Starting Package

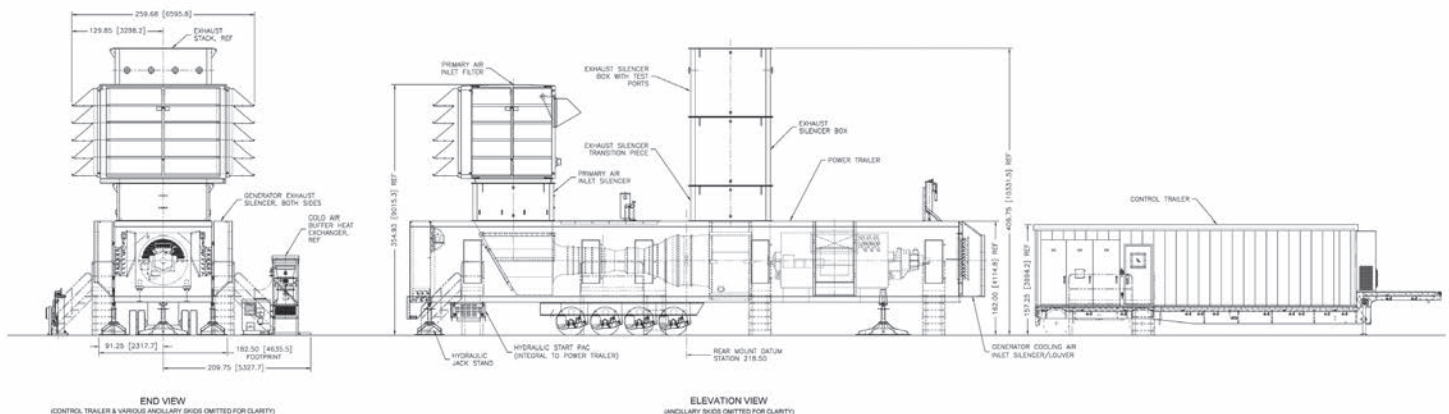
Field Installation Hardware

- 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

- Equipment erection
- Equipment demolition
- Balance of plant (BOP) design, supply, and install
- Freight

General Arrangement Diagram FT8® MOBILEPAC® Gas Turbine Package (GG8-3 Core Engine)



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 and secure inventory area
- Access roads, 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
- Workers' compensation, employers' liability or any other local insurance required
- All supervision and craft labor for complete off-loading

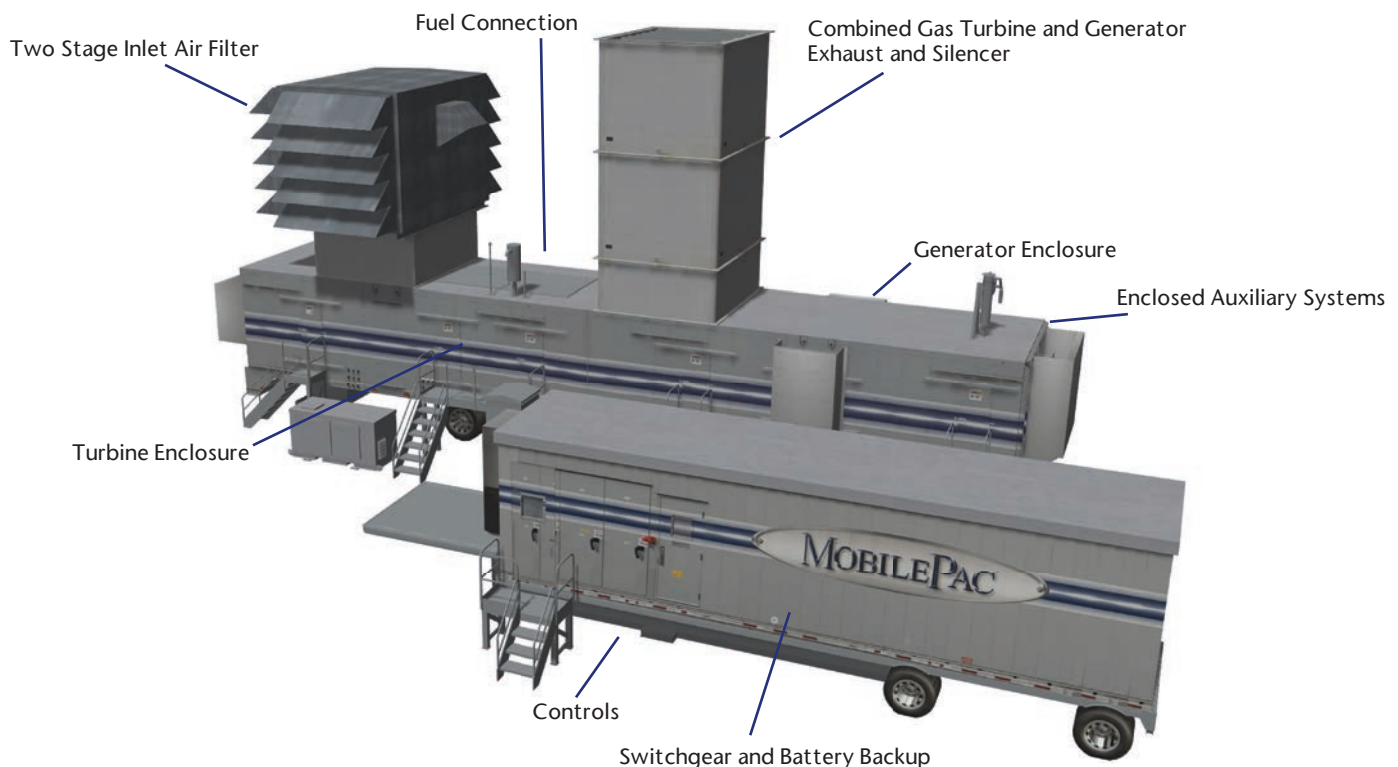
- Required test prior to start-up
- Construction equipment, tools, and aids
- Phasing and synchronizing the generator to purchasers system

Other Responsibilities

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

Interface Requirements and Responsibilities

- Electrical ground grid interconnections grounding pads are provided by PWPS on each trailer and auxiliary 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 and grid signals
- Alternate electrical power supply 255 kW



The MOBILEPAC® gas turbine package is one of the industry leaders in providing state-of-the-art technology with over 30 years of experience. After many successful years of operation, the MOBILEPAC® gas turbine package utilizes the FT8® engine and offers 30 megawatts of movable 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 trailer contains the gas turbine, electric generator, exhaust collector, diffuser, and engine lube oil system. The second trailer carries the 15 kilovolts 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.



Benefits

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

Product Facts

Output (kW)	30,941
Base engine	FT8®
Number of trailers	2
Installation	1 day (site ready and previously commissioned)
Noise	95 dBA at 1m
NOx/CO	50/100 mg/m3
Grid	50 or 60 Hz
Fuel	Liquid or Gas
Weight	291,600 lbs / 132,300 kg

FT8® SWIFTPAC® Gas Turbine Package

The FT8® SWIFTPAC® gas turbine power plant provides quick, reliable power with installation in less than 30 days.



FT8® SWIFTPAC® Gas Turbine Package

Scope of Supply

Gas Turbine Package

- Two (2) aero-derivative engines (30 MW each)
- 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

- 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

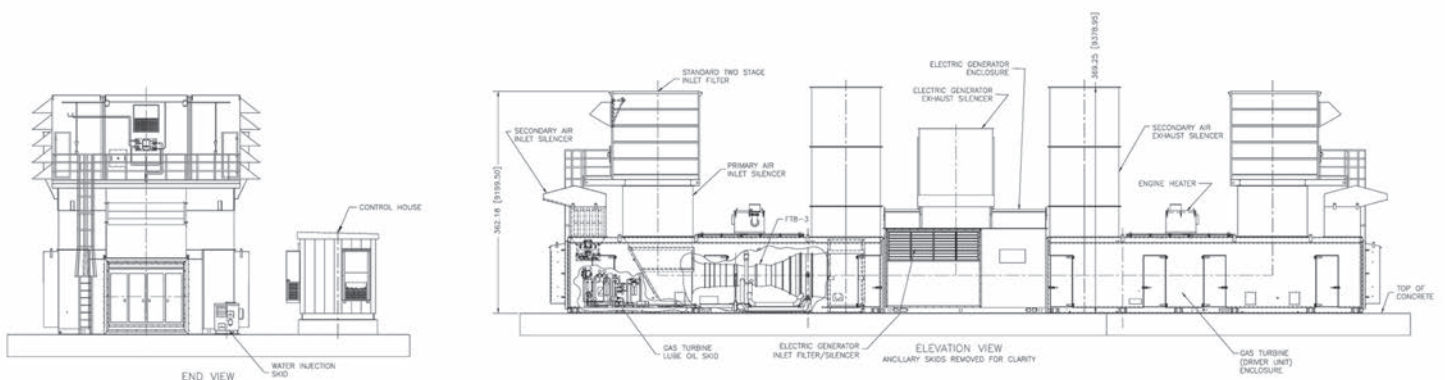
- Operator control cabinet
- Monitoring cabinet
- Instrument cabinet
- Unit control cabinet
- Generator protective relay panel
- Motor control center
- Master terminal cabinet
- Rack-mounted, sealed, lead, acid cell batteries
- Battery chargers
- Switchgear module, 15 kV class
- CTG auxiliary transformer
- FM-200 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 FT8® SWIFTPAC® Gas Turbine Package (60 Megawatts)



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 and secure inventory area
- Access roads, interior roads, and parking areas
- Site prep, leveling and compaction

Engineering and Construction

- Site engineering
- Site organization during construction
- Emissions and acoustic testing
- Workers' compensation, employers' 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 start-up

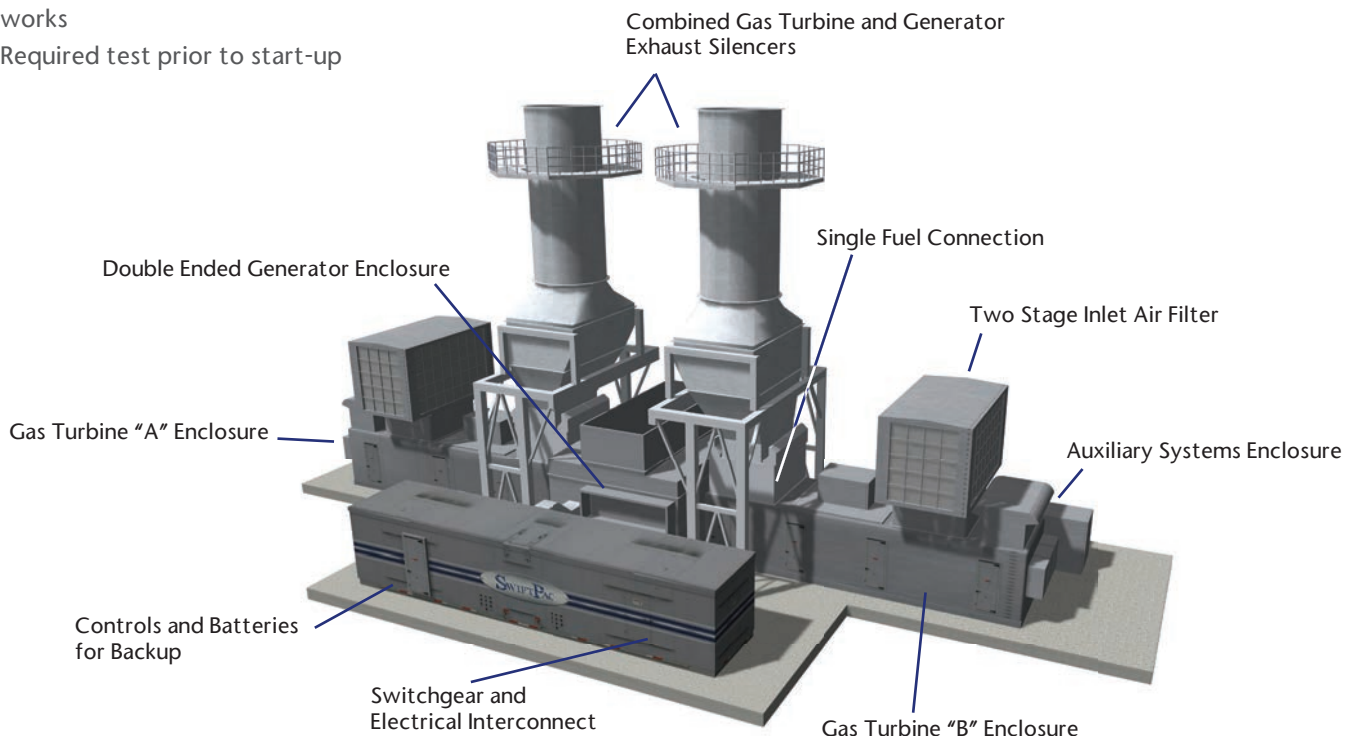
- Construction equipment, tools and aids
- Phasing and synchronizing the generator to purchasers system

Other Responsibilities

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

Interface Requirements and Responsibilities

- Electrical ground grid interconnections grounding pads are provided by PWPS on each trailer and auxiliary 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 and grid signals
- Alternate electrical power supply 255 kW per power island, 380 V, 50 Hz, 3-phase for lighting, heating, and intermittent auxiliaries



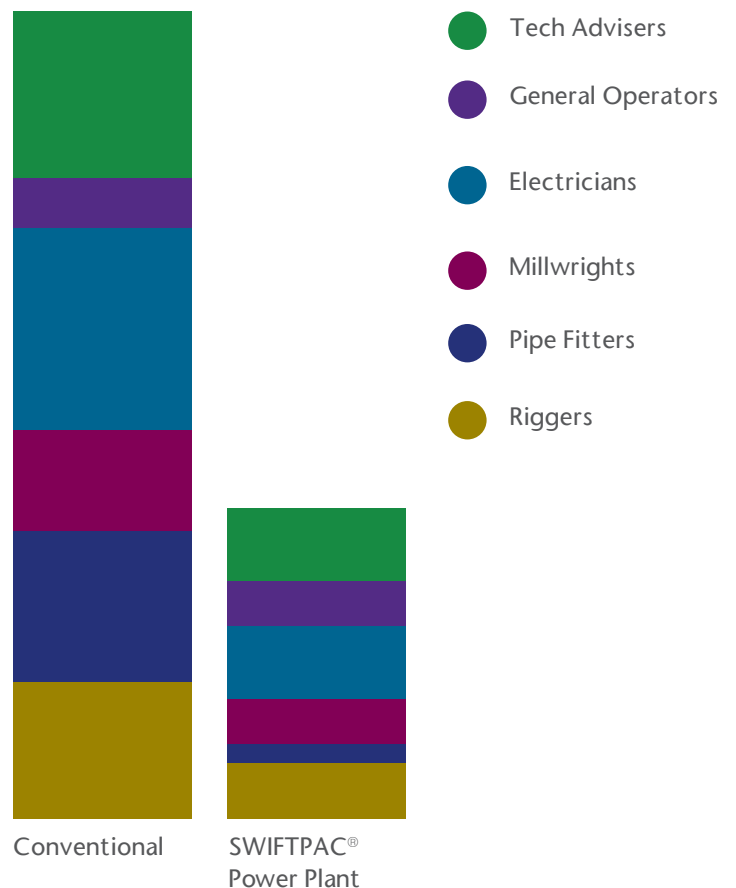


FT8® SWIFTPAC® Gas Turbine Package

The FT8® SWIFTPAC® gas turbine package offers 30 or 60 megawatts of power. Utilizing proven FT8® technology derived from a Pratt & Whitney® JT8D™ 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 FT8® SWIFTPAC® power plant to generate power less than 30 days after arriving on site.

Installation Labor Costs - Typical U.S. Site



Enhancements

- Factory-assembled modules
- Integrated lube oil system
- Factory-tested quick-disconnect cables
- Prefabricated field piping
- Factory-flushed lube oil systems
- Combined gas turbine 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
- Pre-assembled and tested
- Reduced field inventory
- Ease of engine checkout and maintenance
- Operating flexibility
- Ease of transportation and relocation

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