



FT4000® SWIFTPAC® Gas Turbine Package

FT8® SWIFTPAC® Gas Turbine Package

FT8® SWIFTPAC® Combined-cycle Gas Turbine Package

FT8® MOBILEPAC® Gas Turbine Package

## Gas Turbine Packages

**PW Power Systems**

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





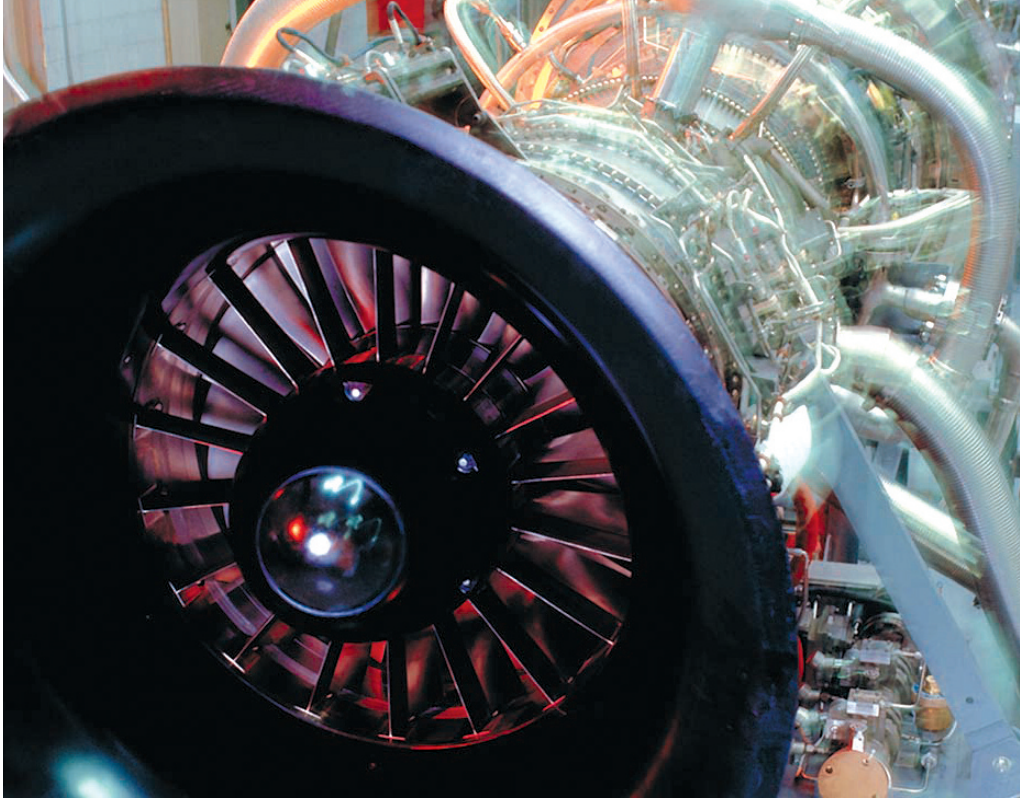
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## About Us



### Mitsubishi Heavy Industries, Ltd.

Mitsubishi Heavy Industries, Ltd. (MHI) is 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

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

### 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.

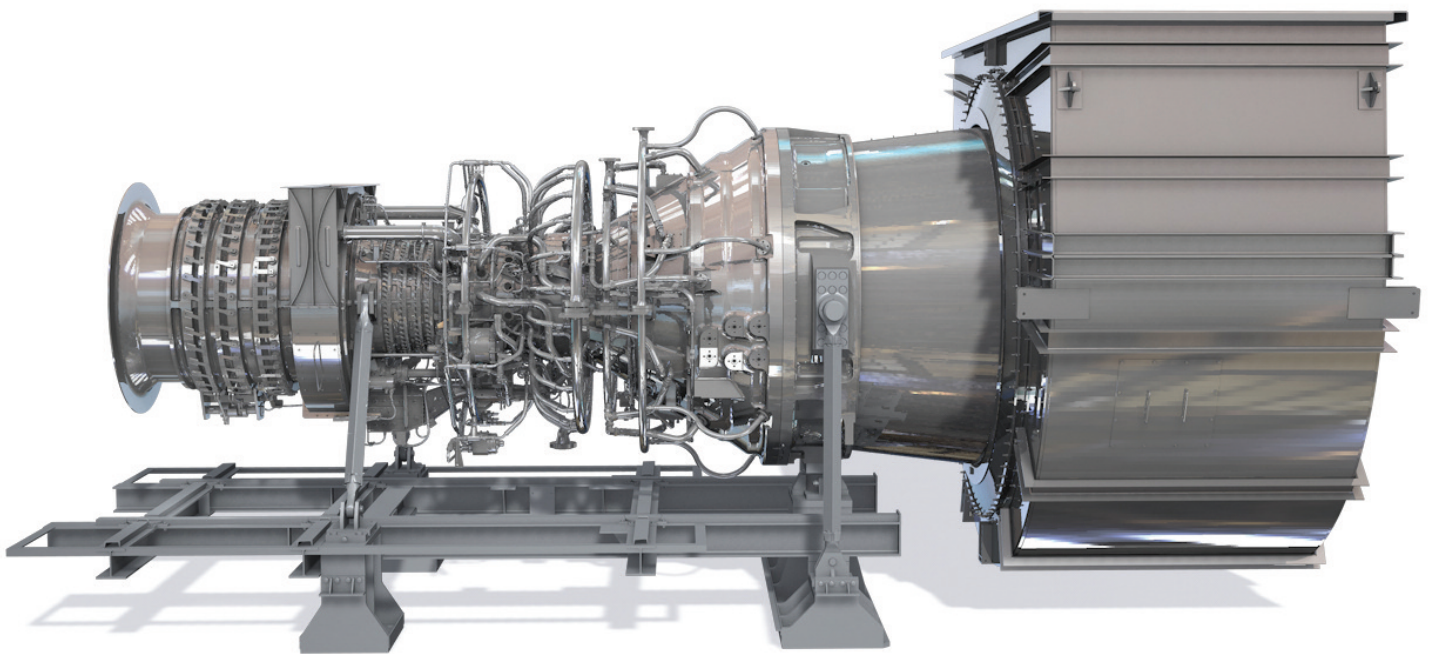
PW Power Systems is a world leader in developing and manufacturing energy solutions for power generation, offering products for aero-derivative and industrial gas turbines. PWPS has more than 2,000 industrial gas turbines installed in over 50 countries worldwide and prides itself on being superior in the gas turbine repair and overhaul sector. The PWPS™ gas turbine engine portfolio offers competitive, efficient and flexible products 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 to 140 megawatts of power within a modular design that is built utilizing over fifty years of aero-derivative design and packaging experience. 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

## 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 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 GT package
- Single- or dual-engine operation
- 50- or 60-Hz performance with no penalty
- >41% thermal efficiency without external cooling





## 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
- Off-line 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-oil-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

#### Standard Options

- Air-cooled heat exchangers
- Evaporative cooler system
- Inlet fogging system
- Wet compression system
- Modular exhaust stacks
- Reduced far-field noise
- Fire suppression: Electric generator enclosure, power control enclosure, 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





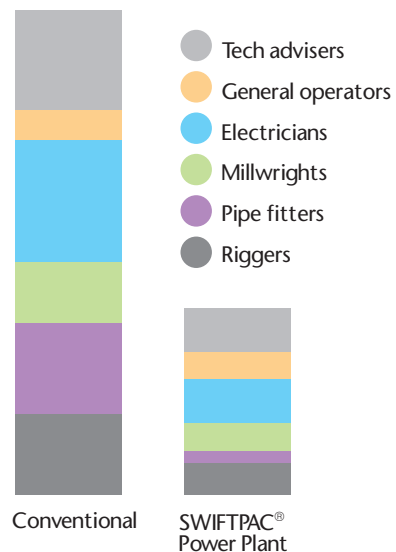
# FT8® SWIFTPAC® Gas Turbine Package

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

The FT8® SWIFTPAC® gas turbine package offers 30 or 60 megawatt 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 FT8® SWIFTPAC® power plant to generate power less than 30 days after arriving on site.

Installation Labor Costs – Typical U.S. Site





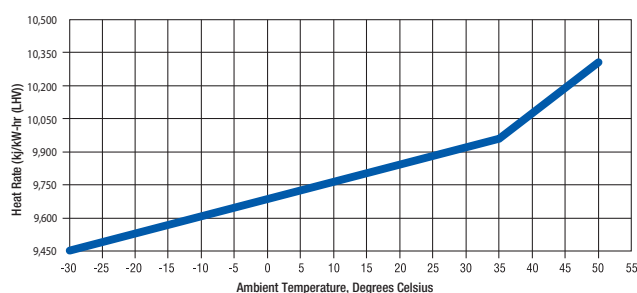
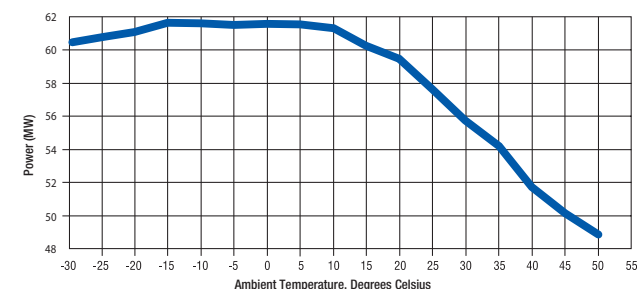
## Typical Performance

FT8® SWIFTPAC® 60 MW gas turbine package 50 Hz, 11.5 kV, 0.80 Pf

Estimated gross power output vs. ambient temperature and heat rate vs. ambient temperature SWIFTPAC® 60 MW gas turbine package, natural gas, WI - 25 ppm NOx

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

### Gas Fuel 50 Hertz Water Injected



### Simple-cycle Performance - Natural Gas

	30 MW	60 MW
Output (kW)*	30,446	61,196
Heat rate* (BTU/kW-hr) (kJ/kWh)	9,312 9,825	9,266 9,776
Thermal Efficiency (%)*	37	37
Exhaust flow (lb/sec)*	201	402
Exhaust temp. (°F)*	895	895
U.S. transport time	6 days	6 days
Foundation	2-3 ft. concrete	3 ft. concrete
Installation	3 weeks	3 weeks
NOx	25	25
Fuel	Dual	Dual
Frequency (Hz)	50/60	50/60

\*Also available with DLN and inlet fogging.



## 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



# FT8® SWIFTPAC® Gas Turbine Package: Dual Fuel, Water Injection

## Scope of Supply

### Gas Turbine Package

- Two (2) aero-derivative engine (30 MW)
- 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

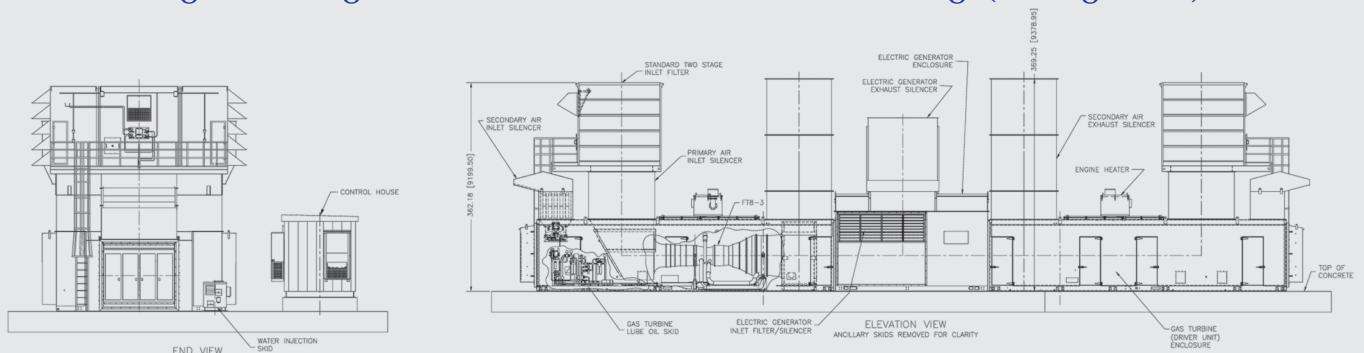
### Control Enclosure with HVAC

- 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

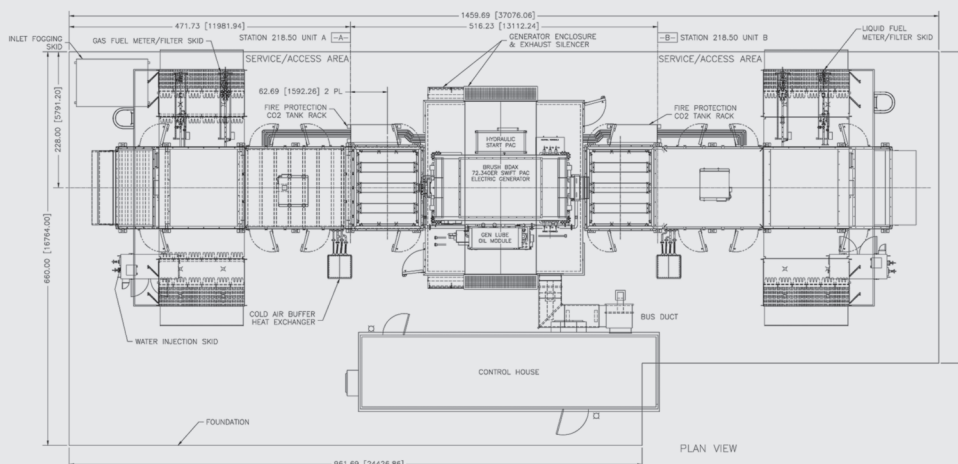
- Consumable material for erection works
- Required test prior to startup
- Construction equipment, tools and aids
- Phasing and synchronizing the generator to purchasers system

### 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
- Intrapersonal 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 (2.2 m<sup>3</sup>/s) per gas turbine
- Injection water for NO<sub>x</sub> 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/min (3.4 bar), 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 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® Combined-cycle Gas Turbine Package





# The FT8® SWIFTPAC® 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—6,883 BTU/kWh (7,262 kJ/kWh)

\*2 FT8® SwiftPac® gas turbine package, 1 steam turbine

## Part-load Performance

Gross output—81 MW\*\*

Gross heat rate—7,041 BTU/kWh (7,429 kJ/kWh)

\*\*1 FT8® SwiftPac® gas turbine package, 1 steam turbine





The FT8® MOBILEPAC® gas turbine package requires the smallest footprint in the industry, utilizing at minimum a 25- by 60-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.



## FT8® MOBILEPAC® Gas Turbine Package

### 30 Megawatts of Mobile Power

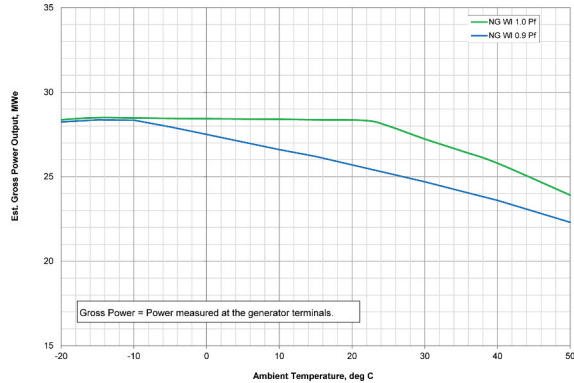
The MOBILEPAC® gas turbine package is the industry leader in providing state-of-the-art technology with over 30 years of experience. After many successful years of operation, the MOBILEPAC® gas turbine package now utilizes the FT8® engine and offers 30 megawatts of moveable power. Utilizing the proven 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.

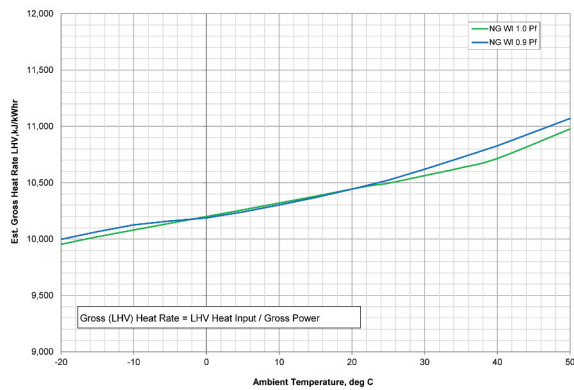
# Typical Performance

## Est. 50Hz "Base Load" Gross Power Output vs. Ambient Temperature

FT8® MOBILEPAC®, 50Hz-11.5kV, NG LHV 48080 kJ/kg, WI to 25 ppm NOx Sea Level, 60% RH, 63.5/25.4 mm H2O Inlet/Exhaust Loss

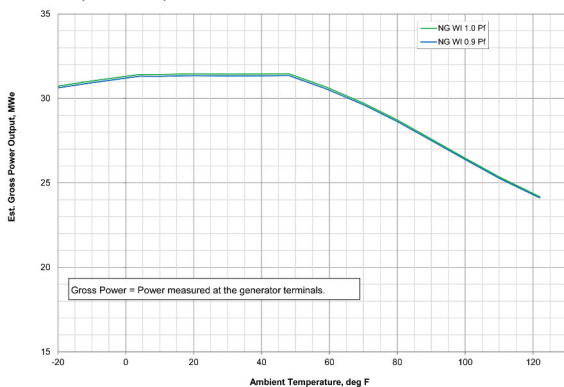


## Est. 50Hz "Base Load" Gross Heat Rate vs. Ambient Temperature

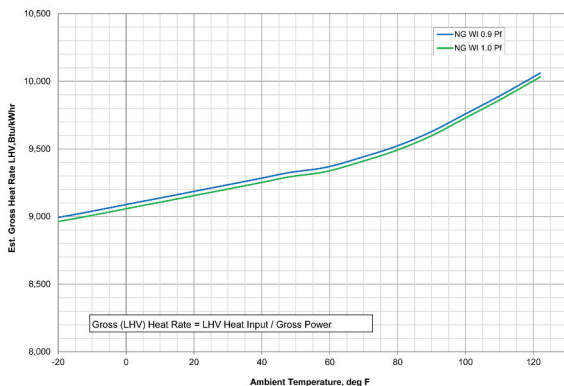


## Est. 60Hz "Base Load" Gross Power Output vs. Ambient Temperature

FT8® MOBILEPAC®, 60Hz-13.8kV, NG LHV 20670 Btu/lb, WI to 25 ppm NOx Sea Level, 60% RH, 2.5/1.0 inch H2O Inlet/Exhaust Loss



## Est. 60Hz "Base Load" Gross Heat Rate vs. Ambient Temperature



## 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

## Product Facts

Output (kW)	30,000
Base engine	FT8®
Number of trailers	2
Installation	8 hours (site ready and previously commissioned)
Noise	95 dBA at 1m
NOx/CO	50/100 mg/m3
Grid	50 or 60 Hertz
Fuel	Liquid or Gas



# FT8<sup>®</sup> MOBILEPAC<sup>®</sup> 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

### Hydraulic Starting Package Field Installation Hardware

- Interconnecting piping and hoses (CO<sub>2</sub>, 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

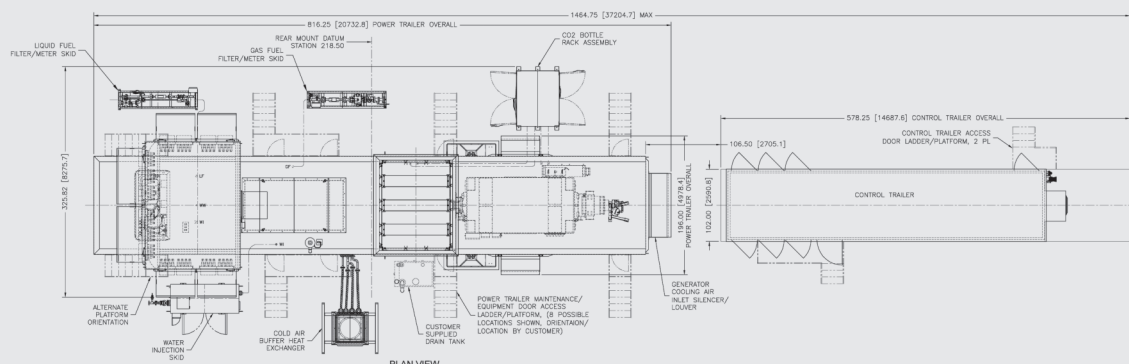
- Equipment erection
- Equipment demolition
- Balance of plant (BOP) design, supply and install
- Freight

### 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

## General Arrangement Diagram FT8<sup>®</sup> MOBILEPAC<sup>®</sup> 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

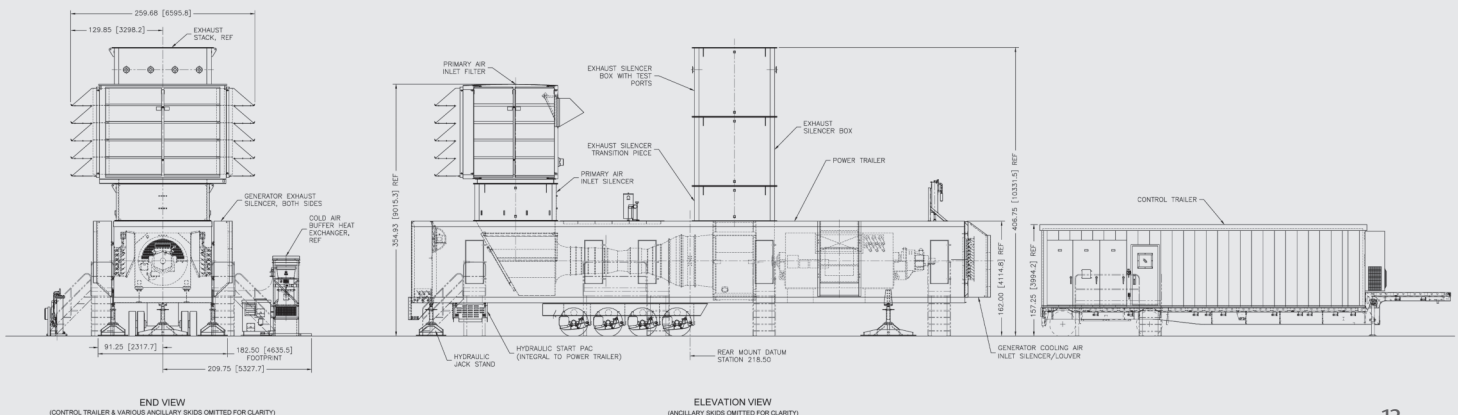
- Required test prior to start-up
- Construction equipment, tools and aids
- Phasing and synchronizing the generator to purchasers system

### 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
- Intrapersonal 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 (2.2 m<sup>3</sup>/s) 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/min (3.4 bar), 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 and grid signals
- Alternate electrical power supply 255 kW





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