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Noviembre, 12 de 2009

Sres. ENELVEN
Atn. Ing. Francisco Quintero

Estimado Ingeniero,

Ante todo quisiera agradecer en nombre de **ProEnergy Services** la oportunidad de permitirnos llevar ante usted la presente disponibilidad de equipos para generación eléctrica.

En el presente documento podrán encontrar dos (02) tablas relacionando los diferentes equipos disponibles para entrega inmediata con cargas inferiores y/o superiores a los 60MW por unidad.

Quisiera aprovechar la oportunidad brindada por la organización a la cual usted honrosamente representa para destacar los siguientes puntos relacionados a las unidades turbo-generadoras presentadas en las tablas anexas.

- 1.- Todas las unidades presentadas a continuación se encuentran abiertas por **ProEnergy Services** al mercado internacional.
- 2.- Cada una de las unidades turbo-generadoras aquí relacionadas están respaldadas por **ProEnergy Services** con su respectiva Garantía.
- 3.- La disponibilidad actual de las unidades aquí expuestas NO es indicativo de que las mismas se encuentren a la exclusiva disposición de su representada.
- 4.- Para poder sacar del mercado cualquiera de las unidades turbo-generadoras aquí presentadas, será necesaria la recepción de un porcentaje de la totalidad del costo de la(s) unidad(es) por parte de su representada.

ProEnergy Services proporcionara una propuesta económica por las unidades aquí expuestas.

ProEnergy Services gustosamente podrá proporcionar ante ustedes una propuesta Económica Global donde se incluya un monto paquetizado por la compra de la(s) unidad(es), así como también, la ejecución de la Ingeniería, Procura y Construcción (IPC) de cualquiera de las unidades que se presentan a continuación. **Garantizando** de

esta forma un tiempo de ejecución insuperable dentro los estándares de calidad en los cuales su representada siempre se ha desarrollado.

ProEnergy Services presenta en el siguiente documento una serie de data referida a cada una de las unidades que aquí se mencionan.

Esperamos el presente documento sea del agrado de su representada. De igual manera estaremos atentos a cualquier comentario y/o solicitud que pueda surgir de su parte.

Agradeciendo de antemano la oportunidad que nos brindan quedamos a sus órdenes,

Atentamente,

Omar Petit
Gerente Regional de Ventas
Latino America
ProEnergy Services



CUADRO DE UNIDADES DISPONIBLES INFERIORES A LOS 60MW

Cantidad	Modelo	Potencia (MW)	Heat Rate (BTU/kWe-Hr)	Combustible	Condicion	Disponibilidad	Ubicacion	Instalacion ***
2	Centaur40	3.5	9,125	Gas / Liq. Fuel	Reacondicionada	Inmediata	USA	90-120
1	Mars100	11	10,320	Gas / Liq. Fuel	Nueva	Inmediata	USA	90-120
1	Titan130	15	9,695	Gas / Liq. Fuel	Nueva	Inmediata	USA	90-120
3	TM2500	22	9,550	Gas / Liq. Fuel	2000 Hrs	Inmediata	Africa	90-120
1	TM2500	22	9,550	Gas / Liq. Fuel	**	60 dias*	Africa	90-120
5	CAT	2	N/A	Liq. Fuel	Reacondicionada	Inmediata	USA	90-120
7	Deutz	1.35	N/A	Liq. Fuel	Reacondicionada	Inmediata	USA	90-120
2	FT4C (Twin Pack)	54	11,800	Gas / Liq. Fuel	Reacondicionada	Inmediata	USA	120
3	FT4 (Power Pack)	25	N/A	N/A	Reacondicionada	Inmediata	USA	120
1	LM2500	22	9,450	Gas / Liq. Fuel	Reacondicionada	30	USA	120
2	LM6000	50	8,400	Gas / Liq. Fuel	Reacondicionada	60	USA	180
4	Trent	58	9,350	Gas / Liq. Fuel	Nueva	Inmediata	USA	180

* A partir del primer pago

** Esta unidad debe ser reacondicionada

*** Dias necesarios para la instalacion considerando que los equipos se encuentren en su totalidad en sitio

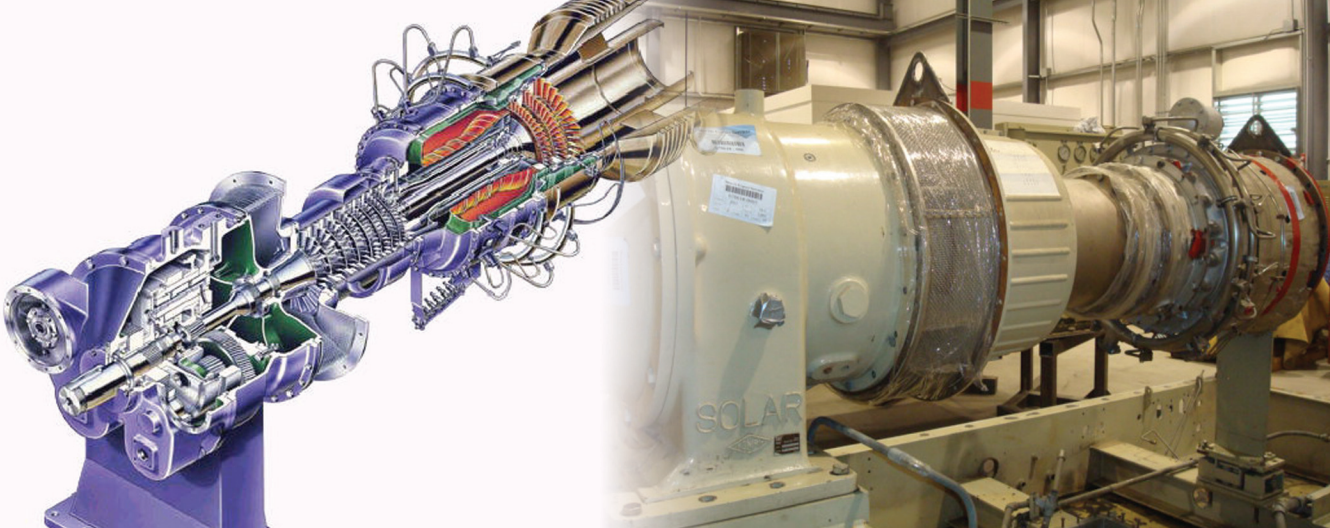
CUADRO DE UNIDADES DISPONIBLES SUPERIORES A LOS 60 MW

Cantidad	Modelo	Potencia (MW)	Heat Rate (BTU/kWe-Hr)	Combustible	Condicion	Disponibilidad	Ubicacion	Instalacion *
3	Frame 7FA	170	N/A	Gas / Liquid Fuel	Nueva	Inmediata	USA	210
1	Frame 7FA	170	N/A	Gas / Liquid Fuel	Nueva	Inmediata	USA	210
2	Frame 7EA	85	10420	Gas / Liquid Fuel	100 Hrs	Inmediata	USA	210

* Dias necesarios para la instalacion considerando que los equipos se encuentren en su totalidad en sitio

DATA SHEET

EQUIPOS EN CONSIDERACION



SOLAR TURBINE FACT SHEET

General Specifications

Centaur® 40 Gas Turbine

Industrial, Two-Shaft

Axial Compressor

- 11-Stage
- Variable Inlet Guide Vanes
- Compression Ratio: 10.3:1
- Inlet Airflow: 18.7 kg/sec (41.3 lb/sec)
- Max. Speed: 15,000 rpm

Combustion Chamber

- Annular-Type
- Conventional or Lean-Premixed Dry, Low Emission (SoLoNOx™)
- 10 Fuel Injectors (Conventional)
- 12 Fuel Injectors (SoLoNOx™)
- Torch Ignitor System

Gas Producer Turbine

- 2-Stage, Reaction
- Max. Speed: 14,965 rpm

Power Turbine

- 1-Stage, Reaction
- Max. Speed: 15,500 rpm

Bearings

- Journal: Tilting-Pad
- Thrust: Fixed Tapered Land

Coatings

- Compressor: Inorganic Aluminum
- Turbine and Nozzle Blades: Precious Metal Diffusion Aluminide

Velocity Vibration Transducer

Key Package Features

Driver Skid with Drip Pans

Driven Equipment Skid

- Compressor
- Compressor Auxiliary Systems

316L Stainless Steel Piping ≤4" dia

Compression-Type Tube Fittings

Electrical System Options

- NEC, Class I, Group D, Div 1
- CENELEC, Zone 1

Turbotronic™ Microprocessor Control System

- Freestanding Control Console
- Color Video Display
- Vibration Monitoring

Control Options

- 24-VDC Control Battery/Charger System
- Package Temperature Monitoring
- Serial Link Supervisory Interface
- Turbine Performance Map
- Compressor Performance Map
- Historical Displays

- Printer/Logger
- Predictive Emissions Monitoring
- Process Controls
- Compressor Anti-Surge Control
- Field Programming

Start Systems

- Pneumatic
- Direct-Drive AC

Fuel Systems

- Natural Gas
- Alternate Fuels

Integrated Lube Oil System

- Turbine-Driven Accessories

Oil System Options

- Oil Cooler
- Oil Heater
- Tank Vent Separator
- Flame Trap

Axial Compressor Cleaning Systems

- On-Crank
- On-Crank/On-Line
- Stationary Cleaning Tank

• Portable Cleaning Tank

Gearbox (if applicable)

- Speed Increasers
- Speed Decreasers

Air Inlet and Exhaust System

Options

Enclosure and Associated

Options

Factory Testing of Turbine and Package

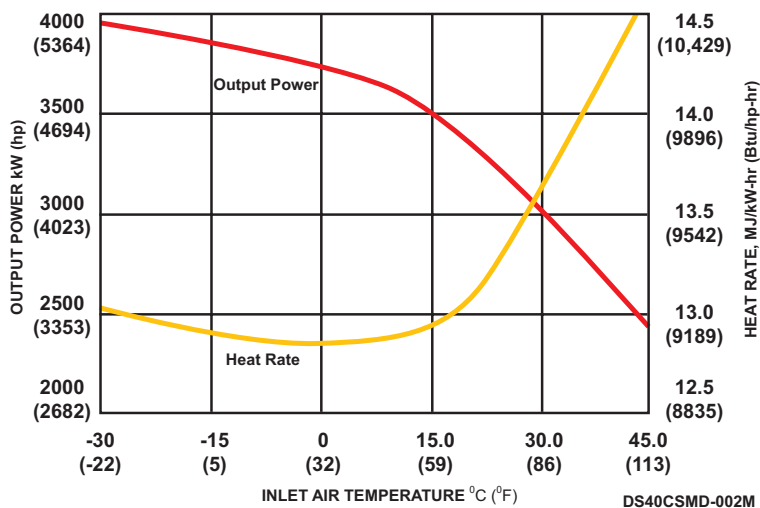
Documentation

- Drawings
- Quality Control Data Book
- Inspection and Test Plan
- Test Reports
- Operation and Maintenance Manuals



SOLAR TURBINE FACT SHEET

Available Power



Performance

Output Power	3500 kW (4700hp)
Heat Rate	12 905 kJ/KW-hr (9,125 Btu/hp-hr)
Exhaust Flow	68 185 kg/hr (150,320 lb/hr)
Exhaust Temp.	445°C (835°F)

Package Dimensions

Length:	8.9 m (23' 3")
Width:	2.4 m (8' 0")
Height:	2.7 m (8' 11")
Typical Weight:	24 950 kg (55,000 lb)

Nominal Rating – per ISO
At 15°C (59°F), at sea level

No inlet/exhaust losses

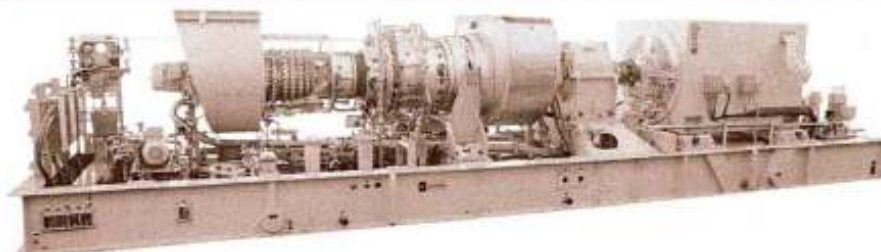
Relative humidity 60%

Natural gas fuel with
LHV = 35 MJ/nm³ (940 Btu/scf)

Optimum power turbine speed

AC-driven accessories

Engine efficiency: 27.9%



General Specifications

Mars® 100 Gas Turbine

- Industrial, Two-Shaft
- Axial Compressor
 - 15-Stage
 - Variable Inlet Guide Vanes
 - Compression Ratio: 17.7:1
 - Inlet Airflow: 41.6 kg/sec (91.8 lb/sec)
 - Max. Speed: 11,170 rpm
 - Vertically Split Case
- Combustion Chamber
 - Standard: Annular-Type (Conventional)
 - Optional: Annular-Type, Lean-Premixed, Dry, Low Emission (SoLoNOx™)
 - 21 Fuel Injectors (Standard)
 - 14 Fuel Injectors (SoLoNOx)
 - Torch Ignitor System
- Gas Producer Turbine
 - 2-Stage, Reaction
 - Max. Speed: 11,170 rpm
- Power Turbine
 - 2-Stage, Reaction
 - Speed, 50-Hz Generator: 8625 rpm
 - Speed, 60-Hz Generator: 8568 rpm
- Bearings
 - Journal: Tilt-Pad
 - Thrust, Active: Tilt-Pad
 - Thrust, Inactive: Fixed Tapered Land
- Coatings
 - Compressor: Inorganic Aluminum
 - Turbine and Nozzle Blades: Platinum Aluminate
- Vibration Transducer Type
 - Proximity Probes
 - Velocity Pick-up

Main Reduction Drive

- Epicyclic Type
- 1500 or 1800 rpm

Generator

- Type: 4 Pole (Salient) Solid Rotor, 6-Wire, Wye Connection, Synchronous Generator with Brushless Exciter

- Construction Options
 - ODP (Open Drip Proof)
 - WPII (Weather Protected II)
 - CACA/TEAAC (Closed Air, Cooling Air/Totally Enclosed, Air to Air Cooling)
 - CACW/TEWAC (Closed Air, Cooling Water/Totally Enclosed, Water to Air Cooling)
- Sleeve Bearings
- Voltage Regulation
 - Solid-State Regulation with Permanent Magnet Generator (PMG)
- Insulation/Temperature Rise
 - NEMA Class F w/VPI / Class B
 - NEMA Class F w/VPI / Class F
- Voltages: 3300 to 13,800 Volts
- Frequency: 50 or 60 Hz
- Package
 - Mechanical Construction
 - Steel Base Frame with Drip Pans
 - 316L Stainless Steel Piping
 - Compression-Type Tube Fittings
 - Suitable for 3-Point Mounting
 - FPSO Modifications (Option)
 - Electrical System
 - NEC, Class 1, Group D, Div 2
 - CENELEC/ATEX Zone 2
 - Conduit/Cable Tray Wiring
 - 120VDC Battery/Charger System
 - Direct-Drive AC Start System
 - Fuel Systems
 - Conventional Combustion or Dry Low Emission (SoLoNOx)
 - Fuel Types
 - Natural Gas or Dual (Gas/Distillate)
 - Integrated Lube Oil System
 - Turbine-Driven Main Pump
 - AC Motor-Driven Pre/Post Pump
 - DC (120V) Motor-Driven Backup Pump
 - Oil Cooler and Oil Heater (Options)
 - Tank Vent Separator and Flame Trap
 - Lube Oil Filter
 - On-Crank or On-Crank/On-Line Turbine Compressor Cleaning System (Options)
 - Portable Cleaning Tank (Option)
- Air Inlet and Exhaust System
 - Carbon Steel
 - Stainless Steel
 - Marine-Type Filters
- Enclosure (Driver Only or Complete)
 - Fire Detection and Suppression
- Factory Testing of Turbine and Package
- Documentation
 - Electrical Drawings
 - Mechanical Drawings
 - Quality Control Data Book
 - Inspection and Test Plan
 - Test Reports
 - Operation and Maintenance Manuals
- Digital Onskid Display Panel
- Turbotronic™ Control System
 - Onskid Control System (Optional Offskid System)
 - 24 VDC Control Power (120VDC Input)
 - Serial Link Supervisory Interface
 - Field Programmable
 - Vibration Monitoring
 - Turbine Bearings and Shaft
 - Gearbox
 - Generator Bearings
 - Temperature Monitoring
 - Turbine Combustion Process
 - Turbine Bearings and Lube Oil
 - Generator Bearings and Windings
 - Generator Control
 - Selectable Control Modes
 - Solid-State Voltage Regulation
 - Automatic Synchronization
 - Metering Panel with Manual Synchronization (Option)
 - KW Control (Option)
 - TT4000 Display and Monitoring System
 - Multiple Operator Display Screens
 - Data Collection and Playback
 - Turbine Performance Map (Option)
 - Printer/Logger (Option)
 - Predictive Emissions Monitoring (Option)

* Non-standard option

Solar Turbines

A Caterpillar Company

MARS 100

Gas Turbine Generator Set

Power Generation

Performance

Output Power	11 430 kW _e
Continuous Duty	
Heat Rate	10 885 kJ/kW _e -hr (10,320 Btu/kW _e -hr)
Exhaust Flow	152 080 kg/hr (335,275 lb/hr)
Exhaust Temp.	485°C (905 °F)

Nominal Rating – ISO
At 15°C (59°F), sea level

No inlet/exhaust losses

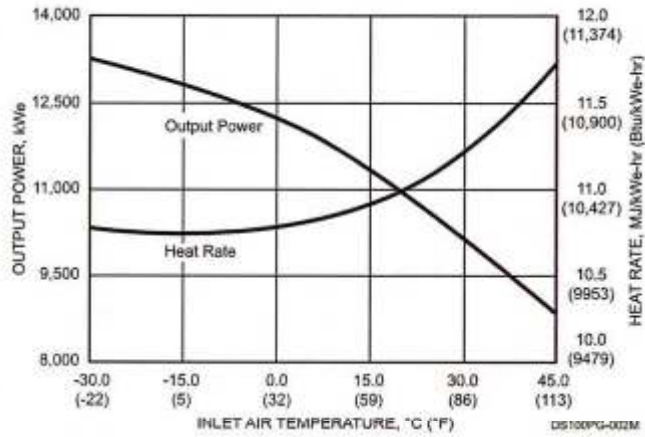
Relative humidity 60%

Natural gas fuel with
LHV = 35 MJ/m³ (940 Btu/scf)

No accessory losses

Engine efficiency: 33%
(measured at generator terminals)

Available Power



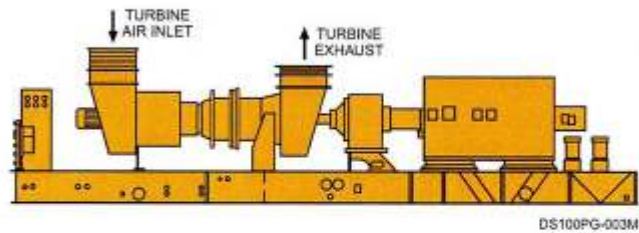
Package Dimensions

Length: 14.5 m (47' 8")

Width: 2.8 m (9' 2")

Height: 3.6 m (11' 8")

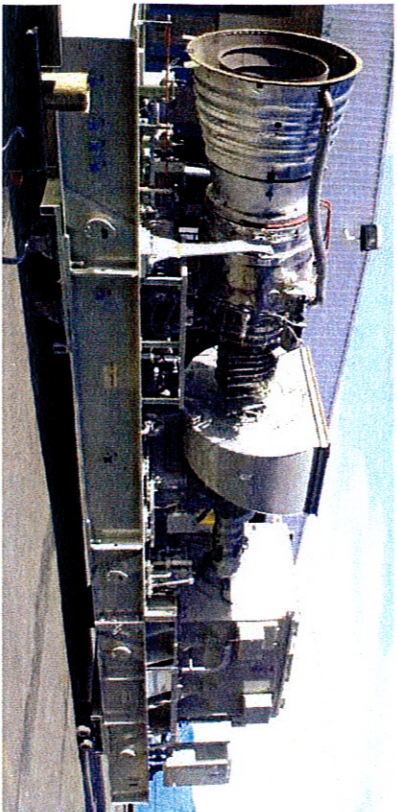
Typical Weight: 67 570 kg (160,000 lb)



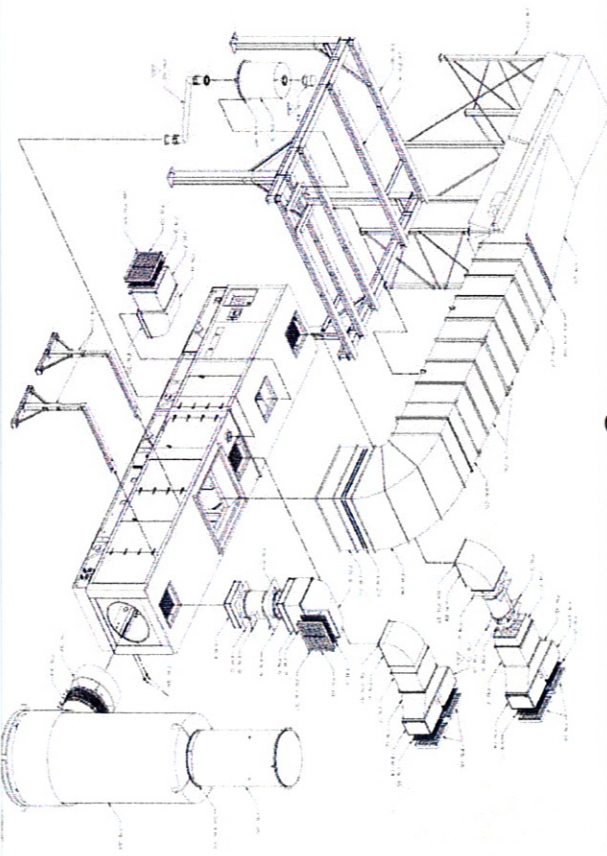
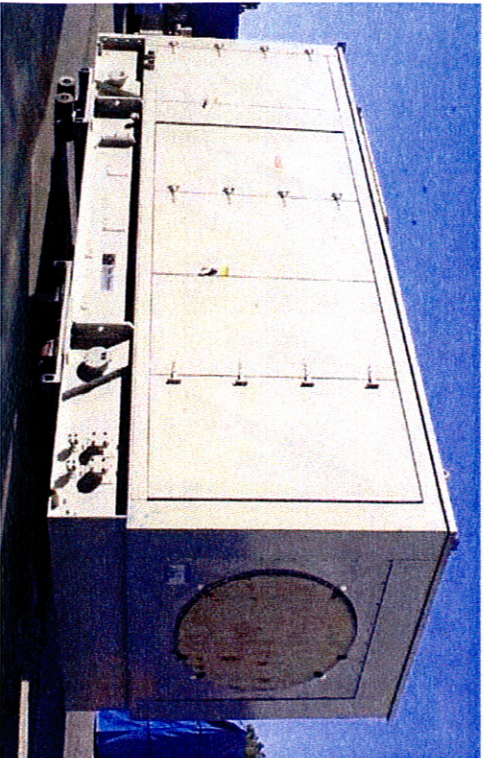
New Solar Titan 130 Turbine Genset

Specifications and Scope

- Mfg by Solar 2001
- Never placed into service
- So-Lo-NOx dry low NOx system
- Professionally stored; Inspected by Solar March 2008
- Config for 60hz; Can convert to 50 hz
- Includes inlet / exhaust equipment
- Includes all drawings & documentation



15,000 KW 9693 btu/kwh



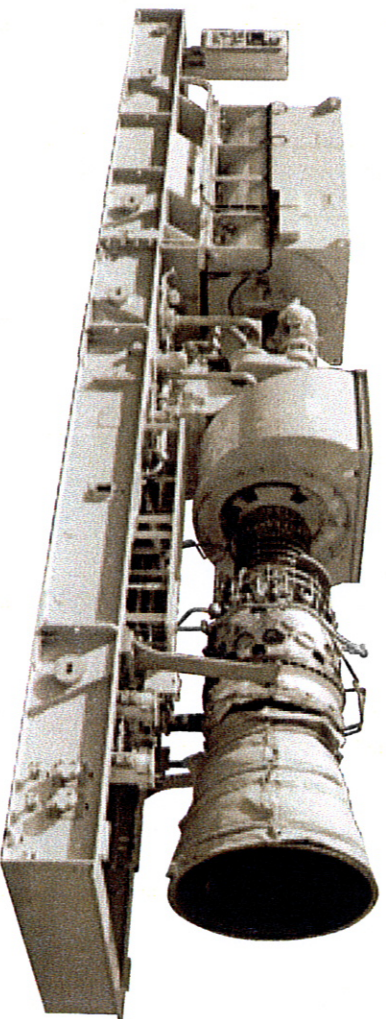
Solar Turbines

A Caterpillar Company

TITAN 130

Gas Turbine Generator Set

POWER GENERATION



General Specifications

Gas Turbine

- Titan™ 130 Industrial, Single-Shaft
- Axial Compressor
 - 14 Stages
 - Variable Geometry
 - Vertically Split Case
 - Compression Ratio: 16:1
 - Speed: 11,197/11,170 rpm (50/60 Hz)
- Annular Combustion Chamber
 - Conventional or Lean-Premixed, Dry, Low Emission (SOLONOx™)
 - 21 Fuel Injectors (Conventional)
 - 14 Fuel Injectors (SOLONOx)
- Proximity Probe Vibration Transducers
- Turbine
 - 3 Stage, Axial Flow
 - Speed: 11,197/11,170 rpm (50/60 Hz)
- **Main Reduction Drive**
 - Epicyclic
 - 1500 or 1800 rpm (50 or 60 Hz)
 - Acceleration Vibration Transducer
- **Generator**
 - Continuous Duty Rating
 - Salient Pole, 3 Phase, 6 Wire, Wye Connected, Synchronous with Brushless Exciter
 - Open Drip-Proof Construction
 - Sleeve Bearings
 - Velocity Vibration Transducers
 - Permanent Magnet Generator
 - NEMA Class F Insulation with F Rise

Package

- Steel Base Frame with Drip Pans
- Direct-Drive AC Start System
- Natural Gas Fuel System
- *Turbotronic™* 4 Control System
 - ControlLogix Controller
 - Standard Display with Discrete Event Log, Strip Chart, Historical Trend, Maintenance Screen
 - Gas Turbine and Generator Control
 - Vibration and Temperature Monitoring
 - CGCM (Combination Generator Control Module) with Load Share, Auto Synchronization, Voltage Control, Reactive Power Control, kW Control
- Integrated Lube Oil System
 - Turbine-Driven Lube Pump
 - Pre/Post Lube Pump
 - Backup Lube Pump
 - Air/Oil Cooler
 - Integral Lube Oil Tank
 - Lube Oil Tank Heater
 - Oil Mist Eliminator
 - Simplex Lube Oil Filter
- Documentation
 - Drawings
 - Quality Control Data Book
 - Inspection and Test Plan
 - Test Reports
 - Operation and Maintenance Manuals
- Factory Testing of Turbine and Package

Optional Equipment

- Generator Options:
 - Standard Voltages: 11,000 V (50 Hz); 12,470, 13,200 or 13,800 V (60 Hz)
- Fuel Systems
 - Liquid
 - Dual (Gas/Liquid)
 - Alternate Fuels (such as naphtha, propane, low Btu gas)
- Lube Oil System
 - Water/Oil Lube Oil Cooler
 - Duplex Lube Oil Filters
 - Vent Flame Trap
- Control System
 - Auxiliary and Remote Display/Control Terminal
 - Heat Recovery Application Interface
 - Serial Link Supervisory Interface
 - Turbine Performance Map
 - Printer/Logger
 - Field Programming Terminal
 - Unfired Waste Heat Recovery System Control (Stand-Alone Panel)
 - Multi-Unit Applications: Load Shed Control (Stand-Alone Panel), Import/Export, kW/KVAR Control (Stand-Alone Panel)
- Accessory Equipment
 - 120-VDC Battery/Charger System
 - Turbine Cleaning System: On-Crank and On-Line
- Weatherproof Acoustic Enclosure
- Ancillary Equipment
 - Inlet and Exhaust Silencers
 - Self-Cleaning or Prefilter/Barrier Air Inlet Filter
 - Inlet Evaporative Cooler
 - Inlet Chiller Coils

Solar Turbines

A Caterpillar Company

TITAN 130

Gas Turbine Generator Set

POWER GENERATION

Nominal Performance

Output Power	15 000 kWe
Heat Rate	10 230 kJ/kWe-hr (9695 Btu/kWe-hr)
Exhaust Flow	179 250 kg/hr (395, 180 lb/hr)
Exhaust Temp.	495°C (925°F)

Nominal rating – per ISO
At 15°C (59°F), at sea level

No Inlet/exhaust losses

Relative humidity 60%

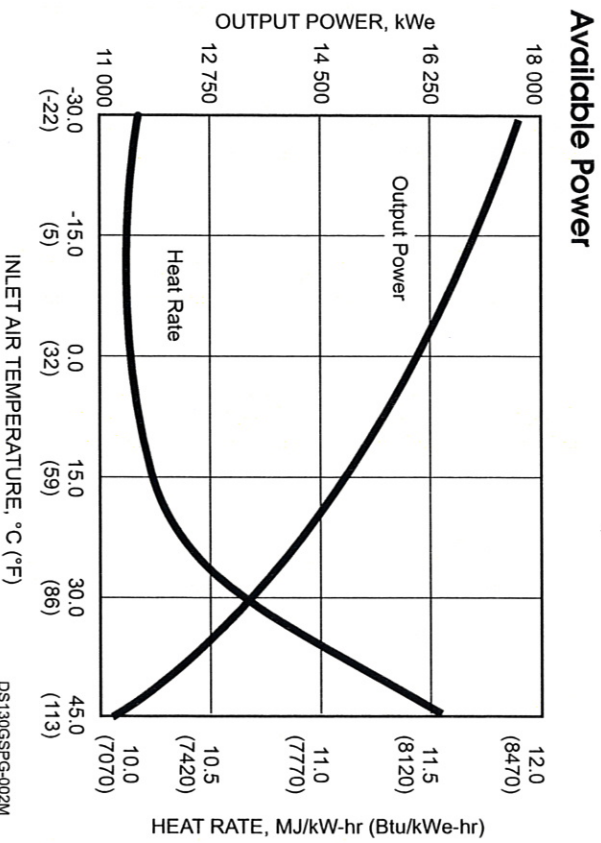
Natural gas fuel with

LHV = 35 MJ/m³ (940 Btu/scf)

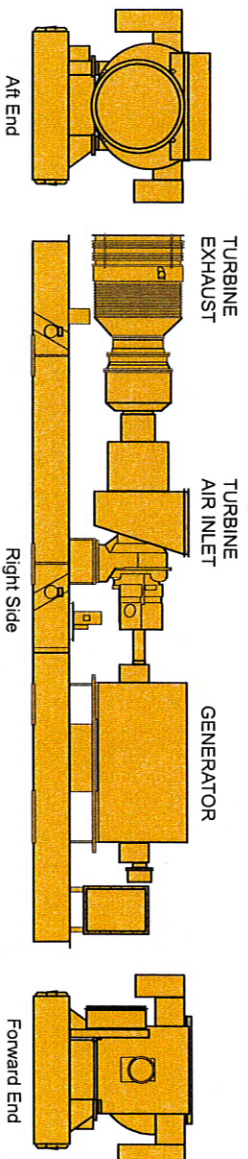
No accessory losses

Engine efficiency: 35.2%

Standard and high ambient ratings available



Typical Service Connections



Package Dimensions

Length:	14 021 mm (46' 0")
Width:	3327 mm (10' 11")
Height:	3302 mm (10' 10")

Approx:

Weight: * 73 668 kg (162,409 lb)

* Unenclosed Dry Weight

Left side

- Lube Oil: Vent, Drain, Cooler
- Generator Control Box, Power
- Drip Pan Drain
- Package Ground
- DC Power - Electronic Actuator
- Generator Monitor Box
- AC Power - Starter Motor
- Generator Terminal Box (line)
- Turbine Control Box

Right side

- Combustor and Exhaust Diffuser Drain
- Fuel: Inlet, Filter Drain, Vent
- Package Air Supply
 - Liquid Fuel Atomizing
 - Self-Cleaning Filter
 - Solenoid Actuation
- AC Power
 - Liquid Fuel Primary Pump
 - Lube Oil Tank Heater
 - Pre/Post Lube Oil Pump
- Air Inlet Duct Drain
- Package Ground



STANDARD 60Hz TM2500 GENERATOR PACKAGE

Gas Turbine

16 Stage Axial Compressor

- 1st 6 stages have variable station
- Horizontal Split Casing
- 20:1 Compression Ratio
- 150 lb/s Nominal Inlet Mass Flow

Annular Combustor

- 30 Nozzles Gas Fuel, Water Injection for NOx Control

6 Stage Power Turbine

Generator

Continuous Duty 13.8kV, 0.85 PF

2 Pole, 3 Phase Brushless Exciter

WPII Weather Protected

Voltage Regulator/Neutral Side Protection CT's

NEMA Class F Insulation & B Temperature Rise

Package

24V and 125V DC Batteries

90dBA Near Field Design

Barrier Inlet Air Filters

Electro-Hydraulic Start System

Class I Div 2 Group D Class Electrical System

Digital Control System with a Human Machine Interface (HMI)

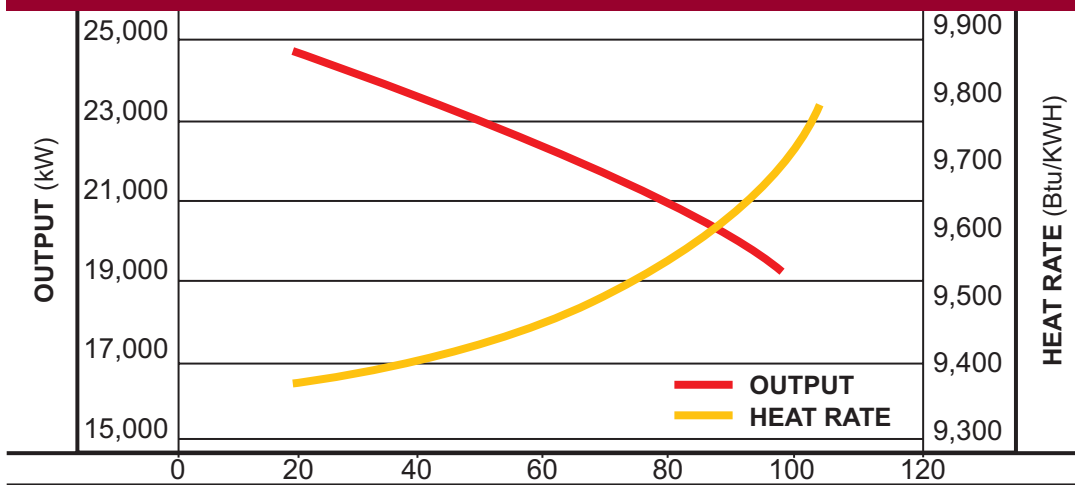
Turbine and Generator Lube Oil System with Simplex Shell and Tube Coolers

On/Off-line Water Wash



TM2500 FACT SHEET

TM2500 60Hz Output and Heat Rate



0 ft. 60% RH, 4/6 in H₂O inlet/exhaust loss on natural gas with water injection to 25ppmvd NO_x water inj.

Turbine

	TM2500
Power Output (kWe)	18,400
Heat Rate LHV (Btu/kWe-Hr)	9,900
Exhaust Flow (lbs/sec)	143
Exhaust Temperature (°F)	860
Emissions (ppmvd)	NO _x /CO
Gas-DLE	25/25
Gas or Liquid-Water	25/75, 42/55
Gas-Steam	25/74
Power Turbine Speed (rpm)	3,600
No. of Compressor Stages	16
No. of Turbine Stages	6



XQ2000 SOUND ATTENUATED POWER MODULE 60HZ

FEATURES:

Emissions

EPA and CARB Emissions Certified for non-road mobile applications.

CAT® Diesel Generator Sets

Factory designed, certified prototype tested with torsional analysis. Production tested and delivered to you in a package that is ready to be connected to your fuel and power lines. Electric Power Design Pro computer sizing available. Supported 100% by your Caterpillar dealer with warranty on parts and labor. Extended warranty available in some areas. The generator set was designed and manufactured in an ISO 9001 compliant facility. Generator set and components meet or exceed the following specifications: AS1359, AS2789, ABGSM TM3, BS4999, DIN6271, DIN6280, EGSA101P, JEM1359, IEC 34/1, ISO3046/1, ISO8528, NEMA MG1-22.

CATERPILLAR® SR4B Generator

Single bearing, wye connected, static regulated, brushless permanent magnet excited generator designed to match the performance and output characteristics of the Caterpillar diesel engine that drives it.

Reliable, Fuel Efficient Diesel

The compact, four-stroke-cycle diesel engine combines durability with minimum weight while providing dependability and economy. The fuel system operates on a variety of fuels.

CATERPILLAR® Cooling System

Sized compatible to rating with energy efficient fan and core.

CATERPILLAR® Switchgear

Single unit or optional paralleling components. Circuit breakers, bus bars, and connection panel ready to connect.

Exclusive CATERPILLAR® Voltage Regulator

Three-phase sensing and adjustable Volts-per-Hertz regulation give precise control, excellent block loading, and constant voltage in the normal operating range.

Sound Attenuated ISO Container

For ease of transportation and protection. Meets 70 dBA at 50 ft or below per SAE J1074 measurement procedure.

Georgia
1395 S. Marietta Pkwy SE,
Suite 218
Marietta, Georgia 30067

Missouri
2031 Adams Road
Sedalia, MO 65301

Texas
1616 FM 1960 West
Suite 750
Houston, Texas 77090

ProEnergy Services de Venezuela C.A.
Urbanización Los Caobos, Paseo Colón,
Torre Polar Oeste, Piso 4, Oficina 4-C
Plaza Venezuela - Caracas
Venezuela





XQ2000 SOUND ATTENUATED POWER MODULE 60HZ

FACTORY INSTALLED STANDARD & OPTIONAL EQUIPMENT:

System	Standard	Optional
Engine	Air cleaner, with service indicator Batteries Filters; fuel, LH with service indicators; lubricating oil Insulated muffler Jacket water heater Pump, fuel priming — LH Radiator Service meter Standard eight-gauge instrument panel Sump pump Governor Electronic ADEM II	
Generator	SR4B brushless, 480 volt, PM excited three-phase with digital voltage regulator, space heater	
Containerized Module	Air intake louvers Bus bar access door Fuel tank — 4730 L (1250 Gal) UL listed Fuel/water separator 110 VAC/24 VDC lighting Sound attenuated (75 dBA @ 50 ft) ISO hi cube container Lockable doors Stainless steel hardware and hinges Vertical radiator and exhaust discharge plenum	
Cooling	Standard cooling provides 110° ambient at prime rating	
Switchgear	Floorstanding switchgear with EMCP II components Automatic start/stop with cooldown timer Battery charger, heavy duty 20A Protection: 32, 59 Circuit breaker, electrically operated Connection terminals, 3-phase and neutral Automatic paralleling Auxiliary power connections for jacket water heater, battery charger, space heaters	Meters: power factor, KW, PF, W/WHM, synchroscope, KVAR Protection: 27, 40, 810, 81U CIM, CCM, remote annunciation Plug and peak shave utility conversion panel

SPECIFICATIONS:

CAT® SR4B Generator

Type Static regulated brushless PM excited
Construction Single bearing, close coupled
Three-phase Wye connected — 6 lead
Insulation Class H — 2 extra dips and bakes on random wound units
Enclosure Drip proof
Alignment Pilot shaft
Overspeed capability 130%
Voltage regulator 3-phase sensing with Volts-per-Hertz
Voltage regulation Less than ±0.5%

Voltage gain Adjustable to compensate for engine speed droop and line loss
Wave form Less than 5% deviation
TIF Less than 50
THD Less than 3%

CAT® 3516B Engine

V-16, 4-stroke-cycle diesel
Bore — mm (in) 170 (6.7)
Stroke — mm (in) 190 (7.5)
Displacement — L (cu in) 69.0 (4210)
Aspiration Turbocharged-Aftercooled

Georgia
1395 S. Marietta Pkwy SE,
Suite 218
Marietta, Georgia 30067

Missouri
2031 Adams Road
Sedalia, MO 65301

Texas
1616 FM 1960 West
Suite 750
Houston, Texas 77090

ProEnergy Services de Venezuela C.A.
Urbanización Los Caobos, Paseo Colón,
Torre Polar Oeste, Piso 4, Oficina 4-C
Plaza Venezuela - Caracas
Venezuela

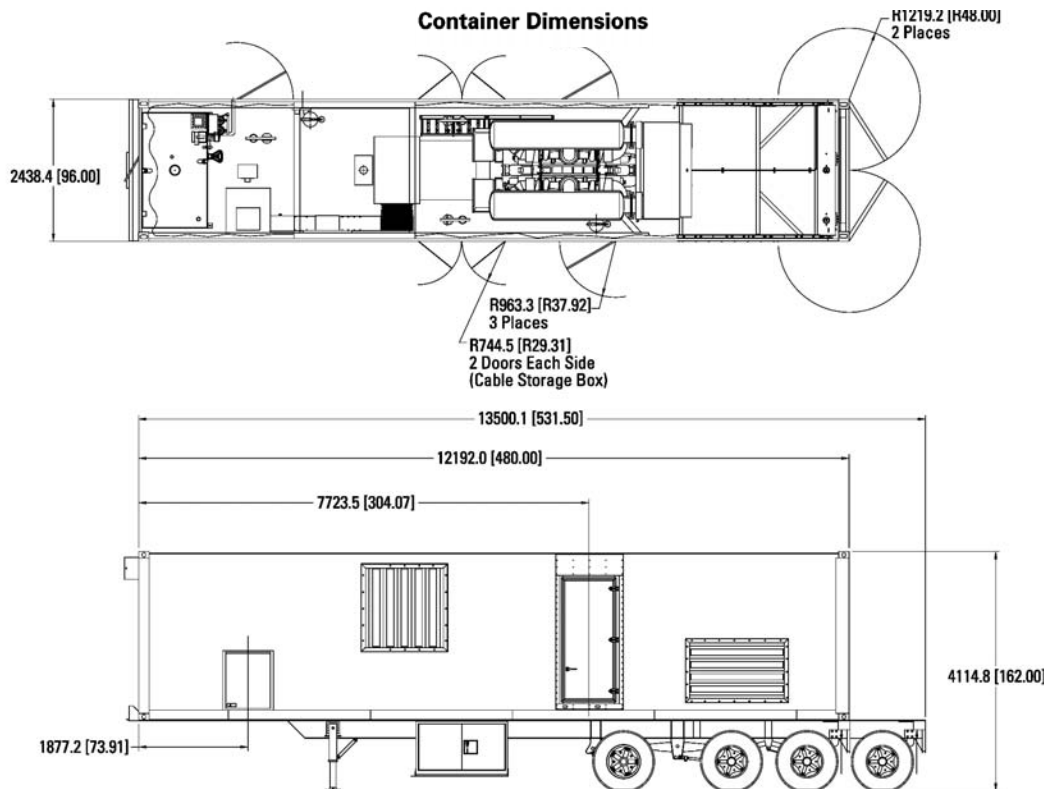


XQ2000 SOUND ATTENUATED POWER MODULE 60HZ

TECHNICAL DATA:

Power Rating 60 Hz	ekW	Standby 2000	Prime 1825
Engine and Container Information Engine Model Container size Container dimensions	m (ft)	3516B 12 (40) see below	
Fuel Capacity Hours of Operation at 60% Load Factor 4732 L (1250 Gal) Standard 12 m (40 ft)	hours	8	9
Approximate Weight (Dry) — Container with Generator Set and Switchgear Including Container With Undercarriage	kg (lb) kg (lb)	32 660 (72,000) 40 370 (89,000)	

Container Dimensions



The power module must have support under the center when set on the ground.

Dimensions		
Length	13500.1 mm	531.50 in
Width	2438.4 mm	96.00 in
Height	4114.8 mm	162.00 in

Georgia
1395 S. Marietta Pkwy SE,
Suite 218
Marietta, Georgia 30067

Missouri
2031 Adams Road
Sedalia, MO 65301

Texas
1616 FM 1960 West
Suite 750
Houston, Texas 77090

ProEnergy Services de Venezuela C.A.
Urbanización Los Caobos, Paseo Colón,
Torre Polar Oeste, Piso 4, Oficina 4-C
Plaza Venezuela - Caracas
Venezuela





XQ2000 SOUND ATTENUATED POWER MODULE 60HZ

STANDARD CONTROLS:

12 m (40 ft) Containers 480V/60 Hz

Floorstanding switchgear includes the following functions and features:

Electronic Modular Control Panel (EMCP II) Components Generator Set Control (GSC)

Monitoring

Sequentially rotating, backlit LCD display of engine hours, engine rpm, DC battery voltage, oil pressure, and water temperature. Includes pushbutton to hold display on any single parameter.

Protection

Shutdowns:

Overspeed, overcrank, high water temperature, low oil pressure, and emergency stop. With LED indicator for each condition.

Alarms:

Low coolant level

AC Metering

Three-phase volts (L-L), amperes and frequency with phase select pushbutton, on backlit LCD. Metering accuracy is 0.5%.

Control

Automatic starting with field adjustable cycle crank, failure to start (overcrank), and cooldown timer.

Programming and Diagnostics

Includes field programmable set-points for engine control and monitoring variables and self diagnosis of EMCP II system component and wiring failures.

Alarm Module

Flashing LED warnings for: low coolant temperature, high coolant temperature (pre-alarm), low oil pressure (pre-alarm), engine control switch not in automatic, and low DC voltage. Includes alarm horn and acknowledge pushbutton.

Engine Control Switch

Snap action rotary switch, four-position — off/reset, automatic, manual, stop/cooldown. Off/reset for engine shutdown and resetting faults, automatic for remote starting by customer contact closure, manual for local starting and manual paralleling, stop/cooldown for manual operation cooldown.

Alarm Acknowledge/Lamp Test Switch

Three-position, spring return to center switch for alarm acknowledge and lamp test of all discrete indicating lamps. Lamp test shall also sound the alarm horn.

Annunciation Circuits

Upon receipt of an alarm or shutdown condition, the horn shall sound and an LED shall flash. Upon acknowledgement from alarm acknowledge/lamp test switch, the horn shall be silenced and the lamp steadied. LED shall be extinguished when ECS is placed in the off/reset position if the alarm condition has been corrected. Circuits are recurring such that the LED shall flash and the horn sound, should another fault occur even prior to correction of the initial fault.

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 **ProEnergy**
SERVICES
"Experience Our Energy"



XQ2000 SOUND ATTENUATED POWER MODULE 60HZ

STANDARD CONTROLS (continued):

Emergency Stop Pushbutton

Mushroom head, twist to reset, causes engine shutdown and tripping of the generator circuit breaker. Prevents engine starting when depressed.

Manual Paralleling

Controls consisting of reverse power relay, synchronizing lights, and switch. Reverse power condition causes tripping of the generator circuit breaker, immediate engine shutdown, flashing of indicating lamp, and sounding of alarm horn.

Circuit Breaker

Fixed mounted, three-pole, manually operated, molded case circuit breaker with solid state trip unit for overload (time overcurrent) and fault (instantaneous) protection. Includes DC shunt trip coil activated on any generator set monitored fault. Circuit breaker is sized for full load capacity of the generator set at 0.8 power factor.

Load Share Governor

Electronic load sharing governor with speed adjust potentiometer, idle/rated switch, and isochronous/droop switch.

Voltage Regulator

Standard Caterpillar generator-mounted digital voltage regulator with voltage adjust rheostat mounted in the floorstanding switchgear.

Current Transformers (3)

Five-ampere secondary with shorting terminal strips

Potential Transformers (3)

120 VAC secondary with primary and secondary fuse protection, two connected to the generator side of the circuit breaker, one connected to the load side of the circuit breaker.

Bus Bars

Three-phase plus fully rated neutral bus bars with NEMA standard hole pattern for connection of customer load cables and generator cables. Bus bars are sized for full load capacity of the generator set at 0.8 power factor. Also includes ground bus, connected to the generator frame ground and container frame with holes for connection of field ground cable. Bus bars are accessible from outside of the power module via hinged, lockable cable access door.

Accessory Power

3500 Power Modules

Three 230 VAC (50 Hz units) or 120 VAC (60 Hz units) shore power connections for jacket water heaters, generator space heater, and battery charger.

Battery Charger

24 VDC/20A battery charger with float/equalize modes and charging ammeter.

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Deutz TBD620V12 Engines and Ancillaries



Deutz TBD620V12 Diesel Power Module

Originally built by Stewart and Stevenson in 2001. This ISO transportable power generation module is designed for today's demanding operations with increased reliability.

Four-cycle diesel engines provide efficient and environmentally friendly power. Coupled with the ultra-reliable Marathon Magnamax generator, this module promises years of trouble-free operation. Heavy-duty sound attenuated ISO containers and simple control layouts ensure quiet and simple operation.

Safety, reliability, and maintainability are key ingredients of this power modules design. Decades of experience with both commercial and military diesel powered products ensure practical and efficient products. Standard features, such as large access doors, remote lube oil drains, and maintenance-free batteries, ensure ease of service.

Standard Features:

- * Rated Output 1500kW Standby or 1350kW Continuous
- * ISO Standard 40' High Cube container
- * Isochronous, parallel load sharing or parallel baseload operation
- * Critical-grade exhaust silencer
- * Fuel Cooler
- * Remote connections for Day Tanks
- * Waste Oil sump pump, 24VDC
- * Engine-mounted Battery charging alternator and 24VDC, 10amp static battery charger
- * Low fuel level alarm
- * Large-capacity, on-board fuel system (UL listed)
- * High ambient, heavy-duty cooling system with modulating capacity control system
- * Sound-attenuating acoustic insulation with perforated metal sheathing
- * Duplex fuel filtration with water separator
- * Sealed, maintenance-free 8D batteries with battery disconnect switch
- * Lockable access doors
- * Oversized power connection with lockable hinged cover and easily accessible customer interfaces
- * Full service history and manuals

Specifications

Model RS1500D Power Generation Module

Complete Unit

Manufacturer Stewart & Stevenson
Houston, Texas

Engine

Manufacturer Deutz DDC
Type Diesel, 4-cycle Diesel, 4-Cycle
Model TBD620 Series 4000
Number of Cylinders V-12 V-12
Bore 6.7 inches (170mm) 6.5 inches (165mm)
Stroke 7.7 inches (195mm) 7.5 inches (190mm)
Displacement 53.1 liters 48.75 liters
Speed(Rated) 1800 rpm 1800 rpm
Governor Woodward ProAct II DDEC
Starting Motor 24VDC 24VDC
Alternator 24VDC, 55A, belt-driven 24VDC, 55A, belt-driven

Generator

Manufacturer Marathon
Type Brushless, single bearing
Model Magnumax 743RSL4050
Insulation NEMA Class H
Temperature Rise (standby) 130°C
Temperature Rise (prime) 105°C
Exciter PMG
Voltage Regulator Digital DVR2000C

Engine Controls

Digital Engine/Generator Controller Basler DGC2000
Protection for Low Oil Pressure
High Coolant Temperature
Engine Overspeed
Large Backlit LCD Display English or Metric Values
UL Recognized CSA Certified

Generator Controls

Automatic Synchronizing module Woodward SPM-A
Load Sharing module Woodward LSM
Load Control module Woodward AGLC
Generator Circuit Breaker General Electric Power Break II
Generator Protective Relay Basler BE3-GPR
Three-phase RMS sensing Microprocessor-based
Wide trip range and reset adjustments UL and CSA Certified

Weights and Dimensions

Length 40 feet
Width 8 feet
Height 9.5 feet
Weight 47,500 lbs(dry) / 50,500 lbs(transport)
Fuel Tank Capacity 1250 gallons

Specifications are subject to change without notice or obligation for continuous improvement.

Instrumentation

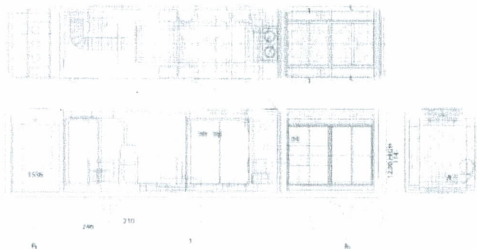
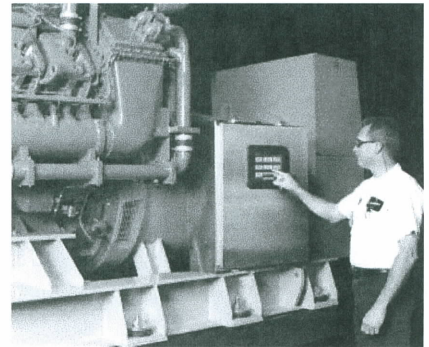
AC Voltmeter (3-phase)
AC Ammeter (3-phase)
AC Frequency Meter
Synchronization Scope and
Lights
Engine Speed
Engine Oil Pressure
Engine Coolant Temperature
Main Breaker Status Lights

Remote Capabilities

Remote Start/Stop input
Remote Breaker Trip input
Remote Emergency Stop input
Remote Status Outputs
(7 functions)
Communications Port

Options

ISO trailer chassis
Cable storage boxes
Extended Warranty
Preventive Maintenance
Agreement



The RS1500DD ISO Containerized Power Generation Module will meet your power generation needs. Each unit is a factory assembled and tested package. The prime mover is a Deutz Corporation diesel engine, model TBD620V12 running at 1800 RPM. The generator is manufactured by Marathon Electric and is model 743RSL4050. The rated output of the RS1500DD is 1500 kWe standby, 1390 kWe prime and 1320 kWe continuous.

1. General Arrangement

- A. The basic unit includes the engine, generator and fuel tank mounted to the deck, which occupies the majority of the container's interior (refer to the attached General Arrangement Drawing). The switchgear cabinet is adjacent to the generator and is coupled to the generator terminal box by buss way. The exhaust silencers are situated above the engine. Service items such as filters and batteries are located on either end of the engine and are accessible through the double doors in both sides of the container. The unit is self-contained and designed to be transported over the road on a standard two-axle ISO container chassis. The completed unit's maximum gross weight is 50,500 pounds, inclusive of coolant, oil and 200 gallons of fuel (without trailer). Loading will not exceed 17,000 pounds per axle based on a 2-axle trailer weight of 10,000 pounds
- B. External connections are provided for normal servicing of the generator set. These connections include fuel transfer ports, engine oil drain and radiator coolant drain. The secondary containment area drain can be used for normal "make ready" cleanup or in the unlikely event of an engine oil, fuel or coolant rupture. The external fuel connection can be utilized to transfer fuel from a bulk fuel storage tank. All drains have plugs installed with the exception of the rainwater drain.
- C. The power rating is applicable to heavy-duty Diesel generator sets and is based on ISO 8528 rating methods. Ratings and emissions compliance are optimized for 1800 RPM (60 Hz.) operation.

2. Engine

- A. The heavy-duty diesel engine is model TBD620V12, manufactured by Deutz Corporation. It is turbocharged and intercooled, operates on the four-stroke cycle, and is in a 90° vee configuration. The TBD620V12 is EPA certified at 1800 RPM and TA LUFT/2 approved for 1500 RPM operation.
- B. All fluids are pumped by engine driven pumps. This includes the fuel system, lube oil system, jacket cooling system and a separate charge air cooling system.
- C. The lube oil system includes a gear type lube oil pump, oil cooler, spin-on oil filters and a centrifugal type filter. A 24 VDC waste oil sump pump is installed to assist with routine oil change maintenance.
- D. A Racor Turbine Series fuel filter is installed on the engine. The Racor filter incorporates centrifugal separation along with a pleated media filter to remove water and solids. The Racor duplex filters are installed in parallel so they can be serviced while the generator set is online. A 24 VDC fuel priming pump assists with initial start up after the container is moved.
- E. The Woodward PRO-ACT II electronic governor provides engine speed control. It provides steady state frequency regulation better than $\pm 0.5\%$.
- F. The starting system consists of two 8D lead acid batteries supplying 24 VDC to the engine mounted starter. The heavy-duty, maintenance-free batteries will be in polyethylene battery boxes. The electric system has a master battery disconnect switch in the negative circuit. A 10 amp, float type battery charger is installed in the container and requires 120 VAC customer furnished power in the standby mode. An engine-mounted, battery-charging alternator maintains the charge on the batteries while the engine is running.

- G. The air intake system is fitted with dry type air filters with replaceable paper elements and restriction indicators. Combustion air for the engine is drawn into the container through fixed louvers and then through the heavy-duty air cleaners.
- H. A gauge panel is installed with mechanical gauges for oil pressure, water temperature, and fuel pressure.
- I. An automatic lube oil level regulating system is installed. The system has a 20-gallon rectangular tank to allow oil make-up while the engine is running.
- J. Dual 4000-watt jacket water heaters will be mounted on the engine block to maintain the engine in a warm, ready to start state. The water will circulate by convection to maintain the appropriate temperature while the engine is not running. The heaters are equipped with isolation valves and operate on 208VAC customer supplied power.
- K. The exhaust system consists of a stainless steel flexible exhaust connection mounted on the turbocharger outlet. This connects to the critical grade exhaust silencer, which provides typical sound attenuation of 25 to 30 dB(A). The outlet of the silencer is protected from debris or rain with a weighted rain cap.

3. Generator

- A. The MAGNAMAX generator is manufactured by Marathon Electric Manufacturing Corporation and is a single bearing design. The generator meets NEMA MG 1, parts 16 and 22, in design, performance and factory test procedures. The generator is rated 1500 kW, 1875 kVA standby and 1430 kW, 1788 kVA prime, 60 hertz, 1800 RPM, 3 phase, and 0.8 lagging power factor. The voltage will be 480 volt, but the units are capable of running at 380 VAC, 50 Hz or 480 VAC, 60 Hz.
- B. The generator is equipped with a permanent magnet generator excitation system. Both the PMG and the rotating brushless exciter will be mounted outboard of the bearing. The system shall supply a minimum short circuit support current of 300% of the rating for 10 seconds. The exciter uses a three-phase full wave rectifier assembly.
- C. The stator shall be a 2/3-pitch design to eliminate the third harmonic. The stator and rotor shall be insulated with NEMA Class H or better, synthetic, non-hygroscopic materials. The generator temperature rise will be 130 degrees C over a 40 degree C ambient at the standby rating.
- D. Voltage regulation shall be ¼% from no load to full load and 5% frequency variation. Regulator drift shall be less than ½% per 40 degree C ambient temperature change.
- E. The programmable digital voltage regulator, Marathon model DVR2000C, is located in the control cabinet.
- F. Strip heaters are installed to minimize condensation forming in the generator. These are supplied with 120 VAC power.

4. Assembly

- A. The generator is direct coupled to the engine flywheel housing and driven through a flex plate attached to the engine flywheel. The engine/generator assembly is mounted on the container floor with vibration isolators sized for the weight and duty.

5. Cooling System

- A. The cooling system consists of two radiator cores located in the container walls. One core serves the engine cooling water circuit and the other the charge air-cooling circuit. Hydraulic motors drive the two (2) high capacity fans. The variable speed fans are thermostatically controlled.
- B. Air is drawn through fixed louvers in the sides of the container and through the radiator cores and exhausted through fixed guards. The radiated heat of the engine-generator compartment does not heat the cooling air. Additional outside air is drawn through louvered openings at the engine end of the container to provide airflow across the engine generator set. The fans are of sufficient capacity to accommodate volume requirements of the radiator cores, the generator and switchgear as well as to dissipate the engine's radiated heat.
- C. Radiator drain lines have accessible valves. Radiator fill port and sight glass are accessible through and located near the rear cargo doors.
- D. The cooling system is designed to provide the rated heat rejection for prime power operation at 113°F ambient, and for standby power operation at 109°F.

6. Controls

- A. The Generator Control Panel is designed in accordance with NEMA and ANSI standards. The enclosure is freestanding and made of aluminum/steel construction. Each unit has the following standard features:
 - i. A Basler DGC2000 controller
 - ii. A Basler GPR generator protection relay with switches and controls.
 - iii. On-board synchronization and load sharing capability.
 - iv. Synchroscope and sync lights
 - v. Master circuit breaker open/closed indicator lamps and operating switch.
- B. The Woodward Governor Company synchronizing and load sharing modules offer a reliable and proven paralleling system working with the Woodward PRO-ACT II electronic governor. The Woodward AGLC allows the system to achieve preset baseload settings, automatically or manually while in the utility mode. The Woodward SPMA acts as a synchronizer for paralleling with an existing grid, utility, or other units. The Woodward Load Sharing Module provides for multiple generator sets to be paralleled and share load.

7. Breaker, Power and Other Connections

- A. The 2500-ampere circuit breaker is a GE Power Break II with an interrupting capacity of 150,000 symmetrical amperes. The main breaker is an electrically operated, stored energy unit equipped for synchronizing and remote operation. The main circuit breaker is fixed in the freestanding generator control cabinet. The breaker cabinet door has lock-out/tag-out provisions.
- B. The electrical connections between the generator and the breaker are oversized bus bars on each phase. The minimum spread between buss bars is 6" for ample spacing. The bus bars continue from the breaker and terminate in the power connection box on the outside of the container. This box is used to house the connection to the customer's power cables.
- C. Customer interface connections are located in a separate section of the power connection box and include power, paralleling, and control signals. Control circuit breakers are included as needed. The customer's power cables are connected to the bus bars by standard lugs. The access door installed on the exterior side of the container for the cables is capable of being locked with the customer's power cables installed for added safety.
- D. A separate power supply is required to maintain the generator set in the standby mode when the engine is not running. Off-line power, 110/208 VAC via standard, twist-lock receptacle for supply

of engine heater, generator strip heaters, battery charger, internal AC lighting, and convenience receptacles must be supplied when the generator set is in the standby mode.

- E. Control signals for paralleling RS1500DD units with other power systems can be accessed via heavy-duty industrial DIN-rail terminal strips mounted in the power connection box.
- F. Control signals for the remote start/stop and status monitoring of the unit can be accessed via heavy-duty industrial DIN-rail terminal strips. All customer control inputs are dry contacts. All customer status outputs are dry normally open contacts. These signals include:
 - i. Remote Start/Stop input (maintained contact)
 - ii. Remote Start input (momentary contact)
 - iii. Remote Stop input (momentary contact)
 - iv. Engine Running/Stopped status dry contact output
 - v. Low Fuel Level status dry contact output
 - vi. Remote breaker trip input.
 - vii. Remote emergency stop input
 - viii. Breaker closed, dry contact.
 - ix. Breaker tripped, dry contact.
 - x. Summary alarm, dry contact.
 - xi. Low battery voltage, dry contact.
 - xii. Low oil pressure pre alarm, dry contact.
 - xiii. High coolant temperature, dry contact.
- G. Grounding and bonding pads are located on the container chassis in two (2) locations, one below the power connection box and another diagonally near the rear side of the container. Full current grounds are provided from the generator set to the container chassis. Bonding straps are installed from the power connection box, control cabinet, fuel tank and engine skid to the container chassis.

8. ISO Container

- A. The container housing the engine-generator set is custom-built for the application and is fabricated to ISO specifications for an ocean going shipping container. It is fabricated from heavy gauge corrugated steel and hollow section to provide a rigid support for the entire generator set. The container is manufactured in accordance with Lloyds of London certification, or equal, and it has a CSC nameplate to signify meeting three-high ocean shipping standards. Since the container meets ocean shipping standards, it has ISO corner castings for twist lock fastening and overhead lifting, and nothing protrudes beyond the corner castings.
- B. The container engine compartment includes multiple access doors for operator safety with internal release hardware to open door even if padlocked from outside. There are standard container lockable doors on the rear of the container. All doors provide full height access with positive closing/locking mechanisms and heavy-duty hinges.
- C. The acoustic treatment is designed to meet a mean average ambient noise rating of 74 dB(A) at 7 meters. The acoustic attenuation is comprised of an acoustic infill of resin bonded mineral fiber of suitable density and thickness. The attenuation lining is non-hygroscopic, non-carcinogenic, non-combustible, and compliant with BS476.4 standard. The walls and roof are lined with the acoustic insulation that is retained by aluminum perforated metal.
- D. Air inlet silencers with suitable corrosion-resistant fixed blade weather louvers cover the openings for compartment ventilation, radiators, and combustion air intakes. The aluminum louvers are mounted to the container with a gasket to prevent corrosion caused by galvanic reaction.
- E. The container includes a seal-welded floor to provide environmental spill containment of up to 110% of the total fluids (fuel, engine coolant, lube oil, and hydraulic fluid). The seal-welded bottom is treated with spray-in type resilient coating to prevent leakage of fluids from the container at every possible point. Containment area drain plugs are included. The container is designed so that there is no inherent entry of rainwater into the fluid containment area.

- F. A connection box is provided for customer power connections located at the generator end of the container adjacent to the circuit breaker. The hinged door over the connection box is secured with a locking device.
- G. Internal lighting consists of fluorescent fixtures, powered by 120VAC shore power and by 24VDC battery power via a timer-controlled switch. Switch boxes for the lights and 120V GFI receptacles are located adjacent to each door.
- H. The exhaust outlet from the internally mounted exhaust silencer consists of rain caps to prevent rainwater from entering the piping while the engine is not running. The rain caps are mounted flush with the top of the container. The rain caps are oriented so that exhaust is deflected toward radiator fans to blow it away from the combustion air intakes.
- I. One portable personnel ladder is included with the optional trailer for container access. There are attachment points for the ladder located below each of the seven (7) access doors.
- J. The container dimensions are standard ISO 40 foot length, width, and "high cube" height. The exterior dimensions are:
 - i. Length: 480 inches (40 ft)
 - ii. Width: 96 inches (8 ft 0 in)
 - iii. Height: 114 inches (9 ft 6 in)

9. Finish Coatings

- A. The painting system is applied in accordance with standard paint specification. This includes all carbon steel parts being commercially sandblasted clean prior to coating.
- B. The container interior and exterior is primed per manufacturer's recommendation. A finish coat is then applied. The container bottom is protected with ten (10) to fifteen (15) mils of a heavy duty sealing coating.
- C. The engine and generator are coated gray, (RAL 7015), controls are white, accessories and components are finished to the manufacturer's standard.
- D. Items fabricated are finished to standard coating and finishing specification.
- E. Finishing materials are applied in accordance with the manufacturer's recommendations and conform to local environmental regulations with regard to OSHA requirements and VOC emissions at the time of application.
- F. Owner furnished logo decals or sign placards are applied as required.

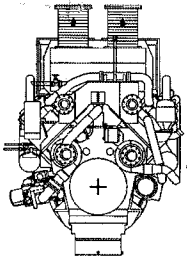
10. Fuel Tank

- A. The unit is provided with a steel, UL-listed, 1100 useable gallon fuel tank. The tank is sized to achieve 8 hours of operating time at prime rating prior to re-filling. To facilitate easy filling, a 1" fill port shall be provided and terminated on the outside wall of the container.
- B. The penetrations from the tank exterior into the fuel tank are through the tank top and they are fully within the spill containment area. All fittings are NPT standard. The tank includes a slanted 4-inch fill neck with removable screen located within the 2-inch containment basin on top of the tank for overflow spill protection, and has an adjacent fuel level gauge.
- C. The fuel tank vent is routed to the outside of the container and incorporates a check valve. The fuel tank 6" emergency pressure/vacuum vent is located on top of the tank and is within the spill containment area.

- D. The fuel supply line to the engine terminates 1" above the tank bottom, and has a check valve. The fuel returns into a separate baffled section of the tank and terminates 1" above the tank bottom. A pick up port is provided for transferring fuel out of the tank.
- E. There are 6-inch clean out ports located at the top of each baffled section of the fuel tank.

11. Manuals

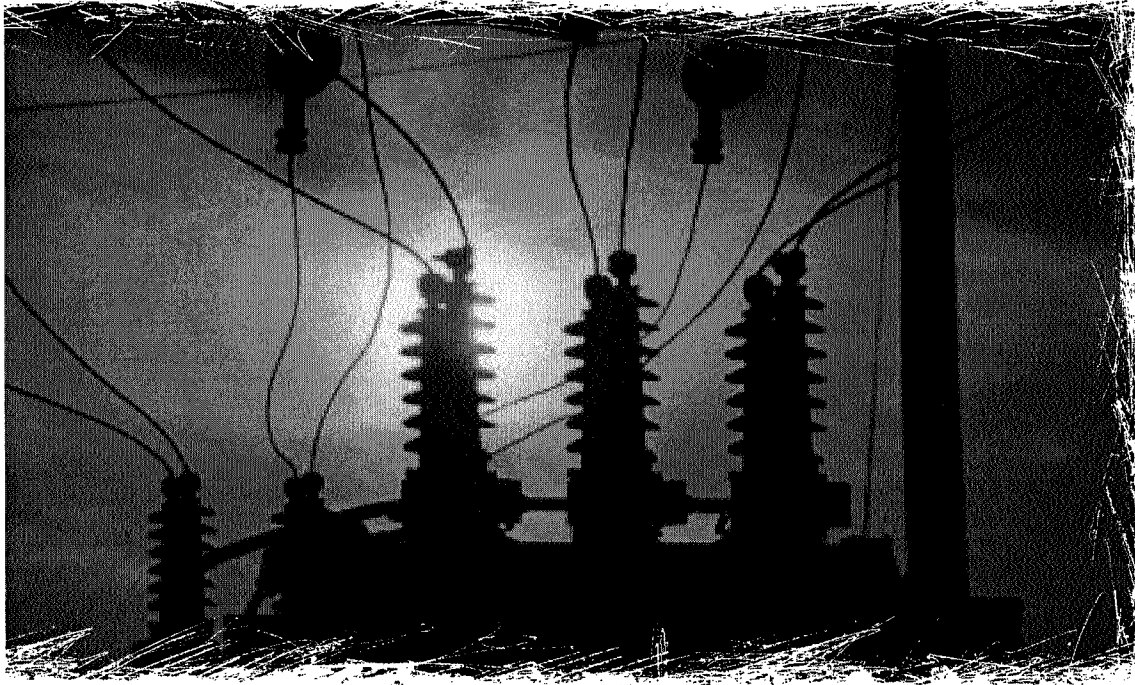
- A. One copy of the standard documentation package is provided. This package consists of:
 - i. General Arrangement Drawing that includes overall dimensions, dry and wet weights, fluid types and capacities, lift-and-load data, tie-down provisions, interface descriptions and locations, clearances, and other basic mechanical or electrical information needed by the customer to successfully install the unit.
 - ii. Electrical Schematics and Wiring Diagrams
 - iii. Operation and Maintenance manuals.
- B. A document box is provided. The box has a hinged top with non-skid surface so that it can be used as a step to assist with manual refueling of the tank.



TBD 620. The Gen engine.



1045-2510 kVA at 1500/1800 min⁻¹



These are the characteristics of the TBD 620:

Modern 8-, 12- and 16-cylinder 90°V-engines.

Turbocharging and charge air cooling.

Exhaust ducting via single-line PEARL® system (Pulse Energy Advanced Recovery Line).

Single cylinder heads with four-valve technology.

Electronic governor included in standard scope of supply.

Swirl optimized for high and low load with HALLO® swirl system (High and Low Load Swirl).

Application-specific cooling system.

Crankshaft with bolted counterweights and external torsional vibration damper.

Compact dimensions.

Your benefits:

- ▶ High compression ratio and high ignition pressure ensure thanks to HALLO® swirl an extremely low fuel consumption. PEARL® guarantees low heat losses.
- ▶ High reliability and a long life of all components further enhance operating economy. Maintenance work is only required after long intervals and can be performed quickly and easily without extended downtimes.
- ▶ Compact dimensions offer optimum prerequisites for low installation costs.
- ▶ The engines are environmentally compatible and laid out for maximized operating economy. They fulfill easily the stringent exhaust emission regulations of TA-Luft 2000.

► Technical data

Engine type		TBD 620 V8		TBD 620 V12		TBD 620 V16	
Speed	min ⁻¹	1500	1800	1500	1800	1500	1800
Frequency	Hz	50	60	50	60	50	60
Engine/ genset ratings¹⁾							
Continuous power, ICN (COP) ²⁾	kW	880	960	1320	1440	1760	1920
Prime power, ICN (PRP) ³⁾	kW	922	1008	1384	1512	1844	2016
Limited-time running power, IFN (LTP) ⁴⁾	kW	968	1056	1452	1584	1936	2112
Typical generator power output (COP) ⁵⁾	kVA	1045	1140	1568	1710	2090	2280
Typical generator power output (PRP) ⁵⁾	kVA	1095	1197	1645	1795	2190	2394
Typical generator power output (LTP) ⁵⁾	kVA	1150	1255	1725	1880	2300	2510
Basic engine data							
Inertia moment J							
– Engine without flywheel	kg/m ²	6.2	6.2	10.75	10.75	7.42	7.42
– Flywheel	kg/m ²	9.5	9.5	4.9	4.9	9.4	9.4
Weight, engine w/o cooling system	kg	3500	3500	4900	4900	6600	6600
Governing							
Governor electronic		Woodward PRO ACT II		Woodward PRO ACT II		Woodward PRO ACT II	
– Speed droop (static, option)	%	adjustable ≤ 5%		adjustable ≤ 5%		adjustable ≤ 5%	
Control quality ⁶⁾		G2	G2	G2	G2	G2	G2
Load acceptance⁷⁾							
Recovery time	approx. sec.	2,2	1,2	2	1,2	2,2	1,1
Speed drop	approx. %	9	5	8	4	8	4
Inertia moment generator	kg/m ²	18.7	18.7	35	35	65	65
Fuel system							
Spec. fuel consumption at COP ⁸⁾							
100% load	g/kWh	193	199	193	199	194	200
75% load	g/kWh	194	200	193	200	194	202
50% load	g/kWh	199	204	199	206	200	208
Cooling system/cooling capacity							
Cooling water volume engine	l	70	70	100	100	140	140
Cooling air flow rate	m ³ /h	86 832	77 160	127 180	124 420	155 520	136 857
Heat in engine cooling water	kW	232	288	414	432	498	602
Heat in charge air cooler	kW	176	213	264	320	352	427
Circulating water flow rate (Δt 10K)	m ³ /h	46	55	54	59	46	56
Permissible resistance at Δt 10 K	bar	1	1,35	0,9	1,3	0,9	1,3
Circulating water flow rate	m ³ /h	27	31	39	47	39	47
Permissible resistance for cooler and water pipes outside the engine	bar	0.85	1.24	1.3	1.9	1.3	1.9
Max. cooling water temperature							
– Engine outlet	°C	82	82	82	82	82	82
– (Alarm)	°C	85	85	85	85	85	85
Heat radiation	kW	50	57	76	85	101	114

Technical data

Engine type	TBD 620V8		TBD 620V12		TBD 620V16	
	1500	1800	1500	1800	1500	1800
Speed	min ⁻¹	60	50	60	50	60
Frequency	Hz	60	60	60	60	60
Lubrication system						
Lube oil consumption at full load	g/kWh	1.0+0.3	1.0+0.3	1.0+0.3	1.0+0.3	1.0+0.3
Lube oil specification		API class CD or CE or CF4 and CCMC class D4/D5 (SHPD oil)				
Lube oil volume	l	70	110	110	150	150
- Oil pan top	l	95	150	150	200	200
- Oil pan bottom	l	90	90	90	90	90
Oil temperature max.	°C	2/3	2/3	4/3	4/3	4/3
Full-flow filter	pcs./l	2	2	2	2	2
Min. oil pressure (shutdown)	bar	2	2	2	2	2
Combustion air system						
Combustion air flow rate (COP)	m ³ /h	4435	4896	6920	7531	9792
Max. vacuum (filter clean)	mbar	20	25	20	25	25
Exhaust system						
Exhaust mass flow rate at full load (COP)	kg/h	5245	5789	8210	8943	11578
Exhaust temperature at full load and 25°C ambient temperature	°C	480	530	420	450	590
Max. permissible exhaust backpressure	mbar	20	25	20	25	25
Exhaust flange	mm	1x250	1x250	2x250	2x250	2x250
TA-Luft (4000)	mg/hm ³	4000	-	4000	4000	4000
Engine electrics						
Electrical equipment:						
- Starter motor	KW	9	9	9	9	15
- Alternator	A/V	55/28	55/28	55/28	55/28	55/28
- Battery (min. capacity)	Ah	300	300	400	400	475
- Coolant preheating unit	W	3	3	6	6	6
- Voltage	V	24	24	24	24	24
Cold-start capability						
Cold-start limit temperature:	°C	-15	-15	-15	-15	-15
- without starting aid						
Noise emissions⁹⁾						
Sound power level	dB(A)/1pW	119	120	119	120	123
Sound pressure level at full load, 1 m distance	dB(A)	106	107	105	108	110

1) Power reduction caused by altitude and temperature without deduction of fan power consumption.
For details refer to DEUTZ.

2) Net continuous power 100% available at flywheel, no time limitation, plus 10% extra power for governing purposes.

3) Prime power 100%, average power output 80% within 24 hours, plus 5% extra power for governing purposes.

4) Limited-time running power 100% which must be available 500 hours/year (thereof max. 300 hours/year continuously, no overload permissible; the required extra power for governing purposes must be taken into account however.

5) Taking into account typical generator efficiency, power factor cos (φ) = 0.8, generator efficiency: 0.95.

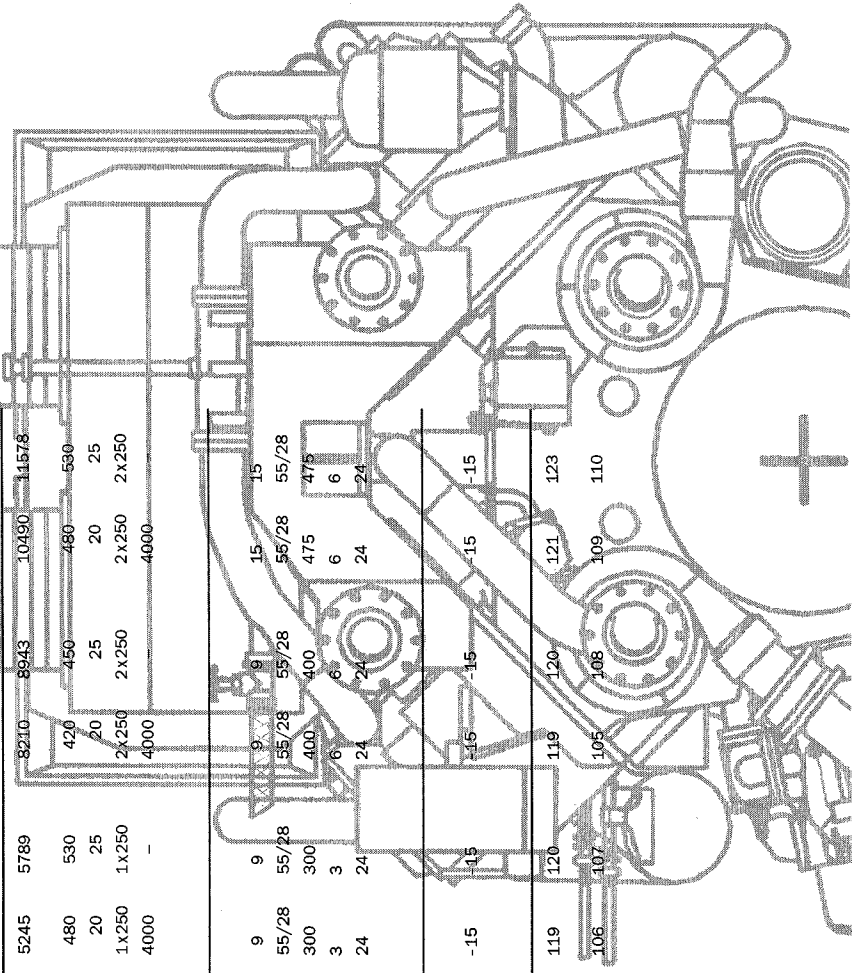
6) Performance acc. to ISO 8528.

7) Load application from 0 to 50% of the rated power starting from the idling speed of 1560 or 1872 min⁻¹ (speed droop 4%).

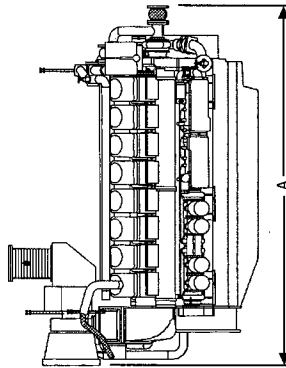
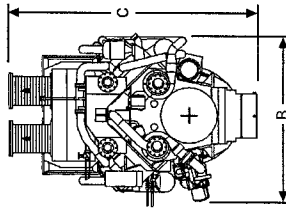
8) For fuel specification see operation manual.

9) Cumulative noise level weighted according to dB (A) with a tolerance of +/- 1.5 dB (A).
Values to be understood without cooling system.

The values given in this data sheet are for information purposes only and not binding. The information given in the offer is decisive.



► Dimensions



Engine type	A	B	C
TBD 620 V 8	1950	1390	2035
TBD 620 V 12	2700	1500	2180
TBD 620 V 16	3200	1500	2180

► Standard Spezifikation

- Standard engine:..... Basic parts
- Cooling systems:..... Dual-circuit cooling system (air-to-water charge air cooling), with LT thermostat loose, mechanical engine cooling water pump, air cooler coolant, cooling water preheating unit, loose.
- Exhaust system:..... Exhaust manifolds and elbow, two exhaust turbochargers (with V8: one turbocharger), insulated exhaust pipes.
- Filters:..... Plate-type air cleaner with paper element, fuel twin filter, lube oil single filter.
- Governor:..... Electronic governor.
- Flywheel:..... Flywheel with 18" connection. With 21" connection for V16.
- Adapter housing:..... SAE O housing.
- Engine electrics:..... Starter motor 24 V, 9 kW (with V16: 15 kW), analog sensor for cooling water and charge air temperature, lube oil and crankcase overpressure, electr. priming to pump set, solenoid shutdown, wiring to engine switchbox.
- Miscellaneous:..... Painting in diamond grey, operation manual, spare parts catalogue.





FT4 SCOPE OF SUPPLY

- Pratt & Whitney Dual Fuel FT-4 / Turbine Gen/Set
- Baseplate with supports for Gas Turbine, & Foundation Bolts
- Main Generator 13.8/11kv 60/50hz .85 P.F.
- PLC Turbine Controls
- Complete Local/Remote Control and Supervisory System for the Gas Turbine and Expander, including all necessary control switches and alarms
- The Generating Plant is Auto : Start, Synch & Parallel
- Water Injection for Power Boost & Exhaust Emissions Control
- Exhaust Silencer
- Exhaust Stack
- Intake Silencer /Screen
- Coupling between the Turbine and the Generator.
- Generator
- Generator is a Self Ventilated Turbo and designed for Open Air Cooling.
- Exciter is located at the Non-Driven End of the Generator.
- Inlet Suction Duct for the Gas Turbine
- Thermal and Acoustical Insulation

Governing And Lubricating Oil System

- Turbine comes with an Integral Governing and Lubricating Oil System which includes all necessary safety and supervisory devices.
- Generator has a separate lubricating system as well as the Load Governor and Over Speed Trip Mechanism.
- Oil is cooled by a radiator located at the side of the unit.
- Fan Cooled Radiator.
- DC Battery is supplied to provide power in case of an emergency and unit power is lost

Fuel System:

- Liquid Fuel/Gas Fuel
- Fuel Connections are located at the side of the unit

Vibration Supervisory System

- Noise Level: the noise level measured at 400 Ft will be 85db or lower

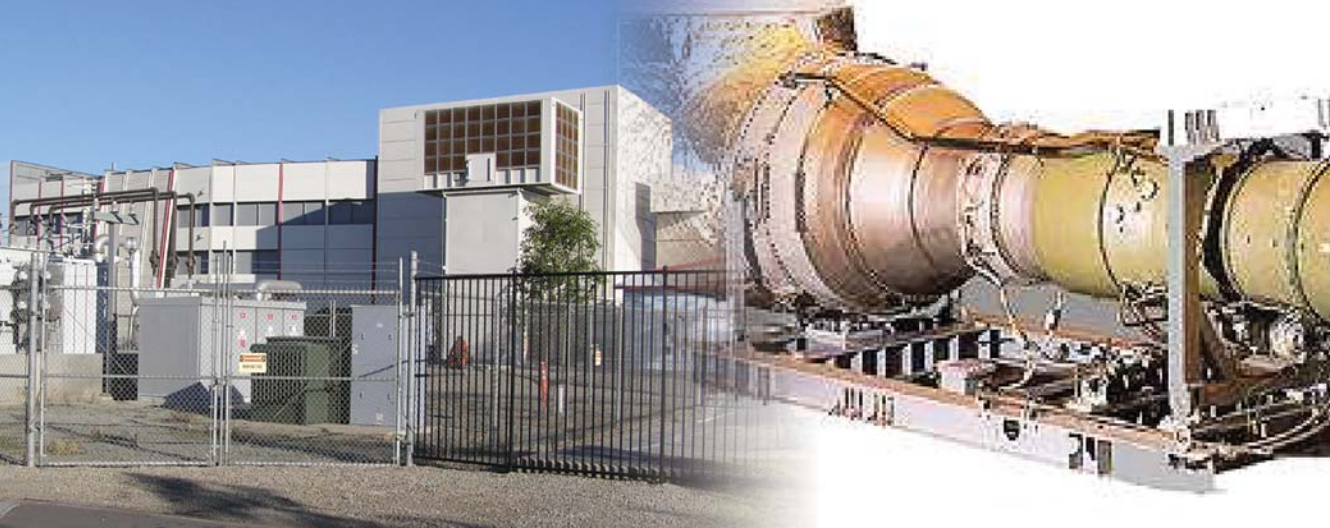
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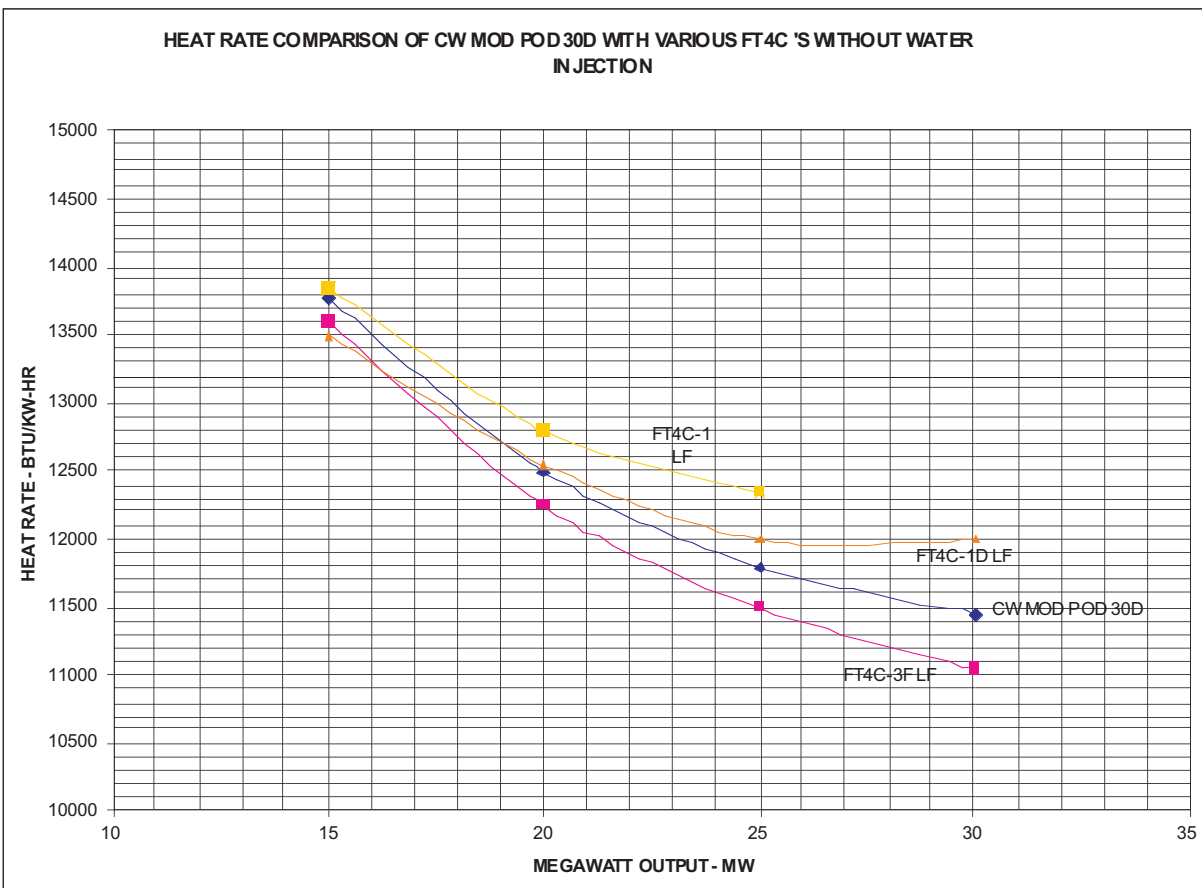
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FT4 FACT SHEET



Turbine (Simple Cycle)

Generator Frequency	50 Hz	60 Hz
Generator Effy. Assumed / Gearbox Effy. Assumed	.980 / N/A	.980 / N/A
Output (kW)	24,300	29,400
Heat Rate (Btu/kWe-hr)	13,200	11,500
Power Turbine Speed (rpm)	3,600	3,600
Exhaust Temp. (deg. F)	570	690

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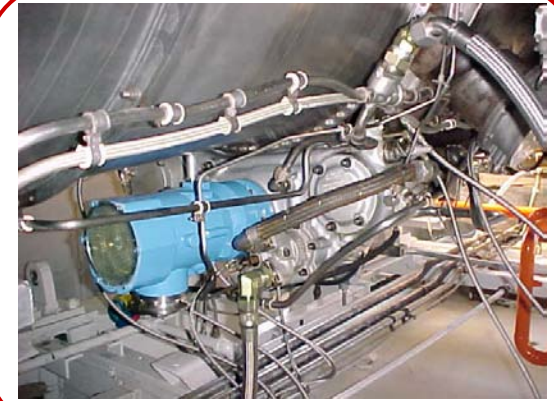
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Power Generation Market



**For information on the following equipment
please call Joaquin Mavares at 713 992-1790
jmavares@proenergyservices.com**



Equipment Packaging



- All those FT-4 will be available in 90 Days

All of those were refurbished By the OEM

All of the FT-4's will carry OEM Warranty



Packages Available



- 2008 – Inventory Packages
- (2) FT4C Twin Pac's (50 MW ea)

UNIT – TP1 HISTORY



- Originally installed at Pacific Gas & Electric Company's Hunter's Point Plant in San Francisco, CA. Operational in June, 1976. Remove from service in 2006 with approximately 8000 running hours.
- Purchased during 2007
- Engine / Free Turbine In shop Inspections – 2008
 - Serial Numbers – 686625 / 686626 / 600538 / 600630
 - Rotor level inspection
 - Test cell acceptance
- BOP – Inspection / refurbishment – 2008
 - Controls Replacement (Allen Bradley Control Logic)
 - 60 HZ Package

TP 1 - GENERATOR SPECIFICATION



- The electric generator was built in 1976 by Electric Machinery Company. Name plate data is as follows:

• Serial number	73-2282-01
• KVA	62,000
• KW	56,250
• Power Factor	0.9
• RPM/HZ	3600/60

• Volts	12,000
• Amps	2007
• Temp Rise-stator	85°C
• -rotor	110°C
• Inlet air temp	59°F
• Altitude	0 ft
• Phase sequence	3-2-1
• Rotation	CCW

UNIT – TP2 HISTORY



- Originally installed at Public Service Electric & Gas Company's – Linden Station in Linden, NJ. Operational in April, 1973. Remove from service in 2006 with approximately 8000 running hours.
- BOP purchased in 2008
- Engine / Free Turbine In shop Inspections – 2008
 - Serial Numbers – 686656 / 686663 / 600425 / 600497
 - Rotor level inspection
 - Test cell acceptance
- BOP – Inspection / refurbishment – 2008
 - Controls Replacement (Allen Bradley Control Logic)
 - 60 HZ Package

TP 2 - GENERATOR SPECIFICATION



- **The electric generator was built in 1973 by Electric Machinery Company. Name plate data is as follows:**

• Serial number	77-11957-01
• Exciter SN	168-162591
• KVA	63,000
• KW	56,700
• Power Factor	0.9
• RPM/HZ	3600/60

• Volts	13,800
• Amps	2640
• Temp Rise-stator	85*C
• -rotor	110*C
• Inlet air temp	59*F
• Altitude	0 ft
• Phase sequence	1-2-3
• Rotation	CW



STANDARD 60Hz LM2500 GENERATOR PACKAGE

Gas Turbine

The LM2500 engine is a split-shaft design with the gas generator separate from the power turbine. The gas generator is aerodynamically coupled to the power turbine. This design allows the power turbine to operate at a continuous speed of 3600 rpm, regardless of the gas generator speed. The gas generator consists of a sixteen-stage, axial-flow compressor, an annular combustor with 30 individual fuel nozzles and a two-stage, high-pressure turbine. The separate power turbine is a six-stage axial-flow turbine.

A/C Generator

The torque developed in the aerodynamically coupled power turbine is directly transferred to the rotor of the alternating current (AC) generator through a flexible diaphragm coupling. The Generator is a continuous duty, two pole, three phase with a brushless exciter. The generator is rated at 13.8 kV, 60Hz, and 0.85 PF.

Package

The package is weather protected and insulated which protects the gas turbine and generator. The package supplied will include an inlet filter house with inlet filters and an exhaust stack. The dimensions are 68'6" x 14'9" x 29'5".

A separate control house contains the following:

- Control system with HMI
- Voltage regulator/neutral side protection CT's
- Vibration system
- 24V and 125V DC batteries and battery chargers
- Electrical system up to the generator main breaker
- Generator main breaker

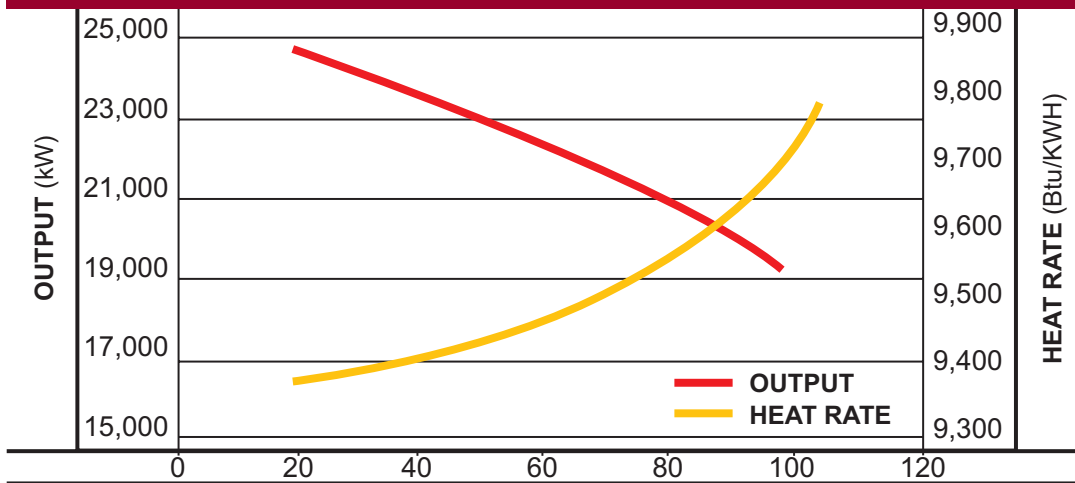
Skid Mounted Equipment:

- Electro-hydraulic start skid and system
- Lube oil skid and system
- On/off-line water wash skid and system
- Fuel oil skid and system (optional)



LM2500 FACT SHEET

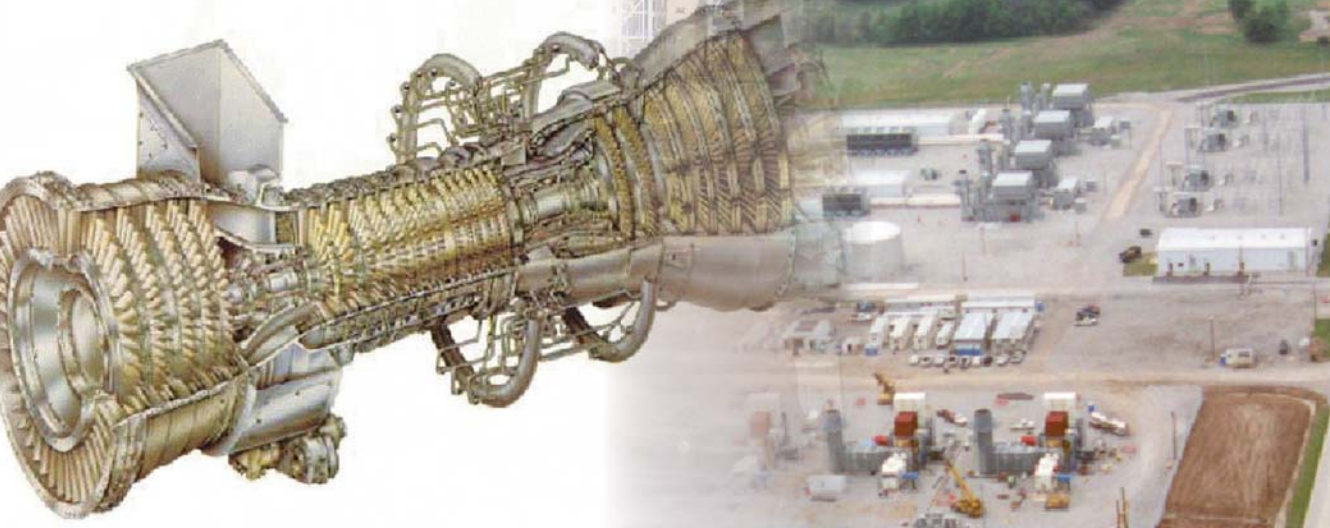
LM2500 60Hz Output and Heat Rate



0 ft. 60% RH, 4/6 in H₂O inlet/exhaust loss on natural gas with water injection to 25ppmvd NO_x water inj. **AMBIENT (°F)**

Turbine

	LM2500
Power Output (kWe)	22,000
Heat Rate LHV (Btu/kWe-Hr)	9,465
Exhaust Flow (lbs/sec)	149
Exhaust Temperature (°F)	990
Emissions (ppmvd)	NO _x /CO
Gas-DLE	25/25
Gas or Liquid-Water	25/50, 42/30
Gas-Steam	25/30
Power Turbine Speed (rpm)	3,600
No. of Compressor Stages	16
No. of Turbine Stages	6



STANDARD 60Hz LM6000 GENERATOR PACKAGE

Gas Turbine

19 Stage Axial Compressor

- 5 stages low pressure and 14 stages high pressure
- Horizontal Split Casing
- 30:1 Compression Ratio
- 275 lb/s Nominal Inlet Mass Flow

Annular Combustor

- 30 Nozzles Gas Fuel, Water Injection for NOx Control

Turbine Stages

- 2 stage high pressure and 5 stage low pressure Power Turbine

Generator

13.8kV, 0.9PF Continuous Duty

2 Pole, 3 Phase, Brushless Exciter

WPII weather protected

Voltage Regulator/Neutral Side Protection CT's

NEMA Class F Insulation & B Temperature Rise

Integrated Protective Relay Panel

Package

24V and 125V DC Batteries

85dBA Near Field Design

Barrier Inlet Air Filters

10 Minute start capability

Electro-Hydraulic Start/Shutdown System

Class I Div 2 Group D Class Electrical System

Digital Control System with a Human Machine Interface (HMI)

Lube Oil System with Duplex Shell and Tube Coolers

On/Off-line Water Wash

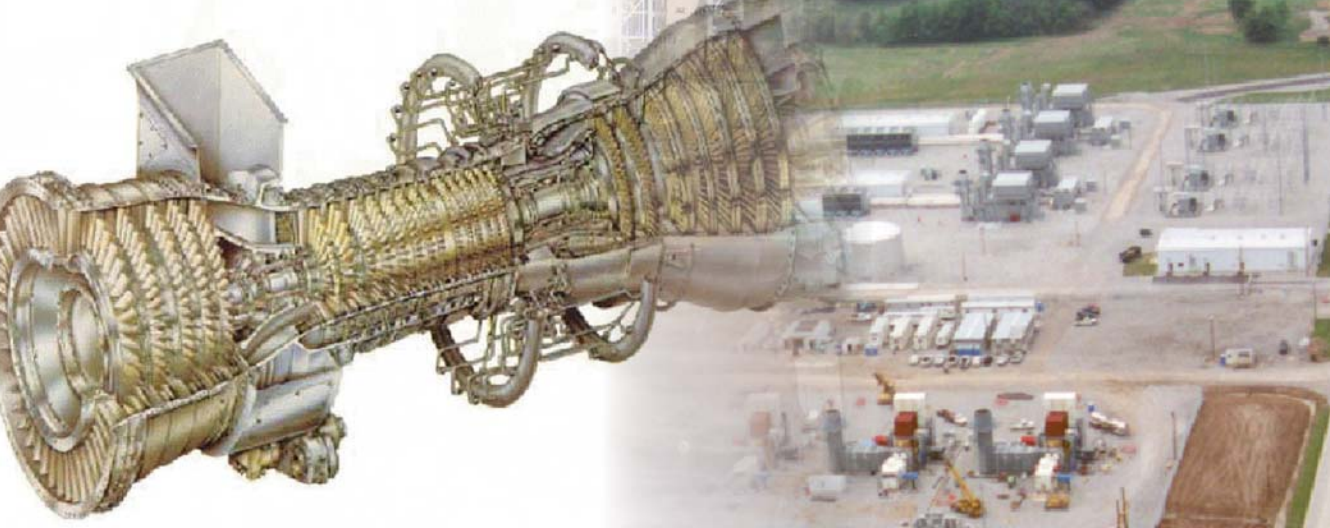
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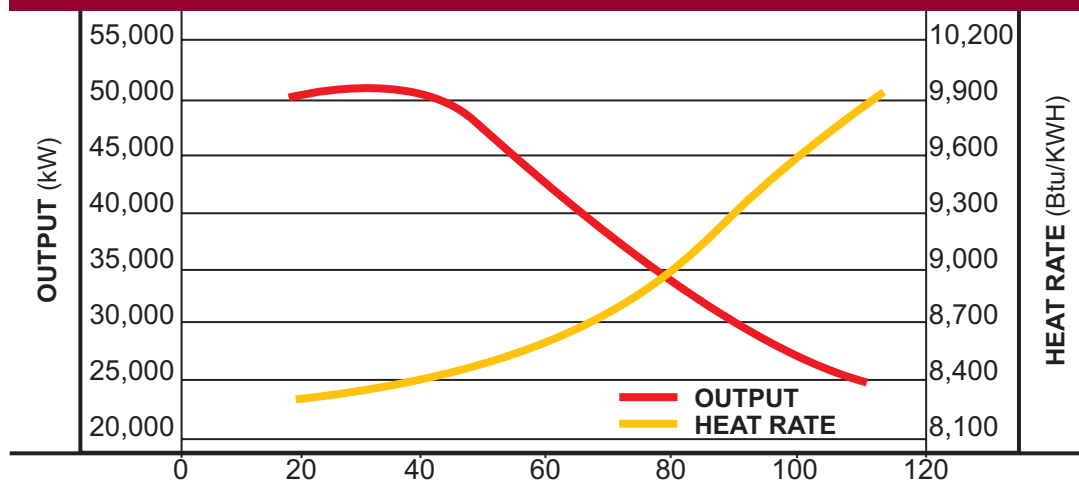
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Venezuela





LM6000 FACT SHEET

LM6000 60Hz Output and Heat Rate



0 ft. 60% RH, 4/6 in H₂O inlet/exhaust loss on natural gas with water injection to 25ppmvd NO_x water inj.

AMBIENT (°F)

Turbine

	LM6000-PC	Sprint
Power Output (KWe)	43,600	50,000
Heat Rate LHV (Btu/kWe-HR)	8,500	8,400
Exhaust Flow (lbs/sec)	284	295
Exhaust Temperature (°F)	792	826
Emissions (ppmvd)	NO _x /CO	
Gas or Liquid-DLE (15 ppm)	15/50, 65/25	15/50, 65/25
Gas or Liquid-DLE (25 ppm)	25/25, 134/25	25/25, 104/25
Gas or Liquid-Water	25/26, 42/6	25/32, 42/6
Gas-Steam	25/21	25/25
Power Turbine Speed (rpm)	3,600	3,600
No. of Compressor Stages	19	19
No. of Turbine Stages	7	7

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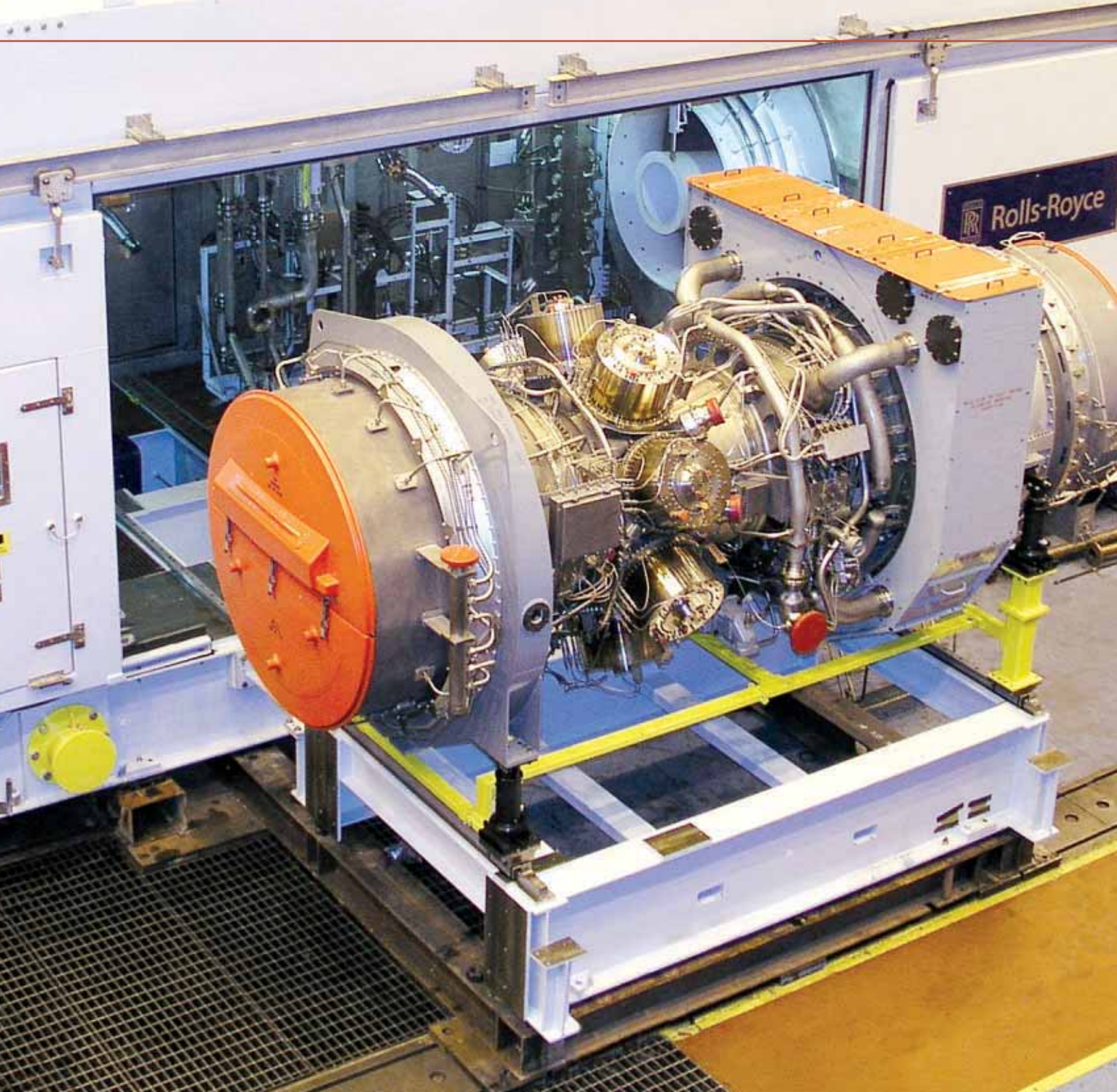




Rolls-Royce

The Trent 60 Gas Turbine

For power generation and mechanical drives



Power generation

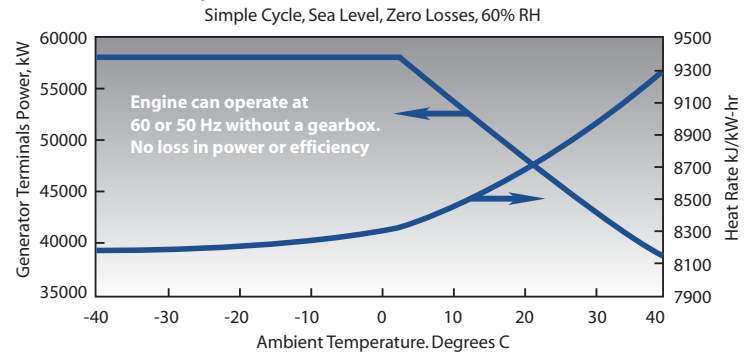
T R E N T

The Rolls-Royce Trent 60 is the most advanced aeroderivative gas turbine available today. Delivering up to 58MW of electric power in simple cycle service, at 42 per cent efficiency, the Trent 60 has established a new benchmark for fuel economy and cost savings. It also offers operators fast delivery and installation times and beneficial environmental performance.

Key features

- Highest power aero derivative gas turbine
- Highest simple cycle efficiency gas turbine
- Efficient package for installation and maintenance
- Power generation at 50 or 60 Hz without a gear
- DLE or WLE systems available for 25 ppm NOx
- Small footprint and low weight
- Proven history from aircraft engine lineage
- Full load train starting with only 250 kW motor
- High cyclic life meets daily peaking market
- Cold start to full power in under 10 minutes

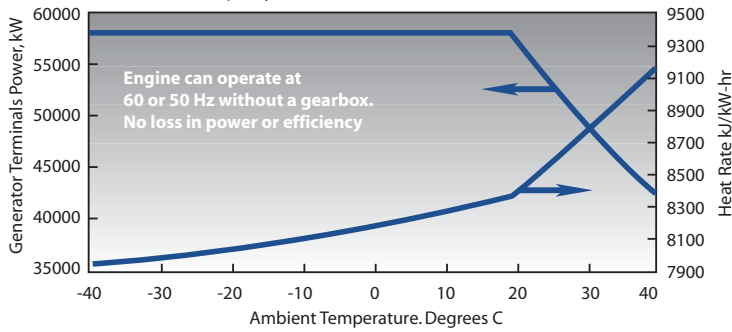
Trent 60 (Dry Low Emissions) Nominal Performance



The Trent 60 package

Trent 60 (Water Injected) Nominal Performance

Simple Cycle, Sea Level, Zero Losses, 60% RH



T R E N T



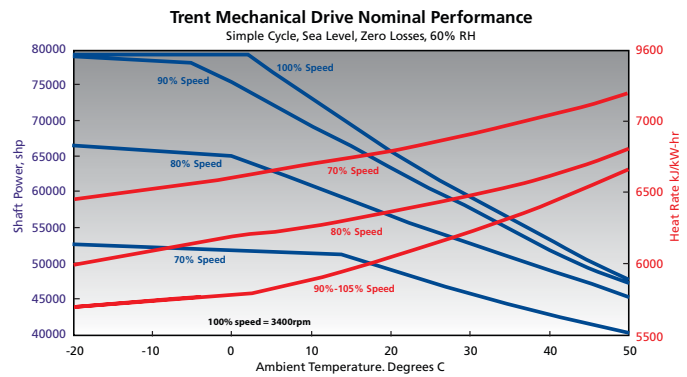
Trent 60 – Dry Low Emissions (DLE)

The Trent 60 DLE engine is designed to meet stringent environmental requirements. The use of an eight canular staged combustion system allows the successful operation of the engine in part load operation while still maintaining NOx and CO compliance. The engine is designed to produce 52MW of power at ISO conditions and is flat rated at 58MW power at temperatures below approximately 2°C.

Trent 60 – Wet Low Emissions (WLE)

The Trent 60 WLE uses the annular combustor system from the Trent aero engine with the introduction of water to reduce emissions and boost performance. Since the Trent 60 engine only uses water in the combustion chamber, water usage is kept to a minimum. At temperatures below 19°C. (varies due to site conditions) the engine is flat rated at 58MW. An online monitoring system allows for the reduction of water usage due to changes in power demand and ambient conditions while still maintaining compliant emission levels.

Mechanical drive



T R E N T

Onshore or offshore



The Trent 60 is ideally suited to meet the higher power, variable speed demands required by applications like natural gas

liquefaction, gas transportation and gas Injection for oil recovery. The design flexibility of the Trent allows the same engine that serves the power generation market to meet the needs of mechanical drive service with no design changes. The Trent, due to its three independent shaft design, is capable of meeting driven equipment power demand at reduced speeds with a minimal drop off in efficiency. The Trent design also allows the starting of large trains with the same standard, low power, starting system that is employed for power generation.

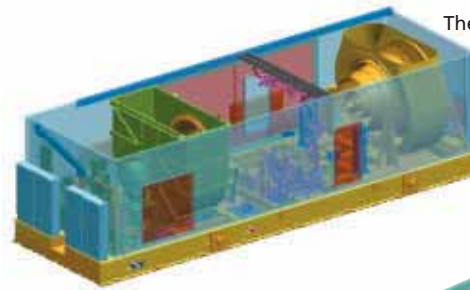
Key features

- The engine is designed for a 100% speed of 3400 RPM
- Can be direct connected to driven equipment or use a gear
- Engine control system can be modified to support a variety of driven equipment
- Speed range of 70-105%.
- Low starting power requirement for large trains
- Identical engine and package for power generation and mechanical drive.
- Multiple daily starts with no extended wait time between starts.

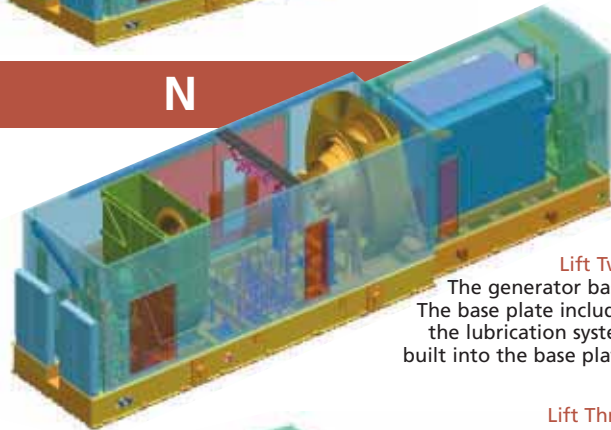


Trent 60 engine on test, driving a centrifugal compressor at full load.

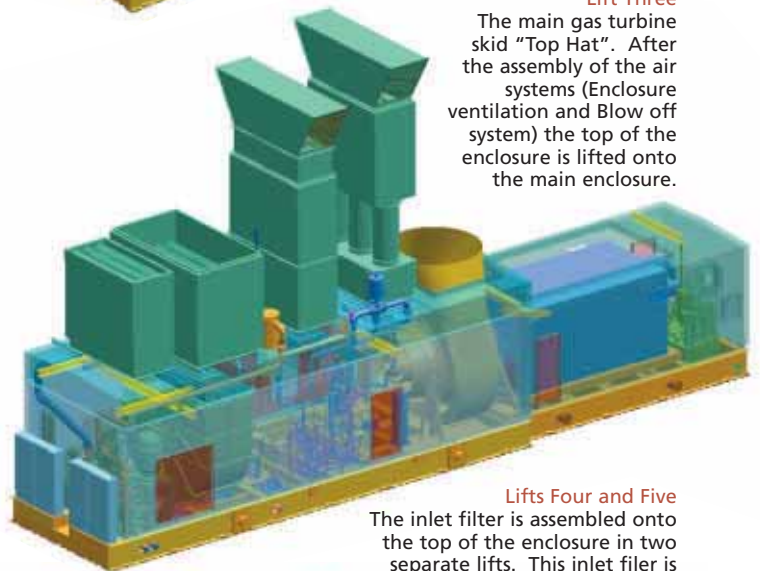
The Trent 60 package



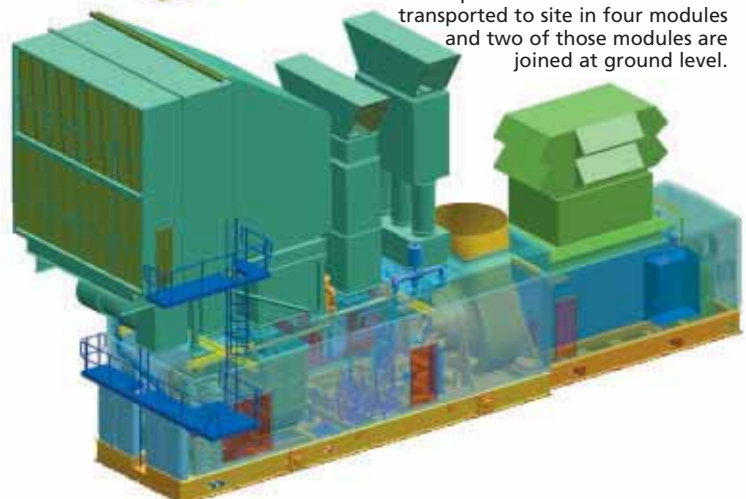
Lift One
The main gas turbine skid base plate. This base includes all required engine lubrication systems, fuel systems and the control panels.



Lift Two
The generator base. The base plate includes the lubrication system built into the base plate.



Lift Three
The main gas turbine skid "Top Hat". After the assembly of the air systems (Enclosure ventilation and Blow off system) the top of the enclosure is lifted onto the main enclosure.



Lifts Four and Five
The inlet filter is assembled onto the top of the enclosure in two separate lifts. This inlet filter is transported to site in four modules and two of those modules are joined at ground level.

T R E N

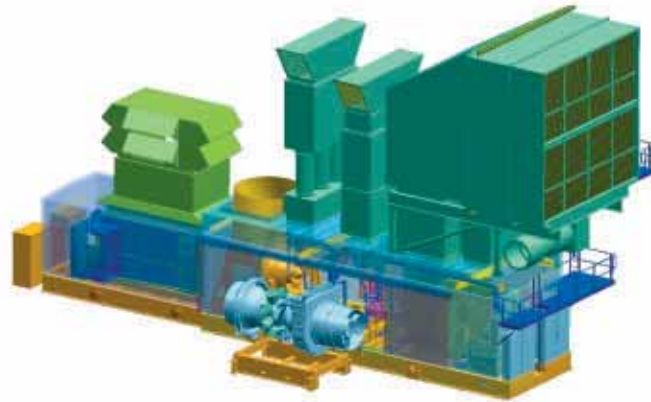
Modular concept

The Trent 60 package is designed with a modular concept to not only allow for quick installation but also for ease of maintenance in the field.

Each of the modules is fully assembled and tested before shipment to the field. Both the gas turbine and the generator base plates hold the required oil systems thus allowing installation, testing and flushing in a shop environment. This greatly reduces site installation time.

Not only are the mechanical systems located on the base plate but the control systems are located there as well. The control systems required for the operation of the Trent engine whether in mechanical drive or power generation service are pre-assembled and tested on the base plate before the unit ships to the field. All train control systems are then accessed by a Human Machine Interface (HMI) which can be located in the main control room.

Trent maintenance



T

R

E

N

T

Flexible design

Due to the Trent's aircraft engine lineage, maintenance of the engine can be accomplished quickly and easily. The Trent package is designed to facilitate engine change out in under 24 hours of working time.

Complete engine servicing can take place in a Rolls-Royce facility.

The Trent engine is also capable of being split into three interchangeable modules:

1. Low pressure compressor
2. Intermediate and high pressure compressors and turbines
3. Low pressure turbine

It is possible to swap these engine modules at the site in under 72 working hours. This reduces overall transport and costs associated with inventory of a spare engine. Rolls-Royce can also offer access to a lease engine or module program.

This program reduces the need for a spare engine and allows significant flexibility in maintenance.



The engine is installed and removed from the side of the package. The use of sliding doors allows full access to the engine and is designed for a complete engine change out in 24 working hours.

Customer service business

Long Term Service Agreements
 Engineered products
 Refurbished power systems
 Repair and overhaul
 Control system upgrades
 Service exchange and lease engines
 Spare parts
 Technical support
 Field service
 Customer training
 Complete installation and commissioning service

T R E N T

Experience holds the key to success

In today's evolving and demanding energy market, Trent gas turbine based packages offer distinct advantages to the power generation and oil and gas industries. This competitive advantage is complemented by an innovative and diverse suite of service solutions tailored to customers' specific needs.

Our ability to keep you operational where others might fail is a direct result of our policy to develop integrated solutions. Our Long Term Service Agreements (LTSAs) create partnerships designed to control operators' maintenance budget while increasing the availability of the equipment.

The equipment upgrades we provide as part of our suite of engineered products rely on the

comprehensive system history and key performance indicators established in our technical support networks.

By diligently monitoring the performance of your installed plant we can plan when major components will need to be removed for repair or overhaul.

We are continually increasing the range and scope of our customer service solutions. Our own online community at www.enegymanager-online.com provides Rolls-Royce users with quick, up to date, easy to access information.



LP Turbine

HP/IP
Core

LP
Compressor

Engine Handling

Due to the Trent's aircraft lineage it is possible for the engine to be split into three modules at the site. This reduces transportation costs and saves on inventory requirements.



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7FA EQUIPMENT OVERVIEW

Gas Turbine

- Feature Specification
- Primary Fuel Natural Gas
- Starting Means Static Start
- Air Filtration Two Stage Static
- Exhaust System Axial Exhaust
- Emissions Control Gas-Dry Low NOx
- Outdoor Enclosure Turbine and Accessory Compartments
- Off-Base Acoustic Enclosure Turbine and Accessory Compartments
- Off-Base Acoustic Enclosure Turbine Compartment

Generator

- Feature Specification
- Model 7FH2
- Cooling Hydrogen
- Frequency 60 Hz
- Power Factor (PF) 0.85 Lagging
- Power Factor (PF) Capability to .90 Leading @ ISO Conditions
- Terminal Voltage 18.0 kV
- Generator Excitation EX2000P-Static Bus Fed
- Outdoor Enclosure Load Compartment
- On-Base Lagging Accessory Base

Control Systems

- Feature Specification
- Turbine-Generator SPEEDTRONIC Mark VI

G.E. SCOPE OF SUPPLY

1. Gas Turbine Systems
2. Generator
3. Gas Turbine-Generator Controls & Electric Auxiliaries
4. Services

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7FA SCOPE OF SUPPLY

1. GAS TURBINE SYSTEMS

Gas Turbine

- Base Mounted PG7241 (FA) 60 Hz gas turbine including:
- Modulating IGV

Combustion System

- Dry Low NOx combustion system -With inlet heating
- Compressor inlet humidity sensor
- Compressor inlet temperature thermocouple

Fuel Systems

Gas Fuel System

- Natural gas only
- Stainless steel gas piping
- Orifice type gas flow measurement system
- Single gas strainer
- Gas fuel valves on accessory base
- Gas fuel temperature supplied per GEI-41040F-Heater by Owner
- Gas Fuel cleaning equipment (fuel gas scrubber) (duplex)

Lubricating and Hydraulic Systems Pumps

- AC Motor driven dual oil pumps
- AC Motor driven dual hydraulic pumps
- DC Motor driven, emergency lube oil pump
- AC/DC Motor driven auxiliary generator seal oil pump
- Dual pump for pressure lift journal bearings in:
 - Turbine
 - Generator
 - Generator seal oil pump

Filters and Coolers

- Dual lube oil system filters
- Dual hydraulic oil filters
- Dual lube oil coolers
 - Plate/Frame type with stainless steel plates
- ASME code stamp
 - Lube oil coolers
 - Lube oil filters

Lube Oil Piping

- 304L stainless steel lube oil feed pipe
- Carbon steel lube oil drain pipe
- Lube system valve stainless steel trim

Mist Elimination

- Lube vent demister

Oil Reservoir

- With heater for -20 deg. F

Instrumentation

- Pressure switches for lubrication and hydraulic oil filters

Inlet System

- Inlet system arrangement
 - Up and Forward inlet system arrangement
 - Inlet compartment supports straddle ductline
- Inlet Filtration
 - Two-stage static filter, prefilter and high efficiency filter
 - Standard filter media (low humidity, non-corrosive environments)
 - Weather protection on inlet filter compartment
 - Inlet system differential pressure indicator
 - Inlet system differential pressure alarm
 - Inlet filter compartment support steel (Seismic Zone 4A=120 mph wind speed)
- Inlet system atmospheric Protection
 - Zinc rich paint inside and outside of the inlet filter compartment
 - Zinc rich paint on inlet filter compartment support steel
 - Zinc rich paint inside and outside of inlet ducting with epoxy topcoat inside ducting
 - Galvanized inlet silencing perforated sheet
 - Zinc rich paint on inlet ducting support steel

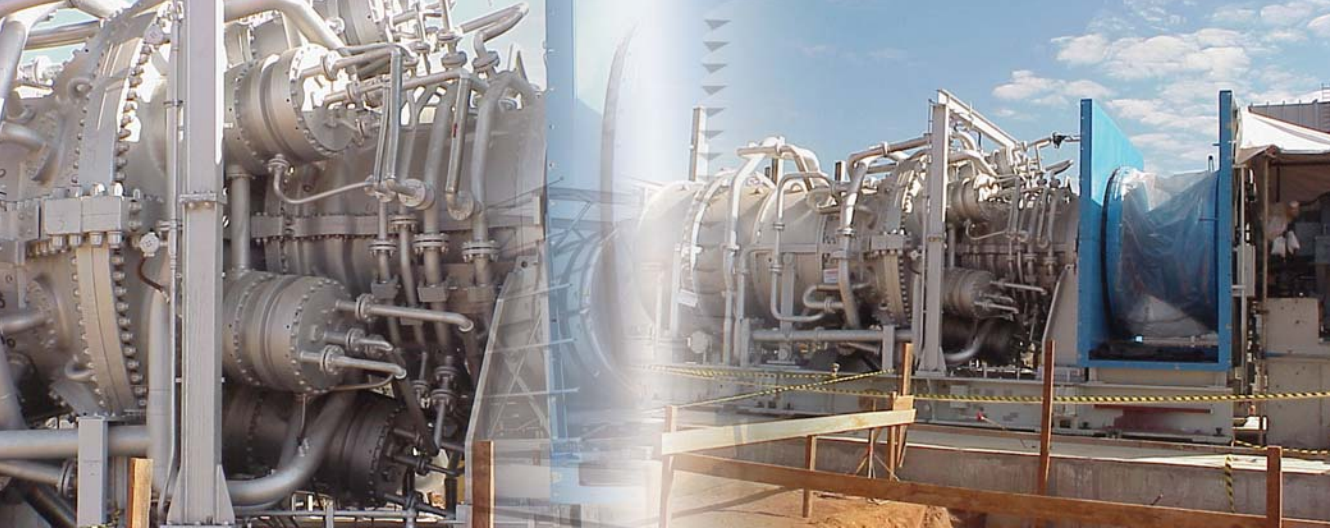
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7FA SCOPE OF SUPPLY

Exhaust System Arrangement

- Exhaust diffuser with an axial exit
- Exhaust expansion joint
- Exhaust stack, if required, by Customer

Couplings

- Rigid load coupling
- Load coupling guard

Gas Turbine Packaging

- Lagging and enclosures
 - On-base accessory compartment lagging
 - Turbine and accessory compartment lagging
 - Load coupling compartment lagging
 - Off-base acoustic enclosure for turbine only
 - Off-base acoustic enclosure for turbine, accessory compartment and exhaust diffuser for 85A dBA
- Compartment ventilation, pressurization and beating
 - Dual turbine compartment vent fans
 - Dual accessory compartment lagging
 - Dual load compartment fan
 - Heated turbine and accessory compartments for humidity control
 - Dual vent fans for diffuser/exhaust area
- Plant Arrangement
 - Turbine designed for installation outdoors
 - Right hand accessory module
 - Unit walkways by customers, mounting pads by GE
- Turbine and accessory base painting
 - Standard primer
- UBC seismic zone #4
- Hazardous area classification
 - NEC Class 1, Group D, Division2
 - Turbine compartment
 - Gas fuel compartment
- Special features
 - Dual (metric-English) indicators and gauges

Fire Protection System

- Fire detection system
 - Turbine and accessory compartment
- Smoke detection system
 - Control cab/PEECC
- Compartment warning signs
- CO2 supply system
 - One low pressure CO2 tank per unit
 - Tank suitable for 0-120 deg. F (-18 to 49 deg. C)
- Fire protecting piping
- Hazardous atmosphere detectors in turbine and gas fuel compartments
- Hazardous atmosphere detector readout

Starting Systems

- Static Start
 - Generator start with inverter/regulator
 - Static start isolation transformer
 - Oil filled
- Shared hardware for two units
 - Isolation transformer fed from auxiliary bus
 - Shared hardware across power blocks using cross ties
 - PLC based changeover panel
 - 12- pulse, water-cooled LCI
 - Single dc link reactor
 - Water to water heat exchanger, shipped loose
- Rotor turning systems
 - Turning gear and motor for rotor cool-down
 - Rotor indexing (borescope inspection)

Miscellaneous Systems Special Systems

- Exhaust frame blowers on turbine compartment roof

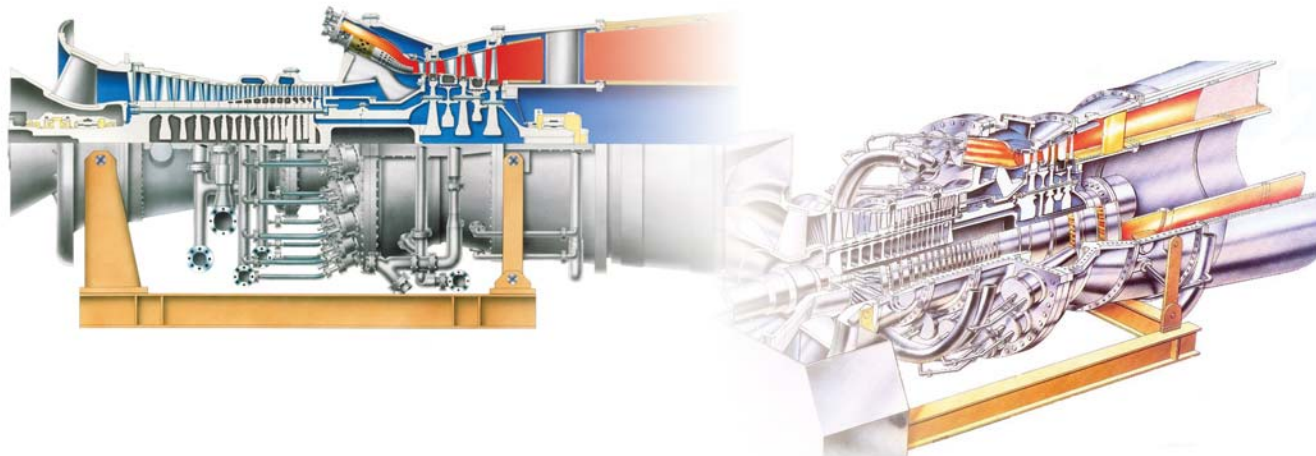
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7FA SCOPE OF SUPPLY

2. GENERATOR

General Information

- Hydrogen cooled generator with conventionally cooled armature
- Outdoor Installation
- 60 Hz generator frequency
- Generator voltage 18.0 kV
- 0.85 power factor (lagging)
- Capability to .90 power factor (leading) @ ISO conditions
- Class "F" armature and rotor insulation
- Class "B" temperature rise, armature and rotor winding
- Generator Bearings
 - End shield bearing support
 - Elliptical journal bearings
 - Rollout bearing capability without removing rotor
 - Insulated collector end bearing
 - Online bearing insulation check
 - Offline bearing insulation check with isolated rotor
- Monitoring Devices
 - Two BN3300 probes per bearing at 45 deg. Angle with monitors
 - Two (2) velocity vibration probes at turbine end, one (1) at collector end
 - Provisions for key phaser-generator
 - Provisions for permanent flux probe
 - Proximity vibration sensors
- Generator Field
 - Direct cooled field
 - Two-pole field
 - Finger type amortisseurs
 - Full-length coil slot amortisseurs

Generator Gas Coolers

- Coolers shipped installed
- Generator gas cooler configuration
 - Five (5) horizontally mounted simplex coolers

- Cooler piping connections on the left side as viewed from collector end
- ASME code stamp
- Single wall cooler tubes
- Victaulic cooler couplings
- Plate fins
- Cooling water manifold and isolation valves
- Generator gas cooling system characteristics
 - Coolant temperature -20 deg. F
 - TEMA Class C coolers
 - Generator capacity with one section out of service 80% with Class "F" rise
 - Maximum cooler pressure capability -125 psi
 - Fouling factor:.002
- Generator gas cooler construction materials
 - 90-10 copper-nickel tubes
 - Carbon steel tube sheets
 - Carbon steel waterbox and coupling flanges with epoxy coating
 - Aluminum cooler tube fins

Generator Lube Oil Systems and Equipment

- Bearing lube oil system
 - Generator lube oil system integral with turbine
 - Sight flow indicator
- Bearing lift oil system
 - Stainless steel lift oil piping and tubing
 - Lift oil supplied from turbine oil system
- Lube oil system piping materials
 - Stainless steel lube oil feed pipe
 - Carbon steel lube oil feed pipe
 - Welded oil piping
 - Flexible pipe as permitted by ANSI 31.3

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7FA SCOPE OF SUPPLY

Generator Grounding Equipment

- Neutral grounding equipment
 - Neutral ground transformer and secondary resistor
 - Mounted in terminal enclosure
 - Motor operated neutral disconnected switch

Generation Temperature Devices

- Stator winding temperature devices
 - 100 ohm platinum RTD's (resistance temperature detector)
 - Single element temperature sensors
 - Four (4) cold gas
 - Two (2) hot gas
 - GTG-2 (common cold gas)
- Bearing temperature devices
 - Chromel alumel (type K) thermocouples
 - Dual element temperature sensors
 - Two (2) bearing metal temperature sensors per bearing
- Collector temperature devices
 - 100 ohm platinum RTD's
 - Single element temperature sensors
 - Collector air inlet temperature sensors
 - Collector air outlet temperature sensor
- Lube oil system temperature devices
 - Chromel alumel (K) thermocouples
 - Dual element temperature sensors
 - One (1) bearing drain temperature sensor per drain

Packaging, Enclosures and Compartment

- Paint and preservation
 - Standard alkyd beige primer
- Generator terminal enclosure (GTE)
- Line-side terminal enclosure
 - Terminal enclosure shipped separate
 - High voltage bushings shipped installed
 - Six (6) ambient air-cooled, high voltage bushings
 - Isolated phase bus duct connection
 - Phase sequence R-C-L when looking at enclosure terminals

Outgoing power connection on right side when viewed from collector end

Lighting arrestors

Voltage transformers, fixed

- Current Transformers
 - Relaying Class C800
 - Metering Class- 0.3B- 1.8 (ANSI C57.13)
 - CT Ratio-800: 5A
 - Line CT's
 - CT16, CT17, CT18
 - CT19 for extension
 - CT19A and CT19C for EX2000
- Neutral Terminal enclosure
 - Integral with lines side terminal enclosure
 - Neutral tie
 - Neutral CT's
 - CT1, CT2, CT3
 - CT4, CT5, CT6
 - CT7, CT8, CT9
 - Top mounted
 - Forced ventilation
- Collector Compartment
 - Collector Compartment shipped separately
 - Outdoor
- Compartment Lighting and Outlets
 - AC Lighting
 - Collector Compartment
- Fountain Hardware
 - Generator Shims
 - Generator Alignment Key(s) – collector end
 - Generator Alignment Key(s) – turbine end
 - Generator Alignment Key(s) – axial

Hydrogen Systems and Accessories

- Hydrogen Control Cabinet
 - NEMA 1 cabinet in collector compartment
 - Hydrogen Gas Manifolds
 - Auto purge gas purge control manifold
 - Hydrogen/CO2 control manifold in collector compartment

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7FA SCOPE OF SUPPLY

- Seal Oil System
 - Control unit mounted in collector compartment
 - Stainless steel seal oil feed pipe
 - Carbon steel seal oil drainpipe

Electrical Equipment

- Motors
 - TEFC Motors
 - Coated with antifungal material for protection in tropical areas
 - High Ambient motor installation
 - Motor Heaters connected to AC power
 - Extra severe duty motors
 - Cast iron motor housing
- Heaters
 - Generator Stator Heaters
 - Generator Collector Heaters
 - Generator Terminal Enclosure Heaters

Generator Excitation Systems, Static Components

- Static excitation with dual hot backup bridge

Excitation Module Features

- Control/ Monitor/Display through TCP
 - Power Factor controller in turbine control system
 - Var controller in turbine control system
 - Selection of automatic or manual regulator
 - Voltage matching in turbine control system
 - Raise-lower of the active regulator setpoint
 - Enter setpoint command
 - Display field amps
 - Display field volts
 - Display transfer volts
 - Display field temperature
- Built-in diagnostic display panel
 - Automatic voltage regulator (AVR)
 - Manual voltage regulator (FVR)
 - Automatic and Manual bi-directional tracking
 - Reactive current compensation (RCC)
 - Volts per hertz limiter (V/Hz LIM)
 - Volts per Hertz protection (24EX) (backup to 24G)

- Over excitation limiter (OEL)
- Offline/online over excitation protection (76EX)
- Loss of excitation protection (40EX)
- Bridge ac phase unbalance protection (47EX)
- Under excitation limiter (UEL)
- Generator over voltage protection (59EX)
- Generator field ground detector (64F)
- VT failure detector (VTFD) (60EX)

- Dual source internal bulk power supply
- Millivolt shunt for field
- Surge protection
 - VT disconnect and CT shorting switches
 - Two phase current sensing (CT's A, C)
 - Three phase voltage sensing
 - Single pole dc field contact/bridge
- Thyristor bridge circuit filtering
- Shaft voltage suppressor circuit (mounted in panel)
 - Field de-excitation circuit (with field discharge inductor)
 - 125 Vdc field flashing circuit (when required)
 - Bridge disconnect: ac no load
- Power system stabilizer

Performance

- 2.0 Response and 160% VFFL (100 degree C) ceiling@ VT=1.0pu
- EX2000 ENCLOSURE LOCATION
- Installed in LCI/EX

LCI Features

- LCI located in LCI/EX compartment
- LCI output isolation switch (89MD)
 - Located in LCI compartment
- LCI disconnect switch (89SS)
 - Located in generator terminal enclosure
- LCI fuse
 - Located in compartment with LCI

PPT Features

- Freestanding oil filled PPT
- PPT fed from auxiliary bus

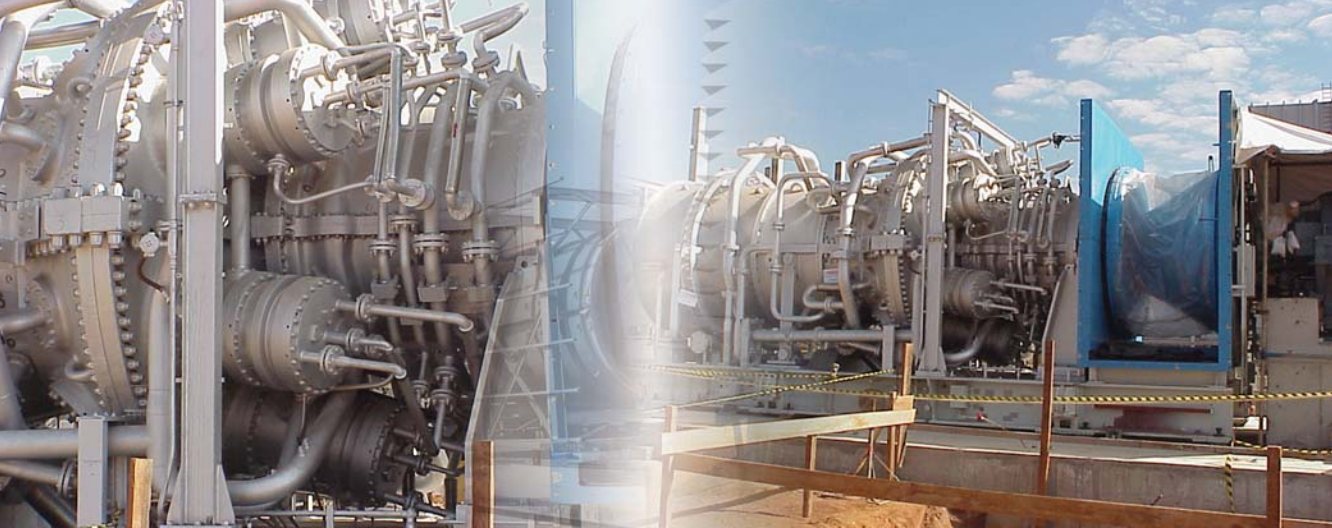
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7FA SCOPE OF SUPPLY

3. GAS TURBINE-GENERATOR CONTROLS & ELECTRIC AUXILIARIES

Control Cab/Packaged Electric and Electronic Control Compartment (PEECC)

- Control panels mounted on a common skid
- Weatherproof, climate control, base mounted enclosure
- Supplemental wall mounted air conditioner by General Electric
- Interconnection cables (hard wire) within enclosures by G. E.
- Interconnection cables (hard wire) between packages by Customer

Gas Turbine Control System Panel Features

- Triple modular redundant (TMR)
- Skid mounted control panels
- Auto/Manual synchronizing module with synchronizing check function
- Generator stator overtemperature alarm (49)
- Droop control
- Load limiter
- Purges cycle
- Customer alarm/trip contact for CRT display
- Additional customer input contacts
- Additional customer output to customer
- Provision for 8 selectable analog inputs from customer
- Provision for 8 selectable analog output from customer
- Wet low NOx data for EPA compliance
- Vibration alarm readout and trip
- Electrical overspeed protection
- Constant settable droop
- Power factor calculation and display
- Power factor control
- VAR Control
- Manual set point pre-selected load
- Mounted in PEECC

Local Operator Station

- Commercial grade personal computer
- Color Monitor
Tabletop
15-inch screen
- Mouse cursor control
- Table top AT 101 keyboard
- Printer
24 pin dot matrix
- Display in English Language
- 50 foot of Arcnet cable between gas turbine control system panel and local operator interface <I> for indoor use
- RS232C two way serial link (MODBUS) via local <I>
Power 120V ac 60 Hz
- Mounted in PEECC

Rotor, Bearing and Performance Monitoring Systems Bentley Nevada 3500

- Performance monitoring systems
Performance monitoring sensors wired to gas turbine control system
- Vibration Sensors
Velocity vibration sensors
Proximity vibration sensors
- Bentley Nevada 3500 Monitor
Relay outputs wired to gas turbine control panel
- Bearing Thermocouples
Bearing Drain thermocouples
Bearing metal thermocouples
- Borescope access holes

Generator Control Panel Generator Control Panel Hardware

- Mounted in PEECC
- Skid mounted with turbine panel

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7FA SCOPE OF SUPPLY

- DGP with test plugs
- DGP without Modbus communication interface
- DGP with communication interface
- DGP with oscillography capture
- DGP with printer port
- DGP with redundant internal power supply
- Generator breaker trip switch (52S/CS)
- Humidity sensor readout
- Bentley Nevada vibration monitor(s)

Digital Generator Protection System (DGP)

- Generator overexcitation (24)
- Generator under voltage (27G)
- Reverse power/ anti-motoring (32-1)
- Loss of excitation (40-1,2)
- Current unbalance/negative phase sequence (46)
- System phase fault (51V)
- Generator overvoltage (59)
- Stator ground detection (64G1)/(59GN)
- Generator over frequency (810-1,2)
- Generator under frequency (81U-1,2)
- Generator differential (87G)
- Voltage transformer fuse failure (VTFF)

Generator Protection Discrete Relays

- Synchronizing undervoltage relay (27BS-1,2)
- Voltage balance relay (60)
- Breaker or lockout trip coil monitor relay (74)
- DC tripping bus, blown fuse protection relay (74-T)
- Generator differential lockout relay

Main Transformer Digital Protection

- SR 745 relay with two restraint windings (86T/87T)

Main Transformer Discrete Relays

- Main transformer lockout relay (86T-1)

Features Integrated into Gas Turbine Control System

- Gas turbine control system with speed matching, synchronization and check
- Manual synchronization displayed on gas turbine control system
- Auto/manual synchronizing module displayed on gas turbine system <1>
- Load control in gas turbine control system
- Temperature indication for generator RTD's

Generator Control Panel Metering

- Generator digital multimeter
 - VM - Generator volts
 - AM - Generator Amps: Phase 1,2,3 and Neutral
 - MW - Generator Mega watts
 - MVAR - Generator Mega VAR's
 - FM - Generator frequency
 - MVA - Generator MVA
 - PF - Generator Power factor
 - MWH - Generator Megawatt Hours
 - MVAH - Generator MVA Hours

Generator Control Panel Transducers

- Generator watt/VAR transducer 4-20 mA output for input to TCP (96GG1)
- Generator TCP/droop control transducer 4-20 mA output (96GW-1)
- Generator power factor transducer 4-20 mA output for customer (96GP-1)
- Generator VAR transducer 4-20 mA output for customer (96GR-1)

Generator Protection

- Generator electrical protection equipment
- Ground brush rigging

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7FA SCOPE OF SUPPLY

Batteries and Accessories

- Lead Acid Battery
- Single phase battery charger
- Battery and Charger mounted in the PEECC

Motor Control Center

- MCC mounted in control cab/PEECC
- Tin-plated copper bus-work
- 42 kA bracing
- 480V 60 Hz auxiliary power

Motor Features

- TEFC motors (200hp)
- Coated with anti-fungal material for protection in tropical areas
- High ambient motor insulation
- Energy saver motors
- Extra severe duty motors
 - Cast iron motor housing
 - All redundant motors to be lead/lag
 - Motor heaters
 - Rated 110/120 volts, 50/60 hertz
 - WP motors > 200 hp
 - Trunions for generator
 - On loan basis only
 - Jacking bolts for generator
 - Foundation/installation washer and shim packs
- Power Systems Studies
 - Provided by customer

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7EA SCOPE OF SUPPLY

Includes one complete combustion turbine generator unit with GE's standard equipment as well as special accessories and services detailed below.

- Lubricating oil system with water/oil coolers and stainless steel supply oil piping and carbon steel return oil piping common to the combustion turbine and generator
- Natural gas valve train and control package
- On and off line compressor water wash system
- 4,160V AC motor starting system
- Hydraulic ratchet rotor turning system arranged for automatic engagement and disengagement complete with a jog switch
- Inlet silencer, self-cleaning pulse type filters, ductwork expansion joints & supports
- Exhaust flange
- Enclosure with acoustic treatment and barrier walls along the GT exhaust plenum
- Control and protection system including provisions for interconnection to Purchaser's DCS system via an RS232C (Modbus)
- Vibration and temperature instrumentation and monitoring system including a Bentley-Nevada system for interfacing with the Purchaser's DCS
- Mark V turbine control system that includes one (1) local and one (1) remote Windows based interface system
- Inlet bleed heating system including the inlet duct bleed heat manifold and the GT air extraction piping system
- Air intake anti-icing provisions
- Coolers designed with 90-10 copper nickel tubes
- On base instruments include: platinum stator RTDs, oil & bearing thermocouples, flux probe and Bentley vibration probes
- All electrical equipment meets CSA codes
- Generator line side equipment located in a skid mounted enclosure complete with generator circuit breaker, draw-out voltage transformers, surge protection and one set of current transformers
- Generator neutral grounding equipment located in a skid mounted enclosure complete with four sets of current transformers
- Redundant generator protections (GE DGP and Multilin SR-489 relays)
- Generator control through the Mark V turbine control system includes: auto-synchronizing, metering, isochronous and droop control modes
- Space heater

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7EA FACT SHEET

Simple Cycle Performance	60Hz Power Generation	Mechanical Drive
Output	85.4 MW	115630 hp
Heat Rate	10420 Btu/kWh (10991 kJ/kWh)	9795 Btu/shp-hr
Pressure Ratio	12.6:1	11.9:1
Mass Flow	643 lb/sec (292 kg/sec)	659 lb/sec (299 kg/sec)
Turbine Speed	3600 rpm	3600 rpm
Exhaust	998°F (537°C)	998°F (537°C)
Model Designation	PG7121EA	M7121EA

Combined Cycle Performance	60Hz (S109EA)	60Hz (S207EA)
Net Plant Output	103.2 MW	263.6 MW
Heat Rate	6800 Btu/kWh (7175 kJ/kWh)	6700 Btu/kWh (7070 kJ/kWh)
Net Plant Efficiency	50.2%	50.9%
GT Number & Type	1 x MS7001EA	2 x MS7001EA

Generator

Manufacturer	Brush
Type	BDAX 8-365er (Brushless)
Excitation System	GE Ex2000 Terminal
Voltage	13.8 Kv, 2 Pole, 3 Phase, Wye Connection Frequency 60 Hertz
Power Factor	.85 Power Factor
Rated Output	86.53 Mw/101.8 Mva
Cooling	Air

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