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## **Introduction**

Derwick Associates S.A. proposes to supply a group of gas turbine-based simple cycle power plant equipment nominally rated at 170 MW that contains two (2) GE Frame 7EA ("7EA") gas turbines with test hours only. Industrial gas turbines are not normally tested prior to installation; the completed testing of these turbines will significantly reduce the installation time. These are completely operational units and ready to be disassembled and transported to your job site.

## **Scope of Supply**

The following is a complete description of the Frame 7EA gas turbine units which Derwick Associates S.A. is quoting:

### **Two GE Frame 7EA Gas Turbines**

2X Gas fueled General Electric (PG7121) 7EA Dry Low NO<sub>x</sub> (DLNI) gas turbine rated at 84.4 MW ISO / 60 Hz (59 °F/15 °C, sea level, 60% RH).

### **Brush-Generator**

Air cooled Brush BDAX 8.365 ER generator with an EX2000 brushless excitation system that is rated at 101.8 MVA@0.85 PF, 13.8 kV, 3600 rpm, 60 Hz, 3 phases. The generator is a synchronous two-pole cylindrical rotor machine.

- **Generator Air Filter**  
Donaldson self cleaning, single stage, pulse clean filter system.
- **Generator-Control-System**  
The Generator Control System includes a Beckwith, Automatic Voltage Regulator (AVR), Digital Generator Protection (DGP) and Nexus 1250 metering module. The system is located in the PEECC and interfaces directly with the turbine control system. Other components included in the generator control system include the GE Multilin transformer protection relay, the EX2000 Excitation System and the lock out relays
- **Generator Auxiliary Compartment**  
Contains the GE 15 kV vacuum circuit breaker. The 15 kV class, vacuum, metal clad switchgear is installed in a NEMA 3R enclosure. Circuit breaker charging and trip/close mechanisms operate from a 125 VDC battery supplied system.

- **Generator Lineside and Neutral Grounding Equipment**

The generator lineside equipment for the gas turbine generators is contained within the 15 kV switchgear that connects the generators to the generation bus. The neutral grounding equipment for the gas turbine generators, consisting of a typical transformer/resistor combination, is contained on the GTG skid within the generator package. The lineside and neutral grounding equipment is comprised of connections, surge arresters, surge capacitors, CTs, PTs and grounding transformers and resistors.

**Accessory Module**

Skid containing the 800 hp electric starting motor, auxiliary gearbox, torque converter and the following equipment for the lube oil system: integrated tank, filter, tube and shell heat exchanger, AC and DC pumps.

**Exhaust Frame Blowers**

Two air blowers provide cooling air to the rear frame of the gas turbine.

**Turbine Inlet Filter**

Donaldson air inlet filter system for the turbine provides clean filtered air for combustion use. The unit includes the louvered inlet, inlet heating, synthetic canister filter elements, pulse cleaning system, turbine inlet silencer, ductwork, ladders/platforms and support steel.

- **Fogging System**

A MEE Industries fogging system consisting of one pump skid, one sub-micron water filter and six high pressure pumps provides a cooling effect to the turbine inlet air by injecting demineralized water under high pressure directly into the inlet air stream. By lowering the temperature of the inlet air, the power output and the efficiency of the turbine is increased.

The skid with a design flow rate of 37.6 gpm contains six high pressure Cat Pump pumps. Five 10 hp pumps are rated for 7 gpm each and one 5 hp pump is rated for 3.5 gpm each for a total water pumping capacity of 38.5 gpm.

- **Air Processing Unit**

Air processing unit provides pressurized air for pulse cleaning of the turbine and generator inlet air filters and instrument actuation. The system dries and cools compressor bleed air.

## Fuel Gas Module

Fuel gas is controlled with the fuel gas stop/ratio valve, gas control valve (GCV), gas splitter valve (GSV) and the gas transfer valve (GTV) assemblies. The stop/ratio valve and the GCV work in conjunction to regulate the total flow to the gas turbine and the GSV and GTV are used to control the distribution of the fuel flow delivered to the GE DLNI combustion chambers. Servo valves, controlled from the TCS control panel, actuate the gas system valves. The system is designed to deliver natural gas fuel at the correct pressure and flow rates to meet all starting, acceleration and loading requirements of gas turbine operation. The following major components comprise the off-base fuel gas system:

- Gas Strainer
- Gas flow meter (corrected)
- Block valves
- Electronic flow control valves
- Electronic and local instrumentation

Fuel gas from the off-base supply system passes through the strainer. The fuel gas flow is controlled by the block valves and electronic control valves before passing to the distribution manifolds and combustion systems. The position of these valves is servo-controlled by electrical signals from the TCS position feedback signals

A flow meter measures fuel gas consumed by the gas turbine. The control valves are activated by the turbine control system to provide the amount and distribution of fuel required by the turbine for a given load or speed. The block valves shut off fuel flow to the turbine when necessary.

## Packaged Electrical and Electronic Control Center (PEECC)

A control module for each gas turbine is provided to minimize field installation. The control module is designed to accommodate the turbine control system, motor control center (MCC), lighting/distribution transformer, misc. electrical panels, battery system, and the Generator Control System. The module is supplied with an HVAC system and ceiling mounted fluorescent lighting fixtures.

- **480V MCC**  
A 480V motor control center, located in the PEECC, serves the gas turbine generator. This includes the 480 VAC and 120 VAC and 120 VDC distribution panels.

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- **Batteries System and UPS**  
125 VDC batteries with two chargers, for reliability. The battery charger maintains the station batteries in a fully charged condition. The uninterruptable Power Supply (UPS) provides power for plant control system backup and protection.
  - **Turbine Control System**  
GE Mark VI Speedtronic Turbine Control System (TCS) that provides operating and controls sequencing for the safe operation and control of the package. The TCS is located inside the Packaged Electrical and Electronic Control Center (PEECC) and is rated for an indoor, non-hazardous environment.

Starting of the gas turbine is accomplished using a closed loop process of temperature and/or speed control for an electrically driven torque converter system for consistent and reliable starts. Bumpless transitions between start, temperature, and speed PID's minimizes wear and reduces maintenance requirements of the package. Temperature and speed rate control during startup allow the turbine to warm up to the manufacturer's specifications.

Generator output controls offer multiple modes of operation. User selectable modes allow for operation of gas turbine on isolated grids. Manual, Megawatt, and Frequency modes are easily selected through the appropriate screens of the Human Machine Interface (HMI).

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## **Balance of Plant Equipment**

### **Mechanical Systems**

- **Lube Oil Demister**  
R.K. Chase mist eliminator system.
- **Fuel Gas Heater**  
500 kW Watlow heater capable of increasing the temperature of the gas 50°F to meet the superheat requirement.
- **Fuel Gas Scrubber**  
National Filtration System vertical dry scrubber knocks out drum that utilizes centrifugal action to achieve last stage removal of solids and entrained liquids. The capacity of the scrubber is 22,100 scfm.
- **Cooling Water Module**  
The cooling water system provides the cooling requirements for the lubricating oil, turbine support legs and flame detectors. The major equipment includes an expansion tank, an air cooled heat exchanger and two circulating pumps. The system utilizes a coolant consisting of a solution of 50% ethylene glycol in demineralized water.

Bailiff Enterprise's 178 gallon expansion tank is open to the atmosphere to allow for coolant expansion due to increases in ambient temperature.

Ecodyne forced draft air heat exchanger designed to supply coolant at a temperature not to exceed 125°F.

Two 75 hp Goulds Pumps, 100% capacity, rated at 967 gpm.

- **Carbon Dioxide Fire Extinguishing System**  
The carbon dioxide (CO<sub>2</sub>) fire protection system supplied by Chemtron for GT fire protection is designed to reduce to an acceptable level the risk of a fire developing within the gas turbine that could result in damage to the plant and/or possible loss of life.

The system consists of the following major components that are located both on base and off base:

- 1) CO<sub>2</sub> tank system
- 2) Discharge pipes and nozzles
- 3) Pilot cylinder and solenoid valve
- 4) Isolating valves and limit switches
- 5) Fire (heat) detectors
- 6) Pressure switches

CO<sub>2</sub> is supplied to a distribution system that conducts the extinguishant through pipes to discharge nozzles located in the various compartments of the gas turbine.

The solenoid valve that opens the CO<sub>2</sub> tank and initiates the discharge is located on the skid. This solenoid valve is automatically actuated by the fire panel when it receives an electrical signal from the heat-sensitive fire detectors that are strategically located in the various compartments of the unit. The system may also be actuated manually in the event of an electrical power failure by means of a lever at the top of each CO<sub>2</sub> tank. Actuation of the system, either electrically or manually, will trip the gas turbine.

Within a few seconds after actuation, a sufficient CO<sub>2</sub> flow from the initial charge system into the compartment of the machine to rapidly build up to an extinguishing concentration. This concentration is maintained for a prolonged period of time by the gradual addition of more CO<sub>2</sub>.

### **Exhaust Stack**

92' Braden simple cycle exhaust stack with silencer panels and emissions monitoring

### **Electrical Systems**

The electrical system is comprised of the generator and associated equipment necessary to supply power to its auxiliary electrical equipment and systems as well as deliver power to the switchyard.

Each of the generators generates electrical power at 13.8 kV, 3-phase, 60 Hz. The output of each will be connected to a generation bus via its own 15 kV class, vacuum type, metal clad, and circuit breaker

Station service power will be supplied from the utility system by backfeed during plant start-up, shutdown, and maintenance periods. The station service power will be supplied at 480V, 3-phase from one of the two station service busses which are fed by the two station service transformers.

Each generator will be synchronized to the utility system by closing its respective 15 kV circuit breaker.

- **Power Distribution Center (PDC)**

The PDC contains various breakers and control equipment including: motor starters, motor management relay, and switchgear breakers for the MCCs located in the PEECC. Other equipment such as the heat trace panel, BOP MCC, UPS, and 125VDC power distribution are also in the PDC.

- **Auxiliary Transformers**

Two low voltage distribution transformers manufactured by Virginia Transformer, suitable for outdoor service, one rated at 13.8 kV/480V, 2341 KVA and one rated at 13.8 kV/4160V, 3000 KVA.

- **Generator Step-Up Transformer**

230 kV Ferranti Packard generator step-up (GSU) transformer, including appropriate protection. The GSU is rated at approximately 200 MVA. Its purpose is to step the 13.8 kV outputs of the generators up to 230 kV as required for interconnection to the utility transmission system.

- **Switchyard Equipment**

- Includes an SF-6 breaker and air switch, CTs, PTs and appropriate relaying, protection and control equipment.

## **Commercial**

There were a number of plants which were available several years ago similar to this one but they have all since been sold and relocated. The Derwick Associates S.A. team has relocated (8) of these Frame 7EA machines and constructed new power plants in the US utilizing the relocated units. Based on our experience, we propose to provide the same services for your company.

These are complete operational units and ready to be disassembled and transported to your job site. The serial numbers of the units are as follows:

**Serial Numbers: 297635, 297636**

## **Price**

**ALL EQUIPMENT IS SUBJECT TO PREVIOUS SALE**

## **Payment**

<b>Transfer Instructions:</b>	
Intermediary Bank: Citibank, N.A. ABA: 021000089  Address: 111 Wall Street, New York, NY 10043	Beneficiary: International Union Bank, S.A. Account: 36246731 Address: Ave. Samuel Lewis, Edif. Omega Piso 5, Apartado 0391 Wtc Panamá, Republica de Panamá  FFC: Davos International Bank/000767- 224-001  Ref: Derwick Associates/ 13102362

## **Availability**

These units are currently available for immediate purchase. Disassembly and transport to the nearest port can be completed in less than 30 days (Optional) from date of contract and receipt of payment.

## **Validity**

This proposal is valid for a period on 30 days.



## Typical Performance Characteristic Curves

## General Electric Model PG7121EA Gas Turbine

### Estimated Performance - Configuration: DLN Combustor

Compressor Inlet Conditions 59 F (15 C), 60% Relative Humidity

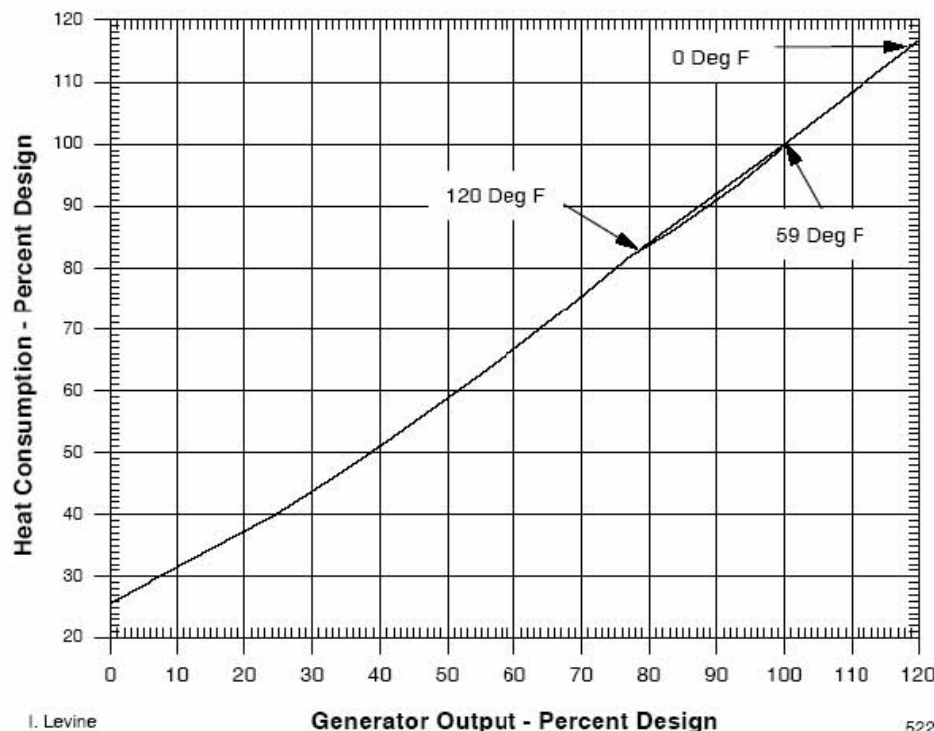
Atmospheric Pressure 14.7 psia (1.013 bar)

Fuel:			Natural Gas	Distillate
Design Output	kW		84360	82890
Design Heat Rate (LHV)	Btu/kWh (kJ/kWh)		10480 (11050)	10570 (11150)
Design Heat Cons (LHV)	Btu/h (kJ/h)x10 <sup>6</sup>		884.1 (932.5)	876.1 (924.2)
Design Exhaust Flow	lb/h (kg/h)x10 <sup>3</sup>		2361 (1071)	2368 (1074)
Exhaust Temperature	deg. F (deg. C)		998 (536.7)	999 (537.2)
Load			Base	Base

#### Notes:

- Altitude correction on curve 416HA662 Rev A.
- Ambient temperature correction on curve 522HA283 Rev 2.
- Effect of modulating IGV's on exhaust temperature and flow on curve 522HA284 Rev 2.
- Humidity effects on curve 498HA697 Rev. B - all performance calculated with a constant specific humidity of .0064 or less as not to exceed 100% relative humidity.
- Plant Performance is measured at the generator terminals and includes allowances for the effects of inlet bleed heating, excitation power, shaft driven auxiliaries, and 3.5 in H<sub>2</sub>O (7.29 mbar) inlet and 5.5 in H<sub>2</sub>O (13.70 mbar) exhaust pressure drops and a DLN Combustor.
- Additional inlet and exhaust pressure loss effects:

	% Effect on		Effect on	
	Output	Heat Rate	Exhaust Temp.	
4 in Water (10.0 mbar) inlet	-1.40	0.42	1.9F (1.0C)	
4 in Water (10.0 mbar) exhaust	-0.42	0.40	1.8F (1.0C)	



I. Levine  
8/17/98

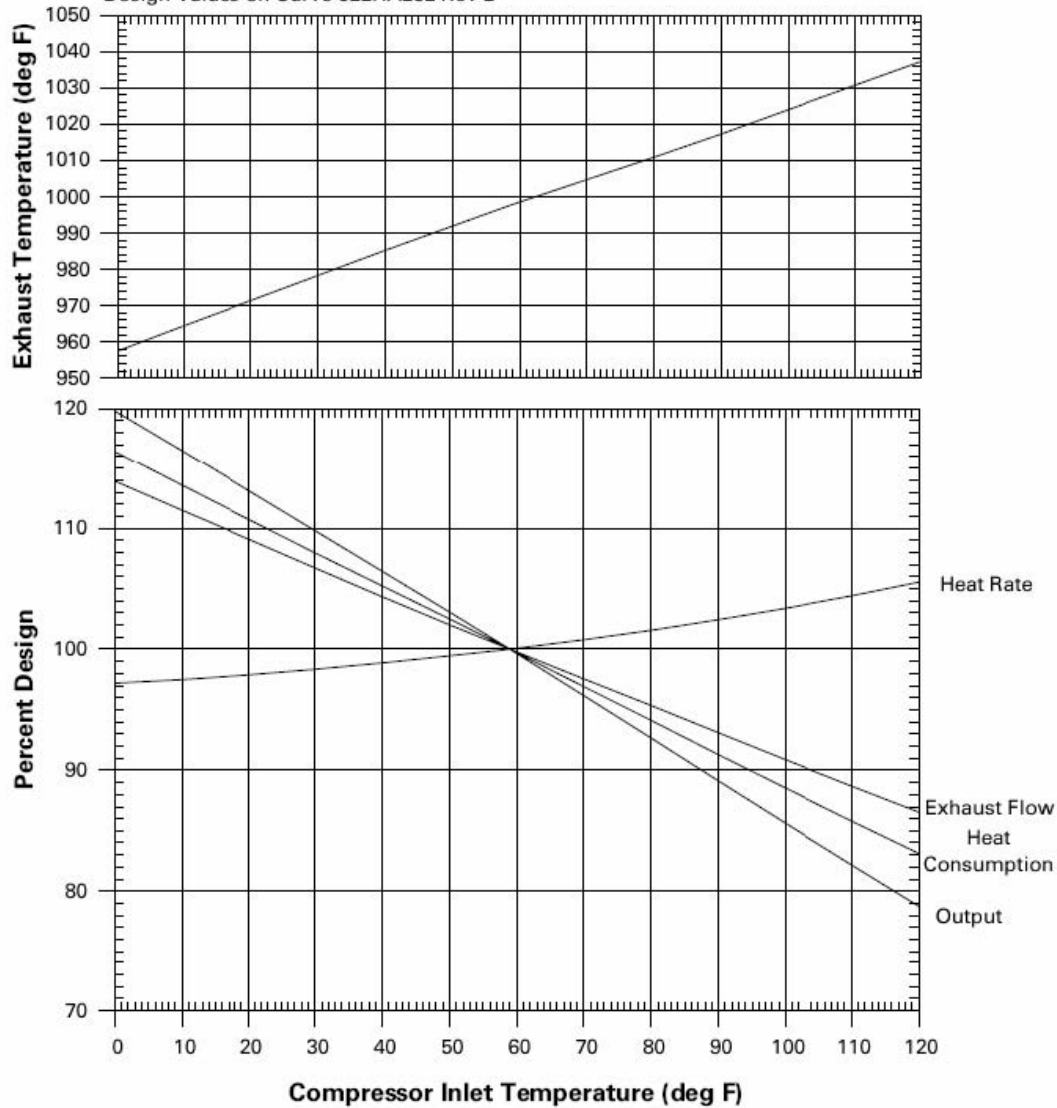
Generator Output - Percent Design

522HA282  
Rev - 2

## GENERAL ELECTRIC MODEL PG7121EA GAS TURBINE

**Effect of Compressor Inlet Temperature on  
Output, Heat Rate, Heat Consumption, Exhaust Flow  
And Exhaust Temperature at Base Load and 100% speed.**

Configuration: DLN Combustor  
Fuel: Natural Gas  
Design Values on Curve 522HA282 Rev 2



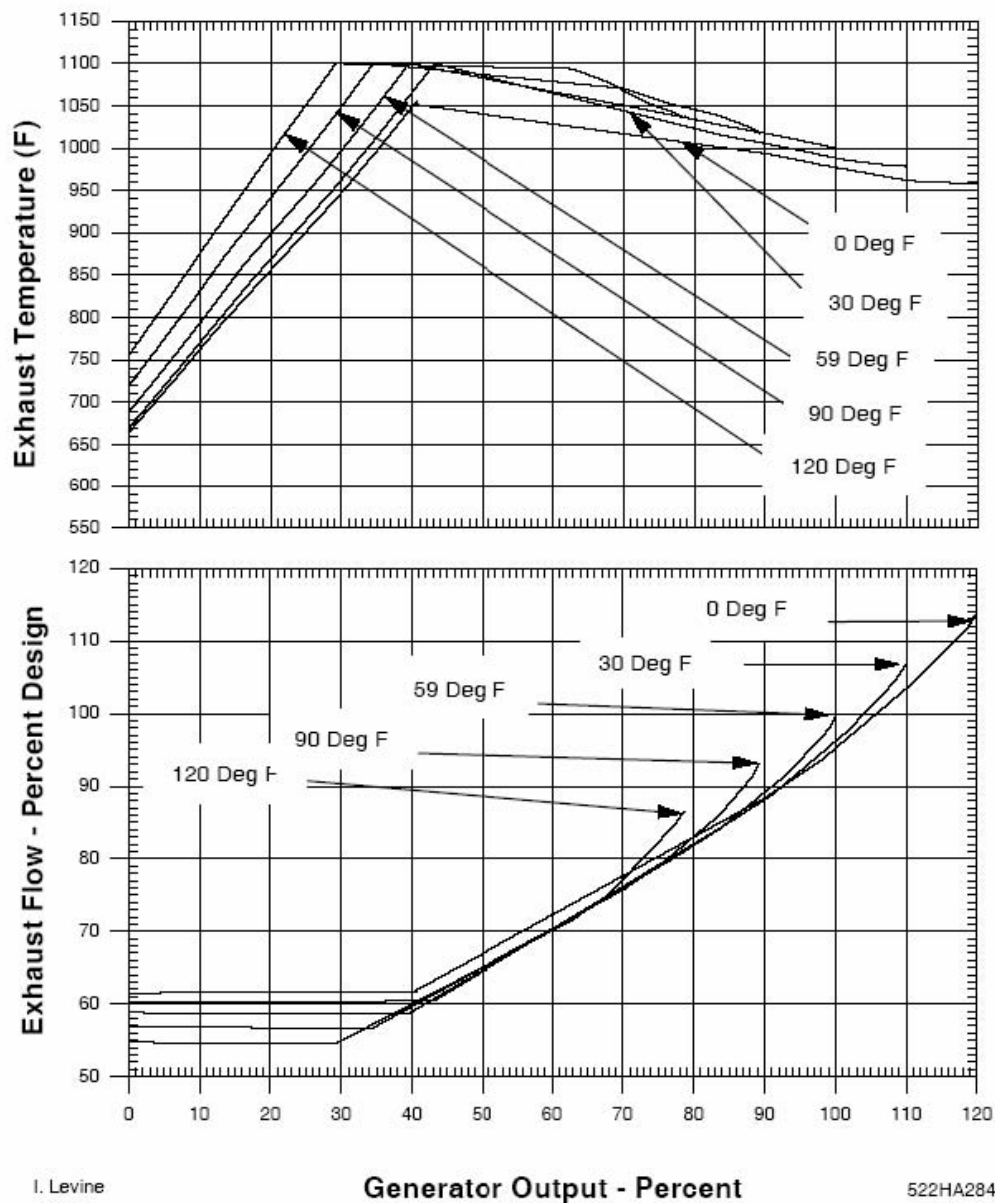
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522HA283  
Rev - 2

## GENERAL ELECTRIC MODEL PG7121EA GAS TURBINE

### Effect of Inlet Guide Vane on Exhaust Flow and Temperature As a Function of Output and Compressor Inlet Temperature

Fuel: Natural Gas  
Design Values on Curve 522HA282 Rev 2



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Generator Output - Percent

522HA284  
Rev - 2





