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Product Specification

Technical Specifications and Descriptions for the Capstone Pre-Engineered Combined Heat & Power (CHP) Solution

Summary

This Product Specification describes a Capstone Pre-Engineered CHP Solution for use in combined heat and power (CHP) operation. CHP allows the user to realize the benefits of usable electrical and thermal power from a single fuel source. The electricity provides on-site power generation for baseloading, peak shaving, and capacity addition in conjunction with local utility power. The heat offsets or replaces local thermal loads such as domestic hot water, space heating, pool heating, and industrial process hot water.

The major CHP system components are two Capstone C60 MicroTurbines, one Unifin MG-4C2 heat recovery unit, and a choice of one or two fuel gas boosters depending on facility gas pressure. The system will allow a user to realize the high total system efficiency below with respect to the incoming fuel energy. This provides economical operation and operational flexibility to the user.

Performance Ratings at Full Power Output

Capstone C60 MicroTurbines

Refer to Capstone Document 460000, Product Specification, for general information on the performance of the Capstone MicroTurbine platforms.

Electrical Performance

The performance ratings are listed at full power output and ISO conditions, which are defined as: 15 °C (59 °F), 60% relative humidity, and sea level altitude. Table 1 below presents the electrical performance ratings for a MicroTurbine operating in Grid Connected mode.

Table 1
Electrical Performance of Two Grid Connected C60 MicroTurbines at Zero Back Pressure and Meeting Fuel Input Requirements

Net Power Output	120 (+0/-4) kW net 166 kVA max at 480 VAC 200A per phase max continuous 50/60 Hz (without gas compression)
Net Electrical Efficiency (LHV)	See Table 4
Nominal Heat Rate (LHV)	12,900 kJ (12,200 Btu) /kWh
Voltage Operating Range	360 to 528 VAC
Frequency Operating Range	50/60 Hz
Output Voltage Connection	3-phase, 3 or 4 wire wye (grid must be neutral grounded)
Output Current	200A RMS maximum steady state
Output Current Total Harmonic Distortion	IEEE 519 compliant, 5%

Ambient Temperature Derating

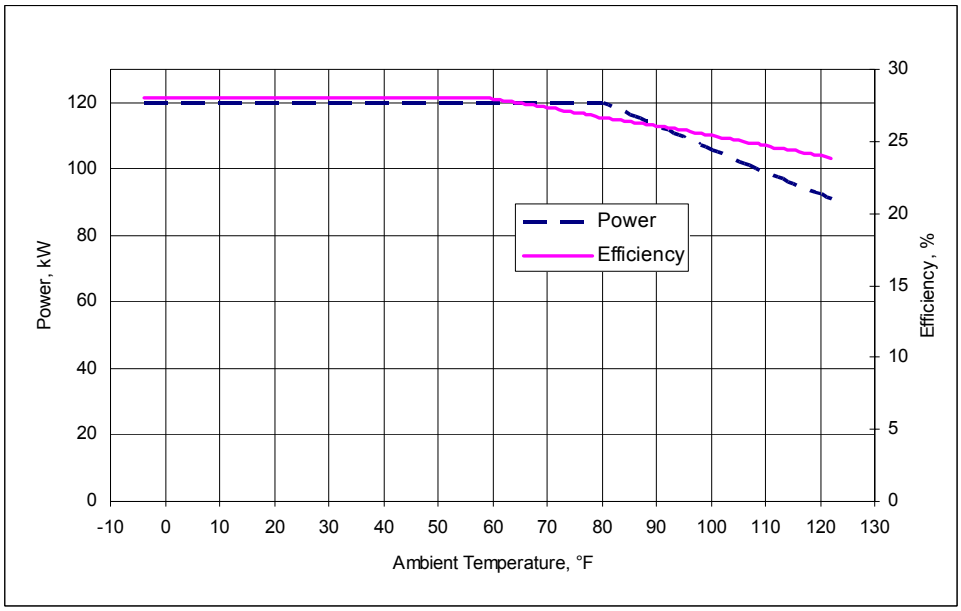

Figure 1
Nominal CHP System Zero Back Pressure Full Power Output and Electrical Generation Efficiency versus Ambient Temperature at ISO Conditions (without Gas Compression)

Back Pressure Derating

The maximum allowable exhaust back pressure on each MicroTurbine is 8 inches of water column. The Unifin heat exchanger and associated ducting already create approximately 4 inches water column (WC) back pressure, so any additional ducting should be minimized and not add more than 4 inches water column of additional back pressure.

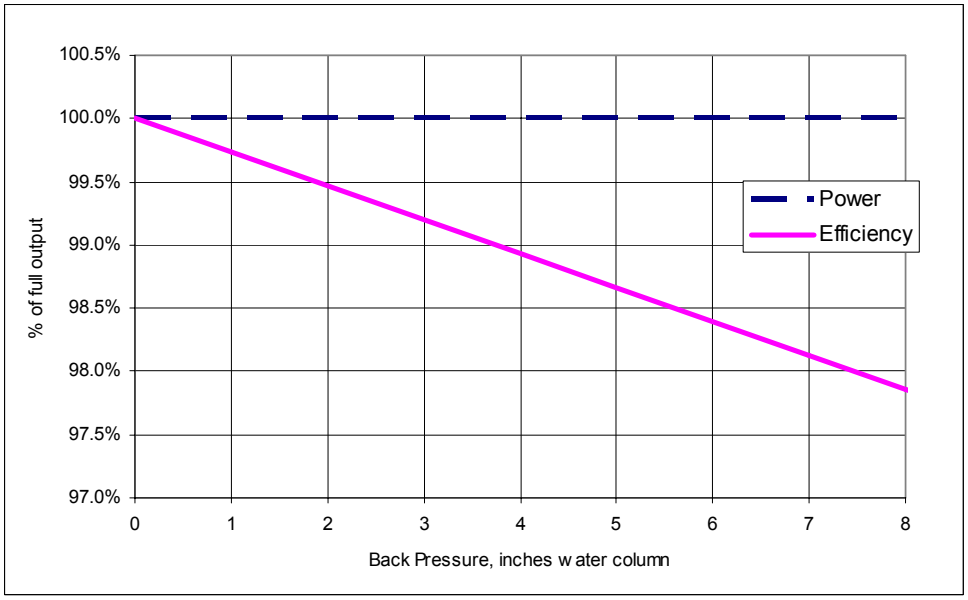

Figure 2
CHP System Fraction of Zero Back Pressure Full Power Output and Efficiency versus Back Pressure at ISO Conditions

Fuel Input Requirements

The Capstone CHP fuel input requirements at full power output and ISO conditions are:

Natural Gas Heat Content Range (HHV)	Nominal Fuel Flow (HHV) (Notes 1 and 2)
38,250 – 44,570 kJ//m3 (970 – 1,130 Btu/scf)	1,698,000 kJ/hr (1,608,000 Btu/hr)

Note 1: The ratio of Higher Heating Value (HHV) to Lower Heating Value (LHV) is assumed to be 1.1.

Note 2: At start-up, transient input fuel flow requirements might be up to 1.5 times the noted values.

Inlet & Exhaust Flows

Table 2 summarizes the nominal air inlet and exhaust flow ratings of the Pre-Engineered CHP Solution.

Table 2
CHP System Inlet Air and Exhaust Flows at Full Power Output

Engine Inlet Air Flow	850 L/s (1,800 cfm)
Engine Inlet Air Temp (Note 1)	-20 to 50 °C (-4 to 122 °F)
Electronics Controller Inlet Air Temp (Note 2)	-20 to 50 °C (-4 to 122 °F)
Electronics Controller Inlet Air Flow (Note 3)	472 L/s (1,000 cfm)
Nominal Exhaust Gas Temp (Note 4)	305 °C (580 °F)
Nominal Total Exhaust Energy	1,142,000 kJ/hr (1,082,000 Btu/hr)
NOx Emissions	<9 ppmv @ 15% O_2
Acoustic Emissions Ratings	73 dBA at 10 m (33 ft)

Note 1: The Engine Dump Valve exhausts air at 227 °C (441 °F) in bursts during rapid deceleration (as in the normal warm down cycle, and also in an Emergency Stop event).

Note 2: The Electronics Controller inlet air temperature must be within 2 °C (3.6 °F) of the Engine inlet air temperature.

Note 3: These values for the Model C60 are comprised of 118 liters/sec (250 CFM) for the Load Control Module and 118 liters/sec (250 CFM) for the Electronics Control Module.

Note 4: This is the final exhaust temperature if the heat exchanger is bypassing exhaust heat. Temperature will be lower while recovering heat.

Unifin Heat Exchanger

In heat recovery mode, the Unifin heat exchanger recovers the exhaust energy of two C60 MicroTurbines. Table 3 below shows the Pre-Engineered CHP Solution heat recovery at various inlet water temperatures.

Table 3
Heat Recovery Performance of CHP System at Varying Water Inlet Temperatures

Water Temperature (°F / °C)		Heat Recovery (Thousand Btu/hr / kW_t)
Inlet	Outlet	
80 / 27	102 / 39	904 / 265
140 / 60	160 / 71	800 / 234
200 / 93	217 / 103	700 / 205

Conditions:

- ±10% performance range
- 80 gal/min water flow
- Full power output @ 120 kWe
- ISO Conditions (59°F/15°C @ sea level)

Copeland Fuel Gas Compressor

Using two Copeland fuel compressors allows the system to operate with as low as 0.3 psig of inlet gas pressure with no startup restrictions. Over 2.5 psig, however, the Pre-Engineered CHP Solution can operate with a single compressor. Depending on inlet pressure, system startup requirements vary when using a single compressor as summarized in Table 4 below.

Table 4
Startup Performance of CHP System using Copeland Compressor in Grid-Connected Operation

Mode	Inlet Pressure (psig) (Note 1)	Net Electrical Efficiency (%) (Note 2)	Startup Requirements
1	0.3 – 2.5	26.5	**Use two compressors:** No startup restrictions; user may start both C60 MicroTurbines at the same time.
2	2.5 – 10	26.7	**Use one compressor:** A staggered start is required where the first system must be operating at *steady state* before the second system is started. Wait 10 minutes between starting first and second C60.
3	10 – 15	27.0	**Use one compressor:** No startup restrictions; user may start both C60 MicroTurbines at the same time.

Note 1: The Copeland compressor is NOT capable of operation with less than 0.3 psig gas inlet pressures. The maximum compressor inlet pressure requirement is 15 psig.

Note 2: A ±2% performance range on net electrical efficiency.

Dimensions & Weights

The following table summarizes the dimensions and weights of each individual major CHP component (not including interconnecting hardware).

	Model C60	Unifin	Copeland
Height	2,110 mm (83 in)	1,783 mm (70 in)	1,178 mm (42 in)
Width	762 mm (30 in)	873 mm (34 in)	601 mm (24 in)
Depth	1,956 mm (77 in)	1,222 mm (48 in)	1,072 mm (46 in)
Weight	758 kg (1671 lb)	370 kg (820 lb)	250 kg (550 lb)

Storage Temperature Ratings

The MicroTurbine may be stored within a temperature range of -40 to 65 °C (-40 to 149 °F).

Certification Information

Certification details are provided in the Capstone MicroTurbine Compliance List. Please contact Capstone for the latest Certification information.

Warranty Information

Warranty details are provided in the Capstone Standard CHP Warranty certificate (Capstone Document 460004).

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Notes and Related Information