Attachment B - CHP Program – CHP Module Qualification Data Form		
Category	**Units**	**Information Required***
Prime Mover		Provide data for 100%, 75%, 50% and 25% load where appropriate
Manufacturer		
Model		
Capacity	kW	
Fuel required	scfm	
Fuel pressure	inches water or psia (please indicate)	
Fuel Booster compressor power (if required)	kW	
Exhaust temperature	°F	
Exhaust flow rate	scfm	
Exhaust pressure available for external use (e.g. HRSG if applicable)	psig	
NOx emissions	lb/MWhe	
PM10 emissions	lb/MWhe	
PM2.5 emissions	lb/MWhe	
CO emissions	lb/MWhe	
VOC emissions	lb/MWhe	
Noise	dBA	
Generator/Inverter		☐ Synchronous ☐ Inverter ☐ Other
Manufacturer		
Model		
Power output rating	kW	
Power output rating	kVA	
Rated voltage	V	
Rated efficiency	%	
Rated current	Amps	
Minimum operation frequency/time	Hz/sec.	
Connection		☐ Delta ☐ Wye ☐ Wye grounded
Total system type tested		☐ Yes ☐ No Provide documentation
Equipment type tested (inverter, protection system)		☐ Yes ☐ No Provide documentation
Synchronous		☐ Salient ☐ Non-salient Attach copies of saturation and Vee curves
Rated speed	RPM	
Torque	ft-lbs	
Field amps at rated voltage and current	Amps	

Field power factor over-excited	%	
Type of exciter		
Output power of exciter	W	
Type of voltage regulator		
Locked rotor current	Amps	
Direct-axis synchronous reactance (X_d)	ohms	
Direct-axis transient reactance (X'_d)	ohms	
Direct-axis sub-transient reactance (X''_d)	ohms	
Inverter		☐ Forced commutated ☐ Line commutated
Heat Recovery		
Hot Water		
Manufacturer		
Model		
Maximum continuous HW supply temperature	°F	
Minimum return HW temperature (excluding dump radiator heat transfer)	°F	
Maximum energy available at the HW supply temperature	Btu/h	
Maximum energy available given the above HW supply and return temperatures	Btu/h	
Chilled Water		☐ Exhaust ☐ Hot water ☐ Hybrid
Manufacturer		
Model		
Minimum continuous chilled water supply temperature	°F	
Maximum supply/return temperature differential	°F	
Maximum energy available at the minimum chilled water supply temperature	Btu/h	
Chiller Coefficient of Performance		
Useful thermal energy required from the prime mover to deliver the maximum energy available at the minimum chilled water	Btu/h per thermal stream including required supply temperatures	
Steam (HRSG)		
Input (e.g. turbine exhaust at HRSG inlet) temperature	°F	
Input (e.g. turbine exhaust at HRSG inlet) flow rate	scfm	

HRSG pressure drop	psig	
Feed water inlet temperature	°F	
Steam output pressure	psig	
Steam output flow rate	lb/hr	
Steam output temperature	°F	
Steam output energy	Btu/h	
System Performance		
Net Electric Efficiency[1] (HHV)	%	
Thermal Energy Available Efficiency[1] (HHV)	%	
CHP Efficiency[1] (HHV)	%	

***Note:** All system performance, fuel consumption and emissions data must be provided at full and part load conditions. Part load is defined as 75%, 50% and 25% of full load capacity. If the CHP Module consists of multiple prime mover/generators, complete a data form for the prime mover/generator and for the CHP Module as a whole.

[1] Show complete calculation

Net Electrical Efficiency

Net electrical energy output is a calculated value that indicates the usable electrical power a system (in contrast to a product) delivers and accounts for the energy required in operating the system. The external parasitic loads shall be identified during test plan development prior to testing and included in the test report.

The net electrical output is calculated based on the total electrical energy out of the system, integrated over the test duration, less all external parasitic losses, such as heat transfer fluid pumps and fans that are outside the product boundary, but inside the system boundary. The net electrical energy produced is given by:

$E_n = E_g – E_a$

Where:

E_a = total auxiliary electrical energy requirements
E_g = total (gross) electrical energy measured
E_n = net electrical energy in kW/h

Net electrical efficiency is the indication of fuel to electricity conversion efficiency of the DG product considering internal and external parasitic losses and accounting for the actual fuel required to operate the CHP product and is based on Higher Heating Value (HHV).

$$\eta_{ne} = \frac{E_n \text{ x } 3412}{Q_i}$$

Where:

η_{ne} = net electrical efficiency based on HHV
Q_i = total fuel into the system (Btu) based on HHV
3,412 = conversion factor from kWe to Btu/hr (Btu/kW·hr)

Thermal Efficiency

Hot Water Supply System

Thermal efficiency is a measure of energy utility; that is, the percentage of total fuel input which is captured and put to useful service by conversion to thermal energy and is based on Higher Heating Value (HHV).

$Q_{hw} = m \text{ x } C_p \text{ x } \Delta T$

or,

$Q_{hw} = F_{hw} \times K \times \Delta T$

Where:

Q_{hw} = hot water supply in Btu/h
m = mass flow rate of water in lb/h
F_{hw} = hot water flow rate in gpm
ΔT = temperature differential (supply temperature – required return temperature)
K = conversion factor from gpm to lb/h [2]
C_p = for water = 1 Btu/lb

$$\eta_{hw} = \frac{Q_{hw}}{Q_i}$$

Where:

η_{hw} = net thermal hot water efficiency based on HHV
Q_i = total fuel into the system (Btu/h) based on HHV

Chilled Water Supply System

Thermal efficiency is a measure of energy utility; that is, the percentage of total energy input, which is captured and put to useful service by conversion to thermal energy and is based on Higher Heating Value (HHV).

$Q_{cw} = m \times C_p \times \Delta T$

or,

$Q_{cw} = F_{cw} \times K \times \Delta T$

Where:

Q_{cw} = chilled water supply in Btu/hr
m = mass flow rate of chilled water in lb/h
F_{cw} = chilled water flow rate in gpm
ΔT = temperature differential (supply temperature – required return temperature)
K = conversion factor from gpm to lb/h [3]
C_p = for water = 1 Btu/lb °F

$$Q_{cwthermal} = \frac{Q_{cw}}{COP}$$

[2] K is 488 for water at 180 °F, need to adjust accordingly for other fluids
[3] K = 500 for chilled water

Where:

$Q_{cwthermal}$ = the useful thermal energy (Btu/h) from the prime mover required by the chiller to deliver Q_{cw}
COP = measured Coefficient of Performance of the chiller (hot water, exhaust gas or hybrid) to deliver the measured Q_{cw}

$$\eta_{cwthermal} = \frac{Q_{cwthermal}}{Q_i}$$

Where:

$\eta_{cwthermal}$ = net thermal chilled water efficiency based on HHV
$Q_{cwthermal}$ = the useful thermal energy (Btu/h) from the prime mover required by the chiller to deliver Q_{cw}
Q_i = total fuel into the system (Btu/h) based on HHV

Steam Supply System

Thermal efficiency is a measure of energy utility; that is, the percentage of total energy input, which is captured and put to useful service by conversion to thermal energy and is based on Higher Heating Value (HHV).

$$Q_{steam} = F_{steam} \times \Delta H$$

Where:

Q_{steam} = steam supply in Btu/h
F_{steam} = steam flow rate in pounds per hour
ΔH = increase in steam enthalpy in Btu/pound (enthalpy of steam output – enthalpy of feed water input)[4]

$$\eta_{steam} = \frac{Q_{steam}}{Q_i}$$

Where:

η_{steam} = net thermal steam efficiency based on HHV
Q_i = total fuel into the system (Btu/h) based on HHV (including fuel used in duct burners or auxiliary boilers integrated into the system)

[4] Enthalpy is a function of the pressure and temperature of steam or feed water