MCU Package Deliverable Outputs

Expected electrical power and steam generation with two turbines operating at an ambient temperature of 59 F (15 C), standard atmospheric pressure at sea level, 2" (50.8 mm) intake losses, 10" (254 mm) exhaust losses, and a generator power factor of 1.0:

A. No steam injection for NO_X control and no supplementary firing:

MCU Gross Heat Rate	**7,912 BTU/kW-hr (LHV basis)**
MCU Gross Electrical Production	2,894 kW
MCU Net Steam Production	16,900 pph (7,664 kg/hr)
MCU Steam Outlet Pressure	420 psig (29.5 kg/cm^2)
MCU Steam Outlet Temperature	571 F (299 C).

B. No steam injection for NO_X control and firing at 14.0 MMBTU/hr (3.53 Mcal/hr):

MCU Gross Heat Rate	7,821 BTU/kW-hr (LHV basis)
MCU Gross Electrical Production	2,894 kW
MCU Net Steam Production	25,000 pph
MCU Steam Outlet Pressure	420 psig (29.5 kg/cm^2)
MCU Steam Outlet Temperature	605 F (318 C)

C. 3,210 pph Steam Injection for NO_X Control and No Supplementary Firing:

MCU Gross Heat Rate	**10,196 BTU/kW-hr (LHV basis)**
MCU Gross Electrical Production	2,946 kW
MCU Net Steam Production	13,690 pph (6,209 kg/hr)
MCU Steam Outlet Pressure	420 psig (29.5 kg/cm^2)
MCU Steam Outlet Temperature	572 F (300 C)

D. 3,210 pph Steam for NO_X Control and Firing at 14.0 MMBTU/hr (3.53 Mcal/hr):

MCU Gross Heat Rate	10,125 BTU/kW-hr (LHV basis)
MCU Gross Electrical Production	2,946 kW
MCU Net Steam Production	25,000 pph
MCU Steam Outlet Pressure	420 psig (29.5 kg/cm^2)
MCU Steam Outlet Temperature	605 F (318 C)

Steam pressure and temperature is measured at the MCU steam header outlet flange. BFW temperature shall be 227 F. Electrical power output is measured at the generator terminals. MCU parasitic losses, main transformer losses, and gas compressor parasitic losses are not included.

For the purposes of this specification, Gross Heat Rate is defined as follows:

$$\text{Gross MCU Heat Rate} = \frac{\text{(Total Heat Input - Net Steam Heat Out)}}{\text{Gross Turb. Electrical Power Output}}$$

For the purposes of this specification, Total Heat Input is defined as follows:

*Total Heat input = Fuel LHV * (Turb. A Fuel Flow + Turb.B Fuel Flow + Duct Burner Fuel Flow - (BFW Flow * BFW Enthalpy))*

For the purposes of this specification, Net Steam Heat Out is defined as follows:

*Net Steam Heat Out = [Gross Steam Production * Steam Outlet Header Enthalpy] - [Sat. Steam Enthalpy *(Turb. A Steam Inj. Flow + Turb. B Steam Inj. Flow)]*

For the purposes of this specification, Gross Turbine Power Output is defined as follows:

$$\text{Gross Turbine Electrical Output} = \frac{\text{(Fuel Flow * Fuel LHV) + Steam Inj. Flow * Sat Steam Enthalpy)}}{\text{Gross Generator Electrical Output}}$$

Electrical power output is at 60 Hertz, 4160 volts at 1.0 power factor of saleable-quality electricity and is further defined as follows:

Operating in Parallel with the Utility Grid:

Frequency Stabilization	Determined by the Utility. Tentative (site specific) limits are +3 HZ at a 30 cycle delay, and -1.5 HZ at a 60 cycle delay.
Daily Load Swings	50 kW est. minimum (determined from Utility stability) to 100 percent as determined by Operator.
Power Factor Limits range)	0.8 lagging to 1.0 (normal with capability to 0.8 leading (emergency).
Load Add Increments	1,000 kW
Load Shed Increments	Full Load

Steam output is measured in the saturated steam line prior to entering the superheater and is compensated by drum pressure. Final pressure and temperature are measured at the MCU steam outlet flange. KGTA will define boiler water and steam quality.

Ambient Conditions

Maximum Temperature	110 F (43 C)
Minimum Temperature	40 F (4.8 C), limited by water freezing
Maximum Elevation	8,200 Feet (2,500 m) Above Mean Sea Level
Relative Humidity	0 - 100 Percent
Rainfall	4 inches per hour (101.6 mm/hr)
Snowfall	Air filter assembly is designed to minimize the ingress of airborne snow.
Inlet Air Quality	
Dust:	Average Industrial conditions. Dust must be non-flammable and non-explosive.
Oil Fumes:	Average Industrial conditions
Snow:	Suitable for light to moderate snowfalls
Airborne chemicals:	No combustible gases, less than 0.02 ppm corrosives as salt, no H_2S
Maximum Wind Load	100 mph (161 km/hr)
Prevalent Wind Direction	360 Degrees

Air Requirements (amounts shown are for total package)

Combustion Air for Turbines	29,500 scfm
Enclosure Cooling	30,000 scfm, (With a nominal heat rejection of approximately 17,000 BTU/min
Generator Cooling	6,400 scfm
Scanner Blowers	20 scfm, (Capacity supplied is 40 scfm)

Filtration Requirements

Combustion Air for Turbines	Prefilter (washable) 50 microns nominal Final Filter to 1 micron absolute
Natural Gas fuel	3 microns absolute
Lubricating Oil	6 microns absolute

Earthquake Zone

The MCU may be exempt from meeting seismic zone requirements since the unit is portable. The unit is designed to meet Zone 2A per the US Uniform Building Code.

MCU Noise Output Limits

Designed to meet 85 dBA at 3 Ft (1 m) horizontal from the MCU trailer perimeter and 5 Ft (1.5 m) vertical above grade, under free field conditions. This design goal is limited to the equipment located within the MCU enclosure and excludes certain site related conditions such as reflectivity and noise from other equipment located near the site.

Electrical Area Classification

MCU must be located in an NFPA 70 (National Electric Code) Non-Classified Area.

Transportability

A. By Truck Tractor:
The MCU package is designed to be transported within the continental United States, Canada and Mexico. Transport speed is limited to 40 MPH (64 km/hr).

B. By Rail:
The MCU package is not designed for rail shipment.

Physical Package Data

English Units	Shipping[1]	Installed[2] - Dry	Installed[2] - Wet	Units
Length	58'-0 ½"	59'-11 ¼"	59'-11 ¼"	Feet
Width	10'-1"	16'-8 "	16'-8 "	Feet
Height	13'-6"	25'-1 ½"	25'-1 ½"	Feet
Weight	178,180	204,511	212,665	Pounds
Metric Units	Shipping[1]	Installed[2] - Dry	Installed[2] - Wet	Units
Length	17.691	18.269	18.269	Meter
Width	3.073	5.083	5.083	Meter
Height	4.115	7.658	7.658	Meter
Weight	80,822	92,766	96,464	Kg

Notes:
1. Does not include truck-tractor information.
2. Does not include stack or stack support.

Largest Ship-Loose Item is the Simple Cycle Exhaust Stacks, with dimensions of:

Length	8'-7 ½" Feet (2.629 m)
Width	4'-2" Feet (1.270 m)
Height	11'-3 " Feet (3.432 m)
Weight	2,056 Lbs (933 kg)

Abreviations for Codes and Standards Used in this Specification:

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing of Materials
AWS	American Welding Society
BPVC	Boiler and Pressure Vessel Code
FCC	Federal Communications Commission
ICEA	Insulated Cable Engineer's Association
ICS	Instrumentation and Controls Society
IEEE	Institute of Electrical and Electronic Engineers
NEC	National Electric Code (NFPA 70)
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
UBC	Uniform Building Code
UL	Underwriter's Laboratory

Component	Applicable Codes/Standards
MCU Fire Protection	NFPA 37
Trailer	AWS D1.1, Fed. Std. 393
Main Enclosure Structure	AWS D1.1, UBC
Boiler	ASME BPVC Section 1 with N.B. Stamp.
Economizer	ASME BPVC Section 1 with N.B. Stamp.
Superheater	ASME BPVC Section 1 with N.B. Stamp.
Feedwater Piping	ANSI B31.1
Steam Piping	ANSI B31.1
Blowdown Piping	ANSI B31.1
Fuel Gas Piping	ANSI B31.1
Lube Oil Piping	ANSI B31.1
Fire System Piping	ANSI B31.1
Generator	Built to NEMA MG-1 and installed per NEC
Controls System	NEMA/ICS 2-230; ANSI/IEEE C37.90; FCC Part #15, Section J, Class A
Controls Cables	UL Listed with NEC Installation
Power Electrical System	NEC (with some exceptions)
5 kV Power Cables	ICEA S-68-516, ASTM 88
600 Volt Wire	NEC
Battery/Charger System	NEC
Exterior Junction Boxes	NEMA 4X
Interior Junction Boxes	NEMA 12

Required Utilities (measured at MCU service connection points)

Fuel Gas (per ApplicableEngineering Specification):

	Pressure (psig)	Temp. (F)	(SCFH at LHV = 1,000 BTU/ft^3 & SG=0.60) Turb. "A"	Turb. "B"	Duct Bnr	Total
Design	**250**	180	22,500	22,500	15,000	60,000
Max. Oper.	**250**	140	21,500	21,500	14,500	57,500
Norm. Oper	**225**	60	20,500	20,500	14,000	55,000
Min. Oper.	**210**	40	7,800	7,800	2,200	By Case

Fuel Gas (per Applicable Engineering Specification):

	Pressure (kg/cm^2)	Temp. (C)	Flow (Nm^3/hr at LHV=8,900 kcal/m^3 & SG=0.60) Turb. "A"	Turb. "B"	Duct Bnr	Total
Design	17.58	82.2	637.2	637.2	424.8	1,699.2
Max. Oper.	17.58	60.0	608.9	608.9	410.6	1,628.4
Norm. Oper.	15.82	15.6	580.6	580.6	396.5	1,557.7
Min. Oper.	14.76	4.4	220.9	220.9	62.3	By Case

Feedwater	71 US GPM (253.6 /m) at 520 PSIG (36.6 kg/cm^2), 227 F (108 C) at the MCU interconnection point. See Engineering Specification no. ADM005.xx for Boiler Feedwater quality requirements.
Electricity	150 kW (peak) at 4160 volts, three phase, 60 Hertz (for startup) backfed through the Generator Step-Up (GSU) transformer.
Boiler Blowdown	8 GPM (30.3 /min) maximum expected continuous flow (based on BFW quality). 80 GPM (302.8 /min) maximum expected intermittent flow.

Waste Materials Generated

Fuel Gas from Gas Vent See data listed under “Package Emission Data”

Spent Lube Oil	None expected. Some may be generated if a bearing failure occurs that requires a total oil changeout.
Cleaning Solutions	Engine internal cleaning solutions are defined in Engineering Specification AMM014.xx. General purpose cleaners and degreasers used by Field Service Technicians may be generated by field maintenance activities.
Cleaning Rags	As generated by Field Service Technicians. All refuse generated shall be removed by the Field Personnel.
Lube Oil Filters	Periodic filter replacement requires removal of approximately 2 quarts (1.9) of lube oil per filter set.
Air Filters	Prefilter elements are washable and reusable. Final filters require replacement. Type of particulate contamination is dependent on site conditions.
Fuel Gas Filters	Periodic filter replacement is required. The type of contamination is dependent on site fuel.
Misc. Scrap Components	See Parts Data in Instruction Books.

Package Emission Data

Fuel Gas Vent	< 0.01 ft^3/min (0.0003 m^3/min) during normal operation.
	< 2 ft^3 (0.057 m^3) during a normal shutdown.
	< 5 ft^3 (0.142 m^3) during an emergency shutdown. This value does not include off-skid fuel gas piping.
Lube Oil Demister Vent	35 ft^3/min (1 NM^3/min) at 100 F (38 C) per Turbine
Fugitive Gas	None expected

Emissions Data at ISO Conditions (data is for two turbines)

Expected Turbine Exhaust Properties at Full Load Without Steam Injection				
Parameter	English Units		Metric Units	
Turb. Exh. Mass Flow	36.135	LB/s	16.391	kg/s
Heat Input	41.078	MMBTU/hr	43,340	MJ/hr
Turbine Exhaust Temp.	964	F	518	C
Specific Heat	0.270	BTU/LB- F	1,130	J/kg- C
Oxygen, O_2	16.99	wt %	16.99	wt %
Carbon Dioxide, CO_2	4.19	wt %	4.19	wt %
Carbon Dioxide	26	ppm @ 15% O2		
Nitrogen, N_2	74.34	wt %	74.34	wt %
Water, H_2O	3.15	wt %	3.15	wt %
Argon, Ar	1.33	wt %	1.33	wt %
Oxides of Nitrogen, NO_X	17.60	LB/hr	7.98	kg/hr
	109	ppmvd @ 15% O_2	109	ppmvd @ 15% O_2
Carbon Monoxide, CO	0.20	LB/hr	0.091	kg/hr
	2	ppmvd @ 15% O_2	2	ppmvd @ 15% O_2
Exhaust Stack Temp.	415	F	213	C
Expected Duct Burner Emission Information at Full Duct Firing				
Heat Input Rate	14.0	MMBTU/hr	14,771	MJ/hr
Oxides of Nitrogen, NO_X	1.4	LB/hr	0.635	kg/hr
	6.5	ppmvd @ 15% O_2	6.5	ppmvd @ 15% O_2
Carbon Monoxide, CO	0.2	LB/hr	0.091	kg/hr
	1.6	ppmvd @ 15% O_2	1.6	ppmvd @ 15% O_2
Exhaust Stack Temp.	413	F	212	C

Expected Turbine Exhaust Properties at Full Load With Steam Injection				
Parameter	English Units		Metric Units	
Steam Injection Rate (S.I.R.)	1.70:1	LB stm:lb gas	1.70:1	kg stm:kg gas
Turb. Exh. Mass Flow	36.55	LB/s	16.58	kg/s
Heat Input	42.440	MMBTU/hr	44,777	MJ/hr
Turbine Exhaust Temp.	964	F	518	C
Specific Heat	0.277	BTU/LB- F	1,160	J/kg- C
Oxygen, O_2	16.25	wt %	16.25	wt %
Carbon Dioxide, CO_2	4.29	wt %	4.29	wt %
Nitrogen, N_2	72.34	wt %	72.34	wt %
Water, H_2O	5.82	wt %	5.82	wt %
Argon, Ar	1.30	wt %	1.30	wt %
Oxides of Nitrogen, NO_x	3.82	LB/hr	1.73	kg/hr
	23	ppmvd @ 15% O_2	23	ppmvd @ 15% O_2
Carbon Monoxide, CO	1.12	LB/hr	0.51	kg/hr
	11	ppmvd @ 15% O_2	11	ppmvd @ 15% O_2
Exhaust Stack Temp.	416	F	213	C
Expected Duct Burner Emission Information at Full Duct Firing				
Heat Input Rate	14.0	MMBTU/hr	14,771	MJ/hr
Oxides of Nitrogen, NO_x	1.4	LB/hr	0.635	kg/hr
	6.5	ppmvd @ 15% O_2	6.5	ppmvd @ 15% O_2
Carbon Monoxide, CO	0.2	LB/hr	0.091	kg/hr
	1.6	ppmvd @ 15% O_2	1.6	ppmvd @ 15% O_2
Exhaust Stack Temp.	414	F	212	C

Time Between Major Overhauls

Gas Turbine and Gearbox overhaul schedule will be in accordance with KGTYA redommendations. The number of allowable start cycles prior to inspection/overhaul shall also meet the recommendations of KGTA .

The Heat Recovery Steam Generator (HRSG) overhaul schedule shall be as required by the Heat Recovery Steam Generator performance and is primarily determined by Boiler Feedwater Quality.

Minimum Service Life

15 Years under normal operating conditions and with properly implemented operation and maintenance procedures.

Availability

93 Percent of Annual Hours under normal operating conditions and with properly implemented operating and maintenance procedures..

Number of Starts and Shutdowns Per Year

One scheduled complete shutdown of the unit per year for a duration of 24 hours. Minimum quarterly maintenance shutdown of each turbine is required for a duration of 8 hours. Unit will operate with one turbine during the maintenance period for the off-line turbine.

Required Site Conditions

Clear, level ground with sufficient load-bearing capacity and free from flooding or other phenomena which could interfere with unit operation. Required maintenance access is defined on Engineering Drawings. Properly designed connections, attachments and other installation features, not within the scope of this specification, shall meet the intended design requirements

Design Philosophy

Modular design to provide a minimum of off-unit components which must be installed at site. Unit to be accessible for maintenance, and shall be designed to minimize maintenance downtime. The Unit can be furnished with accessories required for re-synchronizing to the utility grid following a service outage and once power transmission from the grid has been restored.

Operational Philosophy

Attended, continuous operation of both power trains.

Ability to run with one or more enclosure doors open for short periods of time for Maintenance access with one or two units operating.