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January 16, 2013

VIA EMAIL

Ms. Patricia Kelly
Siting Project Manager
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

Re: Redondo Beach Energy Project (12-AFC-03)
Supplemental Air Quality Information

Dear Ms. Kelly:

On or about January 11, 2013, Applicant AES Southland Development, LLC provided responsive information to the South Coast Air Quality Management District. Such information is enclosed herewith for docketing.

Should you have any questions regarding this submittal, please do not hesitate to contact our office.

Respectfully submitted,

Kristen T. Castaños

KTC:jmw
Enclosure
cc: Mr. Stephen O'Kane, AES Southland Development, LLC
Mr. Jerry Salamy, CH2M Hill, Inc.
Ms. Sarah Madams, CH2M Hill, Inc.

AES Redondo Beach

AES Redondo Beach
690 N. Studebaker Road
Long Beach, CA 90803
tel 562 493 7891
fax 562 493 7320

January 11, 2013

Mr. Brian Yeh
Senior Manager, Mechanical, Chemical, and Public Services Team
South Coast Air Quality Management District
21865 Copley Drive
Diamond Bar, CA 91765-4178

Subject: Redondo Beach Energy Project Permit Application (Facility ID# 115536)

Dear Mr. Yeh:

AES Redondo Beach, LLC (AES-RB) is submitting this letter in response to the South Coast Air Quality Management District's (AQMD) December 21, 2012 request for additional information needed to complete the engineering evaluation of the Redondo Beach Energy Project (RBEP). The additional information requested were:

1) Emission rates for particulate matter with an aerodynamic diameter of 10 microns or less (PM10) and particulate matter with an aerodynamic diameter of 2.5 microns or less (PM2.5)
2) Vendor manufacturer, model number, catalyst life, and emission guarantees for the selective catalyst reduction (SCR) and oxidation catalyst (OxCat)
3) Start up emission details for all start scenarios
4) A technical discussion of the fast start technology
5) Current plans for retirement of Redondo Beach Generating Station Unit 5
6) Information regarding the human health risk emission factors used
7) Emission calculations supporting the greenhouse gas (GHG) emission estimate
8) Clarification of the maximum emission rates used for the air dispersion modeling assessment for each pollutant and averaging period.

The remainder of this letter presents AES-RB's responses to the requested information.

1) Particulate Matter Emission Guarantee

Exhibit 1 presents the turbine vendor, Mitsubishi Power Systems America, Inc. (MPSA), particulate matter emission guarantee. The vendor guaranteed a PM10/PM2.5 emission rate of 4 pounds per hour, including both filterable and condensable fractions, based on Environmental Protection Agency Reference Methods 201/201A and 202 (dry). However, the guaranteed particulate matter emission rate does not include any contribution from fuel-bound sulfur (see Conditions 2 and 3 of the guarantee). AES-RB increased the MSPA PM10/PM2.5 guarantee by 0.5 pounds per hour to account for fuel bound sulfur based on an expected fuel sulfur content of 0.18 grains of total sulfur per 100 cubic feet of natural gas and a 10 percent sulfur dioxide (SO2) to sulfur trioxide conversion rate. The turbine PM10/PM2.5 emission rate used in the RBEP permit application is 4.5 pounds per hour irrespective of load rate.

Exhibit 2 presents the RBEP vendor guarantees (in parts per million by volume dry at 15 percent oxygen for nitrogen oxides [NOx], carbon monoxide [CO], and volatile organic compounds [VOC]) for the SCR and OxCat systems at three ambient conditions for gas turbine operation between 70 percent and 100 percent load rate. Exhibit 2 also includes guaranteed emission rates (in pounds per million British thermal units [MMBtu]) for the duct burners and the expected catalyst life for both the SCR and OxCat. AES-RB determined the duct fired particulate matter emission rate of 9.5 pounds per hour using the turbine particulate matter emission rate of 4.5 pounds per hour, the duct burner particulate matter emission rate of 0.01 pounds per MMBtu, and the duct burner maximum heat input of 500 MMBtu per hour (converting the 450 MMBtu per hour-lower heating value to a higher heating value basis).

2) SCR and OxCat Information

a. Provide the SCR and OxCat Manufacturer and Model Number.

   At this time, AES-RB has not identified the major equipment manufacturer (beyond the gas and steam turbines) and expects equipment procurement will begin once permitting is completed. AES-RB will provide emissions-related equipment specifications to the AQMD for review once the final design is completed and vendors are selected.

b. Provide guarantees for the SCR and OxCat NOx, CO, VOC, and ammonia emission rates as well as the SCR and OxCat catalyst life.

   See Exhibit 2 for the SCR and OxCat NOx, CO, and VOC emission rates guarantees. An ammonia emission guarantee for the 5 parts per million ammonia slip emissions was not provided. However, this ammonia slip limit is routinely considered as best available control technology within the AQMD.

   Per Exhibit 2, the SCR and OxCat catalysts are guaranteed to meet these emissions rates for 24,000 hours of operation or three years after initial exhaust flow into the catalysts, whichever occurs first.

3) Start Up Emissions

a. Discuss how a turbine trip would affect the definitions, durations, and emissions of each start up event.

A "trip" is a generic term used in the electricity generation industry to describe any system condition or fault that results in the automatic opening or "trip" of a breaker or switch to prevent system damage. A trip at a power plant can be caused by system faults or conditions that can be either internal or external to a generation plant. For example, external system conditions on the transmission system or fuel supply system could cause a system condition that would result in an automatic trip of a system switch within a generating plant, while an internal trip could be caused by a control systems failure within the plant.

An internal system trip during the start up of a combustion turbine, while extremely rare and part of the system warrant from the manufacturer, could result from something as simple as a failed logic controller or as major as the loss of the turbine combustor. The cause of a simple trip is identified quickly and typically remedied in less than an hour, while a major failure of a combustor and the gas turbine could result in a unit being removed from service for days or weeks to effect repairs. Start trips are unplanned events that would be treated like any maintenance outage of equipment and would not affect the definition, duration or emissions of a start event since, by definition, the start event would not have been completed. In the event of a start trip in a gas turbine in the Redondo Beach Energy Project, the immediate response after the automatic safe shutdown of the machine would be to start an alternate turbine. In the event the start trip occurred on the third gas turbine while two gas turbines are already on-line or being started, an outage for the turbine would be declared and loss of available capacity would be reported to the system operator. Since the start reliability of the MPSA 501DA is in excess of 99% and that it is expected that the Redondo Beach Energy Project will be operated in the two-on-one, or one-on-one configuration 70% of the time the plant will be in operation, the probability that a start trip would affect operations is negligible.

b. Please provide a breakdown for the 624 start ups per year.

Table AQMD-1 presents the breakdown of start ups per year per turbine.

Table AQMD-1 RBEP Annual Operating Profile

Event	Number of Events	Total Hours
Annual Unfired Hours (i.e., no duct burner firing)	--	5900
Annual Fired Hours (i.e., with duct burner firing)	--	470
Annual Cold Starts	24	36.0
Annual Warm Starts	150	81.3
Annual Hot Starts	450	243.8
Annual Shutdowns	624	104
Total Annual Startup/Shutdown Hours (per turbine)	--	465
Total Annual Operating Hours (per turbine)	--	6835

4) Fast Start Technology

Advances in gas turbine technology have primarily focused on large industrial gas turbines to improve power density (unit size and megawatts [MWs]) and exhaust energy available to a heat recovery system (overall heat rate). The combination of these design considerations provides an economic benefit by employing fewer units to achieve a very high combined output and efficiency. However, these types of gas turbine combined cycle units require increasingly complex cooling schemes with very complex heat recovery components using multiple steam path flows (typically three) in a steam turbine, which requires a large quantity of heat exchangers with unique material properties, in order to function with the high exhaust energy that is made available from the gas turbine. Thus, an unavoidable consequence of these large combined cycle applications are the limitations they place upon the thermal transient and speed by which these units can start up, heat-up, and ramp from minimum to full power. It is also important to note that the efficiency of a gas turbine in a combined cycle application is not static, which is to say that heat rate increases significantly (efficiency drops considerably) when these types of units operate in partial load or off-base design conditions. These are systems designed for high efficiency, base load operations in an "always on" mode. In addition, the cost to start a large, advanced combined cycle gas turbine unit becomes very expensive as the maintenance accruals are very high per start.

AES-RB has worked with all the gas turbine Original Equipment Manufacturers to identify gas turbines with a moderate base load output (100 - 120 MW vs. 200 - 250 MW) and employ the most advanced design features (such as aero-derivative type components and Dry Low NOx combustion) such that the gas turbine retains rapid start capability and environmental performance. It should be noted that the fast start capability of the gas turbine alone is inherent in almost all gas turbine designs; it is the back-end steam cycle that limits the start and ramp speed. Consequently, AES-RB has focused on the exhaust energy conditions of the candidate turbines to determine those that do not exceed the operating limits of materials suited to the rapid cycling of a heat recovery system. By focusing on a simpler steam cycle and steam turbine (single pressure - single admission), different and more malleable materials could be employed. The end result is the "un-coupling" of the steam cycle limitations from the fast start capability of the gas turbine through the use of proven and robust steam cycle components. There is no limit imposed on the rapid start and loading of the gas turbine to its maximum output by the steam cycle regardless of time after shutdown, i.e., cold, warm, or hot. Additionally, the use of mid-sized gas turbines in a 3-on-1 configuration allows the turndown of a single unit (multi-staged) rather than the turndown of the entire facility, which results in improved part-load efficiency through the full range of operation; gas turbines are simply turned on and off in stages to retain base load-like performance of the remaining units in operation.

5) Emission Offsets: Are there current plans for the 175 MWs from the retirement of Redondo Beach Generating Station Unit 5?

AES-RB is planning to retain the 175 MWs from the Redondo Beach Generating Station Unit 5 retirement for repowering activities at other AES-RB owned facilities within the AQMD jurisdiction. No additional repowering is planned to occur at the Redondo Beach facility beyond the RBEP.

6) Health Risk Assessment: Revise the health risk assessment to use the AP-42 emission factors, including for formaldehyde.

As noted in the permit application cover letter, in addition to the health risk assessment (HRA) included in Section 5.9, AES-RB conducted an HRA consistent with the AQMD's current practice of estimating toxic emissions from gas turbines using emission factors listed in Table 3.1-3 of the EPA's AP42 *Compilation of Air Pollutant Emission Factors*. However, the formaldehyde emission rate was based on a maximum allowable formaldehyde concentration of 120 parts per billion for the natural-gas-fired turbines, which is consistent with the toxic emissions discussion included in Section 5.9 of the Application for Certification (AFC). A summary of the air toxics emissions included in the HRA is provided in Table 5.1B.5b of the attached AFC Appendix 5.1B.

A summary of the maximum incremental cancer risk (MICR), chronic health index, and acute health index at the point of maximum impact (PMI) locations have been included in Table AQMD-2, based on the emissions presented in Table 5.1B.5b of AFC Appendix 5.1B. In accordance with AQMD Rule 1401, the results represent the predicted risk for each individual emission unit. Overall, the predicted MICR at the PMI is below the individual source significance threshold of one in 1 million and the predicted chronic and acute indices are also below the AQMD individual source significance threshold of 1.0. Furthermore, the RBEP design includes the use of an OxCat to reduce CO and VOC emissions to the best available control levels of 2.0 parts per million and 1.0 parts per million, respectively. Therefore, it is expected that the actual hazardous air pollutant (HAP) emissions, and resulting predicted health risk impacts, would be significantly less than the potential risk presented in this analysis.[1] The HARP report files have also been included on the dispersion modeling file DVD.

TABLE AQMD-2
RBEP Health Risk Assessment Summary: Individual Units (BASIS: AP-42 Emission Factors)[a, b]

Risk	Turbine 1	Turbine 2	Turbine 3
MICR at the PMI[c] (per million)	0.72	0.66	0.65
Chronic Hazard Index at the PMI	0.0021	0.0019	0.0019
Acute Hazard Index at the PMI	0.019	0.013	0.010

[a]The results represent the predicted risk for each individual emission unit in accordance with AQMD Rule 1401.
[b]A source with a MICR less than one in 1 million individuals is considered to be less than significant. A chronic or acute hazard index less than 1.0 for each source is considered to be a less-than-significant health risk.
[c]Cancer risk values are based on the OEHHA Derived Methodology.

[1] AP-42 Section 3.1 Stationary Internal Combustion Processes guidance document updated in 2000, page 3.1-7— "The performance of these oxidation catalyst systems on combustion turbines results in 90-plus percent control of CO and about 85 to 90 percent control of formaldehyde. Similar emission reductions are expected on other HAP pollutants."

7) Provide supporting calculations for the 1,082 pounds CO_2/Megawatt-Hour emission rate.

Table AQMD-3 presents the heat rate and electrical production rates for the RBEP at various operating levels at an ambient temperature of 71 degrees Fahrenheit (°F) and the expected operating hours with one, two, and three turbines of each power block operating (referred to as states 1, 2, and 3). Table AQMD-4 presents an estimate of the heat rate during start up and shutdown events and is based on MPSA-provided estimates of electrical production and fuel consumption. Table AQMD-5 presents the GHG efficiency for the RBEP, including start up and shutdowns and an assumed efficiency degradation rate of 8 percent. The GHG efficiency is based on a projected 12-month operating profile. The hours of operation per 12-month period in each state is displayed in Table AQMD-3. Note that the operating profile assumed here reflects a realistic estimate of RBEP's GHG efficiency for the project application and is not equivalent to the operating profile being used in the permitting effort.

8) Provide the basis for the maximum modeled impacts (both commissioning and operations) for which each pollutant and averaging period was based.

The commissioning modeling was performed at four different turbine operating rates. The modeling parameters and emission rates are presented in Table 5.1C.1 of AFC Appendix 5.1C. As noted in the footnotes of AFC Table 5.1-28, the maximum nitrogen dioxide (NO_2) and CO impacts occurred during the 50 percent load scenario as presented in Table 5.1C.1 of AFC Appendix 5.1C. The SO2 and PM10/PM2.5 impacts presented in Table 5.1-28 are identical to the operational modeling impacts presented in AFC Table 5.1-29.

The operational modeling was performed for 15 cases representing 3 ambient conditions and four load rates. The modeling parameters, emission rates, and modeling results are presented in Tables 5.1C.4., 5.1C.5., and 5.1C.7a, respectively, of AFC Appendix 5.1C.

If you require further information, please don't hesitate contacting me at 562-493-7840.

Sincerely,

Stephen O'Kane
Manager
AES Redondo Beach, LLC

Attachments:

Exhibit_1_AES_particulate_emission_guarantee_20110801
Exhibit_2_Vogt_Emissions Guarantees
Tables_AQMD-3_to_AQMD-5

cc: Sarah Madams/CH2M HILL
Jennifer Didlo/AES
John McKinsey/Stoel Rives
Kristen Castanos/Stoel Rives
Jerry Salamy/CH2M HILL
Patricia Kelly/CEC

Table AQMD-3 RBEP Heat Rate Estimate

RBEP Expected Annual Average Operating Profile at an Ambient Air Temperature of 71 F[1]																	**Expected Annual Hours**
	Hours/year		125			DB[3]		1600			DB			730			2455
Net Plant Power	**KW**	116977	130750	144285	161150	203570	241081	268702	295720	329459	367913	363249	367918	403656	443066	492265	
Estimated Gross Heat Rate, LHV[2]	**Btu/KWH**	7730	7562	7439	7351	7740	7501	7359	7259	7191	7453	7467	7451	7348	7267	7217	
				State 1[4]					State 2					State 3			
		Average KW	151346	**Average Btu/KWH for State 1**		7564	**Average KW**	300575	**Average Btu/KWH for State 2**		7353		**Average KW**	414031	**Average Btu/KWH for State 3**		7350

1. Operating data from TFLINK 71F Part Load Curve.xls.

2. Station loads ranging from 3.3 to 5.7% and selecting a conservatively low load results in a conservatively high gross heat rate, for estimating annual average CO_2. Therefore, a 3% station load was selected to convert the gross heat rates to net heat rates.

3. DB = Duct firing.

4. State 1 represents a 1 on 1 configuration, State 2 represents a 2 on 1 configuration, and State 3 represents a 3 on 1 configuration.

Conservative average station load 3%

Table AQMD-4 RBEP Start Up/Shutdown Heat Rate Estimate

7776	Btu LHV/kWh
1.1	Btu HHV / Btu LHV
53.02	kg CO2 / MMBtu HHV
2.205	lb/kg
1000	kWh / MWh
1.00E-06	MMBtu / Btu
1,000.00	lb CO2 / MWh

Calculate Effective Heat Rates from SU / SD Data:

2300	lb natural gas / startup	2.6	gross MWh / startup
0.02065	MMBtu LHV / lb		
47.495	MMBtu LHV / startup		
18267	Btu LHV / kWh during startups		
400	lb natural gas / stop	0.5	gross MWh / stop
0.02065	MMBtu LHV / lb		
8.26	MMBtu LHV / stop		
16520	Btu LHV / kWh during stops		

Customer AES
Project: M501D5

Combined Cycle Startup Emissions

Notes
Using : MPS preliminary M501DA Fast Start curve

Total Emissions Per Event (Combined Cycle) at site conditions

CTG/Stack 1

	Duration(1)	NOx	CO	VOC	PM10	GT Net MW	Fuel Gas
	minutes	lb	lb	lb	lb	MWh	klb
Hot Start	9	8.5	142.0	25.6	0.8	2.6	2.3
Shutdown	9.5	11.7	206.0	40.2	1.1	0.5	0.4

Notes
(1) Duration is the total time for the gas turbine between GT ignition and 70% load during Start-Up and Shut-Down.
(2) Calculations are performed for a New and Clean Gas turbine.
(3) Calculations were performed at 71°F dry bulb and 60% RH.
(4) Values are given at the GT Exhaust flange, without duct firing and without Catalyst effects.
(5) Since calculations may be based on some assumed values, Purchaser shall confirm with MPSA prior to using these values for permitting purposes.
(6) Shut down FSNL hold time based on 5 minutes.

Table AQMD-5 RBEP Calculate Annual Average CO_2 (lb/MWh)

Annual Average - Assume all hours for each State are at the average heat rate for that State

Start Up and Stop Heat Rate Calculations

350	startups / yr	
9	min / startup	
52.5	hours startup / year	
18267	Btu/ gross kWh	Effective Heat Rate during Turbine Start
350	stops / yr	
9.5	min / stop	
55.4	hours stops / year	
16520	Btu/kWh Gross	Effective Heat Rate during Turbine Stops

Plant CO2 Efficiency Calculation

7743	Btu LHV / kWh Gross	Weighted Annual Average Heat Rate with SU/SD and no Degradation.
		(125 hrs * 7564 Btu/kWh + 1600 hrs * 7353 btu/kWh + 730 hrs * 7350 btu/kWh + 18267 btu/kWh * 52.5 hrs + 16520 btu/kWh * 55.4 hrs)/(2455 hrs + 52.5 hrs + 55.4 hrs)
8%	Assumed Plant Degradation	
8416	Btu LHV / kWh Gross	Annual Average CO2 Efficiency with SU/SD and Degradation (7743 btu/kWh / (1 - 0.08))
1082	lb CO2 /MWh Gross	Annual Average CO2 Efficiency with SU/SD and Degradation
		(8417 btu/kWh * 1000 kWh/MWh * 1.1 HHV/LHV * $1*10^{-6}$ MMBtu/Btu * 53.02 kg CO2/MMBtu-HHV * 2.205 lb/kg)

EXHIBIT 1

AES PARTICULATE EMISSION GUARANTEE

Particulate Emissions Guarantee for AES Southland:

PM10: 4 lb/hr
PM2.5: 4 lb/hr

Conditions of Guarantee:

1. Particulate emissions shall be the sum of non-condensable emissions determined using EPA Method 201 or 201A and condensable emissions determined using EPA Method 202 dry.
2. Fuel gas composition is as specified in the AES Southland RFQ dated June 20, 2011. No sulfur or fuel bound nitrogen is contained in the fuel gas supplied.
3. Fuel gas supplied is in accordance with MPSA's fuel gas specification.
4. Particulate emission values specified above are stated as the difference between the GT outlet particulate emissions as measured at the GT exhaust flange and the GT inlet particulate emissions as measured at the GT inlet filter house.
5. Particulate emission values specified above are valid for GT normal operation between 100% GT load and 75% GT load.
6. Evaporative cooler is not in service.

EXHIBIT 2

VOGT EMISSIONS GUARANTEE

November 13, 2012

Horacio Larios
Power Engineers Collaborative, LLC
600 West Jackson Blvd, Suite 600
Chicago, IL 60661

Subject: HRSG Proposal - Emissions Guarantees
Redondo Beach Energy Project
VPI Proposal P-1061

Dear Mr. Larios:

With regard to our proposal for the HRSGs and associated equipment for the above referenced project, this is to confirm that with the equipment proposed VPI will provide the following emissions guarantees

1. Given the attached M501DA Gas Turbine (GT) Expected Performance & Emissions provided by Mitsubishi Power Systems Americas, Inc. at the following conditions:

   33°F, 93.8% Relative Humidity, 100% GT Load through 70% GT Load,
   63.3°F, 75.2% Relative Humidity, 100% GT Load through 70% GT Load, and
   106°F, 9.6% Relative Humidity, 100% GT Load through 70% GT Load;

   and with 450 MMBtu/hr (LHV) Duct Burner heat input at the GT 100% load cases

   Stack Emissions associated with each Gas Turbine – Heat Recovery Steam Generator for these conditions are as follows:

	ppmvd@15%O_2
CO	2
VOC	1
NO_X	2

   The CO and SCR catalysts are guaranteed to meet these emission limits for 24,000 hours of operation or three years after initial exhaust flow into the catalysts, whichever occurs first.

2. The Duct Burner's emissions contribution factored into the above stack guarantees are as follows:

	Lbs/MMBtu (HHV)
NO_X as NO_2	0.08
CO	0.05
VOC as CH_4	0.01
PM 10	0.01

Notes:

1. Emission levels given above in lbs/MMBtu (HHV) are guaranteed from 50% to 100% maximum designed heat release of the duct burner system, with all burner runners in operation. For reduced burner loads from 10% to 50% of maximum design heat release with all burner runners in operation, the emissions levels can be higher than those given on a lbs/MM Btu (HHV), but at no point will the burner emissions exceed the mass flow rates on a Lbs/hr bases.
2. For reduced burner loads from 10% to 50% of maximum design heat release, emissions levels given in lbs/MMBtu (HHV) are guaranteed levels when the burner runners are removed from operation (staged) to achieve turndown.
3. VOC's guarantee are non-methane / non-ethane described as methane.
4. PM-10 guarnatee is front and rear half, excludes all inorganic contribution and sulfur/sulfide compounds.

Please do not hesitate to contact me if you have any questions.

Yours sincerely,

Paul Eberle
Account Manager
Vogt Power International Inc.
13551 Triton Park Blvd., Suite 2000
Louisville KY 40223 USA.
Tel. +1-502-899-4614
Cell +1-502-298-4615
Fax. +1-502-899-4699
e-mail peberle@vogtpower.com

Attachments

1. GT Exhaust Outlet Conditions

VogtPower International

M501DA Gas Turbine Expected Performance & Emissions

Engine Type		M501DA	M501DA	M501DA	M501DA
Fuel Type		Nat. Gas	Nat. Gas	Nat. Gas	Nat. Gas
GT Load Condition	%	100%	90%	80%	70%
Ambient Temp.	Deg F.	33	33	33	33
Ambient Press.	psia	14.68	14.68	14.68	14.68
Relative Humidity	%	93.8	93.8	93.8	93.8
Evaporative Cooler	On/Off	OFF	OFF	OFF	OFF
Fuel LHV	Btu/lb	20,648	20,648	20,648	20,648
GT Gross Output	kW	131,700	118,500	105,300	92,200
GT Gross Heat Rate (LHV)	Btu/kWh	10,052	10,142	10,236	10,512
GT Exhaust Flow x 10^3	lb/h	3,347.6	3,031.1	2,716.8	2,397.8
GT Exhaust Temp.	Deg F.	996	991	996	1,027
GT Exhaust Press Loss (total)	in. H2O	18.3	15.1	12.1	9.6
GT Exhaust Composition:					
O2	% wt.	15.35	15.39	15.39	15.26
CO2	% wt.	5.12	5.09	5.09	5.17
H2O	% wt.	4.46	4.44	4.43	4.51
N2	% wt.	73.75	73.76	73.77	73.74
Ar	% wt.	1.32	1.32	1.32	1.32

GT EMISSIONS					
NOx	ppmvd @ 15% O2	9	9	9	9
CO	ppmvd @ 15% O2	10	10	10	10
UHC	ppmvd @ 15% O2	1	1	1	1
VOC	ppmvd @ 15% O2	1	1	1	1
PM10/PM2.5 (front half)	mg/m3N	1	1	1	1

NOTES:

1. All above data is based on New & Clean conditions. All supplied values are estimations and not guaranteed.
2. Fuel characteristics are based on customer supplied fuel analysis. Sulfur and fuel bound nitrogen (FBN) in the fuel are assumed to be zero.
3. A tolerance of 0.75% on Power, 1.0% on Heat Rate, 2% on exhaust flow, and 10°F on exhaust temperature shall apply.
4. Particulate front-half emissions (non-condensables) shall be determined using EPA Method 201 or 201A.
5. The definition of VOC is on a non-methane, non-ethane basis assuming equivalent molecular weight of methane. Measurement of VOC is based on that THC(Total Hydro Carbon) measured by EPA Method 25A except methane and ethane measured by EPA Method 18.

198-AESinCA-DA-Gas-033.0F93.8%-PART-20120306(CUSTOMER) / GNP 3/6/2012

M501DA Gas Turbine Expected Performance & Emissions

Engine Type		M501DA	M501DA	M501DA	M501DA	M501DA
Fuel Type		Nat. Gas	Nat. Gas	Nat. Gas	Nat. Gas	Nat. Gas
GT Load Condition	%	100%	100%	90%	80%	70%
Ambient Temp.	Deg F.	63.3	63.3	63.3	63.3	63.3
Ambient Press.	psia	14.68	14.68	14.68	14.68	14.68
Relative Humidity	%	75.2	75.2	75.2	75.2	75.2
Evaporative Cooler	On/Off	ON	OFF	OFF	OFF	OFF
Fuel LHV	Btu/lb	20,648	20,648	20,648	20,648	20,648
GT Gross Output	kW	121,500	120,000	108,000	96,000	84,000
GT Gross Heat Rate (LHV)	Btu/kWh	10,209	10,224	10,375	10,520	10,859
GT Exhaust Flow x 10^3	lb/h	3,166.7	3,146.2	2,868.9	2,588.5	2,295.9
GT Exhaust Temp.	Deg F.	1,010	1,012	1,007	1,013	1,044
GT Exhaust Press Loss (total)	in. H2O	16.6	16.4	13.6	11.1	8.9
GT Exhaust Composition:						
O2	% wt.	15.28	15.32	15.38	15.39	15.27
CO2	% wt.	5.06	5.05	5.01	5.00	5.09
H2O	% wt.	5.04	4.95	4.92	4.92	4.98
N2	% wt.	73.31	73.37	73.38	73.38	73.35
Ar	% wt.	1.31	1.31	1.31	1.31	1.31

GT EMISSIONS						
NOx	ppmvd @ 15% O2	9	9	9	9	9
CO	ppmvd @ 15% O2	10	10	10	10	10
UHC	ppmvd @ 15% O2	1	1	1	1	1
VOC	ppmvd @ 15% O2	1	1	1	1	1
PM10/PM2.5 (front half)	mg/m3N	1	1	1	1	1

NOTES:

1. All above data is based on New & Clean conditions. All supplied values are estimations and not guaranteed.
2. Fuel characteristics are based on customer supplied fuel analysis. Sulfur and fuel bound nitrogen (FBN) in the fuel are assumed to be zero.
3. A tolerance of 0.75% on Power, 1.0% on Heat Rate, 2% on exhaust flow, and 10°F on exhaust temperature shall apply.
4. Particulate front-half emissions (non-condensables) shall be determined using EPA Method 201 or 201A.
5. The definition of VOC is on a non-methane, non-ethane basis assuming equivalent molecular weight of methane. Measurement of VOC is based on that THC(Total Hydro Carbon) measured by EPA Method 25A except methane and ethane measured by EPA Method 18.

198-AESinCA-DA-Gas-063.3F75.2%-PART-20120306(CUSTOMER) / GNP 3/6/2012

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Vogt Power International

M501DA Gas Turbine Expected Performance & Emissions

Engine Type		M501DA	M501DA	M501DA	M501DA	M501DA
Fuel Type		Nat. Gas	Nat. Gas	Nat. Gas	Nat. Gas	Nat. Gas
GT Load Condition	%	100%	100%	90%	80%	70%
Ambient Temp.	Deg F.	106	106	106	106	108
Ambient Press.	psia	14.68	14.68	14.68	14.68	14.68
Relative Humidity	%	9.6	9.6	9.6	9.6	9.6
Evaporative Cooler	On/Off	ON	OFF	OFF	OFF	OFF
Fuel LHV	Btu/lb	20,648	20,648	20,648	20,648	20,648
GT Gross Output	kW	116,800	102,000	91,900	81,700	71,400
GT Gross Heat Rate (LHV)	Btu/kWh	10,280	10,594	10,847	11,105	11,540
GT Exhaust Flow x 10^3	lb/h	3,080.3	2,872.1	2,657.0	2,428.8	2,168.9
GT Exhaust Temp.	Deg F.	1,017	1,033	1,028	1,034	1,067
GT Exhaust Press Loss (total)	in. H2O	15.8	13.9	11.8	9.8	8.0
GT Exhaust Composition:						
O2	% wt.	15.27	15.70	15.79	15.82	15.70
CO2	% wt.	5.04	4.87	4.81	4.79	4.87
H2O	% wt.	5.24	4.36	4.31	4.29	4.36
N2	% wt.	73.14	73.75	73.77	73.78	73.75
Ar	% wt.	1.31	1.32	1.32	1.32	1.32
GT EMISSIONS						
NOx	ppmvd @ 15% O2	9	9	9	9	9
CO	ppmvd @ 15% O2	10	10	10	10	10
UHC	ppmvd @ 15% O2	1	1	1	1	1
VOC	ppmvd @ 15% O2	1	1	1	1	1
PM10/PM2.5 (front half)	mg/m3N	1	1	1	1	1

NOTES:

1. All above data is based on New & Clean conditions. All supplied values are estimations and not guaranteed.
2. Fuel characteristics are based on customer supplied fuel analysis. Sulfur and fuel bound nitrogen (FBN) in the fuel are assumed to be zero.
3. A tolerance of 0.75% on Power, 1.0% on Heat Rate, 2% on exhaust flow, and 10°F on exhaust temperature shall apply.
4. Particulate front-half emissions (non-condensables) shall be determined using EPA Method 201 or 201A.
5. The definition of VOC is on a non-methane, non-ethane basis assuming equivalent molecular weight of methane. Measurement of VOC is based on that THC(Total Hydro Carbon) measured by EPA Method 25A except methane and ethane measured by EPA Method 18.

198-AESinCA-DA-Gas-106.0F09.6%-PART-20120306(CUSTOMER) / GNP 3/6/2012

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