From: Stephen O'Kane [stephen.okane@AES.com]
Sent: Friday, December 07, 2012 4:34 PM
To: Chris Perri
Cc: Robert.Mason@CH2M.com; McKinsey, John A.; Foster, Melissa A.; Jerry.Salamy@CH2M.com; Miller, Felicia@Energy; Jiang, Tao@Energy; Bemis, Gerry@Energy
Subject: HBEP start/stop emissions and GHG performance
Attachments: SCAQMD response letter 12-07-2012.pdf

Chris,

In response to your questions regarding detail on the estimated start/stop emissions for the Huntington Beach Energy Project turbines and the assumptions that went in to our calculation of GHG emissions per MW-hr, please see the attached letter and accompanying data. If you require further information or explanation for any of our assertions please don't hesitate to ask.

Thanks

Per: Stephen O'Kane
Permitting and Regulatory Approvals, Southland Repower Team

AES
the power of being global

AES Southland
690 N. Studebaker Rd. | Long Beach, CA | 90803
Direct: 562-493-7840 | Cell: 562-508-0962 | Fax: 562-493-7737
stephen.okane@aes.com | www.aes.com

AES Huntington Beach

December 7, 2012

AES Huntington Beach
21730 Newland Street
Huntington Beach, CA 92646
tel 562 493 7891
fax 562 493 7320

Mr. Chris Perri
Air Quality Engineer
South Coast Air Quality Management District
21865 Copley Drive
Diamond Bar, CA 91765-4178

RE: Huntington Beach Energy Project Permit Application (Facility ID# 115389)

Dear Mr. Perri:

AES Huntington Beach, LLC (AES-HB) is submitting this letter in response to the October 26, 2012 South Coast Air Quality Management District's (AQMD) electronic mail request for additional information needed to complete the Huntington Beach Energy Project (HBEP) engineering evaluation. Listed below are your specific requests followed by AES-HB's response. Please note that the requested data are numbered consecutively following previous AQMD requests.

SCAQMD-DR6: On past projects, the turbine manufacturer has provided a detailed assessment of what the estimated emissions are during the start up sequence, even down to a minute-by-minute level. It would be helpful if you could provide this more detailed information, and if not minute by minute then at least a breakdown by load level, ie from 0 to FSNL, then every 10 or 20 MWs until 70% load is reached. Do you have something for cold and warm starts?

Response: For all start up events (cold, warm, or hot), the turbine emissions are the same; the turbine would reach a 70 percent load rate within 9 minutes of the introduction of fuel. However, the emission control systems (selective catalytic reduction and oxidation catalyst systems) would require a slightly longer warm up period to reach the minimum operating temperatures during a cold start, resulting in higher emissions than a hot or warm start up.

AES-HB requested start up and shutdown information from the turbine manufacturer, Mitsubishi Power Systems America (MPSA). In response to this request, the manufacturer provided a table that presents the time from turbine ignition, percent load rate, exhaust gas flow, exhaust oxygen concentration, and pollutant concentrations during a turbine start up. Table DR6-1 presents the manufacturer's start up emissions for the MPSA 501DA. As noted in Table DR6-1, the turbine exhaust flow rates do not increase linearly with an increase in turbine load rate because, once the compressor reaches the set speed, the exhaust flow through the turbine is a function of the relatively small amount of fuel being combusted and the differences in temperature and pressure. During the loading of the turbine, the inlet guide vanes are continually adjusting the compressor flow to maintain a controlled rate of increase of the gas exhaust temperature, which affects gas flow linearity. This temperature rate control is necessary to allow the machine to expand in a controlled manner so as not to thermally overstress the rotor components.

Table DR6-1 Mitsubishi Power Systems America 501DA Start Up Emissions

Time from GT Ignition	GT Load	Exhaust Flow	NOx	CO	VOC	DryO2	Dry EGF
Minute	Percent	metric tons/hour	ppm@15%O2	ppm@15%O2	ppm@15%O2	Vol %	m3N/h (0 °C)
9	70	1,103.5	9	10	0.2	14.83	804,000
8.58	69.43	1,043.1	9	10	1	14.79	759,000
8.4	66.16	1,042.3	9	47	2	15.03	760,000
8.25	63.42	1,041.7	9	100	10	15.24	761,000
8.25	63.42	1,041.7	35	190	10	15.24	761,000
8.16	61.78	1,041.1	36	320	21	15.35	761,000
8.1	60.69	1,041.1	36	450	30	15.43	762,000
7.79	55.2	1,039.9	38	1,100	210	15.83	763,000
7.48	49.63	1,038.7	41	1,960	387	16.21	765,000
6.92	39.5	1,036.7	45	3,950	1,180	16.88	768,000
6.92	39.5	1,036.7	45	300	300	16.88	768,000
6.67	35.05	1,035.8	45	980	431	17.17	769,000
6.55	32.83	1,035.3	45	1,240	500	17.32	769,000
6.42	30.63	1,034.9	45	1,510	530	17.46	770,000
6.24	27.33	1,034.2	45	1,875	600	17.67	771,000
5.93	21.81	1,033.1	45	2,460	980	18.02	772,000
5.62	16.27	1,032.1	45	3,500	1,600	18.35	774,000
5.56	15.18	1,031.9	45	4,000	2,000	18.42	774,000
5.56	15.18	1,031.9	45	400	200	18.42	774,000
5.32	10.87	1,031	45	1,500	600	18.68	775,000
5.03	5.62	1,030	45	2,500	1,000	19	777,000
Expected Values from Time 0 minutes to 5 minutes (From Ignition to Full Speed No Load)*							
			NOx	CO	VOC		
0-5			2.2 lbs	21 lbs	4.1 lbs		

*Minute by Minute Data is unavailable for this time period as exhaust flow does not ramp up linearly during this period nor do emissions stay constant.

Using the manufacturer's data, we calculated the start up emissions on a per minute basis by converting the dry exhaust gas flow rate to dry cubic feet per hour at 60 degrees Fahrenheit (°F) and correcting the pollutant concentrations to actual stack oxygen concentrations. Table DR6-2 presents the start up emissions on a pound per minute basis.

Table DR6-2 Calculated Turbine Start Up Emissions

GT Load	Dry EGF	CO	VOC	NOx	CO	VOC	NOx
Percent	Cubic Feet/min	ppmvd Uncorrected	ppmvd Uncorrected	ppmvd Uncorrected	lb/min	lb/min	lb/min
70	500,148	10.3	0.2	9.3	0.38	0.004	0.6
69.43	472,154	10.4	1.0	9.3	0.36	0.02	0.5
66.16	472,776	46.8	2.0	9.0	1.6	0.04	0.5
63.42	473,398	95.9	9.6	8.6	3.4	0.2	0.5
63.42	473,398	182.3	9.6	33.6	6.4	0.2	1.9
61.78	473,398	301.0	19.8	33.9	10.5	0.4	1.9
60.69	474,020	417.2	27.8	33.4	14.6	0.6	1.9
55.2	474,643	945.3	180.5	32.7	33.1	3.6	1.9
49.63	475,887	1,558.0	307.6	32.6	54.7	6.2	1.9
39.5	477,753	2,691.4	804.0	30.7	94.9	16.2	1.8
39.5	477,753	204.4	204.4	30.7	7.2	4.1	1.8
35.05	478,375	619.6	272.5	28.4	21.9	5.5	1.6
32.83	478,375	752.4	303.4	27.3	26.6	6.1	1.6
30.63	478,997	880.4	309.0	26.2	31.1	6.3	1.5
27.33	479,619	1,026.5	328.5	24.6	36.3	6.7	1.4
21.81	480,241	1,200.8	478.4	22.0	42.6	9.7	1.3
16.27	481,485	1,512.7	691.5	19.4	53.7	14.1	1.1
15.18	481,485	1,681.4	840.7	18.9	59.7	17.1	1.1
15.18	481,485	168.1	84.1	18.9	6.0	1.7	1.1
10.87	482,107	564.4	225.8	16.9	20.1	4.6	1.0
5.62	483,352	805.1	322.0	14.5	28.7	6.6	0.8
0-5	–	–	–	–	4.2	0.82	0.44

Using the duration of each load rate change from Table DR6-1 and an average of the pound per minute emission rates for the current period and previous period, we calculated the emissions for each time period during the start up, which are presented in Table DR6-3. As an example, for the change in load rate between 69.43 and 70 percent load, we averaged the 0.38 and 0.36 lb CO/min and multiplied by the time it took the turbine to transition between these two load rates (9.0 – 8.58 minutes).

Table DR6-3 Turbine Start Up Emissions Per Minute

Time Minute	GT Load Percent	CO lb/min	VOC lb/min	NOx lb/min	CO lbs	VOC lbs	NOx lbs
9	70	0.38	0.004	0.56	0.16	0.01	0.23
8.58	69.43	0.36	0.02	0.53	0.18	0.01	0.09
8.4	66.16	1.63	0.04	0.51	0.37	0.02	0.08
8.25	63.42	3.35	0.19	0.50	–	–	–
8.25	63.42	6.37	0.19	1.93	0.76	0.03	0.17
8.16	61.78	10.52	0.40	1.94	0.75	0.03	0.12
8.1	60.69	14.59	0.56	1.92	7.39	0.65	0.59
7.79	55.2	33.11	3.62	1.88	13.61	1.52	0.58
7.48	49.63	54.71	6.19	1.88	41.89	6.28	1.02
6.92	39.5	94.88	16.23	1.78	–	–	–
6.92	39.5	7.21	4.13	1.78	3.63	1.20	0.43
6.67	35.05	21.87	5.51	1.65	2.91	0.70	0.19
6.55	32.83	26.56	6.13	1.58	3.75	0.81	0.20
6.42	30.63	31.12	6.26	1.52	6.07	1.16	0.27
6.24	27.33	36.33	6.66	1.43	12.23	2.54	0.42
5.93	21.81	42.55	9.71	1.28	14.93	3.69	0.37
5.62	16.27	53.75	14.07	1.14	3.40	0.94	0.07
5.56	15.18	59.74	17.11	1.10	–	–	–
5.56	15.18	5.97	1.71	1.10	3.13	0.76	0.25
5.32	10.87	20.08	4.60	0.99	7.08	1.62	0.27
5.03	5.62	28.71	6.58	0.85	0.75	0.11	0.02
5	0.51	4.2	0.82	0.44	21.0	4.1	2.20
Totals					**144**	**26.2**	**7.6**

MPSA provided a similar set of data for the shutdown period, presented in Table DR6-4. Using the same methodology as applied to the start up emissions, we calculated the shutdown emissions as presented in Table DR6-5.

Table DR6-4 Mitsubishi Power Systems America 501DA Shutdown Emissions

Time from GT Ignition	GT Load	Exhaust Flow	NOx	CO	VOC	DryO2	Dry EGF
Minute	Percent	metric tons/hour	ppm@15%O2	ppm@15%O2	ppm@15%O2	Vol %	m3N/h (0 °C)
0	70	1,043.1	9	10	0.2	14.79	759,000
0.21	66.16	1,042.3	9	50	2	15.03	760,000
0.39	63.42	1,041.7	9	100	10	15.24	761,000
0.39	63.42	1,041.7	35	200	10	15.24	761,000
0.49	61.78	1,041.1	36	350	22	15.35	761,000
0.57	60.69	1,041.1	36	450	30	15.43	762,000
0.92	55.2	1,039.9	38	1,100	215	15.83	763,000
1.28	49.63	1,038.7	41	2,000	400	16.21	765,000
1.94	39.5	1,036.7	45	4,000	1,200	16.88	768,000
1.94	39.5	1,036.7	45	300	300	16.88	768,000
2.23	35.05	1,035.8	45	1,000	433	17.17	769,000
2.38	32.83	1,035.3	45	1,250	500	17.32	769,000
2.52	30.63	1,034.9	45	1,600	540	17.46	770,000
2.73	27.33	1,034.2	45	1,875	600	17.67	771,000
3.09	21.81	1,033.1	45	2,500	1,000	18.02	772,000
3.45	16.27	1,032.1	45	3,500	1,600	18.35	774,000
3.52	15.18	1,031.9	45	4,000	2,000	18.42	774,000
3.52	15.18	1,031.9	45	400	200	18.42	774,000
3.8	10.87	1,031	45	1,500	600	18.68	775,000
4.14	5.62	1,030	45	2,500	1,000	19	777,000
4.48	0.51	1,029	45	3,500	1,600	19.32	778,000
4.51	0	1,028.9	45	1,000	400	19.35	778,000
4.51	0	1,028.9	45	1,000	400	19.35	778,000
9.51	0	1,028.9	45	1,000	400	19.35	778,000

Table DR6-5 Turbine Shutdown Emissions Per Minute

Time Minute	GT Load Percent	CO lb/min	VOC lb/min	NOx lb/min	CO lbs	VOC lbs	NOx lbs
0	69.43	0.36	0.02	0.53	0.1	0.004	0.1
0.21	66.16	1.74	0.04	0.51	0.2	0.01	0.1
0.39	63.42	3.35	0.19	0.50	0.5	0.02	0.1
0.39	63.42	6.70	0.19	1.93	–	–	–
0.49	61.78	11.50	0.41	1.94	0.9	0.03	0.2
0.57	60.69	14.59	0.56	1.92	1	0.04	0.2
0.92	55.2	33.11	3.71	1.88	8.3	0.75	0.7
1.28	49.63	55.83	6.40	1.88	16	1.82	0.7
1.94	39.5	96.08	16.51	1.78	50.1	7.56	1.2
1.94	39.5	7.21	4.13	1.78	–	–	–
2.23	35.05	22.32	5.53	1.65	4.3	1.4	0.5
2.38	32.83	26.77	6.13	1.58	3.7	0.88	0.2
2.52	30.63	32.97	6.37	1.52	4.2	0.88	0.2
2.73	27.33	36.33	6.66	1.43	7.3	1.37	0.3
3.09	21.81	43.25	9.91	1.28	14.3	2.98	0.5
3.45	16.27	53.75	14.07	1.14	17.5	4.32	0.4
3.52	15.18	59.74	17.11	1.10	4	1.09	0.1
3.52	15.18	5.97	1.71	1.10	–	–	–
3.8	10.87	20.08	4.60	0.99	3.6	0.88	0.3
4.14	5.62	28.71	6.58	0.85	8.3	1.9	0.3
4.48	0.51	33.47	8.76	0.71	10.6	2.61	0.3
4.51	0	9.38	2.15	0.69	0.6	0.16	0
4.51	0	9.38	2.15	0.69	–	–	–
9.51	0	9.38	2.15	0.69	46.9	10.7	3.5
Totals					**202.4**	**39.4**	**9.7**

Considering the inherent difficulties in quantifying air emissions during a transient event like a turbine start up or shutdown, the calculated start up and shutdown emissions presented in Tables DR6-3 and DR6-5 compare reasonably well with the expected start up and shutdown emissions provided by the turbine manufacturer.

SCAQMD-DR7: I noticed that the GHG emissions were calculated to be 1,082 lbs CO2/MW-hr (page 3-25). Could you provide (or point to where in the document) the detailed calculations to support this number?

Response: Table DR7-1 presents the heat rate and electrical production rates for the HBEP at various operating levels at an ambient temperature of 71 °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 DR7-2 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 DR7-3 presents the GHG efficiency for the HBEP, 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 DR7-1. Note that the operating profile assumed here reflects a realistic estimate of HBEP's GHG efficiency for the project application and is not equivalent to the operating profile being used in the permitting effort.

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

Sincerely,

Stephen O'Kane
Manager
AES Huntington Beach, LLC

Attachments
cc: Robert Mason/CH2M HILL
Jennifer Didlo/AES
John McKinsey/Stoel Rives
Missy Foster/Stoel Rives
Jerry Salamy/CH2M HILL
Felicia Miller/CEC

Table DR7-1 HBEP Heat Rate Estimate

HBEP Expected Annual Average Operating Profile at an Ambient Air Temperature of 71 F[1]

																	Expected Annual Hours
Blocks 1 and 2	Hours/year		250					3200						1460			4910
Net Plant Power	kW	233954	261500	288570	322300	407140	482162	537404	591440	658918	735826	726498	735836	807312	886132	984530	
Estimated Gross Heat Rate, LHV	Btu/kW-hr	7730	7562	7439	7351	7740	7501	7359	7259	7191	7453	7467	7451	7348	7267	7217	
				State 1					State 2					State 3			
		Average Kw 302693			Average State 1	7564	Average Kw 601150			Average State 2	7353	Average Kw		828062		Average State 3	7350

HBEP Performance for 1 Power Block

Net Plant Power	kW	116977	130750	144285	161150	203570	241081	268702	295720	329459	367913	363249	367918	403656	443066	492265
Net Heat Rate, LHV[2]	Btu/kW-hr	7969	7796	7669	7578	7979	7733	7587	7484	7413	7683	7698	7681	7575	7492	7440
Estimated Gross Heat Rate, LHV	Btu/kW-hr	7730	7562	7439	7351	7740	7501	7359	7259	7191	7453	7467	7451	7348	7267	7217

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

Table DR7-2 HBEP 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 [illegible]

[illegible]

Notes
Using : [illegible] Fast Start curve

[illegible]

[illegible]

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Notes
(1) [illegible] 70% load during Start-Up and Shut-Down.
(2) [illegible]
(3) [illegible]
(4) [illegible]
(5) [illegible]
(6) [illegible]

Table DR7-3 HBEP Calculate Annual Average CO2 (lb/MWh)

Annual Average - assume all hours for each State are at the average of data points provided for heat rate for that State

Start Up and Stop Heat Rate Calculations

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

Plant CO2 Efficiency Calculation

7740	Btu LHV / kWh Gross	Weighted Annual Average Heat Rate with SU/SD and no Degradation.
8%	Assumed Plant Degradation	
8413	Btu LHV / kWh Gross	Annual Average CO2 Efficiency with SU/SD and Degradation
1082	lb CO2 /MWh Gross	Annual Average CO2 Efficiency with SU/SD and Degradation