STOEL RIVES LLP
ATTORNEYS AT LAW

DOCKET
11-AFC-1
DATE SEP 07 2011
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September 7, 2011

VIA EMAIL

Mr. Eric Solorio, Siting Project Manager
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

Re: Pio Pico Energy Center Project (11-AFC-01)
Plume Modeling Data

Dear Mr. Solorio:

On behalf of Applicant Pio Pico Energy Center, LLC, please find enclosed herein for docketing a table relating to the plume analysis presented in Applicant's response to TRANS-48. This table was referred to in the text of Applicant's response, but inadvertently left out of the response. The table was provided to California Energy Commission Staff, Tao Jiang, on September 6, 2011.

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

Respectfully submitted,

Kimberly J. Hellwig
Paralegal

KJH:jmw
Enclosure
cc: Proof of Service List (by email only)

TRAFFIC AND TRANSPORTATION

BACKGROUND

COMMENT: As noted on page 5.11-8, the issue of both visible and invisible thermal plumes from industrial stacks has lately been brought to the forefront regarding aviation safety. The AFC provides no discussion of potential plume impacts or analysis of plume velocity, heat dispersal, or other plume characteristics that might contribute to low altitude turbulence in AFC §5.0 (Traffic & Transportation). Analyses of the velocity, shape, and dispersal of the exhaust plumes are necessary for staff to determine the potential impact of plumes generated by the Pio Pico Energy Center on aircraft flying in the immediate vicinity of the project.

DATA REQUEST 48

COMMENT: Please provide a detailed plume analysis for the thermal plumes generated by the Pio Pico Energy Center exhaust stacks, including:

a) Frequency of plume generation, velocity, shape, continuity, and dispersal of plume(s), up to and including 2000 feet agl.

b) Meteorological impacts on plume formation and behavior. Provide the name of the computer model used and its inputs and outputs.

c) Potential impacts to air mass stability and aircraft operations in the area affected by the plumes. Please consider elements such as aircraft type, speed, and altitude; low visibility; cool temperatures; and calm winds when evaluating potential aviation impacts.

RESPONSE: The closest airport to the PPEC site is the Brown Field Municipal Airport located approximately three miles to the west. As discussed in Section 5.11.1.1 of the AFC, the PPEC project site is located in an advisory avoidance area for both inbound and outbound aircraft at Brown Field Municipal Airport due to the high terrain (up to 3,500 feet) east of the project site. The recommended pattern altitude (the altitude at which an aircraft enters the traffic pattern around an airport) is 1,000 feet above ground level (AGL).[1] CEC staff has indicated that there parachute jumping activity nearby (at the airport and 3 miles east of the airport), and occasional helicopter activity in the area by the US Border Patrol.

CEC staff indicated that sections a) and b) of the data request are standard requests associated with visible plume analysis, and are not relevant to thermal plume analysis.[2] Because of the high exhaust temperature of the simple-cycle turbines, it has been determined by CEC staff that visible plumes are extremely unlikely, and that a visible plume analysis is not necessary.

In response to section c) of the data request, a plume velocity analysis was conducted to assess the turbulence resulting from air plume velocities from the PPEC's gas turbine

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[1] *KSDM Brown Field Municipal Airport.* http://www.airnav.com/airport/KSDM

[2] Personal telephone conversation, Steve Hill (Sierra Research) and Jim Adams (CEC), 6/28/2011

exhausts (see table below). The analysis assumed worst-case meteorological conditions (cool temperatures and calm winds) and all three turbines operated at full load, when the maximum upward plume velocity would be generated. The methodology used to calculate plume vertical velocities is the Spillane Approach. This methodology has been used by CEC to evaluate exhaust stack plume velocities.[3]

The Spillane approach uses the following equations to determine vertical velocity for single stacks during dead calm wind (i.e. wind speed = 0) conditions:

(1) $(V*a)^3 = (V*a)^3 + 0.12*F_o*[(z-z_v)^2-(6.25D-z_v)^2]$
(2) $(V*a)_o = V_{exit}*D/2*(T_a/T_s)^{0.5}$
(3) $F_o = g*V_{exit}*D2*(1-T_a/T_s)/4$
(4) $Z_v = 6.25D*[1-(T_a/T_s)^{0.5}]$
Where:
V = vertical velocity (m/s), plume-average velocity
a = plume top-hat radius (m, increases at a linear rate of $a = 0.16*(z- z_v)$
F_o= initial stack buoyancy flux m4/s3
z = height above ground (m)
z_v= virtual source height (m)
V_{exit}= initial stack velocity (m/s)
D = stack diameter (m)
Ta= ambient temperature (K)
T_s= stack temperature (K)
g = acceleration of gravity (9.8 m/s^2)

For multiple stack plumes, where the stacks are equivalent, the multiple-stack plume velocity during calm winds was calculated using a simplified fashion as follows:

(5) $V_m = V_{sp}*N^{0.25}$

The average plume velocity speed, in meters per second (m/s), as a function of turbine operating conditions, are shown in the table below for both a single turbine and all three turbines combined.

For purposes of this analysis, a plume average vertical velocity of 4.3 m/s was considered the critical velocity of concern to light aircraft.[4] The gas turbine plume velocity drops below 4.3 m/s at approximately 2500 feet AGL, at which height the dimensions of the merged plumes from the gas turbines are approximately 720 feet by 380 feet. The thermal plume from single turbine drops below a vertical velocity of 4.3 m/s at 1100 ft AGL. As a result, adverse impacts could potentially occur to low-flying aircraft due to

[3] See, for example, Final Staff Assessment, Eastshore Power Project (November 2007), Appendix TT-1.
[4] This is based on CEC staff's review of a 2004 safety circular (AC 139-05(0)), prepared by the Australian Government Civil Aviation Safety Authority, which noted "aviation authorities have established that an exhaust plume with a vertical velocity in excess of 4.3 meters per second (m/s) may cause damage to an aircraft airframe or upset an aircraft when flying at low levels" (CASA 2004). In their safety study on thermal plumes, the FAA noted that they "do not necessarily approve/disapprove or warrant the data contained in the CASA AC 139-05." The safety team accepted "the information and data contained in AC 139-05 as a valid representation of hazardous exhaust velocities" (FAA 2006).

project-related turbulence in the airspace above the site. Aircraft observing the recommended pattern altitudes of 1,000 AGL may still encounter project turbulence.

FAA regulations require the project owner to notify the FAA if the height or outward or upward slope of a proposed new structure is more than 200 feet AGL at the site. No such structure exists.

To ensure that plumes associated with PPEC operations do not impact aviation activities, the applicant proposes to consult with the FAA to update all applicable airspace charts to indicate that project plume hazards could exist and to notify all pilots using the Brown Field Airport to avoid direct overflight of the airspace above the PPEC site.

PPEC predicted Calm wind Plume velocities

PPEC Stack Parameters

Case	Cold Base	Cold Low	Average Base	Average Low	Hot base	Hot Low
Ambient Temperature (F)	30	30	63	63	110	110
Ambient Temperature (k)	272.039	272.039	290.372	290.372	316.483	316.483
Stack Height (m)	30.48	30.48	30.48	30.48	30.48	30.48
Stack diameter (m)	4.4196	4.4196	4.4196	4.4196	4.4196	4.4196
Stack Velocity (m/s)	27.98	19.86	28.11	19.89	27.01	22.56
Exhaust Temperature (K)	674	711.2	691.2	717.2	700.9	713.8
Zv Virtual source Height (m)	10.07	10.54	9.72	10.05	9.06	9.23
F^0 initial stack buoyancy (m^4/s^3)	798.55	586.87	780.09	566.47	708.93	600.94
$(V^*a)_0$	39.28	27.14	40.26	27.97	40.11	33.20

PPEC Plume Velocity (m/s)

Ht above stacktop (ft)	Height above stacktop (m)	Cold Base	Cold Low	Average Base	Average Low	Hot base	Hot Low
800	213.36	4.88	4.39	4.84	4.34	4.68	4.42
900	243.84	4.65	4.19	4.61	4.14	4.47	4.22
1000	274.32	4.46	4.02	4.43	3.98	4.29	4.05
1100	304.8	4.30	3.88	4.27	3.83	4.13	3.91
1200	335.28	4.16	3.75	4.13	3.71	4.00	3.78
1300	365.76	4.04	3.64	4.01	3.60	3.88	3.67
1400	396.24	3.93	3.55	3.90	3.50	3.77	3.57
1500	426.72	3.83	3.46	3.80	3.42	3.68	3.48
1600	457.2	3.74	3.38	3.71	3.34	3.59	3.40
1700	487.68	3.66	3.30	3.63	3.26	3.52	3.33
1800	518.16	3.59	3.24	3.56	3.20	3.44	3.26
1900	548.64	3.52	3.17	3.49	3.14	3.38	3.20
2000	579.12	3.45	3.12	3.43	3.08	3.32	3.14
2100	609.6	3.39	3.06	3.37	3.03	3.26	3.08
2200	640.08	3.34	3.01	3.31	2.98	3.21	3.03
2300	670.56	3.28	2.96	3.26	2.93	3.16	2.99
2400	701.04	3.24	2.92	3.21	2.89	3.11	2.94
2500	731.52	3.19	2.88	3.16	2.84	3.06	2.90
2600	762	3.15	2.84	3.12	2.81	3.02	2.86
2700	792.48	3.10	2.80	3.08	2.77	2.98	2.82
2800	822.96	3.07	2.77	3.04	2.73	2.94	2.79

PPEC plume top-hat radius (m)

Ht above stacktop (ft)	Height above stacktop (m)	Cold Base	Cold Low	Average Base	Average Low	Hot base	Hot Low
800	213.36	32.53	32.45	32.58	32.53	32.69	32.66
900	243.84	37.40	37.33	37.46	37.41	37.56	37.54
1000	274.32	42.28	42.20	42.34	42.28	42.44	42.41
1100	304.80	47.16	47.08	47.21	47.16	47.32	47.29
1200	335.28	52.03	51.96	52.09	52.04	52.20	52.17
1300	365.76	56.91	56.84	56.97	56.91	57.07	57.04
1400	396.24	61.79	61.71	61.84	61.79	61.95	61.92
1500	426.72	66.66	66.59	66.72	66.67	66.83	66.80
1600	457.20	71.54	71.47	71.60	71.54	71.70	71.68
1700	487.68	76.42	76.34	76.47	76.42	76.58	76.55
1800	518.16	81.29	81.22	81.35	81.30	81.46	81.43
1900	548.64	86.17	86.10	86.23	86.17	86.33	86.31
2000	579.12	91.05	90.97	91.10	91.05	91.21	91.18
2100	609.60	95.92	95.85	95.98	95.93	96.09	96.06
2200	640.08	100.80	100.73	100.86	100.81	100.96	100.94
2300	670.56	105.68	105.60	105.73	105.68	105.84	105.81
2400	701.04	110.55	110.48	110.61	110.56	110.72	110.69
2500	731.52	115.43	115.36	115.49	115.44	115.59	115.57
2600	762.00	120.31	120.23	120.36	120.31	120.47	120.44

Distance between stacks:

54.00 m

PPEC Plume Velocity (Three Stack Merged Exit velocity, m/s)

Ht above stacktop (ft)	Height above stacktop (m)	Cold Base	Cold Low	Average Base	Average Low	Hot base	Hot Low
800	213.36	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge
900	243.84	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge
1000	274.32	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge
1100	304.80	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge
1200	335.28	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge
1300	365.76	5.32	4.80	5.27	4.74	5.11	4.83
1400	396.24	5.17	4.67	5.13	4.61	4.97	4.70
1500	426.72	5.04	4.55	5.00	4.49	4.84	4.58
1600	457.20	4.93	4.44	4.89	4.39	4.73	4.48
1700	487.68	4.82	4.35	4.78	4.29	4.63	4.38
1800	518.16	4.72	4.26	4.68	4.21	4.53	4.29
1900	548.64	4.63	4.18	4.59	4.13	4.45	4.21
2000	579.12	4.54	4.10	4.51	4.05	4.36	4.13
2100	609.60	4.47	4.03	4.43	3.98	4.29	4.06
2200	640.08	4.39	3.96	4.36	3.92	4.22	3.99
2300	670.56	4.32	3.90	4.29	3.85	4.15	3.93
2400	701.04	4.26	3.84	4.22	3.80	4.09	3.87
2500	731.52	4.20	3.79	4.16	3.74	4.03	3.82
2600	762.00	4.14	3.74	4.11	3.69	3.98	3.76

From: Steve Hill
Sent: Tuesday, September 06, 2011 1:53 PM
To: 'Tao Jiang'; David Jenkins (djenkins@apexpowergroup.com); McKinsey, John A.; Gary Rubenstein
Subject: RE: PPEC plume modeling

No wonder you were confused. The table was not included with the data response.

Here it is.

PPEC predicted Calm wind Plume velocities

PPEC Stack Parameters

Case	Cold Base	Cold Low	Average Base	Average Low	Hot base	Hot Low
Ambient Temperature (F)	30	30	63	63	110	110
Ambient Temperature (K)	272.039	272.039	290.372	290.372	316.483	316.483
Stack Height (m)	30.48	30.48	30.48	30.48	30.48	30.48
Stack diameter (m)	4.4196	4.4196	4.4196	4.4196	4.4196	4.4196
Stack Velocity (m/s)	27.93	19.86	28.11	19.89	27.01	22.58
Exhaust Temperature (K)	674	711.2	691.2	717.2	700.9	713.8
Zv Virtual source Height (m)	10.07	10.54	9.72	10.05	9.06	9.23
F^2 initial stack buoyancy (m^4/s^3)	758.55	538.87	780.09	538.47	708.93	600.94
(Vfac	39.28	27.14	40.28	27.97	40.11	33.20

PPEC Plume Velocity (m/s)

Ht above stackbo (ft	Height above stackbo (m)	Cold Base	Cod Low	Average Base	Average Low	Hot base	Hot Low
800	243.84	4.65	4.19	4.61	4.14	4.47	4.22
900	274.32	4.48	4.02	4.43	3.98	4.29	4.05
1000	304.8	4.30	3.88	4.27	3.83	4.13	3.91
1100	335.28	4.16	3.75	4.13	3.71	4.00	3.78
1200	365.76	4.04	3.64	4.01	3.60	3.88	3.67
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1600	487.68	3.66	3.30	3.63	3.28	3.52	3.33
1700	518.16	3.59	3.24	3.56	3.20	3.44	3.26
1800	548.64	3.52	3.17	3.49	3.14	3.38	3.20
1900	579.12	3.46	3.12	3.43	3.08	3.32	3.14
2000	609.6	3.39	3.06	3.37	3.03	3.26	3.09
2100	640.08	3.34	3.01	3.31	2.98	3.21	3.03
2200	670.56	3.29	2.96	3.26	2.93	3.16	2.99
2300	701.04	3.24	2.92	3.21	2.89	3.11	2.94
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2500	762	3.15	2.84	3.12	2.81	3.02	2.86
2600	792.48	3.10	2.80	3.08	2.77	2.98	2.82
2700	822.96	3.07	2.77	3.04	2.73	2.94	2.79

PPEC plume tophat radius (m)

Ht above stackbo (ft	Height above stackbo (m)	Cold Base	Cod Low	Average Base	Average Low	Hot base	Hot Low
800	243.84	37.40	37.33	37.46	37.41	37.56	37.54
900	274.32	42.26	42.20	42.34	42.28	42.44	42.41
1000	304.8	47.19	47.08	47.21	47.19	47.32	47.29
1100	335.28	52.03	51.96	52.09	52.04	52.20	52.17
1200	365.76	56.91	56.84	56.97	56.91	57.07	57.04
1300	396.24	61.79	61.71	61.84	61.79	61.95	61.92
1400	426.72	66.66	66.59	66.72	66.67	66.83	66.80
1500	457.2	71.54	71.47	71.60	71.54	71.70	71.68
1600	487.68	76.42	76.34	76.47	76.42	76.58	76.55
1700	518.16	81.29	81.22	81.35	81.30	81.46	81.43
1800	548.64	86.17	86.10	86.23	86.17	86.33	86.31
1900	579.12	91.05	90.97	91.10	91.05	91.21	91.18
2000	609.60	95.92	95.85	95.98	95.93	96.09	96.06
2100	640.08	100.80	100.73	100.86	100.81	100.96	100.94
2200	670.56	105.68	105.60	105.73	105.68	105.84	105.81
2300	701.04	110.55	110.48	110.61	110.56	110.72	110.69
2400	731.52	115.43	115.36	115.49	115.44	115.55	115.57
2500	762.00	120.31	120.23	120.36	120.31	120.47	120.44

Distance between stacks:

54.00 m

PPEC Plume Velocity (Three Stack Merged Exit velocity, m/s)

Ht above stackbo (ft	Height above stackbo (m)	Cold Base	Cod Low	Average Base	Average Low	Hot base	Hot Low
800	243.84	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge
900	274.32	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge
1000	304.8	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge
1100	335.28	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge	Not Merge
1200	365.76	5.32	4.80	5.27	4.74	5.11	4.83
1300	396.24	5.17	4.67	5.13	4.61	4.97	4.70
1400	426.72	5.04	4.55	5.00	4.49	4.84	4.58
1500	457.2	4.93	4.44	4.88	4.39	4.73	4.48
1600	487.68	4.82	4.35	4.78	4.29	4.63	4.38
1700	518.16	4.72	4.26	4.68	4.21	4.53	4.29
1800	548.64	4.63	4.18	4.58	4.13	4.45	4.21
1900	579.12	4.54	4.10	4.51	4.05	4.36	4.13
2000	609.60	4.47	4.03	4.42	3.98	4.29	4.06
2100	640.08	4.39	3.96	4.36	3.92	4.22	3.99
2200	670.56	4.32	3.90	4.29	3.85	4.15	3.93
2300	701.04	4.26	3.84	4.23	3.80	4.09	3.87
2400	731.52	4.20	3.79	4.18	3.74	4.03	3.82
2500	762.00	4.14	3.74	4.11	3.69	3.98	3.78

Please let me know if you have any questions.

-----Original Message-----
From: Tao Jiang [mailto:TJiang@energy.state.ca.us]
Sent: Tuesday, September 06, 2011 12:11 PM
To: Steve Hill
Subject: PPEC plume modeling

Hi, Steve
I just read though your data response tran-48. Interestingly, although the DR says "see the table below", there is no table in this DR. Could you send me that table? Please make sure all input parameters are included. Thanks.

Tao

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT
COMMISSION OF THE STATE OF CALIFORNIA
1516 NINTH STREET, SACRAMENTO, CA 95814
1-800-822-6228 – WWW.ENERGY.CA.GOV

APPLICATION FOR CERTIFICATION
FOR THE *PIO PICO ENERGY CENTER, LLC*

Docket No. 11-AFC-1
PROOF OF SERVICE
(Revised 5/15/11)

Pio Pico Energy Center, LLC
Letter to Eric Solorio, Siting Project Manager, California Energy Commission, dated September 7, 2011 Regarding Plume Modeling Data

APPLICANT

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DECLARATION OF SERVICE

I, Judith M. Warmuth, declare that on September 7, 2011, I deposited copies of the aforementioned document and, if applicable, a disc containing the aforementioned document in the United States mail at 500 Capitol Mall, Suite 1600, Sacramento, California 95814, with first-class postage thereon fully prepaid and addressed to those identified on the Proof of Service list above.

AND/OR

Transmission via electronic mail, personal delivery and first class U.S. mail were consistent with the requirements of California Code of Regulations, Title 20, sections 1209, 1209.5, and 1210. All electronic copies were sent to all those identified on the Proof of Service list above.

I declare under penalty of perjury that the foregoing is true and correct.

Judith M. Warmuth