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July 13, 2007

DOCKET
01-AFC-7C
DATE JUL 13 2007
RECD. JUL 13 2007

Mr. Lance Shaw
Project Manager
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

Re: Plume Vertical Velocity Assessment of a Proposed Gas-Fired Power Station at Russell City Energy Center – Addendum 2, prepared by Katestone Environmental, Toowong, Australia

Russell City Energy Center Amendment No. 1 (01-AFC-7C)

Dear Mr. Shaw:

Please find attached one original and 12 copies of the document titled "Plume Vertical Velocity Assessment of a Proposed Gas-Fired Power Station at Russell City Energy Center – Addendum 2," prepared by Katestone Environmental, Toowong, Australia. The document is filed in support of the Petition for Amendment No. 1 for the Russell City Energy Center, Hayward, California (01-AFC-7C).

If you have any questions about this matter, please contact me at (916) 286-0278.

Sincerely,

Jeannette Harris

for Douglas M. Davy, Ph.D.
AFC Project Manager

Attachment

cc: M. Argentine
G. Wheatland

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA

Amendment to the APPLICATION FOR CERTIFICATION OF THE RUSSELL ENERGY CENTER POWER PLANT PROJECT	**Docket No. 01-AFC-7C PROOF OF SERVICE (Revised 7/6/07)**

INSTRUCTIONS: All parties shall 1) send an original signed document plus 12 copies OR 2) mail one original signed copy AND e-mail the document to the web address below, AND 3) all parties shall also send a printed OR electronic copy of the documents that shall include a proof of service declaration to each of the individuals on the proof of service:

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DECLARATION OF SERVICE

I, Jeannette Harris, declare that on July 13, 2007, I deposited copies of the attached Plume Vertical Velocity Assessment of a Proposed Gas-Fired Power Station at Russell City Energy Center – Addendum 2 filed in support of the Petition for Amendment No. 1 for the Russell City Energy Center, Hayward, California (01-AFC-7C) in the United States mail at Sacramento, California with first-class postage thereon fully prepaid and addressed to those identified on the Proof of Service list above.

OR

Transmission via electronic mail was 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.

Jeannette Harris

JEANNETTE HARRIS

Plume Vertical Velocity Assessment of a Proposed Gas-Fired Power Station at Russell City Energy Center

ATMOSPHERIC DYNAMICS Pty Ltd

July 2007

Addendum 2

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DOCUMENT DETAILS

Job Number: *KE0705519*	***Date:*** *13/07/2007*
Title: *Plume Vertical Velocity Assessment of a Proposed Gas-Fired Power Station at Russell City Energy Center – Addendum 2*	
Client: *ATMOSPHERIC DYNAMICS Pty Ltd*	
Document reference: *AtmDyn_memo_enhancement.doc*	

Revision No.	***Prepared by:***	***Reviewed by:***	***Approved by:***	***Date***
Rev 0	*Alex Schloss*	*Christine Killip*	*Simon Welshman*	*13/7/07*

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1. Introduction

Katestone Environmental has been commissioned by Atmospheric Dynamics Pty Ltd to prepare a plume vertical velocity assessment of a proposed gas-fired power station at Russell City Energy Center in California. The results of the assessment can be found in the Katestone report "Plume Vertical Velocity Assessment of a Proposed Gas-Fired Power Station at Russell City Energy Center" Final report June 2007 (Katestone, 2007).

The results that were presented in Katestone (2007) were developed using a two-step process. The prognostic wind field model, TAPM, was used to generate the local meteorological conditions, which were then used in the Katestone Method to estimate the vertical velocity of merged the plumes.

The Katestone Method takes the vertical wind profiles generated by TAPM and using a method derived by Dr Kevin Spillane estimates the process of merging two or more plumes and the subsequent changes to vertical velocities and plume extent.

TAPM is a publicly available model that has been extensively validated and tested (see Hurley 2006 for recent validation papers). TAPM also has a sophisticated dispersion model that is coupled with the wind field model, capable of predicting the plume rise and dispersion of a range of emission sources. Consequently, TAPM can be used with a buoyancy enhancement factor as an alternative method to estimate the vertical velocity of the RCEC project. This approach has been taken and the results are presented in this second addendum report as an independent verification of the Katestone Method.

2. Methodology

Buoyancy enhancement describes a situation where there are multiple vertical exhaust plumes in close proximity that interact to produce enhanced buoyancy. As the plumes rise, they can merge to form a larger single plume of greater vertical velocity and width than that of a single source plume.

TAPM can be used to simulate the buoyancy enhancement by applying a buoyancy enhancement factor to each of the co-located vertical exhaust plumes. The enhancement factor, E_N, can be defined as the ratio of the rise of the combined plume to the rise of a single plume.

Plume rise varies as a function of buoyancy to the power of one third, thus the maximum plume rise enhancement factor, E_N, for N stacks would be $N^{1/3}$ if all emitted buoyancy were completely conserved.

Various studies have been undertaken to determine the form of buoyancy enhancement, such as Briggs (1975), that derive a function that is dependent on the number of stacks, single plume rise and separation distance.

The application of the buoyancy enhancement factor in TAPM is limited to one E_N per stack for all atmospheric conditions. The most conservative assumption is to assume that all emitted buoyancy is conserved by the use of $N^{1/3}$.

For this study a buoyancy enhancement factor of $N^{1/3}$ has been applied to the nine cooling tower plumes (E_N = 2.08) and two gas turbine scenarios (E_N = 1.26).

3. Emission characteristics

A summary of the stack configuration and plume emission characteristics of the proposed Russell City Energy Center (RCEC) project are presented in Tables 1 and 2 below.

Table 1: Stack characteristics of the proposed RCEC project

Parameter	Units	Cooling Towers	Scenario 1 Gas Turbines	Scenario 2 Gas Turbines
Number of stacks	-	9	2	2
Location	AMG (mN, mE)	576424.97 4165459.04 576417.23 4165475.65 576409.48 4165492.27 576401.74 4165508.88 576394.00 4165525.49 576386.26 4165542.10 576378.52 4165558.72 576370.78 4165575.33 576363.04 4165591.94	576552.23 4165363.93 576515.65 4165363.93	576552.23 4165363.93 576515.65 4165363.93
Stack height	m	18.3	44.2	44.2
Stack diameter	m	9.75	5.49	5.49
Volume Flow per stack	m^3/s	770	525	534
Single plume buoyancy flux	m^4/s^3	159	346	392
Exit velocity	m/s	10.3	22.2	22.55
Temperature	°C	28.3	82	89.44
Stack separation	m	18.3	36.6	36.6

4. Results

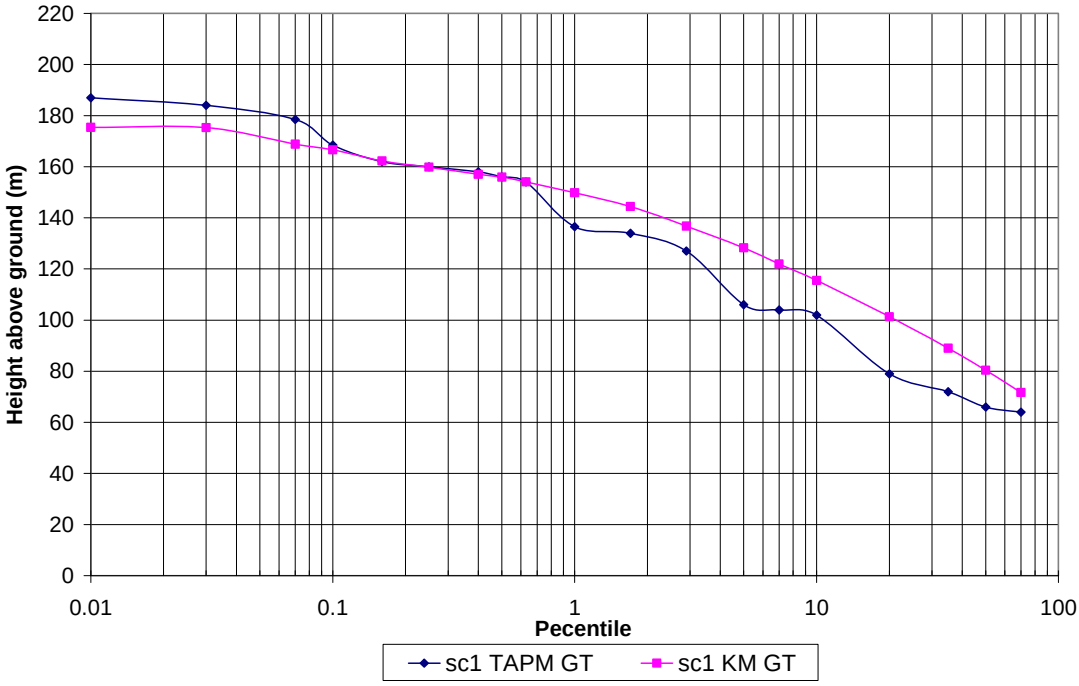
A comparison between the critical plume height calculated using TAPM with buoyancy enhancement and the Katestone Method for merged plumes for the various scenarios is presented in Table 2 and Figure 1. The results indicate that the Katestone Method predicts slightly higher critical plume heights for most of the time compared to TAPM. There is generally very good agreement between the methods.

Table 2: Results for critical plume height for the proposed RCEC cooling towers and gas turbine scenarios and the proportion of the simulation year that the critical height is exceeded.

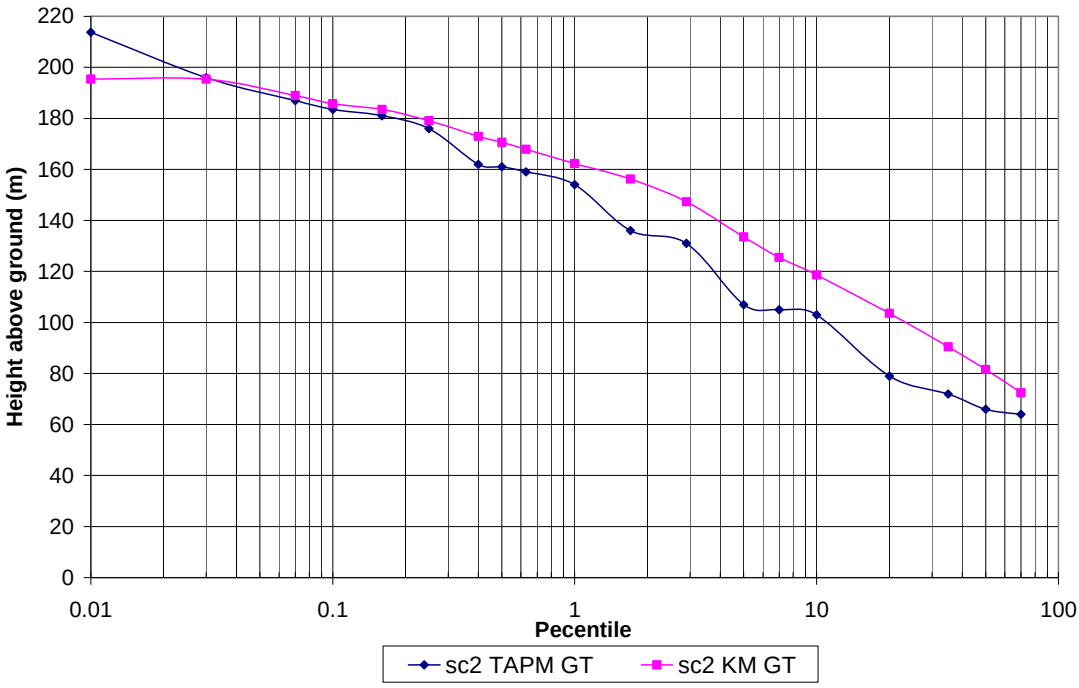
Percent of time (%)	Cooling towers		Gas turbines Scenario 1		Gas turbines Scenario 2	
	TAPM	KE Method	TAPM	KE Method	TAPM	KE Method
E_N	2.08	-	1.26	-	1.26	-
90	29	28	59	64	59	65
80	29	31	59	68	59	68
70	30	34	64	72	64	73
60	30	37	65	76	65	77
50	31	42	66	80	66	82
40	35	47	71	86	72	87
30	36	53	73	92	73	94
20	37	58	79	101	79	104
10	42	64	102	116	103	119
9	42	65	102	118	103	121
8	43	66	103	120	104	123
7	47	67	104	122	105	126
6	47	69	105	125	106	129
5	48	70	106	128	107	134
4	48	73	108	132	110	140
3	67	76	113	136	131	147
2	68	80	132	142	135	154
1	70	84	137	150	154	162
0.5	72	87	156	156	161	171
0.3	73	89	160	159	168	177
0.2	73	90	161	161	180	182
0.1	74	92	173	167	185	187
0.05	95	93	184	175	190	195

Figure 1: Frequency distribution of critical plume height (meters) for merged plume scenarios using the Katestone Method (pink) and TAPM with buoyancy enhancement (blue).

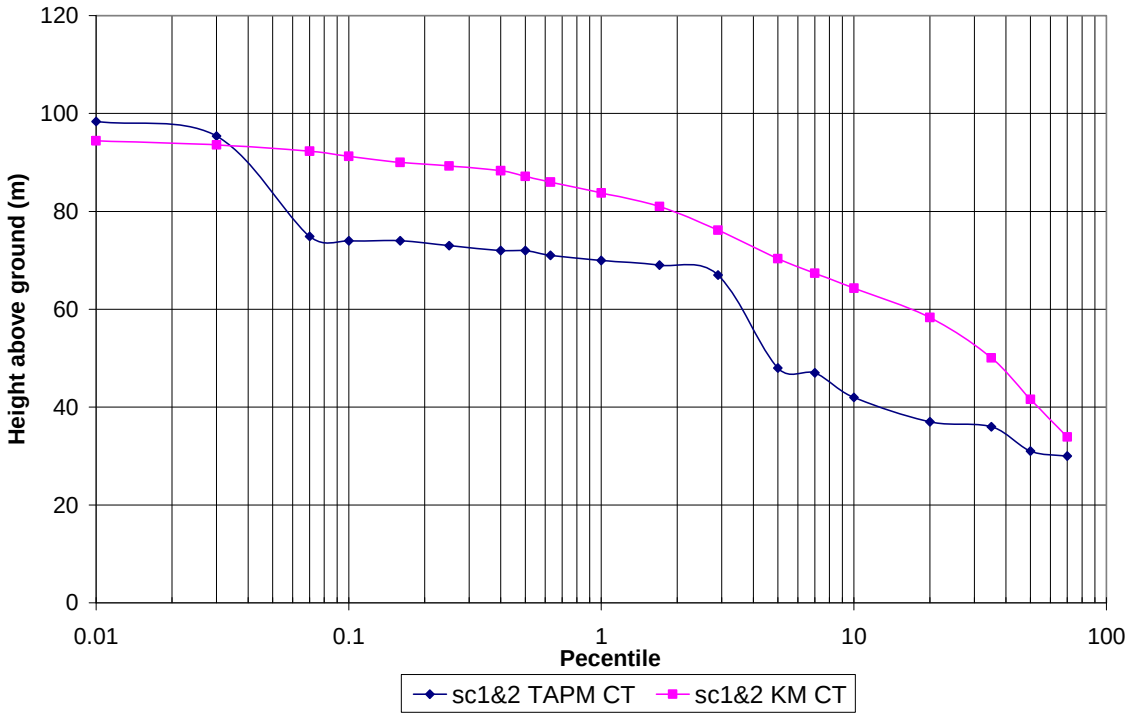
a) Gas Turbines – Scenario 1



b) Gas Turbines - Scenario 2



c) Scenario 1 & 2: Nine Cooling Towers



5. References

Briggs, G.A., 1975, Plume rise from multiple sources: Cooling Tower Environment – 1974 Conference Proceedings edited by S R Hanna and J Pell. Technical Information Center, Office of Public Affairs, Energy Research and Development Administration.

Katestone Environmental, 2007, Plume Vertical Velocity Assessment of a Proposed Gas-Fired Power Station at Russell City Energy Center, A report from Katestone Environmental to Atmospheric Dynamics, June 2007.

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