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Appendix 3.17B, Table 1
Thermal Plume Calculations for Air Coolers
Lightspeed SJC02
August 2021

PETER BEST PAPER ILLUSTRATIVE EXAMPLE

Plume Averaged Vertical Velocities from "*Aviation Safety and Buoyant Plumes*," Peter Best, et. al. (2003)

Data Entry for SJC02 Air Coolers (Buildings SJC02 and SJC03)

Ambient Conditions:

Ambient Potential Temp, θ_a	272	Kelvins	30	°F			
Plume Exit Conditions:							
Stack Height, h_s	9.33	meters	30.6	feet			
Stack Diameter, D	1.50	meters	4.92	feet			
Stack Velocity, V_{exit}	9.70	m/s	31.8	ft/sec	Back-Calc'd from Volumetric Flow		
Volumetric Flow	17.1	cu.m/sec	36,300	ACFM	$\pi V_{exit} D^2/4$		Sect.2/¶1
Stack Potential Temp, θ_s	314	Kelvins	105	°F	Back-Calc'd from Buoyancy Flux		
Initial Stack Buoyancy Flux, F_o	7.08	m^4/s^3			$gV_{exit}D^2(1-\theta_a/\theta_s)/4$ = Vol.Flow$(g/\pi)(1-\theta_a/\theta_s)$		Sect.2/¶1
Plume Buoyancy Flux, F	N/A	m^4/s^3			$\lambda^2 gVa^2(1-\theta_a/\theta_p)$ for a,V,θ_p at plume height (not used here)		

Constants:

Assume neutral conditions (dθ/dz=0)							
Gravity, g	9.81	m/s^2					
λ	1.11						
Conversion Factor	0.3048	meters/feet					

Conditions at End (Top) of Jet Phase:

Height above Stack, z	9.375	meters*	30.8	feet*	6.25D, meters*=meters above stack top		Sect.3/¶1
Height above Ground, z+h_s	18.702	meters	61.4	feet	h_s + 6.25D		Sect.3/¶1
Vertical Velocity, V_{plume}	4.850	m/s	15.9	ft/sec	$0.5V_{exit}$	$V_{exit}/2$	Sect.3/¶1
Plume Top-Hat Diameter, 2a	3.000	meters	9.84	feet	2D	Conservation of momentum	Sect.3/¶1

Spillane Methodology - Analytical Solutions for Calm Conditions for Plume Heights above Jet Phase:

Plume Top-Hat Radius, a	**Solutions in Table Below**				$0.16(z-z_v)$, or linear increase with height		Sect.2/Eq.6
Virtual Source Height, z_v	0.618	meters*	2.0	feet*	$6.25D[1-(\theta_e/\theta_s)^{1/2}]$, meters*=meters above stack top		Sect.2/Eq.6
Height above Ground, z_v+h_s	9.944	meters	32.6	feet*		where $(\theta_a/\theta_s)^{1/2} = (\theta_e/\theta_s)^{1/2}$= 0.93412399	

Method(1): Simplified Plume-averaged Vertical Velocity V' assuming Product Va constant above jet phase such that $V_{plume}(2a) = V_{exit}D$:

Vertical Velocity, V'	**Solutions in Table Below**	$V_{exit}D/2a'$ (conservation of buoyancy)		Sect.3&4

Method(2): Plume-averaged Vertical Velocity V given by Analytical Solution in Paper where Product Va given by equations below:

Vertical Velocity, V	**Solutions in Table Below**	$\{(Va)_o^3 + 0.12F_o[(z-z_v)^2 - (6.25D-z_v)^2]\}^{(1/3)} / a$		Sect.2.1(6)
Product, $(Va)_o$	6.795 m^2/s	$V_{exit}D/2(\theta_e/\theta_s)^{1/2}$		

Table of Plume Top-Hat Diameters (2a) and Plume-averaged Vertical Velocities for both Method(1) (assuming conservation of buoyancy & gaussian distribution of vertical velocities) and Method (2) (based on Peter Best's paper's Analytical Solution) starting at end of jet phase:

from 100 meters above ground in increments of 50.0 meters

						Vert.Vel (m/s)	
		Ht above Ground = $h_{plume}+h_s$		D_{plume} = 2a =	Method (1)	Method (2)	
Height above stack top, meters*		meters	feet	$2*0.16(z-z_v)$	$V'=V_{exit}*D/2a'$	$V=\{(Va)_o^3+0.12F_o[(z-z_v)^2-(6.25D-z_v)^2]\}^{1/3}$ / a	
End of jet phase at 6.25D = 9.375 meters*		***18.702***	***61.4***	***3.000***		***4.85***	
90.673	meters*	100.000	328.1	28.818	0.50	1.34	
140.673	meters*	150.000	492.1	44.818	0.32	1.15	
190.673	meters*	200.000	656.2	60.818	0.24	1.03	
240.673	meters*	250.000	820.2	76.818	0.19	0.95	
290.673	meters*	300.000	984.3	92.818	0.16	0.90	
340.673	meters*	350.000	1148.3	108.818	0.13	0.85	
390.673	meters*	400.000	1312.3	124.818	0.12	0.81	
440.673	meters*	450.000	1476.4	140.818	0.10	0.78	
490.673	meters*	500.000	1640.4	156.818	0.09	0.75	
540.673	meters*	550.000	1804.5	172.818	0.08	0.73	
590.673	meters*	600.000	1968.5	188.818	0.08	0.71	
640.673	meters*	650.000	2132.5	204.818	0.07	0.69	
690.673	meters*	700.000	2296.6	220.818	0.07	0.67	
740.673	meters*	750.000	2460.6	236.818	0.06	0.65	
790.673	meters*	800.000	2624.7	252.818	0.06	0.64	
840.673	meters*	850.000	2788.7	268.818	0.05	0.63	
890.673	meters*	900.000	2952.8	284.818	0.05	0.62	
940.673	meters*	950.000	3116.8	300.818	0.05	0.60	
990.673	meters*	1000.000	3280.8	316.818	0.05	0.59	
1040.673	meters*	1050.000	3444.9	332.818	0.04	0.58	
1090.673	meters*	1100.000	3608.9	348.818	0.04	0.58	
1140.673	meters*	1150.000	3773.0	364.818	0.04	0.57	
1190.673	meters*	1200.000	3937.0	380.818	0.04	0.56	
1240.673	meters*	1250.000	4101.0	396.818	0.04	0.55	

0.000	meters*	9.327	30.6	-0.198	-73.62	-62.67
0.305	meters*	9.632	31.6	-0.100	-145.36	-123.69
0.610	meters*	9.936	32.6	-0.003	-5692.14	-4842.96
0.914	meters*	10.241	33.6	0.095	153.18	130.34
1.219	meters*	10.546	34.6	0.193	75.57	64.33
1.524	meters*	10.851	35.6	0.290	50.16	42.72
1.829	meters*	11.156	36.6	0.388	37.54	31.99
2.134	meters*	11.460	37.6	0.485	29.99	25.59
2.438	meters*	11.765	38.6	0.583	24.97	21.33
2.743	meters*	12.070	39.6	0.680	21.39	18.30
3.048	meters*	12.375	40.6	0.778	18.71	16.03
3.353	meters*	12.680	41.6	0.875	16.62	14.27
3.658	meters*	12.984	42.6	0.973	14.96	12.86
3.962	meters*	13.289	43.6	1.070	13.59	11.72
4.267	meters*	13.594	44.6	1.168	12.46	10.77
4.572	meters*	13.899	45.6	1.265	11.50	9.96
4.877	meters*	14.204	46.6	1.363	10.67	9.28
5.182	meters*	14.508	47.6	1.460	9.96	8.68
5.486	meters*	14.813	48.6	1.558	9.34	8.16
5.791	meters*	15.118	49.6	1.656	8.79	7.71

Number of Stacks (32 Units with 2 Cells/Unit and 2 Stacks/Cell; 2 Admin Stacks)	130	
Stack Diameter	4.9	feet
Center-to-Center Distance Between Stacks	4.9	feet
Stack Distances (assumed right next to each other)	0	feet

	Method (3)		
Ht above Ground = $h_{plume}+h_s$	$V = V'*\text{Number of Stacks}^{0.25}$	**Number of Stacks**	**Plume Diameter**
feet	m/s	(within plume)	feet
30.6	-68.14	1	-0.65
31.6	-134.52	1	-0.33
32.6	-5267.55	1	-0.01
33.6	141.76	1	0.31
34.6	69.95	1	0.63
35.6	46.44	1	0.95
36.6	34.77	1	1.27
37.6	27.79	1	1.59
38.6	23.15	1	1.91
39.6	19.84	1	2.23
40.6	17.37	1	2.55
41.6	15.45	1	2.87
42.6	13.91	1	3.19
43.6	12.66	1	3.51
44.6	11.61	1	3.83
45.6	10.73	1	4.15
46.6	9.97	1	4.47
47.6	9.32	1	4.79
48.6	8.92	1	5.11
49.6	8.67	1	5.43

6.096	meters*	15.423	50.6	1.753	8.30	7.31

50.6	8.44	1	5.75

6.401	meters*	15.728	51.6	1.851	7.86	6.95	51.6	8.23	2	6.07
6.706	meters*	16.032	52.6	1.948	7.47	6.62	52.6	8.03	2	6.39
7.010	meters*	16.337	53.6	2.046	7.11	6.33	53.6	7.85	2	6.71
7.315	meters*	16.642	54.6	2.143	6.79	6.07	54.6	7.69	2	7.03
7.620	meters*	16.947	55.6	2.241	6.49	5.83	55.6	7.53	2	7.35
7.925	meters*	17.252	56.6	2.338	6.22	5.61	56.6	7.39	2	7.67
8.230	meters*	17.556	57.6	2.436	5.97	5.41	57.6	7.25	3	7.99
8.534	meters*	17.861	58.6	2.533	5.74	5.23	58.6	7.13	3	8.31
8.839	meters*	18.166	59.6	2.631	5.53	5.06	59.6	7.01	3	8.63
9.144	meters*	18.471	60.6	2.728	5.33	4.90	60.6	6.90	3	8.95
9.449	meters*	18.776	61.6	2.826	5.15	4.76	61.6	6.80	4	9.27
9.754	meters*	19.080	62.6	2.924	4.98	4.62	62.6	6.70	4	9.59
10.058	meters*	19.385	63.6	3.021	4.82	4.49	63.6	6.61	4	9.91
10.363	meters*	19.690	64.6	3.119	4.67	4.38	64.6	6.52	4	10.23
10.668	meters*	19.995	65.6	3.216	4.52	4.27	65.6	6.44	5	10.55
10.973	meters*	20.300	66.6	3.314	4.39	4.16	66.6	6.36	5	10.87
11.278	meters*	20.604	67.6	3.411	4.27	4.07	67.6	6.28	5	11.19
11.582	meters*	20.909	68.6	3.509	4.15	3.98	68.6	6.21	5	11.51
11.887	meters*	21.214	69.6	3.606	4.03	3.89	69.6	6.14	6	11.83
12.192	meters*	21.519	70.6	3.704	3.93	3.81	70.6	6.08	6	12.15
12.497	meters*	21.824	71.6	3.801	3.83	3.73	71.6	6.02	6	12.47
12.802	meters*	22.128	72.6	3.899	3.73	3.66	72.6	5.96	7	12.79
13.106	meters*	22.433	73.6	3.996	3.64	3.59	73.6	5.90	7	13.11
13.411	meters*	22.738	74.6	4.094	3.55	3.53	74.6	5.85	7	13.43
13.716	meters*	23.043	75.6	4.191	3.47	3.47	75.6	5.80	8	13.75
14.021	meters*	23.348	76.6	4.289	3.39	3.41	76.6	5.75	8	14.07
14.326	meters*	23.652	77.6	4.387	3.32	3.35	77.6	5.70	9	14.39
14.630	meters*	23.957	78.6	4.484	3.24	3.30	78.6	5.66	9	14.71
14.935	meters*	24.262	79.6	4.582	3.18	3.25	79.6	5.61	9	15.03
15.240	meters*	24.567	80.6	4.679	3.11	3.20	80.6	5.57	10	15.35
15.545	meters*	24.872	81.6	4.777	3.05	3.15	81.6	5.53	10	15.67
15.850	meters*	25.176	82.6	4.874	2.98	3.11	82.6	5.49	11	15.99
16.154	meters*	25.481	83.6	4.972	2.93	3.06	83.6	5.45	11	16.31
16.459	meters*	25.786	84.6	5.069	2.87	3.02	84.6	5.42	11	16.63
16.764	meters*	26.091	85.6	5.167	2.82	2.99	85.6	5.38	12	16.95
17.069	meters*	26.396	86.6	5.264	2.76	2.95	86.6	5.35	12	17.27
17.374	meters*	26.700	87.6	5.362	2.71	2.91	87.6	5.32	13	17.59
17.678	meters*	27.005	88.6	5.459	2.66	2.88	88.6	5.29	13	17.91
17.983	meters*	27.310	89.6	5.557	2.62	2.84	89.6	5.26	14	18.23
18.288	meters*	27.615	90.6	5.655	2.57	2.81	90.6	5.23	14	18.55
18.593	meters*	27.920	91.6	5.752	2.53	2.78	91.6	5.20	15	18.87
18.898	meters*	28.224	92.6	5.850	2.49	2.75	92.6	5.17	15	19.19
19.202	meters*	28.529	93.6	5.947	2.45	2.72	93.6	5.15	16	19.51
19.507	meters*	28.834	94.6	6.045	2.41	2.70	94.6	5.12	16	19.83
19.812	meters*	29.139	95.6	6.142	2.37	2.67	95.6	5.10	17	20.15
20.117	meters*	29.444	96.6	6.240	2.33	2.64	96.6	5.07	17	20.47
50.597	meters*	59.924	196.6	15.993	0.91	1.67	196.6	4.20	114	52.47
81.077	meters*	90.404	296.6	25.747	0.57	1.39	296.6	3.30	130	84.47
111.557	meters*	120.884	396.6	35.501	0.41	1.24	396.6	2.79	130	116.47
142.037	meters*	151.364	496.6	45.254	0.32	1.14	496.6	2.47	130	148.47

Exhaust velocity falls below the CEC's 10.6 m/s peak rate using any method

Exhaust velocity falls below the CEC's 5.3 m/s average rate using any method

Project-specific parameters

Appendix 3.17B, Table 2
Thermal Plume Calculations for Natural Gas Generators
Lightspeed SJC02
August 2021

PETER BEST PAPER ILLUSTRATIVE EXAMPLE

Plume Averaged Vertical Velocities from "*Aviation Safety and Buoyant Plumes* ," Peter Best, et. al. (2003)

Data Entry for SJC02 Natural Gas Generators (Buildings SJC02 and SJC03)

Ambient Conditions:

Ambient Potential Temp, θ_a	272	Kelvins	30	°F			
Plume Exit Conditions:							
Stack Height, h_s	3.96	meters	13.0	feet			
Stack Diameter, D	0.22	meters	0.71	feet			
Stack Velocity, V_{exit}	27.2	m/s	89.2	ft/sec	Back-Calc'd from Volumetric Flow		
Volumetric Flow	1.03	cu.m/sec	2,102	ACFM	$\pi V_{exit} D^2/4$		Sect.2/¶1
Stack Potential Temp, θ_s	783	Kelvins	950	°F	Back-Calc'd from Buoyancy Flux		
Initial Stack Buoyancy Flux, F_o	2.11	m^4/s^3			$gV_{exit}D^2(1-\theta_a/\theta_s)/4$ = Vol.Flow$(g/\pi)(1-\theta_a/\theta_s)$		Sect.2/¶1
Plume Buoyancy Flux, F	N/A	m^4/s^3			$\lambda^2 g V a^2(1-\theta_a/\theta_p)$ for a,V,θ_p at plume height (not used here)		

Constants:

Assume neutral conditions (dθ/dz=0)							
Gravity, g	9.81	m/s^2					
λ	1.11						
Conversion Factor	0.3048	meters/feet					

Conditions at End (Top) of Jet Phase:

Height above Stack, z	1.375	meters*	4.51	feet*	6.25D, meters*=meters above stack top		Sect.3/¶1
Height above Ground, z+h_s	5.337	meters	17.5	feet	h_s + 6.25D		Sect.3/¶1
Vertical Velocity, V_{plume}	13.594	m/s	44.6	ft/sec	$0.5V_{exit}$	$V_{exit}/2$	Sect.3/¶1
Plume Top-Hat Diameter, 2a	0.440	meters	1.44	feet	2D	Conservation of momentum	Sect.3/¶1

Spillane Methodology - Analytical Solutions for Calm Conditions for Plume Heights above Jet Phase:

Plume Top-Hat Radius, a	**Solutions in Table Below**				0.16(z-z_v), or linear increase with height		Sect.2/Eq.6
Virtual Source Height, z_v	0.091	meters*	0.30	feet*	$6.25D[1-(\theta_e/\theta_s)^{1/2}]$, meters*=meters above stack top		Sect.2/Eq.6
Height above Ground, z_v+h_s	4.053	meters	13.3	feet*		where $(\theta_a/\theta_s)^{1/2} = (\theta_e/\theta_s)^{1/2}$= 0.93412399	

Method(1): Simplified Plume-averaged Vertical Velocity V' assuming Product Va constant above jet phase such that $V_{plume}(2a) = V_{exit}D$:

Vertical Velocity, V'	**Solutions in Table Below**	$V_{exit}D/2a'$ (conservation of buoyancy)	Sect.3&4

Method(2): Plume-averaged Vertical Velocity V given by Analytical Solution in Paper where Product Va given by equations below:

Vertical Velocity, V	**Solutions in Table Below**		$\{(Va)_o^3 + 0.12F_o[(z-z_v)^2 - (6.25D-z_v)^2]\}^{(1/3)}$ / a		Sect.2.1(6)
Product, $(Va)_o$	2.794	m^2/s	$V_{exit}D/2(\theta_e/\theta_s)^{1/2}$		

Table of Plume Top-Hat Diameters (2a) and Plume-averaged Vertical Velocities for both Method(1) (assuming conservation of buoyancy & gaussian distribution of vertical velocities) and Method (2) (based on Peter Best's paper's Analytical Solution) starting at end of jet phase:

from 100 meters above ground in increments of 50.0 meters

Height above stack top, meters*		Ht above Ground = $h_{plume}+h_s$ meters	feet	D_{plume} = 2a = $2*0.16(z-z_v)$	Vert.Vel (m/s) Method (1) $V'=V_{exit}*D/2a'$	Vert.Vel (m/s) Method (2) $V=\{(Va)_o^3+0.12F_o[(z-z_v)^2-(6.25D-z_v)^2]\}^{1/3}/a$
End of jet phase at 6.25D = 1.375 meters*		***5.337***	***17.5***	***0.440***		***13.59***
96.038	meters*	100.000	328.1	30.703	0.19	0.87
146.038	meters*	150.000	492.1	46.703	0.13	0.75
196.038	meters*	200.000	656.2	62.703	0.10	0.68
246.038	meters*	250.000	820.2	78.703	0.08	0.63
296.038	meters*	300.000	984.3	94.703	0.06	0.59
346.038	meters*	350.000	1148.3	110.703	0.05	0.56
396.038	meters*	400.000	1312.3	126.703	0.05	0.54
446.038	meters*	450.000	1476.4	142.703	0.04	0.52
496.038	meters*	500.000	1640.4	158.703	0.04	0.50
546.038	meters*	550.000	1804.5	174.703	0.03	0.48
596.038	meters*	600.000	1968.5	190.703	0.03	0.47
646.038	meters*	650.000	2132.5	206.703	0.03	0.46
696.038	meters*	700.000	2296.6	222.703	0.03	0.45
746.038	meters*	750.000	2460.6	238.703	0.03	0.44
796.038	meters*	800.000	2624.7	254.703	0.02	0.43
846.038	meters*	850.000	2788.7	270.703	0.02	0.42
896.038	meters*	900.000	2952.8	286.703	0.02	0.41
946.038	meters*	950.000	3116.8	302.703	0.02	0.40
996.038	meters*	1000.000	3280.8	318.703	0.02	0.40
1046.038	meters*	1050.000	3444.9	334.703	0.02	0.39
1096.038	meters*	1100.000	3608.9	350.703	0.02	0.38
1146.038	meters*	1150.000	3773.0	366.703	0.02	0.38
1196.038	meters*	1200.000	3937.0	382.703	0.02	0.37
1246.038	meters*	1250.000	4101.0	398.703	0.02	0.37

0.000	meters*	3.962	13.0	-0.029	-206.36	-187.78
0.305	meters*	4.267	14.0	0.069	87.25	79.41
0.610	meters*	4.572	15.0	0.166	36.01	32.81
0.914	meters*	4.877	16.0	0.264	22.69	20.70
1.219	meters*	5.182	17.0	0.361	16.56	15.15
1.524	meters*	5.486	18.0	0.459	13.04	11.97
1.829	meters*	5.791	19.0	0.556	10.75	9.91
2.134	meters*	6.096	20.0	0.654	9.15	8.47
2.438	meters*	6.401	21.0	0.751	7.96	7.41
2.743	meters*	6.706	22.0	0.849	7.05	6.60
3.048	meters*	7.010	23.0	0.946	6.32	5.95
3.353	meters*	7.315	24.0	1.044	5.73	5.44
3.658	meters*	7.620	25.0	1.141	5.24	5.01
3.962	meters*	7.925	26.0	1.239	4.83	4.65
4.267	meters*	8.230	27.0	1.337	4.48	4.35
4.572	meters*	8.534	28.0	1.434	4.17	4.09
4.877	meters*	8.839	29.0	1.532	3.91	3.87
5.182	meters*	9.144	30.0	1.629	3.67	3.67
5.486	meters*	9.449	31.0	1.727	3.46	3.50
5.791	meters*	9.754	32.0	1.824	3.28	3.34

Number of Stacks (1 representative stack per generator)	224	
Stack Diameter	0.7	feet
Center-to-Center Distance Between Stacks (includes space between enclosures and width of enclosure)	13.0	feet
Stack Distances (not required, as center-to-center distance known)	N/A	feet

Ht above Ground = $h_{plume}+h_s$ feet	Method (3) V = V'*Number of Stacks$^{0.25}$ m/s	Number of Stacks (within plume)	Plume Diameter feet
13.0	-197.07	1	-0.10
14.0	83.33	1	0.22
15.0	34.41	1	0.54
16.0	21.70	1	0.86
17.0	15.86	1	1.18
18.0	12.50	1	1.50
19.0	10.33	1	1.82
20.0	8.81	1	2.14
21.0	7.68	1	2.46
22.0	6.82	1	2.78
23.0	6.14	1	3.10
24.0	5.58	1	3.42
25.0	5.12	1	3.74
26.0	4.74	1	4.06
27.0	4.41	1	4.38
28.0	4.13	1	4.70
29.0	3.89	1	5.02
30.0	3.67	1	5.34
31.0	3.48	1	5.66
32.0	3.31	1	5.98

6.096	meters*	10.058	33.0	1.922	3.11	3.21	33.0	3.16	1	6.30
6.401	meters*	10.363	34.0	2.019	2.96	3.08	34.0	3.02	1	6.62
6.706	meters*	10.668	35.0	2.117	2.83	2.97	35.0	2.90	1	6.94
7.010	meters*	10.973	36.0	2.214	2.70	2.88	36.0	2.79	1	7.26
7.315	meters*	11.278	37.0	2.312	2.59	2.78	37.0	2.69	1	7.58
7.620	meters*	11.582	38.0	2.409	2.48	2.70	38.0	2.59	1	7.90
7.925	meters*	11.887	39.0	2.507	2.39	2.63	39.0	2.51	1	8.22
8.230	meters*	12.192	40.0	2.604	2.30	2.56	40.0	2.43	1	8.54
8.534	meters*	12.497	41.0	2.702	2.21	2.49	41.0	2.35	1	8.86
8.839	meters*	12.802	42.0	2.800	2.14	2.43	42.0	2.28	1	9.18
9.144	meters*	13.106	43.0	2.897	2.06	2.38	43.0	2.22	1	9.50
9.449	meters*	13.411	44.0	2.995	2.00	2.33	44.0	2.16	1	9.82
9.754	meters*	13.716	45.0	3.092	1.93	2.28	45.0	2.11	1	10.14
10.058	meters*	14.021	46.0	3.190	1.88	2.23	46.0	2.05	1	10.46
10.363	meters*	14.326	47.0	3.287	1.82	2.19	47.0	2.01	1	10.78
10.668	meters*	14.630	48.0	3.385	1.77	2.15	48.0	1.96	1	11.10
10.973	meters*	14.935	49.0	3.482	1.72	2.12	49.0	1.92	1	11.42
11.278	meters*	15.240	50.0	3.580	1.67	2.08	50.0	1.88	1	11.74
11.582	meters*	15.545	51.0	3.677	1.63	2.05	51.0	1.84	1	12.06
11.887	meters*	15.850	52.0	3.775	1.58	2.02	52.0	1.80	1	12.38
12.192	meters*	16.154	53.0	3.872	1.54	1.99	53.0	1.77	1	12.70
12.497	meters*	16.459	54.0	3.970	1.51	1.96	54.0	1.74	1	13.02
12.802	meters*	16.764	55.0	4.068	1.47	1.94	55.0	1.73	1	13.34
13.106	meters*	17.069	56.0	4.165	1.44	1.91	56.0	1.72	1	13.66
13.411	meters*	17.374	57.0	4.263	1.40	1.89	57.0	1.71	1	13.98
13.716	meters*	17.678	58.0	4.360	1.37	1.86	58.0	1.70	1	14.30
14.021	meters*	17.983	59.0	4.458	1.34	1.84	59.0	1.69	1	14.62
14.326	meters*	18.288	60.0	4.555	1.31	1.82	60.0	1.68	1	14.94
14.630	meters*	18.593	61.0	4.653	1.29	1.80	61.0	1.67	1	15.26
14.935	meters*	18.898	62.0	4.750	1.26	1.78	62.0	1.67	1	15.58
15.240	meters*	19.202	63.0	4.848	1.23	1.76	63.0	1.66	1	15.90
15.545	meters*	19.507	64.0	4.945	1.21	1.75	64.0	1.65	2	16.22
15.850	meters*	19.812	65.0	5.043	1.19	1.73	65.0	1.64	2	16.54
16.154	meters*	20.117	66.0	5.140	1.16	1.71	66.0	1.64	2	16.86
16.459	meters*	20.422	67.0	5.238	1.14	1.70	67.0	1.63	2	17.18
16.764	meters*	20.726	68.0	5.335	1.12	1.68	68.0	1.63	2	17.50
17.069	meters*	21.031	69.0	5.433	1.10	1.67	69.0	1.62	2	17.82
17.374	meters*	21.336	70.0	5.531	1.08	1.65	70.0	1.62	2	18.14
17.678	meters*	21.641	71.0	5.628	1.06	1.64	71.0	1.61	2	18.46
17.983	meters*	21.946	72.0	5.726	1.04	1.63	72.0	1.61	2	18.78
18.288	meters*	22.250	73.0	5.823	1.03	1.61	73.0	1.60	2	19.10
18.593	meters*	22.555	74.0	5.921	1.01	1.60	74.0	1.60	2	19.42
18.898	meters*	22.860	75.0	6.018	0.99	1.59	75.0	1.59	2	19.74
19.202	meters*	23.165	76.0	6.116	0.98	1.58	76.0	1.59	2	20.06
19.507	meters*	23.470	77.0	6.213	0.96	1.57	77.0	1.58	2	20.38
19.812	meters*	23.774	78.0	6.311	0.95	1.56	78.0	1.58	3	20.70
20.117	meters*	24.079	79.0	6.408	0.93	1.55	79.0	1.58	3	21.02
50.597	meters*	54.559	179.0	16.162	0.37	1.08	179.0	1.46	17	53.02
81.077	meters*	85.039	279.0	25.916	0.23	0.92	279.0	1.47	43	85.02
111.557	meters*	115.519	379.0	35.669	0.17	0.82	379.0	1.49	81	117.02
142.037	meters*	145.999	479.0	45.423	0.13	0.76	479.0	1.51	131	149.02

Exhaust velocity falls below the CEC's 10.6 m/s peak rate using any method

Exhaust velocity falls below the CEC's 5.3 m/s average rate using any method

Project-specific parameters

Appendix 3.17B, Table 3
Thermal Plume Calculations for 1.25-MW Administrative Generator
Lightspeed SJC02
August 2021

PETER BEST PAPER ILLUSTRATIVE EXAMPLE

Plume Averaged Vertical Velocities from "*Aviation Safety and Buoyant Plumes* ," Peter Best, et. al. (2003)

Data Entry for SJC02 1.25-MW Administrative Generator (Building SJC02)

Ambient Conditions:							
Ambient Potential Temp, θ_a	272	Kelvins	30	°F			
Plume Exit Conditions:							
Stack Height, h_s	6.10	meters	20.0	feet			
Stack Diameter, D	0.26	meters	0.83	feet			
Stack Velocity, V_{exit}	100.6	m/s	330.0	ft/sec	Back-Calc'd from Volumetric Flow		
Volumetric Flow	5.34	cu.m/sec	10,798	ACFM	$\pi V_{exit}D^2/4$		Sect.2/¶1
Stack Potential Temp, θ_s	815	Kelvins	1007	°F	Back-Calc'd from Buoyancy Flux		
Initial Stack Buoyancy Flux, F_o	11.11	m^4/s^3			$gV_{exit}D^2(1-\theta_a/\theta_s)/4$ = Vol.Flow$(g/\pi)(1-\theta_a/\theta_s)$		Sect.2/¶1
Plume Buoyancy Flux, F	N/A	m^4/s^3			$\lambda^2 gVa^2(1-\theta_a/\theta_p)$ for a,V,θ_p at plume height (not used here)		
Constants:							
Assume neutral conditions (dθ/dz=0)							
Gravity, g	9.81	m/s^2					
λ	1.11						
Conversion Factor	0.3048	meters/feet					
Conditions at End (Top) of Jet Phase:							
Height above Stack, z	1.625	meters*	5.33	feet*	6.25D, meters*=meters above stack top		Sect.3/¶1
Height above Ground, z+h_s	7.721	meters	25.3	feet	h_s + 6.25D		Sect.3/¶1
Vertical Velocity, V_{plume}	50.285	m/s	165.0	ft/sec	0.5V_{exit}	$V_{exit}/2$	Sect.3/¶1
Plume Top-Hat Diameter, 2a	0.520	meters	1.71	feet	2D	Conservation of momentum	Sect.3/¶1
Spillane Methodology - Analytical Solutions for Calm Conditions for Plume Heights above Jet Phase:							
Plume Top-Hat Radius, a	**Solutions in Table Below**				0.16(z-z_v), or linear increase with height		Sect.2/Eq.6
Virtual Source Height, z_v	0.107	meters*	0.35	feet*	6.25D[1-$(\theta_e/\theta_s)^{1/2}$], meters*=meters above stack top		Sect.2/Eq.6
Height above Ground, z_v+h_s	6.203	meters	20.4	feet*		where $(\theta_a/\theta_s)^{1/2}$ = $(\theta_e/\theta_s)^{1/2}$= 0.93412399	
Method(1): Simplified Plume-averaged Vertical Velocity V' assuming Product Va constant above jet phase such that $V_{plume}(2a) = V_{exit}D$:							
Vertical Velocity, V'	**Solutions in Table Below**				$V_{exit}D/2a'$ (conservation of buoyancy)		Sect.3&4
Method(2): Plume-averaged Vertical Velocity V given by Analytical Solution in Paper where Product Va given by equations below:							
Vertical Velocity, V	**Solutions in Table Below**				$\{(Va)_o^3 + 0.12F_o[(z-z_v)^2 - (6.25D-z_v)^2]\}^{(1/3)}$ / a		Sect.2.1(6)
Product, $(Va)_o$	12.213	m^2/s			$V_{exit}D/2(\theta_e/\theta_s)^{1/2}$		

Table of Plume Top-Hat Diameters (2a) and Plume-averaged Vertical Velocities for both Method(1) (assuming conservation of buoyancy & gaussian distribution of vertical velocities) and Method (2) (based on Peter Best's paper's Analytical Solution) starting at end of jet phase:

from 100 meters above ground in increments of 50.0 meters

Height above stack top, meters*		Ht above Ground = $h_{plume}+h_s$ meters	feet	D_{plume} = 2a = $2*0.16(z-z_v)$	Vert.Vel (m/s) Method (1) $V'=V_{exit}*D/2a'$	Vert.Vel (m/s) Method (2) $V=\{(Va)_o^3+0.12F_o[(z-z_v)^2-(6.25D-z_v)^2]\}^{1/3}$ / a
End of jet phase at 6.25D = 1.625 meters*		***7.721***	***25.3***	***0.520***		***50.29***
93.904	meters*	100.000	328.1	30.015	0.87	1.59
143.904	meters*	150.000	492.1	46.015	0.57	1.34
193.904	meters*	200.000	656.2	62.015	0.42	1.20
243.904	meters*	250.000	820.2	78.015	0.34	1.11
293.904	meters*	300.000	984.3	94.015	0.28	1.04
343.904	meters*	350.000	1148.3	110.015	0.24	0.99
393.904	meters*	400.000	1312.3	126.015	0.21	0.94
443.904	meters*	450.000	1476.4	142.015	0.18	0.90
493.904	meters*	500.000	1640.4	158.015	0.17	0.87
543.904	meters*	550.000	1804.5	174.015	0.15	0.84
593.904	meters*	600.000	1968.5	190.015	0.14	0.82
643.904	meters*	650.000	2132.5	206.015	0.13	0.80
693.904	meters*	700.000	2296.6	222.015	0.12	0.78
743.904	meters*	750.000	2460.6	238.015	0.11	0.76
793.904	meters*	800.000	2624.7	254.015	0.10	0.74
843.904	meters*	850.000	2788.7	270.015	0.10	0.73
893.904	meters*	900.000	2952.8	286.015	0.09	0.71
943.904	meters*	950.000	3116.8	302.015	0.09	0.70
993.904	meters*	1000.000	3280.8	318.015	0.08	0.69
1043.904	meters*	1050.000	3444.9	334.015	0.08	0.68
1093.904	meters*	1100.000	3608.9	350.015	0.07	0.67
1143.904	meters*	1150.000	3773.0	366.015	0.07	0.66
1193.904	meters*	1200.000	3937.0	382.015	0.07	0.65
1243.904	meters*	1250.000	4101.0	398.015	0.07	0.64

0.000	meters*	6.096	20.0	-0.034	-763.33	-712.75
0.305	meters*	6.401	21.0	0.063	413.21	385.83
0.610	meters*	6.706	22.0	0.161	162.60	151.83
0.914	meters*	7.010	23.0	0.258	101.21	94.52
1.219	meters*	7.315	24.0	0.356	73.47	68.63
1.524	meters*	7.620	25.0	0.453	57.67	53.87
1.829	meters*	7.925	26.0	0.551	47.46	44.35
2.134	meters*	8.230	27.0	0.648	40.32	37.69
2.438	meters*	8.534	28.0	0.746	35.05	32.77
2.743	meters*	8.839	29.0	0.844	31.00	28.99
3.048	meters*	9.144	30.0	0.941	27.78	26.00
3.353	meters*	9.449	31.0	1.039	25.18	23.57
3.658	meters*	9.754	32.0	1.136	23.01	21.56
3.962	meters*	10.058	33.0	1.234	21.19	19.86
4.267	meters*	10.363	34.0	1.331	19.64	18.42
4.572	meters*	10.668	35.0	1.429	18.30	17.17
4.877	meters*	10.973	36.0	1.526	17.13	16.08
5.182	meters*	11.278	37.0	1.624	16.10	15.13

Number of Stacks (only 1 1.25-MW administrative generator)	1	
Stack Diameter	0.8	feet
Center-to-Center Distance Between Stacks (Set to 1 to facilitate calculations for single stack)	1.0	feet
Stack Distances (not required, as center-to-center distance known)	N/A	feet

Ht above Ground = $h_{plume}+h_s$ feet	Method (3) V = V'*Number of Stacks$^{0.25}$ m/s	Number of Stacks (within plume)	Plume Diameter feet
20.0	-738.04	1	-0.11
21.0	399.52	1	0.21
22.0	157.21	1	0.53
23.0	97.87	1	0.85
24.0	71.05	1	1.17
25.0	55.77	1	1.49
26.0	45.90	1	1.81
27.0	39.00	1	2.13
28.0	33.91	1	2.45
29.0	29.99	1	2.77
30.0	26.89	1	3.09
31.0	24.37	1	3.41
32.0	22.28	1	3.73
33.0	20.53	1	4.05
34.0	19.03	1	4.37
35.0	17.74	1	4.69
36.0	16.61	1	5.01
37.0	15.62	1	5.33

5.486	meters*	11.582	38.0	1.721	15.19	14.28	38.0	14.74	1	5.65
5.791	meters*	11.887	39.0	1.819	14.38	13.53	39.0	13.95	1	5.97
6.096	meters*	12.192	40.0	1.916	13.64	12.85	40.0	13.25	1	6.29
6.401	meters*	12.497	41.0	2.014	12.98	12.24	41.0	12.61	1	6.61
6.706	meters*	12.802	42.0	2.112	12.38	11.68	42.0	12.03	1	6.93
7.010	meters*	13.106	43.0	2.209	11.84	11.18	43.0	11.51	1	7.25
7.315	meters*	13.411	44.0	2.307	11.34	10.72	44.0	11.03	1	7.57
7.620	meters*	13.716	45.0	2.404	10.88	10.29	45.0	10.59	1	7.89
7.925	meters*	14.021	46.0	2.502	10.45	9.90	46.0	10.18	1	8.21
8.230	meters*	14.326	47.0	2.599	10.06	9.54	47.0	9.80	1	8.53
8.534	meters*	14.630	48.0	2.697	9.70	9.21	48.0	9.45	1	8.85
8.839	meters*	14.935	49.0	2.794	9.36	8.90	49.0	9.13	1	9.17
9.144	meters*	15.240	50.0	2.892	9.04	8.61	50.0	8.83	1	9.49
9.449	meters*	15.545	51.0	2.989	8.75	8.34	51.0	8.54	1	9.81
9.754	meters*	15.850	52.0	3.087	8.47	8.09	52.0	8.28	1	10.13
10.058	meters*	16.154	53.0	3.184	8.21	7.85	53.0	8.03	1	10.45
10.363	meters*	16.459	54.0	3.282	7.97	7.63	54.0	7.80	1	10.77
10.668	meters*	16.764	55.0	3.380	7.74	7.42	55.0	7.58	1	11.09
10.973	meters*	17.069	56.0	3.477	7.52	7.22	56.0	7.37	1	11.41
11.278	meters*	17.374	57.0	3.575	7.32	7.03	57.0	7.17	1	11.73
11.582	meters*	17.678	58.0	3.672	7.12	6.86	58.0	6.99	1	12.05
11.887	meters*	17.983	59.0	3.770	6.94	6.69	59.0	6.81	1	12.37
12.192	meters*	18.288	60.0	3.867	6.76	6.53	60.0	6.65	1	12.69
12.497	meters*	18.593	61.0	3.965	6.60	6.38	61.0	6.49	1	13.01
12.802	meters*	18.898	62.0	4.062	6.44	6.24	62.0	6.34	1	13.33
13.106	meters*	19.202	63.0	4.160	6.29	6.10	63.0	6.19	1	13.65
13.411	meters*	19.507	64.0	4.257	6.14	5.97	64.0	6.06	1	13.97
13.716	meters*	19.812	65.0	4.355	6.00	5.85	65.0	5.93	1	14.29
14.021	meters*	20.117	66.0	4.452	5.87	5.73	66.0	5.80	1	14.61
14.326	meters*	20.422	67.0	4.550	5.75	5.62	67.0	5.68	1	14.93
14.630	meters*	20.726	68.0	4.647	5.63	5.51	68.0	5.57	1	15.25
14.935	meters*	21.031	69.0	4.745	5.51	5.41	69.0	5.46	1	15.57
15.240	meters*	21.336	70.0	4.843	5.40	5.31	70.0	5.35	1	15.89
15.545	meters*	21.641	71.0	4.940	5.29	5.21	71.0	5.25	1	16.21
15.850	meters*	21.946	72.0	5.038	5.19	5.12	72.0	5.16	1	16.53
16.154	meters*	22.250	73.0	5.135	5.09	5.04	73.0	5.06	1	16.85
16.459	meters*	22.555	74.0	5.233	5.00	4.95	74.0	4.97	1	17.17
16.764	meters*	22.860	75.0	5.330	4.91	4.87	75.0	4.89	1	17.49
17.069	meters*	23.165	76.0	5.428	4.82	4.79	76.0	4.81	1	17.81
17.374	meters*	23.470	77.0	5.525	4.73	4.72	77.0	4.73	1	18.13
17.678	meters*	23.774	78.0	5.623	4.65	4.65	78.0	4.65	1	18.45
17.983	meters*	24.079	79.0	5.720	4.57	4.58	79.0	4.57	1	18.77
18.288	meters*	24.384	80.0	5.818	4.49	4.51	80.0	4.50	1	19.09
18.593	meters*	24.689	81.0	5.915	4.42	4.45	81.0	4.43	1	19.41
18.898	meters*	24.994	82.0	6.013	4.35	4.38	82.0	4.37	1	19.73
19.202	meters*	25.298	83.0	6.111	4.28	4.32	83.0	4.30	1	20.05
19.507	meters*	25.603	84.0	6.208	4.21	4.27	84.0	4.24	1	20.37
19.812	meters*	25.908	85.0	6.306	4.15	4.21	85.0	4.18	1	20.69
20.117	meters*	26.213	86.0	6.403	4.08	4.15	86.0	4.12	1	21.01
50.597	meters*	56.693	186.0	16.157	1.62	2.15	186.0	1.88	1	53.01
81.077	meters*	87.173	286.0	25.910	1.01	1.69	286.0	1.35	1	85.01
111.557	meters*	117.653	386.0	35.664	0.73	1.48	386.0	1.11	1	117.01
142.037	meters*	148.133	486.0	45.418	0.58	1.35	486.0	0.96	1	149.01

Exhaust velocity falls below the CEC's 10.6 m/s peak rate using any method

Exhaust velocity falls below the CEC's 5.3 m/s average rate using any method

Project-specific parameters

Appendix 3.17B, Table 4
Thermal Plume Calculations for 0.5-MW Administrative Generator
Lightspeed SJC02
August 2021

PETER BEST PAPER ILLUSTRATIVE EXAMPLE

Plume Averaged Vertical Velocities from "*Aviation Safety and Buoyant Plumes* ," Peter Best, et. al. (2003)

Data Entry for SJC02 0.5-MW Administrative Generator (Building SJC03)

Ambient Conditions:							
Ambient Potential Temp, θ_a	272	Kelvins	30	°F			
Plume Exit Conditions:							
Stack Height, h_s	6.10	meters	20.0	feet			
Stack Diameter, D	0.36	meters	1.17	feet			
Stack Velocity, V_{exit}	16.4	m/s	53.7	ft/sec	Back-Calc'd from Volumetric Flow		
Volumetric Flow	1.66	cu.m/sec	3,442	ACFM	$\pi V_{exit} D^2/4$		Sect.2/¶1
Stack Potential Temp, θ_s	752	Kelvins	894	°F	Back-Calc'd from Buoyancy Flux		
Initial Stack Buoyancy Flux, F_o	3.32	m^4/s^3			$gV_{exit}D^2(1-\theta_a/\theta_s)/4$ = Vol.Flow$(g/\pi)(1-\theta_a/\theta_s)$		Sect.2/¶1
Plume Buoyancy Flux, F	N/A	m^4/s^3			$\lambda^2 g V a^2(1-\theta_a/\theta_p)$ for a,V,θ_p at plume height (not used here)		
Constants:							
Assume neutral conditions (dθ/dz=0)							
Gravity, g	9.81	m/s^2					
λ	1.11						
Conversion Factor	0.3048	meters/feet					
Conditions at End (Top) of Jet Phase:							
Height above Stack, z	2.250	meters*	7.38	feet*	6.25D, meters*=meters above stack top		Sect.3/¶1
Height above Ground, z+h_s	8.346	meters	27.4	feet	h_s + 6.25D		Sect.3/¶1
Vertical Velocity, V_{plume}	8.178	m/s	26.8	ft/sec	$0.5V_{exit}$	$V_{exit}/2$	Sect.3/¶1
Plume Top-Hat Diameter, 2a	0.720	meters	2.36	feet	2D	Conservation of momentum	Sect.3/¶1
Spillane Methodology - Analytical Solutions for Calm Conditions for Plume Heights above Jet Phase:							
Plume Top-Hat Radius, a	**Solutions in Table Below**				$0.16(z-z_v)$, or linear increase with height		Sect.2/Eq.6
Virtual Source Height, z_v	0.148	meters*	0.49	feet*	$6.25D[1-(\theta_e/\theta_s)^{1/2}]$, meters*=meters above stack top		Sect.2/Eq.6
Height above Ground, z_v+h_s	6.244	meters	20.5	feet*		where $(\theta_a/\theta_s)^{1/2} = (\theta_e/\theta_s)^{1/2}$= 0.93412399	

Method(1): Simplified Plume-averaged Vertical Velocity V' assuming Product Va constant above jet phase such that $V_{plume}(2a) = V_{exit}D$:

Vertical Velocity, V'	**Solutions in Table Below**	$V_{exit}D/2a'$ (conservation of buoyancy)	Sect.3&4

Method(2): Plume-averaged Vertical Velocity V given by Analytical Solution in Paper where Product Va given by equations below:

Vertical Velocity, V	**Solutions in Table Below**		$\{(Va)_o^3 + 0.12F_o[(z-z_v)^2 - (6.25D-z_v)^2]\}^{(1/3)} / a$	Sect.2.1(6)
Product, $(Va)_o$	2.750	m^2/s	$V_{exit}D/2(\theta_e/\theta_s)^{1/2}$	

Table of Plume Top-Hat Diameters (2a) and Plume-averaged Vertical Velocities for both Method(1) (assuming conservation of buoyancy & gaussian distribution of vertical velocities) and Method (2) (based on Peter Best's paper's Analytical Solution) starting at end of jet phase:

from 100 meters above ground in increments of 50.0 meters

						Vert.Vel (m/s)
		Ht above Ground = $h_{plume}+h_s$		D_{plume} = 2a =	**Method (1)**	**Method (2)**
Height above stack top, meters*		meters	feet	2*0.16(z-z_v)	V'=V_{exit}*D/2a'	V= {$(Va)_o^3$+0.12F_o[(z-z_v)^2-(6.25D-z_v)^2]}$^{1/3}$ / a
End of jet phase at 6.25D = 2.250 meters*		***8.346***	***27.4***	***0.720***		***8.18***
93.904	meters*	100.000	328.1	30.002	0.20	1.01
143.904	meters*	150.000	492.1	46.002	0.13	0.88
193.904	meters*	200.000	656.2	62.002	0.09	0.79
243.904	meters*	250.000	820.2	78.002	0.08	0.74
293.904	meters*	300.000	984.3	94.002	0.06	0.69
343.904	meters*	350.000	1148.3	110.002	0.05	0.66
393.904	meters*	400.000	1312.3	126.002	0.05	0.63
443.904	meters*	450.000	1476.4	142.002	0.04	0.60
493.904	meters*	500.000	1640.4	158.002	0.04	0.58
543.904	meters*	550.000	1804.5	174.002	0.03	0.56
593.904	meters*	600.000	1968.5	190.002	0.03	0.55
643.904	meters*	650.000	2132.5	206.002	0.03	0.53
693.904	meters*	700.000	2296.6	222.002	0.03	0.52
743.904	meters*	750.000	2460.6	238.002	0.02	0.51
793.904	meters*	800.000	2624.7	254.002	0.02	0.50
843.904	meters*	850.000	2788.7	270.002	0.02	0.49
893.904	meters*	900.000	2952.8	286.002	0.02	0.48
943.904	meters*	950.000	3116.8	302.002	0.02	0.47
993.904	meters*	1000.000	3280.8	318.002	0.02	0.46
1043.904	meters*	1050.000	3444.9	334.002	0.02	0.45
1093.904	meters*	1100.000	3608.9	350.002	0.02	0.45
1143.904	meters*	1150.000	3773.0	366.002	0.02	0.44
1193.904	meters*	1200.000	3937.0	382.002	0.02	0.43
1243.904	meters*	1250.000	4101.0	398.002	0.01	0.43

0.000	meters*	6.096	20.0	-0.047	-124.15	-107.12
0.305	meters*	6.401	21.0	0.050	117.52	101.40
0.610	meters*	6.706	22.0	0.148	39.88	34.47
0.914	meters*	7.010	23.0	0.245	24.02	20.82
1.219	meters*	7.315	24.0	0.343	17.18	14.96
1.524	meters*	7.620	25.0	0.440	13.38	11.71
1.829	meters*	7.925	26.0	0.538	10.95	9.66
2.134	meters*	8.230	27.0	0.635	9.27	8.24
2.438	meters*	8.534	28.0	0.733	8.03	7.21
2.743	meters*	8.839	29.0	0.830	7.09	6.43
3.048	meters*	9.144	30.0	0.928	6.35	5.82
3.353	meters*	9.449	31.0	1.025	5.74	5.34
3.658	meters*	9.754	32.0	1.123	5.24	4.94
3.962	meters*	10.058	33.0	1.221	4.82	4.60
4.267	meters*	10.363	34.0	1.318	4.47	4.32
4.572	meters*	10.668	35.0	1.416	4.16	4.09
4.877	meters*	10.973	36.0	1.513	3.89	3.88
5.182	meters*	11.278	37.0	1.611	3.66	3.70
5.486	meters*	11.582	38.0	1.708	3.45	3.54
5.791	meters*	11.887	39.0	1.806	3.26	3.41

Number of Stacks (only 1 0.5-MW administrative generator)	1	
Stack Diameter	1.2	feet
Center-to-Center Distance Between Stacks (Set to 1 to facilitate calculations for single stack)	1.0	feet
Stack Distances (not required, as center-to-center distance known)	N/A	feet

	Method (3)		
Ht above Ground = $h_{plume}+h_s$	V = V'*Number of Stacks$^{0.25}$	**Number of Stacks**	**Plume Diameter**
feet	m/s	(within plume)	feet
20.0	-115.63	1	-0.16
21.0	109.46	1	0.16
22.0	37.17	1	0.48
23.0	22.42	1	0.80
24.0	16.07	1	1.12
25.0	12.54	1	1.44
26.0	10.30	1	1.76
27.0	8.76	1	2.08
28.0	7.62	1	2.40
29.0	6.76	1	2.72
30.0	6.08	1	3.04
31.0	5.54	1	3.36
32.0	5.09	1	3.68
33.0	4.71	1	4.00
34.0	4.40	1	4.32
35.0	4.12	1	4.64
36.0	3.89	1	4.96
37.0	3.68	1	5.28
38.0	3.50	1	5.60
39.0	3.33	1	5.92

6.096	meters*	12.192	40.0	1.903	3.09	3.28	40.0	3.19	1	6.24
6.401	meters*	12.497	41.0	2.001	2.94	3.17	41.0	3.06	1	6.56
6.706	meters*	12.802	42.0	2.098	2.81	3.07	42.0	2.94	1	6.88
7.010	meters*	13.106	43.0	2.196	2.68	2.98	43.0	2.83	1	7.20
7.315	meters*	13.411	44.0	2.293	2.57	2.90	44.0	2.73	1	7.52
7.620	meters*	13.716	45.0	2.391	2.46	2.83	45.0	2.65	1	7.84
7.925	meters*	14.021	46.0	2.489	2.37	2.76	46.0	2.56	1	8.16
8.230	meters*	14.326	47.0	2.586	2.28	2.70	47.0	2.49	1	8.48
8.534	meters*	14.630	48.0	2.684	2.19	2.64	48.0	2.42	1	8.80
8.839	meters*	14.935	49.0	2.781	2.12	2.59	49.0	2.35	1	9.12
9.144	meters*	15.240	50.0	2.879	2.05	2.54	50.0	2.29	1	9.44
9.449	meters*	15.545	51.0	2.976	1.98	2.49	51.0	2.23	1	9.76
9.754	meters*	15.850	52.0	3.074	1.92	2.45	52.0	2.18	1	10.08
10.058	meters*	16.154	53.0	3.171	1.86	2.41	53.0	2.13	1	10.40
10.363	meters*	16.459	54.0	3.269	1.80	2.37	54.0	2.08	1	10.72
10.668	meters*	16.764	55.0	3.366	1.75	2.33	55.0	2.04	1	11.04
10.973	meters*	17.069	56.0	3.464	1.70	2.30	56.0	2.00	1	11.36
11.278	meters*	17.374	57.0	3.561	1.65	2.27	57.0	1.96	1	11.68
11.582	meters*	17.678	58.0	3.659	1.61	2.24	58.0	1.92	1	12.00
11.887	meters*	17.983	59.0	3.756	1.57	2.21	59.0	1.89	1	12.32
12.192	meters*	18.288	60.0	3.854	1.53	2.18	60.0	1.85	1	12.64
12.497	meters*	18.593	61.0	3.952	1.49	2.15	61.0	1.82	1	12.96
12.802	meters*	18.898	62.0	4.049	1.45	2.13	62.0	1.79	1	13.28
13.106	meters*	19.202	63.0	4.147	1.42	2.11	63.0	1.76	1	13.60
13.411	meters*	19.507	64.0	4.244	1.39	2.08	64.0	1.74	1	13.92
13.716	meters*	19.812	65.0	4.342	1.36	2.06	65.0	1.71	1	14.24
14.021	meters*	20.117	66.0	4.439	1.33	2.04	66.0	1.68	1	14.56
14.326	meters*	20.422	67.0	4.537	1.30	2.02	67.0	1.66	1	14.88
14.630	meters*	20.726	68.0	4.634	1.27	2.00	68.0	1.64	1	15.20
14.935	meters*	21.031	69.0	4.732	1.24	1.98	69.0	1.61	1	15.52
15.240	meters*	21.336	70.0	4.829	1.22	1.97	70.0	1.59	1	15.84
15.545	meters*	21.641	71.0	4.927	1.20	1.95	71.0	1.57	1	16.16
15.850	meters*	21.946	72.0	5.024	1.17	1.93	72.0	1.55	1	16.48
16.154	meters*	22.250	73.0	5.122	1.15	1.92	73.0	1.53	1	16.80
16.459	meters*	22.555	74.0	5.220	1.13	1.90	74.0	1.52	1	17.12
16.764	meters*	22.860	75.0	5.317	1.11	1.89	75.0	1.50	1	17.44
17.069	meters*	23.165	76.0	5.415	1.09	1.87	76.0	1.48	1	17.76
17.374	meters*	23.470	77.0	5.512	1.07	1.86	77.0	1.46	1	18.08
17.678	meters*	23.774	78.0	5.610	1.05	1.85	78.0	1.45	1	18.40
17.983	meters*	24.079	79.0	5.707	1.03	1.83	79.0	1.43	1	18.72
18.288	meters*	24.384	80.0	5.805	1.01	1.82	80.0	1.42	1	19.04
18.593	meters*	24.689	81.0	5.902	1.00	1.81	81.0	1.40	1	19.36
18.898	meters*	24.994	82.0	6.000	0.98	1.80	82.0	1.39	1	19.68
19.202	meters*	25.298	83.0	6.097	0.97	1.78	83.0	1.37	1	20.00
19.507	meters*	25.603	84.0	6.195	0.95	1.77	84.0	1.36	1	20.32
19.812	meters*	25.908	85.0	6.292	0.94	1.76	85.0	1.35	1	20.64
20.117	meters*	26.213	86.0	6.390	0.92	1.75	86.0	1.34	1	20.96
50.597	meters*	56.693	186.0	16.144	0.36	1.25	186.0	0.81	1	52.96
81.077	meters*	87.173	286.0	25.897	0.23	1.07	286.0	0.65	1	84.96
111.557	meters*	117.653	386.0	35.651	0.17	0.96	386.0	0.56	1	116.96
142.037	meters*	148.133	486.0	45.404	0.13	0.88	486.0	0.51	1	148.96

Exhaust velocity falls below the CEC's 10.6 m/s peak rate using any method

Exhaust velocity falls below the CEC's 5.3 m/s average rate using any method

Project-specific parameters