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Plume Vertical Velocity Assessment for the Air Cooled Condensers

Palmdale Energy Project

Palmdale, California

Submitted to California Energy Commission

Submitted by

Palmdale Energy, LLC

Prepared by Atmospheric Dynamics, Inc.



ATMOSPHERIC DYNAMICS, INC Meteorological & Air Quality Modeling

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Introduction

Palmdale Energy, LLC is proposing to develop the Palmdale Energy Project (PEP), located near the Palmdale Airport. The combined-cycle project will utilize two (2) Siemens SCC6-5000F natural gasfired combustion turbine generators (CTG) and two (2) heat recovery steam generators (HRSG) with supplemental duct firing and a 32 cell air cooled condenser (ACC). The PEP site will be located on an approximately 50-acre undeveloped parcel west of the northwest corner of U.S. Air Force Plant 42. An analysis of the ACC plume characteristics was prepared based on the vertical plume-averaged velocities as described below.

Atmospheric Dynamics, Inc. (ADI) has prepared screening level plume vertical velocity assessments based on the calm wind Spillane methodology outlined in the "Aviation Safety and Buoyant Plumes" paper (Peter Best, et. al., presented at the Clean Air Conference, Newcastle, New South Wales, Australia, 2003). This methodology is also recognized as a screening tool for aviation safety set out by the Australian Civil Aviation Safety Authority (CASA) and presented in "AC 139-5(1) Plume Rise Assessments (CASA, 2012)".

The aim of this screening assessment is to conservatively determine the potential for turbulence generated by the ACC waste heat exhaust plumes. Part 139.370 of the Australian Civil Aviation Safety Regulations (1998, 2004) provides that CASA may determine that plume velocities in excess of 4.3 m/s is or will be a potential hazard to aircraft operations. The *Manual of Aviation Meteorology* (Australian Bureau of Meteorology 2003) defines severe turbulence as a vertical wind gust velocity in excess of 10.6 m/s. The assumed critical velocity used as a CEC significance threshold is 4.3 meters per second (m/s) but it should be noted that the basis of this CASA derived threshold has been lost in antiquity and that CASA no longer relies on the 1998 and 2004 regulations that established this critical threshold other than to note that a more rigorous analysis, which includes site specific meteorology, should be used if the 4.3 m/s screening threshold is exceeded. The screening method uses absolute worst-case assumptions of calm winds and neutral atmospheric conditions for the entire vertical extent of the plume to determine these worst-case impacts. It should be noted that these results are extremely conservative in that these worst-case conditions typically only occur during a few hours each year.

The Spillane methodology is generally applied to a limited number of plume source geometry's (turbines, power plant boilers, etc.) with the stacks arranged linearly (in a single straight-line) and separated by distances that typically exceed the individual stack diameters. For this assessment, a conservative assumption was made in order to use the Spillane methodology on an atypical ACC plume configuration which is made up of 32 plumes or cells arranged on a two dimensional surface. Here, the methodology, as described below, assumed all operating ACC cells were merged into a single equivalent ACC cell with an effective diameter based on the combined diameters of all operating cells. In other words, a single large cell was assumed to initially describe the release parameters of the ACC.

Screening Methodology and Vertical Plume Velocity Calculations for ACC

The ACC is comprised of 32 individual cells, arranged along four rows of eight cells each in 4 x 8 matrix. Thus, the 32 cells or radiators are arranged along two axis of direction producing a two dimensional plane in both the x and y directions. ACC stack parameter data (plume velocity, plume temperature) was provided by Siemens and the ACC manufacturer. The ACC will utilize variable speed fans. Additionally, the number of fans that are operational are dependent upon



ambient temperature and plant load. For all ambient conditions, plant operation was assumed to be at full load. Thus, during cold winter conditions, only 10 fans would be operational at low speeds. During annual average conditions, up to 16 fans would be operational while during hot summer days, all 32 fans would be on at maximum speed. This data is summarized in Table 1.

Table 1 ACC Stack Character	istics for Vertica	I Plume Velocity	/ Analysis
Case #	1	2	3
Ambient Temp (°F)*	23	64	98
Number of ACC Cells in Use*	10	16	32
Heat Rejection (MW/hr)*	447.24	447.38	445.28
Exhaust Flow Rate (lb/hr)*	5.12E+07	7.79E+07	1.51E+08
Cell Exit Temperature (°F)*	146.1	145.2	140.1
Cell Height (ft)*	130	130	130
Individual Cell Diameter (ft)*	36.09	36.09	36.09
Effective Stack Diameter (ft)**	114.12	144.36	204.15
Stack Exit Velocity (ft/s)*	3.18	5.24	10.83

*ACC stack data provided by Siemen

** Calculated value based on the cell diameter of 36 feet to the square of the number of operating cells or for example, Case #1: $D_{eff} = 36.09^* \sqrt{10}$

Note: The exit velocities from the ACC are always less than the critical velocity threshold of 4.3

The Spillane methodology was originally developed to treat multiple individual stacks that are arranged along a linear x or y direction but not both directions at once. The ten to thirty-two 11-meter diameter radiator cells (depending upon operating case number) are arranged in the 4 x 8 are separated by between 13.1 meters in the x direction (east-west) and 14.5 meters in the y direction (north-south) in a center-to-center distance. Thus, the stack separations are about the same as the stack diameter. The ability of the Spillane method is limited to a single projection along a single axis and is not suitable for the ACC geometry. Therefore, the Spillane methodology for a single cell, based on the effective plume diameter was calculated for the number of cells in use for each ambient temperature. So for the cold day Case #1, the effective single plume diameter would be based on 16 cells and during the annual temperature Case #2, the effective diameter would be based on 32 cells. The effective diameter for the single cell for each of the three ambient temperatures are presented in Table 1. The plume velocities were then calculated using the Spillane methodology for a single effective diameter or merged cell.

Results

Screening level vertical plume velocity assessments were made for the range of ambient temperatures with calm winds and neutral atmospheric conditions for the three cases presented in Table 1: 10 cells, 16 cells and 32 cells, each case with the calculated effective diameters as shown in the table.

The ACC exit temperature for the three ambient cases are similar to each other and are based on the plant at 100 percent load. Thus, the total heat rejection is similar for each case. However, the effective stack diameters (based on the number of cells in use) and exit velocities decrease significantly for cooler ambient temperatures as the ability to transfer waste heat to the atmosphere is increased for cooler atmospheric temperatures. Thus, the use of variable speed



fans and the ability to cycle each fan based on the cooling needs of the plant allow for the decreased number of fans that are operational during cooler weather (and the decreased fan speed as well). The Spillane method was used for each of the three ambient conditions with the results presented in Table 2 and the output from the calculation worksheet provided in Attachment A.

Table 2 ACC Vertical Plume Ve	locity Analysis R	esults for Refer	ence Height
Case #	1	2	3
Ambient Temp (°F)	23	64	98
Single Plume Results (m/s):			
at 1500-feet agl	3.21	3.54	2.94
Maximum Velocity above 1500- feet agl	3.21	3.56	4.06

From these results and for each ambient condition, the vertical plume velocities are less than the significance value of 4.3 m/s for all heights through 1500 feet-agl and above for the ACC. These cases also represent the worst-case conditions of calm winds at all levels of a neutral atmosphere.

These screening results indicate that mechanical and thermal turbulence levels due to the flow from the ACC always remain in the light turbulence category and below the significance level of 4.3 m/s at all heights above 1500' agl. In reality, even light wind speeds can dramatically decrease the predicted plume-averaged vertical velocities so the above results are very conservative indications of adverse conditions. The important factor for a given location is the appropriateness of available information for estimating true wind and temperature profiles throughout a typical year. Theoretical calculations, as shown in the tables above, are likely to overestimate the expected vertical velocities, for the following reasons:

- The wind profile is assumed constant with height with no occurrence of wind-shear. In reality, there is a considerable variation with height, especially in light winds;
- Worst-case scenarios are based on very light-wind, near-neutral atmospheric conditions with maximum loading.



Attachment A Spillane Method Plume Velocity Calculations



	"Aviation Sa	fety and Du-	Vant Diumoo	" Peter Po	et at al			
	"The Evaluat	ion of Maxin	yant Piumes num Undraft	Sneeds for	si, et. al. Calm Con	ditions at V	arious Heights in the Plume	3
		from a Gas-	Turbine Pow	er Station a	t Oakev. G	ueensland	Australia." Dr. K.T. Spillar	, ne
Ambient Conditions:		nom a Gas	i ui bine i ow		Constants		eutral conditions (dA/dz=0 or 6	A.=A.)
Ambient Potential Temp 0.	268.15	Kelvins	23.0	°F	oonstants.	0.3048	meters/feet	Ja Jej
Plume Exit Conditions:	200.10		20.0		Gravity o	9.81	m/s ² Single Cell Values	
Stack Height he	39.62	meters	130.0	feet	λ	1.11	10	#Cells
Effective Stack Diameter D	34.79	meters	114.12	feet	λ	~1.0	11.00	Diam(m)
Stack Velocity Veria	0.97	m/s	3.18	ft/sec				
Volumetric Flow	921.82	cu m/sec	1 953 077	ACEM	πVD ² /4			Sect 2/¶1
Stack Potential Temp A	336.54	Kolvine	146 1	°⊑	IT V EXIL			0000.2/ [[1
Initial Stack Buoyapov Flux F	58/ 05	m ⁴ /c ³	123.1	°E Delta T	a)/ , D ² (1-) A)/A –)/A	$p = E \log(\alpha/\pi)(1-A/A)$	Sect 2/¶1
Plume Buoyancy Flux F	N/A	m ⁴ /c ³	120.1	T Delta.T	$\lambda^2 \alpha / 2^2 (1 - A)$	/A) for a V	A at plume beight (see belo	0000.2/ [[1
Fiume Buoyancy Flux F	IN/A	111 / 5			// gva (1-0	a/op/iora,v	,op at plume height (see belo	
Conditions at End (Ton) of let Phase:								
Height above Stock 7	217 407	motors*	712.2	foot*	7 - 6 25) motors*-	motors above stack top	Soot 2/¶1
Height above Stack Zjet	217.407	meters	042.2	fact	Zjet = 0.23L		Inelets above stack top	3601.3/11
Height above Glound 2 _{jet} +hs	257.027	m/a	043.3	ft/aca	V 0.5V	V /2		
Diumo Ton Hot Diameter 20	0.400	motoro	000.0	foot	v _{jet} = 0.5v	exit = Vexit/2	Concention of momentum	
Plume Top-Hat Diameter 2a _{jet}	69.570	meters	228.2	reet	$2a_{jet} = 2D$		Conservation of momentum	
Onillana Mathadalami Anabairal Calutiana		liti - u - fa - Di			Dh			
Spillane Methodology - Analytical Solutions		altions for P		s above Jei	Phase			
Single Plume-averaged Vertical Velocity	V given by Ai	halytical Sol	ution in Pap	er where P	roduct va	given by e	quations below:	
Plume Top-Hat Radius a	5	olutions in 1	able Below	4	0.16(z-z _v),	or linear inc	crease with height	Sect.2/Eq.6
Virtual Source Height z _v	23.343	meters*	76.6	reet*	o.25D[1-(0	y⊎ _s)‴∸], mete	ers'=meters above stack top	Sect.2/Eq.6
Height above Ground zv+hs	62.963	meters	206.6	reet	101.2		where $(\theta_a/\theta_s)^{1/2} = (\theta_e/\theta_s)^{1/2} =$	0.8926
Vertical Velocity V	S	olutions in T	able Below	1	{(Va) _o ³ + 0	.12F _o [(z-z _\	/) ² - (6.25D-z _v) ²]} ^(1/3) / a	Sect.2.1(6
Product (Va) _o	15.059	m²/s			V _{exit} D/2(θ _e	'θ _s)'' ²		
Solve for plume-averaged vertical velo	city at height	1,500.0	feet	457.2	meters abo	we ground (z'+h _s)	
Gives the following Height above Stack z'	417.580	meters*	1370.0	feet*				
Plume Top-Hat Diameter 2a'	126.156	meters	413.9	feet	2a'=2*0.16	(z'-z _v)		Sect.2/Eq.6
Vertical Velocity V	3.206	m/s	10.52	ft/sec	V={(Va) _o ³ +	0.12F _o [(z-z	/) ² -(6.25D-z _v) ²]} ^(1/3) /(2a'/2)	Sect.2/Eq.6
Solve for Height of CASC critical vertical	velocity V _{crit}	2.15	m/s plume-a	veraged v	ertical velo	ocity		
Find Height above Stack z _{crit}	1725.314	meters	5660.5	feet	Solve for x	=(z-z _v) simu	Itaneously in both eqs. (i.e.,	Va and a)
Height above Ground z _{crit} +h _s	1,764.934	meters	5790.5	feet	for V=V _{crit} (m/s) using t	he cubic equation ax3+bx2+c	x+d=0, whe
						a=1, c=0,	and b=-(0.12F _o)/(V _{crit} ³ 0.16 ³)=	-1724.360
					and d	=[0.12F _o (6.2	25D-z _v) ² -(Va) _o ³]/(V _{crit} ³ 0.16 ³)=	6485643
							http://www.1728	ora/cubic ht
							11109.07 1111111201	orq/ouble.m
						give	s the real solution x = z-zv =	1701.97
						give	s the real solution x = z-zv = or z(m) =	1701.970 1725.3
Table of Plume Top-Hat Diameters (2a) and F	lume-averag	ed Vertical V	/elocities sta	irting at en	d of jet ph	give ase:	s the real solution x = z-zv = or z(m) = z(ft) =	1701.970 1725.3 5660
Table of Plume Top-Hat Diameters (2a) and P Height (feet)	lume-averag (meters)	ed Vertical \ Plume	√elocitiessta Vert.	irting at en Plume	d of jet ph	give ase:	s the real solution x = z-zv = or z(m) = z(ft) =	1701.97(1725.3 ⁴ 5660
Table of Plume Top-Hat Diameters (2a) and P Height (feet) above ground	lume-averag (meters) above stack	ed Vertical V Plume Radius(m)	Velocities sta Vert. Vel(m/s)	rting at en Plume Temp(K)	d of jet ph	give ase:	s the real solution x = z-zv = or z(m) = z(ft) =	1701.97(1725.3 5660
Table of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 843.3	lume-averag (meters) above stack 217.42	ed Vertical V Plume Radius(m) 34.785	Velocities sta Vert. Vel(m/s) 0.49	rting at en Plume Temp(K)	d of jet ph	give ase: Spillane E	s the real solution x = z-zv = or z(m) = z(ft) =	1701.97 1725.3 5660
Table of Plume Top-Hat Diameters (2a) and P Height (feet) above ground <i>Top of jet = 84.3</i> 1450.0	lume-averag (meters) above stack 217.42 402.34	ed Vertical V Plume Radius(m) <i>34.785</i> 60.639	Velocities sta Vert. Vel(m/s) 0.49 3.22	rting at en Plume Temp(K) 269.25	d of jet ph	give ase: Spillane E V _{plume} ={(Va).	s the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ +0.12F ₀ [(z-z,) ² -(6.25D-z,) ²]) ^{1/2} / a	1701.97 1725.3 5660
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Table of Plume Top-Hat Diameters (2a) and F Height (feet) above ground Top of jet = 843.3 1450.0 1550.0 1600.0 1600.0 1750.0 1600.0 1650.0 1750.0 1850.0 1750.0	lume-averag (meters) above stack 217.42 402.34 417.58 432.82 448.06 463.30 478.54 4493.78 509.02 524.26 533.50	ed Vertical V Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 80.585	Velocities sta Vert. Vel(m/s) 0.49 3.22 3.21 3.19 3.17 3.15 3.14 3.12 3.10 3.08 3.09	rting at en Plume Temp(K) 269.25 269.17 269.04 268.98 268.93 268.89 268.89 268.84 268.81 268.81	d of jet ph	give ase: Spillane E V _{pluma} =((Va), a = 0.16(z- 0p=0a(1+(1	s the real solution x = z-zv = or z(m) = z(ft) = $^{3}+0.12F_{0}[(z-z_{v})^{2}-(6.25D-z_{v})^{2}])^{1/3}/a$ $Z_{v})$ $-(\theta_{e}/\theta_{s}))^{*}(V_{exit}D^{2}/(4V_{plume}*a^{2*}A))$	1701.97 1725.3 566(2))))
Table of Plume Top-Hat Diameters (2a) and F Height (feet) above ground Top of jet = 843.3 1450.0 1500.0 1550.0 1600.0 1600.0 1750.0 1850.0 1700.0 1750.0 1880.0 1800.0 1900.0	lume-averag (meters) above stack 217.42 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74	ed Vertical V Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.585 85.022	Velocities sta Vert. Vel(m/s) 0.49 3.22 3.21 3.19 3.17 3.15 3.14 3.12 3.10 3.08 3.06	rting at en Plume Temp(K) 269.25 269.17 269.10 269.04 268.98 268.89 268.84 268.81 268.81 268.87 268.77	d of jet ph	give ase: Spillane E V _{plume} =((Va), a = 0.16(z- θ _p =θ _a (1+(1	s the real solution x = 2-zv = or z(m) = z(ft) = $z_{v}^{2}(z_{v}^{2}-(6.25D-z_{v}^{2})^{1/3} / a z_{v})$ $-(\theta_{e}/\theta_{s}))^{*}(V_{exit}D^{2}/(4V_{plume}*a^{2*}\lambda$	1701.97 1725.3 566(2))))
Table of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 843.3 1450.0 1500.0 1550.0 1650.0 1770.0 1750.0 1850.0 1900.0 1900.0 1950.0	lume-averag (meters) above stack 217.42 402.34 417.58 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.02	ed Vertical V Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.585 85.023 87.422	Velocities sta Vert. Vel(m/s) 0.49 3.22 3.21 3.19 3.17 3.15 3.14 3.12 3.10 3.08 3.06 3.03	rting at en Plume Temp(K) 269.25 269.17 269.10 269.04 268.89 268.89 268.84 268.81 268.87 268.77 268.74	d of jet ph	give	s the real solution x = Z-ZV = or Z(m) = Z(ft) = ³ +0.12F ₀ [(z-Z ₂) ² -(6.25D-Z ₂) ²]) ^{1/2} / a Z _V) -(θ ₀ /θ ₅))*(V _{exit} D ² /(4V _{plume} *a ^{2*} λ	1701.97 1725.3 5660
Table of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 843.3 1450.0 1500.0 1550.0 1600.0 1650.0 1700.0 1700.0 1850.0 1850.0 1850.0 1900.0 1900.0 1900.0 1900.0 1900.0 1900.0 1900.0 1900.0 1900.0 1900.0 1900.0 1900.0	lume-averag (meters) above stack 217.42 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 509.02	ed Vertical N Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.585 85.023 85.023 87.462 0.2020	Velocities sta Vert. Vel(m/s) 0.49 3.22 3.21 3.19 3.17 3.15 3.14 3.12 3.10 3.08 3.06 3.03 3.01 2.22	rting at en Plume Temp(K) 269.25 269.17 269.04 268.98 268.93 268.83 268.83 268.84 268.81 268.77 268.74 268.74	d of jet ph	give	s the real solution x = Z-ZV = or z(m) = z(ft) = ³ 40.12F ₂ [(z-z,) ² .(6.25D-z,) ²]) ^{1/3} / a Z,) -(θ _θ /θ ₂))*(V _{exit} D ² /(4V _{plume} *a ²⁺ λ	1701.97 1725.3 5660
Table of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 843.3 1450.0 1550.0 1600.0 1650.0 1750.0 1850.0 1900.0 1900.0 1900.0 1900.0 1900.0 1900.0 2000.0 2100.0	lume-averag (meters) above stack 217.42 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46	ed Vertical N Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.585 85.023 87.462 92.339 07.247	Velocities sta Vert. Vel(m/s) 0.49 3.22 3.21 3.19 3.17 3.15 3.14 3.10 3.00 3.08 3.06 3.03 3.01 2.98	rting at en Plume Temp(K) 269.25 269.17 269.10 269.04 268.98 268.89 268.89 268.84 268.81 268.71 268.74 268.74	d of jet ph	give	s the real solution x = Z-ZV = or z(m) = z(ft) = ³ +0.12F ₂ [(z-z,) ² -(6.25D-Z,) ²]) ^{1/3} / a z _y .) (θ _e /θ _s))*(V _{exit} D ² /(4V _{plume} *a ²⁺ λ	1701.97 1725.3 5660 2))))
Table of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 843.3 1450.0 1550.0 1550.0 1660.0 1750.0 1800.0 1750.0 1900.0 1900.0 1200.0 1200.0 1200.0	lume-averag (meters) above stack 217.42 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94	ed Vertical N Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.885 85.023 87.462 92.339 97.215	Velocities sta Vert. Vel(m/s) 3.22 3.21 3.19 3.17 3.15 3.14 3.12 3.10 3.08 3.06 3.03 3.01 2.98 2.94	rting at en Plume Temp(K) 269.25 269.17 269.04 268.98 268.93 268.89 268.89 268.84 268.81 268.87 268.74 268.74 268.74 268.76 268.62	d of jet ph	give	s the real solution x = Z-Zv = or Z(m) = Z(t) = iquations: ³ +0.12F ₆ [(z-z,) ² -(6.25D-Z,) ²]) ^{1/3} / a Z _ν) (6e/θ _s))*(V _{exit} D ² /(4V _{plume} *a ^{2*} Λ	1701.97 1725.3 5660 2 ²))))
Table of Plume Top-Hat Diameters (2a) and F Height (feet) above ground Top of jet = 843.3 1450.0 1500.0 1550.0 1600.0 1600.0 1600.0 1850.0 1750.0 1850.0 1750.0 1700.0 1750.0 1880.0 1880.0 1900.0 2000.0 2100.0 2300.0	lume-averag (meters) above stack 217.42 402.34 417.58 432.82 448.06 463.30 478.54 443.78 509.02 524.26 533.50 554.74 569.98 600.46 630.94 661.42	ed Vertical N Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.585 85.023 87.462 92.339 97.215 102.092	Velocities sta Vert. Vel(m/s) 0.49 3.22 3.21 3.19 3.17 3.15 3.14 3.12 3.10 3.08 3.06 3.03 3.01 2.98 2.94 2.94	rting at en Plume Temp(K) 269.25 269.17 269.04 268.98 268.93 268.89 268.84 268.81 268.71 268.74 268.74 268.66 268.62 268.62 268.68	d of jet ph	give ase: Spillane E $V_{pluma}=((Va), a = 0.16(z - \theta_p = \theta_n(1 + (1 + 1)))$	s the real solution x = z-zv = or z(m) = z(ft) = $^{3}+0.12F_{0}[(z-z_{v})^{2}-(6.25D-z_{v})^{2}])^{1/3}/a$ $Z_{v})$ $(\theta_{e}/\theta_{s}))^{*}(V_{exil}D^{2}/(4V_{plume}*a^{2*}A))$	1701.97 1725.3 566(2))))
Table of Plume Top-Hat Diameters (2a) and F Height (feet) above ground Top of jet = 843.3 1450.0 1500.0 1550.0 1600.0 1600.0 1750.0 1850.0 1700.0 1750.0 1800.0 1200.0 1200.0 2000.0 2100.0 2300.0 2400.0	lume-averag (meters) above stack 217.42 402.34 417.58 432.82 448.06 463.30 478.54 4493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 661.42 661.90	ed Vertical N Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.585 85.023 87.462 92.339 97.215 102.092 106.969	Velocities sta Vert. Vel(m/s) 0.49 3.22 3.21 3.19 3.17 3.15 3.14 3.12 3.10 3.08 3.00 3.03 3.01 2.98 2.94 2.90 2.86	rting at en Plume Temp(K) 269.25 269.17 269.10 268.04 268.98 268.89 268.89 268.84 268.81 268.77 268.74 268.74 268.74 268.65 268.62 268.65	d of jet ph	give	s the real solution x = 2-zv = or z(m) = z(ft) = 3 -40.12F ₀ [(z-z.) ² -(6.25D-z.) ²]) ^{1/3} / a z _v) -(θ_{e}/θ_{s}))*(V _{exit} D ² /(4V _{plume} *a ²⁺ A	1701.97 1725.3 566(2))))
Table of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 843.3 1450.0 1500.0 1550.0 1650.0 1650.0 1750.0 1800.0 1900.0 2000.0 2000.0 2100.0 2200.0 2300.0 2400.0 2500.0	lume-averag (meters) above stack 217.42 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90 722.38	ed Vertical V Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.585 85.023 87.462 92.339 97.215 102.092 106.969 111.846	Velocities sta Vert. Vel(m/s) 0.49 3.22 3.21 3.19 3.17 3.15 3.14 3.12 3.10 3.08 3.06 3.03 3.01 2.98 2.94 2.90 2.86 2.83	rting at en Plume Temp(K) 269.25 269.17 269.10 269.04 268.98 268.89 268.89 268.84 268.81 268.71 268.74 268.74 268.74 268.74 268.75 268.55 268.55	d of jet ph	give ase: Spillane E V _{pluma} =((Va), a = 0.16(z-6), b(y-1), b	s the real solution x = Z-ZV = or Z(m) = Z(ft) =	1701.97 1725.3 5660 2 ²))))
Table of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 843.3 1450.0 1500.0 1550.0 1600.0 1650.0 1700.0 1850.0 1900.0 1950.0 2000.0	lume-averag (meters) above stack 217.42 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90 722.38 752.86	ed Vertical N Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.585 85.023 87.462 92.339 97.215 102.092 106.969 111.846 116.723	Velocities sta Vert. Vel(m/s) 0.49 0.3.22 3.21 3.19 3.17 3.15 3.14 3.12 3.10 3.08 3.06 3.03 3.01 2.98 2.94 2.90 2.86 2.83 2.79	rting at en Plume Temp(K) 269.25 269.17 269.10 269.04 268.89 268.89 268.89 268.84 268.81 268.77 268.74 268.62 268.68 268.62 268.65 268.52 268.52	d of jet ph	give	s the real solution x = Z-ZV = or z(m) = z(ft) = a ³ 40.12F ₂ [(z-z,) ² .(6.25D-z,) ²]) ^{1/3} / a Z,) -(θ _θ /θ _s))*(V _{exit} D ² /(4V _{plume} *a ²⁺ λ	1701.97 1725.3 566(2))))
Table of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 843.3 1450.0 1500.0 1550.0 1600.0 1650.0 1650.0 1650.0 1700.0 1850.0 1850.0 1900.0 1200.0 2000.0 2100.0 22000.0 2400.0 2500.0 2600.0 2700.0	lume-averag (meters) above stack 217.42 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 661.42 661.90 722.38 752.86 783.34	ed Vertical N Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.585 85.023 87.462 92.339 97.215 102.092 106.969 111.846 116.723 121.599	Velocities sta Vert. Vel(m/s) 0.49 3.22 3.21 3.19 3.17 3.15 3.14 3.10 3.00 3.08 3.06 3.03 3.01 2.98 2.94 2.90 2.86 2.83 2.79 2.76	rting at en Plume Temp(K) 269.25 269.17 269.10 269.04 268.98 268.89 268.89 268.89 268.84 268.81 268.71 268.74 268.66 268.62 268.65 268.65 268.55 268.52 268.49 268.49	d of jet ph	give ase: Spillane E Spillane E optimation a = 0.16(z- θ _p =θ _s (1+(1	s the real solution x = Z-ZV = or z(m) = z(ft) = ³ +0.12F ₂ [(z-z,) ² -(6.25D-Z,) ²]) ^{1/3} / a Z _γ) ((θ _e /θ _s))*(V _{exit} D ² /(4V _{plume} *a ²⁺ λ	1701.92 1725.7 566(2))))
Table of Plume Top-Hat Diameters (2a) and F Height (feet) above ground Top of jet = 843.3 1450.0 1550.0 1550.0 1600.0 1600.0 1700.0 1750.0 1850.0 1700.0 1750.0 1850.0 1200.0 1200.0 2000.0 2000.0 2100.0 2200.0 2400.0 2500.0 2600.0 2700.0 2800.0	lume-averag (meters) above stack 217.42 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90 722.38 752.86 783.34 813.82	ed Vertical N Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.585 85.023 87.462 92.339 97.215 102.092 106.969 111.846 116.723 121.599 126.476	Velocities sta Vert. Vel(m/s) 0.49 3.22 3.21 3.19 3.17 3.15 3.14 3.12 3.10 3.08 3.06 3.03 3.01 2.98 2.94 2.90 2.86 2.83 2.79 2.76 2.73	rting at en Plume Temp(K) 269.25 269.17 269.10 269.04 268.98 268.93 268.89 268.84 268.81 268.87 268.74 268.74 268.66 268.62 268.58 268.55 268.55 268.49 268.47 268.47	d of jet ph	give ase: Spillane E V _{pluma} =((Va), a = 0.16(z, θ _p =θ _a (1+(1	s the real solution x = Z-Zv = or Z(m) = Z(t) = iquations: ³ +0.12F ₆ [(z-z,) ² -(6.25D-Z,) ²]) ^{1/3} / a Z _v) (6e/9e))*(V _{exit} D ² /(4V _{plume} *a ²⁺ A	1701.97 1725.3 566(2))))
Table of Plume Top-Hat Diameters (2a) and F Height (feet) above ground Top of jet = 843.3 1450.0 1500.0 1550.0 1600.0 1600.0 1600.0 1600.0 1850.0 1750.0 1850.0 1750.0 1850.0 1850.0 1900.0 1950.0 2000.0 2100.0 2200.0 2400.0 2500.0 2600.0 2700.0 2800.0 2800.0 2900.0	lume-averag (meters) above stack 217.42 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 663.94 661.42 691.90 772.38 752.86 7783.34 813.82	ed Vertical N Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.585 85.023 87.462 92.339 97.215 102.092 106.969 111.846 116.723 121.599 126.476 131.353	Velocities sta Vert. Vel(m/s) 0.49 3.22 3.21 3.19 3.17 3.15 3.14 3.12 3.10 3.08 3.06 3.03 3.01 2.98 2.94 2.90 2.86 2.83 2.83 2.79 2.76 2.73 2.70	rting at en Plume Temp(K) 269.25 269.17 269.04 268.98 268.93 268.89 268.89 268.84 268.81 268.74 268.74 268.74 268.55 268.52 268.45 268.45 268.45	d of jet ph	give ase: Spillane E V _{pluma} =((Va), a = 0.16(z- θ _p =θ _a (1+(1	s the real solution x = z-zv = or z(m) = z(ft) = ³ +0.12F ₀ [(z-z.) ² -(6.25D z.) ²]) ^{1/3} / a z _v) -(θ _e /θ ₂))*(V _{exil} D ² /(4V _{plume} *a ^{2*} λ	1701.97 1725.3 566(2))))
Table of Plume Top-Hat Diameters (2a) and F Height (feet) above ground Top of jet = 843.3 1450.0 1500.0 1550.0 1600.0 1600.0 1600.0 1600.0 1800.0 1750.0 1800.0 1200.0 1200.0 1950.0 2000.0 2100.0 2200.0 2500.0 2600.0 2700.0 2800.0 2800.0 2900.0	lume-averag (meters) above stack 217.42 402.34 417.58 432.82 448.06 463.30 478.54 449.378 509.02 554.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90 7722.38 7752.86 7783.34 813.82 844.30 874.78	ed Vertical N Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.585 85.023 87.462 92.339 97.215 102.092 106.969 111.846 116.723 121.599 126.476 131.353 136.230	Velocities sta Vert. Vel(m/s) 0.49 3.22 3.21 3.19 3.17 3.15 3.14 3.12 3.10 3.08 3.06 3.03 3.01 2.98 2.94 2.90 2.86 2.83 2.79 2.76 2.73 2.70 2.70 2.67	rting at en Plume Temp(K) 269.25 269.17 269.10 269.04 268.98 268.89 268.89 268.89 268.84 268.81 268.74 268.74 268.74 268.74 268.55 268.62 268.55 268.55 268.55 268.43 268.43		give ase: Spillane E V _{plume} =((va), a = 0.16(z-6), b(va),	s the real solution $x = 2 \cdot zv =$ or $z(m) =$ z(ft) = (ft) = (ft) = (ft) = (ft) = (ft) = (ft) = (ft) = (ft) = (ft) =	1701.97 1725.3 566(2))))
Table of Plume Top-Hat Diameters (2a) and F Height (feet) above ground Top of jet = 843.3 1450.0 1500.0 1550.0 1650.0 1650.0 1650.0 1650.0 1750.0 1800.0 1750.0 1700.0 2000.0	lume-averag (meters) above stack 217.42 402.34 417.58 432.82 448.66 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90 722.38 752.86 783.34 813.82 844.30 874.78	ed Vertical N Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.585 85.023 87.462 92.339 97.215 102.092 106.969 111.846 116.723 121.599 126.476 131.353 136.230	Velocities sta Vert. Vel(m/s) 0.49 3.22 3.21 3.19 3.17 3.15 3.14 3.12 3.10 3.08 3.06 3.03 3.01 2.98 2.94 2.90 2.86 2.83 2.79 2.76 2.73 2.70 2.70 2.67	rting at en Plume Temp(K) 269.25 269.17 269.10 269.04 268.98 268.93 268.89 268.84 268.81 268.77 268.74 268.74 268.75 268.65 268.65 268.65 268.65 268.49 268.41 268.43 268.41 268.41	d of jet ph	give ase: Spillane E V _{pluma} =((Va), a = 0.16(z- θ _p =θ _s (1+(1	s the real solution x = Z-zv = or z(m) = z(ft) = ³ 40.12F ₂ [(z-z,) ² .(6.25D-z,) ²]) ^{1/3} / a z,) -(θ _θ /θ ₂))*(V _{exit} D ² /(4V _{plume} *a ²⁺ λ	1701.97 1725.3 566i
Table of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 843.3 1450.0 1500.0 1550.0 1600.0 1650.0 1650.0 1650.0 1750.0 1800.0 1750.0 1700.0 1200.0 2000.0	lume-averag (meters) above stack 217.42 402.34 417.58 432.82 448.06 4463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90 722.38 752.86 778.34 813.82 843.30 874.78 1027.18	ed Vertical N Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.585 85.023 87.462 92.339 97.215 102.092 106.969 111.846 116.723 121.599 126.476 131.353 136.230	Velocities sta Vert. Vel(m/s) 0.49 3.22 3.21 3.19 3.17 3.15 3.14 3.12 3.10 3.08 3.06 3.03 3.01 2.98 2.94 2.90 2.86 2.83 2.79 2.76 2.73 2.70 2.76 2.73 2.70 2.67 2.54	rting at en Plume Temp(K) 269.25 269.17 269.10 269.04 268.98 268.93 268.89 268.89 268.84 268.81 268.71 268.74 268.74 268.65 268.65 268.65 268.65 268.65 268.43 268.44 268.43 268.43 268.43	d of jet ph	give ase: Spillane E V _{pluma} =((Va), a = 0.16(z- θ _p =θ _s (1+(1	s the real solution x = Z-ZV = or z(m) = z(ft) = 3 ³ +0.12F ₂ [(z-z,) ² -(6.25D-z,) ²]) ^{1/3} / a ζ,) -(θ _e /θ ₂))*(V _{exit} D ² /(4V _{plume} *a ²⁺ λ	1701.97 1725.3 5660
Table of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 843.3 1450.0 1500.0 1550.0 1600.0 1650.0 1650.0 1650.0 1650.0 1650.0 1650.0 1650.0 1650.0 1700.0 1850.0 1850.0 1850.0 2000.0 2100.0 2000.0	lume-averag (meters) above stack 217.42 4402.34 447.58 432.82 448.06 4463.30 478.54 4493.78 509.02 524.26 539.50 554.74 569.98 600.46 661.42 691.90 722.38 752.86 783.34 813.82 844.30 874.78 1027.18	ed Vertical N Plume Radius(m) 34.785 60.639 63.078 65.516 67.955 70.393 72.831 75.270 77.708 80.147 82.585 85.023 87.462 92.339 97.215 102.092 106.969 111.846 116.723 121.599 126.476 131.353 136.230 160.614 184.998 209.382	Velocities sta Vert. Vel(m/s) 0.49 3.22 3.21 3.19 3.17 3.15 3.14 3.12 3.10 3.08 3.06 3.03 3.01 2.98 2.94 2.90 2.86 2.83 2.79 2.76 2.73 2.70 2.76 2.73 2.70 2.64 2.43 2.34	rting at en Plume Temp(K) 269.25 269.17 269.10 269.04 268.98 268.93 268.89 268.83 268.84 268.81 268.77 268.74 268.66 268.65 268.65 268.55 268.43 268.43 268.43 268.43 268.43 268.43 268.43 268.43 268.43	d of jet ph	give ase: Spillane E	s the real solution x = Z-Zv = or z(m) = z(ft) = ³ +0.12F ₂ [(z-z,) ² -(6.25D-z,) ²]) ^{1/3} / a z _y) ((θ _e /θ _s))*(V _{exit} D ² /(4V _{plume} *a ²⁺ λ	1701.97 1725.3 5660





	"The Evolution	ion of Mavin	um Undroff	Snoods for	Calm Com	ditions at V	arious Heights in the Dums	
	ine Evaluat	from a C-	Turbing D-	or Station	t Ockers		Australia " Dr. K T. O-:!!	<i>.</i>
		from a Gas-	Turbine Pow	er Station a	at Oakey, Q	ueensiand,	, Australia, Dr. K.I. Spillar	ne o o v
mblent Conditions:		12.1.1	01.0	05	Constants:	Assume ne	eutral conditions (de/dz=0 or e	θ _a =θ _e)
Ambient Potential Temp θ_a	290.93	Keivins	64.0	·F	0 1	0.3048	meters/ieet	
iume Exit Conditions:	00.00		400.0	6	Gravity g	9.81	m/s ² Single Cell Values	
Stack Height hs	39.62	meters	130.0	teet	<u>۸</u>	1.11	16	#Cells
Effective Stack Diameter D	44.00	meters	144.36	teet	۸٥	~1.0	11.00	Diam(m)
Stack Velocity V _{exit}	1.60	m/s	5.24	ft/sec	2			
Volumetric Flow	2,432.85	cu.m/sec	5,145,957	ACFM	πV _{exit} D²/4			Sect.2/¶1
Stack Potential Temp θ_s	336.04	Kelvins	145.2	°F				
Initial Stack Buoyancy Flux Fo	1,019.80	m ⁴ /s ³	81.2	°F Delta.T	gV _{exit} D ² (1-6	$\theta_a/\theta_s)/4 = V_s$	ol.Flow(g/π)(1-θ _a /θ _s)	Sect.2/¶1
Plume Buoyancy Flux F	N/A	m ⁴ /s ³			λ ² gVa ² (1-θ	_a /θ _p) for a,V	θ_{p} at plume height (see below	w)
onditions at End (Top) of Jet Phase:								
Height above Stack z _{jet}	275.000	meters*	902.2	feet*	z _{jet} = 6.250	D, meters*=	meters above stack top	Sect.3/¶1
Height above Ground z _{jet} +h _s	314.620	meters	1032.2	feet				
Vertical Velocity V _{jet}	0.800	m/s	2.62	ft/sec	$V_{jet} = 0.5V_{e}$	$_{exit} = V_{exit}/2$		
Plume Top-Hat Diameter 2a _{jet}	88.000	meters	288.7	feet	$2a_{jet} = 2D$		Conservation of momentum	
illane Methodology - Analytical Solutions f	or Calm Con	ditions for Pl	ume Heights	s above Jet	Phase			
Single Plume-averaged Vertical Velocity	V given by Ar	nalytical Sol	ution in Pap	er where P	roduct Va	given by e	quations below:	
Plume Top-Hat Radius a	S	olutions in T	able Below		0.16(z-z _v),	or linear inc	crease with height	Sect.2/Eq.6
Virtual Source Height zv	19.123	meters*	62.7	feet*	6.25D[1-(0a	$(\theta_{s})^{1/2}$], meter	ers*=meters above stack top	Sect.2/Eq.6
Height above Ground z+h-	58 743	meters	192 7	feet		, ,,	where $(\theta_{a}/\theta_{c})^{1/2} = (\theta_{a}/\theta_{c})^{1/2} -$	0,9305
Vertical Velocity V	S40	olutions in T	able Below		$\{(Va)_{a}^{3} \neq 0$	12F_ [(7-7	$(0_{e}, 0_{s}) = (0.25\text{D}-7)^{2}(1/3) / 3$	Sect 2 1/6)
Product (Va)	32 752	m ² /c			V . D/2(A /	Γ Δ1/2	/) (0.200 2v)]) / u	0000.2.1(0)
	52.132	11173			* exit D/ ∠(Ue/	~s/		
Solve for nume-averaged vertical value	rity at hoight	1 500 0	feet	457.0	metors at -		z'+b)	
Circo the following Height above Stock 7	417 500	1,500.0	1270.0	407.2	meters abo	ve ground (.	2 +11 _S)	
Gives the following Height above Stack 2	417.560	meters	1370.0	leel	0.1.010.40	())		Cont 2/F a C
Plume Top-Hat Diameter 2a	127.506	meters	418.3	teet	2a=2*0.16	(Z'-Z _V)	2 (0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Seci.2/Eq.6
Vertical Velocity V	3.536	m/s	11.60	π/sec	v={(va) _o -+	0.12⊢₀[(z-z∖	v) ⁻ -(6.25D-Zv) ⁻]} ^(~~) /(2a/2)	Sect.2/Eq.6
Solve for Height of CASC critical vertical	velocity V _{crit}	2.15	m/s plume-a	averaged v	ertical velo	ocity		
Find Height above Stock 7	2002 240		0050 5					
This regit above Stack Zcrit	3003.340	meters	9853.5	feet	Solve for x=	=(z-z _v) simu	ultaneously in both eqs. (i.e.,	Va and a)
Height above Ground z _{crit} +h _s	3,042.968	meters	9853.5 9983.5	feet	Solve for x= for V=V _{crit} (I	=(z-z _v) simu m/s) using t	ultaneously in both eqs. (i.e., the cubic equation ax ³ +bx ² +c	Va and a) x+d=0, where
Height above Ground z _{crit} +h _s	3,042.968	meters	9853.5 9983.5	feet	Solve for x= for V=V _{crit} (i	=(z-z _v) simu m/s) using t a=1, c=0, a	Iltaneously in both eqs. (i.e., the cubic equation ax ³ +bx ² +c and b=-(0.12F _o)/(V _{crit} ³ 0.16 ³)=	Va and a) x+d=0, where -3006.2294
Height above Ground z _{crit} +h _s	3,042.968	meters	9853.5 9983.5	feet	Solve for x= for V=V _{crit} (i and d	=(z-z _v) simu m/s) using t a=1, c=0, a =[0.12F _o (6.2	Itaneously in both eqs. (i.e., ' the cubic equation ax^3+bx^2+c and b=-(0.12F _o)/(V _{crit} ³ 0.16 ³)= 25D-z _v) ² -(Va) _o ³]/(V _{crit} ³ 0.16 ³)=	Va and a) x+d=0, where -3006.2294 195964112
Height above Ground z _{crit} +h _s	3,042.968	meters	9853.5 9983.5	feet	Solve for x= for V=V _{crit} (i and d	=(z-z _v) simu m/s) using t a=1, c=0, a =[0.12F ₀ (6.2	$\label{eq:analytical_states} \begin{array}{l} \text{in both eqs. (i.e., } \\ \text{the cubic equation } ax^3 + bx^2 + c \\ \text{and } b= -(0.12F_o)/(V_{crit}^3 0.16^3) = \\ 25D - z_v)^2 - (Va)_o^3/(V_{crit}^3 0.16^3) = \\ & \underline{\text{http:}}/\text{www.1728.}. \end{array}$	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm
Height above Ground z _{crit} +h _s	3,042.968	meters	9853.5 9983.5	feet	Solve for x= for V=V _{crit} (i and d	=(z-z _v) simu m/s) using t a=1, c=0, a =[0.12F _o (6.2 give	$\label{eq:analytical_states} \begin{array}{l} \text{in both eqs. (i.e.,} \\ \text{the cubic equation } ax^3+bx^2+c \\ \text{and } b=-(0.12F_o)/(V_{crit}^30.16^3)= \\ 25D-z_v)^2-(Va)_o^3/(V_{crit}^30.16^3)= \\ \\ \underline{\text{http://www.1728}} \\ \text{is the real solution } x=z-zv= \end{array}$	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248
Height above Ground z _{crit} +h _s	3,042.968	meters	9853.5	feet	Solve for x= for V=V _{crit} (i and d	=(z-z _v) simu m/s) using t a=1, c=0, a =[0.12F ₀ (6.2 give	$\label{eq:ansatz} \begin{array}{l} \text{if the could eqs. (i.e., '}, \\ \text{the cubic equation } ax^3 + bx^2 + c \\ \text{and } b=-(0.12F_o)/(V_{crit}^3 0.16^3) = \\ 25D-z_v)^2 - (Va)_o^3/(V_{crit}^3 0.16^3) = \\ \underline{\text{http://www.1728}} \\ \text{is the real solution } x = z - zv = \\ \text{or } z(m) = \\ \end{array}$	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348
Height above Ground z _{crit} +h _s Height above Ground z _{crit} +h _s	3,042.968 3,042.968	meters meters	9853.5 9983.5	feet feet	Solve for x= for V=V _{crit} (i and d	=(z-z _v) simu m/s) using t a=1, c=0, a =[0.12F _o (6.2 give ase:	$\label{eq:ansatz} \begin{array}{l} \text{in both eqs. (i.e., }\\ \text{ithe cubic equation } x^3 + bx^2 + c\\ \text{and } b=-(0.12F_o)/(V_{crit}^3 0.16^3) =\\ 25D-z_v)^2 - (Va)_o^3/(V_{crit}^3 0.16^3) =\\ \underline{\text{http://www.1728}}\\ \text{as the real solution } x = z-zv =\\ \text{or } z(m) =\\ z(ft) =\\ \end{array}$	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
ble of Plume Top-Hat Diameters (2a) and P	3,042.968 3,042.968 Iume-averag (meters)	ed Vertical V	9983.5 9983.5 /elocities sta Vert.	feet feet arting at en Plume	Solve for x= for V=V _{crit} (r and d	=(z-z _v) simu m/s) using t a=1, c=0, a =[0.12F _o (6.2 give ase:	$\label{eq:and_states} \begin{array}{l} \text{in both eqs. (i.e., }\\ \text{ithe cubic equation } x^3 + bx^2 + c\\ \text{and } b=-(0.12F_o)/(V_{crit}^3 0.16^3)=\\ & \underline{btp.}/(V_{crit}^3 0.16^3)=\\ & \underline{btp.}/(W_{crit}^3 0.16^3)=\\ & \underline{btp.}/(W_{crit}^3$	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
ble of Plume Top-Hat Diameters (2a) and P Height bove Ground Z _{crit} +h _s	3003.946 3,042.968 Iume-averag (meters) above stack	meters meters ed Vertical V Plume Radius(m)	/elocities sta Vert. Vel(m/s)	feet feet arting at en Plume Temp(K)	Solve for x= for V=V _{crit} (t and d d of jet pha	=(z-z _v) simu m/s) using t a=1, c=0, a =[0.12F _o (6.2 give	$\label{eq:andbackground of the qs. (i.e., the cubic equation ax^3+bx^2+c and b=-(0.12F_o)/(V_{crit}^30.16^3)= 25D-z_v)^2-(Va)_o^3/(V_{crit}^30.16^3)= http://www.1728.$ It is the real solution x = z-zv = or z(m) = z(ft) =	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
the regin above Ground z _{crit} +h _s Height above Ground z _{crit} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 1032.2	3,042.968 3,042.968 lume-averag (meters) above stack 274.99	ed Vertical V Plume Radius(m) 44.000	/elocities sta Vert. Vel(m/s) 0.80	feet feet arting at en Plume Temp(K)	Solve for x= for V=V _{crit} () and d:	=(z-z _v) simu m/s) using t a=1, c=0, a =[0.12F _o (6.2 give ase: Spillane E	Itlaneously in both eqs. (i.e., the cubic equation ax^3+bx^2+c and $b=-(0.12F_o)/(V_{crit}^30.16^3)=$ <u>http://www.1728.</u> is the real solution $x = z - zv =$ or $z(m) =$ z(ft) = Equations:	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
able of Plume Top-Hat Diameters (2a) and P Height dove Ground z _{citt} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 1032.2 1450.0	3,042.968 3,042.968 (meters) above stack 274.99 402.34	ed Vertical 1 Plume Radius(m) 44.000 61.315	/elocities sta Velocities sta Vert. Vel(m/s) 0.80 3.51	feet feet arting at en Plume Temp(K) 292.79	Solve for x= for V=V _{crit} () and d:	=(z-z _v) simu m/s) using t a=1, c=0, a =[0.12F _o (6.2 give ase: Spillane E V _{olume} =((Va) ₂	Itlaneously in both eqs. (i.e., ' the cubic equation ax^3+bx^2+c and $b=-(0.12F_0)/(V_{crit}^30.16^3)=$ $25D-z_v)^2-(Va)_3^3/(V_{crit}^30.16^3)=$ http://www.1728. is the real solution $x = z-zv =$ or $z(m) =$ z(ft) = Equations: $x^3-0.12F_n[(z-z_v)^2-(6.25D-z_v)^2]t^{1/3}/a$	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 1032.2 1450.0	3,042.968 3,042.968 (meters) above stack 274.99 402.34	ed Vertical V Plume Radius(m) 44.000 61.315 63.753	/elocities sta Vert. Vel(m/s) 0.80 3.51	feet feet arting at en Plume Temp(K) 292.79 292.64	Solve for x= for V=V _{orit} (t and d	=(z-z _v) simu m/s) using t a=1, c=0, a =[0.12F ₀ (6.2 give ase: V _{plume} ={(Va), a = 0.16(z-	ultaneously in both eqs. (i.e., ' the cubic equation $ax^3 + bx^2 + c$ and $b=-(0.12F_0)/(V_{crit}^3 0.16^3) =$ $25D-z_v)^2 - (Va)_o^3/(V_{crit}^3 0.16^3) =$ http://www.1728. is the real solution $x = z - zv =$ or $z(m) =$ z(ft) = Equations: $a^3 + 0.12F_0[(z-z_v)^2 - (6.25D-z_v)^2])^{1/3} / a$ z_v)	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 1032.2 1450.0 1500.0	3,042.968 3,042.968 (meters) above stack 274.99 402.34 417.58 432.82	meters meters ed Vertical \ Plume Radius(m) 44.000 61.315 63.753 66.102	/elocities sta Vert. Vel(m/s) 0.80 3.51 3.54	feet feet Plume Temp(K) 292.79 292.64	Solve for x= for V=V _{crit} (and d	=(2-Z _v) simu m/s) using t a=1, c=0, i =[0.12F ₀ (6,2 give ase: V _{plume} =((Va), a = 0.16(z- ge=c,1+t)	Itlaneously in both eqs. (i.e., ' the cubic equation $ax^3 + bx^2 + c$ and $b=-(0.12F_o)/(V_{cnt}^3 0.16^3) =$ $25D-z_v)^2 - (Va)_o^3/(V_{cnt}^3 0.16^3) =$ http://www.1728. is the real solution $x = z - zv =$ or $z(m) =$ z(ft) = z(ft) = $a^3 + 0.12F_o[(z - z_v)^2 - (6.25D-z_v)^2])^{1/3} / a$ $z_v)$ $(-G_o(P_0)^*(V_{cnv}) D^2/(4V_{cnv} - x^{2^k})$	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
able of Plume Top-Hat Diameters (2a) and P Height dove Ground z _{crit} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground <i>Top of jet</i> = 1032.2 1450.0 1550.0	3,042.968 3,042.968 (meters) above stack 274.99 402.34 417.58 432.82 449.05	meters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 88.890	/elocities sta Velocities sta Vert. Vel(m/s) 0.80 3.51 3.54 3.55	rting at en Plume Temp(K) 292.79 292.64 292.51	Solve for x= for V=V _{cnt} (t and d	$\begin{array}{l} = (z-z_{v}) \mbox{ simp } t \\ a=1, \ c=0, \ s, \\ = [0.12F_{o}(6.2)] \\ \mbox{ simp } t \\ $	$\begin{split} & ultaneously in both eqs. (i.e., \ \ \ (i.e., \ $	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
able of Plume Top-Hat Diameters (2a) and P Height dove Ground z _{crit} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground <i>Top of jet</i> = 1032.2 1450.0 1550.0 1600.0	3,042.968 3,042.968 (meters) above stack 274.99 402.34 417.58 432.82 448.06 462.20	meters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.000 71.000	/elocities sta Vel.(m/s) 0.80 3.51 3.54 3.55 2.55	teet feet arting at en Plume Temp(K) 292.79 292.64 292.21 292.40	Solve for x= for V=V _{cnt} (i and d	$\begin{aligned} &=(z-z_v) \mbox{ simu f} \\ &=1, \ c=0, \ s, \\ &=[0, 12F_0(6.2)] \\ &=[0, 12F_0(6.2)$	$\label{eq:constraints} \begin{split} & ultaneously in both eqs. (i.e., \ \ \ (i.e., \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
able of Plume Top-Hat Diameters (2a) and P Height above Ground z _{citt} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground <i>Top of jet</i> = 1032.2 1450.0 1500.0 1550.0 1600.0	3,042.968 3,042.968 'lume-averag (meters) above stack 274.99 402.34 417.58 432.82 448.06 433.00 473.51	meters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068	/elocities sta 9983.5 /elocities sta Vert. Vel(m/s) 0.80 3.51 3.54 3.55 3.56 3.56	rting at en Plume Temp(K) 292.79 292.64 292.51 292.40 292.30	Solve for x= for V=V _{ent} (and d	$=(2-Z_v) sim(m's) using t \\ a=1, c=0, i \\ a=1, c=0, i \\ a=1, c=0, i \\ a=0, 12F_0(6.2) \\ give \\ ase: \\ Spillane E \\ V_{plume}=(Va)_c \\ a=0.16(z-\theta_p=\theta_s(1+(1-\theta_p))) \\ a=0.16(z-\theta_p) \\ a=0.16($	$\begin{aligned} & Jltaneously in both eqs. (i.e., \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
able of Plume Top-Hat Diameters (2a) and P Height dove Ground z _{crit} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground <i>Top of jet</i> = 1032.2 1450.0 1550.0 1600.0 1650.0 1700.0	3,042.968 3,042.968 lume-averag (meters) above stack 274.99 402.34 417.58 432.82 448.06 463.30 478.54	ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.017	/elocities sta 9983.5 /elocities sta Ver(m/s) 0.80 3.51 3.54 3.55 3.56 3.56 3.56 3.56	rting at en Plume Temp(K) 292.79 292.64 292.51 292.40 292.30 292.21	Solve for x= for V=V _{ent} (and d	$\begin{aligned} &=(2\-Z_v)\ sim(m's)\ using t\\ &=1,\ c=0,\ s\\ &=[0.12F_0(6.2)\\ &give\\ &ase:\\ &\\ &\\ &se:\\ &\\ &\\ &\\ &se:\\ &\\ &\\ &\\ &\\ &\\ &\\ &\\ &\\ &\\ &\\ &\\ &\\ &\\$	ultaneously in both eqs. (i.e., , the cubic equation $ax^3 + bx^2 + c$ and $b=-(0.12F_0)/(V_{crit}^3 0.16^3)=$ 25D-z _v) ² -(Va) ₃ ³]/(V _{crit} ³ 0.16 ³)= http://www.1728.t es the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ +0.12F ₀ [(z-z ₁) ² -(6.25D-z ₁) ²]) ^{1/3} / a z _v) -(θ _e /θ _s))*(V _{exit} D ² /(4V _{plume} *a ²⁺ λ	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
able of Plume Top-Hat Diameters (2a) and P Height above Ground z _{crit} +h _s Height (feet) above ground <i>Top of jet</i> = 1032.2 1450.0 1550.0 1600.0 1650.0 1700.0	3,042.968 3,042.968 (meters) above stack 277.99 402.34 417.58 432.82 448.06 463.30 478.54 493.78	reters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.945	/elocities sta Vert. Vel(m/s) 0.80 3.51 3.54 3.55 3.56 3.56 3.56 3.56 3.56	feet feet feet rrting at en Plume Temp(K) 292.79 292.64 292.51 292.40 292.30 292.21	Solve for x= for V=V _{cnt} () and d	$\begin{array}{l} = (z - z_v) \; simum's) \; using t \\ a = 1, \; c = 0, \; s \\ = [0.12F_0(6.3, -12F_0(6.3, -12F_0(6.3$	Itlaneously in both eqs. (i.e., the cubic equation $ax^3 + bx^2 + c$ and $b = -(0.12F_0)/(V_{crit}^3 0.16^3) =$ 25D-z _v) ² -(Va) ₀ ³]/(V _{crit} ³ 0.163) = <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ +0.12F ₀ [(z-z _v) ² -(6.25D-z _v) ²]) ^{1/3} / a z _v) -(θ _e /θ ₅))*(V _{exit} D ² /(4V _{plume} *a ^{2*} λ	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
able of Plume Top-Hat Diameters (2a) and P Height dove Ground z _{crit} +h _s Height (feet) above ground <i>Top of jet</i> = 1032.2 1450.0 1500.0 1650.0 1650.0 1700.0 1750.0 1800.0	3,042.968 3,042.968 (meters) above stack 274.99 402.34 417.58 432.82 448.06 463.30 478.54 493.78 5-90.02	reters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.945 78.384	/elocities sta Vert. Vel(m/s) 0.80 3.51 3.54 3.55 3.56 3.56 3.56 3.56 3.55 3.55	feet feet feet Plume Temp(K) 292.61 292.40 292.30 292.21 292.13 292.06	Solve for x=r for V=V _{cnt} (t and d d of jet pha	$=(z-z_v) \ sim(m/s) \ using t$ $a=1, c=0, t = [0, 12F_0(6.3, 12F_0(6.3, 12F_0(6.3, 12F_0(6.3, 12F_0(6.3, 12F_0(6.3, 12F_0(12$	litaneously in both eqs. (i.e., the cubic equation $ax^3 + bx^2 + c$ and $b=-(0.12F_o)/(V_{crit}^3 0.16^3) =$ 25D-z _v) ² -(Va) _o ³]/(V _{crit} ³ 0.163) = <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = z(ft) = 2 gauations: ³ +0.12F ₀ [(z-z _v) ² -(6.25D-z _v) ²]) ^{1/3} / a z _v) -(θ _e /θ _b))*(V _{exit} D ² /(4V _{plume} *a ^{2*} λ	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5 2))))
able of Plume Top-Hat Diameters (2a) and P Height above Ground z _{crit} +h _s Height (feet) above ground <i>Top of jet</i> = 1032.2 1450.0 1550.0 1550.0 1650.0 1700.0 1750.0 1800.0 1850.0	3,042.968 3,042.968 (meters) above stack 274.99 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26	reters meters ed Vertical V Plume Radius(m) 44.000 61.315 66.192 68.630 71.068 73.507 75.945 78.384 80.822	/elocities sta Vert. Vel(m/s) 0.80 3.51 3.55 3.56 3.56 3.56 3.56 3.56 3.55 3.54 3.54	feet feet feet Plume Temp(K) 292.79 292.64 292.51 292.40 292.30 292.21 292.13 292.06 291.99 9	Solve for x=t for V=V _{cnt} (t and d d of jet pha	$=(z-z_v) \ sim(m/s) \ using t$ a=1, c=0, s $=[0.12F_0(6.3)]$ give ase: Spillane E $V_{plume}=(Va)_s$ $a=0.16(z-6)_{0}$ $\theta_p=\theta_s(1+(1))$	litaneously in both eqs. (i.e., the cubic equation $ax^3 + bx^2 + c$ and $b=-(0.12F_o)/(V_{crit}^3 0.16^3) =$ 25D-z _v) ² -(Va) _o ³]/(V _{crit} ³ 0.163) = <u>http://www.1728.</u> as the real solution x = z-zv = or z(m) = z(ft) =	Va and a) x+d=0, where -3006.2294 195964112 0rg/cubic.htm 2984.2248 3003.348 9853.5
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able of Plume Top-Hat Diameters (2a) and P Height above Ground z _{crit} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 1032.2 1450.0 1500.0 1550.0 1600.0 1650.0 1750.0 1800.0 1750.0 1750.0 1800.0 1950.0	3,042.968 3,042.968 above stack 274.99 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74	meters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.945 78.384 80.822 83.260 85.699	/elocities sta 9983.5 /elocities sta Vert. Vel(m/s) 0.80 3.51 3.54 3.55 3.56 3.56 3.56 3.56 3.55 3.55 3.52 3.52 3.52 3.52 3.52 3.52	feet feet feet Plume Temp(K) 292.79 292.64 292.51 292.40 292.30 292.21 292.13 292.06 291.99 291.94 291.94 291.88	Solve for x= for V=V _{ent} (i and d d of jet pha	$= (2-Z_v) sim(m's) using t a=1, c=0, s a=1, c=1, c=1, c=1, c=1, c=1, c=1, c=1, c$	$\label{eq:constraints} \begin{array}{llllllllllllllllllllllllllllllllllll$	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
able of Plume Top-Hat Diameters (2a) and P Height above Ground z _{citt} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground <i>Top of jet</i> = 1032.2 1450.0 1550.0 1550.0 1600.0 1550.0 1700.0 1750.0 1860.0 1750.0 1950.0 2000.0	3,042.968 3,042.968 above stack 274.99 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98	reters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.945 78.384 80.822 83.260 85.699 88.137	/elocities sta 9983.5 /elocities sta Vert. Vel(m/s) 0.80 3.51 3.54 3.55 3.56 3.56 3.56 3.56 3.56 3.56 3.56	feet feet feet rtring at en Plume Temp(K) 292.79 292.64 292.51 292.40 292.30 292.21 292.06 291.99 291.94 291.88 291.88	Solve for x= for V=V _{crit} () and d d of jet pha	$=(z-z_v) sim(m/s) using t$ a=1, c=0, s $=[0.12F_0(6.3) sim(v) sim($	altaneously in both eqs. (i.e., the cubic equation $ax^3 + bx^2 + c$ and $b=-(0.12F_0)/(V_{crit}^3 0.16^3)=$ 25D-z _v) ² -(Va) ₃ ³]/(V _{crit} ³ 0.16 ³)= http://www.1728. as the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ +0.12F ₀ [(z-z ₁) ² -(6.25D-z ₁) ²]) ^{1/3} / a z _v) -(θ _e /θ _s))*(V _{exit} D ² /(4V _{plume} *a ²⁺ λ	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
A mix riegin above Ground z _{crit} +h _s Height above Ground z _{crit} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground <i>Top of jet</i> = 1032.2 1450.0 1550.0 1550.0 1600.0 1550.0 1600.0 1770.0 1850.0 1850.0 1950.0 1850.0 1950.0 2000.0 2100.0	3,042.968 3,042.968 (meters) above stack 277.99 402.34 447.58 432.82 448.06 463.30 478.54 4493.78 509.02 524.26 533.50 554.74 569.98 600.46	reters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.945 78.384 80.822 83.260 85.699 88.137 93.014	/elocities sta 9983.5 /elocities sta Vert. Vel(m/s) 0.80 3.51 3.54 3.55 3.56 3.56 3.56 3.56 3.55 3.54 3.52 3.51 3.52 3.51 3.52 3.51 3.52 3.51 3.52 3.51 3.52 3.51 3.52 3.51 3.52 3.52 3.51 3.52 3.52 3.52 3.52 3.52 3.52 3.52 3.52	feet feet feet Tring at en Plume Temp(K) 292.79 292.64 292.51 292.40 292.30 292.21 292.13 292.06 291.99 291.94 291.83 291.75	Solve for x= for V=V _{cnt} () and d d of jet pha	$=(z-z_v) \ sim(m/s) \ using t$ a=1, c=0, s=0, s=0, s=0, s=0, s=0, s=0, s=0, s	altaneously in both eqs. (i.e., the cubic equation $ax^3 + bx^2 + c$ and $b=-(0.12F_0)/(V_{ent}^3 0.16^3)=$ 25D-z _v) ² -(Va) ₀ ³]/(V _{ent} ^3 0.163)= <u>http://www.1728.</u> as the real solution x = z-zv = or z(m) = z(ft) = z(ft) = 2 capacitons: a ³ +0.12F ₀ [(z-z _v) ² -(6.25D-z _v) ²]) ^{1/a} / a z _v) -(θ _θ (θ ₈))*(V _{exit} D ² /(4V _{plume} *a ^{2*} λ	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5 ²))))
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Interfergin above Stack Z _{crit} Height above Ground Z _{crit} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 1032.2 1450.0 1500.0 1550.0 1650.0 1770.0 1880.0 1900.0 2000.0 2100.0 2200.0 2200.0 2200.0 2200.0 2400.0	3,042.968 3,042.968 above stack 274.99 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90	reters meters ed Vertical V Plume Radius(m) 44.000 61.315 66.192 68.630 71.068 73.507 75.945 78.384 80.822 83.260 85.699 88.137 93.014 97.891 102.768	/elocities sta Vert. Vel(m/s) 0.80 3.51 3.56 3.56 3.56 3.56 3.56 3.55 3.56 3.55 3.54 3.53 3.52 3.51 3.49 3.40 3.40 3.40 3.40 3.40	feet feet feet Temp(K) 292.79 292.64 292.51 292.40 292.30 292.21 292.13 292.06 291.99 291.94 291.88 291.83 291.75 291.76 291.66	Solve for x=t for V=V _{cnt} (t and d d of jet pha	$=(z-z_v) \ sim(m/s) \ using t$ a=1, c=0, s $=[0.12F_0(6.3)]$ ase: $y_{pum}=(Va)_{a}$ $a=0.16(z-6)_{b}$ $=\theta_{p}=\theta_{s}(1+(1))_{b}$	litaneously in both eqs. (i.e., the cubic equation $ax^3 + bx^2 + c$ and $b=-(0.12F_o)/(V_{crit}^3 0.16^3) =$ 25D-z _v) ² -(Va) ₀ ³]/(V _{crit} ³ 0.163) = <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) =	Va and a) x+d=0, where -3006.2294 195964112 00g/cubic.htm 2984.2248 3003.348 9853.5 2))))
And rieght above Ground Z _{efft} Height above Ground Z _{efft} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 1032.2 1450.0 1500.0 1550.0 1660.0 1750.0 1750.0 1880.0 1900.0 2000.0 2000.0 2100.0 2200.0 2300.0 2400.0 2500.0	3,042.968 3,042.968 above stack 274.99 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 681.90 722.38	reters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.945 78.384 80.822 83.260 85.699 88.137 93.014 97.891 102.768 107.644 112.521	/elocities sta 9983.5 9983.5 9983.5 Vert. Vel(m/s) 0.80 3.51 3.54 3.55 3.56 3.56 3.56 3.56 3.55 3.55 3.55	feet feet feet Temp(K) 292.79 292.64 292.64 292.63 292.40 292.30 292.21 292.13 292.06 291.99 291.94 291.88 291.83 291.75 291.68 291.61 291.65 291.61	Solve for x= for V=V _{ont} (i and d d of jet phate 	$=(z-z_v) \ sim(m/s) \ using t$ a=1, c=0, t $=[0.12F_0(6.2)]$ see: $y_{pum}=((Va))$ a=0.16(z-0) $\theta_p=\theta_s(1+(1))$	litaneously in both eqs. (i.e., the cubic equation $ax^3 + bx^2 + c$ and $b=-(0.12F_o)/(V_{crit}^3 0.16^3) =$ 25D-z _v) ² -(Va) _o ³]/(V _{crit} ³ 0.16 ³) = <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) =	Va and a) x+d=0, where -3006.2294 195964112 00g/cubic.htm 2984.2248 3003.348 9853.5 2))))
And rieght above Ground Z _{crit} +hg Height above Ground Z _{crit} +hg able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 1032.2 1450.0 1550.0 1600.0 1550.0 1600.0 1750.0 1800.0 1900.0 2000.0 2100.0 2200.0 2300.0 2400.0 2500.0 2600.0	3,042.968 3,042.968 above stack 274.99 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90 722.38 752.86	reters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.945 78.384 80.822 83.260 85.699 88.137 93.014 97.891 102.768 107.644 112.521 117.398	9653.5 9983.5 9983.5 9983.5 Velocities sta Vert. Vel(m/s) 0.80 3.51 3.54 3.55 3.56 3.55 3.56 3.55 3.56 3.55 3.56 3.55 3.56 3.55 3.52 3.51 3.49 3.40 3.40 3.40 3.40 3.40 3.40 3.40 3.40	feet feet feet rting at en Plume Temp(K) 292.79 292.64 292.51 292.40 292.30 292.21 292.13 292.13 292.13 292.14 291.88 291.83 291.75 291.68 291.61 291.56 291.51 291.56 291.51 291.57	Solve for x= for V=V _{cnt} () and d d of jet pha	$=(z-z_v) sim(m/s) using t$ a=1, c=0, s $=[0.12F_0(6.3) sim(v) sim($	JItaneously in both eqs. (i.e., ' the cubic equation ax ³ +bx ² +c and b=-(0.12F ₀)/(V _{crit} ³ 0.16 ³)= 25D-z _v) ² -(Va) ₃ ³]/(V _{crit} ³ 0.16 ³)= http://www.1728.e the real solution x = z-zv = or z(m) = z(ft) = z(ft) = cquations: a ³ +0.12F ₀ [(z-z ₁) ² -(6.25D-z _v) ²]) ^{1/3} / a z _v) -(θ _e /θ _s))*(V _{exit} D ² /(4V _{plume} *a ²⁺ λ	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
Height above Ground Z _{crit} +h _s Height above Ground Z _{crit} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 1032.2 1450.0 1550.0 1600.0 1650.0 1770.0 1850.0 1850.0 1900.0 2000.0 2000.0 2000.0 2400.0 2500.0 2600.0 2700.0	3,042.968 3,042.968 (meters) above stack 277.99 402.34 447.58 432.82 448.06 463.30 478.54 4493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 669.98 600.46 630.94 661.42 691.90 772.38 752.86 783.34	reters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.945 78.384 80.822 83.260 85.699 88.137 93.014 97.891 102.768 107.644 112.521 117.398	9033.5 9983.5 9983.5 Velocities state Vert. Vel(m/s) 0.80 3.51 3.54 3.55 3.56 3.56 3.56 3.56 3.56 3.56 3.56 3.51 3.49 3.46 3.40 3.40 3.36 3.30 3.26	feet feet feet Tring at en Plume Temp(K) 292.79 292.64 292.51 292.40 292.30 292.41 292.40 292.43 292.64 291.99 291.94 291.88 291.65 291.61 291.51 291.47 291.43	Solve for x= for V=V _{cnt} () and d d of jet pha	=(z-z _v) simum/s) using t a=1, c=0, i =[0.12F ₀ (6 give ase: V _{plume} =((Va), a = 0.16(z- θ _p =θ ₀ (1+(1	JItaneously in both eqs. (i.e., ' the cubic equation ax ³ +bx ² +c and b=-(0.12F ₀)/(V _{ent} ³ 0.16 ³)= 25D-z _v) ² -(Va) ₀ ³]/(V _{ent} ³ 0.163)= http://www.1728. as the real solution x = z-zv = or z(m) = z(ft) = z(ft) = a ³ +0.12F ₀ [(z-z ₁) ² -(6.25D-z ₂) ²]) ^{1/3} / a z _v) -(θ ₀ /θ ₅))*(V _{exit} D ² /(4V _{plume} *a ^{2*} λ	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
Interfergin above Ground Z _{crit} +h _s Height above Ground Z _{crit} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 1032.2 1450.0 1550.0 1600.0 1600.0 1650.0 1775.0 1880.0 1850.0 2000.0 2100.0 2200.0 2300.0 2400.0 2500.0 2600.0 2700.0	3,042.968 3,042.968 (meters) above stack 277.99 402.34 417.58 432.82 448.06 463.30 478.54 449.78 509.02 554.74 539.50 554.74 569.98 600.46 630.94 661.42 661.90 722.38 752.86 753.34 813.82	reters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.945 78.384 80.822 83.260 85.699 88.137 93.014 97.891 102.768 107.644 112.521 117.398	963.5 9983.5 9983.5 Vert. Vel(m/s) 0.80 0.80 0.80 0.55 3.54 3.55 3.56 3.56 3.56 3.56 3.55 3.54 3.52 3.51 3.51 3.49 3.46 3.43 3.40 3.43 3.40 3.36 3.33 3.30 0.326 3.32	feet feet feet Temp(K) 292.79 292.64 292.51 292.40 292.30 292.21 292.40 292.30 292.91 292.40 292.41 292.43 291.99 291.94 291.88 291.61 291.61 291.65 291.51 291.43 291.43 291.43 291.43	Solve for x= for V=V _{cnt} () and d d of jet pha	=(z-z _v) simum/s) using t a=1, c=0, s =[0.12F ₀ (6.2, 12F ₀ (2,	JItaneously in both eqs. (i.e., ' the cubic equation ax ³ +bx ² +c and b=-(0.12F _o)/(V _{crit} ³ 0.16 ³)= 25D-z _v) ² -(Va) ³]/(V _{crit} ³ 0.16 ³)= http://www.1728. is the real solution x = z-zv = or z(m) = z(ft) = z(ft) = calculations: a ³ +0.12F _o [(z-z _v) ² -(6.25D-z _v) ²]) ^{1/3} / a z _v) -(θ _e /θ _b))*(V _{exit} D ² /(4V _{plume} *a ^{2*} A	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5 2))))
Height above Ground Z _{efft} +h _s Height above Ground Z _{efft} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 1032.2 1450.0 1500.0 1500.0 1600.0 1600.0 1650.0 1700.0 1750.0 1880.0 1950.0 2000.0 2100.0 2200.0 2300.0 2400.0 2500.0 2600.0 2700.0 2800.0 2000.0	3,042.968 3,042.968 (meters) above stack 274.99 402.34 417.58 432.82 448.06 463.30 478.54 443.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90 722.38 752.86 783.34 813.82 814.80 814.82 814	meters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.945 78.844 80.822 83.260 85.699 88.137 93.014 97.891 102.768 102.768 107.644 112.521 117.398	963.5 9983.5 9983.5 Vert. Vel(m/s) 0.80 3.51 3.55 3.56 3.55 3.56 3.55 3.55 3.56 3.55 3.52 3.51 3.52 3.51 3.52 3.51 3.52 3.51 3.52 3.53 3.54 3.55 3.54 3.52 3.51 3.52 3.52 3.51 3.52 3.53 3.54 3.55 3.54 3.55 3.54 3.52 3.53 3.54 3.54 3.54 3.54 3.54 3.54 3.53 3.54	feet feet feet Plume Temp(K) 292.79 292.64 292.51 292.40 292.30 292.21 292.30 292.21 292.30 292.91.99 291.94 291.88 291.61 291.55 291.68 291.61 291.51 291.43 291.43 291.40	Solve for x= for V=V _{ort} (I and d d of jet pha	=(z-z _v) simum/s) using t a=1, c=0, t =[0.12F ₀ (6.2000 - 12F ₀ (6.2000 - 12F ₀ (6.2000 - 12F ₀ (6.2000 - 12F ₀)) ase: Spillane E Spillane Spillane E Spillane Spillane E Spillane E Spi	JItaneously in both eqs. (i.e., ' the cubic equation ax ³ +bx ² +c and b=-(0.12F _o)/(V _{crit} ³ 0.16 ³)= 25D-z _v) ² -(Va) _o ³]/(V _{crit} ³ 0.16 ³)= http://www.1728. is the real solution x = z-zv = or z(m) = z(ft) =	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5 2))))
Height above Ground Z _{ent} +h _s Height above Ground Z _{ent} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 1032.2 1450.0 1500.0 1550.0 1650.0 1760.0 1750.0 1850.0 1900.0 1200.0 2000.0 2100.0 2200.0 <td>3,042.968 3,042.968 above stack 274.99 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90 722.38 752.86 783.34 813.82 843.30 87.72</td> <td>meters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.945 78.384 80.822 83.260 85.699 88.137 93.014 97.891 102.768 107.644 112.521 117.398 122.275 127.152 132.028</td> <td>Velocities sta Velocities sta Vert. Vel(m/s) 0.80 3.51 3.54 3.55 3.56 3.56 3.56 3.55 3.55 3.54 3.55 3.54 3.55 3.54 3.55 3.54 3.55 3.54 3.55 3.54 3.55 3.54 3.55 3.54 3.52 3.51 3.49 3.40 3.40 3.40 3.40 3.30 3.20 3.20 3.20 3.20 3.20 3.20 3.2</td> <td>feet feet feet Temp at en Plume Temp(K) 292.79 292.64 292.51 292.40 292.30 292.21 292.13 292.06 291.99 291.94 291.88 291.83 291.85 291.61 291.61 291.61 291.61 291.43 291.40 291.43 291.40</td> <td>Solve for x= for V=V_{ont}(I and d d of jet pha d d of jet pha d d d d d d d f jet pha d d d d d d d d d d f jet pha d d d</td> <td>$=(z-z_v) \ sim(m/s) \ using t$ a=1, c=0, s $=[0.12F_0(6.3)]$ ase: $y_{plume}=(Va)_{a}$ $a=0.16(z-6)_{b}$ $=\theta_{b}=\theta_{b}(1+(1))_{b}$</td> <td>JItaneously in both eqs. (i.e., ' the cubic equation ax³+bx²+c and b=-(0.12F_o)/(V_{crit}³0.16³)= 25D-z_v)²-(Va)_o³]/(V_{crit}³0.16³)= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: a³+0.12F_o[(z-z_v)²-(6.25D-z_v)²])^{1/3} / a z_v) -(θ_e/θ_b))*(V_{exit}D²/(4V_{plume}*a^{2*}λ</td> <td>Va and a) x+d=0, where -3006.2294 195964112 0rg/cubic.htm 2984.2248 3003.348 9853.5 2))))</td>	3,042.968 3,042.968 above stack 274.99 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90 722.38 752.86 783.34 813.82 843.30 87.72	meters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.945 78.384 80.822 83.260 85.699 88.137 93.014 97.891 102.768 107.644 112.521 117.398 122.275 127.152 132.028	Velocities sta Velocities sta Vert. Vel(m/s) 0.80 3.51 3.54 3.55 3.56 3.56 3.56 3.55 3.55 3.54 3.55 3.54 3.55 3.54 3.55 3.54 3.55 3.54 3.55 3.54 3.55 3.54 3.55 3.54 3.52 3.51 3.49 3.40 3.40 3.40 3.40 3.30 3.20 3.20 3.20 3.20 3.20 3.20 3.2	feet feet feet Temp at en Plume Temp(K) 292.79 292.64 292.51 292.40 292.30 292.21 292.13 292.06 291.99 291.94 291.88 291.83 291.85 291.61 291.61 291.61 291.61 291.43 291.40 291.43 291.40	Solve for x= for V=V _{ont} (I and d d of jet pha d d of jet pha d d d d d d d f jet pha d d d d d d d d d d f jet pha d d d	$=(z-z_v) \ sim(m/s) \ using t$ a=1, c=0, s $=[0.12F_0(6.3)]$ ase: $y_{plume}=(Va)_{a}$ $a=0.16(z-6)_{b}$ $=\theta_{b}=\theta_{b}(1+(1))_{b}$	JItaneously in both eqs. (i.e., ' the cubic equation ax ³ +bx ² +c and b=-(0.12F _o)/(V _{crit} ³ 0.16 ³)= 25D-z _v) ² -(Va) _o ³]/(V _{crit} ³ 0.16 ³)= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: a ³ +0.12F _o [(z-z _v) ² -(6.25D-z _v) ²]) ^{1/3} / a z _v) -(θ _e /θ _b))*(V _{exit} D ² /(4V _{plume} *a ^{2*} λ	Va and a) x+d=0, where -3006.2294 195964112 0rg/cubic.htm 2984.2248 3003.348 9853.5 2))))
Height above Ground Z _{ent} +h _s Height above Ground Z _{ent} +h _s able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 1032.2 1450.0 1550.0 1660.0 1660.0 1750.0 1800.0 1900.0 2000.0 <td>Jume-averag (meters) above stack 274.99 402.34 417.58 432.82 448.06 463.30 478.54 449.78 509.02 554.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90 722.38 752.86 783.34 813.82 844.30</td> <td>meters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.945 78.384 80.822 83.260 85.699 88.137 93.014 97.891 102.768 102.768 102.768 102.768 102.768 117.398 122.275 127.152 132.028 136.905</td> <td>963.5 9983.5 9983.5 Velocities sta Vert. Vel(m/s) 0.80 3.51 3.54 3.55 3.56 3.56 3.56 3.56 3.52 3.51 3.46 3.40 3.40 3.40 3.40 3.40 3.33 3.30 3.26 3.23 3.20 3.17</td> <td>feet feet feet rtring at en Plume Temp(K) 292.79 292.64 292.51 292.40 292.30 292.21 292.40 292.30 292.21 292.40 291.33 291.68 291.68 291.61 29</td> <td>Solve for x= for V=V_{ont}(I</td> <td>=(z-z_v) simu m/s) using t a=1, c=0, t =[0.12F₀(6.2 Spillane E Spillane E Spillane E (Va) a = 0.16(z- θ_p=θ_s(1+(1</td> <td>lifaneously in both eqs. (i.e., the cubic equation $ax^3 + bx^2 + c$ and $b=-(0.12F_0)/(V_{ent}^3 0.16^3)=$ 25D-z_v)²-(Va)₃³]/(V_{ent}³0.16³)= http://www.1728. as the real solution x = z-zv = or z(m) = z(ft) = z(ft) = 2quations: ³4-0.12F₀[(z-z₁)²-(6.25D-z₁)²])^{1/3}/ a z_v) -(θ_e/θ₆))*(V_{exit}D²/(4V_{plume}*a²⁺λ</td> <td>Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5 </td>	Jume-averag (meters) above stack 274.99 402.34 417.58 432.82 448.06 463.30 478.54 449.78 509.02 554.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90 722.38 752.86 783.34 813.82 844.30	meters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.945 78.384 80.822 83.260 85.699 88.137 93.014 97.891 102.768 102.768 102.768 102.768 102.768 117.398 122.275 127.152 132.028 136.905	963.5 9983.5 9983.5 Velocities sta Vert. Vel(m/s) 0.80 3.51 3.54 3.55 3.56 3.56 3.56 3.56 3.52 3.51 3.46 3.40 3.40 3.40 3.40 3.40 3.33 3.30 3.26 3.23 3.20 3.17	feet feet feet rtring at en Plume Temp(K) 292.79 292.64 292.51 292.40 292.30 292.21 292.40 292.30 292.21 292.40 291.33 291.68 291.68 291.61 29	Solve for x= for V=V _{ont} (I	=(z-z _v) simu m/s) using t a=1, c=0, t =[0.12F ₀ (6.2 Spillane E Spillane E Spillane E (Va) a = 0.16(z- θ _p =θ _s (1+(1	lifaneously in both eqs. (i.e., the cubic equation $ax^3 + bx^2 + c$ and $b=-(0.12F_0)/(V_{ent}^3 0.16^3)=$ 25D-z _v) ² -(Va) ₃ ³]/(V _{ent} ³ 0.16 ³)= http://www.1728. as the real solution x = z-zv = or z(m) = z(ft) = z(ft) = 2quations: ³ 4-0.12F ₀ [(z-z ₁) ² -(6.25D-z ₁) ²]) ^{1/3} / a z _v) -(θ _e /θ ₆))*(V _{exit} D ² /(4V _{plume} *a ²⁺ λ	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5
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Height above Ground Z _{efft} +h ₈ Height above Ground Z _{efft} +h ₈ able of Plume Top-Hat Diameters (2a) and P Height (feet) above ground Top of jet = 1032.2 1450.0 1550.0 1600.0 1550.0 1600.0 1650.0 1770.0 1750.0 1850.0 1850.0 1200.0 2000.0 <	3,042.968 3,042.968 (meters) above stack 277.99 402.34 417.58 432.82 448.06 463.30 478.54 443.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 661.90 772.38 752.86 783.34 813.82 844.30 874.78 1027.18 1179.58 1331.98	reters meters meters ed Vertical V Plume Radius(m) 44.000 61.315 63.753 66.192 68.630 71.068 73.507 75.945 78.384 80.822 83.260 85.699 88.137 93.014 97.891 102.768 107.644 117.398 102.768 107.644 117.398 102.768 107.644 117.398 102.768 107.644 117.398 102.768 107.644 117.398 102.768 107.644 117.398 102.768 107.644 117.398 102.768 107.644 117.398 102.768 107.644 117.398 102.768 107.644 117.398 102.768 107.644 117.398 102.768 107.644 117.398 102.768 107.644 117.398 102.768 107.644 117.398 102.768	9633.5 9983.5 9983.5 Vert. Velocities state 0.80 3.51 3.54 3.55 3.56 3.56 3.56 3.56 3.56 3.56 3.56 3.51 3.54 3.52 3.51 3.49 3.46 3.43 3.40 3.33 3.00 3.20 3.17 3.03 2.90 7 2.80	feet feet feet feet rtring at en Plume Temp(K) 292.79 292.64 292.71 292.30 292.21 292.30 292.21 292.30 292.91.39 291.94 291.88 291.61 291.61 291.61 291.63 291.51 291.43 291.34 291.34 291.34 291.34	Solve for x= for V=V _{ort} ((and d d of jet pha d d of jet pha d d d of jet pha d d d d d d d d d d d d d d d d d d d	=(z-z _v) simum/s) using t a=1, c=0, s =[0.12F ₀ (6.2, 12F ₀ (2,	JItaneously in both eqs. (i.e., ' the cubic equation ax ³ +bx ² +c and b=-(0.12F _o)/(V _{crit} ³ 0.16 ³)= 25D-z _v) ² -(Va) ₀ ³]/(V _{crit} ³ 0.16 ³)= http://www.1728. is the real solution x = z-zv = or z(m) = z(ft) = z(ft) = cauations: a ³ +0.12F _o [(z-z _v) ² -(6.25D-z _v) ²]) ^{1/3} / a z _v) -(θ _e /θ _b))*(V _{exit} D ² /(4V _{plume} *a ^{2*})	Va and a) x+d=0, where -3006.2294 195964112 org/cubic.htm 2984.2248 3003.348 9853.5 2 ²))))

	"The Evolut	ion of Movi-	num Hnduck	Snoode fe	Calm Corr	litions of h	arious Hoights in the Diverse	
	ine Evaluat	from - O	Turkin - D-	opecus IOF		uoon-l '		,
		from a Gas-	I urbine Pow	er Station a	at Oakey, Q	ueensiand,	Australia," Dr. K.I. Spilla	ne
mbient Conditions:					Constants:	Assume ne	eutral conditions (d0/dz=0 or	θ _a =θ _e)
Ambient Potential Temp θ _a	309.82	Kelvins	98.0	°F		0.3048	meters/feet	
lume Exit Conditions:					Gravity g	9.81	m/s ² Single Cell Values	
Stack Height hs	39.62	meters	130.0	feet	λ	1.11	32	#Cells
Effective Stack Diameter D	62.23	meters	204.15	feet	λο	~1.0	11.00	Diam(m)
Stack Velocity Vexit	3.30	m/s	10.83	ft/sec				
Volumetric Flow	10,035.50	cu.m/sec	21,270,042	ACFM	πV _{exit} D ² /4			Sect.2/¶1
Stack Potential Temp θ.	333.21	Kelvins	140.1	°F				
Initial Stack Buovancy Flux F	2,199,74	m ⁴ /s ³	42.1	°F Delta.T	αV _{avit} D ² (1-6	$\theta_0/\theta_0)/4 = V$	ol.Flow(α/π)(1-θ _a /θ _a)	Sect.2/¶1
Plume Buoyancy Flux F	2,1001/1	m ⁴ /c ³		1 Donai 1	$\lambda^2 \alpha / 2^2 (1 - A)$	/A) for a V	A at nume beight (see belo	w)
Fluine Buoyancy Flux F	IN/A	m /s			∧ gva (i-o	a/op)iora,v	,ep at plume neight (see belo	w)
onditions at End (Top) of Jet Phase:								-
Height above Stack z _{jet}	388.909	meters*	1275.9	feet*	$z_{jet} = 6.25L$), meters*=	meters above stack top	Sect.3/¶1
Height above Ground z _{jet} +h _s	428.529	meters	1405.9	feet				"
Vertical Velocity V _{jet}	1.650	m/s	5.41	ft/sec	V _{jet} = 0.5V	$_{exit} = V_{exit}/2$		
Plume Top-Hat Diameter 2ajer	124.451	meters	408.3	feet	2a _{jet} = 2D		Conservation of momentum	
billane Methodology - Analytical Solutions	for Calm Cone	ditions for P	ume Heiahts	above Je	Phase			
Single Plume-averaged Vertical Velocity	V given by Ar	alvtical Sol	ution in Pane	r where P	roduct Va	aiven by e	quations below:	
Plume Ton-Hat Padius a	s (19.100.12)	olutions in T	able Below		0 16(7-7)	or linear ind	rease with height	Sect 2/Eq.6
	40.000	motore*	45.0	foot*	6 2EDI4 (0	/0) ^{1/2} 1		Sect 2/Eq.6
virtual Source Height zv	13.898	meters"	45.6	ieet"	υ.∠ο⊔[1-(θ _€	yos)‴⁻j, met	ers =meters above stack top	0.0010
Height above Ground zv+hs	53.518	meters	175.6	reet		I	where $(\theta_a/\theta_s)^{1/2} = (\theta_e/\theta_s)^{1/2} =$	0.9643
Vertical Velocity V	S	olutions in T	able Below		{(Va) _o ³ + 0.	12F _o [(z-z	/) ² - (6.25D-z _v) ²]) ^(1/3) / a	Sect.2.1(6)
Product (Va)	99.003	m²/s			$V_{exit}D/2(\theta_e/$	θ _s) ^{1/2}		
Solve for plume-averaged vertical velo	city at height	1,500.0	feet	457.2	meters abo	ve ground (z'+h _s)	
Gives the following Height above Stack z	417.580	meters*	1370.0	feet*				
Plume Top-Hat Diameter 2a	129 178	meters	423.8	feet	2a'=2*0 16	(z'-z)		Sect 2/Eq.6
Vertical Velocity V	2 9/2	m/e	9.65	ft/sec	$V = I(V_2)^{3}$	0 12F [/7-7) ² -(6 25D-7) ²]) ^(1/3) /(22'/2)	Sect 2/Eq.6
Ventical Velocity V	2.342	11// 3	3.05	10360	v = 1(v a) ₀ +	0.121 0[(2-2)	(0.23D-20)]/ (2a/2)	0001.2/Eq.0
Colum for Unight of CACC critical continu		0.45						
Solve for Height of CASC critical vertical	Velocity V _{crit}	2.15	m/s plume-a	veraged v	ertical velo	ocity		
Find Height above Stack z _{crit}	6477.137	meters	21250.5	feet	Solve for x=	=(z-z _v) simu	ultaneously in both eqs. (i.e.,	Va and a)
Height above Ground z _{crit} +hs	6,516.757	meters	21380.4	feet	for V=V _{crit} (m/s) using t	he cubic equation ax ³ +bx ² +c	x+d=0, where
						a=1, c=0,	and b=-(0.12F _o)/(V _{crit} ³ 0.16 ³)=	-6484.4989
					and d	=[0.12F _o (6.1	$(25D-z_v)^2 - (Va)_o^3 / (V_{crit}^3 0.16^3) =$	888095619
					and d	=[0.12F _o (6.	25D-z _v) ² -(Va) _o ³]/(V _{crit} ³ 0.16 ³)= <u>http://www.1728</u> .	888095619 org/cubic.htm
					and d	=[0.12F _o (6.	$(V_{crit}^{3}, 0.16^{3}) = \frac{http://www.1728}{http://www.1728}$	888095619 org/cubic.htm 6463.2391
					and d	=[0.12F _o (6.) give	$(V_{crit}^{3} - (V_{a})_{a}^{3})/(V_{crit}^{3} - (V_{a})_{a}^{3}) = \frac{http://www.1728}{http://www.1728}$ is the real solution x = z-zv = or z(m) =	888095619 org/cubic.htm 6463.2391 6477 137
ship of Diumo Tan Hat Diamotors (2s) and					and d	=[0.12F _o (6.) give	$25D-z_v)^2 - (Va)_o^3/(V_{crt}^3 0.16^3) = \frac{http://www.1728.}{http://www.1728.}$ is the real solution x = z-zv = or z(m) =	888095619 org/cubic.htm 6463.2391 6477.137
able of Plume Top-Hat Diameters (2a) and I	Plume-averag	ed Vertical V	Velocities sta	rting at en	and d d of jet pha	=[0.12F _o (6.: give	$\frac{25D-z_v)^2 - (Va)_o^3 / (V_{cnt}^3 0.16^3) = \frac{http://www.1728.}{http://www.1728.}$ is the real solution x = z-zv = or z(m) = z(ft) =	888095619 org/cubic.htm 6463.2391 6477.137 21250.5
able of Plume Top-Hat Diameters (2a) and I Height (feet)	Plume-averag (meters)	ed Vertical \ Plume	Velocities sta Vert.	rting at en Plume	and d	=[0.12F _o (6. give	25D-z _v) ² -(Va) _o ³)/(V _{ctti} ³ 0.16 ³)= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) =	888095619 org/cubic.htm 6463.2391 6477.137 21250.5
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground	Plume-averag (meters) above stack	ed Vertical \ Plume Radius(m)	Velocities sta Vert. Vertmoverts	rting at en Plume Temp(K)	and d	=[0.12F _o (6. give	25D-z _y) ² -(Va) ₀ ³)/(V _{ctt} ³ 0.16 ³)= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(tt) =	888095619 org/cubic.htm 6463.2391 6477.137 21250.5
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground Top of jet = 1405.9	Plume-averag (meters) above stack 388.90	ed Vertical \ Plume Radius(m) 62.225	Velocities sta Vert. Vel(m/s) 1.65	rting at en Plume Temp(K)	and d	=[0.12F _o (6.) give ase: Spillane E	25D-z _v) ² -(Va) _o ³)(V _{crtt} ³ 0.16 ³)= <u>http://www.1728</u> , is the real solution x = z-zv = or z(m) = z(ft) = Equations:	888095619 org/cubic.htm 6463.2391 6477.137 21250.5
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground Top of jet = 1405.9 1450.0	Plume-averag (meters) above stack 388.90 402.34	ed Vertical V Plume Radius(m) 62.225 62.151	Velocities sta Vert. Vel(m/s) 1.65 2.48	rting at en Plume Temp(K) 315.70	and d	=[0.12F _o (6.) give ase: Spillane E V _{plume} ={(Va),	25D-z _v) ² -(Va) ₀ ³)(V _{crtt} ³ 0.16 ³)= <u>http://www.1728</u> , is the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ +0.12F _a [(z-z _v) ² -(6.25D-z _v) ²]) ¹³ / a	888095619 org/cubic.htm 6463.2391 6477.137 21250.5
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground Top of jet = 1405.9 1450.0 1500.0	Plume-averag (meters) above stack 388.90 402.34 417.58	ed Vertical N Plume Radius(m) 62.225 62.151 64.589	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94	rting at en Plume Temp(K) 315.70 314.41	and d	=[0.12F _o (6 give ase: Spillane E V _{plume} ={(Va), a = 0.16(z·	25D-z _v) ² -{Va ₀ ⁻³ }/{V _{crit} ³ 0.16 ³ } = <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ +0.12F ₀ [(z-z _v) ² -(6.25D-z _v) ²]) ^{1/3} / a z _v)	888095619 org/cubic.htm 6463.2391 6477.137 21250.5
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1550.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82	ed Vertical V Plume Radius(m) 62.225 62.151 64.589 67.027	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23	rting at en Plume Temp(K) 315.70 314.41 313.70	and d	=[0.12F _o (6 give ase: V _{plume} ={(Va), a = 0.16(z· θ _p =θ _s (1+(1	25D-z _v) ² -{Va ₀ ³ }/{V _{otti} ³ 0.16 ³ }= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ +0.12F ₄ [(z-z _.) ² -(6.25D-z _.) ²]) ^{1/3} / a z _v) -(6 ₀ /6 ₅)) ¹ (V _{ext} D ² /(4V _{otume} *a ² ^A)	888095619 org/cubic.htm 6463.2391 6477.137 21250.5
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1550.0 1550.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 48.06	ed Vertical V Plume Radius(m) 62.225 62.151 64.589 67.027 69.466	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.23	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22	d of jet pha	=[0.12F _o (6 give ase: Spillane E $V_{plume}=((Va))$, a = 0.16(z $\theta_p=\theta_s(1+(1))$	$\begin{split} 25D \cdot z_v)^2 - (Va_0)^3) (V_{crit}^{3}0.16^3) = \\ & \underline{http://www.1728.} \\ s the real solution x = z \cdot zv = \\ & or \ z(m) = \\ & z(tt) = \\ & z(tt) = \\ \hline \\$	888095619 org/cubic.htm 6463.2391 6477.137 21250.5
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1500.0 1550.0 1600.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 448.06 463.30	ed Vertical V Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.50	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22 312.86	and d	=[0.12F _o (6 give 3se: $V_{pluma}=(Va),$ $a = 0.16(z \cdot \theta_{p}=\theta_{s}(1+(1$	$25D \cdot z_y)^2 - (Va_0)^3 J (V_{crit}^3 0.16^3) = \frac{http://www.1728.}{http://www.1728.}$ is the real solution x = z-zv = or z(m) = z(ft) = Equations: 3 -0.12F ₀ ((z-z_y)^2-(6.25D \cdot z_y)^2)) ⁴⁵ / a z_v) -($^6\theta_0$))*(V_{exit}D^2/(4V_{plume}*a^{2*}))	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 21250.5
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1550.0 1600.0 1650.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 448.06 463.30 473.54	ed Vertical N Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22 312.86	and d	=[0.12F _o (6 give ase: $V_{plume}=(Va)$, $a = 0.16(z, b_p=\theta_s(1+(1$	$\begin{split} &25D \cdot z_v)^2 - (Va_0^3) (V_{crit}^3 0.16^3) = \\ & \underline{http://www.1728.} \\ & \text{is the real solution } x = z \cdot zv = \\ & or \ z(m) = \\ & z(ft) = \\ & z(ft) = \\ \hline \\ & \textbf{Equations:} \\ & \textbf{S}^{3} \cdot 0.12F_0 ((z \cdot z_v)^2 \cdot (6.25D \cdot z_v)^2))^{4/3} / a \\ & z_v) \\ & -(\theta_e/\theta_s))^* (V_{exit} D^2 / (4V_{plume}*a^{2*}A))^{1/3} = (2\pi)^{1/3} - (2\pi)^{1/3} + (2\pi)^{1/3} - (2\pi)^{1/3} + (2\pi)^{1/3} +$	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 2))))
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1550.0 1600.0 1650.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 448.06 463.30 478.54	ed Vertical V Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.97	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59 3.70	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22 312.86 312.58	and d	=[0.12F _o (6 give ase: Spillane E V _{pluma} =((Va), a = 0.16(z· θ _p =θ _a (1+(1	25D-z _v) ² -{Va ₀ ⁻³ }/{V _{exit} ³ 0.16 ³ }= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ -0.12F ₀ [(z-z _v) ² -(6.25D-z _v) ²]) ^{1/3} / a z _v) -(θ ₀ /θ _s))*(V _{exit} D ² /(4V _{plume} *a ^{2*} λ	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 ²))))
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1550.0 1600.0 1650.0 1700.0 1750.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 448.06 463.30 478.54 493.78	ed Vertical V Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.781	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59 3.70 3.70 3.79	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22 312.86 312.58 312.58	and d	=[0.12F _o (6 give ase: $V_{pluma}=((Va)),$ $a = 0.16(z - \theta_p = \theta_o(1+(1$	$25D \cdot z_{v})^{2} - (Va_{0}^{-3})/(V_{crit}^{-3}0.16^{3}) = \frac{1}{http://www.1728.}$ is the real solution x = z-zv = or z(m) = z(ft) = z(ft) = z(ft) = z(ft) = z(ft) = z(ft) = z_{v}	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 ²))))
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1550.0 1600.0 1600.0 1700.0 1750.0 1750.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02	ed Vertical V Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.781 79.219	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59 3.70 3.79 3.86	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22 312.86 312.58 312.34 312.54 312.54	and d	=[0.12F _o (6 give ase:	$25D \cdot z_{v})^{2} - (Va_{0}^{-3})/(V_{crit}^{-3}0.16^{3}) = \frac{1}{http://www.1728.}$ is the real solution x = z-zv = or z(m) = z(tt) = $z(tt) = \frac{1}{2}$ Equations: z_{v} $-(\theta_{v}\theta_{s}))^{*}(V_{exit}D^{2}/(4V_{plum.e}^{*}a^{2*}A))$	888095619 org/cubic.htm 6463.2391 6477.137 21250.5
able of Plume Top-Hat Diameters (2a) and 1 Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1500.0 1550.0 1650.0 1650.0 1700.0 1750.0 1800.0 1850.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 443.06 463.30 478.54 493.78 509.02 524.26	ed Vertical 1 Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.781 79.219 81.658	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59 3.70 3.70 3.79 3.86 3.91	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22 312.86 312.58 312.54 312.55 311.98	and d	$= [0.12F_{o}(6.)$ give ase: Spillane E $V_{plune}=((Va))$ $a = 0.16(z - \theta_{p} = \theta_{a}(1+(1$	25D-z _v) ² -{Va ₀ ⁻³ }/{V _{erit} ³ 0.16 ³ }= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ -0.12F ₀ [(z-z ₁) ² -(6.25D-z ₁) ²]) ^{1/3} / a z _v) -(θ ₀ /θ ₀))*(V _{exit} D ² /(4V _{plume} *a ^{2*} λ	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 21250.5
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1550.0 1600.0 1650.0 1750.0 1750.0 1750.0 1880.0 1880.0 1900.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50	ed Vertical N Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.781 79.219 81.658 84.096	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59 3.70 3.79 3.86 3.91 3.95	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22 312.86 312.58 312.58 312.34 312.15 311.88	and d	=[0.12F _o (6 give ase: Spillane E V _{plume} =((Va), a = 0.16(z- θ _p =θ _s (1+(1	25D-z _v) ² -{Va ₀ ⁻³ }/{V _{exit} ³ 0.16 ³ }= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ +0.12F ₀ [(z-z _v) ² -(6.25D-z _v) ²]) ^{1/3} / a z _v) -(θ _θ /θ _s))*(V _{exit} D ² /(4V _{plume} *a ^{2*} λ	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 2))))
able of Plume Top-Hat Diameters (2a) and 1 Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1500.0 1600.0 1650.0 1700.0 1750.0 1850.0 1850.0 1850.0 1850.0 1850.0 1900.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 448.06 463.30 478.54 4493.78 509.02 524.26 539.50 554.74	ed Vertical V Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.781 79.219 81.658 84.096 86.535	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59 3.70 3.79 3.86 3.91 3.95 3.99	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22 312.86 312.88 312.34 312.15 311.98 311.84 311.71	and d	=[0.12F _o (6 give ase: Spillane E V _{plume} =((Va) a = 0.16(z. θ _p =θ _s (1+(1	25D-z _v) ² -{Va ₀ ⁻³ }/{V _{exit} ³ 0.16 ³ }= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) =	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 ²))))
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1550.0 1560.0 1650.0 1700.0 1750.0 1880.0 1900.0 1950.0 2000 0 2000 0	Plume-averag (meters) above stack 388.90 402.34 417.58 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98	ed Vertical V Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.781 79.219 81.658 84.096 86.535 88.973	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.24 3.59 3.70 3.79 3.86 3.91 3.99 4.01	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22 312.86 312.58 312.54 312.15 311.98 311.84 311.71 311.60	and d	=[0.12F _o (6 give ase: $V_{pluma}=((Va)),$ $a = 0.16(z - \theta_p = \theta_s(1+(1$	25D-z _v) ² -{Va ₀ ⁻³ }/{V _{erti} ³ 0.16 ³ }= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ +0.12F ₄ (z-z.) ² -(6.25D-z.) ²]) ^{1/3} / a z _v) (-θ _e /θ _s))*(V _{exit} D ² /(4V _{plume} *a ²⁺ λ	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 ²))))
able of Plume Top-Hat Diameters (2a) and 1 Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1550.0 1550.0 1600.0 1750.0 1750.0 1750.0 1750.0 1880.0 1900.0 2000.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46	ed Vertical V Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.781 79.219 81.658 84.096 86.535 88.973 93.850 93.850	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59 3.70 3.79 3.86 3.91 3.95 3.99 4.01	rting at en Plume Temp(K) 315.70 314.41 313.70 312.28 312.86 312.54 312.54 312.54 312.54 312.54 311.84 311.60 311.40	and d	=[0.12F _o (6 give ase: Spillane E V _{plune} =((Va) a = 0.16(z- θ _p =θ _a (1+(1	25D-z _v) ² -{Va ₀ ⁻³ }/{V _{erit} ³ 0.16 ³ }= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ -0.12F ₀ [(z-z ₁) ² -(6.25D-z ₁) ²]) ^{1/3} / a z _v) -(θ _d /θ ₂))*(V _{exit} D ² /(4V _{plume} *a ^{2*} λ	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 21250.5 2)))
able of Plume Top-Hat Diameters (2a) and 1 Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1550.0 1650.0 1650.0 1750.0 1750.0 1800.0 1850.0 1900.0 1900.0 2000.0 2000.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46	ed Vertical 1 Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.781 79.219 81.658 84.096 86.535 88.973 93.850 0.0277	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59 3.70 3.79 3.86 3.91 3.95 3.99 4.01 4.04	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22 312.86 312.34 312.45 311.84 311.84 311.84 311.71 311.60 311.40	and d	=[0.12F _o (6 give ase: Σpillane E V _{plume} =(Va), a = 0.16(z- θ _p =θ _s (1+(1	25D-z _v) ² -{Va ₀ ⁻³ }/{V _{erit} ³ 0.16 ³ }= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ -0.12F ₀ [(z-z _v) ² -(6.25D-z _v) ²]) ⁴⁵ / a z _v) -(θ _e /θ _s))*(V _{exit} D ² /(4V _{plume} *a ^{2*} λ	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 2))))
able of Plume Top-Hat Diameters (2a) and 1 Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1550.0 1600.0 1600.0 1750.0 1750.0 1850.0 1850.0 1950.0 2000.0 2100.0 2200.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 448.06 443.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94	ed Vertical 1 Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.781 79.219 81.658 84.096 86.535 88.973 93.850 98.727 102 202	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59 3.70 3.79 3.86 3.91 3.95 3.99 4.01 4.04	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22 312.86 312.58 312.58 312.53 312.53 311.84 311.18 311.84 311.140 311.40 311.40	and d	=[0.12F _o (6 give sse: V _{plume} =[(Va) a = 0.16(z- θ _p =θ _s (1+(1	25D-z _v) ² -{Va ₀ ⁻³ }/{V _{exit} ³ 0.16 ³ }= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ +0.12F ₀ [(z-z _v) ² -(6.25D-z _v) ²]) ^{1/3} / a z _v) -(θ ₀ /θ _s))*(V _{exit} D ² /(4V _{plume} *a ^{2*} λ	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 2)))
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1550.0 1600.0 1700.0 1750.0 1800.0 1750.0 1880.0 1880.0 1850.0 2000.0 2100.0 2200.0 2300.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42	ed Vertical V Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.781 79.219 81.658 84.096 86.535 88.973 93.850 98.727 103.603	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59 3.70 3.79 3.86 3.91 3.95 3.99 4.01 4.04 4.06	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22 312.86 312.88 312.34 312.44 312.15 311.98 311.84 311.71 311.60 311.40 311.25 311.11	and d	=[0.12F _o (6 give ase: Spillane E V _{plume} =((Va) a = 0.16(z. θ _p =θ _s (1+(1	25D-z _v) ² -{Va ₀ ⁻³ }/{V _{exit} ³ 0.16 ³ }= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) =	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 2)))
Able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground Top of jet = 1405.9 1450.0 1550.0 1600.0 1650.0 1650.0 1650.0 1650.0 1650.0 1750.0 1850.0 1900.0 1900.0 2000.0 2100.0 2200.0 2300.0 2400.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90	ed Vertical V Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.781 79.219 81.658 84.096 86.535 88.973 93.850 98.727 103.603 108.480	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59 3.70 3.79 3.86 3.91 3.95 3.99 4.01 4.04 4.06 4.06	rting at en Plume Temp(K) 315.70 314.41 313.70 312.88 312.88 312.84 312.85 312.84 312.85 312.84 312.85 312.84 312.85 312.84 311.84 311.84 311.84 311.60 311.40	and d	=[0.12F _o (6 give ase: Spillane E V _{pluma} =((Va), a = 0.16(z; θ _p =θ _s (1+(1	25D-z _v) ² -{Va ₀ ⁻³ }/{V _{crit} ³ 0.16 ³ }= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ 40.12F ₂ [(z-z _.) ² -(6.25D-z _.) ²]) ^{1/3} / a z _v) (θ _θ /θ _s))*(V _{exit} D ² /(4V _{plume} *a ² h	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 2))))
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1550.0 1550.0 1600.0 1600.0 1750.0 1750.0 1750.0 1750.0 1750.0 1750.0 2000.0 2000.0 2200.0 2200.0 2200.0 2200.0 2200.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 448.06 463.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90 722.38	ed Vertical V Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.781 79.219 81.658 84.096 86.535 88.973 93.850 98.727 103.603 108.480 113.357	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59 3.70 3.79 3.86 3.91 3.95 3.99 4.01 4.04 4.06 4.06 4.06	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22 312.86 312.58 312.54 312.53 312.54 311.84 311.71 311.60 311.25 311.11 311.00 310.91	and d	=[0.12F _o (6 give ase: Σpillane E V _{plune} =((Va) a = 0.16(z- θ _p =θ _o (1+(1	25D-z _v) ² -{Va ₀ ⁻³ }/{V _{erit} ³ 0.16 ³ }= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ -0.12F ₀ [(z-z ₁) ² -(6.25D-z ₂) ²]) ^{4/3} / a z _v) -(θ ₀ /θ ₀))*(V _{exit} D ² /(4V _{plume} *a ^{2*} λ	888095615 org/cubic.htm 6463.2391 6477.137 21250.5 2)))
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground <i>Top of jet = 1405.9</i> 1450.0 1550.0 1550.0 1650.0 1650.0 1650.0 17700.0 17700.0 1850.0 1850.0 1850.0 1900.0 2000.0 2100.0 22000.0 2300.0 2300.0 2400.0 2500.0	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 448.06 443.30 478.54 493.78 509.02 524.26 539.50 554.74 569.98 600.46 630.94 661.42 691.90 722.38	ed Vertical 1 Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.781 79.219 81.658 84.096 86.535 88.973 93.850 98.727 103.603 108.480 113.357 118.234	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59 3.70 3.79 3.86 3.91 3.95 3.99 4.01 4.04 4.06 4.06 4.06 4.04	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22 312.86 312.34 312.58 312.34 312.58 312.58 312.54 311.84 311.71 311.60 311.40 311.25 311.11 311.00 310.91 310.82	and d	=[0.12F _o (6 give 3se: V _{plume} =(Va), a = 0.16(z- θ _p =θ _s (1+(1	25D-z _v) ² -{Va ₀ ⁻³ }/{V _{erit} ³ 0.16 ³ }= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ -0.12F ₀ [(z-z _v) ² -(6.25D-z _v) ²]) ^{4/2} / a z _v) -(θ _e /θ _a))*(V _{exit} D ² /(4V _{plume} *a ^{2*} λ	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 2))))
Able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground <i>Top of jet = 1405.9</i> 1450.0 1550.0 1550.0 1600.0 1650.0 1700.0 1700.0 17750.0 1850.0 1850.0 1850.0 2000.0 2100.0 2200.0 200	Plume-averag (meters) above stack 388.90 402.34 417.58 432.82 448.06 463.30 478.54 463.30 478.54 509.02 554.74 539.50 554.74 569.98 600.46 630.94 661.42 661.90 722.38 752.86 783.34	ed Vertical N Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.781 79.219 81.658 84.096 86.535 88.973 93.850 98.727 103.603 108.480 113.357 118.234 123.111	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59 3.70 3.79 3.86 3.91 3.95 3.99 4.01 4.04 4.06 4.06 4.06 4.06 4.04	rting at en Plume Temp(K) 315.70 314.41 313.70 313.22 312.86 312.58 312.58 312.58 312.58 312.54 312.53 311.84 311.71 311.60 311.40 311.41 311.00 310.82 310.75	and d	=[0.12F _o (6 give ase: Σpillane E V _{plume} =((Va), a = 0.16(z- θ _p =θ _s (1+(1	25D-z _v) ² -{Va ₀ ⁻³ }/{V _{exit} ³ 0.16 ³ }= <u>http://www.1728.</u> is the real solution x = z-zv = or z(m) = z(ft) = Equations: ³ -40.12F ₀ [(z-z _v) ² -(6.25D-z _v) ²]) ^{1/3} / a z _v) -{(θ ₀ /θ ₀))*(V _{exit} D ² /(4V _{plume} *a ^{2*})	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 2)))
able of Plume Top-Hat Diameters (2a) and I Height (feet) above ground <i>Top of jet</i> = 1405.9 1450.0 1550.0 1600.0 1650.0 1700.0 1750.0 1880.0 1790.0 1880.0 1990.0 2000.0 2100.0 2200.0 200.	Plume-a verag (meters) above stack 388.90 402.34 417.58 448.06 463.30 478.54 493.78 509.02 554.74 569.98 600.46 630.94 661.42 6691.90 722.38 752.86 783.34 813.82	ed Vertical V Plume Radius(m) 62.225 62.151 64.589 67.027 69.466 71.904 74.343 76.781 79.219 81.658 84.096 86.535 88.973 93.850 98.727 103.603 108.480 113.357 118.234 118.234	Velocities sta Vert. Vel(m/s) 1.65 2.48 2.94 3.23 3.44 3.59 3.70 3.79 3.86 3.91 3.95 3.99 3.99 4.01 4.04 4.06 4.06 4.06 4.06 4.04 4.03 4.01 3.99	rting at en Plume Temp(K) 315.70 314.41 313.70 312.88 312.88 312.84 312.85 312.84 312.85 312.84 312.85 312.84 312.85 312.84 311.84 311.84 311.84 311.84 311.85 311.84 311.00 310.81 310.82 310.75 310.75	and d	=[0.12F _o (6 give ase: Spillane E V _{plume} =((va) a = 0.16(z. θ _p =θ _s (1+(1	25D-z _v) ² -{Va ₀ ⁻³ }/{V _{exit} ³ 0.16 ³ }= http://www.1728. is the real solution x = z-zv = or z(m) = z(ft) =	888095619 org/cubic.htm 6463.2391 6477.137 21250.5 2))))
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