STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION
STATE OFFICE BUILDING HARTFORD, CONNECTICUT 06115

September 22, 1980

Mr. Marv Rosenstein
EPA Region I
JFK Federal Building
Boston, MA 02203

Dear Marv:

Attached is the additional documentation you requested for the DEP's New Source Ambient Impact Analysis Guideline. If you have any questions or would like more information please call me or Chuck Carlin at (203) 566-2690.

Very truly yours,

Mike

Michael K. Anderson
Senior Air Pollution
Control Engineer

MKA:er

Interdepartment Message

STO-201 REV 7/79 STATE OF CONNECTICUT
Stock No. 6938-051-01

SAVE TIME: *Handwritten messages are acceptable.*
Use carbon if you really need a copy. If typewritten, ignore faint lines.

To	NAME: Mike Anderson	TITLE: S.A.P.C.E.	DATE: 9/11/80
	AGENCY: Air Compliance Engineering	ADDRESS:	
From	NAME: Chuck Carlin CFC	TITLE: A.P.C.E.	TELEPHONE: 2690
	AGENCY: Air Compliance Engineering	ADDRESS:	

SUBJECT: DOCUMENTATION FOR AIA GUIDELINE

I have compiled some additional documentation for the Ambient Impact Analysis Guideline, per your request. The items are attached, and are described below.

Attachment #1 is a table of effective peak-to-mean ratios for 24-hour averages resulting from the use of PTMTPA-CONN. The least conservative ratio is that for D & F stabilities combined with the ± 15° wind spread. These can be compared to EPA recommendations of 0.4 for flat terrain and 0.25 (VALLEY) for elevated terrain.

Attachment #2 is a graphical depiction of our complex terrain plume flow convention compared to EPA's. Note that the only instance in which we are less conservative than EPA is with a tall stack, not much plume rise, and a hill nearly up to the top of the stack, all under non-stable conditions.

Attachment #3 is a table which indicates stack height and average plume rise (neutral stability, 4 meter per second winds) for 100-ton sources in Connecticut. Note that there are very few cases which combine a tall stack and minimal plume rise. Therefore, the situation detailed above (under Attachment #2) will most likely be rare.

CFC:er

ATTACHMENT #2

Overview of DEP Plume Path Adjustment Schemes

1) For $z < H/2$ and stabilities A through D:

$H' = H-z$

Thus, the DEP uses the CRSTER "full terrain subtraction" scheme for low hills for unstable and neutral conditions.

2) For $z > H/2$ and stabilities A through D:

$H' = H/2$

Thus, the DEP uses a "1/2 plume height stand-off distance" for moderate and high hills for unstable and neutral conditions.

3) For $z < H-10m$ and stabilities E and F:

$H' = H-z$

Thus, the DEP uses the CRSTER "full terrain subtraction" scheme for low and moderate hills for stable conditions.

4) For $z > H-10m$ and stabilities E and F:

$H' = 10m$

Thus, the DEP uses the VALLEY "10 meter stand-off distance" for high hills for stable conditions.

Where:
- m = meters,
- z = receptor elevation,
- H = original final effective plume height, and
- H'= adjusted plume height above the ground level at the receptor

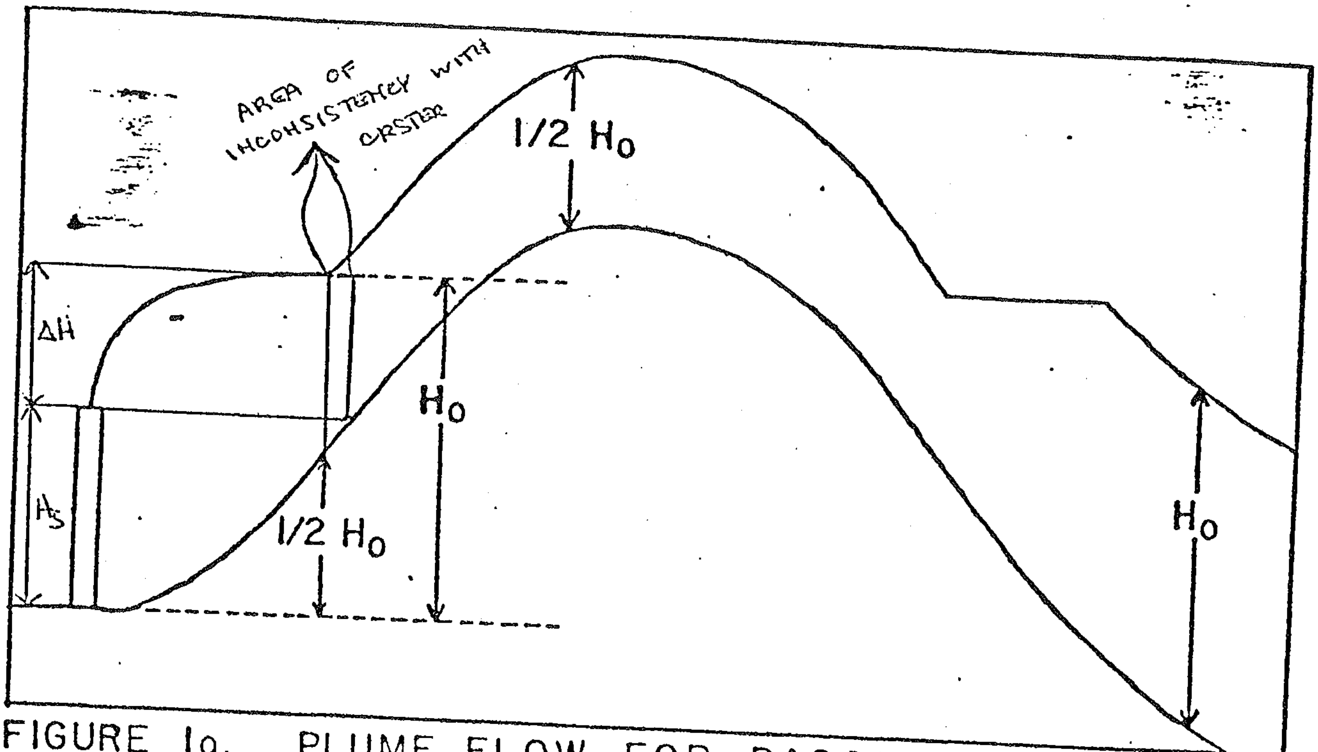


FIGURE 1a. PLUME FLOW FOR PASQUILL STABILITIES A,B,C,D. H_o = HEIGHT OF PLUME CENTER.

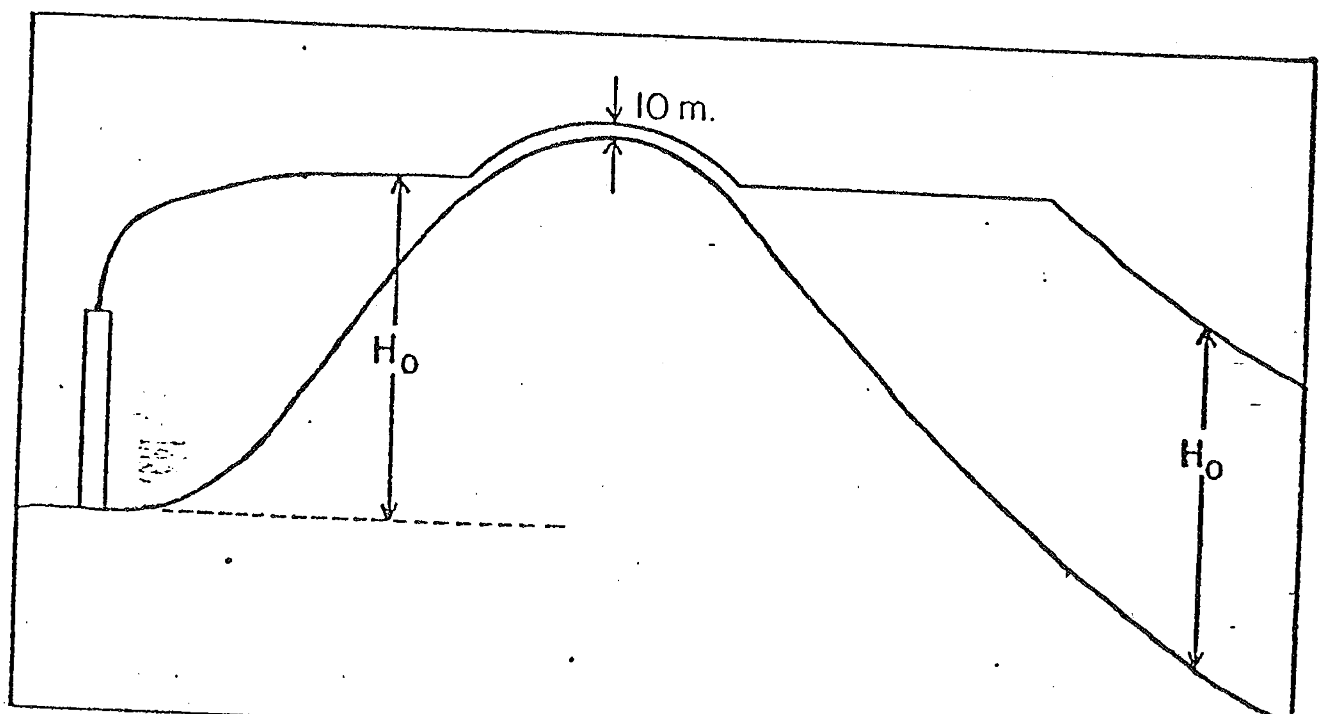
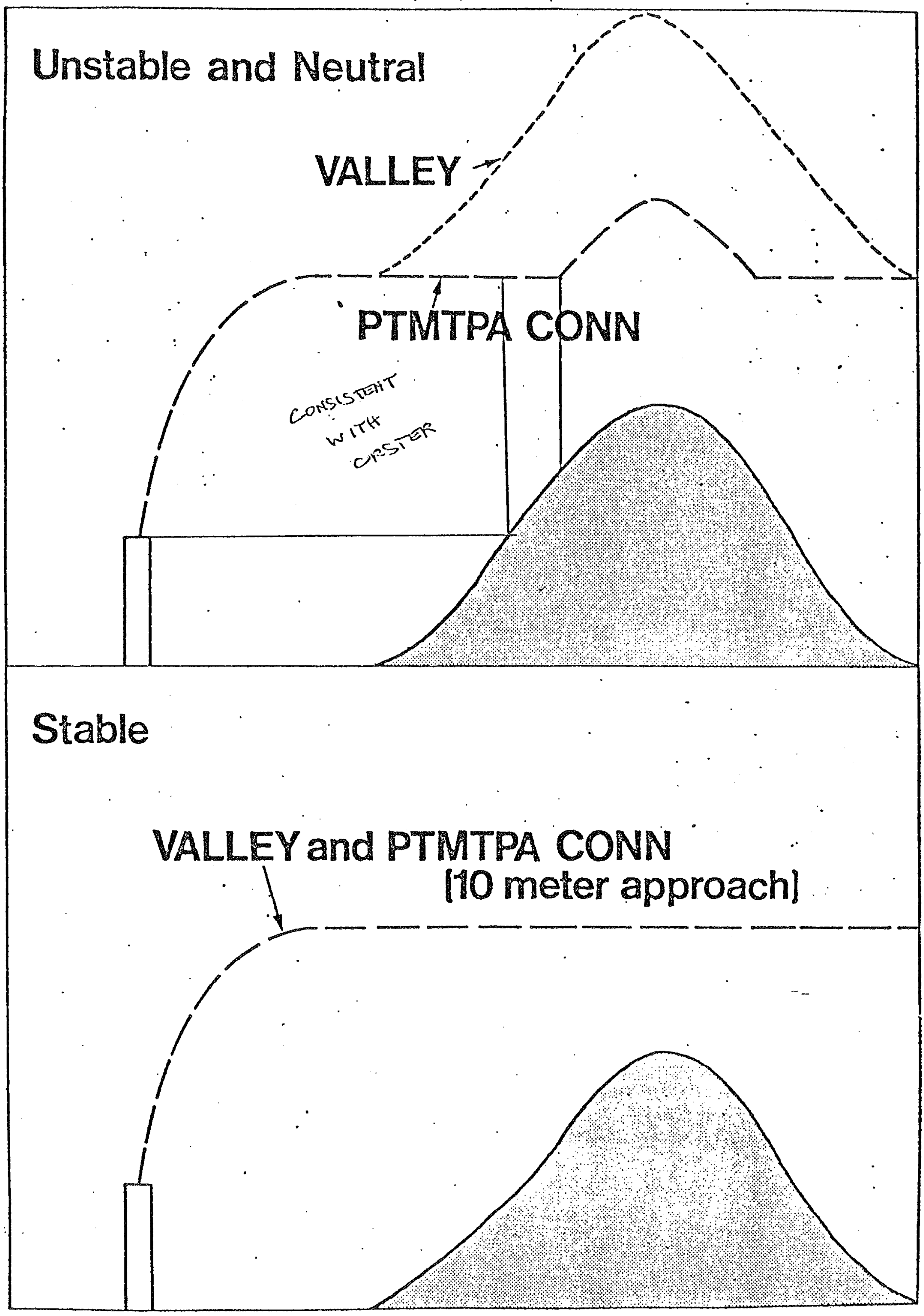
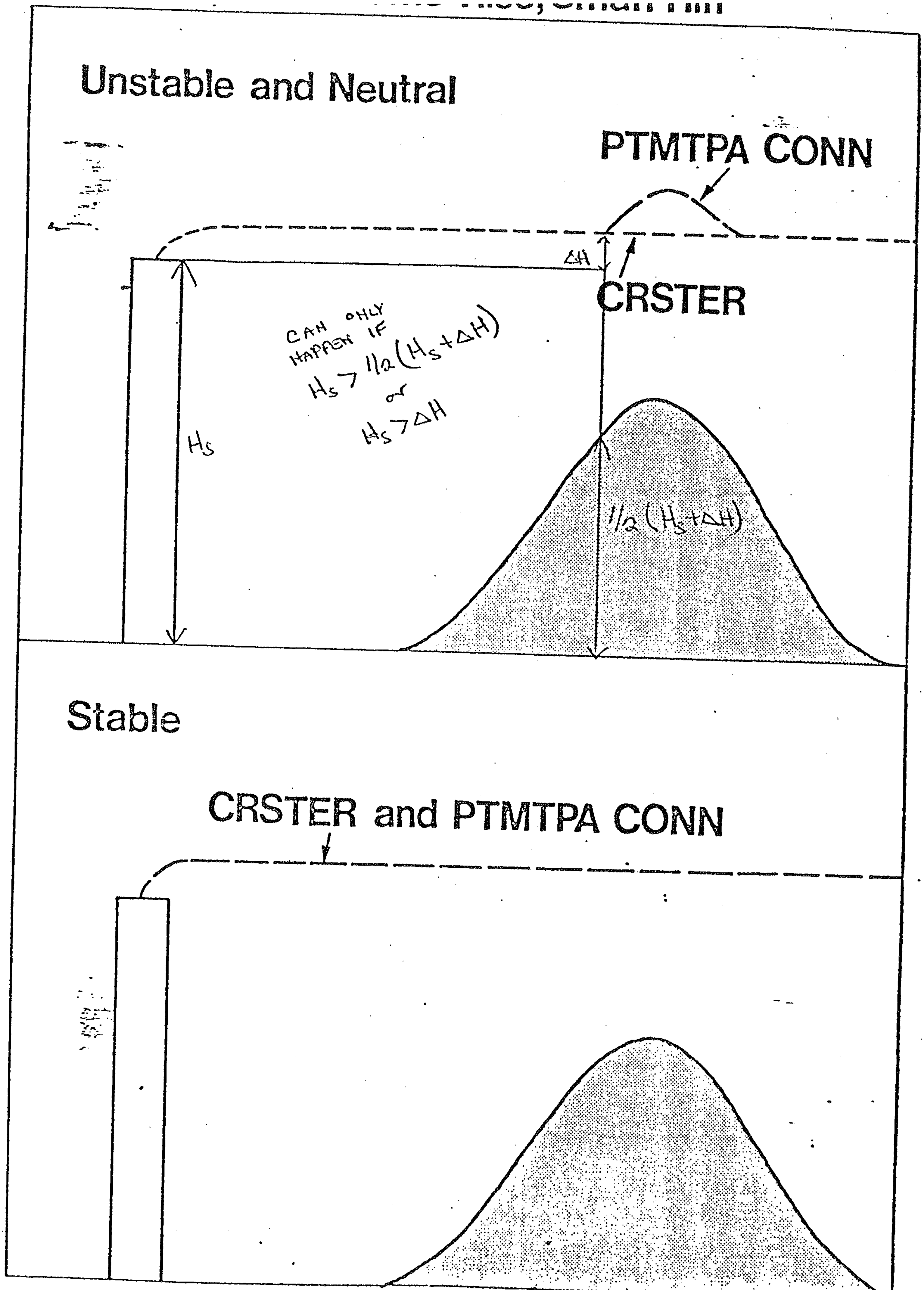


FIGURE 1b. PLUME FLOW FOR PASQUILL STABILITIES E,F. H_o = HEIGHT OF PLUME CENTER.

Short Stack, High Plume Rise, High Hill





Unstable and Neutral
PTMTPA CONN
ΔH
CRSTER
CAN ONLY HAPPEN IF
Hs > 1/2 (Hs + ΔH)
or
Hs > ΔH
Hs
1/2 (Hs + ΔH)
Stable
CRSTER and PTMTPA CONN

ATTACHMENT #3

TABLE STACK HEIGHT AND PLUME RISE FOR 100-TON SOURCES

COMPANY NAME	TSP T/Y	SO_x T/Y	STACK HEIGHT (FT)	ΔH (FT)
UI	73.5	1217.1	203	520
UI	121.2	2006.7	251	780
UI	307.2	5088.6	498	1850
GE	20.9	208.0	200	300
E. Htfd. Pub. Works	404.0	84.0	100	320
E. Htfd. Pub. Works	135.2	42.0	74	330
Pfizer, Inc.	51.4	410.8	200	460
Pfizer, Inc.	13.7	139.7	200	350
Pfizer, Inc.	15.0	325.6	200	265
Electric Boat	10.4	103.0	135	285
Naval Sub Base	26.1	259.6	185	225
Mnsfld Train. School	10.4	102.1	110	160
Uconn	11.3	109.4	154	380
Uconn	11.3	109.4	154	260
Int'l Silver Co.	14.8	147.3	120	120
P & WA	10.6	105.2	115	190
P & WA	10.4	103.0	115	190
Helco	10.1	143.4	266	530
Helco	76.6	1087.8	266	670
Helco	246.7	3604.8	266	1100
NEU Helco	162.2	1611.6	500	3300
CL&P	10.5	104.5	348 ← only one where $H_s > \Delta H$	200
CL&P	33.3	497.5	210	700
CL&P	9.3	134.2	210	610
CL&P	12.7	185.4	210	540
CL&P	34.6	516.6	210	670
CL&P	149.0	2213.6	330	1200
CL&P	35.9	534.0	250	700
CL&P	160.0	1588.8	400	3300
Uniroyal Chem.	12.7	126.0	175	205
Uniroyal Chem.	12.7	126.0	175	210
Stanley Works	12.9	115.9	200	400
Yale - Central Power Plant	12.0	119.2	125	460
Yale - Med. School	15.2	112.3	125	195
Simkins Ind.	28.7	284.7	150	155
UI - N.Haven Harbor	25.2	5008.5	389	1850
Kimberly Clark Corp.	12.4	123.6	103	-105
Fairfield Hills Hosp.	14.3	136.3	150	245
CL&P	363.2	5420.7	350	1450
City of Norwalk	121.5	66.0	140	330
Fed. Paper Board Co.	53.9	535.2	120	240
Stamford Mun. Incin.	70.2	117.0	170	750
Conn. Charcoal Co.	114.0	0.0	2	10
Century Brass	20.7	206.1	185	495
Century Brass	20.7	206.1	200	340
Combustion Engin.	40.4	192.0	140	245
Dexter Corp.	22.4	222.2	80	220

ATTACHMENT #2

Draft for Review
EPA Technical Report
March 1981

SENSITIVITY ANALYSIS OF SCREENING MODELS FOR COMPLEX TERRAIN

by

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SOURCES

The workshop panel had suggested that the stack heights of the point sources used in the sensitivity analysis be 1/4 of the final effective plume height. Michael Mills of Teknekron, Incorporated had recently participated in an analysis of a number of power and industrial plants, Mills (1979).* After consultation with him and consultation with other experts within EPA, it was decided that the suggestion by the panel regarding the relationship between stack height and plume rise would not have been typical of most power and industrial plants. Using Table 4 of Mills (1979), the low, medium, and tall source characteristics were selected and these are presented in Table 1.

TABLE 1. POINT SOURCE CHARACTERISTICS

Source type	Stack height (m)	Stack diameter (m)	Exit velocity (m/s)	Exit temperature (K)	Emission rate (g/sec)	Stable plume rise* (m)
Low	75	3	16	455	700	91
Medium	165	4	38	425	2,750	141
Tall	335	13	16	425	10,000	231

*assumed wind speed of 2.5 m/s, vertical temperature gradient of 0.035 K/m, ambient temperature of 293 K.

The light wind stable plume rise estimates presented in Table 1 were made using the Briggs plume rise equations as used in Valley, Complex II, and Complex I. These plume rise estimates suggest that the ratio of stack height to final effective plume height during very stable conditions range from 0.45 to about 0.60.

* "Data Bases for the Evaluation of Short-Range Dispersion Models" R-001-EPA-79, Teknekron, Inc., Waltham, Mass.

Plume Rise - Unstable & Neutral

① Low Source $H_s = 75m$

$V_f = 0.785\, V_s d^2 = 0.785(16)(3)^2 = 113.04$

$F = 3.12\, V_f \left(\frac{T_s - T}{T_s}\right) = (3.12)(113.04)\left(\frac{455-293}{455}\right) = 125.57$

$x^* = 34 F^{2/5} = 34(125.57)^{2/5} = 234.98$

final rise

$$\Delta H = \frac{1.6 F^{1/3} (3.5 x^*)^{2/3}}{u} = \frac{(1.6)(125.57)^{1/3}([3.5][234.98])^{2/3}}{u} = \frac{703.32}{u}$$

$\Delta H > H_s$ for $u < 9.38$ m/s

② Medium Source $H_s = 165$

$V_f = (0.785)(38)(4)^2 = 477.28$

$F = (3.12)(477.28)\frac{(425-293)}{(425)} = 462.50$

$x^* = 34(462.50)^{2/5} = 395.84$

final rise

$$\Delta H = \frac{(1.6)(462.50)^{1/3}([3.5][395.84])^{2/3}}{u} = \frac{1537.75}{u}$$

$\Delta H > H_s$ for $u < 9.32$ m/s

③ Tall Source $H_s = 335$

$V_f = (0.785)(16)(13)^2 = 2122.64$

$F = (3.12)(2122.64)\frac{(425-293)}{425} = 2056.91$

$x^* = 34(2056.91)^{2/5} = 719.06$

final rise

$$\Delta H = \frac{(1.6)(2056.91)^{1/3}([3.5][719.06])^{2/3}}{u} = \frac{3764.85}{u}$$

$\Delta H > H_s$ for $u < 11.24$

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY EPA Clearinghouse

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DATE: May 29, 1981

SUBJECT: CT New Source Ambient Impact Analysis Guideline

FROM: Marvin Rosenstein, Chief
Environmental Systems Group

TO: Lanny Deal and Dean Wilson
EPA Model Clearinghouse, OAQPS (MD-15)

THRU: Harley F. Laing, Chief
Air Branch

Enclosed please find the documentation we discussed on May 27, 1981, concerning the inconsistency between the CRSTER terrain technique and that used in the CT Modeling Guideline. As we understand things, OAQPS is only concerned with terrain lower than stack top under non-stable conditions.

The departure from the CRSTER technique under these conditions is only possible when the terrain height is greater than ½ of the effective plume height. When this occurs, the CT model lifts the plume over the terrain obstacle while the CRSTER model would continue with the constant plume height approach for terrain up to the stack top. These are inconsistent only when the stack height is greater than ½ of the effective plume height. This is equivalent to a requirement that the stack height be greater than the amount of plume rise. To summarize, there is an inconsistency with CRSTER only when the terrain is lower than stack top but greater than ½ of the effective plume height and the stack height is greater than the plume rise.

Region I discussed this inconsistency with the CT DEP prior to our approval of the CT guideline. In response to our concerns, CT DEP submitted Attachment #1. As the last table in this document clearly shows, the situation described above is very uncommon. Of the 47 stacks listed, only one has a stack height greater than the plume rise. The plume rise was calculated for non-stable conditions and a windspeed of 4 m/sec. As you agreed, it would not be proper to use infrequently occuring high windspeeds in these comparisons.

It is Region I's contention that almost all major buoyant sources will have stack heights less than the attendant plume rises. The chances of the reverse occuring are much too small to be of any practical concern. To look at this more closely, we have calculated in Attachment #2 the plume rise for representative low, medium and tall power and industrial plant stacks using "typical" plant parameters as given in the sensitivity analysis for the complex terrain screening models. Note that page 11 of this study mentions that the Regional Modeling Workshop had suggested a stack height to effective plume height ratio of ¼, well below our critical cut-off of ½ for the issue addressed here. The study points out that under stable conditions the ratio is on the order of .45 to .60. The workshop members were obviously relying on their experience for non-stable conditions when they suggested .25. In any case, ratios of less than 0.50 under non-stable conditions are certainly consistent with ratios of 0.45 to 0.60 for stable conditions.

The table below shows that under non-stable conditions the stack height to effective plume height ratio is always less than ½ for windspeeds less than the critical windspeeds listed. Note that there are no stacks in Region I that fall into the tall stack category.

Type	Stack Height (m)	Critical Windspeed (m/sec)
low	75	9.4
medium	165	9.3
tall	335	11.2

We believe this is convincing justification for approving the CT Modeling Guideline as currently written. The situation you are concerned with is plainly a rare phenomenon and not likely to occur for any new major sources. Please note that the CT Guideline does recognize the potential inconsistency with CRSTER but dismisses it on the basis of the information discussed above.

We are most anxious to resolve this issue. Please call us with your reactions to this material as soon as possible.