cpp.wp6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Research Triangle Park, North Carolina 27711

January 14, 1994

From: William H. Snyder, MD-81
Chief, Fluid Modeling Branch

To: John Irwin, MD-14
Chief, Applied Modeling Research Branch

Subject: Review of CPP Report on Wind Tunnel Modeling of Cape Industries Facility of Wilmington, NC

I have read the subject report, viewed the video tape, and herewith provide my comments per your request of December 4, 1993 (my apologies for being a few days late). My comments relate primarily to the question of the proper conduct of the wind-tunnel study, *i.e.* to the proper application of similarity criteria, techniques, *etc.*. I have made numerous marginal notes and summarize as follows:

1. Strict and proper similarity requirements include matching of plume buoyancy, so that a Froude number or buoyancy length scale would need to be matched between the model and full scale. This has not been done (*cf.*, page 3); CPP has ignored the plume buoyancy, matching only the momentum ratio and density ratio, which is allowed by Huber in his Guideline (EPA, 1981) as being (presumably) on the conservative side for determining GEP stack heights. The current study is not a GEP stack-height determination, *per se*, and therefore, it is not clear that non-rigorous matching of full-scale parameters should be allowed. (Indeed, it is not clear to me that non-rigorous matching for GEP determination should have been allowed in the first place.)

2. The reporting is quite sloppy, with myriad inconsistencies. One example is on page 3, where CPP states that the building Reynolds number should exceed 1000. I believed the number should read 11,000 and, therefore, thought it was a typographical error until I read it twice more on page 4. Another example: in the Reynolds-number-independence tests (page 5), they claim to have varied the building Reynolds number from 5232 to 17,440, a factor of 3.3, whereas the wind speed was varied by a factor of 2. Since no other parameters except wind speed were varied, the Reynolds-number range should have been directly proportional to the wind-speed ranges. Another example: Figure 4 shows the 2% wind speed to be measured at 20ft (6.1 m) AGL, whereas Tables A-* assign this wind speed at the 20 m (66 ft) elevation -- and they flip-flop between 20ft and 20 m in various places. Another example: Equation 8 is wrong as written, although the correct equation was apparently used in Figure 8. Another example: the log-law plotted on Figure 8 (the dashed line) is not correct - I have shown the correct curve using the

parameters supplied by CPP. Another example: the height of the spires is stated in the text (page B-3) as being 1.4 m, whereas Figure B-1 shows them as 1.52 m. Another: the size of the roughness blocks were stated as 2.54 and 10.16 cm in the text (page B-3), but shown as 5.08 and 10.16 cm on Figure B-1. Another: the roughness length was stated as being demonstrated to be 20 cm on page B-3, then to range from 3.3 to 12.1 cm on page B-5. They proceed to flip-flop back and forth on subsequent pages, seemingly using whatever value best fits the discussion at hand.

3. Details are woefully lacking. For example, what were the heights of the various structures? The views with and without nearby structures are frequently of little help because they were taken at different scales and from different angles (compare, for example views a and b of Figure 10d.). There is no way for the reader to check that the buildings removed were the proper ones. Supplying us all the details could turn out to be a nightmare, but some reasonable compromise must be possible. How about painting the portions to be removed with a different color?

4. The overall procedure and rationale are difficult for me to follow and understand. I find myself having to search back and forth, read between the lines, and make assumptions about this and that. On behalf of CPP, the site is exceedingly complex and difficult to describe.

5. In summary, I really cannot find much in the report to reject it outright, but I am absolutely nonplussed by it. With all the obvious errors, inconsistencies, and uncertainties, I am not confident in the results. It is not clear to me that they should be allowed to follow the procedures for a GEP demonstration when it is not such. CPP appears to have followed the formal required procedures, but to me they have done so following the "letter of the law" and not the "spirit of the law".

You also asked for my thoughts on some specific comments prepared by Dean Wilson and yourself.

1. Yes, I agree the title is a bit misleading. Further, its not clear to me why the shape of the equivalent building should be the same as that of the Huber & Snyder building (HxWxL = 1x1x2) or why that building should be oriented with broadside perpendicular to the wind. Seems to me that the jungle of irregular shapes of tanks, piping, structures, *etc.*, that were replaced by the equivalent building will, in general, behave much differently from the Huber/Snyder one (from a downwash viewpoint).

2. I cannot answer this question properly, but can only speculate that ISC modeling of the equivalent building under different stabilities is no worse than ISC modeling of the real structures under different stabilities; to my knowledge, the stability effects on the ISC downwash algorithm have not been properly verified.

3. I am not quite sure of your question, but I will say: I am confident that a carefully designed and well-executed study could provide conclusions that are substantially more tenable than those derived from application of ISC.

4. Seems to me that this question is your call - it is the same one I raised earlier. I simply reiterate that the relaxed similarity criteria allowed by GEP rules could be called into question.

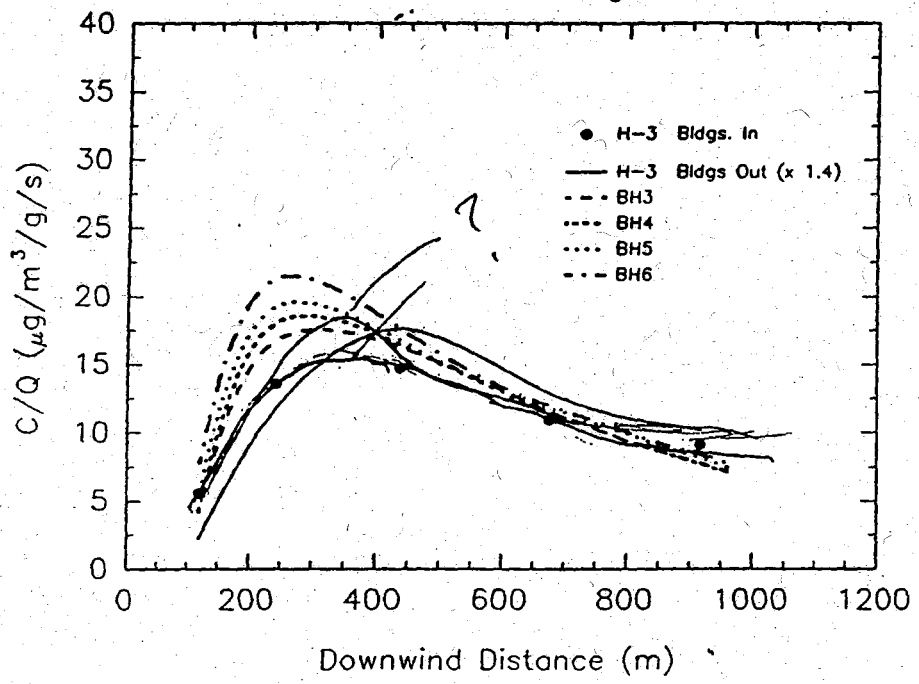
5. I agree that the "90% criterion" appears to be arbitrary. And I agree with your thinking all the way through this question. On the other hand, when we did the example GEP study for OAQPS, Joe Tikvart and Jim Dicke insisted that we demonstrate *the* stack height which resulted in a 40% excess concentration; it did not seem to matter that the data scattered by ± 10%, nor could we interpolate between two stack heights (*e.g.*, one that showed a 39% excess and another that showed a 41% excess)! A related question: How closely has CPP defined the maximum ground-level concentration? Only 5 sampling points are located downwind of the stack, and this number is clearly insufficient in many cases. I attach the figure from page G-1, where I have drawn 3 equally plausible curves through the set of 5 points (lower figure), yet the maximum glc's differ by 60%! Presumably, all the other curves have been derived from sets of 4 or 5 points. But, since the original data points are not shown, we are expected to trust CPP's judgement. Based on the remainder of the report, I am skeptical.

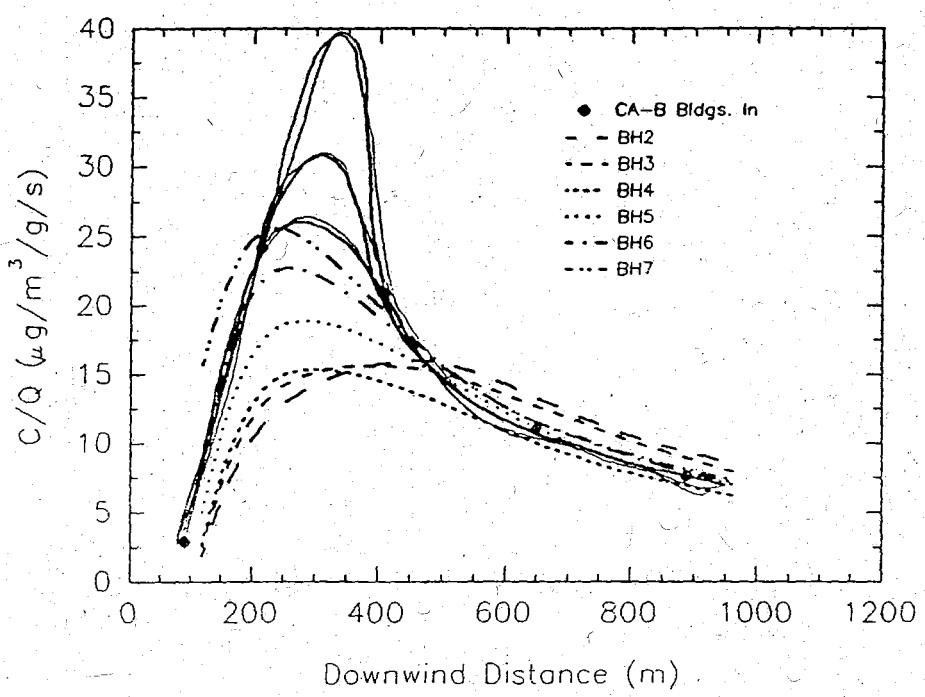
6. Agreed, B-3 is mislabelled on page iii.

7. Agreed, I complained about the lack of detail earlier.

8. I believe the location of the single solid structure is immediately upwind of the stack in question, with broad side perpendicular to the wind -- these solid buildings are not shown in the photographs. In fact, these solid buildings were never placed within the plant complex. They were, instead, placed within an area with enhanced roughness, presumably matching the roughness of the plant complex (see Figure 5, page 37).

Cape Industries
93-0955
Equivalent Building Height Tests
Wind Direction 0 Deg.





FY-94 MODEL CLEARINGHOUSE MEMORANDA

Date	Region	Subject
11/18/93	X	Building Wake Effects on Volume Sources at FMC Corporation
11/24/93	IV	CP&L Stack Height Increase
12/07/93	VI	Revised Technical Comparison Document--Phelps Dodge
01/19/94	IV	Test Proposal for Wind Tunnel Modeling of Plume Impact Under Stable Stratification for the Cane Run Station (CRS) in Louisville, Kentucky
02/02/94	IV	Wind Tunnel Report for Determining Equivalent Building Height Determinations for the Cape Industries Facility of Wilmington, North Carolina