UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

JUL 2 5 1994

MEMORANDUM

SUBJECT: Wind Tunnel Modeling Demonstration to Determine Equivalent Building Dimensions for the Cape Industries Facility, Wilmington, North Carolina

FROM: Joseph A. Tikvart, Chief
Source Receptor Analysis Branch, TSD (MD-14)

TO: Brenda Johnson, Regional Modeling Contact
Region IV

Douglas Neely, Chief
Air Programs Branch, Region IV

This memorandum is in response to your request for additional Model Clearinghouse input to the review of the wind tunnel modeling demonstration report[1] for the Cape Industries facility in Wilmington, NC. This also serves as a followup to Dean Wilson's February 2, 1994 memorandum to you. The February 2 memorandum contained comments from the Clearinghouse and also Dr. William Snyder, Chief of the Fluid Modeling Branch, on the wind tunnel report for the Cape Industries facility.

Subsequent to the February 2 memorandum, we received a request from Region V concerning the review of a wind tunnel modeling protocol to determine equivalent building dimensions. We also became aware that at least three other wind tunnel modeling protocols were being reviewed by a Regional Office or State agency. As a result, the Clearinghouse convened a conference call with the Regional Modeling Contacts to discuss technical issues pertinent to the review of the Cape Industries report and the other wind tunnel protocols. During the call, it was agreed to solicit technical questions and concerns from the Regional Modeling Contacts and appropriate State agencies concerning the technical review of the Cape Industries report and the wind tunnel protocols. Also, it was agreed that a meeting with you, other Environmental Protection Agency (EPA) technical staff, and the consultant developing the Cape Industries report

[1] Petersen, R.L., and B.C. Cochran, "Equivalent Building Height Determinations for Cape Industries Facility of Wilmington, North Carolina," Cermak Peterka, Petersen, Inc., Fort Collins, CO, CPP Project 93-0955, October 1993, prepared for Radian Corporation.

(Cermak, Peterka, Petersen, Inc.) would be useful to address these technical issues associated with reviewing the report.

Subsequent to the conference call, we received a list of technical issues from the Regional Offices and State agencies. These were discussed at the Regional/State Modelers Conference and a final list of issues was developed. A meeting was held with the consultant on June 8, 1994 to discuss these and other technical issues associated with the Cape Industries report.

In reviewing the Cape Industries report, it is important to note aspects of this study in context of the overall ambient air quality modeling analysis objectives. First, it is important to note that the wind tunnel study does not replace an ambient air quality analysis using a preferred air quality model (i.e., Appendix A of the Guideline on Air Quality Models (Revised)). Rather, the wind tunnel demonstration was used to develop appropriate building dimensions for input to the Industrial Source Complex (ISC2) model. Thus, the analysis is viewed as a source characterization study which generally has been considered under the purview of the Regional Office. As a result, the study is considered not subject to the requirements under Section 3.2 of the Guideline (i.e., Use of an Alternative Model).

Second, the purpose of the study is to develop appropriate direction-dependent "equivalent building dimensions" for input to the ISC2 model. The Cape Industries facility consists of lattice-type structures. Using standard techniques, Cape Industries would typically use the full structure height as building height in the ISC2 model. The Cape Industries report states that "this building height would tend to overestimate the downwash effect of the nearby lattice-type structures and as a result produce unrealistically high ground-level concentration estimates."[1] The first step in the wind tunnel study is therefore designed to simulate the actual direction-dependent dispersion from the sources with the actual lattice-type structures in place. This is done by measuring downwind ground-level concentration profiles. Next, the structures are removed from the wind tunnel and replaced with simplified solid structure more typical of the structure from which the ISC2 downwash algorithm was developed (i.e., "Huber-Snyder"). From this, the simplified structure which matches the concentration profiles with the site structures in place according to pre-determined criteria is selected for input to the ISC2 model. Provided the wind tunnel demonstration is technically sound, this seems to be a reasonable approach for deriving the building dimensions input to the ISC2 model.

Attachment 1 contains a list of the technical issues identified at the Modelers Conference and responses based on discussions from the June 8 meeting. These responses should be helpful in your review of the Cape Industries report. (Note that

Attachment 1 references Attachments 2, 3 and 4). Below are some additional comments concerning the technical issues described in Attachment 1.

Issue 1 addresses which structures to include in the wind tunnel modeling. Procedures used in past experiments are provided although no generic guidance can be provided at this time to cover all scenarios. As noted in Attachment 1, use of a uniform roughness across the entire tunnel floor seemed to be the simplest and a reasonable approach according to the meeting participants. However, it was noted that another approach might be to replace the actual site configuration on the turntable with a uniform characteristic surface roughness - similar to the approach used at Cape Industries. The issue of which structures to include/exclude in the tunnel demonstration for the equivalent building would need to be addressed on a case-specific basis.

Issue 2 addresses surface roughness in the wind tunnel. Surface roughness is important in the tunnel both in characterizing the upwind and downwind fetch from the site and characterizing the buildings removed in determining the equivalent building for the site. Based on experience gained thus far, larger magnitudes of surface roughness used in the tunnel simulations tended to yield larger equivalent building dimensions, other factors being equal.

Issue 3 describes the shape of the equivalent building. The wind tunnel demonstrations thus far are appropriate for building dimensions equivalent to "Huber/Snyder" type structures. That is, a structure with a crosswind dimension approximately double the building height. There are cases where this type of building when used in the wind tunnel simulations does not provide an adequate characterization of the ground-level concentrations. As noted in Attachment 1, one resolution for such cases might be to use Building Profile Input Program (BPIP) or some other equivalent technique to define the building dimensions for input into the ISC2 model.

Issue 9 addresses the criteria for demonstrating equivalency. Described are methods that have been suggested in previous protocols. As more experience is gained in these wind tunnel demonstrations, these criteria will likely continue to evolve. The criteria used for Cape Industries was to determine the equivalent building dimensions that yielded maximum ground-level concentrations in the wind tunnel within 10 percent of the maximum observed ground-level concentrations with the actual site buildings in place. You may wish to review these criteria for Cape Industries with the State and Cape Industries to evaluate the appropriateness of this approach.

Another issue not specifically listed in Attachment 1 is the use of zero equivalent building dimensions as input into the ISC2

model for wind directions where downwash is not expected to occur. Some wind tunnel protocols have a provision that if the increase in the wind tunnel simulated ground-level concentrations is less than 40 percent with the site structures in place as compared to the structures removed, then the building dimensions would be zero for input to the ISC2 model for that wind direction. This 40 percent is based on the procedures used in wind tunnel studies to derive Good Engineering Practice (GEP) stack height. It was suggested in the meeting that, to simplify the modeling demonstration, the equivalent building dimensions be identified for all wind directions independent of the increase in ground-level concentrations. These building dimensions could be determined either using BPIP or equivalent processors, guidance, or wind tunnel results, and allow the model to determine the effects on the predicted concentration values. It was noted however that this simplification may not likely change the conclusions from the ISC2 modeling. However, it seemed that this simplification may avoid unnecessary complexity in the wind tunnel simulation and subsequent regulatory agency review. In the case of Cape Industries where the 40 percent criterion was applied, results from the ISC2 modeling are not expected to change even if equivalent building dimensions were included for all directions.

At this time, it would be premature to provide generic guidance on how to conduct wind tunnel studies to determine equivalent building dimensions. Much of the information described thus far is based on recent experience and continues to evolve. Hopefully as more experience is gained in the review and application of wind tunnel demonstrations, more specific guidance can be provided. As a general comment, you may wish to suggest to your State agencies that prospective sources submit complete wind tunnel modeling protocols and receive approval by the State agency and Regional Office prior to initiating any wind tunnel modeling demonstrations.

We recommend that, if you think necessary, you meet with the State and perhaps the technical representatives for Cape Industries. Review the current results in light of the information provided and ascertain whether any additional clarification or studies are needed. We believe that this matter is best resolved at the Regional Office and State level.

If we can be of further assistance please contact me at (919) 541-5562 or Dennis Doll at (919) 541-5693.

Attachments

cc: D. Doll
J. Irwin

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
03/16/94	V	Air Quality Model Evaluation Protocol for Cyprus Northshore Mining Company
03/21/94	VIII	Denver Carbon Monoxide Attainment Demonstration
03/31/94	II	Green Island Resource Recovery Facility - Modeling Emission Inventory
05/17/94	V	Calculating Good Engineering Practice (GEP) Stack Height Due to Terrain Induced Downwash
06/13/94	VIII	Good Engineering Practice (GEP) Stack Height Credit for Montana Sulfur Company Sulfur Recovery Unit
07/25/94	IV	Wind Tunnel Modeling Demonstration to Determine Equivalent Building Dimensions for the Cape Industries Facility, Wilmington, North Carolina