Peer Review Comments on Contribution of Particle Emissions from a Cement-Related Facility to Outdoor Dust in Surrounding Community

Introduction

The report by the Environmental and Occupational Health Sciences Institute of Rutgers/UMDNJ on the study of the contribution of the St. Lawrence/Holcim facility to dust deposition in the Waterfront South neighborhood of Camden was submitted to external peer-review by the New Jersey Department of Environmental Protection.

Two questions were posed to the reviewers:
1. Are the methods used in this study appropriate to answer the question: To what extent does the St. Lawrence Cement facility contribute to the dust deposited in the Waterfront South area of Camden?
2. Do you agree with the overall conclusion of the report that the St. Lawrence Cement facility contributes about 10% of the dust deposited in the Waterfront South community? If not, can you identify a different conclusion from the data presented in the report?

Based on recommendations from scientists in the field of particulate modeling and source identification, two reviewers were initially selected. Gary Norris, Ph.D. of the USEPA-National Exposure Research Lab (NERL) and Patrick T. O'Shaughnessy, PhD, CIH, University of Iowa Department of Occupational and Environmental Health. Dr. Norris additionally requested that his EPA-NERL colleague, Rachelle Duvall, Ph.D. The comments of all three reviewers follow.

Comments of Dr. Gary Norris/Dr. Rachelle Duvall – USEPA-NERL

Alan,

Dr. Rachelle Duvall's review is in the following email. I had some additional comments:

1. List CMB profiles that were used in a table.
2. Discuss inorganic analytical methodology used by PACs and how it compared to the method used in this study. Also, report SRM recovery results.
3. Discuss the applicability of PACS profiles (coarse PM) to the size fraction evaluated in this study.
4. Discuss the MPIN matrix in more detail and provide the species for each source that were most influential in the CMB analysis.

Gary

Gary Norris, Ph.D.

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----- Forwarded by Gary Norris/RTP/USEPA/US on 06/05/2009 11:34 AM -----

Gary,
My feedback is below:

Rachelle
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1. *Are the methods used in this study appropriate to answer the question: To what extent does the St. Lawrence Cement facility contribute to the dust deposited in the Waterfront South area of Camden?*
The methods are appropriate for the study. Ambient and surface dust samples were collected in the area neighboring the cement facility. A sample from the cement pile was also collected to obtain a representative source profile for the cement facility dust. Source apportionment modeling was conducted using the EPA CMB 8.2 model and particle classification was determined with SEM.

2. Do you agree with the overall conclusion of the report that the St. Lawrence Cement facility contributes about 10% of the dust deposited in the Waterfront South community? If not, can you identify a different conclusion from the data presented in the report?
I do not agree with the conclusion. The model results indicated that the plant contributes on average 5-22% of outdoor dust. It seems like the value "10%" was arbitrarily selected. More justification is needed as to how the final value of 10% was deduced.

3. Additional Comments/suggestions/questions:
- Section 2.2: Was there a reason for selecting the summer/fall time frame for collecting dust samples? Are the wind patterns the same throughout the year?
- Section 2.4: Did you consider collected a road dust sample near the cement facility?
- Section 2.6: How many and which species were used in the CMB model for the study samples?
- Section 3.3: Tables 5, 6, and 7 should be labeled as Tables 6, 7, and

8, respectively.
- Section 3.5: Consider adding an unknown slice in the CMB contribution pie charts (Figure 8a and 8b). Since the Ferromanganese furnace contributions are so small, consider including this with the residual oil contribution slice (and indicating that ferromanganese furnance contribution is less than <1%). If you would like to keep the ferromanganese contribution separate change the contributions to "< 0.5%" on the pie charts (rather than 0 or 0.2%)and also change the color since it looks the same as the color for soil. What species were markers for each source?

Comments of Patrick T. O'Shaughnessy, PhD, CIH, Associate Professor, The University of Iowa Department of Occupational and Environmental Health
137 IREH, Oakdale Campus Iowa City, IA 52242

"O'Shaughnessy, Patrick T" <patrick-oshaughnessy@uiowa.edu> 5/20/2009 5:01 PM
Alan,
I am attaching my assessment of the report and the COI statement.
I did not identify myself on the report. If you would like the report on my letterhead, I can do that.
Patrick

1. Are the methods used in this study appropriate to answer the question: To what extent does the St. Lawrence Cement facility contribute to the dust deposited in the Waterfront South area of Camden?
I believe that the methods used in this study were appropriate to answer the question stated above. From reading the report I observed that the primary methods included:

- the use of “deposition” samplers to obtain approximately a month-worth of settled dust in the area of concern,
- surface-wipe sampling of horizontal surfaces in the area, and
- the use of a Chemical Mass Balance source-receptor model to determine the percent of all dust deposited in the area that can be attributed to the cement facility.

The primary result that 10% of the deposited dust originates from the facility is based on the CMB model results.

As indicated by the authors of the report, results obtained from the deposition samplers were the most accurate in terms of answering the question because the surface wipe samples contained dust from local sources such as paint flakes and metal oxides from rusting surfaces. Although not stated, certainly those samples would also be contaminated by organically derived dust sources such as tree and plant pollen. Therefore, the method of obtaining surface samples was appropriate but the authors were correct in not basing their overall conclusion on results obtained from the surface samples.

The methods used to analyze the deposition samplers were appropriate. The samplers themselves are a novel instrument, but have been previously tested by the authors. However the placement of those samplers was less than ideal. The best-case scenario would be to place them in areas with an unhindered view of the cement facility to negate local turbulence effects (building wake) that may either under- or over-represent the actual amount of dust originating from the facility. The authors indicated the need to make the samplers as inconspicuous as possible, which was reasonable given some losses (apparently via vandalism). However, the local "micro-climate" within which they were placed certainly added to the variability of their results.

The CMB modeling method is one that has been used extensively by the USEPA and, therefore, was an appropriate method to apply for this situation.

The question above asked whether the methods were "appropriate" for which I can say they were. However, in my estimation the methods may not have been entirely "adequate" to answer the question, or at least to best indicate the confidence in the final assessment.

The problem of apportioning sources of a pollutant (dry dust in this case) is hugely complex and will necessarily involve some level of estimation. The most "hypothetical" aspect of the CMB analysis was the use of a data set from another study conducted in Portland, Oregon to apply additional potential sources of dust to the model. Certainly, it would be naïve to think that the only source of dust is the cement facility, however an attempt to determine the adequacy of the data obtained from the Portland study should have been conducted and described. This analysis would result in a range of possible "source profiles" which would then result in a range of possible percent-contributions by the cement facility. The only indication of an attempt to indicate the potential variability of these estimates was the author's decision to assume an uncertainty of 10% for each element. Apparently this uncertainty level resulted in the variability seen in the results presented in Table 11. However, a justification for such a narrow range of uncertainty could not be found.

Furthermore, I felt that some analysis of local meteorological events occurring during the two sampling episodes, and for the area in general, should have been performed. The underlying assumption of this analysis is that the cement dust will disperse homogenously in all radial directions from the facility, i.e. a concentration profile of deposited dust from the facility will have a peak at the facility and radiate out in all directions with the same rate of decay. An analysis of wind directions and speeds during the sampling period, and averaged over several years would help to convince the reader that this is a fair assumption by showing a relatively random pattern of wind directions and speeds via a "wind rose". Such an analysis could also help to demonstrate the overall potential for dust from the raw cement material (RCM) pile to become airborne and thus contribute to downwind dust deposition. Although a highly-variable phenomenon, studies on the resuspension of dust from roads, deserts, and agricultural fields could be used to estimate the potential for resuspension given the RCM particle size distribution and local

wind velocities. For example, a basic assessment criteria is: if the wind velocities are never high enough to resuspend dust, and wind directions never are from facility to the community sampled, then it's impossible for the dust in that community to originate from the facility, and therefore 0% of the dust from the facility contributes to dust in the sampled area. An analysis of the potential for any condition other than that which would create this situation would have been helpful.

2. Do you agree with the overall conclusion of the report that the St. Lawrence Cement facility contributes about 10% of the dust deposited in the Waterfront South community? If not, can you identify a different conclusion from the data presented in the report?

The results from Table 11 demonstrate a range of RCM contribution to local dust loadings between 4.9% and 21.8%. Therefore, I agree that a general estimate of "about 10%" is possible from the results given.

As a caveat to that statement, it is unfortunate that the type of assessment performed does not allow for an indication of statistical confidence in that percentage, i.e. a p-value. It seems that this would have been possible if, for example, RCM dust had an easily-identifiable chemical "signature" that could distinguish those particles from all other particles analyzed via the SEM x-ray analysis procedure so that the percentage of RCM particles could be directly measured relative to all other particles. Given that calcium concentrations were discovered to show a relationship with downwind distance (Figure 6), it is interesting that an attempt of that sort was not made with calcium as the label for RCM dust given that the other sources would not typically consist of calcium (soil, marine aerosol, oil combustion, ferromanganese furnace). However, there must be more to this than suspected as I'm sure such an attempt would have been made if possible.

Lacking the data needed to obtain a confidence estimate, the next-best approach would be to obtain the result from a second, independent analysis. Admittedly, that may not have been possible. However, the use of the ISTS3 dispersion modeling technique was brought up (in the Results only, and, given their inclusion in the Conclusion statement, more information should have been provided in the body of the report) with estimated contributions ranging from 18.3% to 33.7%. These values were considered "reasonable" but were also considered very conservative whereas they appear to justify the upper level of the CMB results (~ 20%) rather than the CMB mid-range as suggested by the value of 10%.

In summary, the answer to the overall question of how much the cement plant contributes to local settled dust was determined with a combination of sampling (real values), modeling (estimates), and the expert judgment of the authors. Given the variability in the results, their final statement that the dust contribution is "probably on the order of 10%" reflects their judgment, which should be respected. However, given the combination of both CMB and dispersion modeling results, I would have erred toward the higher end, and ended the final sentence with the "outdoor dust is on average of <20%".

From: Alan Stern [mailto:Alan.Stern@dep.state.nj.us]
Sent: Tuesday, May 26, 2009 10:24 AM
To: O'Shaughnessy, Patrick T
Cc: Gary Buchanan
Subject: RE: Camden dust study report, charge questions and brief COI questionnaire

Patrick,

Thank you very much for your thoughtful review. It is exactly what we were hoping for. I have one question for clarification purposes.

You wrote:
"Given that calcium concentrations were discovered to show a relationship with downwind distance (Figure 6), it is interesting that an attempt of that sort was not made with calcium as the label for RCM dust given that the other sources would not typically consist of calcium (soil, marine aerosol, oil combustion, ferromanganese furnace). However, there must be more to this than suspected as I'm sure such an attempt would have been made if possible."

I believe the calcium-based analysis you were hoping to see is, in fact, presented in Table 9 and referenced in the text in discussion comparing that result to the CMB model results (you can find this by searching for "Table 9" in the text). Is that analysis what you were referring to? If so, I would appreciate it if you could take a quick look at it and if appropriate, add an addendum to your comments. If that is not what you were referring to, could you please briefly explain what, in addition to the analysis relating to Table 9 you would have liked to see with regard to the calcium-based analysis?

Again, my thanks for your time and effort.

Alan

Alan,
The comment of mine you are referring to is in reference to "an attempt" that I think could have been made to further clarify the percent of dust coming from the cement facility relative to all other sources that can contribute to the dust in the area (which I gathered was the main goal of the project). The other "attempt" would be to take samples of dust, apply them to an SEM stub and then systematically analyze the individual particles for Calcium via x-ray spectroscopy (EDX). The calcium would serve as a marker for RCM-derived dust so that the ratio of calcium containing dust particles to non-calcium-containing particles would provide an additional method for determining the percent of total dust attributed to the cement facility.

Therefore, my comment about calcium was to suggest that of all elements that could be identified as originating from the plant, calcium seemed to be the most obvious, especially if there are no other obvious sources for calcium-containing particles in the

area. The authors may argue that such an analysis would not provide meaningful results if there truly are too many other sources for calcium. The Table 9 data does indicate that there is certainly calcium in the "background" dust (however, it appears that background was measured in an area south of the source that could still be impacted by the source). The other issue is that such an analysis would be very expensive and require and SEM-EDX system with an automated processing system. The RJ Lee Group, for example has the capability. So, I made this comment but allowed for the fact that the people on the ground probably thought of this option and new of good reasons to opt against doing it. Hope this helps. You can give me a call if desired.
Patrick

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