Preliminary Comments on the REA Planning Document from Dr. Steven Hanna

Note that my expertise is primarily in atmospheric transport and dispersion modeling and analysis of observed concentrations, and my comments focus on those areas. I was asked to comment on the areas related to "Ambient Air Concentrations", and focus on three specific topic areas copied below in bold italics.

First I have a couple of general requests:

i) Please explain why the 5 minute SO_2 standard is being proposed by the EPA versus the existing WHO SO_2 10 minute standard. Why the difference?

ii) Please explain why my previous suggestions were not followed regarding better use of the literature and existing methods for estimating peak to mean concentrations and space and time variability of concentrations (the EPA work on 5 min vs 60 min peak concentrations appears to have been done without a general review of the topic).

Ambient Air Concentrations Topic Area 1. The use of an AERMOD model-based approach to predict hourly concentrations at all receptor locations within selected study areas [Sections 3.3.2, 4.1.3.3]

Hanna response: I agree that, of the existing recommended suite of EPA air quality models, AERMOD is best and that AERMOD has a basic averaging time of one hour. CMAQ is certainly not applicable. However, line 4 of p 3-7 suggests that a comprehensive review has been done. If that had happened, they would have discovered that most dispersion models used by other agencies can easily model smaller averaging times such as 5 minutes. SCIPUFF is a good example, and I thought that SCIPUFF/SCICHEM was on EPA's list. From a basic science viewpoint (see dispersion texts by Pasquill, Stull, Arya, etc) the models for industrial sources can apply to any averaging time. What is needed is parameterization of how turbulence and turbulence scales vary with averaging time, and this is known and parameterized in models such as SCIPUFF. AERMOD includes these parameterizations in order to provide required turbulence inputs.

On 16 March, I confirmed the above facts during phone calls with Jeff Weil, former leader of the AERMIC group that developed AERMOD, and Akula Venkatram, former member of AERMIC who developed many of the AERMOD algorithms. I suggest that a subcommittee be formed to advise EPA on these key scientific facts.

I also asked David Carruthers, ADMS developer (in the UK), and he replied that ADMS has adjustments to plume width to account for varying averaging times (less than 1 hr). ADMS is the equivalent of AERMOD and is widely used as a regulatory model in Europe and Asia.

All plume dispersion experts agree that the ratio of 5 min to 1 hr peak concentration is dependent on stability (i.e., time of day and wind speed and cloudiness) and on nearness to major point sources or industrial complexes.

The estimation of 5 min values described in section 4.3.3 should also incorporate scientific knowledge

By the way, we feel that the EPA allegation (e.g., line 6 of section 4.1.3.3) that AERMOD is fine for showing spatial variability but does not show time variability is not correct and is at odds with our basic science concepts. Network observations and model simulations verify a large diurnal variability in SO_2 concentrations.

As described on p 4-18, it is a good idea the evaluate the model predictions with the 1 hr and 5 min observations. However, the 1992 EPA model performance measures have been revised as described in the 2005 AERMOD evaluation report and journal article.

p 4-18, first sentence of second paragraph – As described above, we recommend that this purely-statistical and arbitrary approach be enhanced by revising AERMOD to calculate 5 minute concentrations, following existing methods in SCIPUFF, ADMS, and most other dispersion models used across the globe. AERMOD already has the basic turbulence parameterization formulas and they can be easily modified to allow for averaging times other than 1 hr.

p 4-19 top half of page – Here too there is a need to use existing basic science concepts. Maybe the basic science approach does not give significantly different improvements over the arbitrary statistical approach. But the comparison exercise should be used to demonstrate this.

Ambient Air Concentrations Topic Area 2. The use of SO_2 measurements at ambient air monitors within and near the study areas to estimate 5-minute concentrations, where appropriate (e.g., filling missing values for AERMOD hourly predictions) [Sections 3.3.1, 4.1.3.1, 4.1.3.2]

My main comment on this has already been stated in my general request ii at the beginning. In scientific studies, it is required that the existing literature first be reviewed. Gifford (1960), Slade (1968) and Turner (1970) all discuss observations of peak concentration variation with averaging time and propose some simple formulas. Ralph Larsen (career employee of EPA) spent decades studying this topic and published many papers. The literature from 50 years ago suggests that, on average, peak concentration is inversely proportional to averaging time (T_a) to the 1/5 power. Thus peak C (5 min)/peak C (1 hr) would be about 1.6. In the current report, the EPA should have first reviewed the literature (inside and outside EPA), then describe where the existing methods are not appropriate, then justify why an alternate method is being used. Finally, the estimates of the new method should be compared with those of the old methods.

Section 4.1.3.2 addresses estimating missing values in the air monitoring data. This problem often comes up in all fields of environmental study. However, in the atmosphere, there is a need to preserve known correlations in space and time, and these are followed in several EPA analyses that I have reviewed. But I do not see those principles being followed here. For example, persistence or linear interpolation are usually assumed if there are only a few missing data. If available observations are indicating a high-pollution afternoon, then any missing data are likely to be high too. The current EPA report's method seems to go back to climatological values.

Similarly, the method on p 4-15 for "filling in" the missing 11 5 minute values, when only the max 5 minute value in an hour is reported, is non-scientific. At the minimum, use the known probability distribution function (pdf) of concentration variability (e.g., exponential is often used). Known correlations among 5-minute values could be incorporated too.

Ambient Air Concentrations Topic Area 3. The proportional approach selected for adjusting ambient concentrations to simulate air quality that just meets the existing standard [Section 4.1.3.4]

I have no comments since I am not sure of the rationale behind what is being done in this section.

Additional comments on the first part of the document (not covered under topic areas discussions):

p 1-2, lines 9-10 – "Advances in modeling tools and techniques and air quality data that have become available since the last review are also considered" – This statement implies that there has been a comprehensive review of the field in general; however, the current report suggests that, in my topic area, only internal EPA documents and work have been considered.

p 1-4, lines 13 – 15 – I disagree with this statement that "concentrations of SO_2 in ambient air do not exhibit consistently strong temporal variability over daily or seasonal time scales…" Maybe this is true for samplers in rural areas with no industrial sources nearby, but it does not apply in urban or industrial areas or within 20 km of large point sources. And I notice later that the regions being considered for further study are all urban metropolitan areas and include large point sources.

p 1-4, line 3 from bottom – "5 to 10 minutes". Justify why EPA is settling on 5 minutes while WHO settled on 10 minutes.

p 1-7 References – All references are to EPA reports instead of to general (possibly outside of EPA) relevant reports and papers.

p 2-24 References for EPA 2009 REA review section – There are no basic references on atmospheric processes, dispersion models, or statistical analysis of air quality data provided.

Chapter 3 introduction paragraph (p 3-1) and Conclusions Section 3.5 (p 3-10 and 3-11) – These sections emphasize that "newly-available information" is being assessed with respect to its potential effects on risk assessments. The EPA apparently is defining "new information" as that developed within their group (e.g., more 5 minute concentration data and revisions to AERMOD and its processors). I would hope that EPA would also consider relevant information from groups outside of their agency (and outside OAQPS). For example, the dispersion models of most European countries can model concentrations at a variety of averaging times, including less than 1 hour. Within the U.S., the DOD's SCIPUFF dispersion model can also handle any averaging time (following the theoretical derivations in basic turbulence and dispersion textbooks such as Pasquill, as well as fundamental dispersion formulas by Taylor, Batchelor, and Richardson). Note that a version of SCIPUFF called SCICHEM is an alternate model available from EPA.

Chapter 3 References include no "non-EPA" studies of statistical analysis of air quality data, and do not include the various recent updates to the AERMOD dispersion model itself.

References:

Gifford, F.A., (1960) Peak-to-average concentration ratios according to a fluctuating plume model. Int. J. Air Poll. 3, 253-260.

Slade, D.H. (1968). Meteorology and Atomic Energy, U.S. Atomic Energy Commission (No. TID-24190). *U.S. Atomic Energy Commission*, pp 109-111, 154-156.

Turner, D.B. (1970). Workbook of Atmospheric Dispersion Estimates (No. 999-AP-26). *U.S. Environmental Protection Agency*, pp 37-38.