Comments on the
Second Draft Carbon Monoxide Risk and Exposure Assessment (REA) and the First Draft Carbon Monoxide Policy Assessment (PA)

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March 22, 2010

I am Jon Heuss with Air Improvement Resource, Inc. The 2nd draft REA is a distinct improvement over the 1st draft. By taking the spatial variation in CO concentrations and several micro-environments into account, the distribution of COHb exposures is now much more realistic. But no comparison is provided to show the substantial reduction in estimated risk. EPA should include a direct comparison for CASAC. For example, comparing Tables 6-11 and 6-12 in the 2nd draft with Tables 6-22 and 6-23 in the 1st draft, one can see that, for CO levels that just meet the current standard the percentage of persons with maximum COHb levels at or above 2 % was reduced by over a factor of ten, from 6.6 % to 0.5 % in Los Angeles and from 56.5 % to 3.4 % in Denver. We commend EPA for using more realistic assumptions.

In addition to the distribution of maximum COHb levels, we applaud the inclusion of the data on person-days. These data are extremely important in evaluating the risk and putting it into a public health perspective. For example, in Los Angeles, just meeting the current standard results in only 0.002 % of the person-days in the population of adults with coronary heart disease with COHb levels at or above 2 %. In fact less that 0.1 % of the person-days are above 1.5 %. This demonstrates that the current standard is highly protective. Since "as-is" CO concentrations are now lower than the standard, the risk from current ambient CO is even lower as documented in the REA. In addition, the 2nd draft REA risk estimates are quite similar to the risk estimated in the 2000 pNEM analysis for Los Angeles, but somewhat higher for Denver. Thus, the estimates of risk, for a given level of ambient CO, have not materially changed since the standard was last reviewed.

We believe that the upper tail of the COHb distribution estimated for Denver in the 2nd draft is too high because 1) one of the four sites is a micro-scale site located on a traffic island at the intersection of major arterial roads, and 2) the methodology for estimating in-vehicle exposures overestimates in-vehicle concentrations under adverse meteorology. Since day-to-day emissions are relatively constant, the wide distribution in ambient CO concentrations arises due to differences in dispersion that are driven by variations in meteorology. High ground-level concentrations result from low wind speeds and limited vertical dispersion. However, as Chock documented in detail in 1977, the concentration fields around roadways are also influenced by the mechanical turbulence generated by the traffic that effectively limits the build-up of CO and other pollutants under adverse ambient meteorology conditions.[i]

There is no data indicating that the in-vehicle concentrations in the U. S. now approach the upper end of the ranges used in the model.[ii] Rather than use the ratio method, EPA should analyze the data in terms of the increment in mass units.

Turning to the PA, we agree that great weight should be placed on the controlled studies. We urge the staff to add information from the REA on the percent of person-days of COHb above the various benchmarks to Tables 2-5, 2-6, and 2-7. The distribution of person-days of COHb is a more appropriate metric to evaluate the public health risk than just the maximum COHb in a year.

November 2009 AIR comments[iii] provided detailed reasons why the epidemiology summarized in the ISA should be given little weight. First, the pattern of acute associations reported for CO is remarkably similar to that of all the criteria pollutants. Second, multi-city studies report a biologically implausible wide range in individual-city associations from positive to negative for each pollutant. With 25 to 40 percent of the associations in various multi-city studies being negative, it is impossible to characterize the data as consistent. Third, with such stochastic variation, relying on any one individual study or a small cluster of studies is unreliable.[iv] Fourth, there is now greater appreciation that model selection uncertainty, publication bias, and issues of surrogacy or confounding limit the interpretation of the published associations as true effects.

The arguments in the PA for a more stringent standard rely on cardiovascular hospital admissions associations reported in three Atlanta studies. In the one study that reports a statistically significant positive association with CO, the authors do not ascribe that association to an effect of CO, per se, but rather raise the same issues of CO acting as an indicator that are acknowledged in the draft PA.

Although controlled human studies do demonstrate effects on the cardiovascular system, interpreting the epidemiological evidence below the level of the current standard as causal is even more difficult than it was in 2000 because 1) ambient levels of CO are now extremely low compared to levels that cause effects in controlled animal or human studies, 2) there is now evidence that both endogenous and exogenous CO have anti-inflammatory and cytoprotective properties through non-hypoxic mechanisms.

Based on these considerations, and the improved estimates of COHb exposures in the 2nd draft REA, the current 8-hour standard is protective.

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[i] In the mid-1970s when the catalytic convertor was introduced to reduce emissions, because of concerns that the sulfur in gasoline would be oxidized over the catalyst and cause excessive near roadway exposures to sulfate, General Motors and EPA carried out an experiment on a test track at the General Motors Proving Ground that simulated an expressway with a traffic density of 5462 cars per hour. Experiments were conducted on the early morning of 17 days in October 1975, in order to collect data under the most adverse meteorological conditions available. Using the results from an array of chemical and meteorological measurements around the roadway, Chock demonstrated that the turbulence and heat generated by the traffic had a significant effect on the on-road and near-road wind and concentration fields. For example, in the first 50 meters downwind of

the road, mechanical mixing dominates the mixing due to stability considerations so that the vertical dispersion parameters in the first 50 meters approach neutral stability, regardless of the ambient stability. In addition, at very low wind speeds, the heat from the traffic lifts the exhaust above the Gaussian plume axis. These effects limit the concentrations that can build up on and near roadways under adverse ambient meteorology. See S. Cadle, D. Chock, P. Monson, and J. Heuss, "General Motors Sulfate Dispersion Experiment: Experimental Procedures and Results," J. Air Pollut. Control Assoc., **27**, 33-38 (1977); D. Chock, "General Motors Sulfate Dispersion Experiment: Assessment of the EPA HIWAY Model," J. Air Pollut. Control Assoc., **27**, 39-45 (1977).

[ii] There is no U. S. data that report in-vehicle concentrations that approach the greater than 60 ppm level assumed in the model (as shown in Slide 16 of the EPA staff presentation on the draft REA). The CO measurements (made in the year 2003) from the Westerdahl et al., 2005 study in the Los Angeles Basin are particularly informative. The authors measured CO and other pollutants in an instrumented electric vehicle driving on freeways in Los Angeles with a traffic density greater than 200,000 vehicles per day. The vehicle was driven on a freeway- dominated loop that took approximately two hours on several different days. Westerdahl et al. specifically report that roadway CO averaged from 2 to 4 ppm and was usually no more than twice the ambient concentration (the one-minute peak in-vehicle concentration during the study was 14 ppm). This study, conducted on major freeways in the Los Angeles Basin, an area with both historic high CO concentrations, high traffic density, and adverse meteorology demonstrates the magnitude of on-roadway exposures in worst-case driving situations. Since the California and federal motor vehicle control programs are continuing to reduce vehicle CO emissions, future on-road exposures will be even lower. See D. Westerdahl, S. Fruin, T. Sax, P. M. Fine, and C. Sioutas, "Mobile platform measurements of ultrafine particles and associated pollutant concentrations on freeways and residential streets in Los Angeles, Atmospheric Environment, **39**, 3597-3610 (2005).

[iii] J. M. Heuss, D. F. Kahlbaum, and G. T. Wolff, Review and Critique of the U. S. Environmental Protection Agency's Second External Review Draft of the "Integrated Science Assessment for Carbon Monoxide" and First External Review Draft of the "Risk and Exposure Assessment to Support the Review of the Carbon Monoxide Primary National Ambient Air Quality Standards," Air Improvement Resource, Inc. Report, Prepared for The Alliance of Automobile Manufacturers, November 13, 2009.

[iv] Relying on one or a small cluster of CO studies from the literature, when there is so much stochastic variation, is akin to choosing one point from a scatter plot of all results. The wide variation in individual-community results in single-pollutant models and the highly variable changes in multi-pollutant models (with some CO associations increasing, some decreasing, and others relatively unchanged) are demonstrated in the following figure, taken from the Bell et al., 2009 study of emergency hospital admissions for cardiovascular disease. As documented in detail in the AIR November 13, 2009 comments, the pattern of associations reported by Bell et al.

is not consistent with a causal relationship.

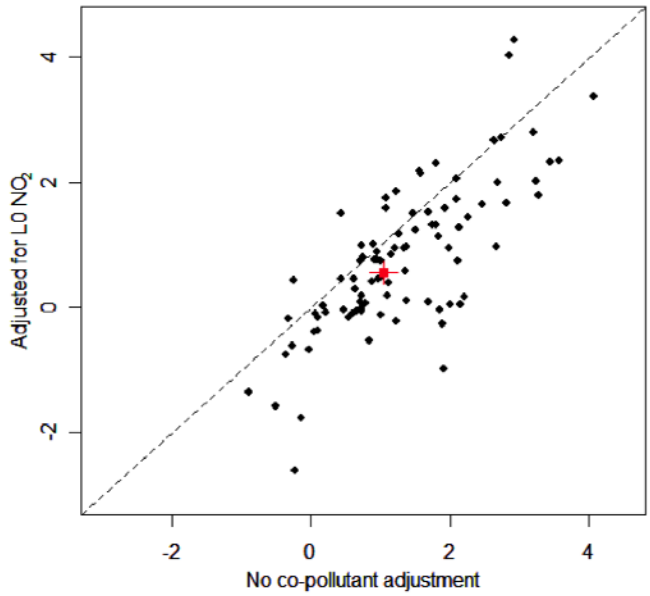

Fig. IIa. With and without adjustment by same day NO_2