Before the

ENVIRONMENTAL PROTECTION AGENCY

Docket No. EPA– HQ–OAR–2006–0922

40 CFR Parts 50 and 58 Primary National Ambient Air Quality Standard for Nitrogen Dioxide; Proposed Rule

Comments of

THE ALLIANCE OF AUTOMOBILE MANUFACTURERS

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COMMENTS OF THE
ALLIANCE OF AUTOMOBILE MANUFACTURERS

The Alliance of Automobile Manufacturers ("Alliance") submits the following comments on the Environmental Protection Agency's ("EPA") notice of proposed rulemaking ("NPRM") for review of the air quality criteria for oxides of nitrogen and the primary national ambient air quality standard ("NAAQS") for oxides of nitrogen as measured by nitrogen dioxide ("NO_2") 74 Fed. Reg. 3,404 (July 15, 2009) ("NPRM Notice").

The Alliance of Automobile Manufacturers is an automobile manufacturing industry trade association made up of eleven car and light truck manufacturers, including BMW Group, Chrysler Group LLC, Ford Motor Company, General Motors, Jaguar Land Rover, Mazda, Mercedes-Benz, Mitsubishi Motors, Porsche, Toyota, and Volkswagen. These eleven companies collectively accounted for approximately eighty percent (80%) of the new passenger cars and trucks sold last year in the United States. The automobile industry has about sixty automobile and light duty truck assembly plants in the United States that, together with the mobile source products produced by those plants, could be affected substantially by the proposed changes to the NO_2 NAAQS.

The NPRM proposed to retain the current NO_2 annual average primary air quality standard of 0.053 ppm and to supplement that standard by establishing a new short-term NO_2 standard based on the 3-year average of the 99th percentile of 1-hour daily maximum concentrations. EPA proposes to set the level of this new standard within the range of 0.08 to 0.10 ppm and solicits comment on standard levels as low as 0.065 ppm and as high as 0.150 ppm. EPA also proposes to establish requirements for an NO_2 monitoring network that will include a substantial number of monitors within 50 meters of major roadways.

These comments are divided into two main parts. In Part I we discuss why EPA's proposal to establish a roadside monitoring network for NO_2 is not supported by current scientific evidence and should be withdrawn. Many urban monitors are already located near roadways and these monitors are not observing high levels of NO_2. The ambient NO_2 data do not show a need to deploy new NO_2 monitors along major roadways. We also discuss the concerns raised by the Clean Air Act Scientific Advisory Committee ("CASAC"), which we share, concerning the use of roadway concentration data in the standard-setting process.

Part II explains why EPA should not finalize a 1-hour standard in the range of .08 to .10 ppm. Scientific evidence indicates that a 1-hour standard of 0.15-0.20 ppm would be highly protective of public health and the current annual standard protects against short-term exposures; separate short-term standard not necessary. Moreover, EPA should not base decisions about the stringency of a new NO_2 NAAQS on a monitoring network for which it is seeking public comment. Also, EPA's proposed short-term standards do not conform to CAA Sec. 109 (i.e. more stringent than necessary).

I. EPA's Proposal to Establish a Roadside Monitoring Network is Not Supported by Current Scientific Evidence and Should be Withdrawn.

A. Based on an analysis of the current monitor locations and measured concentrations, roadside monitors are not measuring high NO_2 concentrations.

The July 15, 2009 NO_2 NPRM states: "estimates presented in EPA's draft Risk and Exposure Assessment ("REA") to Support the Review of the NO_2 Primary National Ambient Air Quality Standard suggest that on/near roadway NO_2 concentrations could be approximately 40% (REA, compare Tables 7–11 and 7–13) or 80% (REA, section 7.3.2) higher on average than concentrations away from roadways and that roadway-associated environments could be responsible for the large majority of 1-hour peak NO_2 exposures (REA, Figures 8–17 and 8–18). Because monitors in the current network are not sited to measure peak roadway-associated NO_2 concentrations, individuals who spend time on and/or near major roadways could experience NO_2 concentrations that are considerably higher than indicated by monitors in the current area-wide NO_2 monitoring network." As a result, EPA says: "We are proposing to require monitoring in locations of expected maximum concentrations near major roads in larger urban areas." More specifically: "We propose that near-road NO_2 monitoring stations must be sited so that the NO_2 monitor probe is no greater than 50 meters away, horizontally, from the outside nearest edge of the traffic lanes of the target road segment, and shall have no obstructions in the fetch between the monitor probe and roadway traffic such as noise barriers or vegetation higher than the monitor probe height."

The rationale for this requirement is based on (1) an analysis EPA presents of observational data in section A-8.2 in the NO_2 REA Appendices, and (2) the exposure modeling for Atlanta presented in Chapter 8 of the REA The observational data comes from studies of NO_2 measurements made downwind of roadways which is described as: "Eleven papers …. spanning several countries, various years, roadway locations, seasons, wind directions, and averaging times (Table A-108). The final data set contained 501 data points, encompassing multiple NO_2 measurements at a distance from a total of 56 individual roads, some of which were collected within 10 m of the road." The exposure modeling described in Chapter 8 of the REA involves use of a Gaussian dispersion model, AAERMOD,[1] to predict both on-roadway, near-roadway and neighborhood NO_2 concentrations that were input into the APEX[2] human exposure model to evaluate the distribution of human exposures. We have serious scientific concerns with EPA's interpretation of both these sources of information. Those concerns are detailed in our discussion of the REA in Section IB below.

To determine whether the 40 to 80% higher relationship mentioned above holds for actual U.S. monitoring data, we examined the existing database contained in EPA's Aerometric Information Retrieval System ("AIRs") data base. The 2001-2006 Monitor Value reports for all US NO_2 monitors were obtained from the EPA AirData web site (www.epa.gov/air/data/index.html). The annual (hour by hour) NO_2 values, monitor identification number, and other information were extracted and placed into a database.

[1] American Meteorological Society (AMS)/EPA Regulatory Model

[2] Air Pollutants Exposure Model, version 4.

The identification number and roadway distance information for 204 NO_2 monitors were extracted from Table A-7 in EPA's REA Appendices. To ensure representative comparisons, only those monitors having valid data for all 6 years were then selected. This step reduced the original 204 monitors down to 108. The 108 monitors were assigned to their respective Metropolitan Statistical Areas ("MSA") based on the AirData designations. The monitors were also assigned a road distance category, using the following ranges: ≤ 20 meters, >20-<100 meters, ≥100 meters. The data were aggregated into two 3-year bins, 2001-2003 and 2004-2006. Using the distance from the roadway information given in Table A-7, the data for each monitor were plotted in Figures 1 and 2 for the annual NO_2 means and the 99th percentile of the daily 1-hour maxima. The least-squares best-fit linear lines are also shown. There is a general tendency for the NO_2 concentrations to decrease when the distances increase from the roadway, but there is considerable scatter in the data, especially in the < 100 m range. Note that the decrease is greater for the annual average than for the short-term 99th percentile metric. Note also for the 99th percentile metric (that is the focus of EPA's proposal) the distance from the nearest roadway is not a major determinant of the observed concentrations, only accounting for about 10 % of the variability.

To further explore these relationships, the data were subdivided into 3 sub-bins based on the distance metrics used by EPA: ≤ 20 meters, > 20 m to < 100 m, and ≥ 100 m from the roadway. These data are graphed showing the average 1-hour daily maxima concentration, the 99th percentile of the 1-hour daily maxima, and the annual means in Figures 3 - 5. While the lowest NO_2 concentrations consistently occur in the ≥ 100 m bin, the highest mean concentrations for all three NO_2 measures occur in the > 20 to <100 m bin rather than in the bin closest to the roadway. The percentage decrease in concentrations as a function of distance is again greater for the annual mean than for the 99th percentile.

The high degree of scatter observed in Figures 1 and 2 is because the data is from 20 different U.S. metropolitan areas with varying levels of NO_2 and the number of monitors in each area ranges from one to twelve. To reduce the scatter, only metropolitan areas that contained one or more monitors in each of the three distance bins were identified, and these data were examined for each individual metropolitan area. Only six metropolitan areas with a total of 42 monitors met these criteria. They are: Boston, Chicago, Los Angeles, Phoenix, St. Louis and Washington. The data for these six areas are displayed in Figures 6 – 8. These figures indicate there is considerable inter-city variability. Boston, Chicago and LA consistently show highest concentrations in the intermediate, > 20 to < 100 m bin. St. Louis and Phoenix show mixed results while only Washington, DC and the six city composite show a consistent decrease of NO_2 when the distances increase from a roadway. However, the decrease is considerably less than EPA's assumed 40 to 80%.

In Table 1, all the data are summarized by showing the ratios of either the NO_2 concentrations at ≤ 20 m or at > 20 to < 100 m to the concentrations of NO_2 at ≥ 100 m for all of the measures for all sites (from Figures 3 – 6), the individual six metropolitan areas, and the average of the six areas. In addition, another extreme value metric, the 98th percentile was also added. In general, the highest ratios (and the highest percentage increases compared to the > 100 m bin) occur for the more robust (annual average and average daily maximum) while the lowest ratios occur for the least robust extreme values (98th and 99th percentiles). This is extremely important because EPA is considering a

form for the 1-hour NO_2 standard that is either the 98th or 99th percentile. The composite ratios for these correspond to an enhancement of NO_2 concentrations of less than 15%.

Two of the cities, Boston and Chicago do indicate a much greater enhancement of the near-road NO_2 concentrations. However, a close examination of the sites that are classified ≥ 100 m provides some insight as to why their concentrations are so low. Boston's two sites that are ≥ 100 m are Long Island, which is on a lightly traveled road on an island in the middle of Boston Harbor three and a half miles east of downtown, and in Lynn, a suburb of Boston about seven miles to the northeast. Both of these sites appear to have much lower NO_2 concentrations than downtown Boston. Two of the three ≥ 100 m sites in Chicago also appear to have much different environments than the city proper. The sites are Braidwood, which is classified as rural and is located about 50 miles to the southwest of Chicago, and the second is in Northbrook, which is a suburb located about 18 miles to the north-northwest of downtown Chicago.

In summary, the above analyses of the available ambient data suggest the following:

1. Many of the presently located urban monitoring sites are already located within 50 meters of a major roadway.

2. These monitors are not measuring the high concentrations that are of concern to EPA.

3. Although the annual averages at these sites tend to be significantly higher than at sites located ≥ 100 m from a road, the short-term one-hour extreme values are comparable.

4. Consequently, there does not appear to be a need to initiate a massive deployment of new NO_2 monitors within 50 m of major roadways.

Metric	Distance	All Sites	6 City Composite	Boston	Chicago	LA	Phoenix	St. Louis	DC
Average Daily Max	≤ 20 meters	1.115	1.154	1.272	1.380	1.181	1.189	0.876	1.070
Average Daily Max	> 20 to < 100 meters	1.249	1.151	1.663	1.624	1.252	0.923	0.643	1.105
99th percentile	≤ 20 meters	1.111	1.088	1.327	1.187	1.096	1.250	0.770	0.965
99th percentile	> 20 to < 100 meters	1.141	1.075	1.490	1.284	1.234	0.884	0.689	0.971
98th percentile	≤ 20 meters	1.114	1.055	1.289	1.167	1.119	1.183	0.716	0.938
98th percentile	> 20 to < 100 meters	1.143	1.062	1.489	1.313	1.226	0.889	0.635	0.969
Annual Average	≤ 20 meters	1.277	1.323	1.530	1.841	1.326	1.333	0.944	1.107
Annual Average	> 20 to < 100 meters	1.332	1.254	2.051	1.958	1.442	0.840	0.616	1.173

Table 1: Ratio of NO2 concentrations at sites ≤ 20 meters from a roadway and sites > 20 meters to < 100 meters from a roadway to the NO2 concentrations at monitors ≥ 100 meters from a roadway for the period 2001 to 2006.

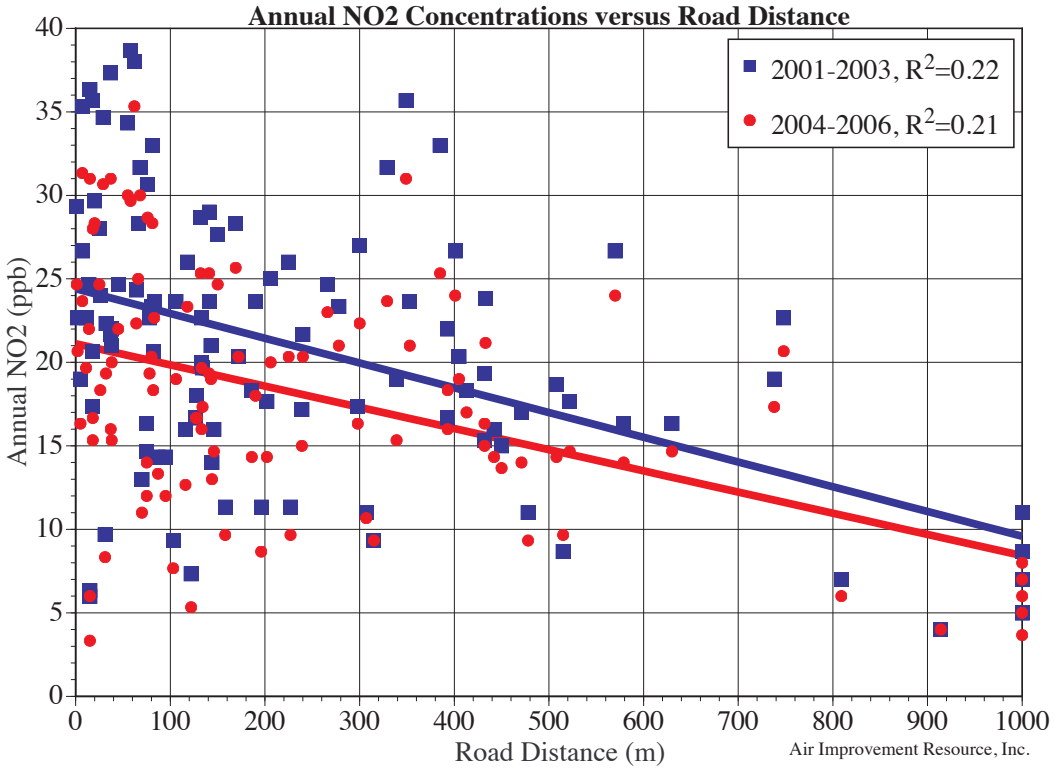


Figure 1: Annual average NO_2 concentrations as a function of the distance to the nearest roadway.

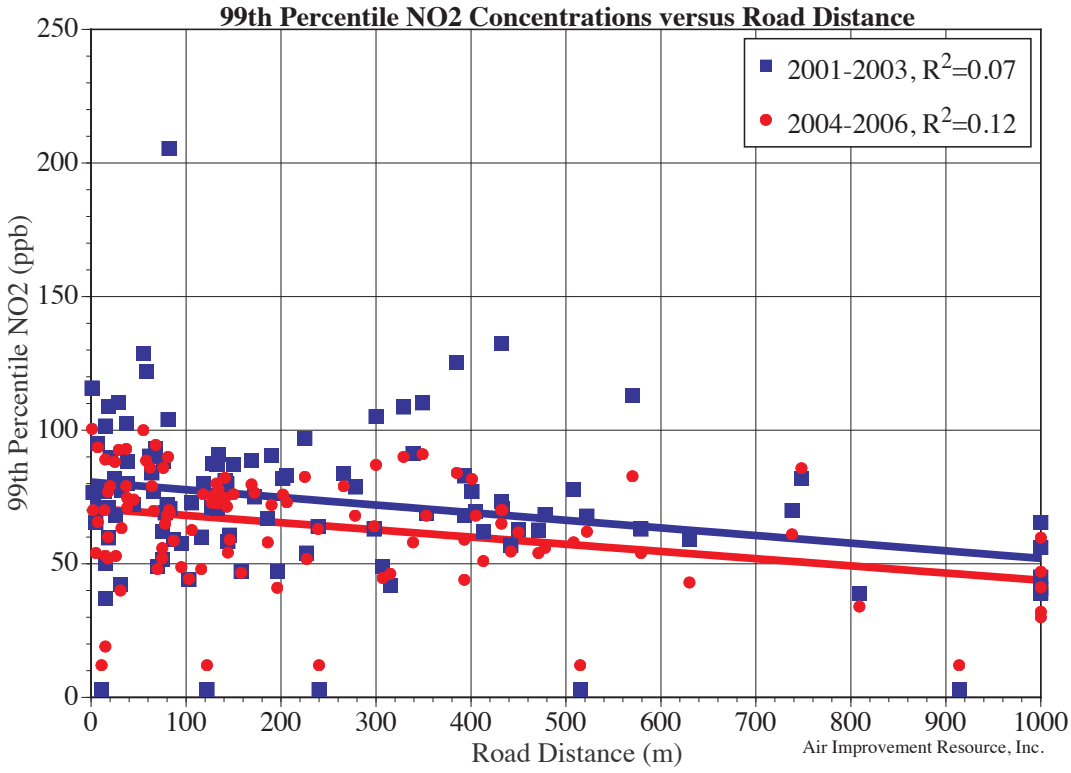


Figure 2: 99th percentile of the 1-hour daily maxima NO_2 concentrations as a function of the distance to the nearest roadway.

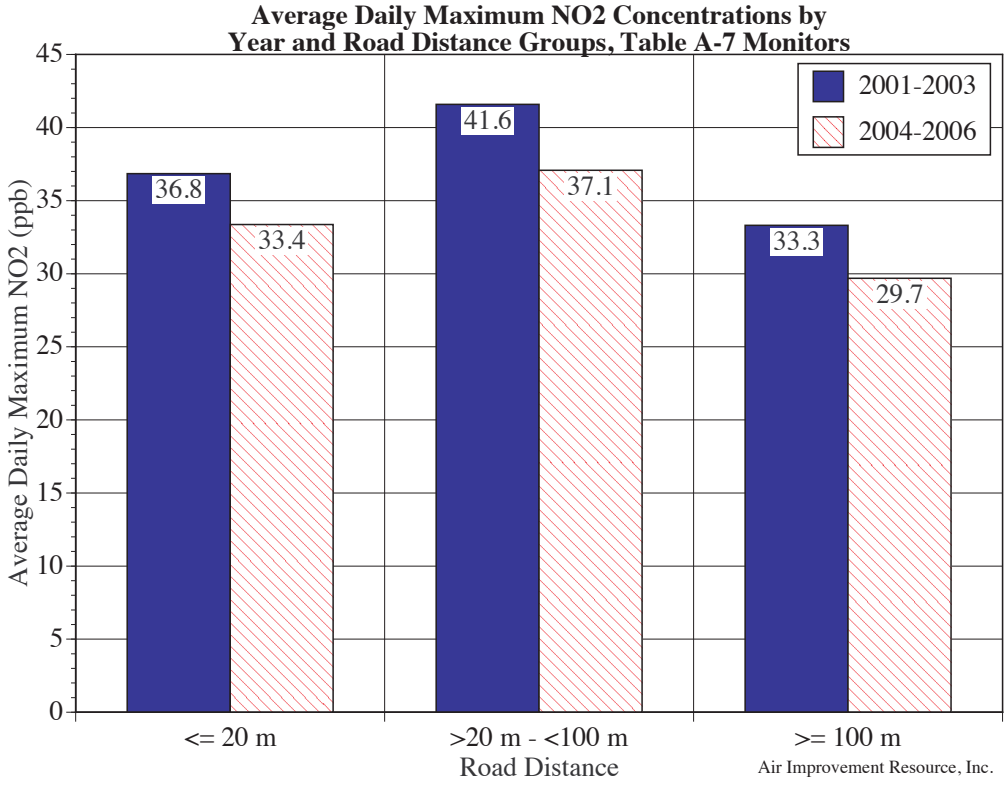


Figure 3: Average daily 1-hour maximum concentrations.

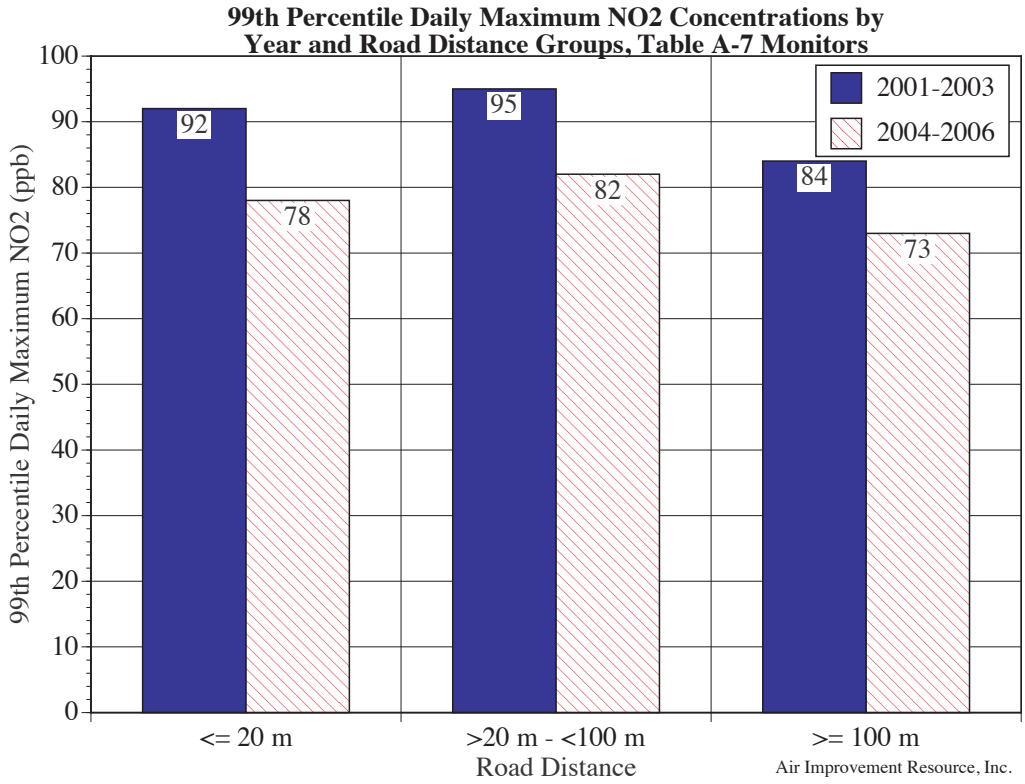


Figure 4: 99th percentile of 1-hour maximum NO_2 concentrations.

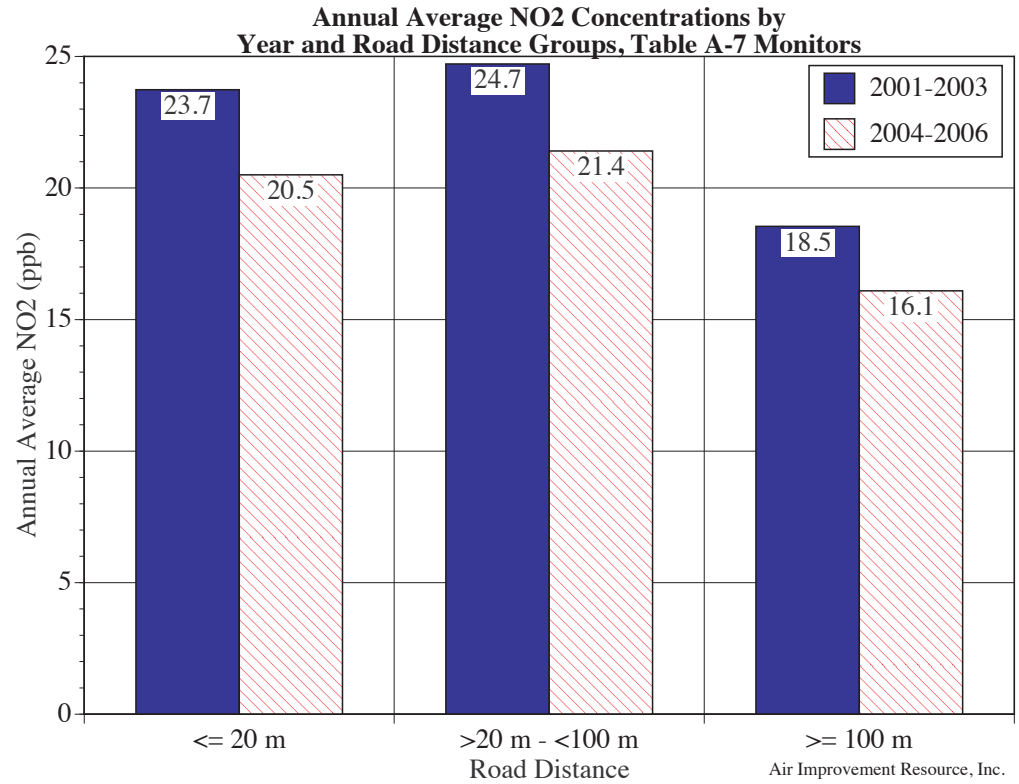
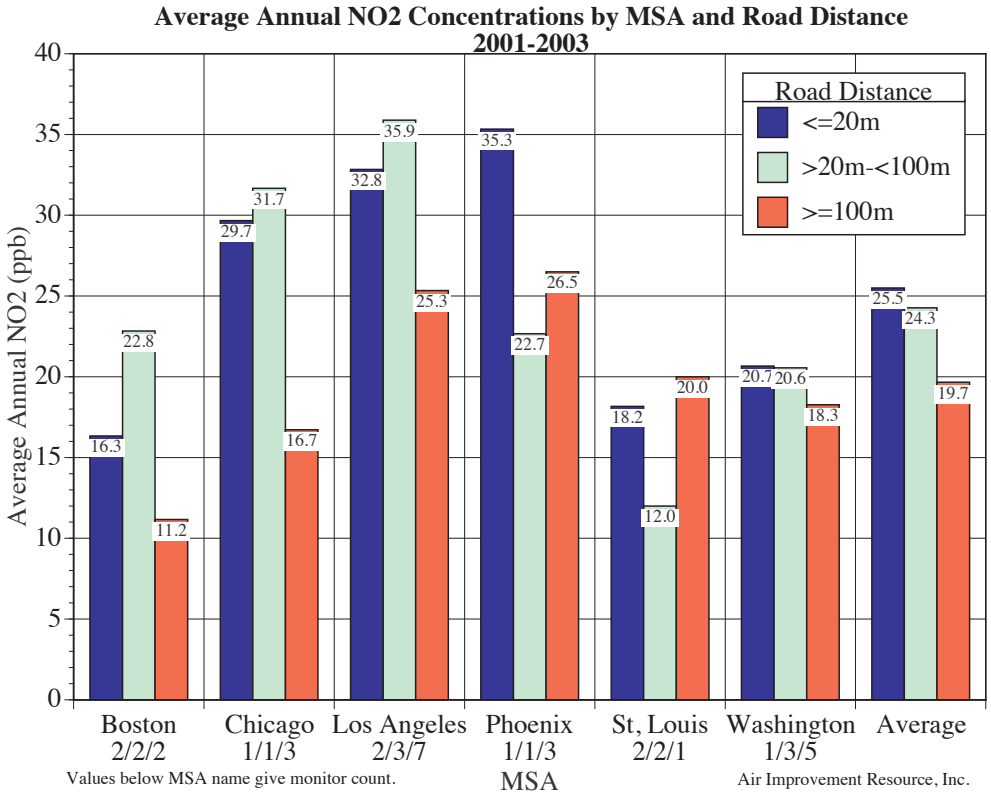


Figure 5: Average annual NO_2 concentrations.



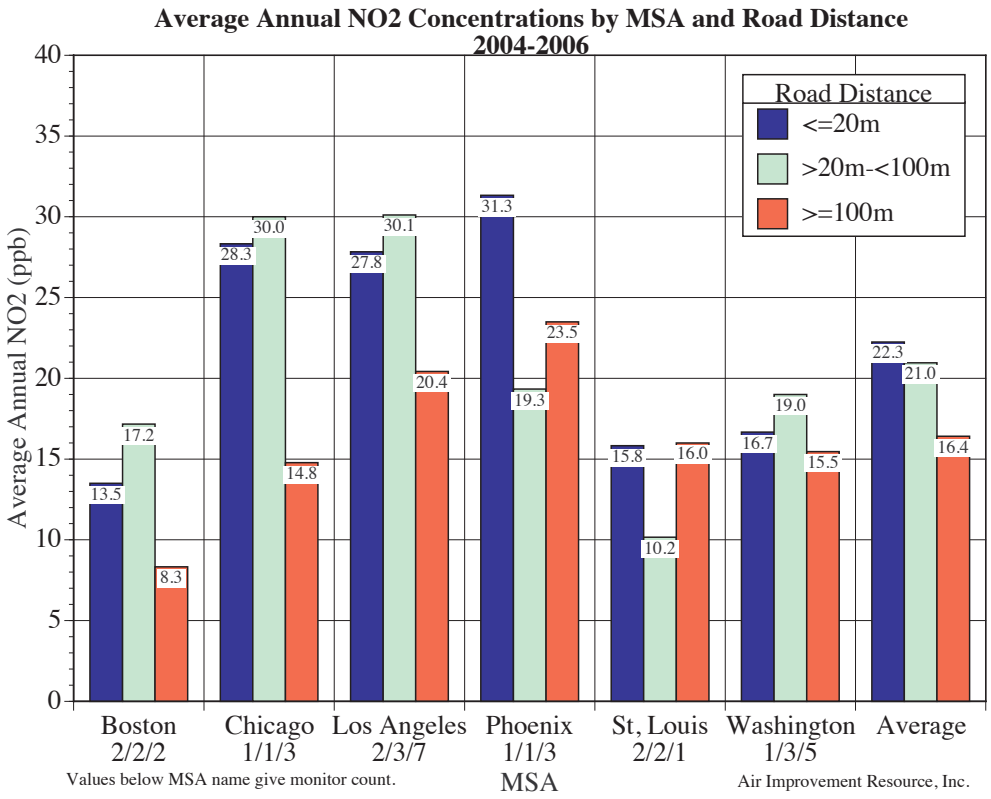
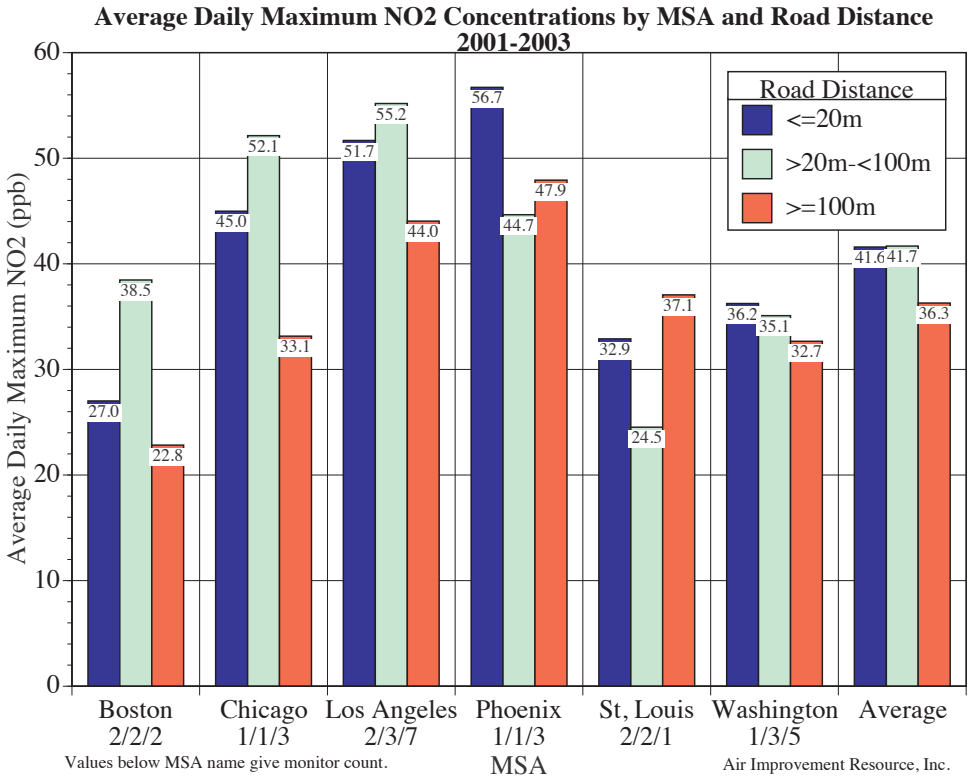


Figure 6: Average annual NO2 concentration by MSA and road distance. Numbers under the city names are the number of monitoring sites locates at ≤ 20 m, > 20 to < 100 m, and ≥ 100 m, respectively.



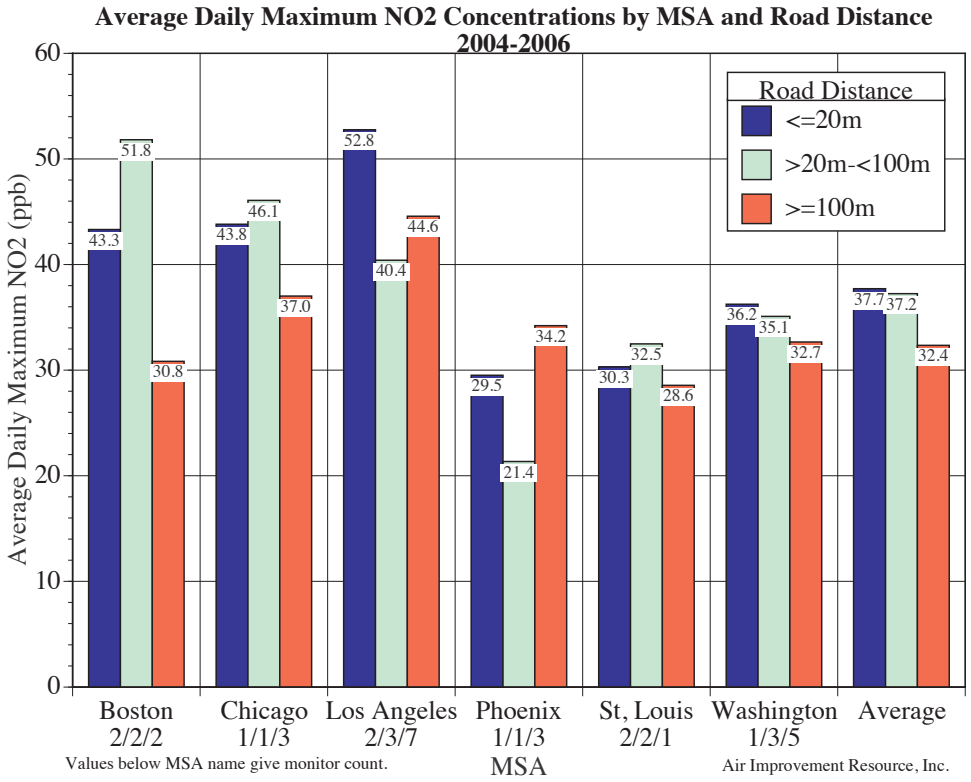
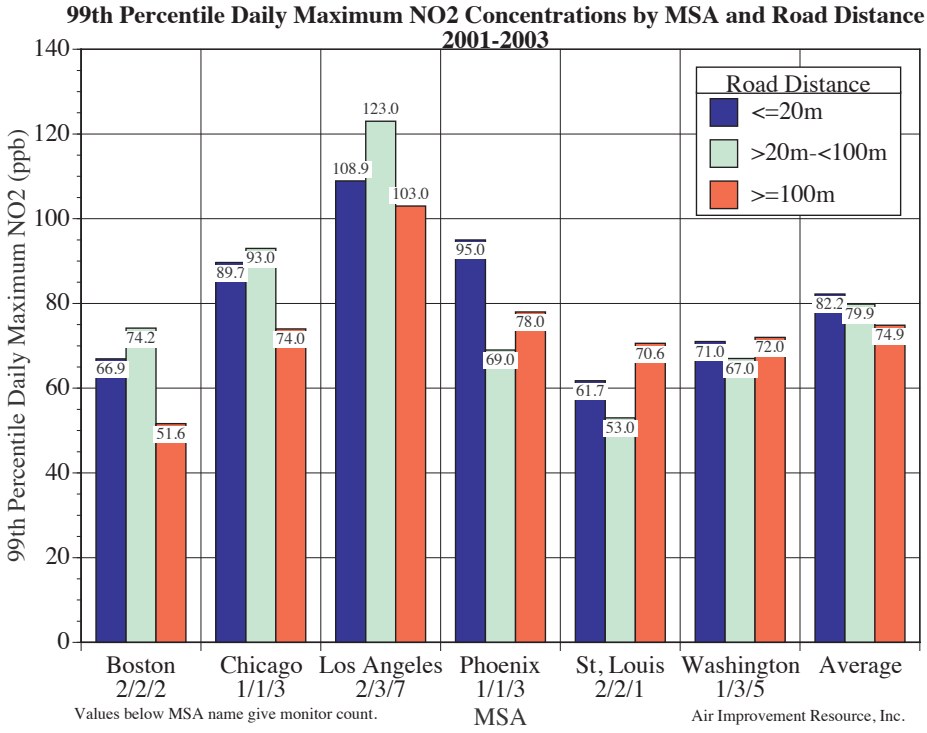


Figure 7: Average daily maximum 1-hour NO_2 concentration by MSA and road distance. Numbers under the city names are the number of monitoring sites locates at ≤ 20 m, > 20 to < 100 m, and ≥ 100 m, respectively.



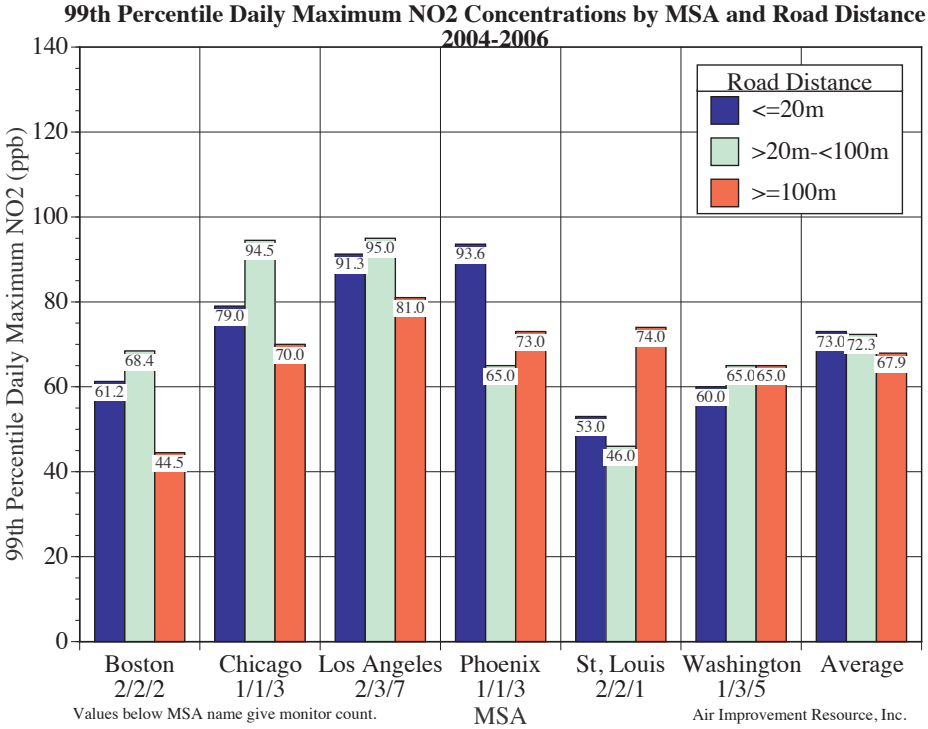


Figure 8: 99th percentile of the daily maximum 1-hour NO_2 concentrations by MSA and road distance. Numbers under the city names are the number of monitoring sites locates at ≤ 20 m, > 20 to < 100 m, and ≥ 100 m, respectively.

B. Ambient Data Indicate That The REA Significantly Overstates Actual Risks From On-Road Exposures.

Knowledge of trends in and current exposure levels to ambient NO_2 is helpful in interpreting health effect studies and considering the adequacy of the current standards. The NOx ISA indicates that mean NO_2 ambient levels are about 0.015 ppm and that peak daily 1-hour levels are typically about 0.030 ppm.

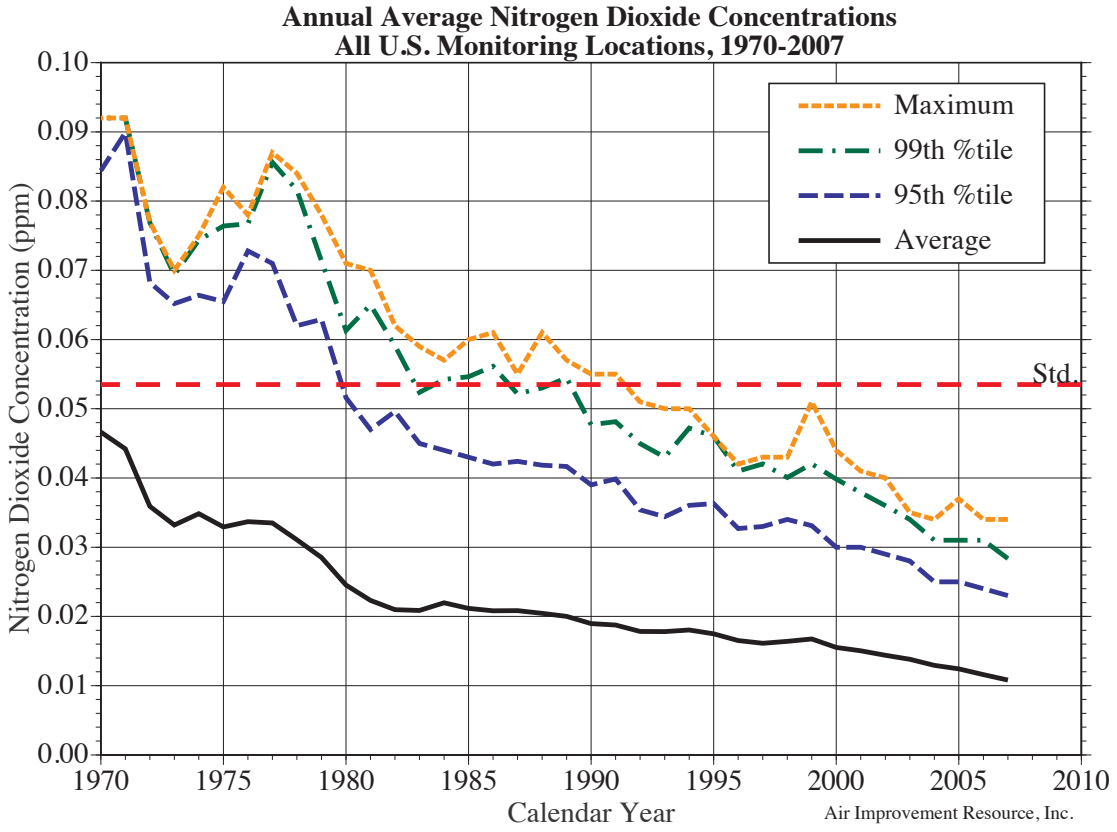


Figure 9: Distribution of annual average NO_2 concentrations at all U. S. monitoring locations from 1970 through 2007. While the number of monitoring sites differs somewhat from year to year, a downward trend that has reduced ambient NO_2 concentrations by a factor of about three over the past 30-some years is evident. Since most of the NO_2 monitoring is conducted in urban or suburban locations, the ambient trend is primarily indicative of emission reductions in and around urban areas.

The REA used three approaches to characterize health risks from ambient nitrogen dioxide. The first involves comparing NO2 ambient monitoring data with potential health effect benchmark levels, using the monitoring data as a surrogate for potential human exposures. The second approach uses modeled estimates of human exposures to compare with the health benchmarks. The third approach uses selected epidemiological associations to estimate health impacts. EPA's proposal discusses the results of the REA, noting that there are various uncertainties that may cause the risk estimates to be over- or under-estimated. However, there is substantial evidence that the risk estimates from all three approaches significantly overestimate actual risks.

i. The results for the first approach - comparing monitoring data with potential health benchmarks - are known to overestimate the distribution of actual human exposures

The first approach, comparing monitoring data with potential health benchmarks, is detailed in Chapter 7 of the REA and is based on the assumption that the monitor reflects people's actual exposure. However, the majority of people spend the bulk of their time indoors, where there is ample evidence that indoor NO_2 concentrations are approximately half of that measured outdoors. Therefore, it is important to use the results of detailed modeling of population exposures to provide realistic estimates of health risks. For example, the exposure results for Philadelphia in the first draft REA and for Atlanta in the final REA using the second approach demonstrated that actual human exposures to NO_2 of ambient origin are substantially below that estimated from ambient monitoring.

Figures 8-9 and 8-10 of the final REA show that the estimated human exposures to NO_2 of ambient origin are generally in the 0.006 to 0.016 ppm range whereas the ambient data indicate annual means of 0.015 to 0.019 ppm. The importance of indoor sources is also shown in Figure 8-9 with an additional annual exposure increment of from 0.001 to 0.004 ppm from indoor sources. The REA notes that in the absence of indoor source contributions, personal exposure concentrations for most of the simulated individuals are estimated to be about 40 to 70 percent that of the local ambient or outdoor concentration. The REA also notes that this estimate is consistent with studies included in the ISA reporting such a relationship based on measurements of personal exposure and ambient concentrations that ranges from around 0.3 to 0.6. Since the results of the first approach overestimate personal exposures, this approach should not be used to make risk estimates.

As part of the first approach, EPA estimated on-road exposures. Although it is well established that the on-road exposures on busy highways are increased relative to up-wind exposures, the procedure EPA used in the REA to estimate the incremental increase is flawed. EPA analyzed the results from a number of studies of near-roadway NO_2 profiles by comparing the ratio of the contribution from the roadway to the background. Since these studies of the profile of NO_2 downwind of roadways were generally carried out in well-defined and often isolated locations, the background, in some cases, was very low. The ratio of on-road increment to background varied substantially in these studies, and EPA used the wide variation to develop a distribution of ratios that were then applied in a random fashion to the concentrations measured at monitors to estimate the on-road exposures. Since a high ratio of on-road increment to background can occur in a situation where the actual on-road increment (in concentration units) is low but the background is very low, applying that high ratio to an urban situation with a high background will

substantially over-estimate the on-road increment. The ratio method also improperly overestimates on-road exposures and risk.

Rather than use the ratio method, EPA should have analyzed the data in terms of the increment in concentration units and the traffic counts, since the magnitude of the on-road NOx source is the major determinant of the on-road increment. A review of the on-road and near-road studies EPA cites in the ISA, REA, and the NPRM reveals that there are no reliable data indicating either on-road or near-road exposures in recent years that exceed the 0.20 or 0.30 ppm benchmarks. For example, NPRM cites the recent Beckerman et al. 2008 paper regarding the drop-off of NO_2 concentrations near roadways. In 2004, Beckerman et al. measured NO_2 at varying distances from two major multi-lane expressway segments in Toronto that carry 349,000 and 395,000 vehicles per day. Monitoring was carried out at sites as close as 4 m from one of the roads and as close as 28 m from the other. The NO_2 concentrations (weekly average) at these near-roadway sites were 0.019 and 0.028 ppm, respectively. None of the near roadway NO_2 concentrations in the studies cited in Chapter 7 of the REA approach the benchmarks. For example, the near roadway NO_2 concentrations reported in Roorda-Knape et al. 1998 for sites 15 m and 32 m from Dutch expressways with between 130,000 and 150, 000 vehicles per day were 0.025 and 0.024 ppm. The peak near-road concentrations reported in the Singer et al. 2004 study of NO_2 near schools and residences downwind of a 200,000 vehicle per day expressway in the East Bay area of California were 0.040 ppm with the average concentrations at the nearest sites to the road were 0.030 ppm.

In addition, with one exception, none of the on-road concentrations cited in the ISA approach the 0.20 or 0.30 benchmarks. The Westerdahl et al. 2005 study of on-road NO_2 concentrations in the Los Angeles Basin is particularly informative. The authors measured NO_2 and other pollutants in an instrumented electric vehicle driving on freeways in Los Angeles with greater than 200,000 vehicles per day that had between 1 and 18 % diesel trucks in the vehicle mix. The vehicle was driven on a freeway-dominated loop that took approximately two hours. As noted in the ISA, the on-freeway NO_2 concentrations ranged from 0.040 to 0.070 ppm. Westerdahl et al. specifically report that roadway NO_2 was usually no more than twice the ambient concentration. This study, conducted on major freeways (including freeways with a high percentage of diesel trucks) in the Los Angeles Basin, the area with both the historic highest NO_2 concentrations and the highest traffic density, 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 NOx emissions, future on-road exposures will be even lower.

The one high on-road NO_2 concentration noted in the ISA is a maximum concentration of 0.548 ppm reported in the Riediker et al. 2003 study of in-vehicle exposures of NO_2 and other pollutants in patrol cars operating in and around Raleigh, NC. However, the 0.548 ppm data point is noted in three places in the Riediker et al. study as being an obvious outlier since it was six standard deviations above the mean of the other measurements and since none of the other pollutants were elevated during the shift in which the high NO_2 sample (on a passive filter badge) was obtained. In fact Riedeker et al. specifically comment that NO_2 inside the cars was always low, and report the average in-vehicle concentration (without the outlier/flawed measurement) was 0.031 ppm. Thus, there are no valid measurements in the literature cited by EPA indicating that on-road or near-roadway concentrations of NO_2 exceed the 1-hour 0.20 or 0.30 ppm benchmarks.

ii. The results of the second approach – estimating risk based on detailed exposure modeling – also overestimate the risk from NO_2

Chapter 8 of the REA presents the results of a detailed human exposure modeling exercise evaluating the risk from short-term NO_2 exposures in Atlanta. Two important components of the analysis include (1) estimating temporally and spatially variable ambient NO_2 concentrations, and (2) simulating human contact with these pollutant concentrations.

AERMOD is a steady state Gaussian plume model that has been developed and tested primarily for stationary source applications. It was used in the REA to simulate both mobile and stationary source impacts in Atlanta. The highways in Atlanta were simulated as various line source segments. A recent EPA review of air-quality modeling tools for near roadways applications discusses AERMOD and other roadway dispersion models. The EPA review indicates that AERMOD has not been compared rigorously for line source applications and that it contains a very simplistic algorithm for line sources.

The detailed modeling uses the AERMOD dispersion model to estimate temporally and spatially varying ambient concentrations that are then input into the APEX ("Air Pollutants Exposure") model to estimate human exposure.

While this approach, in theory, is the appropriate way to estimate risk, the application in the REA also overestimates the exposures to various potential standards. The REA shows in Figures 8-6 and 8-7 that the AERMOD-estimated concentrations substantially overestimate measured NO_2 concentrations in Atlanta particularly at the upper percentiles of the distribution. Figure 8-8 also indicates that AERMOD overestimates the maximum on-road concentrations compared to the ratio method used in Chapter 7, which as shown above, itself overestimates maximum on-road exposures. It is exactly these higher NO_2 concentrations (both near-roadway and in neighborhoods) that are of interest in the risk assessment. The REA acknowledges that:

"When compared to ambient measurement data, predicted upper percentile NO_2 concentrations from AERMOD may be 10-50% higher. Because these AERMOD outputs are used as inputs for our exposure modeling, this suggests the possibility that we are over-predicting upper percentile NO_2 exposures."[3]

In reality, it is not just a possibility but a clear certainty that the EPA modeling system is overestimating the upper percentiles of NO2 exposures. Figures 8-6, 8-7, and 8-8 clearly show that this is the case and that, therefore, the risk assessment substantially over-predicts the extent of benchmark exceedances in the Atlanta exposure analysis.

There are two major limitations or problems with the application of AERMOD in the REA. The first is that AERMOD does not include the most important reactions converting NO to NO_2 in urban areas. The second is that the use of AERMOD to simulate peak concentrations on and near-roadways has not been adequately tested. Each of these limitations will be discussed in turn. As a result of these limitations, EPA has been misled about the importance of near-roadway exposures, in terms of the magnitude

[3] Final REA at page 286.

of the exposures compared to neighborhood exposures and the risk associated with the exposures.

iii. AERMOD has chemical limitations

The ISA notes that NO_2 is basically a secondary pollutant. While AERMOD includes a provision for the reaction of NO with ozone to form NO_2, the Ozone Limiting Method, it does not include the most important reactions converting NO to NO_2 in urban areas. Although the reaction of ozone with NO to form NO_2 is relevant in atmospheric chemistry, in the absence of volatile organic compounds (VOCs), the subsequent photolysis of NO_2 to form NO and an oxygen atom (which reacts with an oxygen molecule to reform ozone) sets up an equilibrium in which ozone cannot build up. As noted in the ISA Annex, the oxidation of reactive VOCs leads to formation of reactive radical species that allow the conversion of NO to NO_2 without participation of ozone so that ozone can accumulate as NO2 photolyzes. The conversion of NO to NO_2 by reactive radicals (Reaction AX2.2-4, in the ISA Annex) occurs over time frames of from several hours to a day depending on time of year and sunlight.

As a result of these photochemical reactions, the fraction of NOx that is NO_2 increases as an air parcel moves downwind. Contrary to EPA's assumption, the maximum concentration of NO_2 in a plume transported downwind of a roadway will not necessarily occur on or next to the road as assumed by EPA.

Since AERMOD does not include the slower photochemical conversion, it miss-characterizes and over emphasizes the relative importance of near-roadway and neighborhood exposures. In addition to miss-characterizing the spatial distribution of NO_2, AERMOD miss-characterizes the temporal distribution, as shown in Figure 8-7 of the REA where the modeled peak NO_2 from the morning rush hour occurs about three hours earlier than the peak in the monitored concentrations in Atlanta.

Although photochemical models (that include the appropriate chemistry) are routinely used to simulate ozone formation, a photochemical model was not used in the REA to provide the input to the APEX model. The ISA notes that ambient photochemical modeling systems (which typically use horizontal grids of 4 km or more) are not optimized for estimating NO_2 at the local scale of interest in the REA.[4] The ISA also notes that inhalation models like APEX can be adapted for NO2 studies, but that such applications would be constrained by data limitations such as ambient characterization at the local scale. To characterize ambient NO_2 at a local scale, the REA applied the AERMOD dispersion model.

iii. AERMOD poses significant limitations in being able to predict credible and more realistic maximum near-roadway exposures

AERMOD is a steady-state Gaussian plume model that has been developed and tested primarily for stationary source applications. It was used in the REA to simulate both mobile and stationary sources impacts in Atlanta. The highways in Atlanta were simulated as various line source segments. A recent EPA review of air-quality modeling tools for near roadway applications discusses AERMOD and other roadway dispersion

[4] ISA Annex at page 3-114.

models.[5] The EPA review indicates that AERMOD has not been compared rigorously for line source applications and that it contains a very simplistic algorithm for line sources.

Since the concern in the REA is for the maximum concentrations and exposures, the important question is how well does AERMOD simulate the extreme values of the NO_2 distribution. In fact, the REA does not address this question. The maximum concentrations occur under conditions of minimum dispersion where the impact of turbulence and heat generated by traffic will be greatest. Since the EPA review acknowledges that AERMOD has not been rigorously evaluated for line source applications and the algorithm is simplistic compared to other line source models that account for turbulence and other traffic effects in greater detail, its predictions of maximum roadway impacts are suspect. For example, the on-road to non-road receptor predictions from AERMOD were used to develop the distribution of proximity factors used in the APEX model for the in-vehicle and near-road microenvironments. As documented in Table B-42 of the REA appendices, multiplicative factors from 1 to as high as 10 to 30 inappropriately were being used to estimate near-road exposures from the estimates of ambient concentrations. In fact, predicted exposures in the near-roadway microenvironment were even higher than in-vehicles, since the in-vehicle microenvironment included a penetration factor (between 0.6 and 1.0) to account for the loss of NO_2 to surfaces inside the vehicle or its ventilation system. With on-road and near-road concentrations assumed to be up to 30 times higher than neighborhood ambient concentrations, it is no wonder that the exceedances of various benchmark concentrations in Figures 8-17 and 8-18 of the REA are dominated by in-vehicle or near-roadway exposures.

Since multiplicative factors as high as 30 are clearly suspect compared to the data in the literature on in-vehicle NO2 exposures, the Agency should rigorously evaluate the AERMOD predictions of extreme values of in-vehicle and near-roadway exposures before relying on the results of the REA for the final decision. In addition, the use of the same proximity factor for both in-vehicle and near-road microenvironments cannot be justified since the REA indicates that there is a 90 % reduction in NO2 exposures within 10 to 15 meters of the edge of the highway.

The combination of over-prediction of neighborhood concentrations and over-prediction of on- and near-roadway concentrations using AERMOD leads to substantial over-predictions of risk in Atlanta in the second approach.

In the absence of a rigorous evaluation of the meteorological conditions and times and places for which AERMOD predicts high exposures, it is not clear if the over-prediction occurs due to problems with the near-roadway dispersion algorithm or the application of the ozone limiting model or both. The issue of EPA highway dispersion models that over-predict near-roadway exposures arose 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

[5] U. S Environmental Protection Agency, Emissions and air quality modeling tools for near roadway applications, EPA/600/R-09/001, December 2008.

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.[6] 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.[7] 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 and are not included in AERMOD.

The measured concentrations in on-road and near-road studies documented in the ISA and summarized in the previous section demonstrate that there are no valid measurements of NO_2 exposures as high as the upper percentiles of exposure predicted by AERMOD. The REA refers to the 0.548 ppm maximum NO_2 concentration in Riedecker et al. 2003 to support the upper end of the AERMOD predictions, but, as Riedecker et al. admits, it is not a valid measurement. There is additional evidence in the literature that microscale monitoring will not identify unmonitored "hot spots" of exposure to motor vehicle pollutants. The South Coast Air Quality Management District has carried out two studies that compared motor vehicle air toxic exposures at microscale sites in Los Angeles suspected of being unmonitored "hot spots" with exposures at current monitoring sites. In both cases, the exposures at the anticipated hot spots were similar to the exposures at the fixed neighborhood-scale monitoring sites.[8]

As the December 2008 EPA review of roadway dispersion models indicates that, with the exception of including the effects of vehicle-induced turbulence, near-roadway dispersion models have advanced little over the last two decades. As noted earlier, the 2008 review indicates that AERMOD has a simplistic line-source algorithm. It further notes that there is a major research need to evaluate "hot spot" models and that, for a modest investment, near-road models could be upgraded to include a more accurate line source algorithm. Thus, while EPA is relying on the unexamined AERMOD predictions in the proposal, EPA staff is acknowledging elsewhere that the model is simplistic and has not been tested and validated for determining hot spots.

[6] 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).

[7] D. Chock, "General Motors Sulfate Dispersion Experiment: Assessment of the EPA HIWAY Model," J. Air Pollut. Control Assoc., **27**, 39-45 (1977).

[8] South Coast Air Quality Management District, Multiple Air Toxics Exposure Study, MATES II, Final Report, March 2000; Multiple Air Toxics Exposure Study, MATES III, Final Report, January 2008.

C. CASAC has raised significant concerns about reliance on roadway monitoring data.

In the Preamble and supporting the Integrated Science Assessment[9] ("ISA") and Risk and Exposure Assessment[10] ("REA"), EPA acknowledges that: (1) there are difficulties with accurately measuring NO_2 levels with current technology employed by monitoring equipment;[11] (2) there is variability among individual monitors based on several factors, making such measurements imprecise;[12] (3) there are analytical challenges in separating out NO_2 effects from the general mix of traffic-related pollutants;[13] (4) the relationship between quality-assured and quality-controlled area-wide monitoring data and actual roadside emissions is highly variable and indeed speculative;[14] and (5) there are relative errors in measurement related to distance from sources and the elevation of monitors.[15]

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[9] "Integrated Science Assessment for Oxides of Nitrogen – Health Criteria," National Center for Environmental Assessment-RTP Division, Office of Research and Development, U.S. Environmental Protection Agency, July 2008.

[10] "Risk and Exposure Assessment to Support the Review of the NO_2 Primary National Ambient Air Quality Standard," Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, November 2008.

[11] The "method for estimating ambient NO_2 levels (i.e., subtraction of NO from a measure of total NOX) is subject to interference by NO_X oxidation products (e.g., PAN, HNO_3) (IISA, section 2.3). Limited evidence suggests that these compounds result in an overestimate of NO_2 levels by roughly 20 to 25% at typical ambient levels." *Ibid*. at 14.

[12] The Preamble to the proposed rule notes that chemiluminescence monitor imprecision is "variable and depends in part on characteristics of individual monitors, such as the design of the instrument inlet, the temperature and the composition of the reducing substrate and the interaction of atmospheric species with the reducing substrate." (74 Fed. Reg. at 34440).

[13] As noted in the Preamble to the proposed rule, "the ISA (section 5.4) noted that it is difficult to determine 'the extent to which NO_2 is independently associated with respiratory effects or if NO_2 is a marker for the effects of another traffic-related pollutant or mix of pollutants.'" 74 Fed. Reg. at 34410. Additionally, referencing the ISA at 5.2.2., EPA indicates that "when interpreting epidemiological results, 'It is difficult to determine * * * the extent to which NO_2 is independently associated with respiratory effects or if NO_2 is a marker for the effects of another traffic-related pollutant or mid of pollutants . . . A factor contributing to uncertainty in estimating the NO_2-related effect from epidemiologic studies is that NO_2 is a component of a complex air pollution mixture from traffic related sources that include CO and various forms of PM.'"

[14] At various places in the Preamble to the proposed rule, EPA cites different information regarding this relationship. Different estimates of the relationship are also expressed in ranges in the supporting ISA and REA. Moreover, even where an estimate is rendered, the actual relationship of the data appears to be transitory. For example, EPA indicates that in the REA "on-road NO_2 concentrations were estimated in this analysis to be an average of 80% higher than concentrations at fixed site monitors (though this relationship will vary across locations and with time." 74 Fed. Reg. at 34426. Elsewhere, EPA states that "NO_2 concentrations near roadways can be approximately 30 to 100% higher than concentrations in the same area but not near the road." 74 Fed. Reg. at 34430.

[15] The Preamble to the proposed rule cites "a gradient in pollution concentrations" but notes. "While this general concept is applicable to almost all roads, the actual characteristics of the gradient and the distance that the mobile source pollution signature from an individual road can be differentiated from background or upwind contributions are heavily dependent on factors including traffic volumes, local topography, roadside features, meteorology, and photochemical reactivity conditions." 74 Fed. Reg. at 34409. In addition, "One comparison has found an average of

Recently, concerns have been raised within the Clean Air Act Scientific Advisory Committee (CASAC) process with respect to the use of *any* roadway concentrations in the standard-setting process. A preliminary draft text to assist CASAC deliberations during an August 10, 2009 Public Teleconference Call ("August 10th document") expresses serious concerns about this course of action.[16] These concerns noted that epidemiological studies used in the current review relied on area-wide monitoring to develop health effect associations and, as a result, "in the face of a lack of sufficient near-roadway health effects studies to develop direct exposure-health effects relationships, CASAC has concerns about including near-roadway concentrations in the standard-setting process at this time . . ."[17] The Alliance believes that the document's criticism of the use of roadside monitoring is fundamental to the inappropriateness of the approach EPA has taken with respect to the entire proposed rulemaking, including both the establishment of standards and the proposal to rely on a roadside monitoring network.[18] It is especially notable that the draft comments also mention that uncertainty with regard to a lower bound of a standard "is much more impacted by the judgment of the appropriateness of the monitoring site in its translation to the population exposure estimates, rather than the issue of co-pollutants."[19] In other words, the determination of a lower boundary based on existing data is highly subjective, which may well mean that the proposed lower boundary goes beyond the level necessary to protect the public health.[20]

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a 2.5-fold higher NO_2 concentration measured at 4 meters above ground compared to 15 meters above the ground." REA at 15.

[16] The Alliance recognizes that this draft text does not, at this time, reflect consensus advice or recommendations of CASAC and that it has not been reviewed or approved by the CASAC panel for the current NO2 review.

[17] Preliminary Draft Text to Assist CASAC Oxides of Nitrogen Primary NAAQS Panel Deliberations at the August 10, 2009 Public Teleconference Call, page 1.

[18] *Ibid*. at 1. Moreover, although it is not clear to what extent EPA relied on this in its analysis, the Preamble notes that "mean in-vehicle NO_2 concentrations are often between 2 and 3 times higher than ambient levels measured at monitors located away from the road." (74 Fed. Reg. at 34419). While there is no dispute that EPA may consider the exposure of subpopulations in arriving at decisions with respect to the review of a NAAQS, those decisions must still be based on exposures to "ambient air." In this regard, long-standing EPA regulations have defined "ambient air" as "that portion of the atmosphere, exterior to buildings to which the general public has access." (40 C.F.R. 50.1(e)). While vehicles are most certainly exterior to buildings when they travel on roads, vehicles generally involve enclosures and the vast majority of vehicles are not accessible to the general public. In the case of buildings, EPA has clarified that while outside ambient air may flow into buildings through windows and ventilation systems, "Once indoors, air is no longer 'external to buildings' and thus not considered ambient air." (Letter to Mr. Daniel Gutman from John S. Seitz, Director, Office of Air Quality Planning and Standards, April 13, 1992). Furthermore, with reference to buildings, EPA has clarified that "except in very unusual situations, we would not consider air at open or operable windows, or at the intakes for mechanically-ventilated buildings, as ambient air for purposes of determining attainment of the national ambient air quality standards." (*Ibid*.). Similarly, EPA should not seek to base any conclusions about ambient air quality standards on the air inside of vehicles.

[19] August 10th Document at 2.

[20] See discussion in Preamble to the proposed rule occurring at 74 Fed. Reg. 34437 to 34448, where it is indicated that the level of the standard may be based on the ratio of area-wide monitoring levels to roadside monitoring levels with lower levels of the standard justified on determination of a lower ratio between measurements at the two different types of monitors.

The August 10th document indicates additional fundamental disagreement with roadside monitoring as part of the standard-setting process. Comments in that document include the following: "Uniformly uncomfortable with using a new roadside monitoring network for attainment demonstration . . . Roadside monitors will be more susceptible to very extreme events because they are nearer to sources and more susceptible to periods of episodically high emissions, low dispersion and other events that could lead to high peak monitored levels that are not reflective of more widespread levels . . . Further analyses are needed to determine the causes and frequencies of extreme, concentrations monitored by near-road monitors and to understand how such peak concentrations related to those measured in the current, population-orientated network."[21]

Finally, the August 10th document raises questions concerning the spatial area represented by roadside monitoring (*e.g.*, how large a nonattainment area would be defined by a violating monitor, the populations affected, the effectiveness of control strategies). The Alliance recognizes that EPA may not take implementation issues into account when reaching its judgment concerning an appropriate level and form of a NAAQS. However, the CASAC comments call into question the fundamental issue of using roadside monitoring as a basis for standard setting. The difficulties that one encounters in using such unstable monitoring data for 1) reaching either necessary judgments concerning the appropriate level and form of a NAAQS, or 2) evaluating evidence based on modeling of such inherently variable concentrations, suggests that EPA should utilize more broad-based data on ambient NO_2 concentrations for purposes of this rulemaking.

A further letter dated September 9, 2009 from Dr. Johnathan Samet, the Chairman of CASAC, to EPA Administrator Lisa Jackson[22] does not resolve the uncertainties inherent in utilizing roadside monitoring as a basis for standard-setting under the CAA. In this letter, Dr. Samet indicates that the CASAC panel for the NO_2 NAAQS did not reach "consensus." Instead, there was an agreement to present different views on monitoring NO_2 monitoring issues to EPA. With regard to those on the CASAC panel who did not favor near-road monitoring, the letter indicated that they "favored retention of EPA's current area-wide monitoring for NO_2 regulatory purposes, due to the lack of epidemiological data based on near-roadway exposure measures and issues related to implementing a near-road monitoring system for NO_2."[23]

Additional comments in Enclosure A to the letter are also revealing. Even among those Panel members that support the two-tier network EPA proposed, the members' rationale appears to be that basing regulations on area-wide monitoring alone was "problematic," because "Such an approach would require EPA to embed uncertainties and assumptions about the relationship between area-wide and roadside monitoring into the area-wide standard."[24] The Alliance would submit that the opposite conclusion is also true, i.e., that establishing a standard as EPA has proposed, the attainment of which would be

[21] *Id*. at 3.

[22] Letter from Dr. Johnathan Samet to Administrator Lisa Jackson, "Subject: Comments and Recommendations Concerning EPA's Proposed Rule for the Revision of the National Ambient Air Quality Standards (NAAQS) for Nitrogen Dioxide," (September 9, 2009).

[23] *Ibid.* at 1.

[24] *Ibid.* at 4.

established by roadside monitors, also embeds uncertainties and assumptions into a form and level of the NAAQS. Moreover, it is instructive that elsewhere in the letter, broad concerns about using roadside monitoring for regulatory purposes have apparently not been resolved. For example, the letter indicates that "*CASAC* is very strongly supportive of a special-purpose monitoring network oriented towards roadside monitoring that is not used for attainment purposes at this point but for research."[25] (Emphasis added).

D. EPA should withdraw its roadside monitoring proposal and either 1) develop a more broad-based monitoring plan, or 2) conduct additional research on NO_2 microenvironments before developing a proposed monitoring plan.

In light of the information presented above, the proposed expansion of the monitoring network is not justified. As documented in Subsection I.A., the near-roadway concentrations are not elevated compared to measurements further from roadways to the extent EPA has assumed. In addition, the available observations on- and near-roadways (including high traffic density urban expressways) do not support the presence of dangerous levels that are currently un-monitored. Moreover, the proposal to add NO_2 monitors within 50 meters of major roadways is based on an unverified exposure analysis that indicates a substantial portion of the higher 1-hour NO_2 exposures occur in near-roadway situations. When the exposure analysis is revised to eliminate the over-prediction of the upper–percentiles of NO_2 exposures, the need for near-roadway monitoring must be re-visited.

The roadside monitoring proposal would establish microscale monitoring sites within close proximity of urban expressways with the heaviest average daily traffic. As noted in the proposal, a microscale monitor is meant to define the concentration in air volumes associated with area dimensions ranging from several meters up to about 100 meters. The heavy focus on microscale monitoring is flawed and inconsistent with the CAA directive to set broad-based ambient air quality standards. The focus of monitoring should not be on protecting progressively smaller volumes of air where people could theoretically be exposed, but relatively little exposure is actually occurring. Since EPA is proposing a 1-hour standard, the spatial extent of the area monitored should be commensurate with the movement and activities of people over periods of one to several hours or more. This is consistent with EPA's historic practice of matching the spatial scale of monitoring with the time scale of the relevant NAAQS.

The existing monitoring network already contains 23 monitors in the middle scale category (defined as representing areas with dimensions from 100 meters to 500 meters) and many monitors within 20 meters of existing roadways, so a great deal of data is already being collected near roadways. The proposal asserts that establishing an even more elaborate near-roadway network would have other advantages including providing data for new public health studies for future NAAQS reviews. However, the establishment of an array of microscale mobile-source oriented sites would be of little value in providing the exposure measurements for public health studies since the population exposed to the concentrations measured within a few meters of major urban expressways would be the extremely small.

[25] *Ibid.* at 7.

In summary, the facts are as follows: 1) there are already many monitors within 50 meters of a major roadway; 2) roadside monitors are not measuring high concentrations of NO_2; 3) one-hour NO_2 concentrations are comparable in roadside and non-roadside locations; 4) risks from on-roadway exposures have been overstated; and 5) CASAC has questioned the reliability of roadside monitoring for making determinations of attainment vs. non-attainment. Given these facts, we believe that EPA has sufficient evidence to determine that its plan for a more extensive roadside monitoring network should be dropped. EPA should instead pursue a more broad-based monitoring network aimed at locations where actual exposures (in terms of both population and duration) are the highest. To the extent that EPA remains interested in a monitoring network focused on microenvironments, it should at a minimum conduct additional research before doing so. Such research should focus on 1) measuring the full range of man-made and natural materials involved with roadways and traffic, and 2) evaluating the various models EPA is using to estimate dispersion and human exposure from these materials. Measurements should be made for a range of roadway configurations. As CASAC indicates in its September 9, 2009 letter, the advice of technical experts should be sought to design a program of research measurements that would not be used for attainment purposes. The CASAC Ambient Air Quality Monitoring Subcommittee and the Health Effects Institute Traffic Review Panel are two groups that could be helpful in designing the research program.

II. EPA Should Not Finalize a 1-Hour Standard in the Range of 0.08 to 0.10 ppm

A. Based on an evaluation of the literature on NO_2 Health Effects, as documented in these comments, a 1-hour standard in the range of 0.15 to 0.20 ppm would be highly protective of public health.

1. Effects in controlled human and animal studies

Information relevant to the health effects of NO_2 comes from a number of disciplines with a number of different experimental approaches. These range from controlled studies of the interaction of NO_2 with animal and cell systems aimed at elucidating the details of the absorption and subsequent reactions with compounds in the epithelial lining fluid, to controlled studies of the effects of various exposure regimes on animals and humans, to observational studies of the associations of NO_2 and other pollutants as measured at central monitoring sites with health data such as daily hospital admissions or mortality counts

Because the evidence regarding NO_2 health effects comes from a mix of controlled and observational (or epidemiological) studies, EPA has introduced a framework for assessing the different lines of evidence and evaluating causality. Section 1.3 of the ISA[26] and the proposal[27] clearly indicate the most compelling evidence of a causal relationship comes from controlled human exposure studies. It is well established that observational or epidemiology studies report statistical associations which, by

[26] NOx ISA at page 1-7.

[27] FR at 34409.

themselves, do not establish cause and effect. The ISA notes that association and causation are not the same. Therefore, it is particularly important to fully and carefully consider the results of controlled studies in the current review of the standard.

i. The effects of NO_2 from controlled studies have not changed materially since the last review

The basics of how NO_2 reacts with the lung have been known for several decades. NO_2 is a slightly soluble, but oxidizing and irritating gas. It reacts with surfactants, antioxidants, and other compounds that are part of the antioxidant defense system in the epithelial lining fluid (ELF). The ISA notes that the compounds thought to be responsible for adverse pulmonary effects are the reaction products themselves or the metabolites of these products in the ELF. NO_2 induces lipid peroxidation that is thought to be responsible for its toxicity in the lung. The peroxidation activates enzymes that mediate an inflammatory response. At high enough concentrations NO_2 impairs host defenses increasing the risks of susceptibility to both viral and bacterial agents. The uptake of NO_2 occurs in the nasal region and in both the upper and lower respiratory tract. With exercise, there is increased uptake in the nasal region due to a switch to nasal from oral breathing as well as deeper into the lower respiratory system due to the increased volume of air breathed. At rest, about 70 % of the NO_2 breathed in is absorbed, while during moderate exercise, the fraction absorbed increases to about 90 %.

Based on knowledge of how NO_2 interacts with the lung, investigators have used both controlled animal and human exposures to evaluate the levels of NO_2 that might cause various adverse respiratory effects such as changes in lung function, lung structure, inflammation, and susceptibility to infection. The human clinical studies have involved both normal and asthmatic subjects. The clinical studies, when reproducible, represent the best source of information on NO_2 effects. Much of this work was summarized in the 1993 science assessment and 1995 staff paper which undergirded the 1996 decision regarding the air quality standard. In fact the ISA notes that a large body of epidemiologic studies had been published since the previous review relating to respiratory morbidity but that relatively few new clinical and animal toxicologic studies have been published since 1993.

In addition, the interpretation of the clinical studies has not changed significantly since the previous review. The only substantive new data is the addition of several studies reporting increased airways responsiveness to allergen-induced inflammation and allergen-induced bronchoconstriction at 0.26 ppm. The data, however, do not materially change the understanding of risk assumed in the previous review. Although NO_2, like ozone, is an oxidizing and irritant gas, the controlled human studies continue to show that it is distinctly less toxic than ozone.

The summary in the ISA indicates that, for normal subjects, the controlled human studies show no consistent effects on lung function, airway responsiveness, or airway inflammation below 1 ppm. A recent California review of the state's NO_2 standard concluded that NO_2 concentrations below 4 ppm do not cause symptoms or alter pulmonary function in healthy individuals.[28] That review also noted that there is evidence of mild inflammation in healthy subjects exposed to 1.5 to 2.0 ppm for several

[28] CalEPA, TSD, Chapter 6.

hours. Given the low exposures to ambient NO_2 noted in the ISA, with few 1-hour NO_2 concentrations above 0.10 ppm in recent years, it is clear that there is a large margin of safety between current ambient exposures and the exposures that cause even the first mild effects in normal individuals.

However, new clinical studies also suggest that short-term NO_2 exposures near 0.25 ppm may enhance the response to inhaled allergen in people with allergic asthma. The authors of these studies note that these are subclinical effects from repeated short-term exposures that might be of clinical importance (Barck et al. 2002, 2005a). The California review noted that these are subclinical effects where the various endpoints were not consistently seen across studies with very similar protocols, and that dose-response information is lacking. It is further acknowledged that the NO_2 exposures did not lead to clinical asthma exacerbation in the participants in these studies. Further, the proposal acknowledges that other studies have failed to find effects using similar, but not identical, approaches.[29]

During the previous review, EPA staff concluded that, for a subset of asthmatics, exposures in the range of 0.20 to 0.30 ppm may cause increased airway reactivity. The previous review relied on the Follinsbee 1992 analysis of 25 studies of NO_2 and airway responsiveness conducted between 1976 and 1991. Follinsbee reported that, on balance, there were more asthmatic subjects that had increased airway reactivity than had decreased airway reactivity when exposed to NO_2 (in the range of 0.1 to 0.3 ppm) as compared to clean air. (For healthy subjects, an increase in airway responsiveness was seen only at concentrations above 1.0 ppm.) The effect in asthmatics was evident only in exposures conducted at rest, which he described as puzzling, since the subjects received higher doses when exercising. It is also puzzling since the "at rest" studies, where the effect was seen, were of shorter duration than the "with exercise" studies. Follinsbee posited several possible explanations, but to date none have been identified as the cause of this counterintuitive finding. Follinsbee noted that the health implications of an acute increase in nonspecific airway responsiveness are unclear. He further noted that it could potentially lead to a temporary exacerbation of asthma symptoms and possibly increased medication use but he also noted that, in the 25 studies he evaluated, there was no reported incidence of increased medication usage following NO_2 exposure.

Regarding other endpoints in clinical studies, the ISA indicates that evidence for other effects at or near ambient concentrations is either inconclusive or inconsistent. Based on the clinical studies then, the only effects that may be expected due to current ambient NO_2 would involve possible enhancement of asthma in some asthmatics. This is acknowledged in the proposal.[30] The clinical significance of the mild first effects on asthmatics is unknown. This is also acknowledged at several places in the proposal.[31] The authors of the studies acknowledge that the NO_2 exposures in these laboratory studies did not lead to clinical asthma exacerbation. Even these subclinical effects would only be expected to occur rarely from exposure to NO_2 of ambient origin.

[29] FR at 34417

[30] FR at 34420.

[31] FR at 34433, 34434, and 34435.

ii. Even though there is no new data establishing clinical effects at lower concentrations than considered in the last review, the final ISA inappropriately draws a different conclusion.

EPA's first draft REA included a detailed set of exposure calculations that were compared to short-term exposure benchmarks that were chosen by staff based on the clinical studies of effects of NO_2 on airways responsiveness. The first draft REA referred to the 1-hour concentrations of 0.20 ppm, 0.25 ppm, and 0.30 ppm as potential health benchmark levels. The first draft characterized these levels as the lowest levels at which controlled human studies have provided sufficient evidence for the occurrence of nitrogen dioxide-related airway responsiveness. However, the second draft and the final ISA added a benchmark at 0.10 ppm. A careful review of the changes between the draft ISA and the final ISA demonstrates that there are no effects on airway responsiveness at 0.10 ppm. Therefore, the addition of a 0.10 ppm benchmark is not scientifically defensible.

iii. Reliance on the Orehek et al. 1976 study in an unpublished meta-analysis to claim an effect at 0.10 ppm is scientifically unsound.

The final ISA includes the results of a meta-analysis that was not vetted in the first or second draft ISAs. The final ISA includes Table 3.1-2 that summarizes relevant studies and Table 3.1-3 that presents the results of the meta-analysis that is described on page 3-16. The text indicates a number of changes from the meta-analysis reported in Folinsbee 1992 that was influential in the 1995/6 review of the standard. The most important issue with the new analysis is that it relies on the Orehek, et al. 1976 study of airway responsiveness that has never been replicated. The large effect reported by Orehek et al. is the reason there is a significant effect at 0.10 ppm in the 50 subjects included in the analysis. However, the Orehek study was fully evaluated and considered during previous NO_2 reviews and discounted because it has never been replicated. For example, the 1995 Staff Paper explicitly concluded "Several controlled exposure studies (Ahmed et al., 1983a,b; Bylin et al., 1985; Hazucha et al., 1982, 1983; Koenig et al., 1985; Orehek et al., 1981) of asthmatics showed no significant effect on responsiveness at very low NO_2 concentrations of 0.1 to 0.12 ppm."[32] There is no new data to change this conclusion. The ISA indicates that the new meta-analysis was restricted to studies for which the individual data were readily available.[33] Thus, it's a re-analysis of selected older data.

The Orehek paper was not included in the second draft ISA. However, it was used to make this critical change but not discussed in the final ISA. The summary of the conclusions in Table 5.3-1 of the second draft ISA regarding airway responsiveness are remarkably similar in the current review and in the past review, noting that this is the most sensitive indicator of response, with effects in the range of 0.20 to 0.30 ppm. However, in the final ISA, these conclusions were re-written to imply new information showing effects now at 0.10 ppm. This change cannot be scientifically supported.

[32] U. S. Environmental Protection Agency, "Review of the National Ambient Air Quality Standards for Nitrogen Dioxide: Assessment of Scientific and Technical Information," OAQPS Staff Paper, EPA-452/R-95-005, September 1995, at page 37.

[33] ISA at page 3-14.

Aside from this change, which is not warranted, the interpretation of the controlled studies of NO_2 exposure is very similar to that in the previous review

The human and animal evidence for NO_2 health effects was summarized in the 1995 Staff Paper (SP). The evidence regarding susceptibility to respiratory illness, pulmonary function decrements, respiratory symptoms, and increased airway resistance and increased airway responsiveness in asthmatics was discussed in detail in the 1995 Staff Paper.[34] The conclusions regarding impaired host-defense systems and increased risk of susceptibility to infections are similar in the 1995 Staff Paper and current draft ISA. For example, the 1995 SP concluded that the weight of evidence provided by animal toxicology and human clinical studies supports the contention that NO_2 impairs the ability of host defense mechanisms to protect against respiratory infection.[35]

While there is new information on airways inflammation, the effects are found at higher than ambient levels.[36] While the ISA concludes that exposure to NO_2 has been found to enhance the inherent responsiveness of the airways to subsequent nonspecific challenges in human clinical studies, there are inconsistencies in the results and the lowest effect levels are similar to those found in the previous review. The ISA notes that there is now suggestive evidence for increased airways responsiveness to specific allergen challenges following NO_2 exposure. However, the small inflammatory responses to the allergen challenge were not accompanied by any changes in pulmonary function or subjective symptoms and the lowest effect levels are not substantially different from the nonspecific challenge levels.

Similar to the previous review, the ISA notes that clinical studies have not provided compelling evidence of NO_2 effects on pulmonary function. The ISA notes that for asthmatics, the effects of NO_2 on pulmonary function have also been inconsistent at exposure concentrations of less than 1-ppm NO_2. Overall, the ISA concludes, clinical studies have failed to show effects of NO_2 on pulmonary function at exposure concentrations relevant to ambient exposures.[37]

iv. The clinical significance of the effects identified in the 0.20 to 0.30 ppm range needs to be considered to properly evaluate the public health impact of the various exposure scenarios in the REA in perspective.

The airway hyperresponsiveness identified in the human clinical studies of allergen and nonspecific bronchial challenges in asthmatics needs to be properly evalauted. The REA notes that transient increases in airway responsiveness have the potential to increase symptoms and worsen asthma control. However, the REA also notes that the allergen-induced effects were not accompanied by any changes in pulmonary function or

[34] 1995 Staff Paper at pages 15 to 46.

[35] 1995 Staff Paper at page 31.

[36] NOx ISA at page 3-15.

[37] NOx ISA at page 3-45.

subjective symptoms. The authors of these studies note that these are subclinical effects from repeated short-term exposures that might be of clinical importance (Barck et al. 2002, 2005a). The recent California review of that state's NO_2 air quality standard noted that these are subclinical effects; that the various endpoints were not consistently seen across studies with very similar protocols, and that dose-response information is lacking. Furthermore, Folinsbee 1992 noted that the NO_2 exposures in the studies in his meta-analysis did not lead to clinical asthma exacerbation. The lack of clinically important responses in the now numerous human exposure studies needs to be considered in the final decision. The proposal recognizes that the clinical significance of the responses is not known, but goes on also to make arguments suggesting that there may be effects below 0.10 ppm.[38] Given the strong evidence cited in the previous review that there are no significant effects at 0.10 to 0.12 ppm, the possibility of effects below 0.10 ppm should be disregarded.

2. Evidence from epidemiology regarding NO_2 health effects

Most of the epidemiological (observational) studies discussed in the ISA and the proposal come from statistical analyses of available air pollution monitoring data and medical statistics gathered for other purposes. The studies take advantage of the fact that the number of health events varies significantly from day to day in a given city as well as from city to city. The ISA separates the discussion into acute and chronic studies. The acute studies are primarily statistical analyses of time-series data on daily health events, weather, and pollution variables. There are now a significant number of regression analyses that report very weak but, in many cases, statistically significant associations of a range of commonly measured pollutants with a variety of human health endpoints including death, emergency room visits, hospital admissions, respiratory symptoms, etc. Nitrogen dioxide as measured at central monitoring sites is one of the pollutants commonly used in these analyses. The ISA focuses on single pollutant model results rather than evaluating the epidemiological results in the context of the full suite of air pollutants. This can lead to double-counting or triple-counting of health effects as the air quality standards for different pollutants are reviewed.

The ISA focuses on the associations in statistical models that include only NO_2 (single-pollutant NO_2 results) and on multi-pollutant analyses that include NO_2. However, many of the studies evaluated a suite of pollutants and report results for many more outcomes. In most cases, the authors implicate air pollution in general, not specifically NO_2, as being associated with a given health endpoint.

The results for multi-pollutant models are very difficult to evaluate because the results are often mixed or inconsistent and the co-pollutants vary from study to study. There are also methodological issues raised with multi-pollutant models that can lead to misleading results. However, the associations found in single-pollutant models are known to be biased high.

[38] FR at 34437.

In the recent PM and ozone reviews, single-pollutant model results were used to estimate the strength and consistency of association. Selected single-pollutant model results were utilized as the baseline for the risk assessments. If selected single-pollutant model results are also used to claim health effects are caused by NO_2, it will be a clear case of double- or triple-counting. For example, single-pollutant ozone associations were used in the recent ozone review as evidence of a causal relation between ozone and respiratory morbidity[39] and now single-pollutant NO_2 associations are used in a similar manner to implicate a causal relation between NO_2 and the same health endpoints in the ISA.[40] Single-pollutant PM associations were also used in the recent PM review as evidence of a causal relation between PM and the same respiratory endpoints.[41]

As the air quality standard for each pollutant is reviewed in turn, the current practice of selecting specific studies and selecting specific single-pollutant associations for that pollutant results in a false appearance of consistency. If the various ISA documents for different pollutants are to be a scientifically sound basis for policy, more thorough analyses considering the full suite of pollutants are mandatory.

i. The issues of model selection uncertainty, confounding, and publication bias hinder the interpretation of air pollution epidemiological studies

Although the NOx and SOx ISAs acknowledge[42] that the summary of health effects evidence is vulnerable to the errors of publication bias and multiple testing, the final NOx ISA does not adequately reflect these concerns. For example, Figure 5.3-1 utilizes data from single-pollutant models from a wide range of different lags.

In interpreting the epidemiological evidence, EPA downplays major new findings concerning uncertainty due to model selection issues. Model selection uncertainty relates to confounding of air pollutant associations by temporal trends, weather and co-pollutants. In the ozone review, EPA acknowledged that the uncertainties in the estimates of pollutant effects are understated by consideration of the statistical uncertainty of the fitted model alone. Much more uncertainty arises from the lack of information regarding the choice of appropriate models for adjusting confounding by other covariates, and the choice of appropriate lag structures. As Lumley and Sheppard (2003) point out:

Estimation of very weak associations in the presence of measurement error and strong confounding is inherently challenging. In this situation, prudent epidemiologists should recognize that residual bias can dominate their results. Because the possible mechanisms of action and their latencies are uncertain, the biologically correct models are unknown.

[39] See Figure 1 in proposed ozone rule, 72 Federal Register 37818, July 11, 2007.

[40] NOx ISA at page 5-9, Figure 5.3-1.

[41] See Figure 1 in proposed PM rule, 71 Federal Register 2620, January 17, 2006.

[42] Second draft ISA at page 3-2.

This model selection problem is exacerbated by the common practice of screening multiple analyses and then selectively reporting only a few important results.[43]

Others have also pointed out the critical importance of model choice, particularly when effect estimates are small. For example, Smith et al. caution:

> From a statistical point of view, the common epidemiological practice of choosing variables (including lagged variables, co-pollutants, etc.) that maximize the resulting effect estimates is a dangerous approach to model selection, particularly when the effect estimates are close to 0 (i.e., RR close to 1).[44]

Smith et al. note that Lumley and Sheppard (2000)[45] showed that the effect of choosing lags in this fashion has a bias which is of the same order of magnitude as the relative risk being estimated.

The revised analyses necessitated by the problems with the commonly used software for time-series analyses clearly show that methods used for controlling temporal trends and weather can profoundly affect the results. To make matters worse, there appears to be no objective statistical test to determine whether these factors have been adequately controlled. The HEI Expert Panel[46] for the re-analysis states, "Ritov and Bickel (1990)[47] have shown, however, that for any continuous variable, no strictly data-based (i.e., statistical) method can exist by which to choose a sufficient number of degrees of freedom to insure that the amount of residual confounding due to that variable is small. This means that no matter what statistical method one uses to select the degrees of freedom, it is always logically possible that even if the true effect of pollution is null, the estimated effect is far from null due to confounding bias." The expert panel concluded further, "Neither the appropriate degree of control for time, nor the appropriate specification of the effects of weather, has been determined for time-series analyses". In other words, it is impossible to adjust temporal trends without accurate information from external sources regarding the appropriate degrees of freedom to use. Such information simply does not exist.

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[43] T. Lumley and L. Sheppard, "Time series analyses of air pollution and health: straining at gnats and swallowing camels?" Epidemiology, 14, 13-14, 2003.

[44] R. Smith , P. Guttorp, L. Sheppard, T. Lumley, and N. Ishikawa, "Comments on the Criteria Document for Particulate Matter Air Pollution," Northwest Research Center for Statistics and the Environment Technical Report Series No. 66, July 2001.

[45] T. Lumley and L. Sheppard, "Assessing seasonal confounding and model selection bias in air pollution epidemiology using positive and negative control analyses," Environmetrics, 11, 705-717 (2000).

[46] Health Effects Institute, Special Report: Revised Analyses of Time-Series Studies of Air Pollution and Health, Health Effects Institute, Cambridge, Massachusetts, at 267, 269 (2003).

[47] Y. Ritov and P. Bickel, "Achieving information bounds in non- and semi-parametric models," Ann. Stat., 18, 925-938 (1990).

With regard to uncertainty due to model selection, the Koop and Tole 2004[48] conclude:

> Point estimates of the effect of numerous air pollutants all tend to be positive, albeit small. However, when model uncertainty is accounted for in the analysis, measures of uncertainty associated with these point estimates became very large. Indeed they became so large that the hypothesis that air pollution has no effect on mortality is not implausible. On the basis of these results, we recommend against the use of point estimates from time-series data to set regulatory standards for air pollution exposure.

Publication bias is another major issue in interpreting the epidemiology. The commentary by Goodman concerning meta-analyses is particularly insightful.[49] He notes a factor of at least three differences between the results of ozone meta-analyses and the NMMAPS data that is not affected by publication bias. Goodman concludes the implications of an EPA-sponsored exercise of funding three separate meta-analyses "go far beyond the question of the ozone mortality effect." He cautions that "depending on published single-estimate, single-site analyses are an invitation to bias." He notes that "the most plausible explanation is the one suggested by the authors, that investigators tend to report, if not believe, the analysis that produces the strongest signal; and in each single-site analysis, there are innumerable model choices that affect the estimated strength of that signal." A separate review by a panel of ten knowledgeable scientists[50] concluded that "Taken together, the meta-analyses provide evidence of a disturbingly large publication bias and model selection bias."

The issues raised in this section apply not only to the NOx ISA but also to the review of each air pollutant in turn as its air quality standard is reviewed.

ii. EPA overstates the strength and consistency of epidemiological evidence regarding various potential health effects

Inferring causation from observational (epidemiologic) associations involves consideration of a range of factors, including the strength of association, consistency, coherence, temporality, biologic plausibility, etc. The framework used in the ISA of judging the overall weight of evidence and putting various types of potential health effects into one of five categories, with different descriptors ranging from "sufficient to infer causation" to "suggestive of no causal relation," is based on similar frameworks developed for other regulatory situations.

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[48] G. Koop and L. Tole, Measuring the Health Effects of Air Pollution: to What Extent Can We Really Say that People are Dying from Bad Air, J. of Environmental Economics and Management, 47, 30-54. (2004).

[49] S. Goodman, "The Methodologic Ozone Effect," Epidemiology, 16, 430-435 (2005).

[50] Report of a Working Conference, Critical Considerations in Evaluating Scientific Evidence of Health Effects of Ambient Ozone, held in Rochester, New York, June 2007.

While the use of such a framework is to be commended, there are two issues with the effort. First, EPA has included the category "sufficient to infer a likely causal relationship (i.e., more likely than not)" between the categories "sufficient to infer a causal relationship" and "suggestive but not sufficient to infer a causal relationship." The main difference in the ISA elaboration between the "sufficient to infer a likely" and "suggestive, but not sufficient" categories is that chance, bias, and confounding are "minimized" in the first instance and "cannot be ruled out" in the second. Given the many problems with interpreting the epidemiology, as noted above, this distinction is too subtle and too subjective. Second, even though the framework is generally applied throughout the ISA, its application is not as rigorous or complete as it should be. In particular, the way consistency is evaluated in the discussion of epidemiology is less than scientifically rigorous or sound. Since ambient NO_2 occurs in conjunction with other common air pollutants, issues of confounding and surrogacy plague the interpretation of the epidemiological literature.

The ISA, using the framework regarding causality, draws separate conclusions regarding the overall weight of evidence for various potential health effects. For short-term exposures to NO_2 and cardiovascular morbidity, the chapter concludes that the available evidence is inadequate to infer the presence or absence of a causal relationship at this time. For short-term exposure and mortality, the data is described as suggestive but not sufficient to infer a causal relationship. For long-term exposure and respiratory morbidity, the evidence is also described as suggestive but not sufficient to infer a causal relationship. For long-term exposure and other morbidity effects, the evidence is described as inadequate to infer the presence or absence of a causal relationship. For long-term exposure and mortality, the evidence is described as inadequate to infer the presence or absence of a causal relationship. As described elsewhere in this critique, the evidence for those categories of effect noted as suggestive is actually weaker than described in the ISA and the proposal.

Only in the case of short-term exposure and respiratory effects does the ISA conclude that the data are sufficient to infer a likely causal relationship. The term "likely" in this case, is defined as more likely than not.[51]

First, the conclusion is drawn with regard to the general category of acute respiratory effects, with the ISA referring to a range of respiratory effects. When the evidence for each category of respiratory effect is examined, the results are mixed and inconsistent. The types of evidence as well as the consistency and coherence vary substantially with the type of respiratory effect. Each is discussed in turn below.

Second, for integrating and interpreting the epidemiological results, the reliance on single pollutant model results weakens the case for causality.

[51] NOx ISA at 5-2.

Third, with regard to the epidemiology, the strong possibility that NO_2 is acting as a surrogate for another pollutant(s) or the mix of pollutants generally also weakens the case for causality.

Fourth, the ISA itself highly mitigates the argument for consistency and coherence. For example, the ISA notes that:[52]

"The epidemiologic evidence for respiratory effects can be characterized as consistent, in that associations are reported in studies conducted in numerous locations with a variety of methodological approaches. The findings are coherent in the sense that the studies report associations with respiratory health outcomes that are logically linked together."

This weak definition of consistency and coherence is akin to the counting of studies that the ISA argues in Chapter 1 is not credible:

"A tallying of studies reporting statistically significant or nonsignificant results does not point toward credible conclusions about the relative weight of the evidence and the likelihood of causality."[53]

In the conclusions of the ISA (Section 5.4), the new body of epidemiological studies is said to provide the strongest evidence of associations with respiratory symptoms and ED and hospital admissions for respiratory causes, that when supported with some evidence from toxicological and human clinical studies, justifies the conclusion that:

"These data sets form a plausible, consistent, and coherent description of a relationship between NO_2 exposures and an array of adverse health effects that range from the onset of respiratory symptoms to hospital admission."[54]

Based on the comments and analysis in this critique, this broad a statement is unwarranted. While there is evidence for respiratory effects from NO_2, the evidence for which there is strong causal support is similar to that in the last review.

A comparison of the conclusions from the previous review with the conclusions in the current review is given in Table 5.3-1. An examination of these sections reveals that the evidence, while more extensive, does not materially change the understanding of NO_2 health effects from the previous review. For impairment of lung host defenses, there was ample evidence in the previous review from animal studies and no major change in understanding in the current review. For airways inflammation, there were no studies in

[52] NOx ISA at 5-6.

[53] NOx ISA at 1-8.

[54] NOx ISA at 5-15.

the previous review, but there are no effects in controlled studies below 1 ppm for 2 to 3 hours in the current review. For airways responsiveness, which was noted as the most sensitive indicator in the previous review, the final ISA changed the level of concern from 0.20 to 0.30 ppm to 0.10 to 0.30 ppm. As noted above, this change was not made based on any new data and is scientifically unsupportable. In addition, the effects are small, subtle changes of uncertain public health significance, and there is still no clear dose-response.

For respiratory symptoms, there was a meta-analysis of 9 gas stove studies in the previous review that was assumed to represent a causal relation. It was difficult, however, to translate the results from indoor gas stove exposures to an equivalent ambient exposure in order to use the results directly to set the ambient standard. In the current review there are a number of additional epidemiological studies, but, as noted above, these studies implicate many pollutants and are also difficult to interpret as effects of NO_2, per se. For lung function changes, the current review concludes that epidemiologic studies are generally inconsistent and the recent clinical evidence generally confirms prior findings.

The only potential respiratory health effect for which the evidence is markedly different in the current review is emergency department (ED) visits and hospital admissions for respiratory causes. However, the pattern of associations is implausibly wide and similar to that for other pollutants, making the assumption of likely NO_2 causality highly suspect.

The current annual standard was set to control both peak and mean NO_2 with few if any exceedances of 1-hr peaks of 0.20 ppm. There is nothing in the clinical data showing substantive effects on public health for healthy or compromised individuals below short-term exposures of 0.20 ppm. The only data suggesting effects below the current standard comes from epidemiology. However, as documented throughout these comments, these studies do not directly implicate NO_2, per se, and do not provide a scientifically sound basis for choosing the air quality standard.

There is a major disconnect between the results of controlled human or animal studies and the current interpretation of the epidemiological results in the ISA. The ISA, in discussing the strengths and limitations of controlled human studies, indicates that they are limited, for ethical and practical reasons, to concentrations expected to produce only mild and transient responses.[55] Since concentrations as high as 4 ppm have been used in human clinical studies, it is clear that the authors did not think that acute exposures in the ppm range would cause premature mortality or respiratory hospital admissions, or the other serious health effects that are implicated by some epidemiological studies as occurring at extremely low concentrations. Since there is a biologically implausible wide range of associations from positive to negative in systematic analyses of observational data, the epidemiological studies should be severely discounted in the current NO_2 review.

[55] NOx ISA Annexes at page 5-2.

In comments on the second draft ISA, CASAC indicated "In summary, the new scientific literature reviewed in the second draft of this ISA document provides a number of strong indications of possible NO_2 health effects, but confounding or exacerbating co-pollutants and variable findings in human clinical studies remain problematic."[56] This highly qualified statement is an accurate summary of the current state of knowledge concerning NO_2 health effects.

iii. Specific examples of the over-interpretation of the health effects epidemiological evidence can be documented

a. Emergency Department visits

The ISA and the proposal overstate the consistency of results for increased Emergency Department (ED) visits and respiratory hospital admissions associated with NO_2. The ISA restricts the main conclusion to positive associations between ambient NO_2 concentrations and ED visits and hospitalizations for all respiratory diseases and asthma.[57] The ISA notes, however, that the limited evidence does not support a relationship between ED visits and hospitalizations for COPD (chronic obstructive pulmonary disease) and ambient NO_2 levels. Further the ISA also acknowledges that there were limited studies providing inconsistent results for many of the respiratory health outcomes other than asthma, making it difficult to draw conclusions about the effects of NO_2 on these diseases.[58]

The EPA needs to acknowledge and consider the wide range of associations with regard to both biological plausibility and the limitations on the use of time series and other epidemiological studies to set ambient standards.

A careful reading of the studies of ED visits and hospital admissions for respiratory causes demonstrates that the NO_2 associations with asthma and other respiratory endpoints are not as consistent or robust as suggested by the ISA. In fact, none of the studies conclude that NO_2, per se, is the prime causal factor in exacerbation of asthma as it relates to air pollution. Most implicate a number of air pollutants, but not necessarily the same pollutants. There is much less consistency than the ISA indicates.

By including only NO_2 associations from selected literature and not putting them into context with the full range of results in the individual studies or the literature in general, the ISA gives a false impression of consistency for this data. Although the text of the ISA indicates that the focus should be on lags that make biologic sense, the data used in Chapter 5 to give the impression of consistency reports best lags that vary from day 0 to day 5, without any discussion of the issue of best lag bias.

[56] June 25, 2008 CASAC letter to Administrator Johnson.

[57] NOx ISA at page 3-41.

[58] NOx ISA at page 3-41.

Several reviews of this ED literature acknowledge the inconsistencies of the implicated pollutant and health endpoints. The Anderson, et al. 1998 study of asthma admissions in London from 1987-1992 concludes that ozone, SO_2, NO_2, and particles all had positive associations with asthma admissions in the dataset, but that there was a lack of consistency across age groups and seasons. Anderson et al. also identified 15 other studies of air pollution and daily asthma admissions in the literature with satisfactory methodology. They evaluated the consistency of these studies and report that, in the all-age group, 3 studies did not find significant associations with any of the pollutants assessed and the proportions with significant findings for ozone, SO_2, NO_2, and particles were 7/14, 6/12, 2/9, and 7/15, respectively. Similar results were found for adults and children considered separately.

Anderson et al. conclude "Taken overall, it is apparent that the evidence is not coherent as to whether there is an effect of pollution or the responsible pollutant."[59] They go on to indicate that ozone, SO_2, and particles were significant in no more than half the studies and that only about a quarter of the studies found significant effects from NO_2. They list a number of possible reasons for the lack of consistency, including false negatives due to lack of statistical power and false positives due to chance, multiple significance testing, post hoc hypothesis testing, or publication bias. They also note differences in pollution level and mix between cities, the presence of highly correlated pollutants, and that pollutants acting as surrogates for unmeasured pollutants or ambient aeroallergens may be involved. They conclude that, while there is evidence that all of the pollutants may have an effect on asthma, there is a lack of consistency in the specific pollutant responsible.

Atkinson et al. 1999a, also note that a number of studies have examined emergency room admissions, predominantly for asthma, with no consistent results emerging. Yang et al. 2007 and Galen et al. 2003 similarly note the inconsistencies among the various studies in the literature.

A major reason for the inconsistent results is demonstrated by the extremely wide variability in individual city associations for hospital admissions and other health endpoints reported in multi-city studies. For example, the Medina-Ramon, et al. 2006[60] study of respiratory hospital admissions in 36 U. S. cities shows that the a 0.010 ppm increase in ozone is associated with anywhere from a 10 % increase to a 10 % decrease in COPD admissions in individual cities in a single-pollutant model. Similarly a 10 $\mu g/m^3$ increase in PM10 is also associated with anywhere from a 10 % increase to a 10 % decrease in COPD admissions. For pneumonia admissions, the ranges were almost as wide. While Medina-Ramon et al. did not consider NO_2 in their analyses, there are a

[59] Anderson, H. R.; Ponce de Leon, A.; Bland, J. M.; Bower, J. S.; Emberlin, J.; Strachen, D. P. (1998) Air pollution, pollens, and daily admissions for asthma in London 1987-92. Thorax 53: 842-848.

[60] M. Medina-Ramon, A. Zanobetti, and J. Schwartz, "The effect of ozone and PM-10 on hospital admissions for pneumonia and chronic obstructive pulmonary disease: A national multi-city study," Am. J. Epidemiol., 163, 579-588 (2006).

number of other multi-city or systematic analyses that show a biologically implausible wide range of positive and negative associations with air pollutants including NO_2 in epidemiological analyses of mortality and morbidity.

One multi-city study that includes NO_2 is the Barnett et al. 2005 study of 7 cities in Australia and New Zealand. Barnett et al. report positive associations of respiratory admissions in children for three measures of PM and two gases (NO_2 and SO_2) but not with two other gases (ozone and CO). Importantly, Barnett et al report significant heterogeneity between cities in the NO_2 associations. As shown in their Figure 1, associations for the 1-4 age group in four of the seven cities are not statistically significant and the range in individual city associations is – 3 to + 6 % for an interquartile increase in NO_2. For the 5-14 age group, again four cities are not significant and the range of associations is from about –1 to + 12 %. Also importantly, in only one of the cities is there a positive association for both age groups. In the two other cities with positive associations in the 5-14 age group, the association in the 1-4 age group is actually negative. This pattern is not consistent with a causal relation yet the ISA relies on the combined associations without showing the range of individual city associations or the lack of consistency and coherence between the two age groups.

Although a wide range of associations (both positive and negative) is clearly evident in systematic studies, the authors of the studies either do not mention the range or mention it only in regard to there being heterogeneity in the results.

b. Respiratory symptoms

The ISA uses the results of respiratory symptom studies to claim coherence with the hospital admissions and ED admissions results.[61] However, the authors of the Mortimer et al. and Schildcrout et al. multi-city studies that the Agency relies on do not implicate NO_2, per se, but summer time air pollution and fine PM, respectively. In addition, the Schwartz et al. 1994 six-city study highly discounts the NO_2 cough association highlighted in the ISA because of the significant non-linearity in the dose-response. In fact, Schwartz et al. note that at the relatively low NO_2 ambient concentrations observed in this study, no clear associations with cough incidence could be observed. In contrast, Schwartz et al. concluded that particulate matter was associated with the incidence of all the respiratory symptoms they evaluated and that ozone was the other pollutant most likely associated with cough incidence. Several of the single city studies of respiratory symptoms included in Figure 5.3-1 also implicate other pollutants or air pollution generally. By focusing on and plotting only NO_2 results and not putting the full results of the studies in context with the author's interpretation of the data, the ISA and the proposal overstates the evidence for respiratory symptoms that might be caused by NO_2.

[61] ISA at page 3-61.

c. Acute mortality

The ISA and the proposal characterizes the epidemiologic evidence on the association of short-term exposure to NO_2 with total non-accidental and cardiopulmonary mortality as suggestive but not sufficient to infer a causal relationship.[62] It further notes that the epidemiologic studies are generally consistent in reporting positive associations but that there is little evidence available to evaluate coherence and plausibility for the observed associations, particularly for cardiovascular and total mortality. Effect estimates are said to range 0.5 to 3.6 % excess risk, and to be robust to adjustment for co-pollutants. It is acknowledged that NO_2 may be acting as a marker for other pollutants or traffic-related mixtures**.**

The ISA is properly cautious about the interpretation of studies of NO_2 and short-term mortality as a causal association. The ISA notes that NMMAPS (The National Morbidity and Mortality Air Pollution Study) is by far the largest multi-city study and that the study's authors concluded that the results did not indicate an association of NO_2 with mortality.[63] Nevertheless, the ISA uses the combined association in single-pollutant models at lag 1 from NMMAPS of 0.5 % as the low end of the range noted above. In reality, there is a wide range of individual city associations ranging from positive to negative at all three lags evaluated in NMMAPS. The individual city single-pollutant NO_2 results at lag 1 are shown below in Figure 10. At each lag, even the lags 0 and 2 for which there was no combined association (as shown in Figure 3.3-1 of the ISA), the individual city results range from minus 2 or 3 percent to plus 3 or more percent per 10 ppb (0.010 ppm) increase in ambient NO_2. As also shown in Figure 3.3-1, the combined association was not statistically significant in any multi-pollutant model.

Where other multi-city studies report individual city results, a wide range from positive to negative is also shown, for example from – 3 % to + 5 % in 12 Canadian cities evaluated in Burnett et al. 2004. Samoli et al. 2005 also shows a wide range from positive to negative for total non-accidental mortality, respiratory mortality, and cardiovascular mortality in 29 European cities.

Such a wide range from strongly positive to strongly negative is not biologically plausible. Since people spend between 80 and 90 % of their time indoors where the exposure to ambient NO_2 is roughly half of the ambient concentration, a ± 3 % change in mortality per 10 ppb (0.010 ppm) increase in ambient NO_2 is equivalent to a ± 6 % change in mortality per 10 ppb increase in personal exposure to NO_2 of ambient origin. This is even less biologically plausible. The wide range includes a substantial portion of negative associations and there is a lack of evidence of significant respiratory or cardiovascular effects in controlled studies at the concentrations implicated by the epidemiology. This indicates that the likelihood of NO_2 causing premature mortality is nil.

[62] ISA at page 5-12.

[63] ISA at page 3-50.

While there are some inverse or negative air pollution associations reported in the literature (implying an unlikely protective effect from exposure to the pollutant), the NMMAPS study shows that there are actually many more "negative" associations in the data than reported in the literature. When the statistical issues with the General Additive Model (GAM) were raised, Ito[64] systematically re-analyzed the 1220 separate air pollution mortality and morbidity associations that were included in the original Lippmann et al. 2000 study of Detroit. Comparing the results using the General Linear Model (GLM) to those with the suspect GAM (Figure 11) shows a wide range of negative and positive excess risks (associations) in Detroit when a large number of pollutants, lags and morbidity and mortality endpoints were considered. All the combinations of pollutant, lag and health outcome evaluated in the original Lippmann study were considered plausible candidates for air pollution health effects. Ito showed in separate figures that the wide range of associations occurred for each pollutant. Although the focus in the original Lippmann study, like most published literature, was on the positive associations, Ito's plot shows that there are many negative associations in the data.

[64] K. Ito,"Associations of Particulate Matter Components with Daily Mortality and Morbidity in Detroit, Michigan," in Health Effects Institute, Special Report: Revised Analyses of Time-Series Studies of Air Pollution and Health, May 5, 2003, at 143-156.

Figure 10

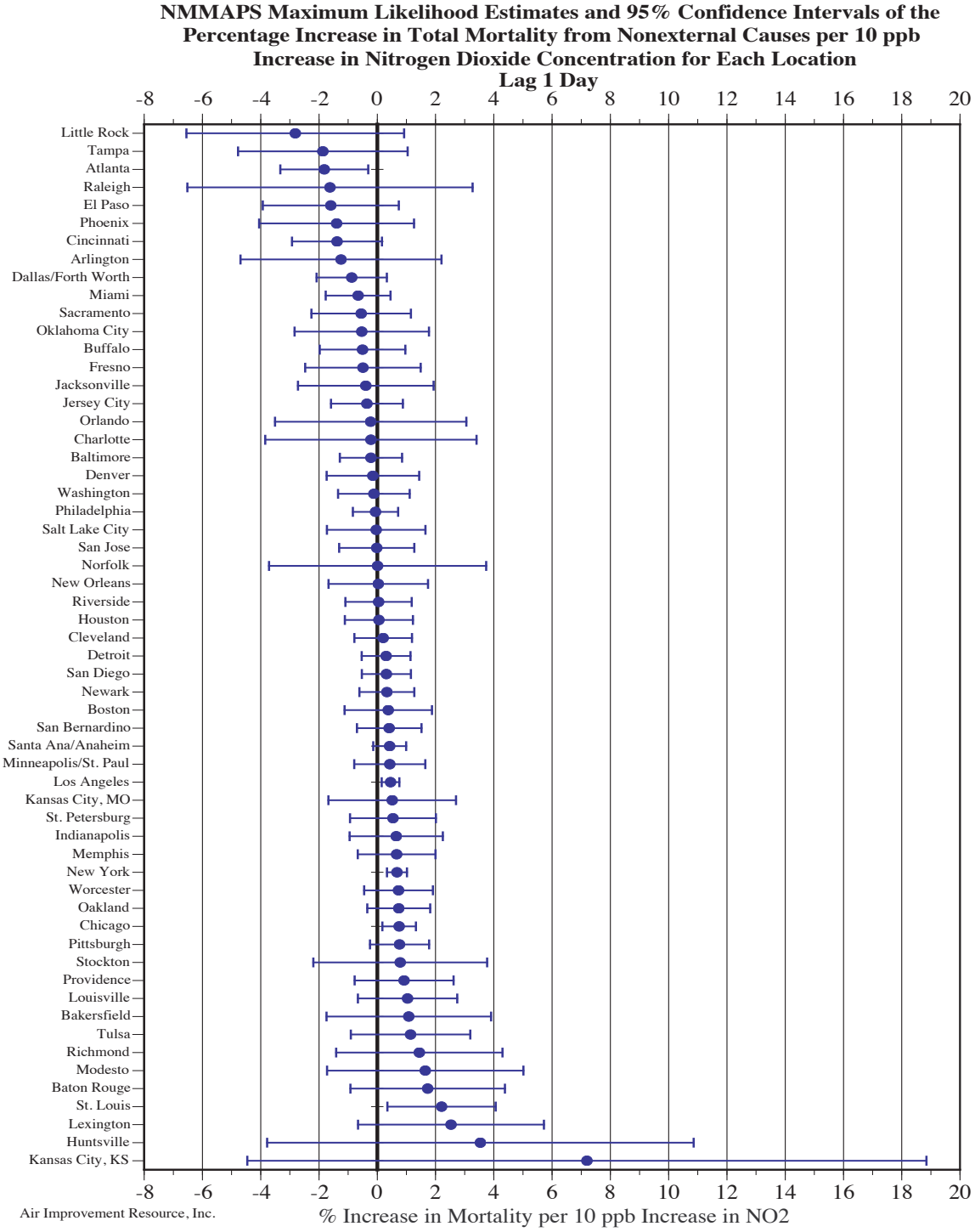
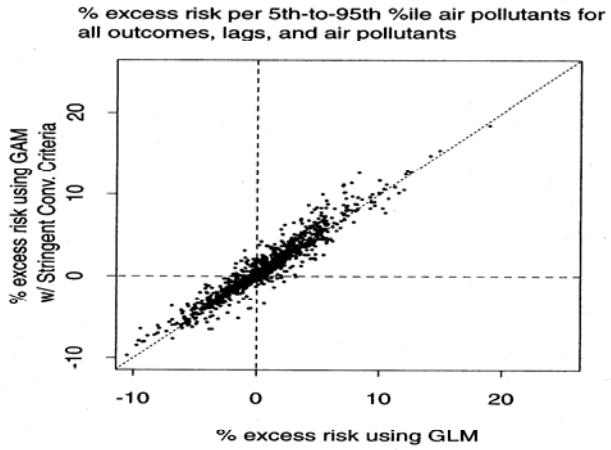

NMMAPS Maximum Likelihood Estimates and 95% Confidence Intervals of the Percentage Increase in Total Mortality from Nonexternal Causes per 10 ppb Increase in Nitrogen Dioxide Concentration for Each Location
Lag 1 Day
-8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20
Little Rock
Tampa
Atlanta
Raleigh
El Paso
Phoenix
Cincinnati
Arlington
Dallas/Forth Worth
Miami
Sacramento
Oklahoma City
Buffalo
Fresno
Jacksonville
Jersey City
Orlando
Charlotte
Baltimore
Denver
Washington
Philadelphia
Salt Lake City
San Jose
Norfolk
New Orleans
Riverside
Houston
Cleveland
Detroit
San Diego
Newark
Boston
San Bernardino
Santa Ana/Anaheim
Minneapolis/St. Paul
Los Angeles
Kansas City, MO
St. Petersburg
Indianapolis
Memphis
New York
Worcester
Oakland
Chicago
Pittsburgh
Stockton
Providence
Louisville
Bakersfield
Tulsa
Richmond
Modesto
Baton Rouge
St. Louis
Lexington
Huntsville
Kansas City, KS
-8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20
Air Improvement Resource, Inc.
% Increase in Mortality per 10 ppb Increase in NO2

Figure 11: Comparison of results using the General Additive Model with the General Linear Model, Figure 2 From Ito 2003



Although there may be somewhat more positive associations than negative associations, there is significant noise or variability in the data. It is beyond the capability of current methods to identify which positive associations may be real health effects and which are not. Time-series epidemiology of air pollution associations is only capable of very blunt analysis. CASAC raised this issue in a June 2006 letter to the Administrator, noting that "because results of time-series studies implicate all of the criteria pollutants, findings of mortality time-series studies do not seem to allow us to confidently attribute observed effects specifically to individual pollutants."[65] Further, due mainly to exposure misclassification concerns, they questioned the utility of the time-series mortality estimates. The Agency needs to acknowledge the stochastic variability in time series associations (both positive and negative) and consider the implications of that variability in both the interpretation of the epidemiology and its integration with results from controlled studies.

One implication of the variability documented in Figures 10 and 11 and in other systematic analyses is that it is not surprising to find some positive NO_2 associations (or other pollutants) in the literature for any health endpoint that is evaluated, even for endpoints where there is no underlying effect. This raises a serious question about the approach taken in the ISA of documenting any and all NO_2 associations in the observational literature. Such an approach is insufficient to establish consistency or coherence. A more holistic and rigorous evaluation of the observational literature is needed if double- and triple-counting of health effects is to be avoided.

[65] R. Henderson, CASAC letter, EPA-CASAC-06-07, June 5, 2006 at page 3.

The lack of a consistent acute cardiovascular morbidity signal in the data also argues against the presence of an acute causal mortality effect of NO_2. The ISA concludes that the available evidence on the effect of short-term exposure to NO_2 on cardiovascular health effects is inadequate to infer the presence or absence of a causal relationship at this time.[66] Evidence from epidemiologic studies of heart rate variability, repolarization changes, and cardiac rhythm disorders among heart patients is described as inconsistent. In most studies, the ISA indicates that observed associations with PM were similar or stronger than associations with NO_2. The ISA also indicates that generally positive associations between ambient NO_2 concentrations and hospital admissions or ED visits for cardiovascular disease have been reported in single-pollutant models but that most of the effect estimates were diminished in multipollutant models also containing CO and PM indices. Mechanistic evidence of a role for NO_2 in the development of cardiovascular disease from studies of biomarkers of inflammation, cell adhesion, coagulation, and thrombosis is described as lacking. Furthermore, the ISA indicates that effects of NO_2 on various hematological parameters in animals are inconsistent and, thus, provide little biological plausibility for effects of NO_2 on the cardiovascular system.

d. Chronic Morbidity

The ISA describes the overall evidence examining the effect of long-term exposure to NO_2 on respiratory morbidity as suggestive but not sufficient to infer a casual relationship at this time. The ISA focuses on lung function growth decrements in children reported in the Southern California Children's Health Study (CHS) as especially important.[67] The ISA includes discussion of the Rojas-Martinez et al. 2007 and Oftedal et al. 2008 studies as well noting that studies of lung function demonstrate some of the strongest effects of long-term exposure to NO_2.[68] The ISA overstates the case for NO_2 causing the decrements in lung function growth in children observed in cohort studies.

The ISA shows in Figure 3-4.3 that while NO_2 and several other pollutants are correlated with reduced lung function growth in children in the CHS, ozone is not. Similarly, Figure 3-4.2 in the first draft ISA showed a correlation of asthma with a number of pollutants including NO_2 but not with ozone in the CHS. The Rojas-Martinez study of lung function growth in Mexico City reported positive associations with a number of pollutants including NO_2, PM10, and ozone. However, the ozone association in multi-pollutant models was smaller and non-significant in boys, the group that would be expected to have the greatest exposure to ambient ozone. Oftedal et al. reported associations of NO_2 and PM with reduced expiratory flow variables, especially in girls, but not with forced volumes, FCV and FEV_1. In all three studies, independent effects of correlated pollutants could not be determined. Therefore, the ISA properly concludes

[66] NOx ISA at page 3-70.

[67] First draft NOx ISA at page 5-11 and page 5-15.

[68] NOx ISA at page 3-81.

that the high correlation among related pollutants made it difficult to accurately estimate the independent effects in these long-term exposure studies.[69]

Since ozone and NO_2 have similar mechanisms of action but ozone is a much stronger oxidant and shows toxicity at lower levels than NO_2, it is extremely unlikely that NO_2 is causing the observed lung function growth effects. Both ozone and NO_2 are irritating and oxidizing gases. However, the chemical oxidizing power (as measured in the neutral KI method) of NO_2 is only one-fifth that of ozone. In addition, although both gases demonstrate similar types of responses in controlled tests, the doses required to cause those effects are much higher for NO_2. Since the mean ambient concentration of NO_2 in urban areas is somewhat below the mean ambient ozone concentration in urban, suburban, and rural areas, it is highly unlikely that NO_2 is the causal factor for lung function growth effects. Thus, the lung growth studies do not provide a basis for an annual standard.

The ISA concludes that epidemiologic studies conducted in both the United States and Europe have produced inconsistent results regarding an association between long-term exposure to NO_2 and respiratory symptoms.[70] It goes on to note that while some positive associations were noted, a large number of symptom outcomes were examined and the results across specific outcomes were inconsistent. In relation to asthma, the ISA concludes that overall, results from the available epidemiologic evidence investigating the association between long-term exposure to NO_2 and increases in asthma prevalence and incidence are inconsistent.[71]

e. Chronic Mortality

The ISA concludes that the data is "inadequate to infer the presence or absence of a causal relationship" noting that the studies were generally inconsistent and that, when associations were suggested, they were not specific to NO_2.[72]

The U. S. studies that the Agency relies on to implicate PM in chronic mortality demonstrate no association of NO_2 with chronic mortality. Chapter 3 of the ISA discusses three major U. S. studies that report no association of NO_2 with long-term mortality. The large American Cancer Society study, the AHSMOG study which includes the high NO_2 areas of California, and the new Women's Health Initiative Study each show no association of NO_2 with chronic mortality. The lack of a chronic mortality signal raises additional questions as to how there could be an acute mortality effect of NO_2.

[69] NOx ISA at page 5-17.

[70] See NOx ISA at section 3.4.3 and page 5-17.

[71] NOx ISA at page 3-92.

[72] NOx ISA at 5-18.

3. Key flaws and unsupported assumptions in the Agency's analysis.

In the case of the evidence for NO_2 health effects, the proposal relies on a new but unpublished meta-analysis that was inserted into the final ISA to claim effects on airway reactivity for asthmatics at 0.10 ppm. During the previous review, EPA staff concluded (based on a meta-analysis published in 1992) that, for a subset of asthmatics, exposures in the range of 0.20 to 0.30 ppm may cause increased airway reactivity. The health implications of an acute increase in nonspecific airway responsiveness are unclear. While the proposal notes that it could potentially lead to a temporary exacerbation of asthma symptoms and possibly increased medication use, there were no reported incidences of increased medication usage following NO_2 exposure in the 25 studies evaluated. In the current review, EPA inserted reference to a new but unpublished meta-analysis in the final ISA to claim effects at 0.10 ppm. However, that analysis included data from a 1976 paper that was disregarded in the 1996 review since numerous other studies had not observed airway reactivity effects at 0.10 to 0.12 ppm. There is no new data published since the previous review to demonstrate effects at 0.10 ppm. When the State of California recently reviewed its state NO_2 standards, its experts reviewed the same studies as did EPA, and they concluded that the first subtle effects from short-term exposures occur in the 0.20 to 0.30 ppm range and California set an 0.18 ppm 1-hour NO_2 standard.

In the case of the REA, however, EPA inappropriately applied a dispersion model that has not been tested to validate its ability to predict the extreme values of roadway and near roadway exposures. The model was used to estimate near roadway and neighborhood NO_2 exposures, resulting in overestimates of both types of exposure. As demonstrated in section IB, there are no data from on-roadway or near roadway studies in the observational literature that report 1-hour NO_2 concentrations that exceed the 0.20 and 0.30 ppm benchmarks. By relying on an unreliable model, EPA overestimates the risk from current ambient concentrations and the contribution from on-roadway and near-roadway exposures to the risk.

With regard to the monitoring network, the Agency inappropriately assumed that "the current network does not include monitors placed near major roadways and, therefore, monitors in the current network do not necessarily measure the maximum concentrations that can occur on a localized scale near these roadways"[73] and inappropriately assumed that near-roadway concentrations were 30 to 80 % higher than neighborhood concentrations. In actuality, as documented in Section I, the current monitoring network does include monitors located near major roadways and the 98th or 99th percentile 1-hour concentrations at those monitors are similar to or only slightly higher than the concentrations measured at sites at greater distances from roadways. In the most recent years, as shown in Figure 2, the 99th percentile 1-hour NO_2 concentrations (within 20 meters of roads or further from roads) do not exceed 0.10 ppm. The EPA analysis of the relation between neighborhood concentrations and near road concentrations is incorrect because it does not consider the fact that NO is converted to NO_2 by photochemical reactions as it is transported downwind of roads so the fraction of NOx that is NO_2 is greater in downwind areas than near the roadway source.

[73] 74 Federal Register at 34408.

4. Specific Concerns with EPA's Proposal

In light of the flaws and unsupported assumptions identified above, this section addresses our concerns with EPA's proposal. Specifically, the discussion of the appropriate indicator, averaging time, form, and range for the level of the primary standard is incomplete and overly-conservative.

Chapter 5 of the REA identified potential alternative standards for analysis. The discussion in the proposal follows the REA closely. Because the ISA concluded that the only area where there was information sufficient to infer a likely causal relationship was for effects of short-term exposure to NO_2 on respiratory morbidity, the proposal focuses on short-term endpoints and a potential short-term standard.

Indicator: Since the vast majority of information on the health effects of various oxides of nitrogen relates to nitrogen dioxide, we agree that NO_2 remains the appropriate indicator. However, the ISA and the proposal[74] acknowledge that current monitoring overestimates the ambient concentrations of NO_2 due to positive interferences from other gaseous species. The impact of the overestimation and the extent to which it provides a margin of safety in the primary standard should be explicitly considered for the final rule. In addition, EPA is encouraged to develop and implement a federal reference method that is not prone to positive interferences.

Averaging time: Staff has chosen to evaluate standards with a 1-hour averaging time. Given the evidence from controlled studies of respiratory effects from short-term exposures, this is reasonable. However, implementing a 1-hour standard may be very difficult given the limitations of current atmospheric models. Therefore, consideration should be given to alternative standards and approaches that can provide equal protection but can be implemented in a practical manner. While the focus of the current review has been on short-term standards, the unsupported assumptions identified above have exaggerated the perceived need for a short-term standard to supplement the annual standard. After these issues are corrected, EPA should re-visit the question of whether a short-term standard is indeed needed.

In the previous review, completed in 1996, the annual average standard was chosen to limit chronic exposures and to avoid peak 1-hr ambient concentrations of 0.20 ppm and above. A key issue in the current review is the extent to which new information materially changes our understanding of the health effects of NO_2. As documented in Section II, the understanding of NO_2 health effects based on controlled studies of humans and animals has not changed substantively since the last review. While there are many more epidemiological studies reporting associations of NO_2 with health endpoints since the last review, there are numerous issues with the epidemiological studies (documented in Section III) that limit their usefulness in the current review.

[74] FR at 34440.

Form: Staff recognized the need for a stable and robust regulatory target and so recommends a 98th or 99th percentile form averaged over three years akin to the judgment made in the recent PM NAAQS review. This would be a 98th or 99th percentile of the 1-hour daily maximum NO_2 concentrations at a site. We encourage the development of a stable and robust target that is linked both to effects of concern and a modeling system that can be used to develop a robust State Implementation Plan. Therefore, a 98th percentile standard would be preferable to a 99th percentile standard. We note that CASAC has recommended the 98th percentile in its September 9, 2009 letter to the Administrator. EPA should evaluate the stability of various percentiles from 95th to 99th using the current monitoring data to determine the relative stability of various forms.

Level: To determine a range of levels for a short-term standard Staff evaluated both the human clinical and epidemiological databases. The REA and the proposal note that only effect detected in controlled human studies that is expected at or near ambient levels is airway hyperresponsiveness in asthmatics. From epidemiology, there are various positive associations of NO_2 with respiratory endpoints in single-pollutant models but, as indicated in footnote 6, referring to the staff's preferred studies in Figures 5-1 and 5-2, the effect estimates only retained statistical significance in one of the studies that evaluated multi-pollutant models.

Based on the airway responsiveness results and the epidemiologic studies, staff indicated that an appropriate upper end of the range of potential standard levels is a daily maximum 1-hr concentration of 0.20 ppm. Since the evidence for causality is strong for the controlled studies but weak and controversial for the observational studies, we believe more weight should be put on the controlled studies in choosing an appropriate range. Since the effects at 0.20 ppm in controlled studies are subclinical, the choice of 0.20 ppm as the upper end of the range is already health conservative. As noted above, California evaluated the same body of clinical studies recently and set a 1-hour standard of 0.18 ppm.

In identifying additional levels to analyze in the REA, staff considered observational studies reporting associations in areas with low NO_2 concentrations, the new meta-analysis referred to above that claims airway responsiveness effects at 0.10 ppm, and the lack of controlled studies of severe asthmatics who could experience increased effects compared to mild asthmatics. Based on these considerations, staff indicated that standard levels of 0.10 and 0.15 ppm would be considered.

Since the new meta-analysis uncritically includes data that was rejected in the prior review, there is no reason to alter the judgment in 1995 that there are no significant effects on responsiveness in asthmatics at 0.10 to 0.12 ppm. Therefore, the choice of potential standards in the REA and in EPA's proposal is overly conservative. Both CASAC and EPA have incorrectly assumed that the threshold for the first effects of NO_2 is 0.10 ppm based on the un-reviewed and flawed meta-analysis.

Dr. Goodman of Gradient Corporation participated in an August 10, 2009 CASAC teleconference on the proposal and indicated that Gradient has conducted more rigorous meta-analyses and meta-regressions, including 10 additional studies, and using more

current and appropriate meta-analysis techniques.[75] Dr. Goodman indicated that Gradient found there is no evidence to suggest that NO_2 leads to significant adverse effects at any of the exposures tested, up to 0.6 ppm. We urge the Agency to fully consider the Gradient analysis when it comes available.

Given the nature of the first subclinical effects of NO_2, the upper end of range could well be 0.30 ppm and still be health protective. The lower end of the range could be 0.20 ppm or somewhat lower if a margin of safety is desired. However, it should also be borne in mind that the allowed frequency of occurrence of a short-term standard, by itself, provides a substantial margin of safety.

Finally, staff referred to the Delfino et al. 2002[76] study reporting an association with asthma symptoms in a location with low NO_2 to support the choice of 0.05 ppm as the low end of the range. There are several reasons why the Delfino et al. 2002 study should not be used to define the low end of the range.

First, the use of epidemiological associations to choose potential standards is equivocal and misleading. Given the biologically implausible wide range of positive and negative associations in time-series studies of ambient pollutants in systematic analyses, the search for the epidemiological study that reports the strongest association with NO_2 (or with any other pollutant) at the lowest concentration of the pollutant will tend to identify an outlier, not a real effect. Second, the Delfino et al. study itself does not implicate NO_2 as an independent causal agent. The single-pollutant association with 1-hour NO_2 was not significant, but the association with 8-hour NO_2 was statistically significant. However, the association became non-significant in a two-pollutant model with PM10. Delfino et al. evaluated a number of pollutants and aeroallergens. The authors also state when both aeroallergens and air pollutants were included in the same model, a decrease in regression parameters for both exposures was observed. However, the actual data for NO_2 with aeroallergens are not presented.

Third, Delfino et al. concluded that peak levels of PM_{10} rather than NO_2 was the air pollution component of concern in their study, noting that their findings "point to the potential relevance of peak PM10 exposures to acute respiratory effects." Fourth, in discussing the NO_2 results, Delfino et al. indicate that the respiratory effects of NO_2 on asthma are not entirely clear, and there are inconsistencies in the experimental literature. They specifically note that while several epidemiologic time-series studies have shown an increase in risk of asthma hospital admissions or emergency department visits with increases in outdoor NO_2 levels, many more have reported either no results or results that

[75] J. Goodman, Comments on US EPA's Proposed Revisions to the NO2 NAAQS, presented to CASAC on behalf of the American Petroleum Institute, August 10, 2009.

[76] R. Delfino, R. Zeiger, J. Seltzer, D. Street, and C. McLaren, "Association of Asthma Symptoms with Peak Particulate Air Pollution and Effect Modification by Anti-inflammatory Medication Use," Environ. Health Perspect., 110:A607–A617 (2002).

were nonsignificant for NO_2.

In summary, the EPA conclusions on the relevance of the NO_2 associations in the Delfino study go far beyond the author's own conclusions concerning their data. Thus, the Delfino et al. study is not an adequate scientific justification for choosing 0.05 ppm or 0.065 ppm as the low end of the range of potential short-term primary standards to be considered by EPA.

B. EPA Cannot Base Decisions Regarding The Stringency Of A NO_2 NAAQS On Unsettled Questions Concerning The Proper Design Of A NO_2 Monitoring Network For Which It Is Concurrently Seeking Public Comment.

As referenced previously, EPA has conjoined its decision concerning a health protective level of a NO_2 NAAQS with deployment of approximately 165 new monitors in microenvironments abutting heavily-traveled roads.[77] This fact is not hidden or implicit within the Preamble, but clearly stated. EPA is taking comment with regard to "[The Administrator's] use of available information on the NO_2 concentration gradient around roadways (i.e. that concentrations near roadways can be 30 to 100% higher than concentrations in the same area but not near the road) *to inform an appropriate range of standard levels*."[78] (Emphasis added).

The August 10th document cited above expresses draft CASAC views about the appropriateness of this unprecedented approach to setting a NAAQS. The fact is that EPA's various judgments in the Preamble regarding the emissions generated by roadways are not based on reliable estimates defining the NO_2 concentration gradients. Yet the July 15th proposal incorporates a future, undefined monitoring network based on such estimates and such gradients directly into the decisions EPA made with respect to the proposal of primary standards for NO_2.

To recount the information EPA considered regarding near-roadway monitoring in its proposed standards: only three NO_2 monitors were classified by the Agency as representing microscale areas of 50 meters or less. It is unclear to highly improbable as to whether any of the three existing monitors would meet the proposed siting criteria for new monitors.[79] Moreover, the Alliance has previously detailed its concerns regarding the information on near-roadway monitoring cited in the NO_2 REA and the EPA's

[77] As proposed, 142 new sites would be required in areas with a population greater than 350,000 persons and a second roadside monitor in 23 additional sites having a population greater than 2,500,000 persons. (74 Fed. Reg. at 34442).

[78] 74 Fed. Reg. at 34438.

[79] Among other requirements, the proposed monitoring regulations require that near-road monitoring stations "be selected by ranking all road segments within a CBSA by AADT (annual average daily traffic) and then identifying the location of locations adjacent to those highest ranked road segments where maximum hourly NO_2 concentrations are expected to be highest and siting criteria can be met in accordance with appendix E of this part . . ." Proposed regulations for Part 58, Appendix D, 4.3.2(1), 74 Fed. Reg. at 34464.

reliance on information contained in eleven papers, most from countries other than the United States and more than half of which are 14 to 27 years old. Thus, EPA's indication that area-wide monitoring compared with microscale monitoring is associated with relative levels at the different monitoring scales of 30 to 100% does not reflect an assessment of what the Agency is proposing as the future monitoring network. Instead, by definition, the estimated relationship between such monitors is based on historical data and the monitors were not deployed in accordance with the specific monitoring regulations proposed in this rulemaking. This uncertainty further compounds the uncertainty surrounding exposure estimates contained in the REA, which also formed part of EPA's judgment in proposing standards. As indicated in the Preamble, the extent to which the air quality data used in the REA was representative of times and laces included in the analysis is "unknown"[80] and the extent to which such results "are representative of other locations in the U.S. is "uncertain."[81]

Indeed, the uncertainty of what monitoring network may be finalized by the Agency as part of the ongoing proceeding and how EPA may ultimately judge the relationship between a final decision on the monitoring network and the separate statutory decision with respect to the level of the NAAQS produces substantial difficulties in responding to the opportunity to comment. Within the current proposal, EPA seeks comment on the near-road monitoring requirement itself, the selection of sites ranked by traffic volume, the consideration of population exposure as a selection criteria, the road distance "set back" requirement and the proposed height of monitor probes.[82] Presumably, other alternatives to the proposed monitoring network, aside from the alternative proposal -- or perhaps in consideration of the alternative -- may constitute local outgrowths of the proposal. By linking the final monitoring network and its unknown relationship to either data produced by the current area-wide monitoring system or to historical data utilized in the REA, the proposed rule has unalterably injected an unknown quantity into EPA's final judgments as to a requisite level of the NO_2 NAAQS.

Moreover, a NAAQS level that is linked to future deployed monitoring system is inherently arbitrary and subject to manipulation. As indicated, EPA first lacks sufficient knowledge of the measurement properties of such a system on which to base a decision regarding the level and form of a NO_2 NAAQS. In addition, however, the proposed monitoring regulations allow flexibility for states to select final monitor locations. For example, a state or local air monitoring agency can take the potential for population exposure into account where multiple acceptable candidate sites are identified, but it is not affirmatively required to do so. In situations where more than one near-road monitor is required, the proposed regulations would require differentiation between the two monitor sites based on eight different criteria without direction as to how each criteria must be evaluated within each such area. In addition, an EPA Regional Administrator may require additional NO_2 monitoring stations above the minimum requirement.[83]

[80] 74 Fed. Reg. at 34423.

[81] *Id*.

[82] *Id.* at 34444.

[83] Proposed monitoring regulations for Part 58, Appendix D., 74 Fed. Reg. at 34464.

In other words, the effective stringency of a NAAQS depends on more than simply the numerical level selected. It also depends on the sensitivity of the monitoring system, and the ability of that system to determine accurately the ambient levels of the pollutant in a consistent manner at monitoring stations across the country. By affixing the stringency of a primary NAAQS to a monitoring system that does not now exist and will be subject to varying interpretation by regional, state and local officials, EPA is in effect delegating the final decision on the NAAQS standard to those officials, contrary to statutory requirements that judgments concerning such standards reside with the Administrator.[84]

For the above reasons, it is also apparent that potential standard levels as low as 65 ppb (in the context of roadside monitoring) or 50 ppb in the alternative proposal for area-wide monitoring[85] would be inconsistent with the Clean Air Act because they could go far beyond that which is "requisite" to protect public health. According to the preamble, a standard as low as 65 ppb could be justified "to the extent that near-road concentrations are determined to be closer to 30% higher than area-wide concentrations or to the extent that additional emphasis is placed on the possibility that exposure to NO_2 concentrations below 100 ppb could increase airway responsiveness in some asthmatics."[86] However, this is pure speculation. Since the monitoring network does not exist and will be subject to later variable implementation, any determination regarding roadside concentrations will not occur until well after EPA is required to make its current decision regarding the level and form of the NO_2 NAAQS. With regard the effects of exposures to NO_2 concentrations of below 100 ppb on asthmatics, the proposed rule does not provide sufficient information to support a conclusion on that point.

C. EPA's Proposed Standards Do Not Conform To Section 109 Of The Clean Air Act Which Requires EPA To Establish National Standards That Are "Requisite" To Protect The Public Health Set At A Level That Is "Sufficient, But Not More Than Necessary."

The Alliance recognizes and respects that the EPA does not need actual certainty before judging that a NAAQS is required under section 109 of the Clean Air Act. EPA may "err on the side of caution" in setting a NAAQS.[87] However, the discretion of EPA to promulgate protective standards is not unbounded. There must be an adequate basis in the record for the decision and decisions on a level of a primary NAAQS standard must

[84] Section 109(b)(1) of the CAA requires that primary NAAQS be set by the Administrator through the "judgment of the Administrator."

[85] The alternative proposal put forward also solicits comment on a range of standards and is similar linked to the consideration of a ratio between area-wide and roadside monitoring values. For example, the alternative proposal indicates a level of 50 ppb would limit roadside concentrations to between 65 and 100 based on the range of the ratio cited elsewhere in the Preamble for area-wide to roadside monitoring values (30-100%). (74 Fed. Reg. at 34438).

[86] 74 Fed. Reg. at 34438.

[87] *American Farm Bureau Federation and National Pork Producers Council v. EPA*, United States Court of Appeals for the District of Columbia Circuit (February 24, 2009) citing *Lead Industries Ass'n v. EPA*, 647 F. 2d 1130 (D.C. Cir. 1976).[put in USC cite]

be -requisite- to protect public health. Section 109 of the Clean Air Act ("CAA") provides that national ambient air quality standards be "based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health."[88] As the Supreme Court indicated in its decision in *Whitman v. American Trucking Associations* (531 U.S. 457, 2001), citing the government's brief:

> We agree with the Solicitor General that the text of §109(b)(1) of the CAA at a minimum requires that "[f]or a discrete set of pollutants and based on published air quality criteria that reflect the latest scientific knowledge, [the] EPA must establish uniform national standards at a level that is requisite to protect public health from the adverse effects of the pollutant in the ambient air." Tr. of Oral Arg. in No. 99--1257, p. 5. Requisite, in turn, "mean[s] sufficient, but not more than necessary." *Id*., at 7. . . .

While EPA indicates that "we have identified exposure to NO_2 at a level of 100 ppb to be the lowest level at which effects have been observed in controlled human exposure studies,"[89] EPA judges that standards below 100 ppb would be expected to limit area-wide concentrations to certain defined levels. For example, EPA indicates that "a standard level of 80 ppb would be expected to limit area-wide concentrations to approximately 50 ppb (80 is 65% higher than 50)."[90] While EPA also cites findings from epidemiological studies and controlled human exposure studies in making this proposal, it is clear that the calculation of the lower bound of the proposed standard is based on the relationship between microscale monitoring and area-wide monitoring, a relationship that elsewhere in the Preamble is acknowledged to be variable and subject to a wide range of estimation, in one iteration by a factor exceeding 300%.

EPA's proposal therefore runs afoul of the Supreme Court's interpretation of section 109 of the CAA for two primary reasons. First, the Supreme Court indicated that a NAAQS level should reflect the "latest scientific knowledge." Knowledge is defined in Webster's Dictionary as "the fact or condition of knowing something with familiarity grained through experience or association." While EPA relied on various estimates of a supposed ratio between area-wide monitored levels of NO_2 and microscale monitoring of NO_2 near roadways, the information presented in the Preamble and supporting documents does not rise to the level of "fact" or the "condition of knowing" with enough precision and confidence to inform EPA's decision making. The data and analysis the Alliance presents with these comments reveals that EPA's estimates of large variations between area-wide and roadside monitoring values are incorrect. Second, should EPA decide not accept the Alliance analysis on this matter and instead rely on the estimates it presented in the Preamble, taking this course would result in a standards are more than requisite to protect public health and/or standards or do not represent "uniform national standards." That is, if EPA selects a value at any point in an unproven range, the probable result is that the ratio would arbitrarily apply more stringently in some areas as opposed to others, and

[88] Section 109(b)(1) of the Clean Air Act (43 U.S.C. 7401 *et seq*).

[89] 74 Fed. Reg. at 34434.

[90] *Id.* at 34437.

effectively be more than necessary to protect the public health in those areas. This fact would not be "cured" by selecting the most extreme value in a range, perhaps on the theory that such an action would amount to an abundance of caution. Instead, disparities in the treatment of areas would likely be magnified since EPA has not been able to articulate anywhere in the rulemaking record that any one ratio is more certain than any other and thus all are presumably equally probable.[91]

[91] Estimates in the Preamble concerning the microscale/area-wide monitoring relationship describe the relationship as varying between locations and over time and that the relationship ratio "*may be 30 to 100%*."(Emphasis added) (74 Fed. Reg. at 34437) Thus, conceivably, a standard utilizing the most extreme value would be over three times more stringent from one area to the next in addition to being subject to measurement variations noted elsewhere (e.g., the influence of daily traffic patterns).