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United States Environmental Protection Agency
Office of Air Quality Planning and Standards • Air Quality Strategies and Standards Division
(MD-15) • Research Triangle Park, North Carolina 27711

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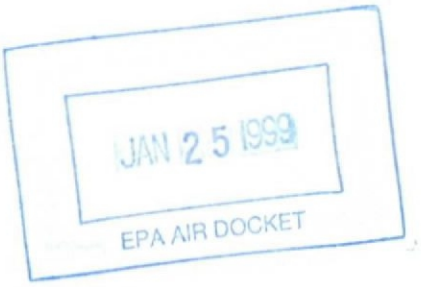

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From: **Scott Mathias**
Phone No: **(919) 541-5310**
Facsimile No: **(919) 541-0839**

Message:

Attached is a redline/strikeout version of EPA's latest revisions to the ozone mortality section of Volume 2 of the NOx SIP Call RIA (Health and Welfare Benefits). These revisions are based on written comments received from you on December 4, 1998, and additional verbal comments (via teleconference) on December 21, 1998. This latest set of revisions deletes from the ozone mortality section the discussion of the sensitivity meta-analysis based solely on epidemioligical studies with significant, positive findings of the association between ozone exposure and premature mortality (this includes deletion of the results in Table 4-9). In its place, EPA proposes to add language intended to clarify the interpretation of the "high end" ozone mortality estimates contained in Table 4-8. Please review these revisions and provide a response as soon as possible. Thanks.

cc: Ron Evans
Bryan Hubbell
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Ozone-related Mortality

The literature on the possible relationship between exposure to ambient ozone and premature mortality has been evolving rapidly. Of the 28 time-series epidemiology studies identified in the literature that report results on a possible association between daily ozone concentrations and daily mortality (see EPA, 1997a, Appendix J), 21 were published or presented since 1995. In particular, a series of studies published in 1995 through 1997 (after closure on the ozone Criteria Document) from multiple cities in western Europe has significantly increased the body of studies finding a positive association. Fifteen of the 28 studies report a statistically significant relationship between ozone and mortality, with the more recent studies tending to find statistical significance more often than the earlier studies. The ozone-mortality datasets have also tended to become larger in more recent studies as longer series of air quality monitoring data have become available over time. This suggests that it may take many years of data before the ozone effect can be separated from the daily weather and seasonal patterns with which it tends to be correlated.

In 1997, as a part of the ozone NAAQS promulgation RIA, EPA staff reviewed this recent literature. They identified 9 studies that met a defined set of selection criteria, and conducted a meta-analysis of the results of the 9 studies. The result of this work was included as Appendix J in the NAAQS RIA, "Assessment and Synthesis of Available Epidemiological Evidence of Mortality Associated with Ambient Ozone from Daily Time-series Analyses" (EPA, 1997a).

The NOx SIP call related benefits analysis implements the same basic meta-analysis approach to quantifying ozone mortality as the NAAQS RIA, with the exception that a subset of 4 of the 9 studies is used, representing only U.S. based analyses. In a post-NAAQS RIA review of the methodology for assessing ozone mortality effects, it was determined that the relationships between ambient ozone and mortality in the non-U.S. study locations included in the original NAAQS-related meta-analysis may not be representative of the range of ozone-mortality concentration-response relationships in the United States. Although ozone is the same everywhere (in contrast to PM), its effects on mortality may depend on its interactions with other pollutants and with meteorological variables. In addition, there are population and societal differences (air conditioning incidence, building construction, human activity patterns, etc.) across locations that could affect the relationship between ambient ozone levels and mortality. To reduce the potential for applying inappropriate concentration-response functions in analysis of the ozone mortality benefits from the NOx SIP call, only U.S. studies are included, based on the assumption that demographic and environmental conditions on average would be more similar between the study and policy sites. However, the full body of peer-reviewed ozone mortality studies should be considered when evaluating the weight of evidence regarding the presence of an association between ambient ozone concentrations and premature mortality.

Table 4-7
Summary of Mortality Valuation Estimates[a]

Study	Type of Estimate	Valuation per Statistical Life (millions of 1990 $)
Kneisner and Leeth (1991) (U.S.)	Labor Market	0.6
Smith and Gilbert (1984)	Labor Market	0.7
Dillingham (1985)	Labor Market	0.9
Butler (1983)	Labor Market	1.1
Miller and Guria (1991)	Contingent Valuation	1.2
Moore and Viscusi (1988a)	Labor Market	2.5
Viscusi, Magat, and Huber (1991b)	Contingent Valuation	2.7
Gegax et al. (1985)	Contingent Valuation	3.3
Marin and Psacharopoulos (1982)	Labor Market	2.8
Kneisner and Leeth (1991) (Australia)	Labor Market	3.3
Gerking, de Haan, and Schulze (1988)	Contingent Valuation	3.4
Cousineau, Lacroix, and Girard (1988)	Labor Market	3.6
Jones-Lee (1989)	Contingent Valuation	3.8
Dillingham (1985)	Labor Market	3.9
Viscusi (1978, 1979)	Labor Market	4.1
R.S Smith (1976)	Labor Market	4.6
V.K. Smith (1976)	Labor Market	4.7
Olson (1981)	Labor Market	5.2
Viscusi (1981)	Labor Market	6.5
R.S. Smith (1974)	Labor Market	7.2
Moore and Viscusi (1988a)	Labor Market	7.3
Kneisner and Leeth (1991) (Japan)	Labor Market	7.6
Herzog and Schlottman (1987)	Labor Market	9.1
Leigh and Folson (1984)	Labor Market	9.7
Leigh (1987)	Labor Market	10.4
Gaten (1988)	Labor Market	13.5

[a] Source: Viscusi, 1992

Because of differences in the averaging times used in the underlying studies (some use daily average ozone levels, while others use 1-hour daily maximum values), it is not possible to conduct a meaningful meta-analysis directly on the coefficients of the C-R functions. Instead, for each pair of air quality modeling results

(for the baseline and a given regulatory alternative) for the NOx SIP call, each C-R function is translated into a set of predicted mortality incidence changes that would be estimated by that C-R function, given the set of air quality changes. The meta-analysis approach is then applied to the predicted mortality incidence changes that would be estimated by each of the studies. Additional details of the approach are described in the technical support document for the NOx SIP call (Abt Associates, 1998a).

Table 4-8 presents the range of estimates of avoided incidences of ozone-related mortality and monetary benefits associated with five regulatory alternatives for the NOx SIP call. Note that the lower estimate for this endpoint is zero to reflect both the number of peer-reviewed studies finding no significant relationship between ozone and premature mortality and the lack of a directly established biological mechanism linking ozone and premature mortality. In its review of the epidemiological ozone-mortality literature, EPA has determined that there is a reasonable probability that increased ozone concentrations are associated with incidences of premature mortality. In Table 4-8 the higher estimate allows for the existence of an ozone-mortality relationship, but assumes there is some probability that for any specific location within the SIP call region that the effect of ozone on premature mortality is zero. This probability is embedded in the previously discussed meta-analysis approach, which includes studies both with and without findings of a statistically significant relationship between ozone concentrations and premature mortality.

Table 4-8
Range of Avoided Ozone-related Mortality Incidences and Monetary Benefits Associated with the NOx SIP Call[a]

Regulatory Alternative	Avoided Incidences (cases/year)		Monetary Benefits (millions 1990$)	
	Low	High	Low	High
0.12 Trading	0	315	$0	$1,496
0.15 Trading	0	279	$0	$1,326
Regionality 1	0	251	$0	$1,191
0.20 Trading	0	234	$0	$1,108
0.25 Trading	0	174	$0	$824

[a] Annual baseline incidence for non-accidental deaths in the general population for all ages is 803/100,000. Total annual baseline incidence for the NOx SIP call region is 1,768,014 non-accidental deaths.

Note that the high estimate presented in Table 4-8 does not represent the limiting upper end of potential ozone-related mortality benefits. The high estimate in Table 4-8 represents the mean estimate of benefits derived from the distribution of concentration-response functions generated from the meta-analysis described above. The limiting upper end for ozone-related mortality is generated by assuming that the highest concentration-response function applies everywhere. This would generate a benefits estimate considerably higher than the high estimate in Table 4-8. Because the probability of this limiting case occuring is relatively low, EPA has chosen to present the mean estimate from the meta-analysis as the high estimate. It should be noted that the probability of ozone having zero effect on mortality may be equally low. However, to provide a conservative lower bound, the low estimate in Table 4-8 is set to zero.

~~Table 4-9 shows the results of a sensitivity analysis based on the opposite of the assumption driving~~

the low-end estimate presented in Table 4-8. The results in Table 4-9 are based on the assumption that there is a positive relationship between ozone exposure and premature mortality, and that this relationship is captured by studies that find a statistically significant relationship between ozone concentrations and premature mortality. This assumption might be the preferred approach if there were strong clinical data suggesting a relationship, but, due to data and statistical limitations, epidemiological studies have had difficulty isolating an effect. The practical implication of this assumption is that one of the four studies used in the meta-analysis in Table 4-8 is dropped from the analysis in Table 4-9. This approach generates an upper-end estimate of potential avoided ozone-related premature mortality incidences and associated monetary benefits. This upper-end is presented only as a sensitivity analysis and is not included in the calculation of the high-end estimate of total ozone-related benefits in Tables 4-30 through 4-34. The monetary benefits for this sensivity analysis shown in Table 4-9 are about 45 percent higher than those shown in the primary mortality analysis.

Table 4-9
Sensitivity Analysis: Avoided Ozone-related Mortality Incidences and Monetary Benefits Associated with the NOx SIP Call -- Significant Studies Only[a]

Regulatory Alternative	Avoided Incidences (cases/year)	Monetary Benefits (millions 1990$)
0.12 Trading	460	$2,195
0.15 Trading	408	$1,947
Regionality 1	365	$1,725
0.20 Trading	341	$1,627
0.25 Trading	254	$1,211

[a] Annual baseline incidence for non-accidental deaths in the general population for all ages is 803/100,000. Total annual baseline incidence for the NOx SIP call region is 1,768,014 non-accidental deaths.