September 9, 1998

EPA-SAB-COUNCIL-ADV-98-003

Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency
401 M Street, SW
Washington, DC 20460

RE: Advisory Council on Clean Air Compliance Analysis (COUNCIL) Advisory on the Clean Air Act Amendments (CAAA) of 1990 Section 812 Prospective Study: Overview of Air Quality and Emissions Estimates Modeling, Health and Ecological Valuation Issues Initial Studies.

Dear Ms. Browner:

Pursuant to requirements of the Clean Air Act Amendments (CAAA of 1990, Section 812 (CAAA-1990, Pub. Law 101-549, November 15, 1990, 104 Stat. 2399), the Advisory Council on Clean Air Compliance Analysis ("the Council") has reviewed various issues and initial studies related to the Prospective Study of Benefits and Costs of the 1990 Clean Air Act Amendments. The Council held a public meeting on February 5-6, 1998. This followed public meetings of the Air Quality Models Subcommittee (AQMS) of the Council on January 22-23, 1998 (which addressed both air quality modeling and emissions issues) and Health and Ecological Effects Subcommittee (HEES) of the Council on January 29-30, 1998. Following final approval by the Council, the reports of these Subcommittees will also be transmitted to you.

The following charge questions were provided by the Agency staff, consistent with the review responsibilities of the Council as defined in Section 812 of the CAAA90 and are as follows:

a) Are the input data used for each component of the analysis sufficiently valid and reliable for the intended analytical purpose?

b) Are the models, and the methodologies they employ, used for each component of the analysis sufficiently valid and reliable for the intended analytical purpose?, and

c) If the answers to either of the two questions above is negative, what specific alternative assumptions, data or methodologies does the Council recommend the Agency consider using for the first prospective analysis?

While the above charge defines the general scope of the advice requested from the Council, specific questions and issues are also identified for individual analytical components in the briefing slides and discussion papers provided to the Council for the February 5 and 6, 1998 meeting.

The Council's answers to questions a) and b) above are generally in the affirmative. Indeed, we wish to congratulate the Agency on doing an admirable job in carrying out what is an inherently difficult task. To answer the issues raised in the briefings of February 5 and 6, 1998, the Council provides advice on four important issues concerning the development of the EPA's Prospective Study: 1) Scope and Objectives of the Study; 2) Measurement of Costs; 3) Measurement and Valuation of Ecological Benefits, and 4) Measurement and Valuation of Health and Welfare Benefits. (See items 4-6, below).

We also wish to underscore in this letter several issues raised by the Council's AQMS in their deliberations (these issues are addressed in detail in their forthcoming report). Specifically, we urge that the Agency address the apparent inconsistency between modeled and actual trends in particulate matter (both PM_{10} and $PM_{2.5}$) which may undermine the credibility of the Prospective Study. As noted in our letter of September 9, 1997[1], modeled PM_{10} emissions in both the pre-CAAA and post-CAAA scenarios are predicted to increase between 2000 and 2010. This is also true of ambient concentrations. This predicted increase is in stark contrast to actual ambient PM trends, which have shown a decline ranging from 33 to 17 percent between 1988 and 1994. Although the differences in PM_{10} concentrations between the pre-CAAA and post-CAAA scenarios may be accurate, the PM levels do not appear to be correct, and this inconsistency will likely undermine the credibility of the study. This issue is especially important in view of the key role that PM plays in calculating the benefits of the CAAA.

1. Scope and Objectives of the Study

1.1 *Objectives of the Study*

In terms of the scope and objectives of the study, the Council is in general

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[1] U.S. EPA/SAB/COUNCIL, Council/Air Quality Modeling Subcommittee (AQMS) Letter Report in Review of CAAA90 Section 812 Prospective Study Emissions Modeling and Associated Air Quality Modeling Issues, EPA-SAB-COUNCIL-LTR-97-012, September 9, 1997.

agreement with the goals of the Prospective Study, as articulated by the Agency, but wishes to elaborate upon them. The Agency correctly states that the study should benefit future research and policy making, as well as providing a greater understanding of the benefits and costs of the 1990 CAAA. The Council wishes to emphasize that the analysis: a) should serve as an example of the best practice of benefit-cost analysis as it is applied to evaluating environmental programs; and b) should yield, to the extent practicable, insights into the efficiency of key provisions of the 1990 CAAA. Such insights would serve to place future legislative efforts with respect to air pollution control on a more sound economic footing, as well as providing benefits for focusing future research and policy making.

1.2 *Scope of the Study*

In work to date, emphasis has been placed on estimating the benefits and costs of all titles of the 1990 CAAA in the aggregate. In previous letters we have recommended that analyses of benefits and costs be disaggregated whenever possible, to provide a better guide to regulation. The Agency is now considering options for disaggregating the Prospective analysis by title, or supplementing the aggregate analysis by studying additional pollution controls beyond the 1990 CAAA. Each approach has its merits. Disaggregating the benefits and costs of the 1990 CAAA by title would suggest to the Agency which portions of the 1990 Amendments pass the benefit-cost test and which do not. This could suggest areas in which further pollution controls are warranted and areas in which they are not. For the purposes of informing future legislation it would, however, be more useful to analyze additional controls beyond the 1990 amendments.

The Council recommends that the following supplemental analyses be undertaken, as resources permit: a) an additional 50% reduction in SO_2 emissions by electric utilities beyond Title IV requirements, together with a further reduction in NO_x emissions; b) additional NO_x and VOC controls on highways vehicles; and c) items a) and b) combined.

1.3 *Presentation of Results*

In presenting the results of the study, the Council recommends that benefit and cost figures be presented in as disaggregated a form as possible, even if resources do not permit separate benefit-cost analyses of each title of the 1990 CAAA. Cost estimates have been generated for each title of the amendments and should be presented by title. Disaggregation of benefits by title is more difficult because of nonlinearities in pollution creation. Nevertheless, the Council recommends that benefit estimates be presented by pollutant (for example, premature mortality avoided due to reductions in PM).

1.4 *Discussion of Choice of Regulatory Assumptions on Study Results*

The choice of regulatory assumptions will have a significant impact on the study's results. The Prospective Study, which was begun in 1993, of necessity ignores the impact of the recent PM and ozone standards on the control (with-CAAA) and no-control (without-CAAA) scenarios. The same is true of developments that may occur before 2010 (the last year of the analysis), such as controls to reduce CO_2. The fact that a program was not mandated by the 1990 CAAA does not imply that it would have the same impact on with-CAAA and without-CAAA emissions, and no effect on abatement costs. A program to reduce CO_2 emissions, for example, would alter the costs of achieving provisions of the 1990 CAAA.

The Council believes that there should be a clear discussion of programs and regulations that affect emissions of the criteria air pollutants but are not being examined in the Prospective Study. These include the recent PM and ozone standards, any programs to reduce greenhouse gas emissions, and the Forest Service's prescribed burning program. It is perfectly defensible not to analyze such programs, but some discussion is essential as to how the programs might alter the conclusions of the Prospective Study.

2. Measurement of Costs

The measurement of costs is also a major issue. The Council is aware of the tremendous difficulty involved in estimating the costs of complying with regulations to be issued under the 1990 CAAA and wishes to commend the Agency on the excellent job it has done in estimating direct costs. In general, the Council agrees with the Agency's estimates of the direct costs of complying with the various titles of the 1990 CAAA. We note, however, that the estimate of the costs of Inspection and Maintenance (IM) programs appear to be at some variance from estimates in the literature. For instance, IM estimates do not appear to include the opportunity cost of owner's time, which is a legitimate component of cost. We recommend a focus on reconciliation of the costs of IM programs.

2.1 *Presentation of Cost Estimates*

In presenting cost estimates, we believe that it is important to discuss the degree of uncertainty in the various cost estimates and, when possible, to show the sensitivity of cost estimates to underlying assumptions. The credibility of the Prospective Study will be greatly enhanced if the cost estimates, when presented to the public, are accompanied by a discussion of the modeling options available and some rationale for the options chosen. It is also important that the reader be given a sense of which are the key assumptions; i.e., of the assumptions that, if changed, would generate the largest change in the cost estimates. If possible, some sensitivity analysis should be

presented showing how much costs change when assumptions change.

Regarding uncertainty in the cost estimates, we recognize that a formal uncertainty analysis is likely to be impossible. Nevertheless, it would be desirable to indicate qualitatively the degree of uncertainty in various categories of cost estimates; i.e., which estimates are the most uncertain.

2.2 *Direct versus Indirect Costs*

In presenting the estimates of compliance costs, it is important to indicate that what is estimated are the *direct costs* of compliance; that is, the costs of pollution abatement to firms undertaking such abatement. A growing body of economic research indicates that these costs may significantly understate the full economic costs of pollution abatement. We believe that the *indirect costs* of pollution abatement merit discussion in the text of the Prospective Study.

Recent research shows that, by raising production costs and output prices, environmental regulations reduce the returns to factors of production such as labor and capital. The reduction in factor returns (both in the regulated industry and in other industries) introduces efficiency losses over and above the firm-level costs of compliance. For example, if a fall in the real wage accompanies increased pollution control costs, this will increase the dead weight loss associated with labor (i.e., income taxes). These additional efficiency losses are larger the higher the pre-existing tax rates on factors of production. Published studies on this subject indicate that when these factor-market efficiency costs are taken into account, the overall economic costs will be 25-75 percent higher than the firm-level compliance costs.

The Council believes that the Prospective Study should make clear the distinction between compliance costs and overall economic costs, and that the overall cost assessment should include reference to the potential range of additional costs associated with regulation-induced factor market distortions.

3. Measurement and Valuation of Ecological Benefits

3.1 *Scope of Ecological Benefits*

The impacts of air pollution on the functioning of ecosystems involve complex interactions that are difficult to measure and to value in dollar terms. In view of the complexity of these relationships, and the difficulty in valuing them, the Agency has focused on the impacts of air pollution on the commercial services flows generated by ecosystems, such as timber, crops and fish. While the Council understands the need to limit the categories of ecological benefits quantified during the first Prospective Study, we hope that economists within the Agency will work with ecologists to better

define and measure the broader ecosystem benefits of air pollution control.

We urge the Agency to develop a comprehensive framework for consideration of ecological effects before making decisions about which effects to quantify and value. Such a framework should be developed along the following lines:

a) For each major type of ecosystem, identify the major stressors originating from air emissions subject to control under the CAAA90. Major types of ecosystems considered might include: forests subject to commercial harvest; other forest ecosystems; grasslands; managed agriculture; freshwater aquatic systems; marine aquatic systems; and wetlands.

b) For each ecosystem type and stressor, identify the possible impacts of such things as community structure, species richness, net primary productivity, other major ecosystem functions, and the flows of ecosystem services to people. This could provide a basis for identifying those impacts that for which quantification might be possible.

c) Note that not all ecosystem changes are necessarily adverse. Consider criteria for identifying adverse changes. The criterion that emerges from economics focuses on changes that result in reductions in service flows to people. Which of the stressors and changes identified above are likely to lead to the largest reductions in valued service flows? The answers to this question can be used to: 1) select service flows for valuation; and 2) identify research priorities.

3.2 *Validity of Existence Values for Ecosystems*

The ability to better describe and quantify ecosystem improvements should help economists measure the existence values people place on these improvements. The Council acknowledges that people are willing to pay for ecological improvements based solely on the knowledge that these improvements exist. The Council agrees that existence values for ecological improvements are a legitimate source of benefits that should be discussed in the text of the final report. We believe, however, that the state of the art may not be sufficient to provide a comprehensive set of existence values. However, there are some studies that measure existence values reasonably accurately.

3.3 *Inappropriateness of Avoided Costs as a Method of Valuing Ecological Benefits*

Because of the difficulty in quantifying and valuing the benefits of reduced environmental damage to ecosystems, it is sometimes suggested that an *avoided cost* approach be used. To illustrate, one of the benefits of the 1990 CAAA is reduced

nitrogen deposition in lakes. The avoided cost approach would look at the cost of other methods of reducing nitrogen deposition (e.g., the cost of other regulations to reduce nitrogen deposits), and value the reductions achieved by the C AAA using these costs.

The Council urges that the Agency refrain from using the avoided cost approach to value reduced ecosystem damages. The main difficulty with the approach is that it does not value the damages themselves, but measures the cost of alternative ways of reducing the damages. There are some circumstances under which the avoided cost approach may legitimately capture environmental benefits but these requirements, while easily established, are generally unmet (i.e., difficult to achieve).

The key requirement is that there be a direct link between the: a) the implementation of the Federal environmental regulation; and b) the abandonment of a (costly) environmental regulatory program by some other agency (e.g., a state-level environmental authority), where this abandonment resulted because the Federal regulatory effort made similar efforts at the local or state level redundant and unnecessary. In this case the benefit from the Federal environmental program is the avoided regulatory cost at the local or state level, plus the value of the net improvement (if any) in environmental quality between a) the quality level that results after the Federal regulatory effort and b) the quality level that would have resulted through efforts at the state or local level. Note that if Federal environmental clean-up exactly substitutes for clean-up that otherwise would have been brought about by state or local agencies, then the benefit of the Federal program is simply the avoided state or local regulatory cost, since in this case the Federal program leads to no net improvement in the environment.

The Council believes that it is generally very difficult to establish the requirement described above, and that in most cases it will be inadvisable to employ avoided costs in connection with the assessment of benefits.

4. Measurement and Valuation of Health Outcomes

4.1 *Measurement of Human Health and Welfare Benefits*

The Council was also asked for advice on the measurement of health and agricultural outcomes associated with air pollution, as well as for advice on appropriate methods to value these outcomes. In almost all cases the Council agreed with the Agency's suggestions regarding the appropriate method for measuring impacts and the appropriate valuation techniques. Items that required further comment are discussed below.

The Agency has suggested that measures of willingness-to-pay for environmental improvements be adjusted upward to account for the expected increase

in real income over the period 1990-2010. In principle, such adjustments should be made provided there are reliable estimates of the income elasticities of willingness-to-pay for the relevant endpoints. The Council is not confident that there is an adequate empirical basis for estimating these income elasticities at the present time, but it is willing to examine proposals from the Agency staff.

4.2 *Valuation of Mortality Risk Reductions*

The mortality risk reductions associated with reducing exposures to particulate concentrations and their subsequent valuation were the driving forces behind the Retrospective Study[2] and can be expected to be similarly important for the Prospective Study. Thus, the Council wishes to emphasize that an exemplary and comprehensive treatment of these effects and their monetized benefits is of the utmost importance to making the study credible.

The Council believes that the conceptually correct measure of the value of reductions in mortality risk is what an individual would pay today for a shift in that person's survival curve, which describes the chances that the individual will survive to each future age. The shift in the survival curve captures precisely changes in a person's life expectancy and the timing of these changes. Furthermore, the shift in the survival curve is the way in which a change in air pollution affects mortality in the Pope et al (1995)[3] study, which forms the basis for measuring the physical impacts of a change in air pollution on premature mortality.

The Council acknowledges, however, that no reliable empirical estimates exist of the value of shifts in survival curves. We therefore recommend, for the purposes of completing the Prospective Study, that the same approach to valuing mortality risk reductions be used as was employed in the Retrospective Study. Statistical lives saved should be valued using the same Value of a Statistical Life (VSL) as in the Retrospective Study, and the value of the corresponding life-years saved should also be presented.

The Council urges, however, that the Agency review the studies as well as the alternative methods of valuing changes in mortality risks and discuss these in an

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2 U.S. EPA,*"The Benefits and Costs of the Clean Air Act, 1970 to 1990,"* Prepared for U.S. Congress by U.S. Environmental Protection Agency, Office of Air and Radiation, October 1997.

3 Pope, C.A. III; Thun, M.J.Namboodiri, M.; Dockery, D.W.; Evans, J.S.; Speizer, F.E., and Heath, C.W., Jr. Particulate Air Pollution is a Predictor of Mortality in a Prospective Study of U.S. Adults. *Am. J. Respir. Care Med.*, Vol. 151, March 1995, pp.669-674.

Appendix to the Prospective Study. Specifically, the Council recommends that alternative measures of mortality risk reductions, including VSL, be discussed and compared to one-another for their appropriateness in capturing the types of effects estimated in the Pope *et al.*(1995)[3] study. These measures would include changes in life expectancy, changes in risk of dying, changes in life-days per person (or life-years in the aggregate) and changes in statistical lives lost (both age-adjusted and age-unadjusted).

5. Valuation of Morbidity Outcomes

5.1 *Adjustment of Cost-of-Illness Estimates*

Agency Staff discussed the possibility of adjusting cost-of-illness estimates of the benefits of reduced morbidity to account for the fact that the cost-of-illness under-estimates total willingness-to-pay to avoid the effect. They concluded that there is not a sufficient empirical basis for making these adjustments at this time. The Council agrees with this conclusion, but suggests that the report include some illustrative calculations to show the sensitivity of total benefits to the range of possible adjustments to cost-of-illness estimates.

5.2 *Health Benefits of Reducing Stratospheric Ozone Depletion*

To estimate the health benefits of reducing stratospheric ozone depletion, the Agency is proposing to base its analysis of the benefits of Title VI on the Regulatory Impact Analysis (RIA) prepared in 1992 for compliance with Section 604. The Council was not briefed on the methods used in the RIA. But, it appears that the benefits of reducing ultraviolet (UV) radiation were calculated by estimating the reductions in the incidence of melanomas that would result. This assumes that people have not altered their behavior in response to the increase in UV radiation by, for example, spending less time in the sun, wearing protective clothing, or using sunscreen. Such behavioral changes are referred to as averting behavior. The Agency needs to address the issue of averting behavior and its impact on estimated benefits associated with Title VI. Further, if UV-B effects are discussed for stratospheric ozone, they should also be discussed in terms of substitution risks associated with reduced ambient ozone concentrations.

The report should also include at least a qualitative discussion of the benefits to aquatic and terrestrial ecosystems that might be expected with a decrease in UV radiation.

6. Valuation of Materials Damage

The Council questions the continued use of the valuation function for household soiling taken from the New York State Externality Cost Study to value materials damage. That function is based primarily on data from two household surveys conducted in 1970 and 1972-3 and on the observed relationship between cleaning expenditures/activities and Total Suspended Particulate (TSP) levels. We believe that the use of these data for the Retrospective Study was defensible, but we question whether values derived for TSP using 25-year-old behavioral data can be applied to value changes in PM_{10} and $PM_{2.5}$ over the time period 1990-2010.

7. Concluding Remarks

We believe that, overall, the Agency is doing an admirable job of answering what are inherently difficult questions: what are the human health and ecological damages avoided by the 1990 CAAA? ... and ... what is the dollar value of these damages? The effort required to generate credible benefit and cost estimates is enormous, and the Agency is to be congratulated on its accomplishments. We believe that, subject to the above caveats, the Agency has made appropriate choices regarding the models used for each component of the analysis and has chosen appropriate data for use in these models. We must however, note our particularly strong concerns over the modeled PM emission trends. We suggest that the AQMS provide a consultation on new PM emission projections as soon as they become available. Also, we urge the Agency's economists to confer with ecologists to better define and measure the broader ecosystem benefits of air pollution control, and to develop a comprehensive framework for consideration of ecological effects before making decisions about which effects to quantify and value. Such a framework should be developed along the lines outlined above.

We thank the Agency for the opportunity to be of service in review of the various building blocks which will lead to the Prospective Study: Report to Congress, and look forward to continuing productive dialogue on this important topic to the nation.

Sincerely,

Dr. Maureen L. Cropper, Chair
Advisory Council on Clean Air Compliance Analysis

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GLOSSARY OF TERMS AND ACRONYMS

ADV	Advisory
AQMS	Air Quality Models Subcommittee (of the Council)
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAAA90	Clean Air Act Amendments of 1990
CO_2	Carbon Dioxide
EPA	U.S. Environmental Protection Agency (U.S. EPA)
HEES	Health and Ecological Effects Subcommittee (U.S. EPA/SAB/ Council)
IM	Inspection and Maintenance
LTR	Letter Report
NO_x	Oxides of Nitrogen
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter (2.5 microns in diameter)
PM_{10}	Particulate Matter (10 microns in diameter)
Pub.	Public
ORD	Office of Research and Development (U.S. EPA/ORD)
RIA	Regulatory Impact Analysis
SAB	Science Advisory Board (U.S. SAB/EPA)
SO_2	Sulfur Dioxide
Stat.	Statute
TSP	Total Suspended Particulate
U.S.	United States
UV	Ultra Violet (radiation)
UV-B	Ultra Violet - Beta (radiation)
VOC	Volatile Organic Compounds
VSL	Value of a Statistical Life

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