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Project Work Plan for Revised Air Quality Criteria for Ozone and Related Photochemical Oxidants

Notice
This document is a preliminary draft. It has not been formally released by EPA and should not at this stage be construed to represent Agency policy. It is being circulated for comment on its technical accuracy and policy implications.

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This document is an external draft for review purposes only and does not constitute U.S. Environmental Protection Agency policy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

PREFACE

This project work plan has been prepared as a managerial and management information tool for the U.S. Environmental Protection Agency's National Center for Environmental Assessment Division in Research Triangle Park, NC. It will be modified and amended from time to time, as necessary, to reflect actual project requirements and progress. As a result, any proposed schedules and outlines, or any lists of technical coordinator assignments, authors, or reviewers are subject to change.

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I. INTRODUCTION

A. LEGISLATIVE BACKGROUND

Two sections of the Clean Air Act (CAA) govern the establishment, review, and revision of National Ambient Air Quality Standards (NAAQS). Section 108 (42 U.S.C. 7408) directs the Administrator of the U.S. Environmental Protection Agency (EPA) to identify ubiquitous pollutants that may be reasonably anticipated to endanger public health or welfare and to issue air quality criteria for them. These air quality criteria are to reflect the latest scientific information useful in indicating the kind and extent of all identifiable effects on public health or welfare that may be expected from the presence of the pollutant in ambient air.

Section 109(a) of the CAA (42 U.S.C. 7409) directs the Administrator of EPA to propose and promulgate primary and secondary NAAQS for pollutants identified under Section 108. Section 109(b)(1) defines a primary standard as one that, in the judgment of the Administrator, if attained and maintained is requisite to protect the public health (see inset) based on the criteria and allowing for an adequate margin of safety. The secondary standard, as defined in Section 109(b)(2), must specify a level of air quality that, in the judgment of the Administrator, if attained and maintained, is requisite to protect the public welfare (see inset) from any known or anticipated adverse effects associated with the presence of the pollutant in ambient air, based on the criteria.

PUBLIC HEALTH EFFECTS

Effects on the health of the general population, or identifiable groups within the population, who are exposed to pollutants in ambient air
Effects on mortality
Effects on morbidity
Effects on other health conditions including indicators of:

- pre-morbid processes,
- risk factors, and
- disease

PUBLIC WELFARE EFFECTS

Effects on personal comfort and well-being
Effects on economic values
Deterioration of property
Hazards to transportation
Effects on the environment, including:

- animals
- climate
- crops
- materials
- soils
- vegetation
- visibility
- water
- weather
- wildlife

Source: U.S. Code (1999)

Section 109(d) of the CAA (42 U.S.C. 7409) requires periodic review and, if appropriate, revision of existing criteria and standards. If, in the Administrator's judgment, the Agency's review and revision of criteria make appropriate the proposal of new or revised standards, such standards are to be revised and promulgated in accordance with Section 109(b). Alternatively, the Administrator may find that revision of the standards is inappropriate and conclude the review by leaving the existing standards unchanged.

B. REGULATORY BACKGROUND[1]

On April 30, 1971, the EPA promulgated primary and secondary NAAQS for photochemical oxidants under Section 109 of the CAA (36 FR 8186). These were set at an hourly average of 0.08 ppm total photochemical oxidants not to be exceeded more than 1 h per year. On April 20, 1977, the EPA announced (42 FR 20493) the first review and updating of the 1970 Air Quality Criteria Document (AQCD) for Photochemical Oxidants in accordance with Section 109(d) of the CAA. In preparing the AQCD, the EPA made two external review drafts of the document available for public comment, and these drafts were peer reviewed by the Subcommittee on Scientific Criteria for Photochemical Oxidants of EPA's Science Advisory Board (SAB). A final revised AQCD for ozone (O_3) and other photochemical oxidants was published on June 22, 1978.

Based on the 1978 revised AQCD and taking into account the advice and recommendations of the Subcommittee, and the comments received from the public, the EPA announced (44 FR 8202) a final decision to revise the NAAQS for photochemical oxidants on February 8, 1979. The final rulemaking revised the primary standard from 0.08 ppm to 0.12 ppm, set the secondary standard to be the same as the primary standard, changed the chemical designation of the standards from photochemical oxidants to O_3, and revised the definition of the point at which the standard is attained to "when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is equal to or less than one" (see Table 1).

Table 1. National Ambient Air Quality Standards (NAAQS) for Ozone

Date of Promulgation	Primary and Secondary NAAQS	Averaging Time
February 8, 1979	0.12 ppm[a] (235 μg/m^3)	1 h[b]
July 18, 1997	0.08 ppm[a] (157 μg/m^3)	8 h[c]

[a]1 ppm = 1962 μg/m^3, 1 μg/m^3 = 5.097 × 10^{-4} ppm @ 25 °C, 760 mm Hg.
[b]The standard is attained when the expected number of days per calendar year with a maximum hourly average concentration above 235 μg/m^3 (0.12 ppm) is equal to or less than one.
[c]Based on the 3-year average of the annual fourth-highest daily maximum 8-h average concentration measured at each monitor within an area.

Source: Federal Register (1979, 1997)

On March 17, 1982, in response to requirements of Section 109(d) of the CAA, the EPA announced (47 FR 11561) that it planned to revise the existing 1978 AQCD for O_3 and other photochemical oxidants, and on August 22, 1983, it announced (48 FR 38009) that review of the primary and secondary NAAQS for O_3 had been initiated. Two public peer-review workshops on draft chapters of the revised AQCD were held on December 15-17, 1982, and on November 16-18, 1983. The EPA considered comments made at both workshops in preparing the first external review draft that was made available (49 FR 29845) on July 24, 1984, for public review.

[1]This text is excerpted and adapted from the "Proposed Decision on the National Ambient Air Quality Standards for Ozone," Preamble (40 CFR Part 50; Federal Register 57: 35542-35557, 1992) and updated from the “National Ambient Air Quality Standards for Ozone; Final Rule” (40 CFR 50; Federal Register 62: 38856-38896, 1997).

On February 13, 1985 (50 FR 6049), and on April 2, 1986 (51 FR 11339), the EPA announced two public meetings of the Clean Air Scientific Advisory Committee (CASAC) of EPA's SAB to be held on March 4-6, 1985, and on April 21-22, 1986, respectively. At these meetings, the CASAC reviewed external drafts of the revised AQCD for O_3 and other photochemical oxidants. After completion of this review, the CASAC forwarded to the Administrator of EPA a closure letter, dated October 22, 1986, that stated the document "represents a scientifically balanced and defensible summary of the extensive scientific literature." The EPA released the final draft document in August 1986.

The first draft of the Staff Paper "Review of the National Ambient Air Quality Standards for Ozone: Assessment of Scientific and Technical Information" was reviewed by CASAC at a public meeting on April 21-22, 1986. At that meeting, the CASAC recommended that prior to closure new information on prolonged exposure effects of O_3 be considered in a second draft of the Staff Paper. The CASAC reviewed this second draft and also a presentation of new and emerging information on the health and welfare effects of O_3 at a public review meeting held on December 14-15, 1987. The CASAC concluded that sufficient new information existed to recommend incorporation of relevant new data into a supplement to the 1986 AQCD (O_3 Supplement) and in a third draft of the Staff Paper.

A draft O_3 Supplement, "Summary of Selected New Information on Effects of Ozone on Health and Vegetation: Draft Supplement to Air Quality Criteria for Ozone and Other Photochemical Oxidants," and the revised Staff Paper were made available to CASAC and to the public in November 1988. The O_3 Supplement reviewed and evaluated selected literature concerning exposure- and concentration-response relationships observed for health effects in humans and experimental animals and for vegetation effects that appeared as peer-reviewed journal publications or as proceedings papers from 1986 through early 1989. On December 14-15, 1988, CASAC held a public meeting to review these documents. The CASAC sent the Administrator a closure letter, dated May 1, 1989, that stated the draft O_3 Supplement, the 1986 AQCD, and the draft Staff Paper "provide an adequate scientific basis for the EPA to retain or revise the primary and secondary standards of ozone." The CASAC concluded that it would be some time before enough new information on the health effects of multihour and chronic exposure to O_3 would be published in scientific journals to receive full peer review and, thus, be suitable for inclusion in a criteria document. The CASAC further concluded that such information could be considered in the next review of the O_3 NAAQS. A final version of the O_3 Supplement has been published (U.S. Environmental Protection Agency, 1992).

On October 22, 1991, the American Lung Association and other plaintiffs filed suit to compel the Agency to complete the review of the criteria and standards for O_3 in accordance with the CAA. The U.S. District Court for the Eastern District of New York subsequently issued an order requiring the EPA to announce its proposed decision on whether to revise the standards for O_3 by August 1, 1992, and to announce its final decision by March 1, 1993.

The proposed decision on O_3 appearing in the Federal Register on August 10, 1992 (57 FR 35542), indicated that revision of the existing 1-h NAAQS was not appropriate at this time. A public hearing on this decision took place on September 1, 1992, at the EPA Education Center in Washington, DC, and public comments were received through October 9, 1992. The final decision was published in the Federal Register on March 9, 1993 (58 FR 13008). This decision, however, did not take into consideration a number of recent studies on the health and welfare effects of O_3 that were published since the last literature review in early 1989.

The Agency initiated incorporation of the new studies into revised workshop draft chapters that were peer reviewed in July and September 1993, followed by public release of the First External Review

Draft in February 1994 and CASAC review on July 20-21, 1994. A new (revised) document was released and reviewed by CASAC on September 19-20, 1995 and closure was recognized in a November 28, 1995 letter to the EPA Administrator. The final AQCD for O_3 was published in July 1996.

On the basis of the 1996 evaluation of the key information for regulatory decision-making purposes, the EPA promulgated (62 FR 38856) a new 8-h NAAQS for ground-level O_3 in July 1997 (see Table 1). That 8-h O_3 standard currently is the subject of ongoing litigation. In a 1999 decision, the U.S. Court of Appeals for the District of Columbia remanded the 8-h NAAQS but did not question the need for the new NAAQS, or the science behind it. The Court did not vacate the existing 1-h NAAQS.

At this time, EPA is not implementing a program to attain the 8-h O_3 standard, pending the final outcome of the litigation. The EPA appealed the District Court's decision to the U.S. Supreme Court and on November 7, 2000, the Supreme Court reviewed the O_3 NAAQS cases. On February 27, 2001, the U. S. Supreme Court summarized the case holdings of Whitman, Administrator of the U.S. EPA et al. versus American Trucking Associations, Inc. et al. (99-1257 and 99-1426). The U.S. Supreme Court determined that EPA must reconsider its implementation plan for moving from the 1-h standard to the revised 8-h standard. The Court instructed EPA to develop an implementation plan, including a timetable, consistent with the Court's opinion. After remand, and the Court of Appeals final disposition of this case, it is left to the EPA to develop a reasonable interpretation of the nonattainment implementation provisions insofar as they apply to revised ozone NAAQS.

The EPA's National Center for Environmental Assessment in Research Triangle Park, NC (NCEA-RTP) is proceeding with the next periodic review of the air quality criteria for O_3. Under the processes established in Sections 108 and 109 of the CAA, the EPA began by announcing the commencement of the review in the Federal Register with a call for information (see Appendix A). After carefully assessing and evaluating the pertinent new studies, the EPA will then prepare a preliminary draft of a revised criteria document and subject it sequentially to review at expert peer-review workshops, by the public, and by the CASAC. Once the CASAC has reviewed the first external review draft of the revised criteria document, thus providing a preliminary basis for review of the existing standards, the EPA's Office of Air Quality Planning and Standards (OAQPS) staff will prepare a draft Staff Paper assessing the most significant information contained in the draft criteria document and develop recommendations on whether to retain or revise, if appropriate, the NAAQS for O_3. Subsequent reviews by the public and by CASAC will occur, as necessary. A proposed schedule and project status for the overall criteria document preparation process can be found below in Table 2.

Table 2. Proposed Schedule for Revised Ozone Air Quality Criteria Document Development[2]

Major Milestones	Target Dates
1. Literature Search	Ongoing
2. Initiate Draft Project Work Plan	August 2000
3. Initiate Procurement Requests for Phase I Document Preparation	August 2000
4. Federal Register Call for Information	September 26, 2000
5. Initiate Procurement Requests for Phase II Document Preparation	March-August 2001
6. Release of Project Plan for CASAC Review	December 2001
7. CASAC/SAB Public Meeting to Review Project Work Plan	March 2002
8. First Rough Draft (Internal) of Document Chapters	April 2002
9. Workshop Draft of Criteria Document	June 2002
10. Peer-Review Workshop	July 2002
11. First External Review Draft (ERD)	September 2002
12. Public Comment Period	October-December 2002
13. CASAC/SAB Public Review Meeting *(First External Review Draft)*	February 2003
14. Send Proposed Final Draft to CASAC	September 2003
15. Public Comment Period	October-November 2003
16. CASAC/SAB Public Review Meeting (Closure)	December 2003
17. Final Draft Document	March 2004

[2]Proposed schedule will be modified from time to time, as necessary, to reflect actual project requirements and progress.

II. SCIENTIFIC BACKGROUND AND KEY ISSUES

A. HEALTH EFFECTS OF EXPOSURE TO OZONE

Ozone is a respiratory tract irritant that reacts primarily with the lungs (see Table 3). Large variability is common between individuals in their responsiveness to the acute pulmonary-function effects of ozone. About 5 to 20% of individuals tested in clinical trials experienced pulmonary function decrements or respiratory symptoms at O_3 levels lower than those affecting many others. Thus, data from controlled human studies indicate that acute, reversible decrements in lung function and increased respiratory symptoms, such as cough and shortness of breath, occur in some individuals exposed for 1 to 3 hours to O_3 concentrations as low as 0.12 to 0.16 ppm while performing heavy exercise (e.g., running). These effects may decrease exercise performance in certain individuals, particularly at the higher O_3 concentrations within this range. With more prolonged exposure (up to 7 hours), similar health effects are found at even lower O_3 concentrations ranging from 0.08 to 0.12 ppm in individuals performing moderate exercise (e.g., brisk walking). Children and adolescents ($\leq$18 years old) respond to O_3 exposure in a similar manner as young adults, except for less reporting of respiratory symptoms, while older adults ($\geq$50 years old) may, in fact, have smaller changes in lung function and symptoms. Low ambient O_3 exposure also has been linked with the exacerbation of symptoms in individuals with respiratory disease (e.g., asthma), leading to increased hospital admissions and increased visits to emergency departments during warm weather. It is not clear what effects other pollutants, other environmental factors (e.g., temperature and relative humidity), and allergens may have in conjunction with O_3 exposure.

In humans, 7-hr O_3 exposures also have been associated with inflammation of the lungs which may be involved in the progression from acute to chronic health effects. Human epidemiology studies, as well as studies involving laboratory animals, suggest there may be persistent pulmonary-impairment effects associated with chronic O_3 exposure. Thus, many health professionals are concerned that repeated exposure to O_3 over a lifetime may compromise normal lung function, possibly increase development of lung fibrosis, and may even accelerate lung function decline associated with the aging of the lung. Research is needed to assess if such effects are actually occurring in naturally exposed populations, as well as to determine the temporal exposure patterns that may be associated with particular chronic effects.

Controlled exposure studies conducted with humans have demonstrated that, with repeated daily exposure to O_3, there is an increase from the first to the second day in the magnitude of pulmonary function changes (e.g., constriction of airways leading to reduction of air flow into the lungs). However, with continued daily exposures these effects become much smaller in size from the third or fourth day onwards. This attenuation phenomenon was previously termed "adaptation" or "habituation" and was interpreted by some to represent a beneficial biological coping mechanism to repeated ozone exposure. New evidence, however, has clarified that this attenuation is neither permanent nor likely to be beneficial. That is, persons showing the attenuation upon first exposure to O_3 over multiple days show the same magnitude of their original response upon reexposure to O_3 after a week or so without O_3 exposure. Also, persons living in high background O_3 areas show similar responses upon initial exposure to higher peak O_3 levels. Lastly, the attenuation of acute response, when it occurs during later days of multi-day O_3 pollution episodes, allows more air flow into the lungs. This exposure increases the delivery of more O_3 to lung tissue and increases the risk of more serious chronic exposure effects of the types noted above. This is supported by animal studies that found less attenuation of responses such as inflammation, even though pulmonary function changes were attenuated upon repeated O_3 exposure.

Table 3. Summary of Pulmonary Effects from Exposure to Ozone

Health Effect(s)[a]	At-Risk Population[b,c]
Decrements in lung function (reduced ability to take a deep breath) and increased respiratory symptoms (cough, shortness of breath, pain upon deep inspiration) with 1 to 3 hour ($\geq$0.12 ppm) or 7 hour ($\geq$0.08 ppm) exposures; increased inflammatory indicators with 2 hour ($\geq$0.4 ppm) or 7 hour ($\geq$0.08 ppm) exposures	Moderate and heavily exercising children and adults
Reduced maximal exercise performance with high ambient exposure ($\geq$0.18 ppm)	Heavily exercising children and adults
Exacerbation of respiratory symptoms with low ambient O_3 exposure, increased ambient temperature, and other environmental factors, resulting in increased hospital admissions and emergency department visits for respiratory causes during warm weather.	Individuals with asthma
Increased susceptibility to bacterial respiratory infections based on experimental animal studies	Unknown
Changes in lung structure, function, and biochemistry indicative of airway irritation and inflammation following long-term exposures of experimental animals; possible development of chronic lung disease	Unknown

[a]EPA has an existing significant harm level of 0.6 ppm O_3 for an averaging time of 1 hr. Exposure under these conditions would be expected to create life-threatening or permanently disabling health effects in significant portions of the population engaged in light exercise.
[b]Exercising individuals in the general population, especially where outdoor activity results in markedly increased minute ventilation, may be particularly responsive to ozone exposure.
[c]Ethical concerns have limited the research in persons with preexisting respiratory disease such that low O_3 concentrations and light exercise levels were utilized or "mild" cases were evaluated; however, functional or symptomatic effects of the same magnitude in individuals with reduced lung function may have greater clinical significance than for healthy adults without preexisting disease states.

A number of factors will determine the response of a given individual to O_3 exposure. Certainly, O_3 concentrations measured by fixed-site urban monitors will be a factor. But O_3 concentrations can vary over time and place within a specific urban area. In addition, frequent periods of ambient exposure, particularly at high O_3 concentrations, also may affect responsiveness to O_3 during other sequential periods of exposure. Individual exposure, therefore, will vary depending on where the individual lives and works and how long the person is exposed to O_3 at their respective locations. Since pulmonary function will affect the amount of O_3 inhaled, it is also important to know the type and level of activity performed under these exposure conditions to better understand the consequences.

Even if exposure history is well defined, some individuals may be more O_3 sensitive because of their medical history. In individuals with pre-existing pulmonary disorders, such as asthma or chronic obstructive pulmonary disease (COPD), decreases in pulmonary function produced by exposure to ozone, while similar to those experienced by healthy individuals, represent a further decline in lung volumes and flows that are already diminished. It is possible that such declines may further impair the ability of these individuals to perform normal activities.

Studies of children show that their pulmonary function response to acute O_3 exposure is similar to that of adults. However, children, whose lungs are still developing, may be more likely to experience high O_3 doses insofar as they exercise outdoors more than the typical adult. Preliminary laboratory animal studies have indicated some age-dependent lung responses to O_3. However, additional research is needed in this area. Thus, special attention should be given to evaluation of O_3 levels in areas and at times when children are at school or play.

B. ECOLOGICAL EFFECTS OF EXPOSURE TO OZONE

Ozone is the gaseous pollutant most injurious to the many different biological components that make up all natural and managed ecosystems (U.S. Environmental Protection Agency, 1986, 1996). Ozone, more than any other air pollutant, is known to impair the growth of agricultural crops, and native vegetation in ecosystems throughout the United States. Exposure of vegetation to O_3 inhibits photosynthesis, alters carbon allocation, and interferes with mycorrhizal formation in tree roots. Disruption of these important physiological processes can suppress the growth of trees, shrubs, and herbaceous vegetation by decreasing their capacity to form the carbon compounds needed for growth and maintenance and their ability to absorb water and mineral nutrients from soil. In addition, loss of vigor increases susceptibility of trees and crops to insects and pathogens, and reduces their capacity to reproduce.

Only O_3 that enters the plant through openings in the leaves, termed stomata, can impair plant processes. Ozone injury will not be detected if (1) the rate of O_3 uptake is small enough for the plant to detoxify or metabolize O_3 or its reaction products, or (2) the plant is able to repair or compensate for the O_3 effects. Also, an effect will occur only if sufficient O_3 reaches the sensitive sites within a leaf cell. The uptake and movement of O_3 to sensitive cellular sites are subject to various biochemical and physiological controls. The magnitude of O_3-induced effects will depend upon the physical environment of the plant, including both macro- and micro-climatic factors; the chemical environment of the plant, including other gaseous pollutants; and biological factors, including genetic potential, developmental age of the plant, and interaction with plant disease-causing organisms. Cellular injury may manifest itself in a number of ways, including visible foliar injury; premature senescence; reduced growth or yield, or both; reduced plant vigor; and sometimes death. The alterations in the biochemical and physiological processes mentioned above may occur with or without visible injury to the plant.

Through the process of photosynthesis, green plants use the sun's radiant energy to combine carbon dioxide from the atmosphere with water taken up through the roots to form sugars (chemical energy). These sugars are made for use by plants, but all other organisms that are directly or indirectly dependent upon green plants for food also utilize this stored chemical energy.

The sugars (carbon compounds) formed during photosynthesis are moved about the plant to buds, stems, leaves, and roots to be used during growth, maintenance, and reproduction. Ozone-induced inhibition of photosynthesis decreases the amount of sugars that plants can produce and, therefore, alter the allocation and translocation of the sugars from the leaves and shoots to the roots. In addition, when O_3 injury occurs, plants use the sugars and other stored compounds to repair injured tissues, rendering them unavailable for growth, maintenance, and reproduction.

Sugars translocated from the leaves to the roots are of particular importance in forming mycorrhizae, a symbiotic relationship between the roots of most plants and the mycelia of soil fungi. Mycorrhizae play an important role in the root uptake of mineral nutrients, especially nitrogen, and water from the soil. Many studies have shown that plants cannot compete with other plants for nutrients and water, and in many cases, lose vigor and die when prevented from forming mycorrhizae or when the mycorrhizal relationship is disrupted. Plants unable to absorb water and mineral nutrients from the soil are more susceptible to drought, insect infestation, and attack by pathogens. Mycorrhizae have also been shown to protect trees from root diseases.

Not all plants are sensitive to O_3. Sensitive plant species, however, are found throughout the United States. A wide range in sensitivity exists both within and among plant species. For example, though most plant species differ in O_3 sensitivity, different cultivars of crop plants within the same species also may differ in sensitivity.

Fumigation studies (in the laboratory or field, on crops or trees) suggest that plants will exhibit a response to O_3 concentrations above 0.06 ppm within hours of exposure. Concern arises from the fact that O_3 is a regional pollutant. Concentrations across most of eastern North America exceed 0.06 ppm during most of the growing season.

Reductions in growth and reproduction (yield) of agricultural crop plants due to O_3 exposure occur during their life span which is usually one growing season. Trees and shrubs, on the other hand, live for many years. They must cope with the cumulative effects of both short- and long-term stresses. The needles of sensitive trees, such as eastern white pine, may develop visible symptoms within days of exposure to high O_3 concentrations. Repeated episodic O_3 exposures above 0.08 ppm lasting from hours to several days have been shown to have the greatest impact on growth and reproduction of both crops and trees. In most cases, tree responses are more subtle because growth responses take time. Decreased growth and dieback in trees may not become noticeable for years and are usually the result of cumulative responses to continuing O_3 exposures, as well as interaction with other stresses, over a period of many years. Studies in the San Bernardino Mountains of California, on the Cumberland Plateau of East Tennessee, and in the Appalachian Mountains of Virginia, indicate that reductions in growth, determinable from growth rings, began as early as 20 years before the studies began. When measurements were available, all growth reductions could be associated with 1-h O_3 concentrations exceeding 0.08 ppm.

In conclusion, O_3 has been shown to be the gaseous pollutant most injurious to plants. It is a regional pollutant. During the growing season, plant exposure to phytotoxic concentrations occurs throughout the United States east of the Mississippi River and near urban areas of the western United States. The effects of O_3 on plant growth, especially crop plants, are well documented. The biochemical and physiological processes in plants that are altered by the entrance of O_3 through the leaves are generally recognized even though the exact manner in which O_3 alters them is not yet fully understood.

C. SUMMARY OF MAJOR ISSUES TO BE ADDRESSED IN THE PREPARATION OF AIR QUALITY CRITERIA FOR OZONE AND RELATED PHOTOCHEMICAL OXIDANTS

A number of issues continue to be identified by authors and reviewers of the previous Air Quality Criteria Document (AQCD) on Ozone (O_3) and other photochemical oxidants (U.S. Environmental Protection Agency, 1996). Many of these issues were enumerated following public discussions on draft versions of the AQCD or the Staff Paper or in comments received from the Clean Air Scientific Advisory Committee of the U.S. Environmental Protection Agency's (EPA's) Science Advisory Board. They are listed below, by subject category, as a series of questions that need to be addressed in the next revision of the O_3 criteria document.

C.1 Specific Issues on Ozone Photochemistry

- What is the effect of particulate matter on the photochemical production and destruction of ozone?
- How important to background concentrations is the intrusion of ozone from the stratosphere into the troposphere?
- How important is the downward transport of ozone and its precursors from layers of elevated concentrations of these species in the mid-troposphere? What is the origin of these layers?
- What is the effect of ozone produced in polluted boundary layers of the United States on the photochemistry of the background atmosphere?

C.2 Specific Issues on Environmental Ozone Concentrations

- What fraction of observed regional ozone concentrations can be attributed to other sources such as anthropogenic emissions outside North America?
- What are the spatial concentration patterns of oxidants other than ozone, for example, PAN and how do these differ from ozone?
- How well do the statistics of ozone concentrations obtained using one averaging period relate to those obtained using different averaging periods?

C.3 Specific Environmental Effects Issues Related to Ozone

The previous review (U.S. Environmental Protection Agency, 1996) indicated that remaining uncertainties in available data for a number of environmental effects categories increased the difficulties associated with developing qualitative or quantifiable risks to various components of agronomic, forested, and natural ecosystems. The following issues address these uncertainties in the data and identify new scientific information that would help select an appropriate secondary standard that is protective of crops, natural vegetation, and ecosystem components and processes.

The common theme at a recent international air pollution conference held in Research Triangle Park, North Carolina was the need for more complete information on air pollutant interactions. The era of single pollutant - single species ecological risk assessment may be drawing to a close. The need to better understand how ozone influences ecosystems in a complex and changing global climate has come to the forefront in recent years. Due to financial and logistical constraints of conducting large-scale studies, multistressor-multispecies ecological risk assessments will require new and innovative approaches that may rely more on modeling pollutant exposure and ecosystem response.

The four major categories where additional environmental effects information is needed are shown below with research and monitoring assessment questions put forth for elucidative purposes. Questions are grouped by subcategories within each of the four major categories.

1. **Exposure Dynamics:** monitoring to determine ambient ozone concentrations encountered in urban, rural farm/forest areas, exposure patterns (episodes), concentrations vs flux, relationship between chamber and field exposure data, plant uptake;

a. Modeling

- What is the state of the science in modeling ozone concentration gradients across plant canopies, plant communities, or multiple ecological resource landscapes?
- How precise and accurate are these models?
- How well can these models be extrapolated temporally and spatially within or across different forest types, crops, ecophysiographic regions, the urban-rural interface, etc.?
- Can passive samplers be useful to "fill in the gaps" in model-derived ozone concentrations at remote areas where continuous ozone monitoring is not routinely performed?

b. Exposure Regimes

- How do episodic exposures (predisposition) alter plant or animal response to chronic, cumulative ozone exposures?
- How do we translate fumigation chamber results, that are typically conducted on tree seedlings or crops, to whole trees, forest stands, ecosystems, watersheds, airsheds, or ecophysiographic regions?

2. **Plant/Animal Response and Mode of Action:** biological, chemical and physical, especially cellular biochemical physiological mechanisms; individual plant sensitivity/ genetic composition; site/habitat influences; pest, disease, and abiotic stress interactions;

a. Plants

- Is there new information regarding ozone's mode of action once it enters a plant?
- Are there genetic markers that can be identified using state-of-the-art molecular biological methodologies that differentiate ozone tolerant and intolerant cultivars and species?
- What is known about ozone's effects on floral ecosystem components in combination with other air pollutants?
- How does ozone, both singly and in combination with other air pollutants, influence plant-pathogen and plant-pest interactions?

b. Wildlife

- Are the exposure effects of ozone on mammalian wildlife similar to human exposure responses?
- Has ozone altered the nutritional content of forage for domestic animals or wildlife populations?

- What is known about ozone's effects on faunal ecosystem components in combination with other air pollutants?

3. **Ecosystems:** increase understanding of the exposure/response relationships of sensitive individual plant species and forest trees to ozone, under ambient conditions, characterize the impact of exposure on interspecific competition on both above- and below-ground interactions and on ecosystem products and services.

   a. Biodiversity

   - Does tropospheric ozone influence the biodiversity of ecological systems?
   - Moreover, if ozone has already brought about a change in biodiversity, can such a change alter the production of biogenic precursors that, in turn, influence natural ozone formation?

   b. Terrestrial-Aquatic Interface

   - Have terrestrial ecosystem effects of ozone exposure affected aquatic ecosystems?
   - Has ozone altered the nutrient cycling in forested catchments that may manifest themselves as changes in water chemistry at the stream and watershed levels?

   c. Ozone and Global Change

   - What is the role of ozone in the planetary boundary layer in attenuating solar UV-B radiation?
   - How is this role affected by the presence of other scattering and absorbing pollutants, for example fine particles in the planetary boundary layer?
   - What is the contribution of ozone generated in polluted boundary layers to radiative forcing and hence to climate change?
   - Does ozone affect interspecific competition for both above- and below-ground carbon allocations?

4. **Assessment:** assessment of economic impacts on products (crops, forests, etc.) and ecosystem services, benefits derived from control of ozone exposures. Removal of as many of the uncertainties cited above as possible will benefit and assist EPA in developing a secondary NAAQS for ozone that will protect vegetation and other ecosystem components and processes.

   a. Economics

   - Have new and innovative methods evolved for monetizing ecosystem services and non-consumptive use products (e.g., aesthetics, recreation, plant nutritional quality for wildlife)?
   - Have the economic impacts of ozone on consumptive-use ecosystem products (e.g., crop yields, timber) been reassessed and revised since the last criteria document?

   b. Scaling Up

   - What recent advances, if any, now allow for localized or spatiotemporally disparate data sets to be aggregated for regional ecological effects assessments?

C.4 Specific Health Effects Issues for Ozone

1. The concentration, duration, and nature of real-world, human exposure to ozone and other potentially harmful air pollutants

    - What is the current status of population-based information on total human O_3 exposure?
    - What is the current level of understanding of atmospheric chemistry involving O_3?
    - What is the current level of understanding of human exposure to other potentially harmful air pollutants that co-exist with O_3 in the ambient air?

2. Determination of factors influencing O_3 dosimetry and the magnitude of O_3 response

    - What are the inherent interspecies differences in sensitivity to O_3 and O_3 dosimetry in different regions of the respiratory tract?
    - What O_3 reaction products can be found in the respiratory tract cells, tissues, or fluids as biomarkers of short- or long-term O_3 exposure?

3. Effects of repeated short-term, prolonged, or long-term O_3 exposure on potential histopathologic, pathophysiologic and clinical sequelae of respiratory disease (e.g., increased decline in lung function, increased asthma incidence, elevated daily mortality, and increased frequency of hospitalization and emergency room visits)

    - Does repeated, short-term or prolonged exposure to O_3 cause permanent loss of lung function or acceleration of lung function loss rate in adults?
    - Does repeated, short-term or prolonged exposure to O_3 cause retardation of lung function growth rate in children?
    - Does long-term O_3 exposure promote development of asthma or chronic lung disease?
    - Does long-term O_3 exposure promote shortening of human life span via promotion of such diseases?

4. Health risks of continuous versus intermittent daily exposure to O_3

    - What annual and seasonal patterns of long-term O_3 exposure are most instrumental in promoting potentially harmful health effects?

5. Identification of groups potentially at-risk from O_3 exposure as well as the host and environmental factors responsible for differential susceptibility to O_3

    - What is the nature of health effects in persons with pre-existing disease who are exposed to O_3? What are the quantitative relationships between ambient O_3 exposures and the frequencies of these effects?
    - Will repeated, elevated short-term exposure to O_3 affect disease outcome?
    - Is susceptibility to the effects of short-term O_3 exposure associated with long-term O_3 susceptibility?
    - What host and environmental factors (e.g., demographic, socioeconomic, and genetic) are associated with susceptibility to short- and long-term exposure to O_3?

6. Studies on the attenuation ("adaptation") of O_3 effects with repeated exposures

   - Does "adaptation" to repeated, short-term O_3 exposure actually increase the long-term dose of $O_{3,}$ and thereby increase disease risk in persons who "adapt"?

7. Role of inflammation in response to O_3

   - What is the nature and time-course of lung inflammation in healthy persons and persons with pre-existing lung disease like asthma?
   - What is the significance of the inflammatory response to O_3 inferred from bronchoalveolar lavage?

8. Biological mechanisms of action of O_3

   - What are the mechanisms and time-courses of O_3-induced cellular and tissue injury, repair, and remodeling?
   - What are the effects of age, gender, and pre-existing disease on cellular and tissue responses to O_3-induced injury?

9. Quantitative laboratory animal-to-man extrapolation of effects (*also see* #2 *above*)

   - What are the interspecies differences in basic mechanisms of lung injury and repair, irrespective of environmental pollution effects on these processes?
   - Which O_3-induced health effects are sufficiently characterized to be quantitatively compared across species?

10. Interaction of O_3 with other air pollutants

    - What is the nature of health effects in persons exposed to multi-pollutant mixtures that contain O_3 in comparison to exposure to O_3 alone?
    - What is the nature of health effects in persons exposed to multi-pollutant mixtures with and without O_3?

11. Influence of O_3 on host defenses against infectious and neoplastic disease

12. Tests evaluating small airway function in humans (e.g., small-airway resistance, gas-exchange surface and oxygen diffusion capacity, and ventilation-perfusion mismatches)

13. Influence of O_3 exposure on inhaled particle dosimetry

14. The responses of bronchial and alveolar epithelium to O_3 in humans

15. Genotoxic, carcinogenic, and co-carcinogenic effects of O_3

16. Extrapulmonary effects of O_3

III. ORGANIZATIONAL STRUCTURE AND PLANNING

A. ORGANIZATION AND CONTENT

The updated AQCD for O_3 and related photochemical oxidants will critically evaluate and assess scientific information on the health and welfare effects associated with exposure to the concentrations of these pollutants in ambient air. The document is not intended to be an exhaustive literature review. Rather, the cited references should reflect the current state of knowledge on the most relevant issues pertinent to the NAAQS for O_3, now set at 0.12 ppm for 1 h and 0.08 ppm for 8 h. Although emphasis is placed on the presentation of health and welfare effects data, other scientific data will be presented and evaluated in order to provide a better understanding of the nature, sources, distribution, measurement, and concentrations of O_3 and related photochemical oxidants in ambient air, as well as the measurement of population exposure to these pollutants.

The focus of the selected scientific information in the text will come from more recent literature published since completion of the previous O_3 criteria document (U.S. Environmental Protection Agency, 1996). Emphasis will be placed on studies conducted at or near O_3 concentrations found in ambient air. Other studies may be included if they contain unique data, such as the documentation of a previously unreported effect or of a mechanism for an observed effect; or if they were multiple-concentration studies designed to provide exposure-response relationships. Generally, this is not an issue for human clinical or epidemiology studies. However, for animal toxicology studies, typically only those studies conducted at less than 1 ppm O_3 will be considered. Studies presented in the previous AQCD and whose data impacted the derivation of the current NAAQS will briefly be discussed in the text, along with specific citations to the previous document. Prior studies will also be discussed if they are (1) open to reinterpretation in light of newer data, or (2) potentially useful in deriving revised standards for O_3. Generally, only published information that has undergone scientific peer review will be included in the criteria document. Newer studies not published in the open literature but meeting high standards of scientific reporting may also be included.

The proposed structure of the document will begin with an Executive Summary and Conclusions. Chapter 1 will provide a brief introduction and present information on the legislative background and purpose of the document, as well as an overview of the organization of the document. Chapter 2 will provide information on the physics and chemistry of O_3 and related photochemical oxidants in the atmosphere. Chapter 3 will cover environmental concentrations, patterns, and exposure estimates and Chapter 4 will deal with environmental effects of O_3 and related photochemical oxidants. Chapters 5, 6, and 7 will discuss animal toxicological studies, human health effects, and extrapolation of animal toxicological data to humans, respectively. The final chapter (Chapter 8), will be an integrative and interpretive evaluation of health risks.

B. METHODS AND PROCEDURES FOR DOCUMENT PREPARATION

The procedures for developing the revised criteria document for O_3 and related photochemical oxidants will be essentially the same as those used for recent criteria documents (Figure 1). Briefly, the respective responsibilities are as follows. The Director of NCEA-RTP appoints a project manager and team whose responsibility is developing the project work plan for preparation of the O_3 criteria document. NCEA-RTP's Director also invites input from individuals in other EPA program and policy offices listed on the EPA Work Group (see Appendix B). The resulting project plan will be discussed with CASAC and then revised, as appropriate. A literature search has been ongoing to collect references

Figure 1. Summary of Criteria Document Preparation Process

Preparation and Internal Review of NCEA Air Quality Criteria Documents

Phase I: Document Planning and Initiation

- Initiation of Literature Search and Article Procurement Procedures—Notice in Federal Register
- Assignment of Project Manager and Other NCEA-RTP Staff Members to Document Preparation Team
- Recruitment of Internal EPA Task Force and Outside Contributing Consultants
- Development of Work Plan and Timetable for Document Preparation—Definition of Document Contents
- Briefing of EPA Science Advisory Board (SAB/CASAC) on Document Plan and Contents—Revise Plan as Advised

Phase II: Preparation of Working Draft

- Accumulation and Analysis of Pertinent Literature
- Writing of Rough Drafts of Document Sections—Mainly Summarizing Relevant Published Studies
- Preliminary Meeting of Authors to Expand Initial Drafts—Initiate Critical Assessment of Studies
- Typing and Circulation of Working Draft to Internal Task Force and Outside Reviewing Consultants

Phase III: Review and Revision of Working Draft

- Convening of NCEA-RTP Team, Document Authors, EPA Internal Task Force, and Reviewing Consultants at Revision Workshop Open to Public
- Follow-Up Meetings of NCEA-RTP Staff, Reviewers, and Authors as Necessary to Resolve Revision Issues
- Post-Workshop Revision of Document Working Draft
- Critical Reading and Editing of Draft by NCEA-RTP Staff
- Typing, Graphics, and Printing of External Review Draft

External Review of NCEA Air Quality Criteria Documents

Phase IV: Public Review of External Draft

- Publication of Federal Register Notice Announcing Availability of External Review Draft of Document
- Circulation of External Draft to Other Government Agencies, EPA's SAB, CASAC, and the General Public
- In-Depth Cataloging, Review, and Analysis of Public Comments and Preparation of Proposed Revisions
- Presentation and Review of External Draft and Revisions at Public CASAC Meeting

Phase V: Post CASAC Meeting Document Revision

- Debriefing of NCEA-RTP Staff, Other EPA Personnel, and Consultants Regarding CASAC Recommendations
- Assignment of Specific Revision Responsibilities to NCEA-RTP Staff Members and Contributing Consultants
- Execution of Revision Assignments and Consultation with Individual CASAC Members as Needed
- Typing, Editing, and Reproduction of Revised Draft and Resubmittal of Document to CASAC

Phase VI: Final CASAC Closure and Publication

- Recirculation of External Review Draft for Public Comment CASAC Meeting
- Presentation and Review of External Draft and Revisions at Public CASAC Meeting
- Submittal of Written CASAC Committee Closure Letter on Document to EPA Administrator
- Typing, Editing, and Printing to Preprint Draft Publication of Document at Time of NAAQS Proposal

on the health effects of O_3. Additional literature searches will be initiated on other respective areas to be covered in the criteria document NCEA-RTP has developed a reference information base to access the references and provide quality assurance and quality control functions. Specific chapter or section authors are selected on the basis of their expertise in the subject areas and their familiarity with the relevant literature. Both EPA and non-EPA scientific experts will be involved in this effort. The main focus of the revised criteria document will be an evaluation and interpretation of data that deal with O_3 air quality effects on health and welfare as chosen by these scientific experts. A workshop convened to review the draft criteria document chapters will focus on the selection of pertinent studies included in the chapters, the potential need for additional information to be added to the chapters, and the quality of the summarization and interpretation of the literature. The respective authors of the draft chapters will revise them on the basis of the workshop recommendations. If needed, the revised chapters will be recirculated to workshop participants for further review. After resolution of outstanding issues and comments, NCEA-RTP will release the document as the first external review draft for public comment and CASAC review. Any necessary revisions will be made on the basis of the public comments and CASAC recommendations before the final version of the criteria document is released.

C. PERSONNEL

Mr. James A. Raub will serve as the NCEA-RTP project manager and will also provide overall technical guidance for the health effects chapters. Other proposed NCEA-RTP project team members providing overall technical guidance for individual chapters are as follows: Dr. Joseph Pinto for the chapter on chemistry and physics; Mr. William Ewald and Ms. Beverly Comfort for the chapter on environmental concentrations, patterns, and potential exposures; Dr. J.H.B. Garner and Dr. Timothy Lewis for the chapter on environmental effects; Mr. James A. Raub for the chapter on toxicological effects; and Dr. Robert Chapman for review and evaluation of epidemiological studies. Additional technical assistance on health effects and air quality will be obtained directly from EPA scientists in the National Exposure Research Laboratory, National Health and Environmental Effects Research Laboratory, and the Office of Air Quality Planning and Standards. If not available from within EPA, scientific expertise will be obtained from outside EPA utilizing small purchase requests for professional services. Members of NCEA-RTP's project team and other EPA and non-EPA personnel expected to contribute to the document are listed in Appendix C.

D. APPROACH

Discussions will be held with the authors at the initial stages of document development to acquaint them with detailed guidelines and specifications. Subsequent workshops may be conducted to facilitate continuity within and between chapters. The authors will be provided copies of the previous criteria document (U.S. Environmental Protection Agency, 1996). New sections for the updated document should summarize the information presented in the previous documents, including reference to the "key" studies noted above. Once this background information is presented, the remainder of the sections should be updated with a discussion of the newer literature. In some cases where no new information is available, the summary from the previous criteria document will suffice.

A list of references published since completion of the 1996 criteria document will be made available to the authors. The references will be selected from information data base searches conducted by EPA. Hard copies of any of these references will be supplied upon request. Additional references may need to be added to the list (e.g., missed or recently published papers or "in press" publications). Authors must furnish a copy of each reference cited in the text that was not listed on the bibliographies of new references or was not cited in the previous criteria document or the addendum to that document.

As an aid in selecting pertinent new literature, the authors will also be provided with the summary of issues that need to be addressed in the preparation of the revised air quality criteria document for O_3. These issues were identified by authors and reviewers of the previous documents and continue to be enumerated following public discussions, workshops, or in comments received by EPA. The list of issues may not be complete, however, and the author should feel free to discuss any other issues that have not been identified.

A good approach to evaluation of selected literature is to separate studies into three groups. The first group (*relevant*) includes those studies directly relevant to the issues identified in the previous section. The second, or *may be relevant* group, includes research that possibly should be mentioned. The final group (*not relevant*) is a repository for studies that obviously are not relevant to assessing health and welfare effects for standard-setting activities. The first and second groups can be further subdivided into most relevant, less relevant, and least relevant references. The most relevant material should be discussed first in the section. Less relevant material should receive a lower priority. Least relevant results may be mentioned only briefly, put into a table, or left out of the document. The most important studies identified by this evaluative approach should be fully described. Readability should be emphasized. Documents are read not only by the author's peers but also by people with different interests and levels of expertise. These people initiate important legal, economic, and societal actions. The proposed chapter and section outline for the O_3 criteria document appears in Appendix D.

E. PUBLIC AND SCIENTIFIC PEER REVIEW

1. Review and Revision of the Peer-Review Workshop Draft

When all components of the working draft document have been completed by the authors, a workshop will be convened by the NCEA-RTP Project Team. The workshop will include the document authors, EPA Work Group participants, and reviewing consultants chosen on the basis of scientific expertise within specific areas covered. The workshop will be open to the public, as announced in a Federal Register Notice. After review of the Workshop Draft, the authors, contributing reviewers, and NCEA-RTP Project Team will resolve comments, as necessary, to revise the draft chapters in preparation for a formal external peer-review process, which includes public comment and CASAC review of the external review draft(s) of the criteria document.

2. Public Review of the External Review Draft

After the workshop peer review process is completed, the authors and NCEA-RTP Project Team will resolve comments, as necessary, to revise the draft chapters in preparation for an External Review Draft (ERD) document. After clearance by the U.S. EPA, the document will be released to the public through a Federal Register Notice. Electronic and printed copies of the ERD will be made available for review during a specified time period of usually 60 to 90 days. Written comments are solicited during this time.

3. Review by the Clean Air Scientific Advisory Committee

At the time the External Review Draft is released to the public, the document is sent to the Clean Air Scientific Advisory Committee (CASAC) of EPA’s Science Advisory Board established under the Federal Advisory Committee Act (see Appendix E). The CASAC members and selected consultants will review the draft document and discuss their comments in a public meeting announced in the Federal Register. The NCEA-RTP Project Team will present a summary of the public comments received on the document at the meeting and be prepared to discuss proposed revisions, if indicated. At the end of the meeting, the CASAC will present their summary comments and recommendations for disposition of the document. Several options are possible at that time. Comments on the document may be serious enough to warrant another complete revision cycle and release of a second ERD; or specific chapters of the document may need major revision before reconsideration of the document; or only minor revisions of the document would be required. When satisfied that the document provides an appropriate scientific basis for review and possible revision of the O_3 NAAQS, the CASAC will submit a written letter of closure to the EPA Administrator. The final document is subsequently printed and announced in the Federal Register.

References

Federal Register. (1979) National primary and secondary ambient air quality standards: revisions to the National Ambient Air Quality Standards for photochemical oxidants. F. R. (February 8) 44: 8202-8237.

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U.S. Environmental Protection Agency. (1992) Summary of selected new information on effects of ozone on health and vegetation: supplement to 1986 air quality criteria for ozone and other photochemical oxidants. Research Triangle Park, NC: Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office; EPA report no. EPA/600/8-88/105F. Available from NTIS, Springfield, VA; PB92-235670.

U.S. Environmental Protection Agency. (1996) Air quality criteria for ozone and related photochemical oxidants. Research Triangle Park, NC: Office of Research and Development; report nos. EPA/600/AP-93/004aF-cF. 3v. Available from: NTIS, Springfield, VA; PB96-185582, PB96-185590, and PB96-185608. Available online at: www.epa.gov/ncea/ozone.htm.

U.S. Environmental Protection Agency. (2000) Peer review handbook. Washington, DC: Science Policy Council; EPA draft report; August 14, 2000.

APPENDIX A

ENVIRONMENTAL PROTECTION AGENCY
[FRL–6877–1]

Air Quality Criteria for Ozone and Related Photochemical Oxidants
AGENCY

Environmental Protection Agency.

ACTION

Notice; call for information.

SUMMARY

The National Center for Environmental Assessment, Office of Research and Development, of the U.S. Environmental Protection Agency (EPA) is undertaking to update and revise, where appropriate, the Air Quality Criteria for Ozone and Related Photochemical Oxidants (EPA–600/P–93–004aF-cF) published in July 1996.

Since completion of the 1996 ozone criteria document, the EPA has continued to collect scientific information on the effects of ground-level ozone on health and vegetation. A summary and evaluation of this and other selected literature that may be particularly relevant to a review of the National Ambient Air Quality Standards for ozone will be presented in the forthcoming revised criteria document.

As part of this continuing review, interested parties are invited to assist the EPA in developing and refining the scientific information base for updating the air quality criteria for ozone. While EPA has continued to follow the literature and gather appropriate studies since early 1996, the Agency is interested in additional new information, particularly concerning the effects expected from the presence of ground-level ozone in the ambient air on: humans and laboratory animals; vegetation, both in agroecosystems (crops) and in natural ecosystems; nonbiological materials; and global climate. EPA also seeks recent information in other areas of ozone research such as its chemistry and physics, sources and emissions, analytical methodology, transport and transformation in the environment, and ambient concentrations. To be considered for inclusion in the revised criteria document, submitted information should be published, accepted for publication, or have been presented at a public scientific meeting.

DATES

All communications and information must be submitted by December 1, 2000, and addressed to the Project Manager for Ozone and Related Photochemical Oxidants, National Center for Environmental Assessment (MD–52), U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

Dated: September 15, 2000.
William H. Farland,
Director, National Center for Environmental Assessment.
[FR Doc. 00–24676 Filed 9–26–00; 8:45 am]
BILLING CODE 6560–50–U

APPENDIX B

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  arrhythmias

APPENDIX C

NCEA-RTP PROJECT TEAM AND OTHER TECHNICAL CONSULTANTS

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[3]The list of non-EPA scientists is proposed on the basis of published, peer-reviewed scientific publications on topic areas that are likely to be included in the revised criteria document or on the basis of previous involvement as an author, contributor, or reviewer of the 1996 criteria document. Contractual agreements for professional services would be the likely mechanism for obtaining their participation in workshops and their contributions to the revised air quality document for O_3.

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APPENDIX D

PROPOSED CONTENTS AIR QUALITY CRITERIA FOR OZONE AND RELATED PHOTOCHEMICAL OXIDANTS

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APPENDIX E

SCIENCE ADVISORY BOARD CLEAN AIR SCIENTIFIC ADVISORY COMMITTEE MEMBERS
Fiscal Year 2001

The Clean Air Scientific Advisory Committee (CASAC) has a statutorily mandated responsibility to review and offer scientific and technical advice to the Administrator on the air quality criteria and regulatory documents that form the basis for the national ambient air quality standards (NAAQS), which are currently lead, particulate matter (PM), ozone and other photochemical oxidants (O_3), carbon monoxide (CO), nitrogen oxides (NO_x) and sulfur oxides (SO_x).

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