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Ozone Attainment Requires Long-Term Solutions to Solve Complex Problems

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The Honorable John D. Dingell
Chairman, Subcommittee on Oversight
and Investigations
Committee on Energy and Commerce
House of Representatives

The Honorable Quentin N. Burdick
Chairman, Committee on Environment
and Public Works
United States Senate

At your request we have reviewed the efforts of the Environmental Protection Agency (EPA) to reduce ozone levels to meet the national air quality ozone standard. This report discusses the nation's progress in reducing ozone levels, the status of EPA's review of the latest scientific data on the health effects of ozone, problems three areas have had in implementing ozone programs, and EPA's oversight of state and local efforts to reduce ozone.

As arranged with your offices, unless you publicly release its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time we will send copies of the report to appropriate congressional committees; the Administrator, EPA; and the Director, Office of Management and Budget. We will also make copies available to others upon request.

This work was performed under the direction of Hugh J. Wessinger, Senior Associate Director. Major contributors are listed in appendix V.

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Executive Summary

Purpose

Although considerable progress has been made in controlling air pollution, in 1985 (the latest year for which data were available) approximately 77 million Americans lived in areas that exceeded the ozone standard. Scientific and medical research have linked ozone to reduced lung functions, coughing, chest pain, and reduced ability to resist lung infections. The Clean Air Act of 1970 required the Environmental Protection Agency (EPA) to set national air quality standards for ozone and other pollutants.

The Clean Air Act Amendments of 1977 required EPA and the states to identify areas not meeting the ozone standard and set December 31, 1987, as the final date for meeting the ozone standard. In response to requests by the Chairmen of the Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, and the Senate Committee on Environment and Public Works, GAO examined (1) the nation's progress in reducing ozone levels to the standard; (2) the status of EPA's review of the latest scientific data on the health effects of ozone and (3) the efforts of EPA, state, and local governments to address the ozone problem in three areas not attaining the standard.

Background

In accordance with the act, EPA established the national air quality ozone standard at a level intended to protect the public's health. Many of the health effects from ozone are considered by EPA to be short-term and reversible when peak ozone concentrations are reduced. Concern exists, however, that repeated short-term exposures to ozone may cause long-term damage to the lungs.

The complex process by which ozone is formed has complicated efforts to control it. Ozone is not emitted directly into the air, but is formed when certain chemicals—primarily hydrocarbons and nitrogen oxides from vehicles and industrial sources—react to sunlight and heat. EPA's basic strategy for reducing ozone is to control hydrocarbon emissions. Because atmospheric reactions that form ozone take time, and meteorological factors affect its formation and location, high concentrations often occur far from the source of the precursor emissions.

Results in Brief

Most areas identified as not in attainment with the current ozone standard in 1979 were still not in attainment by January 1, 1987. Some areas are close to meeting the standard while ozone levels in other areas remain far above it.

EPA's latest review of the health data concluded that the standard may not include an adequate margin of safety and that it may therefore need to be more stringent. A group of independent scientists agrees with EPA's conclusion, while others question the significance of some health effects that EPA attributes to ozone.

The three locations GAO reviewed—Charlotte, North Carolina; Houston, Texas; and Los Angeles, California—did not reach planned air quality reductions because control measures were not implemented, control measures implemented were not enforced, or such measures were not as effective as anticipated. In addition, GAO found instances in which deficiencies identified in the three areas' ozone control programs were not corrected, indicating that EPA's oversight was not as effective as it should have been.

While GAO believes more effective program implementation would have led to greater ozone reductions, other factors, such as technical uncertainties in determining the control needed and the scientific complexities associated with ozone formation, contributed to the act's deadlines being unachievable. Accordingly, GAO believes that the Congress needs to amend the Clean Air Act, to better deal with these difficulties through a strategy of (1) setting new deadlines that acknowledge the variation in different areas' ozone problems, and (2) specifying the conditions under which sanctions would apply.

Principal Findings

Limited Progress in Reducing Ozone Levels

In 1979, EPA identified 317 counties or parts of counties and 31 metropolitan areas that did not meet the current ozone standard. These counties were supposed to meet the standard (set at 0.12 parts per million) by December 31, 1982, while the 31 metropolitan areas were granted extensions to December 31, 1987. Out of the 317 counties, 123, or 39 percent, had met the ozone standard as of January 1, 1987, the latest year for which data were available. As of August 1987, none of the 31 metropolitan areas had met the standard. Some areas' ozone levels are close to meeting the standard (0.13-0.14 parts per million), some areas' ozone levels are far away from the standard (0.20 parts per million to 0.35 parts per million), and some areas' ozone levels are in between.

Ozone Standard Based on Protecting the Public

The current national air quality standard for ozone is intended to protect the public from the harmful health effects of ozone. EPA's March 1986 study of the latest scientific information concluded that the current standard may need to be more stringent. While a group of independent scientists agreed with the conclusion, groups opposed to lowering the standard raised a number of questions, particularly about the significance of some of the health effects cited by EPA. EPA is revising its study to, among other things, more clearly define what constitutes adverse health effects.

Planned Ozone Reductions Not Met

Planned ozone reductions were not met for a variety of reasons including the following: (1) In the Los Angeles area, 16 of 29 planned measures to control hydrocarbon emissions from stationary sources had not been implemented because the control technology was not fully developed or was considered too costly to use. In addition, some measures implemented were not as effective in controlling emissions as planned. (2) In the Charlotte area, some control measures were not enforced because variances and compliance extensions to the regulations were granted without EPA approval. In addition, the plan was based on a deficient model that EPA no longer allows for ozone planning. (3) In the Houston area, control measures were generally implemented, but the plan understated the amount of control needed because incorrect data were used in the modeling.

GAO also found that, in some instances, EPA did not use the tools provided by the Clean Air Act (such as imposing economic sanctions), to carry out its oversight responsibilities. As a result, EPA took no action or took action that did not correct the deficiencies identified in the ozone programs. However, when EPA did attempt to apply the construction ban sanction in 1983 because areas missed the 1982 attainment deadline, it met strong resistance from the states and the Congress and withdrew its proposal.

EPA's Post-1987 Ozone Strategy

Because it realized that many areas would not meet the ozone standard by December 31, 1987, and in some cases for many years, EPA recently announced a proposed post-1987 ozone program. The program would call for revised ozone plans for areas that do not meet the attainment deadline and would administratively extend the attainment deadline for some areas without imposing sanctions. In other areas, EPA would impose the construction ban sanction unless attainment with the standard could be demonstrated in 5 years.

Observations

While GAO has not analyzed EPA's recent proposal, GAO concurs with EPA's concept of requiring areas to submit revised ozone plans if they do not meet the December 31, 1987, deadline. However, disagreement exists over whether attainment deadlines can be extended—and sanctions averted—without new legislation. GAO has reported in the past and continues to believe that EPA may not administratively extend the deadlines set out in the Clean Air Act in lieu of enforcing the statutory penalties; therefore, GAO believes that unless Congress amends the act, EPA is required to impose the construction ban in all areas that it determines do not meet the 1987 ozone deadline. (Recently, legislation was enacted that, among other things, prohibits EPA from imposing such a ban in ozone nonattainment areas until August 31, 1988.) On the other hand, EPA has taken the position that imposing the construction ban is discretionary and is not applicable in all cases.

Furthermore, complicating the appropriateness of sanctions are such factors as the scientific uncertainties over the formation of ozone, and the impact of weather patterns on ozone levels. These factors have contributed to difficulties in achieving attainment deadlines. Therefore, GAO believes that the Congress needs to address these matters by building more flexibility into the act.

Recommendations to the Congress

To build additional flexibility into the Clean Air Act by recognizing the diversity of problems areas have had in dealing with the ozone problem, and to clear up the confusion over the use of sanctions so that the act can be properly enforced, GAO recommends that the Congress amend the act to (1) establish a strategy that places areas into different categories and establishes different attainment dates based on the severity of their ozone problems, and (2) specify the conditions under which sanctions will apply, such as when an area fails to implement its plan or does not meet its attainment deadline, and the extent to which EPA will have discretion in applying such sanctions.

Agency Comments

GAO discussed the matters in this report with EPA officials and incorporated their comments where appropriate. However, as requested, GAO did not obtain official agency comments on the report's conclusions and recommendations.

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Abbreviations

CAA	Clean Air Act
CASAC	Clean Air Scientific Advisory Committee
EKMA	Empirical Kinetic Modeling Approach
EPA	Environmental Protection Agency
GAO	General Accounting Office
OAQPS	Office of Air Quality Planning and Standards
ppm	parts per million
psi	pounds per square inch
REEP	Reasonable Extra Efforts Program
RFP	Reasonable further progress
RVP	Reed Vapor Pressure
SIP	State Implementation Plan
TACB	Texas Air Control Board
UAM	Urban Airshed Model

Introduction

Ozone, a primary constituent of smog, is one of the nation's most pervasive air pollution problems. Formed when emissions of volatile organic compounds[1] combine with nitrogen oxides in the presence of heat and sunlight, ozone has been linked to reduced lung functions, which affects breathing and causes symptoms such as coughing and chest pain. Studies using animals have linked ozone to reducing the lung's ability to resist infections. In addition, high levels of ozone have been shown to reduce yields of several agricultural crops and may have caused severe damage to trees in California. Although considerable progress has been made in reducing air pollution, in 1985 about 77 million Americans lived in areas where ozone levels exceeded the standard.

Since 1970, federal, state, and local governments have been trying to reduce the ozone level in polluted areas to what is believed to be a safe level. The Clean Air Amendments of 1970 require EPA to identify the highest levels at which six specific air pollutants will not endanger public health and to establish air quality standards at or below these levels. Ozone is one of the six.[2] The standards are to be based on the latest available scientific information and must protect the public from known and anticipated adverse health effects. Further, the Clean Air Act (CAA) set deadlines by which the standards must be met. The first ozone attainment deadline was 1975, which few areas reached. In 1977 the Congress extended the deadline to December 31, 1982, with extension possible to December 31, 1987, for some areas if certain requirements were met. However, even this deadline was optimistic for many small urban areas and was out of reach for many large urban areas.

Complexity of Controlling Ozone

The control of ozone has been complex because it is not emitted directly into the air. Rather it is formed in the atmosphere through a complex series of chemical reactions between hydrocarbons and nitrogen oxides emitted from vehicle exhaust and industrial sources in the presence of sunlight. Because heat plays a significant role in the formation of ozone, the vast majority of standard violations occur on hot summer days.

[1]Volatile organic compounds include methane hydrocarbons and nonmethane hydrocarbons. Since methane is considered only negligibly reactive in ambient air, the volatile organic compounds of importance as oxidant precursors are called nonmethane hydrocarbons. For this report we are using the term hydrocarbons to refer to nonmethane hydrocarbons and volatile organic compounds in general.

[2]The other five pollutants are carbon monoxide, lead, nitrogen dioxide, particulate matter, and sulfur dioxide.

Because the atmospheric reactions that form ozone take time, ozone is often concentrated many miles from the source of the precursor emissions. In addition, meteorological factors such as (1) degree of atmospheric stability, (2) wind speed and direction, and (3) intensity and wavelength of sunlight play an important role in forming ozone. These variables make it extremely difficult to assess how much emissions from any one source contribute to creating a specific amount of the pollutant. Likewise, it is hard to estimate the ozone reductions that can be achieved from regulating any given source of ozone precursors.

Despite these difficulties in identifying sources, EPA has identified three major source categories of hydrocarbons:[3] (1) industrial processes (petroleum refineries, petroleum products, chemical plants, etc.); (2) transportation (light duty gasoline vehicles, light duty trucks, and heavy duty gasoline vehicles); and (3) fuel combustion (electric utilities, industrial, commercial, and residential facilities using coal, fuel oil, and natural gas).

Evolution of the Ozone Standard

The CAA and its subsequent amendments required EPA to identify the highest levels of air pollutants that will not endanger public health and to establish air quality standards—"primary standards"—at or below these levels with an adequate margin of safety. The act also defined "welfare" effects, which are those that harm the environment, and required EPA to set "secondary standards" to protect against these effects. These standards were to be implemented through state programs approved by EPA.

The ozone standard was originally established in 1971 as a photochemical oxidant standard. The standard was set at an hourly average level of 0.08 parts per million (ppm) not to be exceeded more than 1 hour per year. The hourly standard was based on epidemiological studies that showed an increased asthma attack rate in areas where ozone levels were high. Many of the health effects from ozone are considered by EPA to be transitory and reversible when ozone levels are reduced. Concern exists, however, that repeated exposures may cause long-term damage to the lungs.

In 1979 the current standard was set at 0.12 ppm, the designation was changed to ozone, and the method for calculating whether an area exceeded the standard was changed. The standard is attained when the

[3]National Air Quality and Emissions Trends Report, 1985, EPA, 450/4-87-001.

expected average number of daily exceedances per calendar year is equal to or less than one. For each monitoring station the number of days with maximum hourly concentrations above 0.12 ppm is determined for each year and then averaged over the preceding 3 years. A day is considered an exceedance if the maximum hourly average concentration exceeds 0.12 ppm. For example, an area would not meet the standard if, over a 3-year period, the highest hourly ozone concentrations in a day exceeded 0.12 ppm on 4 separate days. A period of fewer than 3 years can be used if monitoring data are not available. (See app. I for a detailed discussion of the evolution of the ozone standard.)

State Implementation Plan Process

The CAA requires states to prepare implementation plans for each defined nonattainment area. The State Implementation Plan (SIP) process is a cooperative effort involving EPA, state governments, and local jurisdictions. Elements of the SIP process include inventorying emission sources, identifying needed control measures, adopting these measures, and evaluating progress.

Under the CAA EPA and state governments are collectively responsible for defining the size of an area for air quality planning purposes. Although EPA initially approved areas as small as a single county or part of a county, it now believes larger geographical areas made up of several counties/cities is the most effective scale for air quality planning purposes.

The actual measurement of ozone concentrations is a key in determining air quality planning goals for an area. This information is gathered from the ambient air monitoring networks (the group of air pollution monitors for each area) described in appendix I. EPA requires that at least two ozone monitors be located in urban areas with populations greater than 200,000. Many areas, however, have more. The most polluted area—Los Angeles—uses 28 monitors to determine its levels and distribution of ozone concentrations.

Inventorying Emission Sources

Hydrocarbons and nitrogen oxides are the two major precursors to ozone. Controlling hydrocarbon emissions is EPA's basic strategy for reducing ozone. When developing SIPs, areas are required to inventory stationary and mobile sources emitting hydrocarbons and nitrogen oxides.

Techniques for compiling emissions inventories are inexact, ranging from questionnaires to mobile models. EPA requires all major point sources—plants and facilities emitting 100 tons per year—to be inventoried individually, while emissions for minor sources may be inventoried individually or collectively as area sources. Major sources are typically inventoried using questionnaires, plant visits, and permit data. Small source emissions are determined from such methods as (1) individual plant information, (2) local surveys to determine the amount and type of hydrocarbon-emitting products that are sold and used in an area, and (3) per capita estimates using emission factors developed by EPA.

To inventory highway vehicle emissions, EPA has developed different generations of a model called Mobile. Vehicle miles traveled and vehicle speed are key data for vehicle emission estimates. Mobile 1 was available for the 1979 SIP revisions that demonstrated attainment in 1982; Mobile 1 and Mobile 2 were available for 1982 SIP revisions that demonstrated attainment in 1987, although EPA encouraged areas to use Mobile 2 because it was considered more accurate. Since the 1982 SIP revisions, EPA has developed Mobile 3 and is developing Mobile 4.

Determining the Amount of Control Needed

Once the emissions inventory was completed, areas using models then estimated the percentage of total emissions reductions needed to attain the standard and the specific reductions that should occur from implementing various control measures. EPA has developed three models: the Urban Airshed Model (UAM), the Empirical Kinetic Modeling Approach (EKMA), and the linear rollback modeling technique.

The linear rollback model, which EPA no longer allows was used in the earlier planning. It assumes a simple, proportional reduction: If total emissions are reduced by 10 percent, the model estimates that ambient pollutant levels would be reduced by 10 percent. EPA found that the model worked reasonably well for pollutants such as carbon monoxide, where a direct relationship exists between emissions and ambient air concentrations. This model did not work as well for ozone because ozone formation is much more complex. Consequently, EPA developed the more complex EKMA and UAM models.

The EKMA model, widely used by states in the 1980s, factors in the effects of sunlight, chemical reactivity, and the ozone being transported into an area. However, EKMA can use only simplified meteorological conditions and can analyze only maximum concentrations.

UAM, on the other hand, is a more sophisticated model. It considers meteorological conditions and can estimate differences in air quality at different places in an area. It can demonstrate progress in terms of declining peak ozone concentrations as well as indicate how peak ozone concentrations will change across an entire urban area. UAM is more costly than EKMA, and requires much more data, computer validation, and computer capacity. Because of these factors, states have not used it widely to develop SIPs.

Adopting Control Measures

Once an area knows the amount of emission reductions needed, it must adopt control measures to accomplish these reductions. For stationary sources, areas must adopt control measures EPA has outlined in its control technique guidelines or develop substitute control measures.

The control technique guidelines define "reasonable available technology" for controlling an emission source and provide estimates on the amount of reduction that can be expected, the costs of controls, and facilities covered. The guidelines cover a variety of sources including gasoline truck loading facilities, storage tanks, petroleum refinery leaks and large dry cleaners.

Transportation control measures outlined in section 108 (f) of the CAA include programs to improve public transit, establish carpool and bus lanes, stagger work hours, improve traffic flow, and establish commuter parking facilities. The act also required areas that were granted extensions past 1982 to adopt vehicle inspection and maintenance programs.

Evaluating Progress in Implementing SIPs

Section 110 of the CAA requires that each SIP include procedures for revising it as necessary, including whenever EPA finds information demonstrating that the plan is substantially inadequate to achieve the standard. If a state fails to revise the plan after notification from EPA, EPA is required to develop a plan.

Sections 171 and 172 of the CAA established the concept of reasonable further progress (RFP) and defined it as annual emission reductions of the applicable pollutant (including substantial reductions in the early years following approval of the SIP) which would, in the judgment of the Administrator, EPA, provide attainment of the standard by the required date. EPA rules for the 1979 and 1982 SIP revisions required states to submit annual reports by July 1 of the following year outlining progress toward achieving the standard. These reports are to include the status

on implementation of control measures as well as reductions achieved in emissions (for ozone these are hydrocarbons).

The CAA allows EPA to impose economic sanctions against states for failure to comply with the act's planning and control requirements. The sanctions include withholding federal highway funds, clean air grants, and sewage treatment grants, and imposing a construction moratorium on facilities that would contribute to concentrations of a pollutant in nonattainment areas.[4]

The construction ban is the mandatory penalty for nonattainment after the attainment deadline passes.[5] In addition it could be used by the Administrator, EPA, at any time for any SIP-related deficiencies. The act also required termination of clean air grants once there has been a finding of nonimplementation of a revised SIP. Also, the act authorized the withholding of some highway funds if areas did not make reasonable efforts to develop SIP revisions required in 1979 and 1982. Grants authorized by the Federal Water Pollution Control Act for construction of new sewage treatment facilities can be withheld if the Administrator determines that the applicable SIP revision does not adequately take into account the air quality consequences of the construction.

Progress in Reducing Ozone

The Congress revised the ozone attainment deadline on two occasions because of the difficulties areas were having in meeting the ozone standard. A comparison of ozone design values for the period 1979 to 1981 with the period 1983 to 1985 indicates mixed results in lowering ozone levels to the standard. EPA's national trends data show that the number of exceedances declined by 38 percent over the last 6 years, with the high readings decreasing by 10 percent. On the other hand, only 39 percent of the counties designated to reach attainment by December 31, 1982, had done so as of January 1987.

[4]On December 22, 1987, legislation was enacted (P.L. 100-202) that prohibits EPA from taking action to impose economic sanctions under the CAA in ozone and carbon monoxide nonattainment areas until August 31, 1988.

[5]The construction ban is in section 110 (a)(2)(I) of the act. EPA maintains that the Administrator, EPA, does not have to impose the ban if an area fails to meet the standard by the legislative deadline as long as the area has an approved plan and has made reasonable efforts to implement the plan. (See ch. 4 for further discussion.)

National Trends Data Indicate Ozone Levels and Number of Violations Are Decreasing

National trends data are developed from the state and national ambient air monitoring networks. During the 9-year period from 1976 to 1985, ozone readings collected from 183 monitoring sites showed that ozone levels on the average decreased by 19 percent. However, comparisons of data prior to 1979 need to be qualified because EPA made a calibration change on the monitors in 1979 that resulted in lower ozone readings. EPA and others estimate that the calibration change could result in ozone level decreases ranging from 10 to 18 percent. EPA's trends data since the calibration change (1979 to 1985) show that ozone levels decreased by 10 percent. For the same 6-year period, the estimated number of exceedances decreased by 38 percent.

Design Value Changes Indicate Some Progress

Because EPA's national trends data are based on only selected urban areas, we asked EPA for ozone design values on areas exceeding the standard for the periods 1979 to 1981 and 1983 to 1985. These data show that of 90 areas, 65 (72 percent) of the areas reduced their ozone design values, 16 (18 percent) had design values that were greater, and 9 (10 percent) had no change. In addition, of the 90 areas, 21 (23 percent) had reduced their ozone design values to 0.12 ppm or less. The remaining areas' design values ranged from 0.13 ppm to 0.36 ppm.[6]

Progress Since 1977

The 1977 amendments required EPA and the states to designate all areas that did not meet the standard. These areas were required to revise their SIPs to demonstrate attainment by December 31, 1982, or at the latest, December 31, 1987. In 1979 EPA identified 317 counties or parts of counties that were to demonstrate attainment with the current ozone standard by December 31, 1982, and 31 metropolitan areas that were granted an extension to December 31, 1987. Of the 317 counties, 123, or 39 percent, had reached attainment as of January 1, 1987.[7] None of the 31 metropolitan areas had reached the standard as of August 1987.

Objectives, Scope, and Methodology

Because many areas clearly will not reach ozone attainment by the legislatively mandated date, the Chairmen of the Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, and the

[6]These figures represent monitoring data through 1985 and are the latest information available for all 90 areas. (See app. II for detailed information on the 90 areas' design value changes.)

[7]This data is not directly comparable to the 90 areas because it covers different time periods and because EPA has grouped some of the counties together for the purpose of computing design values and for air quality planning.

Senate Committee on Environment and Public Works asked us to review the problems associated with ozone attainment. As agreed with the requesters' staffs, we examined

- the progress areas have made in reaching the ozone standard (ch. 1.);
- the status of EPA's efforts to reevaluate the scientific data on the health effects of ozone (ch. 2.); and
- the efforts of EPA and three case study areas (Charlotte, North Carolina; Houston, Texas; and Los Angeles, California) to implement ozone control programs (chs. 3 and 4).

We performed our work between May 1986 and August 1987. Work was performed at EPA headquarters in Washington, D.C.; EPA's Office of Air Quality Planning and Standards (Durham, N.C.) and Office of Mobile Sources (Ann Arbor, Mich.); and its regions IV (Atlanta, Ga.), VI (Dallas, Tex.), and IX (San Francisco, Calif.). We also performed work at the California Air Resources Board and the South Coast Air Quality Management District; North Carolina's Department of Natural Resources and Community Development and the Mecklenburg County Department of Environmental Health; and the Texas Air Control Board and Houston Health Department. We selected the three particular case study areas to ensure coverage of areas that are both close to and far from reaching attainment of the standard, in accordance with the requesters' wishes. (See app. III for a brief description of the three areas.)

To determine areas' progress in reaching the ozone standard, we gathered and analyzed nationwide statistics from EPA's Office of Air Quality Planning and Standards (OAQPS). The data included the number of ozone nonattainment areas designated under the CAA 1977 amendments and the latest information on those now considered to be in attainment, and monitoring data developed from the state and national monitoring networks. We also reviewed EPA's 1984 and 1985 national air quality trend reports, which are the latest reports available.

To determine the status of EPA's efforts to review the ozone standard, we reviewed the latest summary reports on ozone health effects prepared by EPA's Environmental Criteria and Assessment Office and OAQPS, interviewed officials who are responsible for assessing the information on health effects, reviewed comments from industry and others on EPA's assessment and interpretations of the health data, and reviewed the Scientific Advisory Board's comments on the adequacy of EPA's interpretations of the health effects data.

To determine how well the three areas and EPA were implementing their ozone programs, our work included obtaining information on the procedures used to develop the SIPs and EPA's review of them; reviewing and analyzing reasonable further progress reports, evaluations by the American Lung Association, and an audit report on implementation of the Los Angeles area SIP; discussing with state, federal, and local officials, and industry and environmental representatives (1) the development and implementation of the SIPs, (2) why progress has not been as rapid as anticipated, and (3) additional actions that could be taken to bring areas into attainment.

We discussed with EPA officials state and local efforts to control ozone and problems the nation faces with this pollutant, and have included their comments in the report where appropriate. However, as requested we did not obtain official agency comments on the conclusions and recommendations in this report, nor did we request official agency comments on a draft of this report. We performed our review in accordance with generally accepted government auditing standards.

Status of EPA's Review of Health Data

The CAA requires EPA to review and update the National Ambient Air Quality Standards (including ozone) by the end of 1980 and every 5 years thereafter. In the update, EPA is to use the latest scientific information on known and suspected health and welfare effects and allow for an adequate margin of safety (error). From its current review of data for updating the standard, EPA's OAQPS concluded that the existing ozone standard may not provide an adequate margin of safety and that an additional ozone standard could be needed to protect individuals from ozone levels of longer duration.[1]

The Clean Air Scientific Advisory Committee (CASAC) of the Science Advisory Board[2] and a number of groups opposed to lowering the standard commented on drafts of EPA's review of the standard. The Committee unanimously concluded that the EPA's work represented a scientifically balanced and defensible summary of the scientific literature on ozone and other photochemical oxidants. On the other hand, some opponents questioned, among other things, whether some of the health effects were adverse.

EPA has estimated the impact a lower ozone standard would have on the population exposed to ozone exceedances. Under the current standard, approximately 44 million people are exposed to 1-hour exceedances on the average of 9 times during the ozone season. If the standard were 0.08 ppm, the number of people exposed to exceedances would triple.

Existing Standard May Be Inadequate

During its current review of health data, OAQPS recommended that the ranges of ozone levels of concern for the health effects standard is 0.08 to 0.14 ppm. They also concluded that a standard of longer duration may be needed.

EPA Offices Involved in the Standard-Setting Process

Two EPA offices have primary responsibility for setting air quality standards: the Office of Health and Environmental Assessment and OAQPS. The Office of Health and Environment Assessment initiates the standard-setting process by performing, or contracting with scientists outside

[1]The current ozone standard is a 1-hour standard set at 0.12 ppm to address peak ozone levels over short periods of time. A multiple- hour standard may be set to address ozone levels less than 0.12 ppm that occur over longer periods of time, such as 6 to 8 hours. EPA is also looking at the need for an ozone standard that would cover several months to a year.

[2]The Science Advisory Board is a group of independent scientists who review the quality and sufficiency of scientific data underlying regulatory development of some EPA actions.

of EPA to perform, an extensive review of all scientific information concerning a pollutant, including its potential health effects. The results ar published in a criteria document.[3]

As soon as the criteria document is substantially complete, OAQPS begins preparing a staff paper.[4] The staff paper is intended to help bridge the gap between the scientific review contained in the criteria document an the judgments required of the Administrator, EPA, in setting standards for pollutants such as ozone.

Lower Range of Ozone Levels Associated With Health Effects

From its review of recent health data, the OAQPS staff concluded that th range of ozone levels of concern for the health effects standard is 0.08 t 0.14 ppm, as compared with the 1979 range of 0.15 to 0.25 ppm. This assessment is based on controlled human exposure, field, epidemiology, and animal toxicology studies. Some of the studies cited in the assessment include the following:

- OAQPS cites controlled human exposure studies performed in 1983 and 1985 that found statistically significant lung function decrements in intermittently heavily exercising, healthy children and adults exposed for 2 hours of 0.12 ppm ozone, and in continuously heavily exercising, healthy adults exposed for 1 hour at 0.16 ppm. These studies are considered the strongest evidence of adverse human health effects because (1) known exposure levels were fairly accurate, (2) other pollutants were not present, (3) temperature and humidity were monitored, and (4) human subjects were used.
- Field studies performed in 1983 through 1985 showed statistically significant lung function decrements in continuously heavily exercising, healthy adolescents at average ozone levels of 0.144 ppm and in continuously heavily exercising, healthy adults at average ozone levels of 0.153 and 0.165 ppm. Field studies are not considered to be as precise as controlled exposure studies because other pollutants are present.
- In controlled exposure studies respiratory symptoms such as chest pain coughing, and wheezing showed a close association with changes in the

[3]For ozone the criteria document is "Air Quality Criteria for Ozone and Other Photochemical Oxidants" (Aug. 1986), Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment.

[4]For ozone the staff paper is "Review of the National Ambient Air Quality Standards for Ozone: Preliminary Assessment of Scientific and Technical Information" (Mar. 1986), Strategies and Air Standards Division, OAQPS.

pulmonary functions when exposure was above 0.12 ppm. Similar symptoms have been qualitatively associated in children and young adults at exposures above 0.10 ppm.

- Animal studies indicated evidence of possible health effects at low levels, including increased incidence of bacterial infections. Several of the animal studies reported increased infection in mice exposed for 3 hours at ozone levels of 0.08 ppm to 0.10 ppm.

Necessity for Longer Term Health Effects Standard

The need for a longer term health effects standard, according to OAQPS, centers around concern that repeated peak exposures to ozone (i.e., a few days) and/or exposures to certain levels over long periods (i.e., years) may cause irreversible effects on the lung. As part of the current review and in response to the CASAC comments, OAQPS is looking at the need for a 6- to 8-hour average standard. Recent human studies have shown that as exposure over time increases, loss in lung functions increases and it takes longer for the effects to reverse.

- One study found that children's lung function decrements following a 4-day exposure to a smog period remained as long as a week. The ozone concentration peaks for the 4 days were in the range of 0.12 to 0.185 ppm.
- In a recent study by EPA researchers, 10 men were exposed to ozone concentrations of 0.12 ppm for 6 3/4 hours. Lung function losses increased as exposure progressed. Of the 10 subjects, 5 exhibited lung function losses of less than 10 percent, including 2 who exhibited no response, and 5 exhibited losses greater than 10 percent, including 1 whose loss was in excess of 40 percent. The men were exercising moderately, which was supposed to simulate an adult engaged in moderate to severe physical work or of a child or adolescent engaged in very active play.

OAQPS is also looking at the need for a monthly or annual long-term standard because animal studies have demonstrated that ozone affects the lung's ability to resist bacterial and viral infections, and accelerates the lung's aging process. The aging process is accelerated because as the lung is exposed to ozone, sensitive tissues are damaged. When the lung heals, scar tissue remains and as this process repeats itself, scar tissue builds up. Scar tissue reduces the pulmonary elasticity of the lung and, according to researchers, is tantamount to premature aging.

Since the 1979 standard was set, the data base on animal research has increased because a number of additional animal studies address long-term effects. Questions remain, however, on whether repeated peak

exposures are more serious than exposures at lower levels over long periods of time. The basic problem of extrapolating animal study results to human effects also continues. As a result, EPA does not expect to reach a definitive decision under the current review on the need for a monthly or annual long-term standard.

Independent and Opposing Views of EPA's Review of the Standard

The CASAC essentially agreed with the presentation and summary of scientific data on health and welfare effects from ozone as presented in the criteria document. It also completed an initial review of the OAQPS staff paper and provided oral comments which agree with OAQPS that little, if any, margin of safety exists in the current standard and that a long-term health standard may be needed. Groups opposed to lowering the standard also reviewed the documents and raised questions regarding, among other things, what should be defined as "adverse health effects."

CASAC Generally Concurs With EPA's Interpretation

In an October 22, 1986, letter to the EPA Administrator, the chairman of CASAC stated that the committee unanimously concluded that the criteria document represents a scientifically balanced and defensible summary of the extensive scientific literature on ozone and other photochemical oxidants. Other specific points made in the letter were that (1) exercise is the dominant factor used in determining health effects responses to ozone, (2) risk groups are not as well defined for ozone as they are for other criteria pollutants, and (3) there is no consensus as to what "responders" (individuals who show a greater response to ozone but cannot be defined as a group) represent. The committee also recommended that EPA perform additional analysis on the results of animal studies that demonstrate long-term health effects.

CASAC did not provide written comments on the OAQPS staff paper, but in an April 1986 meeting advised EPA that the range of the primary health-based standard should be between 0.08 to 0.12 ppm rather than the 0.08 to 0.14 ppm standard recommended in the staff paper, and that a longer-term standard may be needed.

Groups Question EPA's Interpretations of Adverse Health Effects

Groups representing oil, chemical, and automobile industries and one automobile manufacturer have provided comments on EPA's review of the health data. Some of the comments question EPA's interpretation of effects from ozone exposure as adverse.

For example, one group commented that the staff paper appeared to focus on a very narrow interpretation of section 109 of the CAA and includes all effects as "adverse" no matter how trivial, and that minimal pulmonary function decrements should not be deemed "significant adverse health effects" because the response disappears very rapidly once the cause is removed and the decrease is a defensive response. Another group said that EPA should define what constitutes adverse health effects by distinguishing between statistical significance and biological significance in documenting human responses to ozone exposure. Finally, a third group said that the staff paper implies that any symptom or measurable change in pulmonary function is adverse to health and that it agreed with the American Thoracic Society's guidelines as to what constitutes adverse respiratory health effects.[5]

Although the CAA does not specifically define "adverse health effects," the language in sections 108 and 109 indicates that if EPA is to err in setting standards it should be on the side of protecting the public health. Section 108 (a)(1) and (a)(2) states that in establishing the primary and secondary ambient air quality standards, the criteria should reflect the latest scientific information useful in identifying the kind and extent of all identifiable effects on public health or welfare that may be expected from a pollutant. Section 109 (b)(1) further states that the primary standards shall be based on criteria that allow an adequate margin of safety required to protect the public health.

The National Commission on Air Quality provided a similar view in its March 1981 report, stating "the Congress based the CAA on the principle that to protect the public health, government must act to control potentially harmful pollutants despite scientific uncertainty about the precise harm they cause and the levels of exposure that cause that harm."[6]

During the CASAC April 1986 hearing on ozone, members' opinions varied on how to define adverse health effects. One scientist said that any biological response should be considered adverse, while another believed that a "clinical response" was a better definition. Still another scientist

[5]The American Thoracic Society's guidelines define adverse respiratory health effects as medically significant physiologic or pathologic changes generally evidenced by one or more of the following: (1) interference with the normal activity of the affected person or persons, (2) episodic respiratory illness, (3) incapacitating illness, (4) permanent respiratory injury, and/or (5) progressive respiratory dysfunction.

[6]Congress established the National Commission on Air Quality under the 1977 amendments to make an independent analysis of air pollution control and alternative strategies for achieving the goals of the act.

commented that EPA should not attempt to quantify or define effects as adverse, but rather look at all the effects as a whole in making a decision. An OAQPS project officer told us they are looking at ways to better define and quantify what constitutes adverse health effects as they redraft the staff paper on ozone.

EPA's Environmental Criteria and Assessment Office is preparing an addendum to the criteria document which will address CASAC's recommendation that additional analysis be performed on long-term health effects. The addendum, which will incorporate two new studies, is expected to be published in the spring of 1988 and will be completed in the fall of 1989. In the meantime, OAQPS is revising the staff paper on the basis of the committee's and public comments.[7]

Lowering the Standard: EPA Estimates More Areas Will Be in Nonattainment, More People Exposed to Exceedances

EPA does not have national data on the number of additional areas that would be in nonattainment if the standard was lowered. However, in response to the Chairman of the Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, EPA's region IX administrator said that lowering the standard to 0.11 ppm would add 1 additional area to the 17 in the region now considered in nonattainment (16 in California and 1 in Arizona). Lowering the standard to 0.10 ppm would add 11 more nonattainment areas to the existing 17, 13 more at 0.09 ppm, and 15 at 0.08 ppm.

By using modeling and existing air quality monitoring data, EPA developed national estimates of exposure at different ozone levels. Under the current standard EPA estimates that approximately 44 million people are exposed to 1-hour exceedances on the average of 9 times during the ozone season. At 0.10 ppm, EPA estimates that 71 million people are exposed to 1-hour exceedances on an average of 11 times during the ozone season. At 0.08 ppm, EPA estimates that 133 million people are exposed to 1-hour exceedances on the average of 20 times a year.

Summary

In its current review of health data, EPA has found that some children and adults exposed to ozone at the current standard while exercising can suffer a loss in lung function. This finding has led EPA to conclude that the current standard may not provide an adequate margin of

[7]On Dec. 14 and 15, 1987, CASAC held hearings on the revised OAQPS staff paper. However, the results of those hearings are not yet available.

safety. The CASAC of the Science Advisory Board agrees with EPA's position.

EPA also learned from one study that lung function decreases in children persisted for a number of days after exposure to ozone levels slightly higher than the standard on 4 consecutive days. This has led to EPA and CASAC concern that a 6- to 8-hour primary standard may be needed in addition to the current 1-hour standard. CASAC has asked EPA to reassess and compile all health data that address the need for a 6- to 8-hour standard.

Groups opposed to lowering the standard have charged that OAQPS is interpreting the CAA too narrowly and including all health effects as adverse no matter how trivial. They questioned whether minimum lung function decreases should be adverse since they are reversible and, according to some researchers, are a defensive response to protect the lungs. Further, they said that EPA should define what constitutes adverse health effects. EPA is looking at ways to better define and quantify what constitutes adverse health effects.

Reasons Why Ozone Reductions Have Been Less Than Anticipated

EPA estimates that as many as 60 metropolitan areas in the United State may not meet the ozone standard by December 31, 1987. Some of the areas are close to meeting the standard while others may not reach attainment in the foreseeable future. Our review of three areas' efforts to reduce ozone—Charlotte, North Carolina; Houston, Texas; and Los Angeles, California—identified a variety of problems that individually or in combination contributed to not reaching the air quality reductions outlined in these areas' SIPs.

For example, some of the planned control measures were not implemented, and some that were implemented were not always being enforced or were not as effective as anticipated. In addition, ozone reductions planned for may not have been realistic because the hydrocarbon emissions inventories were understated. If the inventory figure i understated, an area will not identify enough control measures to get the needed ozone reductions. Further, assumptions used in the modeling and in some cases, incorrect data, as well as the uncertainties that exist in the models, may have led to inaccuracies in the ozone plans. EPA officials believe these problems are not isolated in the three areas we reviewed, but have nationwide applicability.

Some Control Measures Not Implemented and Others Not as Effective as Anticipated

Among the reasons that emissions of hydrocarbons have been higher than anticipated are (1) planned controls were not implemented and (2) implemented controls were not as effective as projected or were not enforced. Further, implementing control measures is not always seen as a high priority if measures involve changes in life-styles or in an area's industrial or business development.

Control Measures Were Not Implemented

In each of the three areas, some control measures were not always implemented. However, the impact on planned reductions in hydrocarbon emissions was significant only in Los Angeles.

The Los Angeles area SIP called for short-term control measures that were expected to reduce hydrocarbon emissions by approximately 220 tons per day by December 1987 in order to reduce ozone levels to 0.30 ppm. These control measures were aimed at three major categories: stationary source controls (99 tons per day); mobile source controls (80 tons per day); and transportation and energy controls (41 tons per day).

The latest ozone readings (1984-1986) show levels of 0.35 ppm in the Los Angeles area compared with 0.40 ppm in 1982. The following explains why the Los Angeles area did not implement all of the control measures it planned to in the three categories:

- As of September 1986, 16 of 29 stationary source control measures, such as controlling hydrocarbon emissions while oil tanks are being cleaned, had not been implemented as scheduled in the SIP. These measures were intended to reduce hydrocarbons by 44 tons per day, or approximately 45 percent of the total target reductions expected from stationary source controls by 1987. In general, the measures had not been implemented either because the control technology was not fully developed or the local air quality board considered the measures too costly given the expected reductions.
- Of eight mobile source control measures, four were not implemented and had been designated as long-range control measures that needed further study before implementation.[1] EPA approved the action. The measures included developing a new vehicle strategy, including alternative fuels, electrifying railroad line haul operations, converting to methanol vehicles, and establishing emission standards for pleasure craft. The measures had been intended to account for 29 percent of total hydrocarbon emission reductions expected from mobile sources by 1987.
- In analyzing implementation of 31 transportation and energy measures,[2] the American Lung Association found that (1) no actions had been taken on 7 measures that accounted for 40.7 percent of the 1987 expected emissions reductions in this category; (2) action was behind schedule on measures accounting for 33.7 percent of the expected reduction; and (3) action on the remaining measures was described as limited (4 measures), of unknown benefit (6 measures), of negative effect (2 measures), and at saturation point (1 measure). Only 3 measures showed actions completed or on schedule, accounting for 7.4 percent of the expected reductions. The report concluded among other things that voluntary compliance was not an effective way to achieve targeted reductions. Many of the measures were to be implemented by local county and city governments.

[1]The South Coast Air Quality Management Plan of 1982, Revisited in 1986, American Lung Association of California (Mar. 1987).

[2]These 31 measures were grouped under the following general categories: purchase and use of low-polluting vehicles; trip diversions; goods movement (promoting greater efficiency in trucking industry); transportation system design; aviation and marine sources (improving airport/marine vessel operations); and energy conservation.

Control Measures and Enforcement Were Sometimes Ineffective

Another reason why emissions of hydrocarbons have been higher than anticipated is that implemented control measures did not always reduce emissions as much as projected, and enforcement was sometimes ineffective. The following examples from Los Angeles and Charlotte illustrate these problems:

- A 1986 joint audit by EPA and the California Air Resources Board found that more hydrocarbon reductions could have been attained by increasing the effectiveness of enforcement, improving permit programs, and revising rules to use more recently available control technology. Field inspections of 230 industrial facilities and 424 gasoline stations revealed that emission reductions from controls were 10 percent lower than expected in the SIP because of such things as sources not having permits and sources not complying with permits. In addition, rules were not always interpreted consistently by inspectors, and sometimes inspections were incomplete.
- An EPA review of Mecklenburg County records in 1984 and subsequent inspection of plants in the Charlotte area in 1985 found that Mecklenburg County was not enforcing the rules adopted under its 1979 plan. During at least 11 inspections, EPA identified 13 plants that were emitting more hydrocarbons than regulations allowed. EPA also found that the county had granted variances to regulations and compliance extensions to some operators without EPA's approval. According to EPA officials, the county has been taking steps to improve enforcement.

Vehicle inspection and maintenance programs are not always effective, because of weak implementation and exemptions.[3] Inspection programs assume that emissions will be reduced because (1) inspections will be an incentive for owners to keep the pollution equipment operating properly and (2) inspections will identify pollution equipment that is not operating properly or that has been disconnected, and repairs will be made.

However, California's vehicle inspection program illustrates why these assumptions may be incorrect. The 1982 revised plan called for an annual inspection program, but it was replaced with a biennial program. Emission reductions were about half of what they were expected to be (12.8 tons per day), according to the 1984 RFP report. (See ch. 1 for discussion of reasonable further progress requirements.) In addition, the

[3]GAO has issued two reports on vehicle inspection and maintenance implementation problems: Vehicle Emissions: EPA's Response to Questions on Its Inspection and Maintenance Program (GAO/RCED-86-129BR, May 2, 1986), and Vehicle Emissions Inspection and Maintenance Program Is Behind Schedule (GAO/RCED-85-22, Jan. 16, 1985). (See app. IV for a listing of recently-issued GAO reports on ozone.)

program could be made more effective because state legislation exempts compliance if repair costs exceed $50; consequently, according to California state officials, pollution equipment does not have to be repaired.

Improving Air Quality Is a Low Priority If Control Measures Affect Life-Styles or Economic Development

Discussions with state and local government and industry officials indicated that there is a general reluctance to implement control measures that will have a negative impact on economic development or change life-styles. This reluctance stemmed from various factors including a belief that (1) the health effects from ozone exposure do not warrant measures necessary to achieve the standard, (2) the public is unwilling to trade jobs or change life-styles for air quality, (3) past efforts do not demonstrate that additional costly measures will reduce ozone enough to reach the standard, and (4) controlling hydrocarbons is not the correct strategy for reducing ozone. The following summarizes some of the comments to us:

- Officials from an association of Southern California governments said that in order to reach the ozone standard in the Los Angeles area, it will be necessary to require life-style changes and restrict economic growth. However, these actions may not be politically acceptable because political forces generally succumb to the desires of developers and those who promote economic development rather than those who espouse air quality.
- Local city council members in California noted that the air quality board for the Los Angeles area did not have the political will to require control measures that affect life-style changes or economic development.
- An official from the city of Houston said that economic feasibility needs to be considered in controlling ozone.
- Members of a Houston ozone task force noted that the issue of health effects on the population is not a dominant factor and that Houston needs an ozone program that is effective without being economically disruptive.
- Air quality officials from the states of California and Texas and the city of Houston question whether controlling hydrocarbons alone was the right strategy. A city official from Houston believes that hydrocarbons have been significantly reduced in the Houston area, yet very little reduction has occurred in ozone levels.
- An official from the American Lung Association of California said that the public questions the health standards and a perception exists that economic growth is the driving influence in making air quality decisions.
- An official from the city of Los Angeles pointed out that local government will always give economic issues more weight because people want

jobs, and the health effects from ozone are not well known to the public or local political leaders.

Some of these officials and a California state air quality official said that the public needs to be better educated on the importance of achieving the ozone standard.

Ozone Plans Understated Hydrocarbon Emissions Inventories

EPA's basic strategy for reducing ozone is to control hydrocarbon emissions. As part of the planning process, states and local areas take an inventory of how much hydrocarbon is being emitted (current and for the period covered by the plan) and from what sources. This information is used to determine how many tons of hydrocarbons need to be reduced to reach the ozone standard. If the inventory figure is understated, an area will not identify enough controls to reduce the ozone.

One of the major reasons nonattainment areas have not made more progress in attaining the ozone standard, according to OAQPS officials, is understatement of the hydrocarbon emissions inventories. Reasons for these understatements include (1) emissions from certain sources inadvertently excluded from the inventory; (2) low estimates of vehicle miles traveled; and (3) data collection problems, including a lack of procedures to verify data accuracy.

Exclusion of Sources From Inventories

EPA is revising its emissions inventory guidance requirements and plans to include sources that were excluded from SIP inventories. Because they were not considered significant sources, publicly-owned sewage treatment plants and hazardous waste treatment, storage, and disposal facilities were excluded. None of the three areas we visited included emissions from these sources in their inventories.

Area officials could not quantify the significance of the sources excluded from the inventory. However, EPA contracted for a study of air emissions from hazardous waste treatment, storage, and disposal facilities.[4] From that study EPA estimates that emissions from these sources may range from 1 million to 2.7 million tons per year, the higher range being about 10 percent of total hydrocarbon emissions emitted in the country. An OAQPS official cautioned, however, that these figures are preliminary estimates and the final figures may differ.

[4]Preliminary Source Assessment for Hazardous Waste Air Emissions from Treatment, Storage and Disposal Facilities, GCA Corporation (Feb. 1985).

Low Vehicle Mileage Estimates

Hydrocarbon inventories include emissions from mobile sources and are based in part on estimates of vehicle miles traveled. The plan for the Los Angeles area estimated that vehicle mileage would increase by 14 percent for the planning period, but the mileage actually increased during the 1979 to 1985 period by 26 percent. Thus, emissions from mobile sources were understated.

Travel estimates in the Charlotte area plan were understated because figures provided by North Carolina's Department of Transportation did not include the entire geographical area of Mecklenburg County. According to the SIP inventory, vehicle emissions were 17,794 tons based on mileage of 2.4 billion. We were unable to determine the impact of using state mileage figures, but a Charlotte Department of Transportation official estimated that the figures would be about 20 percent less compared to mileage for the entire county.

Data Collection Problems

Even when all sources are included and estimates are fairly reliable, inventories may be understated because of other data collection problems. For example, the Administrator of EPA testified in April 1987 before the Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, that some sources, such as degreasing facilities, have a small amount of widely dispersed emissions. Data collection from such facilities is difficult. Further, he said that inventories are often based on a typical summer day without incorporating fluctuations in production rates and operating schedules. In addition, emissions inventory data are generally not gathered by actual monitoring of sources because of the costs. Rather, data are based on indirect methods such as questionnaires, local surveys, emission factors developed by EPAand others, and modeling.

An additional problem with the inventory data is that although EPA regional and OAQPS officials reviewed inventory data developed by state and local authorities, the accuracy of the figures is difficult to verify because of methods used to gather the data and the significant costs required to monitor hydrocarbon sources. One official told us that EPA was aware that weaknesses existed in some inventories, but emphasis was on convincing areas to adopt control measures. As a result, EPA was willing to accept inventory data even if it knew the data contained some inaccuracies. The three case study sites provided examples of some data collection problems.

Los Angeles

According to local air quality officials, the 1979 inventory for the 1982 SIP was regarded as the most complete listing of emissions produced up to that time. However, there were problems in developing the 1979 inventory, which, according to officials, probably understated emission figures. The following describes some of these problems:

- Some operators of stationary sources failed to obtain the necessary permits for construction and operation; therefore, the sources were not included in the inventory. Other stationary sources were emitting more hydrocarbons than the permits allowed. In taking the information from the permits for the inventory, officials assumed that the sources were in compliance. A joint 1986 EPA/California audit found that such problems still existed about 7 years later. Permits were still not being complied with or contained conditions that had become obsolete, and many facilities were being constructed without obtaining the proper permits.
- Mobile source emission factors were difficult to develop accurately because of technical problems in obtaining critical data. For example, general deterioration of engine performance over time, high incidence of fuel-switching and emission control system tampering, variations in gasoline fuel content, and total organic gas specifications all affect the determination of the amount of hydrocarbons emitted from an engine.

Houston

Texas Air Control Board (TACB) officials told us uncertainties exist in the Houston inventory because of such things as difficulty in identifying and quantifying emission sources, organizing available data within time and resource constraints, and uncertainties and inconsistencies in emission factors. Further, an April 1982 OAQPS memorandum pointed out a number of deficiencies with the Houston area's initial inventory submission and concluded that "while TACB appears to have made a good faith effort to cover all major sources and has incorporated rigorous quality assurance checks into its mail survey, we find it difficult to assess the acceptability of the emission totals without thorough documentation." Some of the specific problems included the following:

- EPA's data listed 10 major source textile polymer and resin manufacturing plants in the Houston area, but none was in TACB's inventory.
- Documentation did not specify how small point sources were handled, if at all.
- Area source documentation was virtually nonexistent except for vessels aircraft, and railroads.

We were unable to determine whether these deficiencies were corrected. TACB officials said they were not aware of the OAQPS memorandum. EPA regional officials had no records to indicate that the deficiencies had been corrected. However, officials said since the Houston area SIP had been approved they assumed the deficiencies in the memorandum had been addressed.

Charlotte

Mecklenburg County and the State of North Carolina developed the 1976 inventory for the Charlotte area plan using such procedures as questionnaires, plant visits, EPA emission factors, and Mobile 1 projections. According to Mecklenburg County officials, the 1976 inventory is suspect, because the county had to rely largely on estimates and inexperienced personnel.

Comparing the latest hydrocarbon emissions inventory (1985) with the figures in the SIP (1976 inventory) demonstrates the imprecision involved in the SIP planning process. We found that total annual hydrocarbon emissions in 1985 were about 657 tons higher than the 1976 emission figure despite a plan that called for a 40-percent reduction by 1982. The difference varied in that some categories in the latest inventory showed greater reductions than anticipated in the SIP, while in other categories the latest figures were higher than the base year despite controls.

The following examples demonstrate these differences:

- Mobile source emissions in the SIP totaled 17,794 tons compared with 20,445 tons in the 1985 inventory. The plan estimated that the base-year figure would be reduced by 42 percent, down to 10,399 tons by 1982. As discussed earlier, the base-year mileage figure used in the SIP was understated which, in part, explains why reductions were not as great as anticipated. Another reason may be the difference in mobile models. Mobile 1 was used for the 1976 figures and Mobile 3 was used for the 1985 figures.
- In the petroleum marketing category, reductions were greater than anticipated in the SIP. The 1976 annual emissions totaled 7,309 tons. The SIP called for control measures that would reduce the figure to 2,531 tons. The 1985 inventory shows that emissions were reduced to 1,625 tons, or 900 tons more reductions than anticipated in the SIP. A Mecklenburg County official speculated that the 1976 base-year figure was probably overstated due to the methodology used in estimating emissions from gasoline stations.

- The degreasing category is an example in which the 1985 inventory figure of 1,281 tons is considerably higher than the 1976 base-year figure of 114 tons. According to a Mecklenburg County official, the 1976 figure was based on known facilities, but the 1985 figure was based on emission factors applied to the population. The SIP did not call for controls in this category.

Modeling Uncertainties Caused Deficiencies in Ozone Plans

EPA and the states use photochemical and mobile models in the ozone planning process (see ch. 1). Photochemical models factor in the effects of sunlight and chemical reactivity and are used to estimate hydrocarbon emission reductions needed to reach the ozone standard and estimate the impact of control measures. Mobile models are used principally to estimate highway vehicle emissions for the mobile source inventory. Because modeling is not an exact science, estimates from models will contain some uncertainty.

In addition, the uncertainties normally associated with model estimates were exacerbated in the three areas reviewed because of assumptions used in the models, and in some cases, incorrect data. This led to understating vehicle emission inventories as well as the amount of hydrocarbon emission control needed, and ultimately it led to the control measures called for in SIPs that, even if effectively implemented, would not achieve projected ozone reductions.

Assumptions in Mobile Models Understate Vehicle Emission Estimates

Mobile models are empirical models based on actual emission measurements of vehicles operated by the public, according to EPA. Although actual emission measurements form the core of the models, many assumptions about emissions in the future vehicle fleet have to be made. Although EPA has not evaluated the error factors associated with mobile models, it continually tests vehicles to gather more emissions data on the vehicle fleet. The data developed from the testing are used to form the next-generation mobile model. EPA also makes improvements in the models based on user comments. EPA is currently completing the development of Mobile 4.

The amount of vehicle emissions estimated in a SIP will vary depending on which mobile model an area uses. For its 1979 SIP, the Charlotte area used Mobile 1, which was based on two assumptions that were later changed or shown inaccurate: (1) vehicles would be fueled with gasoline that had a volatility level of 9.0 pounds per square inch (psi) reid vapor

pressure[5] and (2) the public would not tamper with emission control systems. Gasoline volatility has climbed from about 9.0 psi in the late 1970s to as high as 11.5 psi in 1985. In addition, a 1985 survey in Charlotte found that 19 percent of inspected vehicles had at least one of their emission control components disabled or removed.

Because Mobile 1 assumed a lower volatility and an absence of tampering, its use contributed to the understating of the mobile source component of Charlotte's hydrocarbon inventory and may have resulted in the underestimation of needed hydrocarbon reductions. For example, EPA estimates that daytime evaporative emissions more than doubles when gasoline volatility increases from 9.0 psi to 10.5 psi.

A similar situation existed in the Houston area. In its 1982 SIP revision, the Houston area used the Mobile 2 model, which did not fully take into account tampering and did not include gasoline volatility increases. However, a 1985 survey in Houston found that 18 percent of the inspected vehicles had at least one of their emission control components disabled or removed.

The newer generation models (Mobile 3 and Mobile 4) will show higher emissions than the older mobile models. For example, Mobile 4 uses a gasoline volatility level of 10.5 psi rather than 9 psi, which Mobile 1 and Mobile 2 used, thereby doubling the evaporative hydrocarbon emissions estimates for vehicles with carburetors.

Uncertainties in Models May Affect Emission Reduction Estimates

Our case study areas used three models to estimate the amount of control needed to reach the standard and to estimate the impact of control measures: (1) the Urban Airshed Model (UAM), (2) the Empirical Kinetic Modeling Approach (EKMA), and (3) the linear rollback modeling technique. (See ch. 1 for a description of these models.)

The Los Angeles and Houston areas used the EKMA model when preparing their 1982 SIP revisions to estimate the amount of control needed to reach the ozone standard. Studies conducted in 1982 by an EPA contractor showed that the accuracy of the EKMA's estimates varied, depending

[5]Reid vapor pressure is a measure of a fuel's vapor pressure when tested at 100 degrees Fahrenheit, which is in the usual range of temperatures found in vehicle fuel tanks during the summer. Reid vapor pressure is the most common measure of gasoline volatility.

upon the complexity of the data and assumptions used.[6] When more complex data and assumptions were used, the model consistently unde estimated actual peak ozone concentrations. When less complex data and assumptions were used, the model estimated peak ozone concentra tions to within plus or minus 30 percent of actual levels. However, the estimates based on the more simplified data may have been more accurate only by chance, according to the study, which concluded that the model needed further evaluation.

Los Angeles also used the UAM in preparing its 1982 SIP to estimate the impact that planned control measures would have in reducing ozone levels. The UAM is more sophisticated, complex, and expensive to use than the EKMA. A summary report on studies of the UAM shows that it has a tendency to underestimate peak ozone levels;[7] however, EPA officials believe it is better than the EKMA for estimating attainment. The accuracy of the model varies greatly with the quality of data used as input and the experience and ability of people using it, according to an EPA study. Studies have shown that the UAM's results generally vary by plus or minus 30 percent.

Because EPA expected the Charlotte area to reach attainment with the ozone standard before the December 31, 1987, deadline, it did not require North Carolina to revise its Charlotte SIP in 1982. As a result, the area's current projections are based on its 1979 SIP, which relied upon the linear rollback modeling technique to project emission control requirements. This model assumed that ambient concentrations of a pollutant were directly proportional to the emissions of that pollutant. However, this is not the case with ozone formation, and EPA no longer allows the use of the linear rollback model for ozone SIPs.

Incorrect Data in Modeling Understate Emissions Control Needed

An important input into the EKMA model is the hydrocarbon/nitrogen oxide ratio for ozone formation. This ratio is used to determine the percentage of total hydrocarbon emissions that need to be reduced to reach the standard. Generally, as the ratio increases, so does the percentage. Once the percentage is known, it is applied to the emissions inventory figure to determine the number of tons of needed hydrocarbon emission reductions. Once the tonnage figure is known, areas identify control

[6]Comparison of Three Ozone Models: Urban Airshed, City-Specific EKMA and Proportional Rollback, OAQPS (Mar. 1982), An Evaluation of the Empirical Kinetic Modeling Approach Using the St. Louis RAPS Data Base, OAQPS (June 1982).

[7]A Review of Recent Applications of the SAI Urban Airshed Model, OAQPS, EPA (Dec. 1983).

measures that will result in the tonnage reduction needed. In general, the ratios used in the EKMA model for some of the areas' SIPs were lower than more current data show. This means that the percentage reduction in hydrocarbon emissions needed for reaching attainment as outlined in the SIPs was understated; therefore, areas did not implement enough control measures.

For example, Houston's 1982 SIP was based on a 5.8-to-1 ratio which, when considered in the EKMA model, showed that a 41-percent reduction in hydrocarbon emissions would be needed for Houston to attain the 0.12 ppm standard. However, EPA's analysis of data collected by state and local agencies in 1985 for Houston indicated that the ozone formation ratio was higher—12.9 to 1. According to EPA, with the higher ratio, hydrocarbon emissions would need to be reduced 71 percent for Houston to be in attainment. Data were also gathered in 1984 and 1985 for six other cities,[8] and compared with the ratios used for planning purposes. Except for Boston, the newer data indicate that the ratios should have been higher, with Cincinnati showing the greatest difference—9.1 to 1 instead of 3.9 to 1. According to EPA officials, improvements in measuring equipment and procedures account for the differences.

Summary

Our review of three areas' efforts to reduce ozone identified a variety of problems throughout the planning and implementation phases of ozone control efforts that contributed to the areas' not achieving the reduced ozone levels projected in the SIPs. Some of the problems, such as understatement of inventories, uncertainties in the models, and uncertainty of data used in modeling, seem inherent in the existing process.

To what degree the uncertainties affected the accuracy of the SIPs is hard to quantify; however, the imprecision involved in inventorying emissions is probably significant. EPA acknowledges that when the earlier inventories were developed, it did not know that hazardous waste treatment, storage, and disposal facilities were major emitters of hydrocarbons. An EPA-contracted study estimates that these facilities may emit as much as 10 percent of all hydrocarbon emissions. Difficulty in identifying the smaller and widely dispersed hydrocarbon sources (the numbers of which are probably not even known in some areas) also contributes to the uncertainty. Further, EPA does not know the accuracy of its mobile models, but it is evident that substantial differences occur and

[8]Boston, Mass.; Cincinnati and Cleveland, Ohio; Philadelphia, Pa.; St. Louis, Mo.; and Washington, D.C.

the amount of mobile emissions predicted will vary depending on the model used.

Another important uncertainty in ozone control efforts is that no practical method exists to verify the accuracy of inventories, although EPA can review the procedures and emissions factors used to develop the figures. Without accurate inventories EPA cannot determine with any certainty whether the control measures identified in the plan are adequate to reduce ozone to the desired levels. Likewise, because of the uncertainties, inventories taken after the plan has been implemented cannot be used to evaluate whether the control measures did, in fact, reduce emissions as projected.

Another factor that affected the areas' efforts to implement ozone control programs was how EPA carried out its oversight responsibilities. Some of the problems, such as not implementing control measures or not enforcing rules and regulations, may be correctable through stronger oversight by EPA. (See ch. 4.)

EPA's Oversight Not as Effective as It Should Have Been

EPA's oversight responsibilities in controlling ozone include reviewing and approving SIPs, determining whether an area is demonstrating reasonable further progress in reducing hydrocarbons to ensure that ozone reductions will be met, and calling for revisions to SIPs that contain major deficiencies. Our review indicates that EPA did not fully carry out these responsibilities in Charlotte, Houston, or Los Angeles. Specifically, EPA did not ensure that the reasonable further progress (RFP) requirements were met in Los Angeles and Charlotte, did not require corrective action when significant deficiencies were identified in the Houston and Charlotte SIPs, and suspended final action on the Los Angeles SIP until mid-1987, when it ultimately proposed disapproval.

EPA officials provided various reasons why more action had not been taken to correct deficiencies in the three areas' ozone control efforts. In the case of Charlotte, in 1984 EPA assumed the area would meet the standard under its existing plan. Moreover, the EPA regional office did not monitor the area between 1982 and mid-1984, when a mid-year audit identified problems. In the case of Houston, EPA believes that additional data are needed to demonstrate the need for a revised SIP. In the Los Angeles area, EPA considered using sanctions because of the deficiencies, but generally tried to avoid using them. Regional officials told us that the deficiency of late RFP reporting did not seem serious enough to warrant withholding clean air grants, and instead of using sanctions the region chose to try and get the area to do more through discussions and cooperative efforts. A final decision on whether the area has implemented its plan is still pending. Regional officials also said that the Los Angeles area was doing more than any other place in the country to reduce ozone levels. Recently, however, EPA proposed to disapprove the Los Angeles area ozone plan and impose a construction ban.

Purpose of RFP Requirements Not Achieved in Three Areas

RFP requirements are intended to have areas demonstrate that annual emission reductions are sufficient in the judgment of the Administrator, EPA, to ensure attainment of the standard by the required date. EPA guidelines for the 1982 SIP revisions required states to submit annual reports by July 1 of each year, outlining progress towards achieving the standard. The following illustrates how RFP requirements did not achieve their purpose in the three areas because either EPA did not enforce the requirements or, in Houston's case, the requirements were met but were not effective.

RFP Reports Not Submitted for Charlotte Area

Although the North Carolina SIP called for the state to submit annual RFP reports, Mecklenburg County did not do so. County officials stated that they were not tracking annual emissions and failed to comply with the reporting requirement because of other priorities. EPA regional officials could not explain why the region did not enforce the requirement, but officials told us that the office did not monitor the Charlotte area between 1982 and mid-1984. They also said that resources were limited, which, in turn, limited the number of local program audits that could be performed. The region began monitoring the Charlotte area when a mid-1984 audit identified enforcement problems. A June 22, 1987, EPA audit report on North Carolina air pollution control activities states that Mecklenburg County needs to begin tracking RFP for ozone.

RFP Requirements Not Met in Los Angeles

The Los Angeles area has not implemented many of the SIP's control measures and has not achieved the emission reduction outlined in the 1982 SIP. Therefore, the area has not met RFP requirements. The area also has not developed measures designed to address the shortfall. Further, the area submitted its reports late and in EPA's judgment, some of the reports contained inadequate information. If EPA makes a finding that an area has not implemented its SIP, it must withhold clean air grants. The Los Angeles area expected to reduce ozone readings by December 31, 1987, to 0.30 ppm. The area's ozone reading for the period 1984-1986 was 0.35 ppm.

Both the area's 1983 and 1984 RFP reports were late, with the 1984 report being a full year late. The 1983 report stated that although not all ozone control measures had been implemented, the area was ahead of schedule in reducing hydrocarbon emissions because of other factors such as plant shutdowns. In a February 27, 1985, letter, however, EPA told local air quality officials that the report did not address six stationary source measures scheduled for adoption. EPA also said that reductions not attributable to control measures—such as plant shutdowns—were not appropriate demonstrations of RFP. EPA requested that the RFP report be revised to address the issues and pointed out that section 105 grant funds could be withheld for failure to comply.

The Los Angeles area's 1984 RFP report acknowledged an emission reduction shortfall of about 40 tons per day (18 tons for stationary sources and 22 for mobile sources). This represented about 22 percent of the total reductions (220 tons per day) sought by December 1987. In a September 9, 1986, letter, EPA told Los Angeles area air quality officials that the area had failed to demonstrate RFP as defined by the 1982 SIP

and federal requirements. In addition, the letter cited errors in the area's emissions calculations; these errors understated the amount of reduction necessary to comply with the plan. Further, EPA stated that the report failed to explain why 13 out of 24 stationary source measures had not been fully implemented and did not provide information on substitute measures to account for the shortfall.

The Los Angeles area's 1985 RFP report dated April 1987, showed a greater shortfall. The 1985 shortfall was 81 tons per day, with stationary sources accounting for 53 tons and mobile sources for 28 tons. According to the report, the shortfall resulted from not implementing all of the control measures or not achieving the reductions anticipated from implemented control measures.

EPA regional officials stated that sanctions were not imposed over the RFP reports because (1) officials did not believe that lateness of reports was sufficient ground to withhold section 105 grant moneys, and (2) substitute measures could not be required unless the plan contained such a requirement, and in this case, it did not.

In September 1987, the region's Director of the Air Management Division said that a final decision is still pending before EPA on determining whether the Los Angeles area should be cited for failure to implement its SIP. He further stated that the region probably could have pushed harder for sanctions but chose to use discussions and cooperative efforts to get the area to do more. This included working with California state and local air quality officials in developing a program for Los Angeles and other California areas that did not have approved ozone SIPs. The program was referred to as the Reasonable Extra Efforts Program (REEP) and was intended to go beyond 1987. It included identifying additional control measures to reduce hydrocarbon emissions and resulted in a joint EPA/California audit, which identified deficiencies in the Los Angeles area program that are now being corrected. According to the Director, the cooperative approach has resulted in the Los Angeles area now moving to adopt many of the stationary source control measures which had been scheduled to be adopted before the end of 1987. There is, however, still a significant shortfall in adopting the transportation, energy, and land use control measures.

On the basis of the region's experience with RFP, including the Los Angeles situation, the region's Director, Air Management Division, recommended to OAQPS in May 1987 that EPA's post-1987 ozone policy address whether the Clean Air Act's RFP requirements are mandatory in terms of

submitting reports, tracking emissions, and meeting targets for adopting and implementing control measures in accordance with the dates outlined in the SIP. In addition, the memo stated that the post-1987 policy should specify the action required when an area fails to meet RFP, such as implementing additional control measures, developing a new SIP, or invoking sanctions.

Houston RFP Reports Not Effective

Although the reports for the Houston area met the RFP requirements, they did not adequately illustrate the ozone situation in Houston because the RFP determination does not require an analysis of ozone data. According to the TACB, RFP reports that were submitted for 1983, 1984, and 1985, the Houston area achieved planned hydrocarbon reductions as required in both stationary and mobile source emissions. However, the reports did not address the fact that even though emissions had been reduced by approximately 70 percent of the planned reductions, ozone design values at the end of 1985 were still at 0.25 ppm—twice the 0.12 ppm standard. A comparison of design values from 1980-1982 to 1982-1984 shows that the ozone levels were reduced just 0.01 ppm—from 0.26 ppm to 0.25 ppm.

In reviewing the 1983 RFP report, EPA raised the concern that the report did not contain ozone air quality trend data. Such data could have shown that although hydrocarbon reductions were being achieved, ozone remained at about the same level. In a December 20, 1983, letter to EPA, TACB objected to including the data. TACB officials told us they had already provided air quality data to EPA. These officials questioned the value of including such data as part of the RFP report and cited insufficient resources to provide the data in the report. EPA has issued new guidance that is more specific and places emphasis on analysis and interpretation of emission data, recommends an assessment of ozone air quality data, and requires areas to report on the need for SIP revisions.

EPA Took No Action on Deficiencies in the Charlotte and Houston SIPs

Section 110 of the CAA requires that each SIP include procedures for revising it as necessary, including whenever EPA finds information demonstrating that the plan is substantially inadequate to achieve the standard. If a state fails to revise the plan after notification from EPA, the agency's remedy is for EPA to promulgate a plan. The following section describes major deficiencies in the Houston and Charlotte SIPs. Although it might have done so, EPA did not call for SIP revisions in Charlotte because EPA assumed that the area would meet the standard or, in Houston, because EPA officials said that more data were needed.

Houston SIP Based on Faulty Data

EPA now believes that Houston's revised 1982 SIP demonstrating attainment by 1987 was based on an incorrect hydrocarbon/nitrogen oxide ratio. As discussed in chapter 3, this ratio is an important input to the EKMA model and is used to determine the total percentage of hydrocarbon reduction needed to attain the standard. In this case the SIP was based on a 5.8 to 1 ratio, which meant that hydrocarbon emissions needed to be reduced by 41 percent. However, EPA's 1985 data indicated that the ratio should have been around 12.9 to 1, which would have required a 71 percent reduction in hydrocarbon emissions. TACB officials said recent monitoring data support a 12 to 1 hydrocarbon/nitrogen oxide ratio, but the exact percentage reduction required would not be known until a new round of modeling was completed.

Despite its 1985 data, EPA did not call for a SIP revision; instead it believed that additional data were needed to provide a legal basis that the SIP was deficient, according to regional officials. However, according to a TACB 1981 air quality report, monitoring data indicated that the lower ratio was incorrect and that it should be closer to 12 to 1 and possibly as high as 14 to 1. The 1981 report stated that EPA discounted the data. EPA regional officials said they were unaware of any EPA criticism of the early 1981 data. EPA is funding an ongoing TACB study of the hydrocarbon/nitrogen oxide ratio. Regional officials also agreed with TACB that additional modeling with the new data is needed before the exact percentage of hydrocarbon emissions reduction is known.

Regional officials also said that EPA decided not to ask for a revised SIP for Houston until all 1987 air quality data is analyzed because it would not have a legally defensible position. Houston's plan calls for measures to be implemented in 1987 that are suppose to reduce hydrocarbon emissions further. Officials acknowledged, however, that Houston will not reach attainment by December 31, 1987. EPA headquarters officials told us that even though newer hydrocarbon/nitrogen oxide data has become available, EPA has decided to wait and deal with Houston's SIP as it deals with other areas in the post-1987 program. Houston's ozone design value for the period 1984 to 1986 was 0.20 ppm.

Charlotte SIP Based on Deficient Model

Charlotte's 1979 SIP demonstrated attainment in 1982. The SIP was based on the linear rollback model, which assumes the ambient concentrations of a pollutant are directly proportional to the emissions of the pollutant. This is not the case with ozone, however, because it is not directly emitted from sources. EPA prohibited the use of the linear rollback model for

the 1982 SIP revisions that demonstrated attainment by 1987 because o this deficiency.

EPA regional officials were first aware that the Charlotte area would not meet the 1982 deadline in early 1982. In spite of this realization and the knowledge that the SIP was based on a deficient model, they took no action because, according to regional officials, a national policy issued in 1982 stated that areas with design values of 0.15 ppm or less would not be required to submit a revised SIP. Charlotte's ozone design value for the period 1980 to 1982 was 0.13 ppm. Again in 1984, EPA issued a national policy stating that SIP revisions should be made in those areas where design values were equal to or greater than 0.14 ppm. According to an OAQPS official it was assumed that those areas with lessor ozone readings would reach the standard based on controls in their existing ozone plans and from benefits from the federal motor vehicle control program. Charlotte's ozone design value for the period 1982 to 1984 remained at 0.13 ppm. Charlotte's ozone design value for the 1984 to 1986 period remained at 0.13 ppm and because of exceedances in 1986 it will not attain the standard by the act's December 31, 1987, deadline.

Los Angeles Area Plan Failed to Demonstrate Attainment by 1987 Deadline

The Los Angeles area ozone plan dated October 1982 stated that it could not demonstrate attainment by December 31, 1987, or for that matter, by the year 2000. The plan's goal was to attain the ozone standard "as expeditiously as practicable." EPA regional officials said the region knew as early as 1978 that the Los Angeles area would not demonstrate attainment by the end of 1987. These officials said that the revised 1982 plan was based on a 1981 national policy recognizing that some large areas would be unable to meet the 1987 deadline.

The policy that was announced in the January 22, 1981, Federal Register stated that an area could submit a plan that did not show attainment by December 31, 1987, with certain conditions. The plan must identify and adopt measures that would demonstrate attainment at the earliest possible date after 1987. In the February 3, 1983, Federal Register, EPA proposed to disapprove the Los Angeles area plan and other California plans because of three major deficiencies including failure to demonstrate attainment by December 31, 1987.[1] This notice stated that if deficiencies in the plans were not corrected, the existing construction ban

[1]This same notice proposed to impose construction ban sanctions in several areas of the country for failure to attain air quality standards by Dec. 31, 1982. Later, in Nov. 1983, EPA softened its overall position on sanctions.

would continue and highway and sewer grant funds sanctions might be imposed.[2]

EPA approved the emission control measures in the Los Angeles plan on July 30, 1984, but took no action on whether the attainment and reasonable further progress demonstrations in the plan met the CAA requirements. Instead, EPA and the state of California began the program called REEP. REEP was intended to reduce emissions of hydrocarbons and other pollutants in four California nonattainment areas, including the Los Angeles area, in order to meet the national ambient air quality standards as expeditiously as possible.

EPA formally announced REEP and solicited comments in the September 26, 1986, Federal Register. EPA proposed REEP as an alternative to implementing sanctions against areas that do not meet the 1987 deadline. However, we testified in April 1987 before the Chairman, Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, that using REEP for California areas that do not meet the 1987 deadline would not be legally correct.

In the July 14, 1987, Federal Register, EPA proposed to disapprove ozone and carbon monoxide plans covering 17 areas in 8 states. This included disapproving the Los Angeles area ozone plan and three others in California because the plans do not provide for attainment by December 31, 1987, or a fixed near-term date thereafter. In the notice, EPA also proposed imposing the new source construction ban sanction, and regarding REEP, stated that the program was not consistent with the intent of the Congress.

[2]Prior to the Feb. 3, 1983, notice, a construction ban had been imposed because of California's failure to adopt and implement a vehicle inspection and maintenance program as required in its 1979 SIP revision. Although California adopted an inspection and maintenance program with its 1982 SIP revision, EPA did not lift the ban because the program's scheduled starting date was unacceptable. These sanctions were lifted in Nov. 1983.

EPA Has Had Difficulties in Implementing a Consistent Sanctions Policy

In mid-1982 EPA began developing a sanctions policy for areas that were supposed to meet the National Ambient Air Quality Standards, including ozone, by December 31, 1982. EPA classified areas into those that were likely to meet the standards and those unlikely to meet one of the standards or that had various implementation plan deficiencies. In February 1983, EPA announced that it would impose construction bans against 14 areas.

Instead of implementing these sanctions, however, as a result of concerns of Members of Congress and the affected states, EPA reanalyzed its position and in November 1983, said that it would call for revised SIPs. At about the same time, Congress added a provision to the Department of Housing and Urban Development—Independent Agencies Appropriations Bill for fiscal year 1984—that prohibited EPA from imposing sanctions in areas for failure to attain the standards. The provision applied only to fiscal year 1984. EPA has not changed its sanction policy since the November 1983 decision.

We have reported several times to the Chairman, Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, that EPA's policy is not consistent with the CAA because the legislation requires automatic imposition of the construction ban once it is established that an area is in nonattainment.[3] In our 1985 report we recommended that EPA impose the ban on those areas that missed the 1982 deadline or seek legislative relief. EPA, on the other hand, maintains that the CAA authorizes the Administrator to use discretion in imposing the construction ban and that as long as an area has an approved SIP and has made good faith efforts to implement its provisions, the ban does not have to be applied.

In testimony on April 27, 1987, before the Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, the Administrator, EPA, reiterated the agency's position that sanctions are to be applied for failing to plan for attainment, not for failing to attain the standard. He also stated that he understood how the CAA could be interpreted in different ways on the use of sanctions. During these hearings, we testified that the CAA affords EPA no alternative but to apply the construction ban to those areas that have not attained the ozone standard by December 31, 1987.

[3]EPA's Sanctions Policy Is Not Consistent With The Clean Air Act, GAO/RCED-85-121, Sept. 30, 1985; GAO legal opinions B-221421 (Feb. 1986); B-208593 (Jan. 6, 1986) ID., April 21, 1983, and Dec. 31, 1982.)

Summary

The CAA (1) authorized EPA to use sanctions if an area failed to develop a plan that demonstrated attainment or failed to implement its plan, (2) established a provision for EPA to issue a call for a revised SIP if information became available demonstrating that a plan was inadequate, and (3) established RFP requirements. Despite its oversight responsibilities, EPA did not effectively use the authority provided under the CAA to address these problems.

EPA has been reluctant to use sanctions against Los Angeles. EPA accepted (but never formally approved) a SIP for the Los Angeles area that did not demonstrate attainment by the act's December 31, 1987, deadline. The area also has failed to implement significant portions of its plan, and will not meet its short-term goal of reducing ozone levels to 0.30 ppm by December 31, 1987. Los Angeles' 1983 RFP report stated that some control measures were not being implemented; its 1984 RFP clearly confirmed the lack of reasonable further progress, as did the recently completed 1985 RFP report. Additionally, the reports themselves were late, and, by EPA's own judgment, the 1983 and 1984 reports were inadequate. EPA could have withheld section 105 grant funding for these irregularities, according to regional officials.

Houston and Charlotte both had major deficiencies in their SIPs. The Houston SIP called for a percentage of hydrocarbon reductions that was based on an incorrect hydrocarbon/nitrogen oxide ratio. According to a 1981 TACB report, EPA was alerted to this in 1981 before the SIP was approved and again in 1985 when it developed its own data. EPA chose, however, not to call for a revised SIP. Houston's 1983 to 1985 ozone reading was 0.25 ppm, more than twice the 0.12 ppm standard.

The Charlotte area missed reaching attainment by December 31, 1982, and because of exceedances in 1986, the area will not meet the act's December 31, 1987, deadline. Further, Charlotte's SIP contains a major weakness—it is based on data from the now-obsolete linear rollback model. EPA knew in 1982 about both the failure to reach attainment and the SIP's use of an inadequate model. Nevertheless, EPA did not require a revised SIP. EPA also did not require the Charlotte area to meet RFP requirements until June 1987.

Conclusions and Recommendations

When the Congress last revised the CAA in 1977, it anticipated that nonattainment areas would be able to meet the National Primary Ambient Air Quality Standard for ozone by December 31, 1987. This has not happened. Some areas are close to meeting the standard while others may not reach attainment in the foreseeable future. EPA and states already face a challenge to attain the current standard and, as discussed in chapter 3, EPA's review of the latest scientific data suggests that the standard should perhaps be set even lower than the current 0.12 ppm.

Our review of three areas' efforts to reduce ozone identified a variety of problems that individually or in combination contributed to not achieving the reductions outlined in their SIPs. In some instances planned control measures were not implemented and some that were implemented were not always being enforced or were not as effective as anticipated. In addition, ozone reductions planned for may not have been realistic because hydrocarbon emission inventories were understated, a deficient model was used in one instance, and incorrect data were used in the modeling in another instance. Further, uncertainties that exist in the models and some of the assumptions used in the models may have led to inaccuracies in the ozone plans.

While more effective program implementation and stronger oversight by EPA could have led to correcting some of the problems, thus leading to greater ozone reductions, this alone would not have resulted in the areas meeting the ozone deadlines. We believe that other factors, such as the scientific uncertainties in ozone formation, weather patterns, inventorying sources, modeling, and determining the amount of control needed, plus the enormity of the problem, all contributed to the deadlines being unachievable. Thus, many areas will miss the act's December 31, 1987, deadline, and some areas, such as Los Angeles and Houston, will not meet the standard for many years.

Our review of experience with past ozone reduction efforts suggests that no single solution can be effective. Rather, a variety of solutions and the recognition that attainment in some areas can be achieved only in the long term are necessary to begin reducing ozone levels more effectively in areas that exceed the standard. Accordingly, we believe the Congress should amend the CAA and (1) establish a strategy that differentiates among areas with regard to attainment dates based on the severity of their ozone problem and (2) revise the act's sanctions and set a clear policy on when the sanctions will be activated.

All Areas Should Not Be Treated the Same Way

Under existing law, all areas must generally follow the same requirements in working toward attainment of the ozone standard. However, areas' ozone levels varied significantly because of differences in population, number and type of sources emitting hydrocarbons, and in some cases meteorological and geographic factors that contribute to ozone formation. These differences remain, and, as a result, some areas have to reduce hydrocarbon emissions much more than other areas to meet the standard. For example, the Charlotte area's ozone design value is 0.13 ppm. It would presumably be able to reach the standard sooner and with fewer control measures than areas with more serious problems such as Los Angeles and Houston. (The higher the design value, the greater the percentage of hydrocarbon emissions to be reduced to reach the standard.) Los Angeles and Houston, with ozone design values of 0.35 and 0.20 ppm, respectively, would require hydrocarbon reductions estimated at as much as 70 percent. Such areas may not be realistically expected to reach such a reduction for many years. There are also areas between the two extremes.

Because of these differences, we do not believe it is appropriate to establish the same attainment date for all areas. One option could be a strategy that would place nonattainment areas into different categories on the basis of their design values, emission reductions needed, or both, with attainment dates for each category.

- The first category would include areas that would only need to implement and enforce existing SIP requirements plus gain benefits from national controls such as reduced gasoline volatility or the federal motor vehicle control program to reach the standard. In August 1987 EPA proposed national controls to reduce evaporative hydrocarbon emissions by placing limits on gasoline volatility and requiring vehicles to have onboard controls to reduce emissions from refueling of motor vehicles at service stations.[1] A 5-year attainment date could be set and could include those areas that have design values of 0.13 ppm and 0.14 ppm. These areas will probably have to reduce hydrocarbon emission inventories by amounts ranging from 10 to 30 percent, according to EPA estimates. Before new estimates could be made, inventories would have to be updated and a new round of modeling take place to estimate the amount of hydrocarbon emission reduction needed.

[1]Our report, Air Pollution: EPA's Efforts to Control Vehicle Refueling and Evaporative Emissions (GAO/RCED-87-151, Aug. 7, 1987), examined EPA's analysis of the costs and benefits of these controls.

- The second category would include areas close to the standard (design values from 0.15 ppm to 0.18 ppm) but needing to implement additional controls beyond those in their existing SIPs. Given past experience, these areas will probably need more than 5 years to reach attainment. EPA estimates show that emissions need to be reduced from 25 to 61 percent. Such reductions will require control of various source categories because no one source can be cited as the problem.
- The third category would includes those areas with the worst pollution problems, such as Houston and Los Angeles, which must reduce their hydrocarbon emission inventories by even larger percentages to reach the standard. These areas would be required to reduce their ozone levels by specified amounts to achieve the standard by a date which, in all likelihood, would not be in the near term. Without using drastic measures, such as forbidding vehicle traffic, reducing hydrocarbon emissions by such large percentages may not be possible, especially in areas of rapid growth such as Los Angeles.

House and Senate bills have been proposed that would treat nonattainment areas differently. In October 1987, S. 1894 was approved by the Senate Environment and Public Works Committee. This bill, among other things, would provide for 3-, 5-, 10-, or 15-year deadline extensions. The proposal would require more control measures for a longer deadline extension.

H.R. 3054, introduced on July 29, 1987, would classify nonattainment areas into three categories: moderate, serious, and severe. States would have to require sufficient percentages of emission reductions in moderate areas to reach attainment in 3 years, serious areas in 5 years, and severe areas in 10 years. For moderate areas, the states would choose control measures consistent with existing CAA requirements. The bill would require additional controls and the revision of SIPs in serious and severe nonattainment areas.

Sanctions Policy Needs to Be Clarified

We believe the Congress needs to rewrite the CAA's sanctions provisions to achieve better enforcement of the act and to eliminate the uncertainty and conflict over imposing them when areas make unsatisfactory efforts to meet the air quality standards. As discussed in chapter 4, it appears that EPA has been reluctant to use sanctions against the Los Angeles area. EPA accepted (but never formally approved) a SIP for the Los Angeles area that did not demonstrate attainment by the act's December 31, 1987, deadline. The area also failed to implement significant portions of

its plan. Recently, EPA proposed to disapprove the Los Angeles plan and impose a construction ban.

In addition, we interpret the CAA differently than EPA on the use of the construction ban when an area fails to meet the attainment deadlines. After the 1982 deadline passed, EPA attempted to impose the construction ban in those areas that were required to meet the deadline. However, the action met opposition from many sources, including the Congress, and EPA withdrew the proposal stating that it would call for revised SIPs instead. EPA has concluded that the CAA authorizes the Administrator to use discretion in imposing the ban and that as long as an area has an approved SIP and has made good faith efforts to implement its provision, the ban does not have to be applied if the area misses the attainment deadline.

However, we have reported to the Chairman, Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, on various occasions that we did not believe EPA could administratively extend the deadlines set out in the CAA in lieu of enforcing the construction ban. In our 1985 report (GAO/RCED-85-121), we recommended that EPA either impose the construction ban in those areas not meeting the act's deadlines or seek legislative relief.

In an April 2, 1987, letter to the Chairman we gave our views on EPA's proposed programs, REEP and the Sustained Progress Program. REEP's purpose was to reduce hydrocarbon emissions and other pollutants in four California nonattainment areas in order to meet the National Ambient Air Quality Standards as expeditiously as possible. EPA proposed REEP as an alternative to implementing sanctions against areas that would not meet the 1987 deadline. The sustained progress program was similar to REEP and was intended to be applied on a nationwide basis but was never formally proposed. We said that if the programs were implemented, our position would be that they are not legally correct. In July 1987 EPA said it was not going to implement the REEP program because it was not consistent with the intent of Congress.

In the November 24, 1987, Federal Register, EPA announced a new post-1987 ozone program that calls for revised plans for areas that will not meet the December 31, 1987, deadline. The program, among other things, would extend the deadline for reaching attainment by 3 years and for some areas 5 years without imposing the construction ban. Areas that cannot demonstrate attainment within the 5 years would be subject to the construction ban and have to adopt controls that would, at

a minimum, reduce hydrocarbon emissions by an annual average of 3 percent until attainment is achieved.

While we have not analyzed EPA's latest proposal, we concur with its concept of requiring areas to submit revised ozone plans. Nevertheless, we continue to believe that EPA may not administratively extend the deadlines set out in the CAA in lieu of enforcing the statutory penalties, and, therefore, unless Congress amends the CAA, EPA is required to impose the construction ban in all areas it determines have not met the 1987 ozone deadline. Recently, legislation was enacted that, among othe things, prohibits EPA from imposing such a ban in ozone nonattainment areas until August 31, 1988.

Recommendations to the Congress

In order to build flexibility into the CAA that recognizes the variety of problems areas face in attempting to reach the ozone standard, and to clear up the confusion over the use of sanctions, we recommend that the Congress amend the CAA to

- establish a strategy that places nonattainment areas into different categories on the basis of their design values, emission reductions, or both, with new attainment dates for each category (the Congress may wish to either establish the new attainment dates and provide criteria, or provide EPA with the authority to do so) and
- specify the conditions under which sanctions will apply (such as when an area fails to implement its plan or does not meet its attainment deadline) and the extent to which EPA has discretion in applying such sanctions.

Evolution of the Ozone Standard

The Clean Air Act of 1970 and its amendments required EPA to identify the highest levels of air pollutants that will not endanger public health and to establish air quality standards at or below these levels with an adequate margin of safety—primary standards. The act also defined welfare, or environmental, effects and required EPA to set secondary standards to protect against these. These standards were to be implemented through federal, state, and local programs by specified dates.

The Act's Criteria for Defining Health and Welfare Effects

In setting any air quality standard, EPA is faced with data that varies in conclusiveness, especially as it refers to adverse health effects. For the ozone standard, uncertainties exist as to how to define adverse health effects, and at precisely what ozone levels such effects occur. For the current standard, EPA reviewed health studies and concluded that some people exposed to ozone levels of 0.15 ppm or greater could incur health effects severe enough to inhibit their daily activities. EPA set the standard at 0.12 ppm in order to allow a margin of safety.

For the ozone standard, EPA identifies as sensitive those people who have existing respiratory disease and people engaged in exercise. (Because exercise results in heavy breathing, more ozone can be inhaled.) In defining health effects, EPA grouped the effects into four categories: (1) aggravation of asthma, emphysema, and chronic bronchitis (2) reduction in breathing functions; (3) chest discomfort and irritation of the respiratory tract; and (4) reduced resistance in bacterial infections. In selecting the proper levels for the standard, EPA focused on five areas it considered critical: (1) reported effect levels from human studies, (2) characterizing the sensitive population, (3) nature and severity of effects, (4) probable level of adverse health effects in sensitive persons, and (5) judgment as to what constitutes an adequate margin of safety. EPA concluded that the most probable level of adverse health effects in sensitive persons occurs when ozone concentrations falls in the range of 0.15 to 0.25 ppm. EPA acknowledged that its evidence was more convincing and the effects more pronounced at the higher end of the range. Further, EPA said that no clear threshold of ozone levels exist where data indicate the onset of adverse health effects and that determining at what levels effects most likely occur is a judgment call.

Once EPA had identified what it considered the level at which adverse health effects occur, it estimated a margin of safety and proposed a standard. Initially, EPA proposed to set the standard at 0.10 ppm. However, public comments on the regulation disputed EPA's interpretation and application of health study results. As a result, EPA reconsidered

and concluded that the studies did not dictate as wide a margin of safety as initially proposed. Consequently, EPA set the standard at 0.12 ppm.

In addition to the primary standard (the one that covers health effects), EPA set a secondary standard for public welfare, or environmental, effects. This standard is much more clearly defined in the act than the primary standard and includes the effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility, and climate; damage to and deterioration of property and hazards to transportation; and effects on economic values and personal comfort and well-being.

EPA initially proposed setting the secondary standard at 0.08 ppm after applying a mathematical model to the results of studies that showed 5- to 10-percent injury to foliage could produce detectable reductions in growth or yield. After analyzing comments, discussing the proposal with experts, and considering more current research, EPA concluded that growth and yield responses were related to long-term ozone concentrations and set the secondary standard at 0.12 ppm.

Setting the Standard

The ozone standard was originally established in 1971 as a photochemical oxidant standard.[1] The standard specified that the average hourly concentrations must not exceed 0.08 ppm more than once a year. Because no satisfactory method existed for measuring the photochemical oxidants as a class, ozone was measured and used to determine compliance with the original standard.

In 1979 the standard's designation was changed from photochemical oxidants to ozone. At that time, EPA set a less stringent standard by limiting it to 0.12 ppm and changing the method of calculating whether an area exceeded the standard. That is, an area exceeds the standard if the maximum hourly average concentration exceeds 0.12 ppm. The original standard had allowed only one 1-hour exceedance in 1 year. EPA's rationale for this change was that the hourly standard was too easily affected by short-term weather conditions. In making the change, however, EPA did not reinterpret health data and admits that the less stringent standard could pose increased health risks.

[1]Photochemical oxidants are largely secondary pollutants formed in the atmosphere from their precursors—volatile organic compounds and oxides of nitrogen—by processes that are a complex nonlinear function of precursor emissions and meteorological factors; ozone is one such substance.

Attainment of the Ozone Standard

The Clean Air Amendments of 1970 required each state to submit to E a SIP describing its program for attaining the ozone standard by 1975 (at the latest, mid-1977. However, a number of areas did not meet the deadline. The 1977 amendments provided states with nonattainment areas a further opportunity to comply with the standard by extendin the deadline to December 31, 1982. An additional extension to December 31, 1987, was allowed for areas demonstrating that attainment by 1982 was not possible.

The 1977 amendments to the act required EPA and states to identify al areas not meeting the national air quality standards and required are to revise their SIPs to reach attainment by the deadline. EPA required tl the classification be based on measured ambient air quality data wher known and where not known, on the estimated air quality in the area highest pollutant concentration.

Monitoring Requirements

The 1977 Clean Air Act Amendments required a uniform ambient air quality monitoring network and data reporting system to (1) develop and implement SIPs and (2) obtain national air pollution trends. The ac also required EPA to establish criteria for monitoring air pollution nati wide. Pollutants to be monitored were those for which national ambie air quality standards have been established, according to EPA's May 1979 regulations.

In creating the national monitoring network, EPA modified the existing network to meet the provisions of the 1977 amendments. These monitors, called state and local monitoring stations, provide air quality dat for SIP purposes. The national air monitoring stations network is a subset of the state network and provides national trend data. Data from these monitors are used to determine whether an area is in attainment with the national ozone standard.

Ozone Design Values for 90 Areas, 1979-1981 and 1983-1985

Area	1979-81 design value	1983-85 design value	Percentage change (increase)
Los Angeles, Calif.	0.44	0.36	18.2
Houston, Galveston, and Brazoria, Tex.	0.30	0.25	16.7
Greater Connecticut	0.24	0.23	4.2
New York City, N.Y., and parts of N.J. and Conn.	0.27	0.22	18.5
San Diego, Calif.	0.29	0.21	27.6
Chicago, Ill.; Gary and Lake County, Ind.; and parts of Wis.	0.21	0.20	4.8
Atlantic City, N.J.	0.16	0.19	(18.8)
Providence and Pawtucket, R.I., and Fall River, Mass.	0.19	0.18	5.3
Philadelphia, Pa., and parts of N.J. and Del.	0.20	0.18	10.0
Sacramento, Calif.	0.17	0.18	(5.9)
Baltimore, Md.	0.18	0.17	5.6
Cincinnati and Hamilton, Ohio, and parts of Ky. and Ind.	0.17	0.17	0
Fresno, Calif.	0.18	0.17	5.6
Milwaukee, Wis.	0.18	0.17	5.6
San Francisco, Calif.	0.19	0.17	10.5
Atlanta, Ga.	0.16	0.16	0
Bakersfield, Calif.	0.18	0.16	11.1
Baton Rouge, La.	0.18	0.16	11.1
Beaumont and Port Arthur, Tex.	0.20	0.16	20.0
Boston, Lawrence, and Salem, Mass., and parts of N.H.	0.22	0.16	27.3
Dallas and Fort Worth, Tex.	0.17	0.16	5.9
El Paso, Tex.	0.17	0.16	5.9
Phoenix, Ariz.	0.16	0.16	0
Portland, Maine	0.18	0.16	11.1
Santa Barbara, San Maria, and Lompoc, Calif.	0.18	0.16	11.1
St. Louis, Mo., and St. Louis, Ill.	0.18	0.16	11.1
Washington, D.C., and parts of Md. and Va.	0.18	0.16	11.1
Longview and Marshall, Tex.	0.13	0.15	(15.4)
Louisville, Ky., and parts of Ind.	0.18	0.15	16.7
Memphis, Tenn., and parts of Ark. and Miss.	0.19	0.15	21.1
Modesto, Calif.	0.15	0.15	0
Salt Lake City and Ogden, Utah	0.16	0.15	6.2
Stockton, Calif.	0.14	0.15	(7.1)
Worcester, Mass.	0.18	0.15	16.7
Allentown and Bethlehem, Pa., and parts of N.J.	0.15	0.14	6.7
Cleveland, Ohio	0.15	0.14	6.7

(continued)

Area	1979-81 design value	1983-85 design value	Percenta chan (increas
Dover, Del.	0.13	0.14	(
Gardiner, Maine	0.12	0.14	(1
Huntington W.Va., Ashland, Ohio, and parts of Ky.	0.13	0.14	(
Jacksonville, Fla.	0.12	0.14	(1
Kansas City, Mo., and Kansas City, Kans.	0.16	0.14	1
Lake Charles, La.	0.18	0.14	2
Muskegon, Mich.	0.14	0.14	
Nashville, Tenn.	0.13	0.14	(
Northampton County, Va.	0.12	0.14	(1
Birmingham, Ala.	0.16	0.13	1
Charleston, W.Va.	0.10	0.13	(3
Charlotte and Gastonia, N.C., and Rock Hill, S.C.	0.14	0.13	
Dayton and Springfield, Ohio	0.13	0.13	
Denver and Boulder, Colo.	0.15	0.13	1
Detroit and Ann Arbor, Mich.	0.15	0.13	1
Erie, Pa.	0.14	0.13	
Grand Rapids, Mich.	0.12	0.13	(
Harrisburg, Lebanon, and Carlisle, Pa.	0.12	0.13	(
Iberville Parish, La.	0.16	0.13	1
Indianapolis, Ind.	0.14	0.13	
Janesville and Beloit, Wis.	0.11	0.13	(1
Lancaster, Pa.	0.14	0.13	
Miami and Fort Lauderdale, Fla.	0.15	0.13	1
Pittsburgh and Beaver Valley, Pa.	0.17	0.13	2
Portland, Oreg., and Vancouver, Wash.	0.13	0.13	
Portsmouth, Dover, and Rochester, N.H., and parts of Maine	0.14	0.13	7
Reading, Pa.	0.16	0.13	1
Richmond and Petersburg, Va.	0.13	0.13	
Tampa, Saint Petersburg, and Clearwater, Fla.	0.12	0.13	(
Tulsa, Okla.	0.15	0.13	1
Visalia, Tulare, and Porterville, Calif.	0.15	0.13	1
York, Pa.	0.14	0.13	7
Yuba City, Calif.	0.09	0.13	(44
Albany, N.Y.	0.13	0.12	7
Austin, Tex.	0.13	0.12	7
Buffalo, N.Y.	0.13	0.12	7
Chattanooga, Tenn.	0.13	0.12	7
Johnson City and Kingsport, Tenn.	0.14	0.12	14
Manchester, N.H.	0.13	0.12	7

(continue

Area	1979-81 design value	1983-85 design value	Percentage change (increase)
New Orleans, La.	0.13	0.12	7.7
Raleigh and Durham, N.C.	0.13	0.12	7.7
Scranton and Wilkes Barre, Pa.	0.15	0.12	20.0
South Bend, Ind.	0.14	0.12	14.3
Steubenville, Ohio, and Weirton, W.Va.	0.14	0.12	14.3
Toledo, Ohio	0.14	0.12	14.3
Columbus, Ga.	0.13	0.11	15.4
Corpus Christi, Tex.	0.14	0.11	21.4
Johnstown, Pa.	0.14	0.11	21.4
Knoxville, Tenn.	0.13	0.11	15.4
Little Rock, Ark.	0.14	0.11	21.4
Youngstown and Warren, Ohio	0.13	0.11	15.4
Omaha, Nebr., and parts of Iowa	0.14	0.10	28.6
Springfield, Mo.	0.14	0.09	35.7
Syracuse, N.Y.	0.13	0.09	30.8

Source: EPA

Case Study Areas and Their Progress Toward Ozone Attainment

Our review examined three areas'—Los Angeles, California; Houston, Texas; and Charlotte, North Carolina—efforts to achieve the ozone standard. This appendix briefly describes these areas and the progres they have made toward attaining the ozone standard.

Los Angeles, California

The South Coast Air Basin, a 6,600 square mile area, includes all of Orange and parts of Los Angeles, Riverside, and San Bernadino counti The four counties in which the basin lies increased in population from 4.8 million in 1950 to 12.2 million in 1986. In part because of a combin. tion of meteorological and geographic factors, this air basin encompass ing the Los Angeles area is considered to have a high air pollution potential and has the worst ozone problem in the United States. Chang in life-styles such as the increase in the use and number of automobile has further increased the difficulty of pollution control. Air pollution has been a serious concern for the Los Angeles area since the mid-194(long before the Clean Air Act was passed.

For the 1979 to 1981 period, the area's ozone reading has decreased from 0.44 ppm to 0.35 ppm for the 1984 to 1986 period. California's 198 air quality management plan called for the implementation of a variet of control measures to move the Los Angeles area closer to meeting the standard. However, the plan stated that even if such measures are implemented, the Los Angeles area could not reach the ozone standard by December 31, 1987, or even by the year 2000. Implementation of short-term control measures was intended to reduce the peak ozone readings to 0.30 ppm by the end of 1987.

Mobile sources make up 54.4 percent of the hydrocarbon emissions esti mated in the South Coast Air Basin, while stationary source emissions comprise 45.6 percent. Surface coating is the largest offender of the st tionary sources contributing roughly 16.1 percent of the stationary source emissions.

Houston, Texas

The Houston nonattainment area consists of Harris County and has a population of about 2.4 million. The county's land area totals about 1,734 square miles. Like the Los Angeles area, Houston has meteorolog cal and climatological conditions favorable for ozone production.

For the 1979 to 1981 period, the Houston area had an ozone level of 0.3 ppm. For the 1984 to 1986 period, that value declined to 0.20 ppm. Hous- ton's 1982 revised SIP, planned to reduce ozone by the end of 1987 to

0.12 ppm through hydrocarbon reductions from the manufacturing of organic chemicals and plastics as well as other sources, including motor vehicle emissions. EPA data show that even though proposed hydrocarbon reductions have been met, the area will not meet the ozone standard by the target date or in the foreseeable future.

Mobile sources make up 29 percent of the hydrocarbon emissions estimated in the Houston area, while stationary sources account for 71 percent. Petroleum refineries are the largest contributor of the stationary sources, accounting for about 24 percent of the stationary source emissions.

Charlotte, North Carolina

The Charlotte nonattainment area consisted of Mecklenburg County and has a population of about 400,000. The county's land area is 528 square miles. For the 1979 to 1981 period, the Charlotte area had an ozone level of 0.14 ppm, and for the 1984 to 1986 period, this level had declined to 0.13 ppm. Although this decline shows improvement, the Charlotte area will not reach attainment by the act's December 31, 1987, deadline.

According to the Charlotte area SIP, which was based on a 1976 inventory, mobile sources make up 53 percent of the hydrocarbon emissions, while stationary sources account for 47 percent. Petroleum marketing contributes about 45 percent of all stationary source emissions.

Ozone-Related Reports Recently Issued by GAO

Air Pollution: EPA's Efforts to Control Vehicle Refueling and Evaporat Emissions (GAO/RCED-87-151; August 7, 1987)

Air Quality Standards: EPA's Standard Setting Process Should Be More Timely and Better Planned (GAO/RCED-87-23; December 1986)

Vehicle Emissions: EPA Response to Questions On Its Inspection and Maintenance Program (GAO/RCED-86-129BR; May 1986)

Air Pollution: Improvements Needed in Developing and Managing EPA Air Quality Models (GAO/RCED-86-94; April 1986)

Air Pollution: EPA's Strategy to Control Emissions of Benzene and Gas line Vapor (GAO/RCED-86-6; December 1985)

EPA's Sanctions Policy Is Not Consistent With The Clean Air Act (GAO/RCED-85-121; September 30, 1985)

Vehicle Emissions Inspection and Maintenance Program is Behind Sch ule (GAO/RCED-85-22; January 16, 1985)

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