FHWA-PD-98-001
DOT-VNTSC-FHWA-97-7

U.S. Department
of Transportation
**Federal Highway
Administration**

The Role of Motor Vehicle Emission Controls in State Implementation Plans

PB98-128812

November 1997
Final Report

SEEING CLEARLY...A Series of Reports on Transportation and Air Quality

Prepared for

Environmental Analysis Division
Office of Environment and Planning
Federal Highway Administration
U.S. Department of Transportation

Prepared by

Service Assessment Division
Office of Research and Analysis
Volpe National Transportation Systems Center
Research and Special Programs Administration
U.S. Department of Transportation

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. PB98-128812

2. REPORT DATE
November 1997

3. REPORT TYPE AND DATES COVERED
Final Report
January 1992 - December 1996

4. TITLE AND SUBTITLE
The Role of Motor Vehicle Emission Controls in State Implementation Plans

5. FUNDING NUMBERS
HW765/H7040

6. AUTHOR(S)
Sergio Ostria, Elizabeth Deysher, Donovan Robinson,
Don Pickrell, Philip vanderWilden

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
*Jack Faucett Associates
4550 Montgomery Ave.,
Suite 300 North
Bethesda, MD 20814

U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe Transportation Systems Center
Cambridge, MA 02142-1093

8. PERFORMING ORGANIZATION REPORT NUMBER
DOT-VNTSC-FHWA-97-7

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Federal Highway Administration
Environmental Analysis Division/Office of Environment and Planning
400 7th Street, SW
Washington, DC 20590

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
FHWA-PD-98-001

11. SUPPLEMENTARY NOTES
*under contract to:
U.S. Department of Transportation
Research and Special Programs Administration
Volpe National Transportation Systems Center
Cambridge, MA 02142-1093

12a. DISTRIBUTION/AVAILABILITY STATEMENT
This document is available to the public through the National Technical Information Service, Springfield, VA 22161

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

The Clean Air Act (CAA) of 1970 established the framework for a Federal and State partnership to both attain and maintain air quality standards. The principal program of the CAA established the need for developing nationwide air quality goals and the requirement for each State to submit a plan detailing how it will meet those goals. Under the Act, the Environmental Protection Agency is charged with developing national ambient air quality standards (NAAQS), while each State's governor (or representative) is responsible for submitting a State implementation plan (SIP) for each pollutant for which it does not meet these standards. The SIPs detail how each nonattainment area will reduce pollutants to acceptable levels.

The objective of this study is to examine the data that has been reported in the SIPs in order to assess the contribution of transportation to air pollution in areas across the country and to determine the relative effectiveness of transportation sources in reducing this contribution. The analysis also focuses on the relative effectiveness of transportation control measures (TCMs) in mitigating emissions from on-road sources.

14. SUBJECT TERMS
nonattainment, air quality, Clean Air Act, pollution, emissions, air quality standards, state implementation plan (SIP), transportation control measures (TCMs)

15. NUMBER OF PAGES
104

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT
Unclassified

18. SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

19. SECURITY CLASSIFICATION OF ABSTRACT
Unclassified

20. LIMITATION OF ABSTRACT

PREFACE

This report was originally drafted by Jack Faucett Associates and edited by a team of staff from the Volpe Center. The authors are grateful to the Federal Highway Administration and the Environmental Protection Agency for their careful review and insightful comments on earlier versions of the report.

This report is one in a series of publications produced by the Federal Highway Administration of the U.S. Department of Transportation to address important issues in transportation and air quality planning for metropolitan areas. Copies of this and other reports in this series can be ordered by calling 202-366-2069.

METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in) = 2.5 centimeters (cm)
1 foot (ft) = 30 centimeters (cm)
1 yard (yd) = 0.9 meter (m)
1 mile (mi) = 1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2) = 6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2) = 0.09 square meter (m^2)
1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)
1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)
1 acre = 0.4 hectare (ha) = 4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz) = 28 grams (gm)
1 pound (lb) = .45 kilogram (kg)
1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp) = 5 milliliters (ml)
1 tablespoon (tbsp) = 15 milliliters (ml)
1 fluid ounce (fl oz) = 30 milliliters (ml)
1 cup (c) = 0.24 liter (l)
1 pint (pt) = 0.47 liter (l)
1 quart (qt) = 0.96 liter (l)
1 gallon (gal) = 3.8 liters (l)
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

°C=5/9(°F - 32)

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm) = 0.04 inch (in)
1 centimeter (cm) = 0.4 inch (in)
1 meter (m) = 3.3 feet (ft)
1 meter (m) = 1.1 yards (yd)
1 kilometer (km) = 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)
1 square meter (m^2) = 1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2) = 1 hectare (ha) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm) = 0.036 ounce (oz)
1 kilogram (kg) = 2.2 pounds (lb)
1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons

VOLUME (APPROXIMATE)

1 milliliter (ml) = 0.03 fluid ounce (fl oz)
1 liter (l) = 2.1 pints (pt)
1 liter (l) = 1.06 quarts (qt)
1 liter (l) = 0.26 gallon (gal)
1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

°F=9/5(°C) + 32

QUICK INCH-CENTIMETER LENGTH CONVERSION

INCHES	0			1			2			3			4		5
CENTIMETERS	0	1	2		3	4	5	6	7		8	9	10	11	12	13

QUICK FAHRENHEIT-CELSIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50. SD Catalog No. C13 10286.

Updated 8/1/96

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (CONTINUED)

Table | Page

EXECUTIVE SUMMARY

The Clean Air Act Amendments of 1990 (CAAA) require that states submit State Implementation Plans (SIPs) detailing strategies to improve air quality in nonattainment areas. This analysis first reviews the administrative procedures that states and the EPA must undertake to submit and approve SIPs, as well as the status of that process. Then, the analysis examines data that has been reported in selected SIPs in order to assess the contribution of transportation to air pollution in areas across the country and to determine the relative effectiveness of transportation sources in reducing this contribution.

The SIP submittal and approval process has moved forward slowly and steadily, but there are some important SIP elements that the EPA has not yet approved. Congressional actions as well as EPA's desire to provide flexibility to states as they submit their transportation-related SIPs in a complex and fluctuating regulatory environment has resulted in extended submittal deadlines in order for states to modify emission control programs, such as the inspection and maintenance (I&M) program, and update certain SIP elements.

The data gathered from selected SIPs show that, although the on-road transportation source category contributed significantly to CO in 1990, and somewhat less to volatile organic compounds (VOC) and NOx, it is the source that was expected to contribute the most to the reduction of these emissions in the following five to six year timeframe. In fact, this is the only source expected to contribute to reductions in CO and VOC emissions far in excess of its contribution to 1990 base year emissions. The SIP elements do not report the contribution of transportation sources to NOx reductions since states ozone SIPs were only required to show VOC reductions.

On-road mobile sources are estimated to have contributed the majority of CO in 1990, however between 1990 and 1995, the largest reduction occurred within this category. As a whole, the on-road source category's contribution to expected CO emissions reductions exceeds its contribution to base year CO emissions by nearly 40 percent. In contrast, the other sources were not expected to contribute a larger share to total CO emissions reductions than to base year emissions. The nonroad source category, the second highest contributor to CO, and the area source category were expected to increase in the future, and there were slight increases in the point source category.

VOC emissions in 1990 were more evenly distributed across all source categories than were CO emissions. Despite the even distribution among contributors, the majority of VOC reductions by 1996 were expected to occur from the on-road source category. Smaller reductions were gained from the point, area, and nonroad source categories, with some nonattainment areas showing increases from nonroad sources. Reductions expected by 1996 in the on-road and point source categories were particularly large by comparison to their base year inventory. The area and nonroad source categories contributed, on average, less to reductions than to their base year contributions.

NOx emissions were concentrated, on average, in the point and on-road source categories in 1990. The relative contribution of source categories to NOx emissions appeared to depend on the level of industrial activity within a region. The point source category was the major contributor of NOx in areas characterized by heavy industry, whereas the on-road source category was the major contributor in regions experiencing rapid population and job growth. As stated earlier, NOx reductions were not available from the SIPs used in this analysis.

Mandated on-road requirements, including enhanced inspection and maintenance, reformulated gasoline, and Stage II vapor recovery accounted for most, if not all, of the estimated VOC reductions from on-road sources. Transportation control measures contributed only marginally to emissions reductions and appeared to be included only where they had been previously adopted for reasons unrelated to air quality (rather than because of their potential to offset increases in emissions from expected VMT growth). Although nonroad sources contributed to VOC, control measures for these sources were not included in the SIPs, possibly because their start dates would have extended beyond the timeframe of the SIP. According to the EPA, nonroad emission standards that have been or are being promulgated will achieve most of their emission reduction benefits in the year 2000.

Both the paved and unpaved categories for road dust were large contributors to PM_{10} in 1990, however, they were not classified consistently as area or mobile sources from one SIP to the next.

According to this report's definition of source categories for PM_{10} emissions, dust from paved roads is designated as a mobile source and dust from unpaved roads as an area source. As with NOx, PM_{10} emissions reductions were not available in the SIPs used for this analysis.

1. BACKGROUND

The Clean Air Act (CAA) of 1970 established the framework for a Federal and State partnership to achieve national air quality goals. The CAA directed the Federal Government to establish the nationwide air quality goals, and required each state to submit a plan detailing how it would meet those goals. Under the Act, the Environmental Protection Agency (EPA) is charged with developing national ambient air quality standards (NAAQS), while the governor (or representative) of each state is responsible for submitting a state implementation plan (SIP) for each pollutant for which the state does not meet these standards. The SIPs detail how each nonattainment area will reduce pollutants to acceptable levels.

The Clean Air Act Amendments of 1990 (CAAA) require that states submit revisions to SIPs detailing strategies to bring air quality in nonattainment areas into compliance with the NAAQS for carbon monoxide (CO), particulate matter (PM_{10}), and ozone (O_3). The three types of SIP submissions reviewed for the purpose of this report are the following:

> ***Emission Inventory*** - An emission inventory is the estimated contribution of weekday and annual emissions from all sources in the nonattainment area, including a 25-mile radius beyond the nonattainment area boundary for the 1990 base year.
>
> ***15% Reasonable Further Progress (RFP) plan*** - The 15% RFP plan details measures needed for interim progress toward attainment of the NAAQS for ozone. It identifies the control measures that will contribute to a 15 percent reduction of volatile organic compounds (VOC), an ozone precursor, from the 1990 baseline by 1996. Estimated reductions of nitrous oxides (NOx), another ozone precursor, can also be included in these SIPs, although there is no regulatory requirement to specific reductions in NOx emissions.
>
> ***Attainment Demonstration*** - An attainment demonstration is a SIP revision providing for specific annual reductions in emissions "as necessary to attain the national ambient air quality standard," by a designated attainment year.

The sources of emissions are categorized in each SIP as follows: point, area, on-road mobile, and nonroad mobile sources. Point sources are large, relatively fixed sources of emissions, such as chemical processing industries. Area sources are small, fixed sources, such as dry cleaners or bakeries, that collectively contribute to air pollution. On-road mobile sources include passenger cars, light-duty trucks, heavy-duty trucks and buses, and motorcycles. Nonroad mobile sources are off-highway transportation modes such as locomotives, aircraft, marine vessels, and recreational watercraft.

The following information is found in emission inventories: the nonattainment area and its meteorology; air quality and emissions; mobile source modeling inputs, outputs, and emissions calculation methodologies; point sources by site and activity; and area source and nonroad mobile source emissions calculation methods. Information in 15% RFP plans typically includes: an economic profile of the area; projected economic activity; a base year emissions inventory adjusted for growth; and proposed VOC control measures for implementation and their associated emissions reductions. Information in attainment demonstrations includes: data summarizing the baseline emissions inventory; a description of the control measures to be implemented for each source category; control measure effectiveness in terms of emissions reduction potential; forecasts of vehicle miles traveled (VMT); and air quality dispersion modeling data.

1.1 PURPOSE AND SCOPE OF ANALYSIS

The objective of this study is to examine data that has been reported in the SIPs in order to assess the contribution of transportation to air pollution in areas across the country and to determine the relative effectiveness of transportation sources in reducing this contribution. The analysis also focuses on the relative effectiveness of transportation control measures (TCMs) in mitigating emissions from on-road sources.

Data are analyzed that have been gathered from a sample of emission inventory SIPs, 15% RFP plans and attainment demonstration plans. Twenty-six emission inventories report the estimated contribution of transportation to CO, O_3 precursors, and PM_{10}. The controls that are proposed in 10 CO and 9 PM_{10} attainment demonstration SIPs to reduce CO and PM_{10}, as well as those proposed in ten 15% RFP plans to reduce ozone precursors are reviewed and compared to the emission inventories. Additional data, such as VMT forecasts and travel by road type, are examined to provide a more detailed discussion of transportation sources to pollution.

The SIP documents provide a source of detailed information on the contribution of the transportation sector to air pollution in nonattainment areas and the types of measures that are being proposed to reduce emissions from transportation-related activities. However, it should also be emphasized that the emissions estimates that are reported in all three types of SIP submissions are generated using the EPA's approved modeling techniques. They are not based on actual measurements of ambient air concentrations. Table 1 lists the nonattainment areas included in this study along with each area's nonattainment classification under 1990 CAAA.

Table 1. Selected Nonattainment Areas by Classification.[1]

Carbon Monoxide		Particulate Matter		Ozone	
Nonattainment Area	Classification	Nonattainment Area	Classification	Nonattainment Area	Classification
Anchorage	Moderate > 12.7 ppm	Maricopa & Pinal Counties (AZ)	Moderate	Atlanta	Serious
Phoenix	Moderate < 12.7 ppm	Adams, Denver, & Boulder Counties (CO)	Moderate	Baltimore	Severe-15
Fresno	Moderate > 12.7 ppm	Ada County (ID)	Moderate	Baton Rouge	Serious
Denver-Boulder	Moderate > 12.7 ppm	Union County (NJ)	Moderate	Philadelphia-Wilmington-Trenton	Severe-15
New York-New Jersey-Long Island	Moderate > 12.7 ppm	Spokane County (WA)	Moderate	Providence	Serious
Las Vegas	Moderate > 12.7 ppm	Presque Isle (ME)	Moderate	Boston-Lawrence-Worcester	Serious
Seattle-Tacoma	Moderate > 12.7 ppm			Muskegon	Moderate
Spokane	Moderate > 12.7 ppm			Portsmouth-Dover-Rochester	Serious
				Houston-Galveston	Severe-17
				Sheboygan	Moderate

[1] Reclassifications to Serious since completion of this analysis: Phoenix (CO), Denver-Boulder (CO), and Las Vegas (CO); Maricopa & Pinal Counties (PM_{10}). Redesignations to attainment since completion of this analysis: Seattle-Tacoma (CO), Presque Isle (PM_{10}), Muskegon (O_3), Sheboygan (O_3).

1.2 ORGANIZATION OF THE REPORT

The remainder of this report is organized into three sections: section 2 outlines the SIP revision administrative procedures and pollution control requirements by classification and nonattainment area and reviews the status of SIP submittals and approvals; section 3 reviews the SIPs for 24 nonattainment areas to assess the contribution of source categories to the CO, O_3, and PM_{10} inventories, and the effectiveness of control strategies proposed to reduce these pollutants and their precursors. This discussion focuses on measures to mitigate the contribution of on-road sources. Section 4 discusses the travel parameters determining on-road emissions and examines emissions contributions by transportation mode.

2. OVERVIEW OF THE 1990 CLEAN AIR ACT AMENDMENTS

The Clean Air Act Amendments of 1990 (CAAA) maintain, enhance, and add requirements to the 1970 and 1977 Clean Air Acts for attaining the National Ambient Air Quality Standards (NAAQS) for three criteria air pollutants that are created, in part, by transportation sources: carbon monoxide (CO), ozone (O_3), and particulate matter of 10 microns or less in aerodynamic size (PM_{10}). As part of the NAAQS, the U.S. Environmental Protection Agency (EPA) has established primary standards for all three pollutants to protect human health (table 2)[2]. Areas not meeting these standards are designated as nonattainment areas and are classified according to the frequency and severity of NAAQS violations they experience based on air quality monitoring data.

Table 2. National Ambient Air Quality Standards.

Pollutant	Primary Standard
Particulate Matter (PM_{10})	**$\mu g/m^3$**
annual arithmetic mean[1]	50
24-hour concentration[2]	150
Carbon Monoxide	**ppm**
8-hour average concentration	9
1-hour average concentration	35
Ozone	**ppm**
1-hour concentration[2]	0.12

1 cannot be exceeded

2 attained when days per year with average concentration exceeding standard are ≤ 1

2.1 STATE IMPLEMENTATION PLANS (SIPS) FOR CO, O_3, PM_{10}

The CAAA require states to develop state implementation plans (SIPs) for areas designated to be in nonattainment of the NAAQS for CO, O_3, or PM_{10}. A state submits a SIP for each requirement; for example: one type of SIP estimates the level of emissions for a base year of 1990, while another defines specific control measures to reduce those emissions. There are Federally mandated deadlines for each type of SIP, as shown in table 3. The EPA must review and approve each SIP. States failing to submit a SIP are subject to a Federal implementation plan (FIP).

---

2 On July 16, 1997, the EPA issued a more stringent standard for O_3 and a new standard for fine particulates which will increase the number of nonattainment areas for ozone by 12-27 and for particulate matter by 30.

Table 3. SIP Submittal Deadlines.

Pollutant	Date SIP is Due
Carbon Monoxide	
Emissions Inventory	November 15, 1992
Attainment Demonstration Plans	November 15, 1992
Ozone	
Emissions Inventory	November 15, 1992
15% Reasonable Further Progress Plans	November 15, 1993
Attainment Demonstration Plans	November 15, 1994
Particulate Matter	
Emissions Inventory	November 15, 1991
Attainment Demonstration Plans	November 15, 1992

The SIP submittals in table 3 actually represent a small fraction of the total required revisions to state implementation plans. There are several transportation requirements of the CAAA, Title I, Part D, that apply to all nonattainment areas and others that are based on the pollutant and nonattainment classification. Tables 4 and 5 summarize the transportation SIP provisions and requirements for CO, O_3, and PM_{10} nonattainment areas as originally defined in the CAAA.

Table 4. CAAA Transportation Provisions for Ozone Nonattainment Areas.

MARGINAL	MODERATE	SERIOUS	SEVERE	EXTREME
				TCMs for Heavy Traffic Hours
			TCMs for Growth in VMT	TCMs for Growth in VMT
			Employer Trip Reduction	Employer Trip Reduction
		Long-Term Measures	Long-Term Measures	Long-Term Measures
		Pilot Test Program (CA)	Pilot Test Program (CA)	Pilot Test Program (CA)
		Clean-Fuel Vehicle Program	Clean-Fuel Vehicle Program	Clean-Fuel Vehicle Program
		Transportation Controls	Transportation Controls	Transportation Controls
		RFP Demonstrations	RFP Demonstrations	RFP Demonstrations
		Milestone Compliance	Milestone Compliance	Milestone Compliance
	Attainment Demonstration	Attainment Demonstration	Attainment Demonstration	Attainment Demonstration
	Tracking Plan	Tracking Plan	Tracking Plan	Tracking Plan
	Gasoline Vapor Recovery	Gasoline Vapor Recovery	Gasoline Vapor Recovery	Gasoline Vapor Recovery
	Contingency Measures	Contingency Measures	Contingency Measures	Contingency Measures
	15% VOC Reductions	15% VOC Reductions	15% VOC Reductions	15% VOC Reductions
I&M Corrections	Basic I&M	Enhanced I&M	Enhanced I&M	Enhanced I&M
Emissions Corrections	Emissions Statements	Emissions Statements	Emissions Statements	Emissions Statements
Reformulated Gas Opt-In	Reformulated Gas Opt-In	Reformulated Gasoline	Reformulated Gasoline	Reformulated Gasoline
Periodic Inventory	Periodic Inventory	Periodic Inventory	Periodic Inventory	Periodic Inventory
RFP Milestones	RFP Milestones	RFP Milestones	RFP Milestones	RFP Milestones
Emissions Inventory	Emissions Inventory	Emissions Inventory	Emissions Inventory	Emissions Inventory

Table 5. CAAA Transportation Provisions for CO and PM_{10} Nonattainment Areas.

Carbon Monoxide

MODERATE < or = 12.7 ppm	MODERATE > 12.7 ppm	SERIOUS
		Severe Ozone TCMs
		Long-Term Measures
		Clean-Fuel Fleet Program
	Milestone Compliance	Milestone Compliance
	Tracking Plan	Tracking Plan
	Attainment Demonstration	Attainment Demonstration
	VMT Forecasts	VMT Forecasts
	Contingency Measures	Contingency Measures
	Special TCMs for Denver	Special TCMs for Denver
I&M Corrections	Enhanced I&M	Enhanced I&M
Oxygenated Fuels	Oxygenated Fuels	Oxygenated Fuels
Periodic Inventory	Periodic Inventory	Periodic Inventory
Emissions Inventory	Emissions Inventory	Emissions Inventory

Particulate Matter

MODERATE	SERIOUS
Precursor Controls	Precursor Controls
Contingency Measures	Contingency Measures
Quantitative Milestones	Quantitative Milestones
Reasonable Further Progress	Reasonable Further Progress
Attainment Demonstration	Attainment Demonstration
Emissions Inventory	Emissions Inventory

2.2 ADMINISTRATIVE PROCESS FOR SIP SUBMITTALS AND APPROVALS

The administrative process that states undergo to submit SIPs to the EPA and to obtain EPA's approval is complex and time consuming. Each state with nonattainment area(s) must submit SIP revisions to the respective EPA regional office. Each SIP first undergoes a screening review that examines only the contents of the SIP revision and not its potential for approval, thereby allowing the EPA to return obviously deficient SIP submittals to the state for correction. States may submit SIP revisions for a completeness determination via the sequential rulemaking process, in which revisions have gone through all necessary state procedures and are finally adopted or issued by the EPA, or via the parallel rulemaking process, in which revisions are concurrently undergoing the necessary State and Federal procedures for final approval. The EPA regional office reviews each submittal for consistency with the following completeness criteria:

Sequential Rulemaking

1. A letter from the appropriate State official requesting the EPA's approval;
2. Evidence that the necessary public notice was given and a public hearing was held;
3. A document (regulation, permit, state order) that is fully adopted/issued and enforceable by the requesting agency for incorporation by reference with its effective date clearly indicated; and
4. The technical support necessary to determine that approval of the revision will not violate ambient air quality standards or prevention of significant deterioration (PSD) increments, will not interfere with reasonable further progress (RFP), and is consistent with requirements for maintenance of ambient standards.

Parallel Rulemaking

1. A letter from the appropriate State official requesting parallel-processing of the revision;
2. A schedule for completing the adoption/issuance process at the state level
3. A proposed or draft document (regulation, permit, state order, consent agreement) that will eventually be adopted/issued by the state and formally submitted as a SIP revision; and
4. Sufficient technical support to evaluate the proposed revision's impact on air quality and conformance with Federal statutes, regulations, and policies.

After granting a completeness determination, the EPA reviews the SIP for final approval. The EPA's decision may result in full approval, partial approval, limited approval, conditional approval, or disapproval. The EPA can disapprove any portions of a SIP that do not comply with CAAA. If the disapproved portions are *separable*, meaning that they will not affect the stringency of other portions of the SIP, then the EPA can partially approve the SIP and disapprove the separate parts. If *inseparable* portions of the SIP are disapproved because of failure to comply with all of the CAAA requirements, but the SIP as a whole provides progress toward attainment or reasonable further progress, then the EPA can grant limited approval. Finally, conditional approval is granted if a State commits to adopt specific measures by a specified date that falls within one year after the date of SIP approval. If the commitment is not met within the year, the conditional approval automatically turns into a disapproval.

The procedures to be followed to reach a determination of approval or disapproval requires specific SIP actions to be processed in one of the four following ways:

1. **Sequential Processing** results in EPA proposing action on a rule (Notice of Proposed Rulemaking), requesting public comments, and publishing the final action on the state submittal in the Federal Register;

2. **Direct Final Rulemaking** is applicable only to those SIP actions judged to be noncontroversial and, therefore, no adverse public comment is anticipated;

3. **Parallel Processing** reduces the delay between final state action and final rulemaking by allowing EPA to process a draft rule in parallel with the state adopting the final rule; or

4. **Letter Notice** allows EPA to use letters to affected states and parties rather than notice and comment rulemaking to approve insignificant SIP actions.

Regardless of the manner in which a State's formal submission of a SIP revision or request will be processed, the EPA Regional Administrators are responsible for review and sign-off. Headquarters review may be requested by the Regional Office.

The EPA may conclude that a SIP submittal is deficient either during the screening review for completeness or through processing the SIP submittal. The CAAA requires specific actions by the EPA depending on the reason for the deficiency. Section 179(a) requires EPA to impose sanctions for four deficiencies:

1. A finding that a state has failed to submit a SIP, a SIP element, or submitted the same that does not satisfy the completeness criteria;

2. EPA disapproval of a SIP submission for a nonattainment area based on its failure to meet one or more elements required by the CAAA;

3. A determination that the state has not made any other submission, or an adequate submission (as required by the CAAA), or that EPA disapproves such submission; or

4. A finding that a requirement of an approved plan is not being implemented.

As Section 110(m) requires, the EPA has established criteria for applying sanctions to ensure that they are not applied on a statewide basis if only one or more areas within the state are responsible for the deficiency. This rule has been published in the August 4, 1994 Federal Register (Vol. 59, No. 149).

Under Section 110(c)(1), the EPA is required to promulgate a Federal Implementation Plan (FIP) based on two types of deficiencies:

1. A finding that a state has failed to make a required submittal or a submittal does not satisfy the minimum completeness criteria, or

2. EPA disapproval of a SIP submittal in whole or in part.

None of the sanctions and FIP triggers listed above require immediate imposition, and certain findings (i.e., failure to submit and SIP disapproval) trigger both sanctions and FIPs. The CAAA provide a grace period ("clock") before the EPA is required to impose sanctions and FIPs. States are given up to 18 months to correct deficiencies. Under Section 179(b)(1) and (2), if sanctions are deemed necessary, the initial sanction would limit emissions in the affected area by requiring any major new or expanding facility to find 2-to-1 offsets for any projected increase in emissions. The second sanction that would come into effect six months after the first sanction would impose a prohibition on the approval by the Secretary of Transportation of certain projects, or the awarding of certain grants.

2.3 STATUS OF SUBMITTALS AND APPROVALS

Table 6 documents the States' progress in submitting transportation-related SIP elements required by the CAAA, including all transportation-related elements required for ozone, CO and PM_{10} nonattainment areas. It shows that a significant number of the required SIP elements were submitted after the legislated deadlines. This occurred partly because the deadlines specified in the CAAA deadlines were extremely ambitious, while guidance for developing many of the required SIP elements was not provided, and many states adhered to biennial legislative cycles that delayed their submittals. The deadlines for PM_{10} SIPs were particularly tight: SIPs were required by November 15, 1991, which was only one year after the enactment of the Act.

As table 6 also shows, there were 824 total transportation-related SIP elements required to be adopted and submitted by the States. Of that total, 691 (or 84%) have been submitted and found complete. The largest number of remaining incomplete elements (33) are the VOC 15% Reduction Plans, many of which were found incomplete due to their failure to include adopted I&M programs. Many states failed to adopt I&M programs (or chose to reconsider the design of previously adopted programs) because, in response to widespread public concern, the EPA (and subsequently Congress in the 1995 National Highway System Designation Act) granted states' flexibility to design individualized I&M programs and granted additional time to implement them[3]. States with incomplete VOC 15% Reduction SIP elements have subsequently been asked to resubmit revised versions including adopted I&M plans, and EPA has continued to work with these States to develop complete and approvable plans.

Table 6 also reveals that a large number of ozone attainment demonstrations for Serious, Severe and Extreme nonattainment areas have not yet been submitted. The deadline for submitting these SIP elements has been suspended pending the outcome of the Ozone Transport Assessment Group's (OTAG) attempts to develop satisfactory procedures for incorporating the effects of transported ozone in "recipient" states'[4] air quality planning, modeling, and selection of appropriate emissions controls. Finally, table 6 shows that some emission inventories were submitted late or as part of a nonattainment area's redesignation request because some states delayed conducting public hearings on their proposed emission inventories until they could be combined with hearings on related SIP elements, including VOC 15% Reduction plans and redesignation requests[5].

Table 7, which shows EPA's progress in processing the required SIP elements, shows that EPA has approved significant numbers of CO and ozone-related SIP elements, but has not yet taken final action on many PM_{10} SIP elements. This pattern reflects EPA's efforts to set priorities in the presence of limited staff resources; because ozone and CO nonattainment areas are more densely populated and frequently overlap, focusing attention on processing ozone and CO SIP elements has the largest potential impact on public health. In addition, some PM_{10} SIPs contain deficiencies and EPA has provided states submitting these SIPs with additional time to correct

---

[3]Environmental Protection Agency, Inspection and Maintenance (I&M) Flexibility Amendments, September 18, 1995.

[4]Environmental Protection Agency, memorandum from the Assistant Administrator for OAR entitled "Ozone Attainment Demonstrations," March 2, 1995.

[5]Environmental Protection Agency, memorandum, entitled "Public Hearing Requirements for 1990 Base-Year Emissions Inventories for Ozone and Carbon Monoxide Nonattainment Areas." September 29, 1992.

the deficiencies in order to reduce the possibility of SIP disapproval and the subsequent imposition of sanctions.

Table 6. State's Progress in Submitting Transportation-Related SIP Elements.

Pollutant	SIP Element	Total Due	Duedate Specified in CAAA	Complete Submissions: On Time	Complete Submissions: Late	Complete Submissions: Date not Recorded	Complete Submissions: Total	Incomplete Submission	No Submission
CO	CO Emissions Inventory	48	11/15/92	9	29	5	43	1	4
CO	Basic I&M	10	11/15/92	3	6	1	10	0	0
CO	Enhanced I&M	4	11/15/92	0	2	0	2	2	0
CO	CO Contingency Measures	48	11/15/92	15	21	2	38	1	9
CO	Oxygenated Fuels	47	11/15/92	27	19	0	46	0	1
CO	TCMs to Offset Growth	1	11/15/92	0	1	0	1	0	0
CO	VMT Forecast	11	11/15/92	0	9	0	9	0	2
CO	Attainment Demonstration	12	11/15/92	0	11	1	12	0	0
O_3	O_3 Emissions Inventory	110	11/15/92	20	90	0	110	0	0
O_3	Basic I&M	29	11/15/92	10	14	1	25	1	3
O_3	Enhanced I&M	39	11/15/92	2	34	0	36	2	1
O_3	Stage II Vapor Recovery System	80	11/15/92	41	35	0	76	0	4
O_3	TCMs to Offset Growth	17	11/15/93	4	13	0	17	0	0
O_3	VOC 15% Reduction Plan	68	11/15/93	10	23	0	33	33	2
O_3	VOC or NOx Contingency Measures	66	11/15/92	17	26	0	43	5	18
O_3	Attainment Demonstration for Intraregion	8	11/15/94	2	6	0	8	0	0
O_3	Attainment Demonstration for Intra ST Mod	4	11/15/92	3	0	1	4	0	0
O_3	Attainment Demonstration Urban Airshed Model	57	11/15/92	20	21	0	41	0	16
PM_{10}	PM_{10} SIP	83	11/15/91	26	44	1	71	3	9
PM_{10}	PM_{10} Contingency Measures	82	11/15/91	28	36	2	66	0	16
Total		824		237	440	14	691	48	85

Status of SIP submittals as of 12/9/96

Table 7. EPA's Progress in Approving/Disapproving Transportation-Related SIP Elements.

			Approved Submissions			
Pollutant	SIP Element	Complete Submission	Initial Submission Approved	Revised Submission Approved	Total Approved	No Final Approval
CO	CO Emissions Inventory	43	23	0	23	20
CO	Basic I&M	10	10	0	10	0
CO	Enhanced I&M	2	2	0	2	0
CO	CO Contingency Measures	38	25	0	25	13
CO	Oxygenated Fuels	46	32	1	33	13
CO	TCMs to Offset Growth	1	0	0	0	1
CO	VMT Forecast	9	4	0	4	5
CO	Attainment Demonstration	12	3	0	3	9
O_3	O_3 Emissions Inventory	110	61	0	61	49
O_3	Basic I&M	25	25	0	25	0
O_3	Enhanced I&M	36	8	12	20	16
O_3	Stage II Vapor Recovery System	76	49	25	74	2
O_3	TCMs to Offset Growth	17	4	0	4	13
O_3	VOC 15% Reduction Plan	33	26	0	26	7
O_3	VOC or NOx Contingency Measures	43	18	0	18	25
O_3	Attainment Demonstration for Intraregion	8	8	0	8	0
O_3	Attainment Demonstration for Intra ST Mod	4	4	0	4	0
O_3	Attainment Demonstration Urban Airshed Model	41	8	0	8	33
PM_{10}	PM_{10} SIP	71	41	3	44	27
PM_{10}	PM_{10} Contingency Measures	66	39	0	39	27
Total		691	390	41	431	260

Status of SIP submittals as of 12/9/96

3. ON-ROAD MOBILE SOURCE EMISSIONS AND THEIR REDUCTION

3.1 BACKGROUND

This section compares the estimated levels of CO, ozone precursors, and PM_{10}, by source, for the 1990 base year, as well as the reductions in these pollutant levels resulting from Federally mandated and state-selected control measures. Estimates of CO and PM_{10} reductions are provided in attainment demonstration SIPs, and the reductions in VOC are estimated in the 15% RFP plans. Although the estimated reductions from all sources is included, the analysis focuses on the transportation strategies that are expected to mitigate on-road emissions. Both the initial emission levels and potential reductions reported in the SIPs are estimated using the EPA's vehicle emissions model. For an overview of the model, see "The MOBILE Model and Transportation Planning: A Brief Overview" and for a complete discussion of the model's structure and its evolution over time, see "Evaluation of the MOBILE Vehicle Emission Model."

Section 3.2 discusses the emission characteristics of eight CO nonattainment areas. A total of ten SIPs were reviewed for these eight areas, since the New York-New Jersey-Long Island nonattainment area is comprised of three states, and therefore three SIPs. Section 3.3 describes the inventories and reductions reported by ten ozone nonattainment areas. Data from six PM_{10} nonattainment areas are presented in section 3.4. Finally, section 3.5 summarizes observations about the contribution of transportation sources to emission inventories and to emissions reductions.

3.2 CARBON MONOXIDE NONATTAINMENT AREAS

The eight CO nonattainment areas selected for this analysis each encompass different economies, populations, meteorology, and topography, such as the extremely cold weather of Anchorage, the dense metropolitan development of the New York-New Jersey-Long Island area, the agriculture-based economy of the San Joaquin Valley, and the high altitude of the Denver nonattainment area. Examining the CO emission inventories and attainment demonstrations leads to several important conclusions.

- The on-road mobile source category is the largest contributor to total CO emissions however, it has decreased significantly. On-road vehicle CO emissions have been reduced by 31 percent from 1970 to 1994, while total emissions have declined by less (24 percent) over the same time period. On-road vehicles account for almost 90 percent of total CO emissions reduction.

- Most of the reductions in total CO emissions are attributable to the on-road mobile source category. There are slight increases in area and nonroad emissions, and almost no change in point source emissions.

- There are few control strategies proposed for point, area, and nonroad sources relative to the number of measures proposed for on-road sources. The on-road control measures that are most frequently included are the enhanced I&M and oxygenated fuels programs.

- As required by the CAAA, these CO nonattainment areas have proposed TCMs as contingency measures, although they may never be implemented. Areas appear to have selected politically feasible TCMs which do not restrict public choice.

Contributions to CO Emissions. Figure 1 compares the relative contributions to CO emissions by source category as reported by each nonattainment area, highlighting the contribution of on-road mobile sources. Despite the economic and geographic differences across the nonattainment areas analyzed, on-road mobile sources are estimated to contribute the majority of emissions -- at least two times more than the next highest source category in each of the ten regions. For the areas included in this study, on-road sources averaged 74 percent of CO emissions during a typical winter day, while nonroad sources averaged 13 percent, area sources 10 percent, and point sources 5 percent. The 1990 estimated emission levels reported in each emission inventory are provided in appendix A.

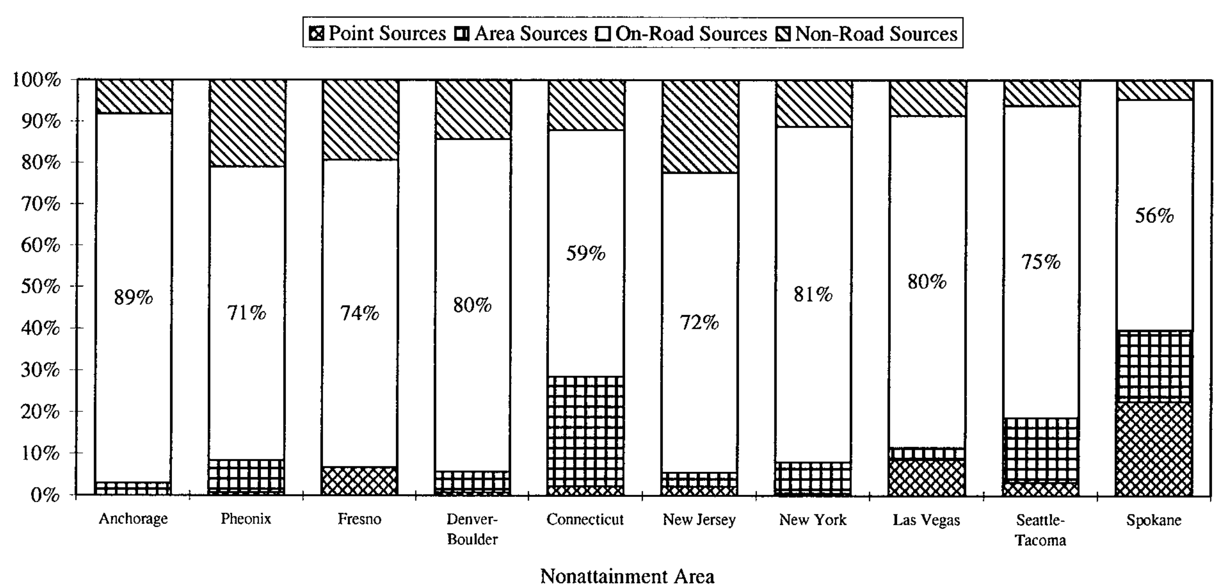

Figure 1. CO Nonattainment Area Emissions for 1990.
(Relative Contribution of On-Road Sources)

MOBILE Source CO Reductions. Table 8 shows the impacts of proposed controls on emissions reported in the four attainment demonstration plans for which data were available, including the New Jersey portion of the New York-New Jersey-Long Island area and the Las Vegas, Seattle-Tacoma, and Spokane nonattainment areas. In each SIP, CO reductions were reported by source, and were not disaggregated by individual strategies. As a result, it was not possible to compare the relative effectiveness of enhanced I&M and oxygenated fuels, for example, across the nonattainment areas. Yet, various conclusions can be drawn from the areas for which data were available.

Table 8. CO Reductions (by Source Category) in CO Nonattainment Areas: 1990-1995[6].

Nonattainment Area	State	Point	Area	On-Road	Nonroad	Total
NY NJ LI	NJ	8%	3%	-56%	0%	-40%
Las Vegas	NV	-83%	9%	-24%	12%	-26%
Seattle Tacoma	WA	0%	4%	-49%	4%	-36%
Spokane	WA	0%	3%	-52%	13%	-27%

Note: Negative denotes an emissions decrease.

Between the 1990 base year and the 1995 attainment year, the largest reduction of CO emissions occurs within the on-road mobile source category. Each of the four nonattainment areas shows an increase in area and nonroad emissions, reflecting the lack of controls being proposed for these sources, as well as increases in activity. Three of the nonattainment areas show no change or a slight increase in the quantity of emissions from point sources, with the exception of Las Vegas, where a proposed corrective action plan to reduce emissions from a single industrial plant (TIMET) is expected to decrease emissions from point sources by 83 percent.

Reductions in CO Compared to Base Year Inventories. Using data from four CO nonattainment areas, table 9 compares the percentage of 1990 base year CO emissions accounted for by each source category with the percentage of 1990-95 reductions in CO emissions it is expected to contribute.[7] As the table shows, three of the four areas project that on-road sources will contribute more toward expected 1990-95 reductions in CO emissions than to 1990 base year emissions.[8] In contrast, only one of the four areas anticipates that any of the remaining source

[6] 1990 emissions tabulated from attainment demonstrations may not match 1990 emissions from base year inventories (figure 1) due to revisions from subsequent documents. 3) The underlying data are available in appendix D.

[7] The percent CO reductions shown in table 9 exclude reductions from noncreditable programs, in contrast with the inferred reductions that are represented in table 8.

[8] The negative signs in table 9 indicate that some nonattainment areas project increases in CO emissions from the non-road and area source categories between 1990 and 1995.

categories — nonroad, point, or area sources — will contribute a larger share to total CO emissions reductions than to base year CO emissions. The exception is Las Vegas, where an expected plant closing causes the point source category's contribution to 1990-95 emissions reductions to be unusually large. On average, table 9 shows that the on-road mobile source category's contribution to expected CO emissions reductions exceeds its contribution to base year CO emissions by nearly 40 percent.

Table 9. Contributions of Individual Source Categories to 1990 CO Emissions and 1995 Reductions.

Nonattainment Area	On-Road Source Category			Non-Road Source Category			Point Source Category			Area Source Category		
	% Contribution to 1990 Emissions	% of 1990-95 Reductions	Ratio	% Contribution to 1990 Emissions	% of 1990-95 Reductions	Ratio	% Contribution to 1990 Emissions	% of 1990-95 Reductions	Ratio	% Contribution to 1990 Emissions	% of 1990-95 Reductions	Ratio
New Jersey	72%	101%	1.40	22%	0%	-0.01	2%	0%	-0.21	3%	0%	-0.07
Las Vegas	79%	71%	0.90	6%	-3%	-0.43	11%	33%	3.07	4%	-1%	-0.33
Seattle	75%	103%	1.36	6%	-1%	-0.11	3%	0%	0.00	15%	-2%	-0.12
Spokane	56%	104%	1.88	5%	-2%	-0.45	23%	0%	0.00	17%	-2%	-0.12
Average	71%	95%	1.38	10%	-1%	-0.25	10%	8%	0.72	10%	-1%	-0.16

Transportation-Related Control Strategies. Table 10 shows the frequency that specific transportation programs are proposed in each of the CO attainment demonstration SIPs. The most prevalent control measures are enhanced I&M and oxygenated fuels. Three of the ten SIPs analyzed (Spokane and the New Jersey and Connecticut portions of the New York-New Jersey-Long Island area) did not implement additional on-road measures beyond these two.[9] Additional proposed on-road control measures can be classified into two general groups: controls to reduce vehicle emission rates and controls to reduce vehicle utilization. New York has provisions for implementing California emission standards for new vehicles, while Alaska is implementing plans to reduce emissions through more stringent cold-temperature CO vehicle certification.[10] Fresno is instituting the following controls: parking management that includes supply limits and increased parking prices; an alternative fuel program for fleet operators; and a smoking vehicles program which strives to mitigate smoke emissions predominantly from heavy-duty diesel vehicles.

There are fewer control strategies being proposed for point, area, and nonroad sources relative to the number of measures proposed for on-road sources. In Fresno, Denver, Las Vegas, and the New York and New Jersey portions of the New York-New Jersey-Long Island nonattainment area, emission controls for point sources include new source review and indirect source permitting programs requiring reasonably or best available control technology. For nonroad source emissions, which are (on average) the second most significant contributor to CO emissions, only Nevada proposes emissions reduction strategies — specifically, policies and ordinances to encourage desert landscaping in an attempt to mitigate emissions from lawn and garden equipment. Controls targeting nonroad transportation sources (i.e., locomotives, aircraft, and marine vessels including pleasure craft) were not included in any attainment demonstration plans.

---

9 The available data did not include control strategy information for Phoenix, Arizona. This area is classified as moderate with a design value less than or equal to 12.7 ppm and is not required to demonstrate attainment.

10 New York is currently placing on hold the adoption of California emission standards due to concerns of the availability of technology to achieve the standards.

Table 10. Carbon Monoxide Control Strategies by Nonattainment Area.[11]

CONTROL MEASURE	AK	CA	CO[12]	CT	NV	NJ	NY	WA	WA
	Anchorage	Fresno	Denver/ Boulder	NY/ NJ/ LI	Las Vegas	NY/ NJ/ LI	NY/ NJ/ LI	Seattle/ Tacoma	Spokane
MEASURES TO REDUCE EMISSION RATES									
Road Construction/ Improvement					✓				
Traffic Flow Improvements		✓	✓		✓		✓		
Oxygenated Fuels Program	✓	✓	✓	✓	✓	✓	✓	✓	✓
Alternative Fueled Buses								✓	
FMVCP/Federal Tailpipe Standards	✓						✓		
California Emissions							✓		
Cold-Temperature CO Certification	✓								
Enhanced I/M[13]		✓	✓	✓	✓	✓	✓	✓	✓

[11] Data for Phoenix, Arizona were not available.

[12] TCMs are mandatory for Denver, Colorado.

[13] Guidance issues by EPA on 8/13/96 states that urban nonattainment areas are allowed to substitute hybrid I/M programs that produce equivilant emissions reductions as the enhanced I/M program.

	AK	CA	CO[12]	CT	NV	NJ	NY	WA	WA
CONTROL MEASURE	Anchorage	Fresno	Denver/ Boulder	NY/ NJ/ LI	Las Vegas	NY/ NJ/ LI	NY/ NJ/ LI	Seattle/ Tacoma	Spokane
Basic I/M	✓								
Alternative Fuels Program		✓							
Smoking/High Emitter Vehicles Program		✓			✓				
MEASURES TO REDUCE TRAVEL									
Parking Management		✓					✓	✓	
Programs for Improved Public Transit		✓	✓		✓			✓	
HOV Lanes			✓		✓				
Employer-Based Transportation Management		✓	✓						
Parking Facilities for HOVs or Transit Service		✓						✓	
Shared Ride Services	✓	✓							
Non-Motorized Vehicles or Pedestrian Rights of Way					✓				
Bike Lanes/Secure Facilities		✓						✓	

CONTROL MEASURE	AK Anchorage	CA Fresno	CO[12] Denver/ Boulder	CT NY/ NJ/ LI	NV Las Vegas	NJ NY/ NJ/ LI	NY NY/ NJ/ LI	WA Seattle/ Tacoma	WA Spokane
Employer Sponsored Flexible Work Schedules		✓							
Transportation Demand Management Program					✓				
Telecommuting		✓							

8 Data for Phoenix, Arizona were not available.

9 TCMs are mandatory for Denver, Colorado.

Proposed TCMs. Six CO attainment demonstrations, including Denver-Boulder (for which the program is mandatory), Anchorage, Fresno, Las Vegas, the New York portion of New York-New Jersey-Long Island, and Seattle, proposed TCMs as contingency measures, however, there is no indication in the SIPs that given areas will implement them (table 10). Areas appear to have selected politically feasible TCMs which are almost exclusively under the jurisdiction of State transportation planning agencies, rather than TCMs which restrict public choice such as trip reduction ordinances. Proposed measures address the transportation infrastructure or services that transportation agencies provide such as: HOV lanes, parking facilities, bike and pedestrian rights-of-way and facilities, traffic flow improvements, and programs for improved public transit or shared-ride services. Fresno and Denver-Boulder have also proposed a comprehensive employer-based transportation management program which addresses parking facilities, carpool and vanpool services, economic incentives, and pick-up and delivery schedules. Other controls being proposed include an unspecified transportation demand management program in Las Vegas, telecommuting in Fresno, and a plan to reduce the number of diesel buses in Seattle.

Spokane has not proposed TCMs, however its estimated total CO reduction is comparable to reductions being achieved in areas proposing mandated and additional transportation controls such as TCMs. This could indicate that TCMs may only contribute marginally to emission reductions, and may be best suited for mitigating increases in emissions attributable to VMT growth and increased tripmaking. As currently proposed, TCMs alone are unlikely to contribute significantly to large scale emission reductions from the base year.

3.3 OZONE NONATTAINMENT AREAS

Ozone, better known as smog, forms in the air from chemical reactions between emissions of VOC and NOx in the presence of sunlight. The diversity of sources emitting ozone precursors and the dependence on meteorological and environmental factors for its formation make controlling ozone a challenge.

This section begins with data and observations on the contributions of both ozone precursors to 1990 baseline emissions, however it follows with observations on reducing only VOC. The CAAA require nonattainment areas to demonstrate reasonable further progress in reducing VOC by 1996 in the 15% RFP plans, which were available for this analysis. NOx reductions can be substituted for VOC, in certain circumstances, in the ozone attainment demonstrations plans, which document estimated reductions after 1996. These plans were not available for the analysis.

There is a broader spectrum of control strategies adopted in the 15% RFP plans than in the CO and PM_{10} attainment demonstrations, since the sources of ozone precursors are more diverse and the contribution of each source to total emissions is more evenly distributed. In addition, unlike the CO and PM_{10} attainment demonstrations, these SIPs provide more substantial information related to the types of control measures that are being proposed, including their relative contributions to emissions reductions. Examining ten areas, classified as moderate or higher, leads to the following conclusions:

- VOC emissions are more evenly distributed across all source categories than are NOx, which are concentrated, on average, in the point and on-road source categories.

- Despite the even distribution among contributors, the majority of VOC reductions are expected to occur from the on-road source category. Smaller reductions are gained from the point, area, and nonroad source categories, with some nonattainment areas showing increases from nonroad sources.

- Reductions in on-road and point source categories are particularly large by comparison to their base year inventory. The area and nonroad source categories contribute, on average, less to reductions than to their base year contributions.

- On-road controls most frequently proposed are reformulated gasoline, I&M programs, and Stage II vapor recovery. These programs account for virtually all of the estimated reductions from the on-road source category.

- TCMs are more frequently relied upon for reducing VOC than CO, however they contribute very little to VOC reductions.

<u>Contributions to VOC and NOx Emissions.</u> Figures 2 and 3 provide graphical comparisons of VOC and NOx emissions across the ten ozone nonattainment areas. Biogenic sources of VOC are not included in this report because there are no regulatory requirements to reduce them. The underlying data, presented in appendix B, show that VOCs are more evenly distributed across point, area, on-road, and nonroad source categories, with each contributing from 16 to 34 percent of total VOC emissions, while NOx emissions appear to be concentrated in point (46 percent) and on-road (38 percent) source categories. The relative contribution of source categories to NOx emissions depends on the level of industrial activity within a region. For example, in areas characterized by heavy industry, such as Houston and Baton Rouge, the point source category is the major contributor of NOx, whereas the on-road source category is the major contributor in Providence and particularly in Atlanta, a region experiencing rapid population and job growth.

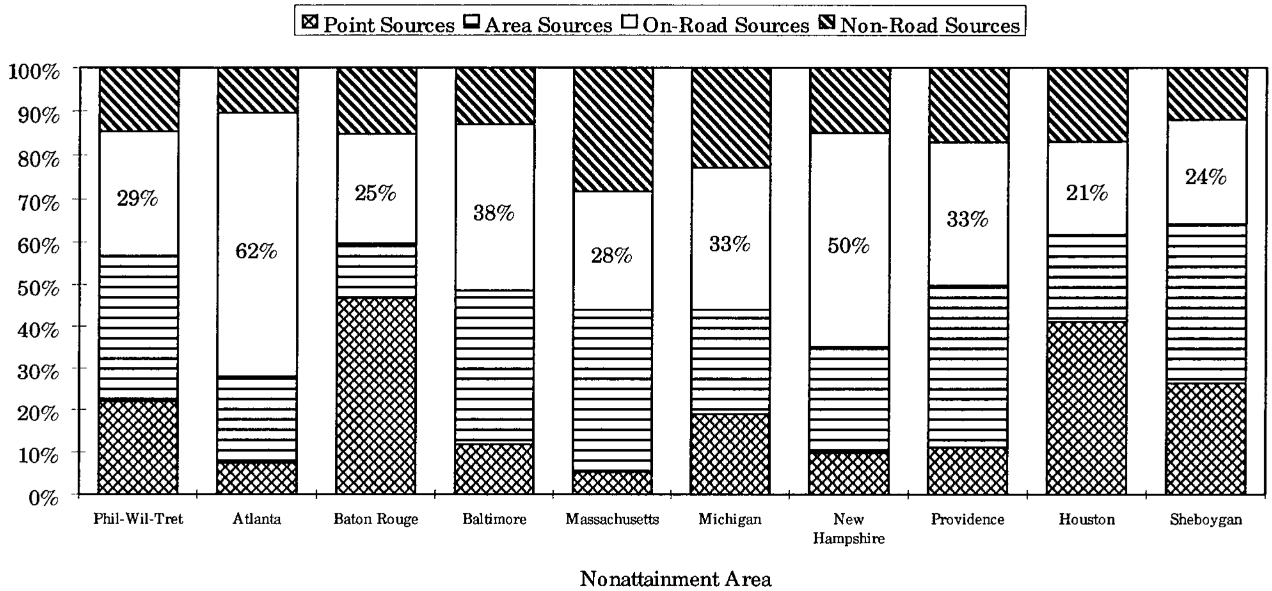

Figure 2. Ozone Nonattainment Area Emissions for 1990 (Relative Contribution of On-Road Sources to VOC Emissions).

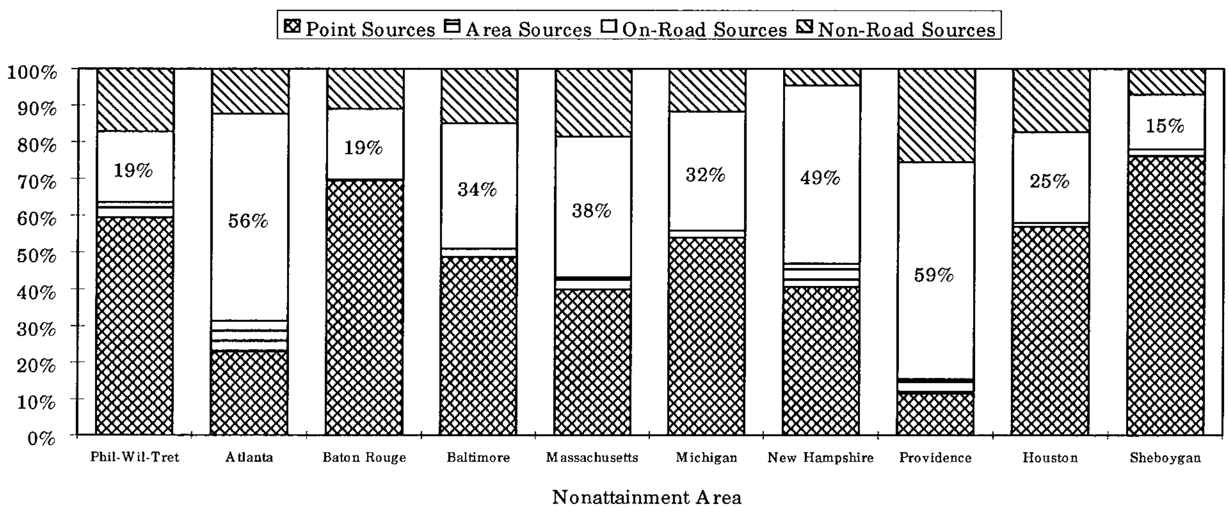

Figure 3. Ozone Nonattainment Area Emissions for 1990 (Relative Contribution of On-Road Sources to NOx Emissions).

MOBILE Source VOC Reductions. Table 11 shows the relative VOC reductions, by source category, reported in each 15% RFP plan. Unfortunately, data for Sheboygan were not available.[14] The emission

[14] In Sheboygan, control measures and associated reductions are aggregated across a 9-county area that contains nonattainment regions outside of Sheboygan.

reductions include all of the control measures that are accounted for by the states in their 15% RFP plans, including noncreditable reductions from the following programs: 1) Federal Motor Vehicle Control Program tailpipe or evaporative standards promulgated before 1990; 2) Federal regulations promulgated by November 15, 1990; 3) State regulations required to correct deficiencies in existing RACT regulations; and 4) previously required RACT rules.

As shown in table 11, although each source category contributes to the required VOC reductions, the largest reductions originate from the on-road source category. Most of the areas predicted a 50 percent or more reduction in on-road emissions, with the exception of the Delaware portion of the Philadelphia-Wilmington-Trenton area, the Portsmouth-Dover-Rochester area, and the Providence area, where on-road emissions are estimated to decrease by 23 percent, 42 percent, and 49 percent, respectively. Area source emissions are estimated to decrease from 6 to 20 percent. Point source emissions are also estimated to decrease in all areas from 12 to 46 percent, except in Muskegon, where they are projected to remain at 1990 levels. Nonroad sources contribute, on average, the least to VOC emission reductions. They are estimated to decrease by 13 and 9 percent in the Portsmouth-Dover-Rochester and Boston-Lawrence-Worcester areas respectively. However, in Baton Rouge and Muskegon, nonroad source emissions are estimated to remain at their base year levels, and the five remaining areas expect increases.

Table 11. VOC Reductions (by Source Category) in Ozone Nonattainment Areas: 1990-1996.[15]

Nonattainment Area	State	Point	Area	On-Road	Nonroad	Total
Atlanta	GA	-12%	-8%	-58%	5%	-36%
Baltimore	MD	-12%	-16%	-52%	11%	-26%
Baton Rouge	LA	-21%	-12%	-54%	0%	-25%
Philadelphia/Wilmington/Trenton	DE	-41%	-6%	-23%	4%	-17%
Providence	RI	-27%	-9%	-49%	6%	-23%
Boston/Lawrence/Worcester	MA	-20%	-18%	-54%	-9%	-25%
Muskegon	MI	0%	-12%	-64%	0%	-26%
Portsmouth/Dover/Rochester	NH	-46%	-20%	-42%	-13%	-32%
Houston Galveston	TX	-23%	-11%	-54%	0%	-23%

Note: Negative sign denotes a decrease in emissions.

<u>Reductions in VOCs Compared to Base Year Inventories.</u> Table 12 compares the percentage of 1990 base year VOC emissions accounted for by each source category with the percentage of state-sponsored

[15] Emissions include noncreditable reductions but do not include biogenic sources. 1990 emissions tabulated from the 15 percent VOC reduction plans may not match 1990 emissions reported in the emission inventory SIPs due to subsequent revisions in 1990 emissions inventories. Underlying data is available in appendix D.

1990-96 reductions in VOC it is expected to contribute.[16] All nine areas project that the on-road source category will contribute more toward expected reductions in 1990-96 VOC emissions than to 1990 base year emissions. Over half of the nonattainment areas for each of the point and area source categories project similar outcomes, while none of the areas anticipate the nonroad source category to contribute a larger share to 1990-96 VOC reductions than to 1990 base year emissions.

The 1990-96 VOC reductions are expected to exceed the 1990 base year emissions by an average of about 40 and 15 percent for the on-road and point source categories. However, average 1990-96 VOC reductions for the area and nonroad source categories are expected to be smaller than the 1990 base year emissions by about 5 and 85 percent, respectively.

[16]The percent VOC reductions shown in table 12 exclude reductions from noncreditable programs, in contrast with the inferred reductions that are represented in table 11.

Table 12. Contributions of Individual Source Categories to 1990 VOC Emissions and 1996 VOC Reductions.

	On-Road Source Category			Non-Road Source Category			Point Source Category			Area Source Category		
Nonattainment Area	% Contribution to 1990 Emissions	% of 1990-96 Reductions	Ratio	% Contribution to 1990 Emissions	% of 1990-96 Reductions	Ratio	% Contribution to 1990 Emissions	% of 1990-96 Reductions	Ratio	% Contribution to 1990 Emissions	% of 1990-96 Reductions	Ratio
Wilmington	29%	44%	1.5	14%	0%	0.0	22%	46%	2.0	35%	10%	0.3
Atlanta	59%	74%	1.3	13%	0%	0.0	8%	3%	0.4	20%	23%	1.1
Baton Rouge	25%	27%	1.1	16%	0%	0.0	46%	55%	1.2	13%	18%	1.4
Baltimore	38%	48%	1.3	13%	2%	0.1	12%	11%	0.9	37%	39%	1.1
Boston/Lawrence/Worcester	28%	53%	1.9	28%	15%	0.5	5%	5%	1.0	38%	27%	0.7
Muskegon	35%	61%	1.7	23%	0%	0.0	18%	10%	0.6	24%	29%	1.2
Portsmouth/Dover/Rochester	48%	50%	1.0	18%	2%	0.1	9%	15%	1.6	25%	33%	1.4
Providence	34%	51%	1.5	18%	3%	0.1	14%	23%	1.6	33%	23%	0.7
Houston	21%	31%	1.5	17%	6%	0.4	41%	45%	1.1	21%	18%	0.9
Average	**35%**	**49%**	**1.4**	**18%**	**3%**	**0.1**	**20%**	**24%**	**1.2**	**27%**	**24%**	**1.0**

Frequently Proposed Transportation Controls. Table 13 summarizes the transportation control strategies that are being proposed by each of the ten nonattainment areas.[17] Most areas are implementing the required motor vehicle emissions control programs such as reformulated gasoline, inspection and maintenance (I&M) programs, and Stage II vapor recovery.[18] Other proposed controls targeting on-road emissions include credits for Tier I of the Federal tailpipe standards included in the plans of five areas, a plan to implement the California low emissions vehicle program in the Boston-Lawrence-Worcester area, and a plan to deploy remote sensing to mitigate emissions from vehicles found to be super-emitters proposed by the Baton Rouge area. Tier I standards are explicitly modeled in only five areas, probably because it is technically difficult to model this standard.

The most prevalent strategy proposed to control emissions from nonroad sources is the reformulated gasoline program, since most nonroad vehicles and equipment (not including locomotives and large marine vessels) are powered by gasoline. Reformulated gasoline for this purpose is being proposed by Boston-Lawrence-Worcester, Portsmouth-Dover-Rochester, Providence, Houston-Galveston, and Sheboygan. The Boston-Lawrence-Worcester area is also proposing a maintenance program for recreational vessels and Stage II vapor recovery at marinas. Other than the impact of reformulated gasoline on recreational vessels, no area is proposing specific measures for controlling emissions from locomotives, aircraft, and marine vessels.

Since on-road mobile sources account for the majority of VOC reductions between 1990 and 1996, a more detailed analysis of the contributions of specific measures is warranted. Table 14 tabulates the emission reduction estimates from proposed control measures by nonattainment areas for on-road sources. Despite differences in the way that data are reported by nonattainment area, the data show that mandated requirements are expected to contribute 80 to 100 percent of the estimated VOC reductions

---

[17]The control measures listed do not represent all of the mitigation strategies adopted by the States, nor do they represent all of the controls required by the 1990 Amendments. In addition to showing progress toward meeting the NAAQS, States also had to submit attainment demonstrations by November of 1994 for ozone. Control measures included in ozone attainment demonstrations may differ in substance and quantity to those that are proposed in 15% RFP plans.

[18] The EPA is reexamining the requirements of the I&M program following complaints from States. It may require time to create substitute I&M programs, however future programs should continue to contribute to reductions of on-road sources.

from on-road sources. The reductions are particularly large from the enhanced I&M, reformulated gasoline, and Stage II vapor recovery programs.

Table 13. Proposed Ozone Control Strategies by Nonattainment Area.

CONTROL MEASURES	DE Phila./ Wilm./ Trenton	GA Atlanta	LA Baton Rouge	MD Balti-more	MA Boston/ Lawrence/ Worcester	MI Muskegon	NH Portsmouth/ Dover/ Rochester	RI Provi-dence	TX Houston/ Galveston	WI Sheboygan
MEASURES TO REDUCE EMISSION RATES OF ON-ROAD SOURCES										
Reformulated Gasoline	✓	✓	✓	✓	✓		✓	✓	✓	✓
Tier I Federal Vehicle Standards	✓			✓			✓	✓		✓
Enhanced I/M[19]	✓	✓	✓		✓		✓	✓	✓	✓
Basic I/M						✓				
Stage I/II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
California Low Emission Vehicle Program					✓					
Remote Sensing			✓							
MEASURES TO REDUCE TRAVEL										
Programs for Improved Public Transit		✓				✓			✓	
HOV Lanes		✓							✓	
Employer-Based Transportation Management									✓	✓
Traffic Flow Improvements/IVHS/ATMS		✓				✓			✓	
Parking Facilities for HOVs or Transit Service		✓							✓	
Programs to Restrict Vehicle Use										
Shared Ride Services		✓				✓			✓	
Non-Motorized Vehicles/Pedestrian Rights of Way		✓								
Bike Lanes/Secure Facilities		✓								
Removal from Marketplace of Pre-'80 LDV/LDT						✓				

[19] Guidance issues by EPA on 8/13/96 states that urban nonattainment areas are allowed to substitute hybrid I/M programs that produce equivilant emissions reductions as the enhanced I/M program.

CONTROL MEASURES	DE Phila./ Wilm./ Trenton	GA Atlanta	LA Baton Rouge	MD Balti-more	MA Boston/ Lawrence/ Worcester	MI Muskegon	NH Portsmouth/ Dover/ Rochester	RI Provi-dence	TX Houston/ Galveston	WI Sheboygan
MEASURES TO REDUCE EMISSION RATES OF OFF-ROAD SOURCES										
Reformulated Gasoline on Off-Road Engines					✓		✓	✓	✓	✓
Maintenance Program for Recreational Vessels					✓					
Stage II Vapor Recovery at Marinas					✓					

Table 14. Creditable Reductions in On-Road Mobile Source VOC Emissions
Tons per Day Reductions
(% of Total On-Road Mobile Source Reductions).[1]

CONTROL MEASURES	Nonattainment Area							
	DE	LA	MD	MA	MI	NH	RI	TX
	Wilmington	Baton Rouge	Baltimore	Boston	Muskegon	Portsmouth	Providence	Houston
CAAA REQUIRED MEASURES								
Tier I			1.2	✓			0.2	1.5
% of Total			3%				1%	2%
Stage I					0.4			
% of Total					10%			
Stage II VRS/Onboard	0.9	3.5	7.4		0.6	2.9	3.3	16.9
% of Total	6%	34%	20%		15%	37%	14%	23%
Basic I&M					2.8			
% of Total					70%			
Enhanced I&M	✓		16.8	✓			14.3	34.5
% of Total			45%				61%	47%
Reformulated Gasoline	✓		11.8	✓			5.5	19.3
% of Total			32%				24%	26%
I&M, Reform, Tier 1						4.9		
% of Total						63%		
Enhanced I&M & CAAA Mandates		4.8						
% of Total		47%						
Subtotal: Required Measures	**14.9**	**8.3**	**37.2**	**N/A**	**3.8**	**7.8**	**23.3**	**72.2**
% of Total	**100%**	**81%**	**100%**	**N/A**	**95%**	**100%**	**100%**	**98%**

CONTROL MEASURES	Nonattainment Area							
	DE	LA	MD	MA	MI	NH	RI	TX
	Wilmington	Baton Rouge	Baltimore	Boston	Muskegon	Portsmouth	Providence	Houston
OPTIONAL MEASURES								
California LEV				✓				
% of Total								
TCMs					0.2			1.9
% of Total					5%			3%
Remote Sensing		2.0						
% of Total		19%						
Subtotal: Optional Measures		**2.0**		**N/A**	**0.2**			**1.9**
% of Total	**0%**	**19%**	**0%**	**N/A**	**5%**	**0%**	**0%**	**3%**
TOTAL	**14.9**	**10.3**	**37.2**	**100.0**	**4.0**	**7.8**	**23.3**	**74.0**

[1] A checkmark indicates that control measures are included in the SIP, however individual reductions are not available.

Transportation Control Measures. Table 13 lists the transportation control measures (TCMs) that are proposed in the 15% RFP SIPs. The heavier reliance on TCMs to control VOC emissions results from States' emphasis on motor vehicles as a source of VOC emission reductions, together with the fact that most technological measures available to reduce VOC emission rates have been implemented.

Four of the ten ozone nonattainment areas included in this analysis are implementing at least one type of TCM. Rideshare programs and plans to improve public transit are being proposed by Atlanta, Houston-Galveston, and Muskegon (which is proposing a bus replacement program). Atlanta and Houston-Galveston are proposing plans to build/expand networks of HOV lanes and parking facilities for HOVs. The Houston-Galveston and Sheboygan areas are also proposing to implement an employer-based transportation management program.

Several areas are proposing specific traffic flow improvements. For example, Muskegon plans to upgrade the signalization system and to implement a reverse commute demonstration program; Atlanta is developing an Advanced Traffic/Incident Management program. Specific detail on traffic flow improvements being proposed by the Houston-Galveston area were not provided. Other types of TCMs being proposed include the vehicle scrappage program in Muskegon, as well as pedestrian rights-of-way and bike facility projects in Atlanta.

Atlanta, Muskegon, Sheboygan, and Houston-Galveston have committed to implementing one or more transportation control measures in their 15% RFP plans. Table 15 lists the TCMs and the estimated contribution to VOC emissions reductions.

Table 15. VOC Reductions of Committed TCMs: 1990-1996 (Tons per Day).

Nonattainment Area	Total VOC Emissions	On-Road VOC Emissions
Atlanta, Georgia	3%	4%
Bike and Pedestrian Facilities Traffic Signal System Optimization Park-and-Ride Lots Transit Improvements HOV Lanes Regional Rideshare Program ATMS/Incident Management Program		
Muskegon, Michigan	2	3
Bus Replacement Rideshare Program Reverse Commute Demonstration Program Area Signal System Upgrade		
Houston, Texas	0	0
HOV Lanes Traffic Flow Improvement Park-and-Ride Lots Transit Improvements Area-Wide Rideshare IVHS		
Sheboygan, Wisconsin	4	6
Employee Commute Options		

Although these TCMs are part of each area's strategy to reduce VOC emissions, they contribute only marginally to total projected VOC reductions. The bulk of the emissions reductions are obtained from other control strategies. It appears that emissions reductions from TCMs that may have already been adopted for reasons other than improving air quality are being included to ensure that necessary emission increases from growth in VMT are mitigated. This supports the notion that TCMs are not being proposed as measures that will substantially impact the base year emissions inventory.

Cost-effectiveness is an important issue to consider when evaluating the relative effectiveness of TCMs to other control strategies. Unfortunately, cost figures were not provided in the CO attainment demonstrations and 15% RFP plans that were reviewed for this study. Yet, cost-effectiveness analyses are extremely important to ensure that control strategies are actually contributing significantly to emissions reductions.

The following TCM costs and emission reductions were proposed in Atlanta's transportation implementation plan (TIP):

Table 16. TCM Costs and VOC Reductions in Atlanta.

Transportation Control Measure	Annual & Capital Costs	Estimated VOC Reductions (TPD)	Estimated Cost Effectiveness ($/TPD)
Bike/Pedestrian Facilities	$36,810,000	.025	$4,034,000
Traffic Signal System Optimization	$17,312,000	2.29	$21,000
Park & Ride Lot	$600,000	.004	$412,000
Transit Improvement	$9,948,000	.115	$237,000
HOV Lanes	$16,221,000	0.06	$741,000
Regional Rideshare Program	$3,150,000	0.26	$33,000
ATMS/Incident Management Program	$18,400,000	0.93	$54,000
Total	$102,442,000	3.684	$76,000

Cost-effectiveness was calculated by translating annual and capital costs to a daily basis and dividing by the estimated tons per day reductions. These data show traffic flow and rideshare programs to be significantly more cost-effective than other TCMs. Measures to promote non-motorized transport, such as bicycling and walking, are comparatively expensive relative to their contribution to emission reductions.

3.4 PARTICULATE MATTER NONATTAINMENT AREAS

Particulate matter (PM_{10}) includes dust, soot, liquid droplets, and particles formed in the atmosphere by gases such as sulfur dioxide and volatile organic compounds. Six areas that are in violation of the EPA's emission standard for PM_{10} have been selected to examine contributions by source. Although more emission inventory SIPs were available, selection was limited to those that provided sufficient detail on fugitive dust from paved and unpaved roads. Although the expected reductions in PM_{10} emissions were not available in the attainment demonstration SIPs used for this analysis, control measures were available in nine of them.

Many of the PM_{10} emissions inventories reviewed give a detailed description of the topography and meteorology of the nonattainment area because of the strong influence of these factors on regional air quality and corresponding violations of the NAAQS for PM_{10}. Areas in basins and valleys are more susceptible to temperature-inversion-induced exceedances. For instance, areas such as La Grande and Ada County have total PM_{10} emissions well below that of other areas but were nonetheless designated to be in nonattainment of the national standards. This suggests that the same level of emissions in a more topographically benign environment may not exceed the PM_{10} air quality standard.

To examine the emissions data for this analysis, it was necessary to re-apportion some sources grouped in one category to another in order to make consistent comparisons across nonattainment areas. Based on this reclassification, fugitive road dust from unpaved roads and street sweeping has been placed in the area source category, while fugitive dust from paved roads has been placed in the on-road mobile source category.

Examining the PM_{10} emission inventories and attainment demonstrations SIPs leads to these conclusions:

- Based on the classification of dust from paved and unpaved roads as described above, area and on-road sources are the largest contributors to PM_{10}.

- Proposed strategies to reduce emissions include residential space heating, and fugitive dust from paved and unpaved roads.

<u>Contributions to PM_{10} Emissions.</u> Figure 4 summarizes the contribution to PM_{10} emissions by source that were reported in six SIPs, highlighting the relative contribution of on-road sources. Area and on-road mobile sources average 37 and 54 percent of total PM_{10}. The largest sources of emissions are residential space heating, and fugitive dust from paved and, to a lesser extent, unpaved roads. The nonattainment areas are described in more detail in appendix C.

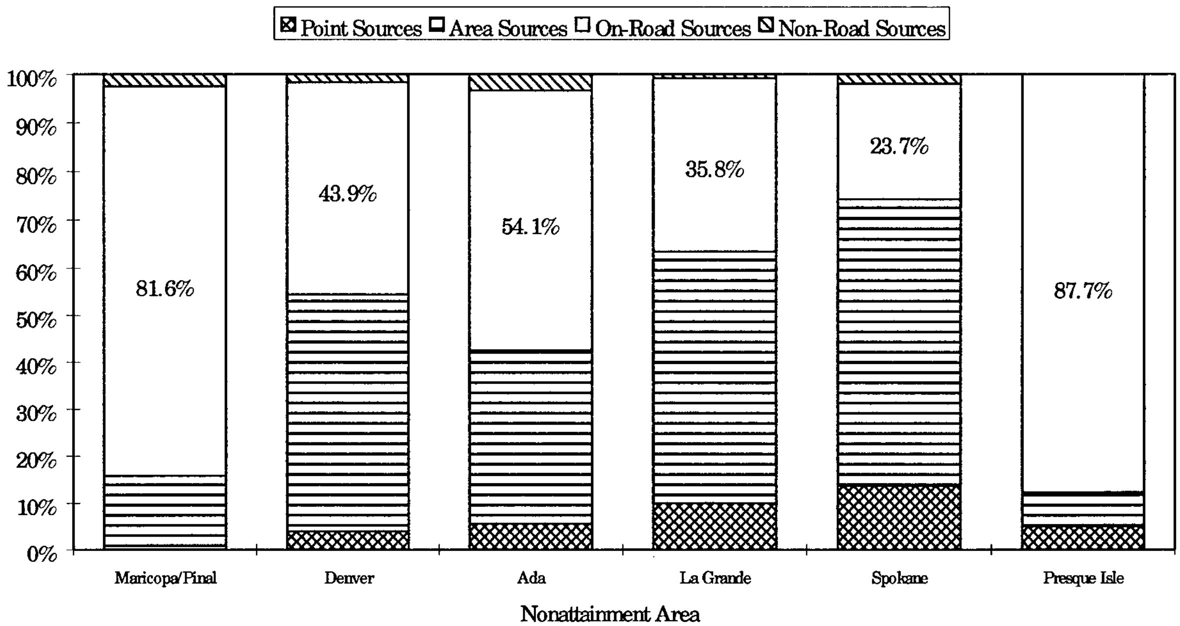

Figure 4. PM_{10} Nonattainment Area Emissions for 1990 (Relative Contribution of On-Road Sources).

Control strategies to reduce PM_{10}. Table 17 lists the control strategies proposed in nine attainment demonstration SIPs to reduce PM_{10} emissions. Proposed control strategies generally strive to reduce emissions from residential space heating (not shown), re-entrained dust from paved roads, and fugitive dust from unpaved roads. Space heating strategies include activity curtailments, activity restrictions, and public information programs. Control programs for fugitive and re-entrained dust mainly include paving and sweeping programs. Only the Denver area elected to use TCMs for reducing PM_{10} emissions. This is probably due to the fact that the area is also in nonattainment for carbon monoxide and ozone, and already relies on TCMs to address the CAAA requirements for those pollutants.

Table 17. PM_{10} Control Strategies.

CONTROL MEASURES	AZ Phoenix	CO Denver/ Boulder/ Longmont	ID Boise-Ada County	MT Missoula	NM Anthony	OR La Grande	UT Salt Lake City	WA Spokane	WY Sheridan
MEASURES TO REDUCE FUGITIVE DUST FROM UNPAVED ROADS									
Pave Roads, Alleys, and Parking Lots	✓				✓	✓		✓	
Pave Driveways and Curbing	✓					✓			
Prohibition of Unpaved Haul Roads/Parking/Staging Areas	✓								
Traffic Reduction Plans	✓								
MEASURES TO REDUCE FUGITIVE DUST FROM PAVED ROADS									
Sanding & Cleaning Material Specifications/Guidelines	✓	✓		✓			✓		✓
Liquid De-Icer Requirement				✓					
Frequent Sweeping	✓	✓		✓				✓	✓
Local Management Plans		✓			✓				
MEASURES TO REDUCE EMISSION RATES									
Oxygenated & Diesel Fuels Program/Standards		✓							
Urban Bus Program		✓							
Federal Tailpipe Standards				✓					
Enhanced I/M		✓							
Prohibition on Sale of New Diesel Vehicles	✓								
Requirement for Use of Clean-Burning Diesel Fuel	✓								
Diesel I/M Program		✓					✓		

CONTROL MEASURES	AZ Phoenix	CO Denver/ Boulder/ Longmont	ID Boise- Ada County	MT Missoula	NM Anthony	OR La Grande	UT Salt Lake City	WA Spokane	WY Sheridan
MEASURES TO REDUCE TRAVEL									
Programs for Improved Public Transit		✓							
HOV Lanes		✓							
Employer-Based Transportation Management		✓							
Shared Ride Services		✓							
Bike Lanes/Secure Facilities		✓							
Construction of Non-Motorized/Pedestrian Paths		✓							
REQUIREMENT FOR TRUCK COVERS									
Cover or Treat Particulate Material During Transport	✓				✓				
MEASURES TO REDUCE UTILIZATION OF OFF - ROAD ENGINES									
Restrict Use of Motorized Vehicles for Off - Road Purposes	✓								
Restrict Use of Blowers for Landscaping Maintenance	✓								

1) Data for California were not available.

3.5 SUMMARY OF 1990 CO, O_3, AND PM_{10} LEVELS AND EMISSIONS REDUCTIONS

The data gathered from these SIPs show that, although the on-road transportation source category contributes significantly to CO and somewhat less to VOC emissions, it is the source that is expected to contribute the most to the reduction of these emissions. The other source categories are responsible for varying amounts of emissions. Point and area sources are significant contributors to VOC and NOx emissions and they are expected to decline in the future, however not by the same volume as the on-road mobile source category.

Because on-road sources in CO emission inventories are estimated to contribute 56 to 89 percent of total CO emissions, there is a focus on mobile source control measures in the CO attainment demonstrations. Of four nonattainment areas with available data, the largest portion of CO emission reductions comes from on-road sources. Each area showed no change or a slight increase in the quantity of emissions from point, area, and nonroad emissions, reflecting the lack of controls being proposed for these sources as well as increases in activity.

Contributions of O_3 precursors, volatile organic compounds (VOC) and nitrous oxides (NOx) are more evenly distributed among sources than are CO and PM_{10}. NOx emissions, however, appear to be emitted largely from the point and on-road source categories. The largest portion of the VOC reduction originates from measures to control emissions from the on-road source category. In fact, this category contributes to reductions in VOC emissions far in excess of its contribution to base year emissions. Mandated on-road requirements, including enhanced inspection and maintenance, reformulated gasoline, and Stage II vapor recovery account for most, if not all, of the estimated VOC reductions from on-road sources. Emissions from area and point sources are decreasing in almost all ozone nonattainment areas included in the study. The nonroad source category contributes the least to VOC emission reductions. Although nonroad sources contribute to VOC and NOx emissions, control measures for these sources are consistently overlooked. According to the EPA, however, nonroad emission standards that have been promulgated or are being promulgated will achieve most of their emission reduction benefits in the year 2000.

According to this report's definition of source categories for PM_{10} emissions, dust from paved roads is designated as a mobile source and dust from unpaved roads as an area source. Under this framework, area and mobile sources are major contributors to PM_{10}. Road dust from paved and unpaved roads are large components, however, there is no consistency from one area to the next as to how these should be classified.

Areas in nonattainment of both the PM_{10} and/or ozone and carbon monoxide NAAQS include TCMs as part of their PM_{10} control plan — although they are probably implemented to resolve problems associated with ozone and/or CO.

Finally, areas appear to select politically acceptable TCMs that do not restrict public choice. Transportation control measures contribute only marginally to emissions reductions and appear to be included only where they have been previously adopted for reasons unrelated to air quality (rather than because of their potential to offset increases in emissions from expected VMT growth.)

4. DETAILED ANALYSIS OF MOTOR VEHICLE AND OTHER TRANSPORTATION EMISSIONS

4.1 BACKGROUND

The contribution of transportation activities to air pollution is an ongoing concern to policy makers who design strategies to improve air quality without sacrificing the mobility and economic benefits that transportation provides. As shown in section 3, on-road mobile sources are the largest contributors to CO emissions and they also contribute to ozone precursors.

This section describes the contribution of transportation sources (on-road and nonroad) to CO, VOC, and NOx emissions in a subset of the nonattainment areas that have been reviewed in section 3, and discusses the factors that influence on-road motor vehicle emission levels. The following areas were chosen solely on the basis of data availability: 1) the Denver-Boulder CO nonattainment area; 2) the Seattle-Tacoma CO nonattainment area; 3) the Providence ozone nonattainment area; and 4) the Sheboygan ozone nonattainment area. Carbon monoxide data was available from the SIPs of all four nonattainment areas, since summer season CO levels are estimated in the 15% RFP SIPs.[20]

Section 4.2 discusses the contribution of transportation sources (on-road and nonroad) to emissions. Section 4.3 discusses the relationships between on-road vehicle emissions and travel by time-of-day and road type and, and discusses the relative contributions of specific vehicles types to total VMT and on-road vehicle emissions. Appendix E presents the data that support these subsections.

4.2 EMISSIONS FROM TRANSPORTATION ACTIVITIES

The on-road mobile source category includes virtually all types of motor vehicles that operate on highways and roads, and that provide for the transport of both passengers and freight.[21] In

---

[20]Carbon monoxide emissions are normally estimated during the winter months, because both CO emission rates and ambient CO concentrations tend to be higher at colder temperatures. Conversely, ozone precursors, including CO, reported in ozone SIPs are estimated during the hottest months of the year, since higher temperatures are generally more conducive to the formation of ozone.

[21]This definition includes: 1) passenger cars, usually referred to as light-duty gasoline and/or diesel vehicles; 2) pick-up trucks, often broken down into a) light duty gasoline trucks up to 6,000 pounds of gross vehicle weight (GVW), b) light duty gasoline trucks between 6,001 and 8,500 GVW, and c) light duty diesel trucks up to 8,500 GVW; 3) trucks and buses, broken down into heavy duty gasoline vehicles rated at GVWs above 8,500 pounds and heavy duty diesel vehicles rated above 8,500 GVW; and 4) motorcycles.

addition to on-road sources, locomotives, airplanes, and watercraft (marine vessels and pleasure craft), which are classified in the nonroad source category, are included in this section in order to accurately characterize the contribution of transportation activities to air pollution problems in regions across the country.[22] Examining the SIPs of four nonattainment areas leads to several important conclusions:

- On-road motor vehicles contribute virtually all transportation-related emissions of CO and NOx and about four-fifths of transportation-related VOC emissions (the remaining one-fifth is generated by non-road vehicles).

- Passenger vehicles (autos and light trucks) contribute most of the CO and VOC emissions generated by on-road motor vehicles, while diesel trucks and buses contribute a significant share of on-road motor vehicles' NOx emissions. Among non-road vehicles, watercraft are the largest contributor of CO and VOC emissions.

- On-road motor vehicle emissions vary across nonattainment areas in response to differences in both vehicle miles traveled (VMT) and emission rates.

<u>Contribution of On-Road and Non-Road Vehicles to Emissions.</u> Table 18 illustrates the contributions of transportation sources (i.e., on-road and nonroad) to total emissions. Transportation activities are significant contributors to CO emissions, ranging from 67 to 81 percent. Most of these contributions are attributable to on-road sources. Nonroad transportation sources (i.e., locomotives, aircraft, and watercraft) contribute relatively insignificant amounts to CO emissions in Denver-Boulder and Seattle/Tacoma, where CO levels were estimated during the winter season, and somewhat more significant amounts to CO emissions in Providence and Sheboygan, where CO levels were estimated during the summer season. The higher contributions of nonroad transportation sources to CO emissions during summer months may be attributable to differences in boating activity between the summer and winter seasons.

Transportation sources also contribute to total VOC and NOx emissions, although, as demonstrated in section 3.3, the on-road mobile source contribution can vary depending on the level of industrial activity in the region. The transportation sector accounts for 40 percent of VOC emissions in Providence and almost 30 percent in Sheboygan. There is more variability for

---

[22]Locomotives, airplanes, and watercraft are a subset of the nonroad source category, which also includes lawn and garden, industrial, construction, recreational, commercial, and agricultural equipment.

NOx emissions in this small sample, with transportation contributing 62 percent in Providence and 16 percent in Sheboygan. As with CO, on-road motor vehicles account for the bulk of transportation's contribution to VOC and NOx.

Table 18. Contribution of Transportation to Total Emissions in Select CO and Ozone Nonattainment Areas.

		Contribution to Total Emissions		
Pollutant	**Nonattainment Area**	**Transportation**	**On-Road Vehicles**	**Nonroad Vehicles[23]**
Carbon Monoxide				
CO	Denver-Boulder (Winter Season)	81%	80%	1%
CO	Seattle-Tacoma (Winter Season)	77%	75%	2%
CO	Providence (Summer Season)	76%	72%	5%
CO	Sheboygan (Summer Season)	67%	61%	5%
Volatile Organic Compounds				
VOC	Providence	40%	33%	7%
VOC	Sheboygan	29%	24%	5%
Nitrogen Oxides				
NOx	Providence	62%	59%	3%
NOx	Sheboygan	16%	15%	1%

Note: Numbers may not add due to rounding.

Contribution by Vehicle Type. Emissions contributions by on-road sources and the transportation subset of nonroad sources that are depicted in figures 5 and 6 show, for each of the four nonattainment areas, the relative contributions of each mode to total emissions.

As shown in figure 5, passenger cars are responsible for the bulk of CO emissions in each of the four areas. In Denver-Boulder, they contribute over 50 percent to CO emissions and in the Seattle-Tacoma area, they contribute almost twice the number of CO emissions of any other transportation mode. In Providence, where summer season CO emissions were available,

[23]Includes locomotives, airplanes, and watercraft.

passenger cars contribute approximately five times more to total CO emissions than any other mode.

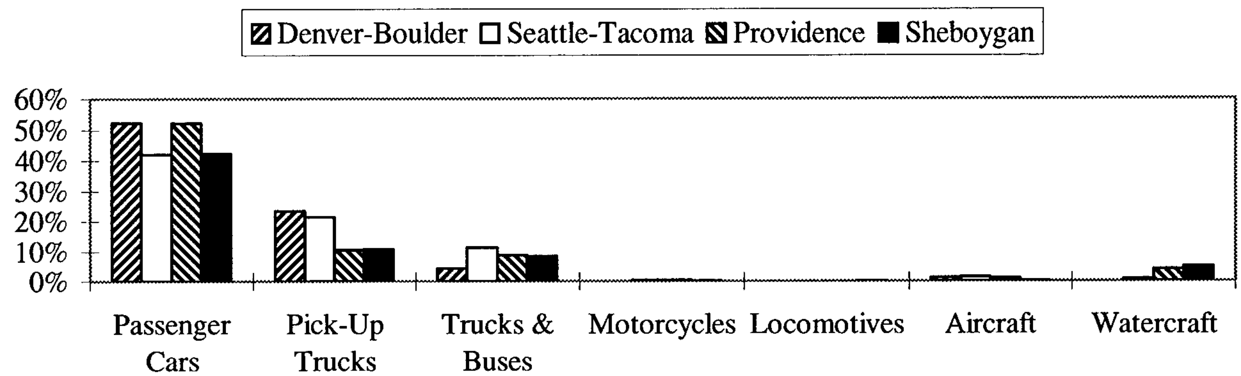

Figure 5. CO Emissions by Transportation Mode (as a % of total emissions).

The contribution of transportation modes to VOC emissions in Providence and Sheboygan is shown in figure 6. All classifications of on-road motor vehicles contribute less to VOC than to CO. The contribution of nonroad sources (especially watercraft) to VOC is higher than corresponding contributions to CO. Unlike on-road motor vehicles, the engines that power boats do not currently have emission control technologies such as catalytic converters. In the future, large emission reductions are possible from these types of transportation modes since Federal emission standards are forthcoming to control them.

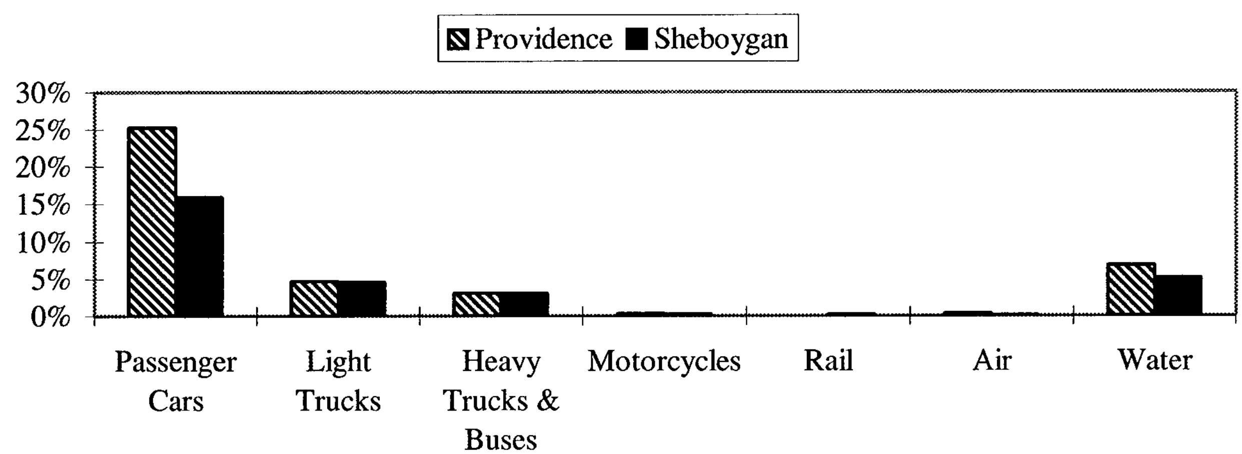

Figure 6. VOC Emissions by Transportation Mode (as a % of total emissions).

As shown in figure 7, heavy-duty trucks and buses are a major source of NOx emissions in Providence and Sheboygan. In Providence, trucks and buses account for over 20 percent of total NOx emissions, while heavy-duty trucks and buses operating in Sheboygan account for over 10 percent of transportation-related NOx.

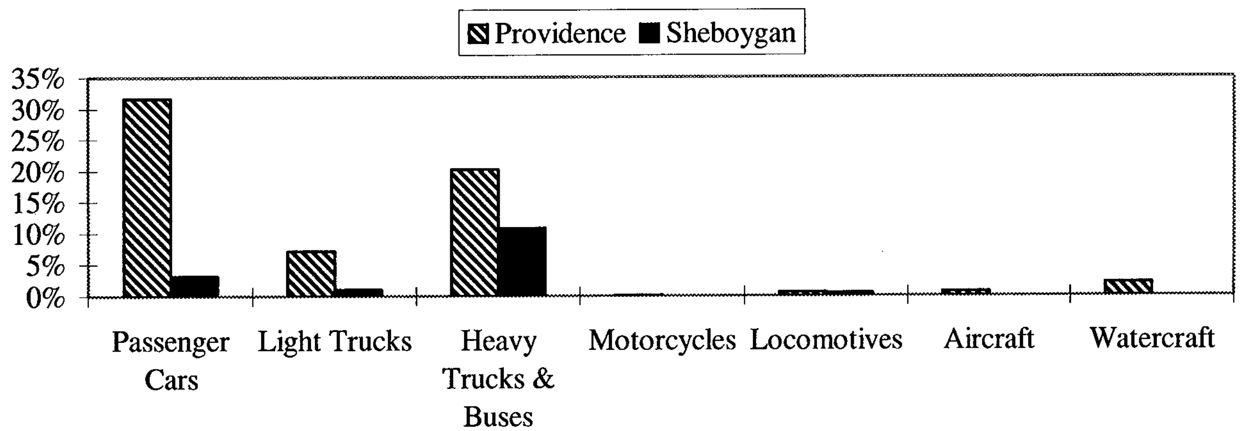

Figure 7. NOx Emissions by Transportation Mode (as a % of total emissions).

Table 19 presents emissions and VMT levels in the four nonattainment areas. Sheboygan has lower levels of total CO emissions (10 times lower) and VMT (17 times lower) than Providence. Likewise, total CO emissions in Denver-Boulder are roughly 50 percent lower than in Seattle-Tacoma, while the number of daily vehicle miles traveled in Denver-Boulder are lower in Seattle-Tacoma by roughly 30 percent.[24]

[24]CO emissions for Sheboygan and Providence are compared since the emissions data from both regions was extracted from the 15% RFP SIPs, which measure summer season CO. Likewise, CO emissions for Denver and Seattle-Tacoma were compared since these data were estimated for the winter season.

Table 19. Summary of Emissions and VMT for Select CO and Ozone Nonattainment Areas.

Nonattainment Area	Emissions (tons/day)	VMT (million miles/day)	Emission Rate (grams/mile)
Carbon Monoxide			
Denver Boulder (Winter Season)	1,095	40	25.17
Seattle Tacoma (Winter Season)	1,578	51	27.87
Providence (Summer Season)	516	27	17.60
Sheboygan (Summer Season)	52	2	30.35
Volatile Organic Compounds			
Providence	62	27	2.13
Sheboygan	6	2	3.53
Oxides of Nitrogen			
Providence	58	27	1.98
Sheboygan	11	2	6.43

4.3 EMISSIONS AND VMT BY TIME-OF-DAY, ROAD CLASS, AND VEHICLE TYPE

Motor vehicle emissions (specifically tailpipe emissions) are generally a function of the speed and grade at which the vehicle is operating, which affects the vehicle's emission rate, and the number of miles that the vehicle is driven during a specified time frame. Speed, temperature, and operating mode are functions of the type of roadway on which the given vehicle is operating and the specified time frame. As a result, emissions are expected to differ by the time-of-day and by the type of roadway. Reviewing a limited amount of data reported in SIPs shows that:

- CO emission rates do not appear to differ substantially between peak and off-peak periods, at least in the two nonattainment areas where this comparison can be made.

- Although higher travel speeds on freeways and arterials results in lower emissions rates, these facilities carry such large shares of total VMT that they account for the largest share of emissions.

- While most vehicle classes contribute similar shares of VMT and on-road emissions, the NOx emissions rates of heavy-duty diesel vehicles (trucks and buses) are so high that they account for a larger share of on-road NOx emissions than of total VMT.

Peak Versus Off-Peak CO Emissions. Ordinarily, the slower travel speeds associated with the peak travel period would be expected to result in higher emission rates during the peak period rather than the off-peak. However, table 20 shows that this is not the case for CO data provided by Denver-Boulder and Seattle-Tacoma nonattainment areas.

The small differences between peak and off-peak emission rates in the Denver-Boulder and Seattle-Tacoma areas may suggest that the effect of congestion on average speed and emissions is not being fully captured in emissions modeling. The use of extended peak periods (typically 6:00 to 9:00 AM and 3:00 to 6:00 PM), which include some hours when travel conditions are generally not heavily congested, may result in similar average speeds for peak and off-peak travel. Coupled with the "flatness" of emissions versus speed relationships over a wide range of speeds, this produces very similar emission rates during peak and off-peak periods.

Table 20. Summary of CO Emissions and VMT for the Denver-Boulder and Seattle-Tacoma Areas.

CO Nonattainment Area	On-Road Emissions (TPD)		VMT (Millions/Day)		Average Emission Rate (lb./mile)	
	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Denver-Boulder	438	657	15	25	0.059	0.053
Seattle-Tacoma	537	1,041	16	35	0.067	0.059

Emissions by Road Class. Figures 8 through 10 depict the relative accumulations of VMT and emissions by road class for Denver-Boulder, Seattle-Tacoma, and Providence, respectively.[25] In Denver-Boulder and Seattle-Tacoma, freeways and arterials each account for a larger share of VMT than of on-road emissions. While higher average speeds on arterials and freeways result in lower vehicle emission rates, the shares of VMT carried by these facilities are generally so large that they account for the bulk of on-road emissions. In Providence, however, high emission rates associated with unusually low arterial travel speeds result in contributions to total emissions exceeding the share of VMT carried by arterials.

---

[25]Emissions and VMT data by road class were not available for Sheboygan.

Figures 8 -10
Comparison Of VMT and Emissions by Road Type

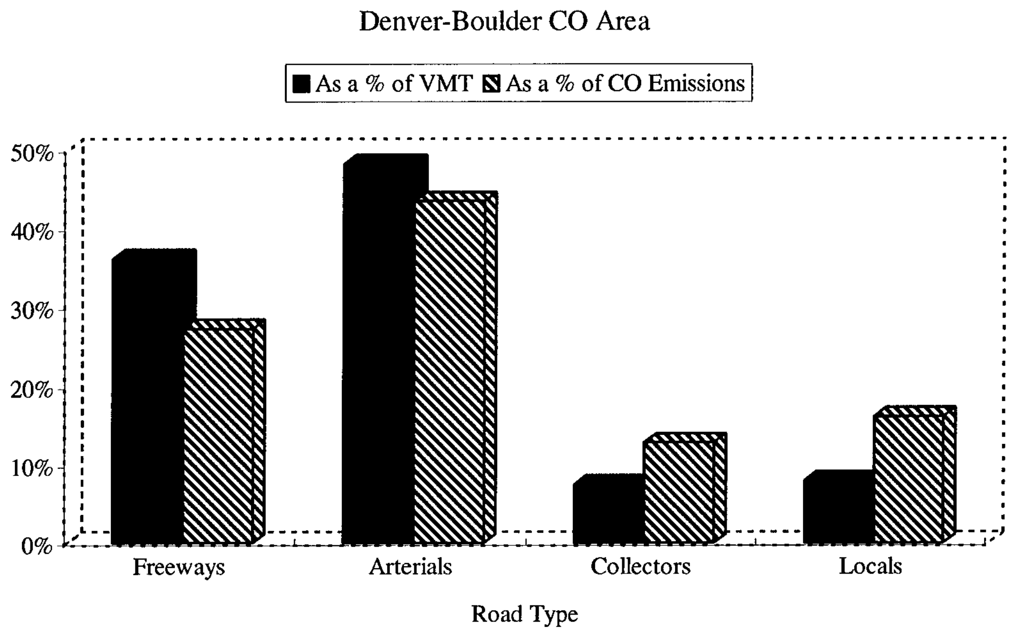

Figure 8

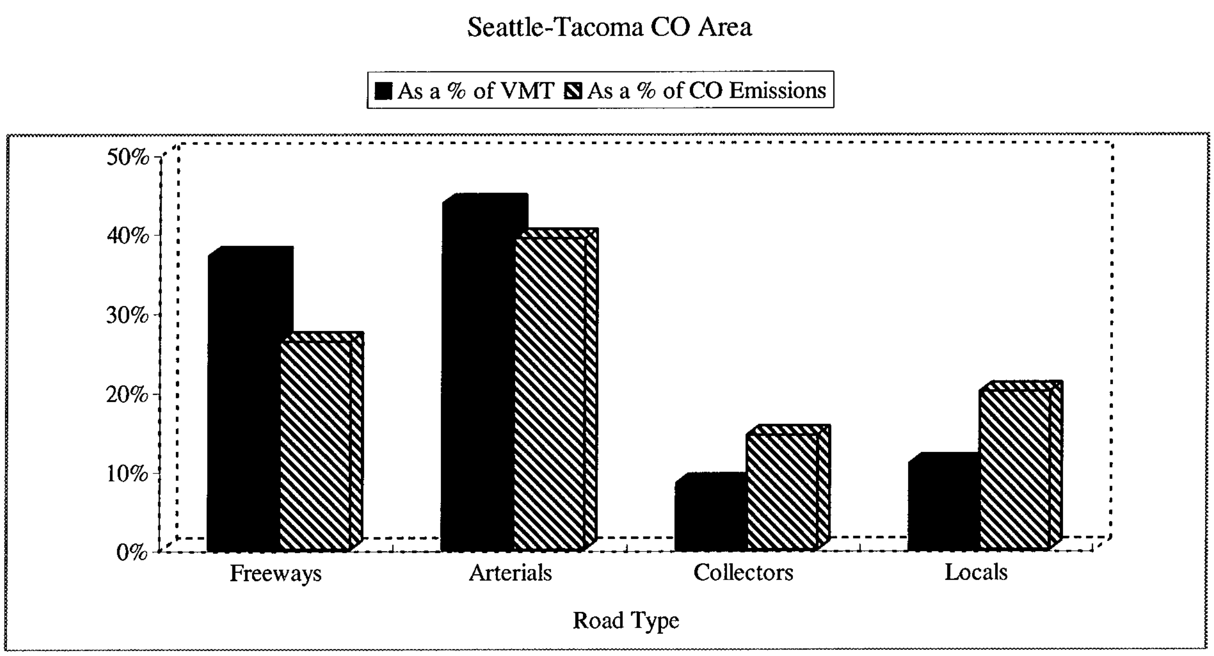

Figure 9

Providence Ozone Area

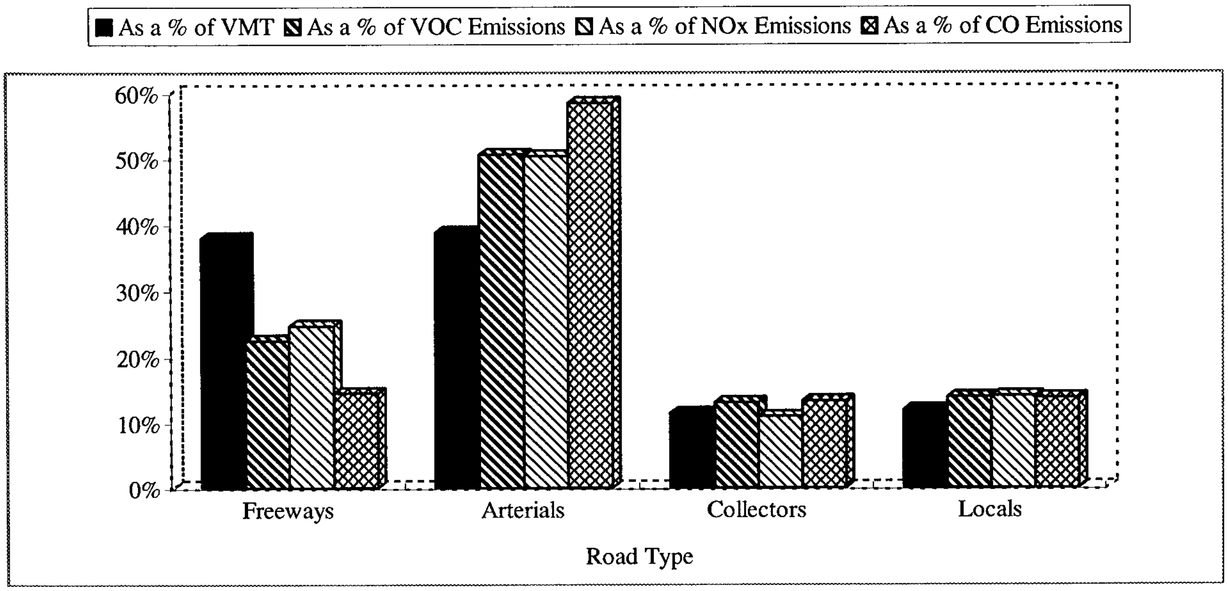

Figure 10

<u>Contribution to On-Road Emissions by Vehicle Type.</u> Data from two nonattainment areas shows that the relative contribution of HDDTs to VMT is smaller than the contributions to on-road emissions. The relative contributions of specific vehicle types to on-road emissions and VMT are depicted in figures 11 through 14. The nomenclature follows that of EPA's MOBILE emissions forecasting model: LDGVs represent gasoline powered passenger cars; LDGT1s represent gasoline powered light duty trucks rated below 6,000 GVW; LDGT2s represent gasoline powered light duty trucks rated above 6,001 GVW, but below 8,500 GVW; HDGVs represent gasoline powered heavy duty vehicles; LDDVs represent diesel powered passenger cars; LDDTs represent diesel powered light duty trucks below 8,500 GVW; HDDTs represent diesel powered heavy duty vehicles; and MCs represent motorcycles.

As expected, LDGVs account for the bulk of winter season CO emissions and VMT in the Denver-Boulder and Seattle-Tacoma areas. In Denver-Boulder, LDGVs account for over 60 percent of total VMT and on-road CO emissions, while in Seattle-Tacoma, LDGVs contribute roughly 65 percent of the VMT and 55 percent to on-road CO emissions. Gasoline powered vehicles (LDGVs, LDGT1s, LDGT2s, and HDGVs) account for roughly 90 percent of each area's total on-road CO emissions.

Figures 11-14

Vehicle Contributions to VMT and On-Road Emissions

Denver-Boulder

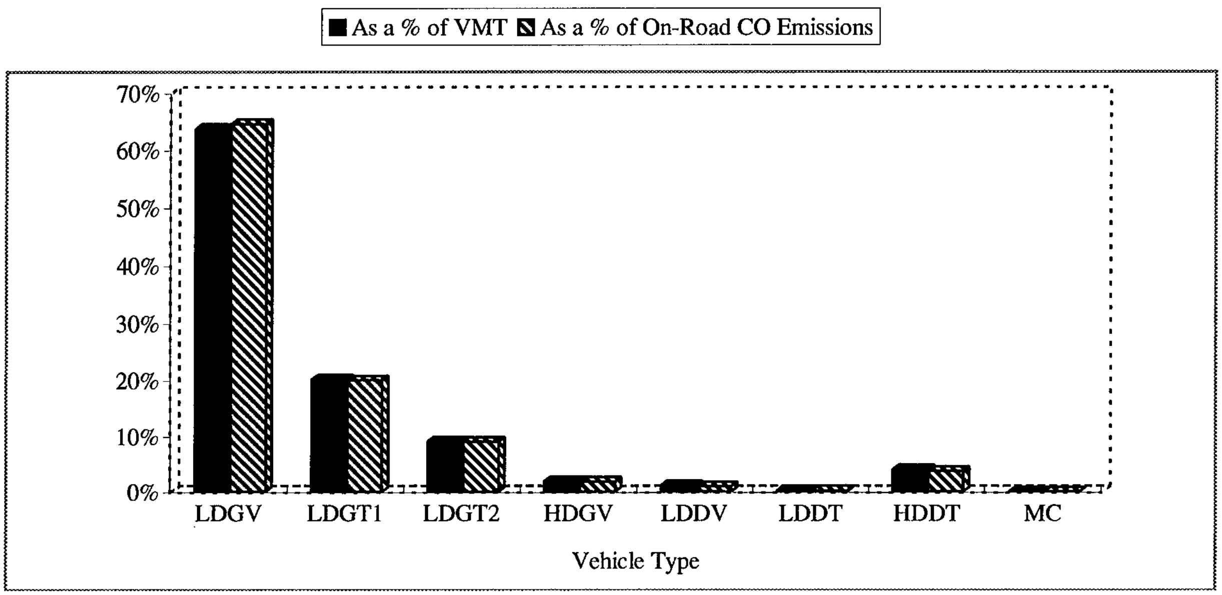

Figure 11

Seattle-Tacoma

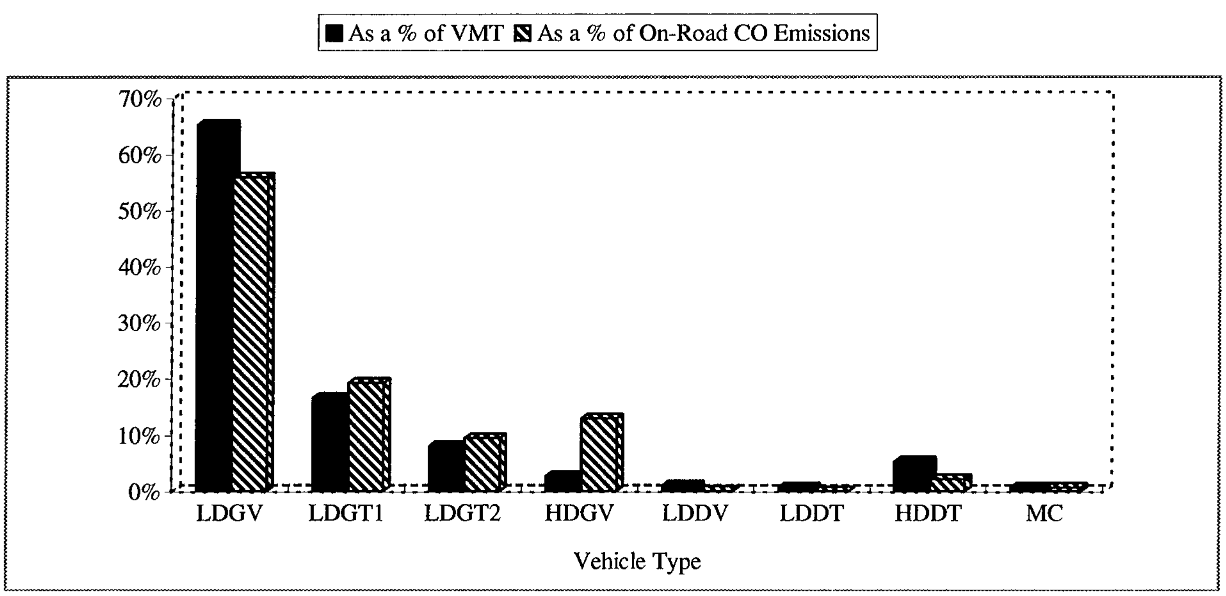

Figure 12

Providence

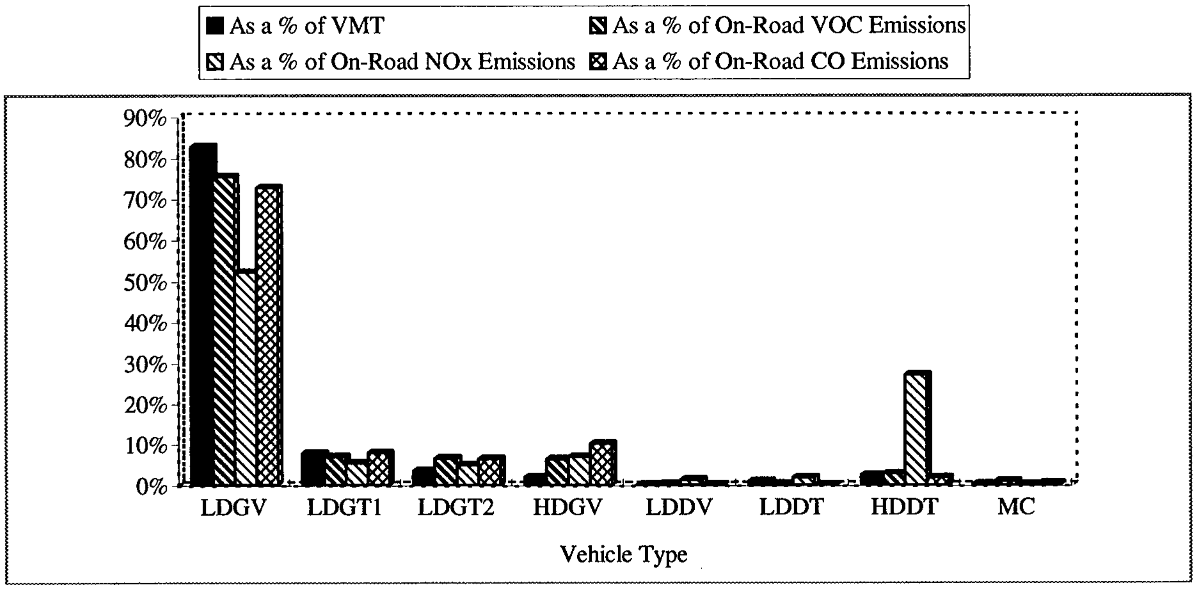

Figure 13

Sheboygan

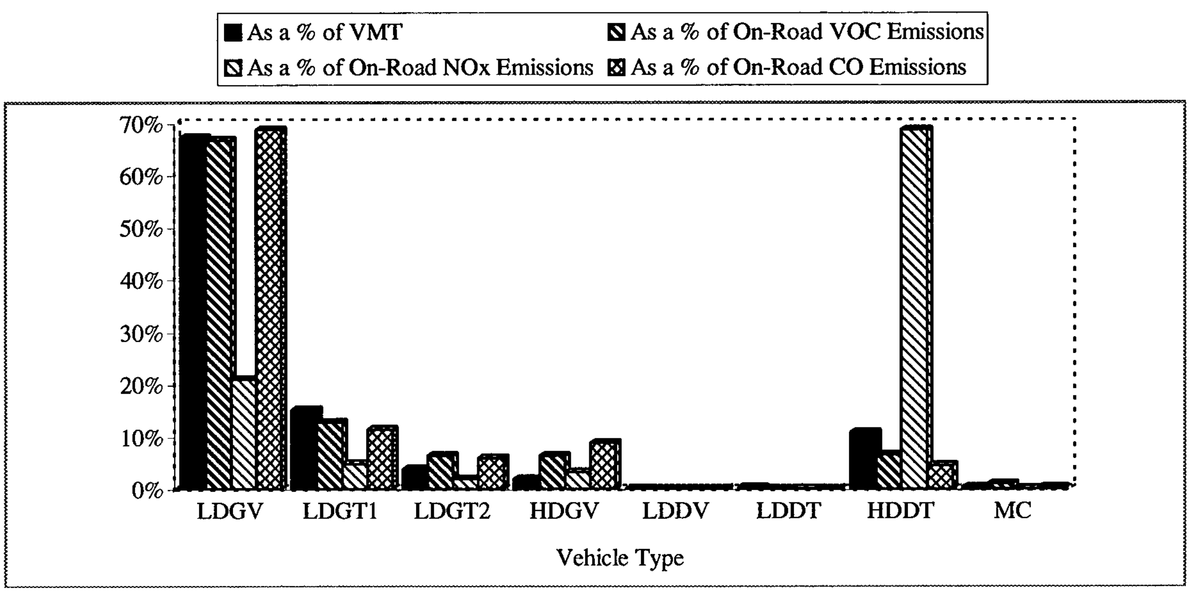

Figure 14

Figures 13 and 14 show that the relative contribution of HDDTs to VMT is smaller than the contribution to on-road emissions in the Providence and Sheboygan areas. For example, HDDTs in Sheboygan account for almost 70 percent of NOx emissions, but account for only 11 percent of total VMT. The large contribution of diesel powered vehicles to NOx emissions is due to differences in the fuel combustion process employed by diesel engines, which produces extremely high temperatures that lead to the formation of NOx.

4.4 SUMMARY OF TRANSPORTATION'S ROLE

This section has highlighted the impact of the transportation sector to emissions in CO and ozone nonattainment areas. Transportation activities are one of the main contributors CO emissions in nonattainment regions and are an important source of emissions of ozone precursors. Across different types of transportation modes, on-road motor vehicles, especially gasoline powered passenger cars, are the major contributors to CO and VOC emissions. These vehicles also account for the majority of VMT accumulated in nonattainment areas. In contrast, nonroad transportation-related sources of emissions, such as locomotives, aircraft, and watercraft, contribute marginally, but increasingly, to the air pollution problems experienced in CO and ozone nonattainment areas. However, the fact that some of these sources are uncontrolled and are not currently being regulated for emissions (specifically watercraft) suggests that large marginal emissions reductions are possible from these sources. The EPA is now starting to control these sources.

The review of on-road sources showed that, in both the Denver-Boulder and Seattle-Tacoma nonattainment areas, travel during off-peak periods appears to contribute more to VMT and emissions than travel during peak periods despite congestion during the peak periods. Although this conclusion is consistent with empirical evidence, the proportionate contribution of peak travel to VMT and emissions from our case studies suggests that the speed and emission effects of congestion are not fully represented in on-road emission estimates. To resolve this issue, detailed VMT and emissions data on other nonattainment areas needs to be collected and analyzed. In any event, the effect of speed on motor vehicle emissions was depicted in emission and VMT comparisons across road types, which indicated the relatively higher contribution to VMT relative to emissions of roadways characterized by high average speeds.

APPENDIX A. 1990 CO EMISSION INVENTORIES

Anchorage Area

The Cook Inlet Intrastate Air Quality Control Region consists of the Greater Anchorage Area Borough, the Kenai Peninsula Borough, and the Matanuska-Susitna Borough. The area encompasses approximately 44,000 square miles and has the largest concentration of residential and commercial land use in the state. The population of this region is approximately 322,000. A portion of the Municipality of Anchorage was designated as a moderate nonattainment area for CO with a design value of 13.1 ppm. As shown below, about 88 percent of wintertime CO emissions in Anchorage are from motor vehicles, due to high levels of vehicle travel in the community and the magnitude of CO emitted under "cold-start" conditions. Emissions at 20 F have been shown to be 3 to 10 times higher than at 75 F. Most of these emissions are concentrated in the warm-up period when engine temperatures are low, the fuel mixture is rich, and the vehicle's catalytic converter has not reached its "light-off" temperature. Anchorage's cold winter temperatures exacerbate this "cold-start" phenomenon.

The CO problem in Anchorage is compounded by the area's poor air dispersion conditions due to its climate. During the winter, Anchorage experiences strong and persistent temperature inversions which trap CO emissions from combustion sources close to the ground. Anchorage's CO emissions are summarized below by source.

State	Alaska	
Counties	Anchorage Election District (Part)	
Total CO Emissions (TPD)	168.73	
Point	N/A	--
Area	4.97	3%
On-Road	150.03	89%
NonRoad	13.73	8%

Phoenix Area

The Maricopa County nonattainment area includes the metropolitan area of Phoenix. The nonattainment area encompasses approximately 1,962 square miles, or 20 percent of the county land area, with a population of roughly 2.2 million. The area was classified by EPA as moderate and has a design value of 12.6 ppm. The CO season covered by the emissions inventory is November 1989 through January 1990. Average daily CO emission in 1990 were 1,144 tons, with point sources contributing less than 1 percent, area sources 8 percent, on-road sources 71 percent, and nonroad sources 21 percent. Details about the Phoenix CO nonattainment area are summarized below.

State	Arizona	
Counties	Maricopa (Part)	
Total CO Emissions (TPD)	1,144.10	
Point	8.7	1%
Area	87.7	8%
On-Road	807.7	71%
Nonroad	240	21%

Fresno Area

The San Joaquin Valley Unified Air Pollution District includes several areas which are classified as nonattainment for carbon monoxide. Fresno is one of four urbanized areas in the San Joaquin Valley which is in nonattainment for CO. Part of Fresno County, specifically the Fresno Urbanized Area, is classified as moderate nonattainment with a design value of 13.0 ppm. As can be seen from the information provided below, sources within the urbanized area of Fresno emit 409 tons of CO each winter day. On-road mobile sources contributed 74 percent of total emissions. Light duty trucks and vehicles emitted 88 percent of the on-road emissions. Nonroad mobile sources contributed 19 percent of total emissions mostly generated by mobile and utility equipment (60 percent).

State	California	
Counties	Fresno (Part)	
Total CO Emissions (TPD)	408.98	
Stationary	27.48	7%
On-Road	302.43	74%
Nonroad	79.08	19%

Note: Stationary sources include both point and areas emissions as reported by California.

Denver-Boulder Area

Denver and the surrounding counties were classified as a moderate CO nonattainment area with a design value of 16.2 ppm. The nonattainment area consists of Denver County and portions of Adams, Arapahoe, Boulder, Douglas, and Jefferson counties, comprising a population of 1.7 million, 745 thousand households, and 1.05 million jobs. Sources within the Denver-Boulder area emit 1,368 tons of carbon monoxide daily during the CO season (defined as the three-month period of November, December, and January). Eighty percent of these CO emissions are generated from on-road sources, while 14.2 percent of the emissions come from nonroad mobile sources.

State	Colorado	
Counties	Denver and Parts of Adams, Arapahoe, Boulder, Douglas, and Jefferson	
Total CO Emissions (TPD)	1,367.96	
Point	10.02	1%
Area	68.23	5%
On-Road	1,094.85	80%
Nonroad	194.86	14%

New York-New Jersey-Long Island Area

This area is a multistate nonattainment area with portions in New York, New Jersey, and Connecticut. The area is classified as moderate nonattainment with a design value of 13.5 ppm. The Connecticut portion of the area includes the towns of New Milford and Bridgewater in Litchfield County, and all towns in Fairfield County except Shelton. CO emissions for a typical winter day total 592 tons per day, of which 59.5 percent are generated by on-road sources.

All of contiguous New Jersey counties of Bergen, Hudson, Essex, and Union counties and part of Passaic County are classified moderate nonattainment for carbon monoxide with a design value that is greater than 12.7 ppm. During the 1980s, carbon monoxide concentrations have declined in New Jersey as a result of the implementation of control measures to improve combustion and further air pollution controls on motor vehicles. In the past several years, carbon monoxide concentrations usually approached or exceeded the 8-hour standard during the cooler months on relatively "hot" days. During these exceedances, there were usually clear skies at night, allowing radiational cooling at the ground, while warm air above the ground created temperature inversions. Moreover, the motoring public traveled over 161 million miles per day on New Jersey's roadways, contributing significantly to nonattainment of the CO standard. As shown below, sources in the area produced 1,070 tons of CO emissions per winter day in 1990. Of this total, 72 percent originated from on-road sources and 22 percent originated from nonroad sources.

The New York metropolitan area remains in nonattainment of the air quality standards for carbon monoxide. The five boroughs of New York City, Westchester County and Nassau County were classified moderate with a design value greater than 12.7 ppm. The carbon monoxide problem in the New York metropolitan area may be characterized by an area source component (background) and a local on-street component (hot spot). The high density of traffic and congestion on many of its roads result in relatively high CO emissions throughout the region. Highway vehicles alone are responsible for roughly 80 percent of carbon monoxide emissions in the area. This contributes to the overall concentration of CO and makes background CO levels a significant component of CO measured at any given site. Although background levels are significant contributors to ambient levels, they are not sufficient by themselves to cause exceedances of the CO air quality standard.

States	Connecticut		New Jersey		New York	
Counties	Parts of Fairfield and Litchfield		Bergen, Essex, Hudson, Union, and part of Passaic		Bronx, Kings, Nassau, New York, Queens, and Richmond	
Total CO Emissions (TPD)	592.1		1,070		5,127.15	
Point	13.11	2%	24	2%	31.26	1%
Area	155.18	26%	35	3%	380.16	7%
On-Road	352.23	60%	772	72%	4,138.02	81%
Nonroad	71.62	12%	239	22%	577.71	11%

Las Vegas Area

The Las Vegas Valley, consisting of the cities of Las Vegas, North Las Vegas, and Henderson, and part of Clark County, was classified as moderate nonattainment for CO emissions with a design value of 14.4 ppm. This area is contained within a hydrographic basin surrounded by mountains — Spring Mountains to the west, Sheep and Las Vegas Mountains to the north, Frenchman Mountain to the east, and the McCullough Range and Big Spring Range close the airshed to the south. Within the basin, CO NAAQS exceedances have occurred during the winter season in a limited area. Exceedances were recorded in an area adjacent to converging major transportation corridors where three state highways intersect.

The local climate also exacerbates the potential for CO exceedances. The area experiences little precipitation during the winter and wind speeds are generally slow. During the day, air masses move upward and to the west as the air is heated. However, at night, the wind direction is reversed and cool air from higher elevations is drawn back into the valley. During the peak season for CO emissions, an average daily quantity of 325.38 tons of CO are contributed to the atmosphere. On-road mobile sources are responsible for the majority of emissions (80 percent). Nonroad mobile sources contribute 8.68 percent.

State	Las Vegas	
Counties	Clark (Part)	
Total CO Emissions (TPD)	325.38	
Point	28.39	9%
Area	9.04	3%
On-Road	259.73	80%
Nonroad	28.22	9%

Seattle-Tacoma Area

The Seattle-Tacoma-Everett Urban Area, also referred to as the Central Puget Sound Urban Area, includes portions of King, Pierce, and Snohomish counties. The area is classified moderate nonattainment for CO with a design value of 14.8 ppm. Exceedances of the national standard tend to occur primarily during fall and winter evenings when stable stratification prevails and wind speeds average less than 1 meter per second. The area's peak CO season extends from October through December. Peak 1-hour concentrations occur primarily between 5 P.M. and 9 A.M., with peak 8-hour exceedance periods ending between 10 P.M. and midnight. In 1990, Puget Sound area emissions totaled 2,097 tons of CO per weekday. On-road mobile sources contributed 75 percent of those emissions and nonroad sources contributed 6 percent.

State	Washington	
Counties	Parts of King, Pierce, and Snohomish	
Total CO Emissions (TPD)	2,097.00	
Point	68.5	3%
Area	322	15%
On-Road	1,577.50	75%
Nonroad	129	6%

Spokane Area

The Spokane Urban Area is classified moderate nonattainment with a design value of 13.8 ppm. The nonattainment area includes a portion of Spokane County encompassing the City of Spokane. Exceedances of the CO standard tend to occur during periods characterized by temperatures that are below 40 F with high stability and low wind speeds. The three-month peak CO season extends from October to December. In 1990, Spokane's CO emissions totaled 342 tons per weekday. Fifty-six percent of 1990 CO emissions were attributable to on-road sources and 5 percent were attributable to nonroad sources, as shown below.

State	Washington	
Counties	Spokane (Part)	
Total CO Emissions (TPD)	342.1	
Point	77	23%
Area	58.7	17%
On-Road	190.2	56%
Nonroad	16.2	5%

APPENDIX B. 1990 OZONE EMISSION INVENTORIES

Atlanta Area

The Atlanta nonattainment area is designated as serious for ozone with a design value of 0.162 ppm and is required to meet the ozone NAAQS by 1999. The area consists of thirteen counties: Cherokee, Cobb, Fulton, Gwinnett, Douglas, Clayton, DeKalb, Rockdale, Henry, Fayette, Coweta, Paulding, and Forsyth. The Atlanta area's VOC and NOx emissions are distributed differently across sources. For example, on-road sources contribute roughly 60 percent to VOC emissions (exclusive of biogenic emissions) in the Atlanta area, while on-road sources contribute well over 90 percent to NOx emissions. Emissions by source and pollutant are provided below.

State	Georgia			
Counties	Cherokee, Cobb, Fulton, Gwinnett, Douglas, Clayton, DeKalb, Rockdale, Henry, Fayette, Coweta, Paulding, Forsyth			
	VOC		NOx	
Total Emissions (TPD)	775.00		529.25	
Point	57.00	7%	121.30	23%
Area	160.00	21%	44.60	8%
On-Road	477.00	62%	297.55	56%
Nonroad	81.00	10%	65.80	12%

Baltimore Area

Statewide, the air in Maryland has exceeded the Federal health standard for ozone in each of the last 20 years. During this period, the number of days of violation ranged from a low of 4 to a high of 56. In the summer of 1993, Maryland ranked second among Northeastern States with 16 days in violation of the NAAQS.

The Baltimore nonattainment area is comprised of Baltimore City and Baltimore, Howard, Hartford, Anne Arundel, and Carroll Counties and is classified as severe-15 with a design value is 0.194 ppm. Exclusive of biogenic emissions, the contributions from each source to VOC and NOx differ. Unlike Atlanta, on-road sources represent a smaller portion of NOx emissions. This is due to the larger presence of industry in the Baltimore area.

State	Maryland			
Counties	Baltimore, Howard, Hartford, Anne Arundel, Carroll			
	VOC		NOx	
Total Emissions (TPD)	344.6		474.9	
Point	40.3	12%	231.4	49%
Area	127.1	37%	10.6	2%
On-Road	132	38%	161.2	34%
Nonroad	45.2	13%	71.7	15%

Baton Rouge Area

The Baton Rouge nonattainment area, classified as serious with a design value of 0.164, is comprised of six parishes: Ascension, East Baton Rouge, Iberville, Livingston, Pointe Coupee, and West Baton Rouge.

Baton Rouge's substantial industrial base is a significant contributor to air quality problems, as demonstrated by the contribution of point sources to VOC and NOx emissions. Point sources account for roughly 30 percent of the area's total VOC emissions (about 47 percent, exclusive of biogenic sources), and 69 percent of NOx emissions. By way of comparison, on-road sources account for 25 percent of VOC emissions (exclusive of biogenic) and 19 percent of NOx. The following table summarizes emissions in this ozone nonattainment area.

State	Louisiana			
Parishes	Ascension, East Baton Rouge, Iberville, Livingston, Pointe Coupee, West Baton Rouge			
	VOC		NOx	
Total Emissions (TPD)	222.08		348.14	
Point	103.66	47%	241.76	69%
Area	28.8	13%	0.78	0%
On-Road	55.8	25%	67.2	19%
Nonroad	33.82	15%	38.4	11%

Philadelphia-Wilmington-Trenton Area (Delaware Portion)

The Philadelphia-Wilmington-Trenton nonattainment area includes counties in the States of Maryland, Pennsylvania, New Jersey, and Delaware. Data presented in the table below only represent emissions for the Delaware portion of this ozone nonattainment area. Delaware's three counties are all in nonattainment of the NAAQS for ozone. However, only the northern counties, New Castle and Kent, fall within the Philadelphia consolidated metropolitan statistical area which is classified as severe-17 with a design value of 0.187.

Exclusive of biogenic sources, area sources account for the largest percentage of VOC emissions in the area with a contribution of 34 percent, followed by on-road sources with a contribution of roughly 29 percent. Point sources contribute the most to NOx emissions (59 percent). These distributions by pollutant and across sources follow the general pattern of areas that are characterized by relatively high levels of industrial activity.

State	Delaware			
Counties	New Castle, Kent			
	VOC		NOx	
Total Emissions (TPD)	137.54		155.15	
Point	30.3	22%	91.97	59%
Area	47.72	35%	6.6	4%
On-Road	39.4	29%	29.79	19%
Nonroad	20.12	15%	26.79	17%

Providence Area

The Providence ozone nonattainment area is comprised of Bristol, Kent, Newport, Providence, and Washington counties, which account for the entire State of Rhode Island. Therefore, the entire state was designated as a serious nonattainment area with a design value of 0.162 ppm.

Emissions in Rhode Island during the ozone season total 260.70 tons of VOC emissions per day and 98.40 tons of NOx emissions per day. A total of 84 point sources were identified within the state, contributing 11 percent to VOC emissions (exclusive of biogenic sources) and 11 percent to total NOx emissions. Area sources account for almost 39 percent of VOC emissions (exclusive of biogenic sources) and roughly 4 percent of total NOx emissions. Specific area sources that account for the bulk of these emissions include surface cleaning and coating operations, commercial and consumer solvent use, automobile refinishing, gasoline distribution and boiler combustion sources. Nonroad sources contribute 17 percent to VOC emissions (exclusive of biogenic sources) and approximately 26 percent to NOx emissions. The majority of nonroad-related VOC emissions (70 percent) originated from recreational boats and lawn and garden equipment, while 78 percent of NOx emissions originating from nonroad sources are attributable to construction and industrial equipment. On-road sources account for 33 percent of VOC emissions in the area (exclusive of biogenic sources) and almost 59 percent of NOx emissions. Passenger vehicles account for the bulk of this source's VOC and NOx emissions, while heavy-duty diesel vehicles contribute the most to NOx emissions originating from on-road sources. The table presented below summarizes emissions by source in the Providence area.

State	Rhode Island			
Counties	Entire State			
	VOC		NOx	
Total Emissions (TPD)	187.8		98.4	
Point	20.6	11%	11.3	11%
Area	72.7	39%	3.8	4%
On-Road	62.4	33%	58.1	59%
Nonroad	32.1	17%	25.2	26%

Boston-Lawrence-Worcester Area

As is the case with Rhode Island, the entire State of Massachusetts was designated an ozone nonattainment area with a serious classification. Massachusetts is divided into two nonattainment regions (the western and eastern regions of the state), of which the Boston-Lawrence-Worcester area comprises the eastern nonattainment region. This eastern nonattainment area has a design value of 0.165 ppm.

Given the appropriate meteorological conditions, ozone exceedances continue to occur in Massachusetts at frequencies in excess of the NAAQS. During the summer of 1993, Massachusetts experienced eight days during which the ozone standard was violated. Area sources within the Boston-Lawrence-Worcester area contributed the most (38 percent) to VOC emissions (exclusive of biogenic sources), while point and on-road sources each contributed approximately 40 percent of the area's NOx emissions.

State	Massachusetts			
Counties	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester			
	VOC		NOx	
Total Emissions (TPD)	900.48		837.32	
Point	46.7	5%	333.27	40%
Area	348.8	39%	28.09	3%
On-Road	249.8	28%	319.68	38%
Nonroad	255.18	28%	156.28	19%

Muskegon Area

Several areas in Michigan were classified as moderate ozone nonattainment areas including Muskegon, Detroit-Ann Arbor, and Grand Rapids. The Muskegon area is comprised of the entire county of Muskegon and has an ozone design value of 0.181 ppm. Compared to the other ozone nonattainment areas in Michigan, Muskegon requires the least tons per typical ozone season weekday reductions to meet the 15% VOC reduction requirement.

Contributions to VOC emissions are more evenly distributed among sources than for NOx. Exclusive of biogenics, on-road sources contribute 33 percent of VOC, followed by area sources at 25 percent. Point sources contribute 54 percent of NOx, followed by on road sources at 32 percent.

State	Michigan			
Counties	Muskegon			
	VOC		NOx	
Total Emissions (TPD)	38.34		32.05	
Point	7.28	19%	17.3	54%
Area	9.6	25%	0.6	2%
On-Road	12.69	33%	10.39	32%
Nonroad	8.77	23%	3.76	12%

Portsmouth-Dover-Rochester Area

The Portsmouth-Dover-Rochester area includes the cities of Portsmouth, Dover, and Rochester in New Hampshire. The area includes regions along the seacoast and the border with Maine and is comprised of Strafford County and part of Rockingham County. It is classified as serious with a design value of 0.165 ppm.

The distribution of VOC and NOx differs across sources. Biogenic and on-road sources account for the bulk of VOC emissions, and point and on-road sources account for the majority of NOx emissions.

State	New Hampshire			
Counties	Strafford and part of Rockingham			
	VOC		NOx	
Total Emissions (TPD)	41.81		42.79	
Point	4.07	10%	17.39	41%
Area	10.63	25%	2.71	6%
On-Road	20.85	50%	20.76	49%
Nonroad	6.26	15%	1.93	5%

Houston-Galveston Area

The Houston-Galveston ozone nonattainment area includes the Texas counties of Brazoria, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller, and Chambers. This area has been classified as severe-17 with a design value of 0.22 ppm.

The area's distribution of emissions across sources and precursors is presented below. Within each specific pollutant, point sources in Houston-Galveston are responsible for the bulk of emissions, contributing over 40 percent of VOC emissions (exclusive of biogenic sources) and 57 percent of total NOx emissions. VOC emissions are more evenly distributed among the remaining sources, while on-road sources are the second largest contributor to NOx emissions.

State	Texas			
Counties	Brazoria, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller, Chambers			
	VOC		NOx	
Total Emissions (TPD)	1179.27		1370.17	
Point	484.45	41%	780.51	57%
Area	242.96	21%	14.37	1%
On-Road	251.72	21%	337.03	25%
Nonroad	200.14	17%	238.26	17%

Sheboygan Area

Sheboygan County in Wisconsin was designated as a moderate ozone nonattainment area with a design value of 0.176 ppm. The 1990 base year emissions of ozone precursors for this county are provided below.

Biogenics are the largest contributor, at over 50 percent, to VOC emissions. Excluding biogenics, there is a more even distribution of VOC among sources, with the exception of nonroad sources, which contribute the least amount. The largest contributor to NOx emissions is point sources, at 76 percent.

State	Wisconsin			
Counties	Sheboygan			
	VOC		NOx	
Total Emissions (TPD)	25.61		74.04	
Point	6.74	26%	56.35	76%
Area	9.69	38%	1.37	2%
On-Road	6.11	24%	11.12	15%
Nonroad	3.07	12%	5.2	7%

APPENDIX C. 1990 PM_{10} EMISSION INVENTORIES

Maricopa and Pinal Counties

Portions of Maricopa and Pinal Counties surrounding Phoenix, Arizona were determined to be in moderate nonattainment for the PM_{10} national standards. The Maricopa County urban planning area encompasses the Maricopa portion of the nonattainment area which is surrounded by mountains, contains twenty-four cities and towns, and includes five river systems. The climate is arid with extreme ranges in daily temperatures. The land use for the area is 50 percent residential, 25 percent streets and roadways, 20 percent commercial and industrial, and 5 percent public. The largest contributor to PM_{10} emissions in the Maricopa County portion of the nonattainment area is fugitive dust at 91 percent. Mobile sources contribute only 6 percent, while residential wood combustion contributes less than 1 percent.

The Pinal County portion of the nonattainment area encompasses the city of Apache Junction, east of the Phoenix metropolitan area. Pinal County has relatively the same meteorology, typography, and land use pattern as Maricopa County. In Pinal County, fugitive dust contributes 60 percent to total PM_{10} emissions, while mobile sources contribute 30 percent.

As shown below, emissions for the combined area total 97 tons per day, of which over 85 percent are attributable to area sources mostly in the form of fugitive dust. On-road sources contribute only 7.5 percent to total PM_{10} emissions in the area.

State	Arizona	
Counties	Parts of Maricopa and Pinal	
Total PM_{10} Emissions (TPY)		40,795
Point	36	0%
Area	6,405	16%
On-Road	33,297	82%
Nonroad	1,057	3%

Adams, Denver, and Boulder Counties

The Denver nonattainment area includes all of Denver, Jefferson, and Douglas counties, as well as portions of Boulder, Adams, and Arapahoe counties with a population of approximately 1.6 million residents. The area is located in north-central Colorado in the western plains, 25 to 45 miles east of the Continental Divide. Denver's climate is semi-arid with temperatures ranging from a high above 100 F to lows below -20 F. Denver's location within a broad valley and its climatic conditions frequently result in calm wind conditions. Coupled with cold temperatures and periods of snow cover, severe temperature inversions usually occur during the winter and early spring. Fifty percent of the emissions per day result form mobile sources and 44 percent result from area sources.

State	Colorado	
Counties	Denver, Douglas, Jefferson and parts of Adams, Arapahoe, Boulder	
Total PM_{10} Emissions (TPD)	64	
Point	3	4%
Area	32	50%
On-Road	28	44%
Nonroad	1	2%

Ada County

The City of Boise in Ada County is located in southwestern Idaho. Boise is the largest city in Idaho with a population of over 125,000 residents supporting a diverse economic base. The city is in the Snake River Basin protected from severe winter storms and climatic extremes. Exceedances of the 24-hour standard are associated with prolonged stagnation periods during the winter season. As demonstrated below, area sources represent 89 percent of PM_{10} daily winter emissions. Wood burning alone contributes 71 percent to the total of 16 tons per day.

State	Idaho	
Counties	Ada (Part)	
Total PM_{10} Emissions (TPY)	5,860	
Point	323	6%
Area	2,167	37%
On-Road	3,170	54%
Nonroad	200	3%

Union County

The boundary of this nonattainment area is defined by the urban growth area of La Grande in Union County which is located in northeastern Oregon. The Grande Ronde Valley of the area has a semi-arid high desert climate. The surrounding mountains reach nearly 10,000 feet, creating topographical barriers that restrict air mass dispersion. The population within the urban area is approximately 12,300 residents comprising 4,500 households. Daily PM_{10} emissions are dominated by area sources. Residential wood burning accounts for 60 percent and fugitive dust accounts for 31 percent of area source emissions. As can be deduced from the information below, on-road sources contribute only 4 percent to total PM_{10} emissions in this area.

State	Oregon	
Counties	Union	
Total PM_{10} Emissions (TPY)	752	
Point	75	10%
Area	402	53%
On-Road	269	36%
Nonroad	6	1%

Spokane County

Spokane is in the eastern-central region of Washington State in what is commonly known as the Inland Empire. The city lies in a broad, flat valley traversed by the Spokane and Little Spokane Rivers. The nonattainment area encompasses the metropolitan area of Spokane and some surrounding sections of Spokane County. In general, the area has a mild, arid climate in summer, and cold, moist climate in winter. Long-term monthly mean temperatures range from 26.8 F in January to 70.1 F in July, with an annual mean temperature of 48.1 F. The predominant wind direction is from the south to southwest and from the north to east-northeast. Most high wind speed conditions are associated with winds out of the south to west-southwest. The inventory characterized area sources as the dominant category of emissions, accounting for 87 percent of daily emissions.

State	Washington	
Counties	Spokane	
Total PM_{10} Emissions (TPY)	6,737	
Point	924	14%
Area	4,084	61%
On-Road	1,596	24%
Nonroad	133	2%

Presque Isle

Presque Isle is a city in northern Maine. It is primarily an agricultural community with no heavy industry and a small scattering of light industry and commercial operations. Presque Isle has a very heavily traveled road system with major north, south, east, and west highways in the City's center. Compounding this problem is the long winter requiring sanding and salting. Warm days in March can dry the sanding material on the roads, causing concentrations of PM_{10} build up from the combination of dried sand and vehicular travel on the roadways.

State	Maine	
Counties	Presque Isle	
Total PM_{10} Emissions (TPY)	3,436	
Point	171	5%
Area	251	7%
On-Road	3,014	88%
Nonroad	-	0%

APPENDIX D. DATA UNDERLYING THE TABLES IN SECTION 2

Data Supporting Table 8

CO Reductions: 1990-1995

		Emissions (TPD)									
		Point		Area		On-Road		Nonroad		Total	
Nonattainment Area	State	1990	1995	1990	1995	1990	1995	1990	1995	1990	1995
NY NJ LI	NJ	24	26	35	36	772	340	239	240	1,070	642
Las Vegas	NV	30	5	11	12	222	168	17	19	284	210
Seattle Tacoma	WA	69	69	322	336	1,578	802	129	134	2,097	1,340
Spokane	WA	77	77	59	61	190	91	16	18	342	248

Data Supporting Table 11

VOC Reductions: 1990-1996

Nonattainment Area	State	Emissions (TPD)									
		Point		Area		On-Road		Nonroad		Total	
		1990	1996	1990	1996	1990	1996	1990	1996	1990	1996
Atlanta	GA	57.6	50.8	138.9	127.3	401.7	167.4	88.6	93.4	686.8	438.9
Baltimore	MD	40.3	35.4	127.1	107.0	134.2	65.0	45.2	50.1	346.8	257.5
Baton Rouge	LA	103.7	82.1	29.7	26.2	55.8	25.8	34.8	34.8	223.9	168.8
Philadelphia-Wilmington-Trenton	DE	31.0	18.4	47.7	44.7	39.3	30.3	19.8	20.6	137.8	114.0
Providence	RI	25.9	19.0	60.5	55.1	62.3	31.8	32.1	34.1	180.8	140.0
Boston-Lawrence-Worcester	MA	46.0	37.0	349.0	286.0	250.0	115.0	255.0	233.0	900.0	671.0
Muskegon	MI	7.0	7.0	9.4	8.3	13.5	4.8	8.8	8.8	38.7	28.8
Portsmouth-Dover-Rochester	NH	4.1	2.2	10.8	8.6	21.1	12.2	7.8	6.8	43.8	29.8

Houston-Galveston	TX	484.5	373.5	243.0	215.6	251.7	116.3	200.1	200.2	1,179.3	905.5
Sheboygan	WI	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

APPENDIX E. LIST OF ABBREVIATIONS AND ACRONYMS

ATMS	Advanced Traffic Management System
CAA	Clean Air Act of 1970
CAAA	Clean Air Act Amendments of 1990
CO	carbon monoxide
EPA	U.S. Environmental Protection Agency
GVW	gross vehicle weight
HDDV	heavy duty diesel vehicle
HDGV	heavy duty gasoline vehicle
HOV	high occupancy vehicle
I/M	inspection and maintenance
ITS	Intelligent Transportation Systems
LDDT	light duty diesel truck
LDDV	light duty diesel vehicle
LDGT	light duty gasoline truck
LDGV	light duty gasoline vehicle
LDT	light duty truck
LDV	light duty vehicle
MC	motorcycle
mg/m^3	microgram per cubic meter
NAAQS	National Ambient Air Quality Standards
PM_{10}	particulate matter
ppm	parts per million
RFP	Reasonable Further Progress
SIP	State Implementation Plan

TCM	transportation control measure
TPD	tons per day
VMT	vehicle miles traveled
VOC	volatile organic compound

BIBLIOGRAPHY

General Reference Documents

1. *Clean Air Desk Book, The Environmental Law Reporter*, Environmental Law Institute, Washington, D.C., March 1992.

2. J. F. Elliot, M. A. Henderson, W. P. Parkin and S. C. Soong, *The Complete Guide to Environmental Law*, Specialty Technical Publishers, Inc., May 1993.

3. *State Implementation Plans; General Preamble for the Implementation of Title I of the Clean Air Act Amendments of 1990; Proposed Rule*, 57 FR 13498, April 16, 1992.

4. *National Air Quality and Emissions Trends Report,* 1992, EPA 454/R-93-031, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, October 1993.

5. *Air Quality: Transportation Plans, Programs, and Projects; Federal or State Implementation Plan Conformity; Rule*, 58 FR 62188, November 24, 1993.

6. *Designation of Areas for Air Quality Planning Purposed, Final Rule*, 56 FR 56694, November 6, 1991.

7. Memorandum. David C. Misenheimer to multiple addresses. Office of Air Quality Planning and Standards, Inventory Guidance and Evaluation Section. "Comparison of SIP Emission Inventory Data in Hard Copy Submittals Versus in AIRS and EPA National Inventory," May 31, 1994.

8. *Emission Inventory Requirements for Carbon Monoxide State Implementation Plans*, EPA 450/4-91-011, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, March 1991.

9. *Emission Inventory Requirements for Ozone State Implementation Plans*, EPA 450/4-91-010, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, March 1991.

10. Ozone and Carbon Monoxide Areas Designated Nonattainment, Significant Changes Since the November 6, 1991 Federal Register and October 26, 1991 Summary of the November 6, 1991 Federal Register, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, October 1993.

11. "EPA Releases Status of State Clean Air Plans." *Environmental News*, U.S. Environmental Protection Agency, Communications, Education and Public Affairs, July 22, 1994.

Carbon Monoxide Documents

1. *State Air Quality Control Plan, Volume II: Analysis of Problems, Control Actions*, Alaska Department of Environmental Conservation, 1983.

2. *1990 Base Year Carbon Monoxide Emission Inventory for Maricopa County, Arizona Nonattainment Area,* Maricopa County Environmental Quality & Community Services Agency, March 1993.

3. *Federal 1992 Air Quality Attainment Plan for Carbon Monoxide*, San Joaquin Valley Unified Air Pollution Control District, November 1992.

4. *1990 Base-Year Carbon Monoxide Emission Inventory for the Denver, Colorado Nonattainment Area*, Colorado Department of Health, Air Pollution Control Division, November 1992.

5. *Bureau of Air Management 1990 Emissions Inventory*, Connecticut Department of Environmental Protection, January 1993.

6. *Carbon Monoxide Air Quality Implementation Plan, Las Vegas Valley Nonattainment Area, Clark County, Nevada*, Clark County Board of County Commissioners, Department of Comprehensive Planning, October 1992.

7. *Proposed State Implementation Plan Revision for Attainment and Maintenance of the Carbon Monoxide National Ambient Air Quality Standards*, New Jersey Department of Environmental Protection and Energy, November 1992.

8. *New York State Implementation Plan, Carbon Monoxide Attainment Demonstration, New York Metropolitan Area*, Department of Environmental Conservation, November 1992.

9. *Seattle-Tacoma Urban Carbon Monoxide Nonattainment Area, Parts of King, Pierce and Snohomish Counties, WA, 1990 Base Year Emissions Inventory*, Puget Sound Air Pollution Control Agency and Washington State Department of Ecology, October 1992.

10. *Spokane County Carbon Monoxide Nonattainment Area 1990 Base Year Emissions Inventory*, Washington State Department of Ecology, November 1992.

Particular Matter Documents

1. *MAG 1991 Particulate Plan for PM_{10} for the Maricopa County Area*, Maricopa Association of Governments, November 1991.

2. *State Implementation Plan for the Pinal County Portion of the Pinal County Portion of the Phoenix PM_{10} Nonattainment Area*, Office of Air Quality, Arizona Department of Environmental Quality, November 1991.

3. J. C. Chow and J. Watson, et al., *Planning for SJVAQS/AUSPEX Particulate Matter and Visibility Sampling Analysis.*

4. *Colorado State Implementation Plan for Particulate Matter (PM_{10}), Denver Metropolitan Nonattainment Area Element,* Regional Air Quality Council and Colorado Department of Health, Air Pollution Control Division, May 1993.

5. *Northern Ada County/Boise Particulate (PM_{10}) Air Quality Improvement Plan*, Idaho Division of Environmental Quality, November 1991.

6. *Technical Support Document, PM_{10} SIP Revision for Missoula, Montana*, May 1993.

7. *Clean Air Act Approval and Promulgation of PM_{10} Implementation Plan for Montana*, Notice of Proposed Rulemaking.

8. *Revision to the New Mexico PM_{10} State Implementation Plan for Anthony, New Mexico*, New Mexico Environment Department, Air Quality Bureau, November 1991.

9. *New Mexico; Revision to the State Implementation Plan*, Proposed Rulemaking.

10. *PM_{10} Control Strategy for Particulate Matter, La Grande, Oregon Nonattainment Area, A Plan for Attaining and Maintaining the National Ambient Air Quality Standard for PM_{10}*, Department of Environmental Quality, Air Quality Division, October 1991.

11. *Utah PM_{10} SIP, Salt Lake and Utah Counties, Technical Support Document*, US EPA Region VIII.

12. State Implementation Plan for Particulate Matter in the Spokane Study Area, Washington State Department of Ecology, November 1991.

13. *Sheridan PM_{10} SIP Development Plan*, January 1989.

Ozone Documents

1. Atlanta Emissions Inventory (Section 5, Highway Mobile Sources).

2. *1990 Base Year Emission Inventories for the State of New Hampshire*, Department of Environmental Services, Air Resources Division, January 1993.

3. *1990 Base Year Emissions Inventory for the Rhode Island Nonattainment Area,* Department of Environmental Management, Division of Air and Hazardous Materials, February 1993.

4. *Documentation Report for 1990 Base Year State Implementation Plan Emission Inventory for Precursors of Ozone*, Department of Natural Resources, Division of Environmental Quality, January 1993.

5. *Proposed State Implementation Plan (SIP) for the 15 Percent Rate of Progress Plan,* Delaware Department of Natural Resources and Environmental Control, November 1993.

6. *Transportation Component, 1993 Rate-of-Progress Update, State Air Quality Implementation Plan*, Atlanta Regional Commission, November 1993.

7. *15% VOC Reduction Reasonable Further Progress Plan*, Department of Environmental Quality.

8. *Rate-of-Progress Plan for the Baltimore Nonattainment Area and Cecil County*, Maryland Department of the Environment, March 1994.

9. *Revision to the Massachusetts State Implementation Plan for Ozone*, Department of Environmental Protection, November 1993.

10. *15% Rate of Progress Plans for Southeast Michigan, Grand Rapids MSA, and Muskegon MSA Moderate Nonattainment Areas,* Department of Natural Resources, November 1993.

11. *New Hampshire 1996 15% Rate-of-Progress Demonstration,* Department of Environmental Services, Air Resource Division, January 1994.

12. *Rate of Progress Analysis, Rhode Island Nonattainment Area*, March 1994.

13. *Revisions to the State Implementation Plan (SIP) for the Control of Ozone Air Pollution, 1993 Rate-of-Progress SIP for Dallas/Fort Worth, El Paso, Beaumont/Port Arthur, and Houston/Galveston Ozone Nonattainment Areas*, Texas Natural Resource Conservation Commission, November 1993.

14. *Wisconsin Ozone SIP 15% Volatile Organic Compound Reduction Plan Submittal*, Department of Natural Resources, November 1993.