Critical Analysis of the Federal Motor Vehicle Control Program

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PREFACE

The top priority of air quality management officials is to protect the public from exposure to unhealthy levels of air pollutants. Motor vehicles are the single most significant source of carbon monoxide, volatile organic compounds, nitrogen oxides and toxic compounds (e.g., benzene, toluene, diesel particulate) across the United States. The health effects resulting from exposure to these pollutants and their secondary by-products range from debilitating to chronic to potentially carcinogenic.

States are responsible for devising and implementing plans to attain air quality standards. However, in the case of mobile sources, the Federal Government is responsible for regulating the performance of vehicle manufacturers. States' mobile source activities are limited to implementing various programs to keep the consumer-owned vehicles in compliance with emission standards, and other strategies dealing with the use of vehicles.

This report provides an overview of the achievements of the Federal Motor Vehicle Control Program and identifies program shortcomings. In light of the persistent ozone and carbon monoxide nonattainment problems, this report recommends a number of specific federal and state measures which can be instituted to more effectively control vehicle emissions. Attaining clean air standards in the US will require a combination of new mobile source strategies and additional resources as well as improving existing mobile source programs.

This report was written by Michael P. Walsh, a former Director of the Federal and New York City motor vehicle pollution control programs and currently an international environmental consultant. It was prepared under the direction of the Northeast States for Coordinated Air Use Management (NESCAUM) Mobile Source Committee and staff from the Maryland, Illinois, and Oregon Air Quality Control Offices.

A draft of the report was sent to outside reviewers, including agencies and private organizations. In addition to comments from the Committee, comments were received from the California Air Resources Board, the Environmental Defense Fund, the Nevada Department of Conservation and Natural Resources, the Manufacturers of Emission Controls Association, the Motor Vehicle Manufacturers Association, the Texas Air Control Board, and the US EPA Office of Mobile Sources. These comments were reviewed and considered by Mr. Walsh and the Committee and in many cases incorporated into the report.

The Committee members charged Mr. Walsh with addressing the entire field of motor vehicle control, including the most difficult issues of the last decade. Many of these questions have no clear or single answer. However, the agencies involved in this study feel strongly that some of the basic questions in controlling motor vehicle emissions must be addressed before the next era of vehicle emission control is undertaken.

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EXECUTIVE SUMMARY

In December 1970, in response to mounting concerns regarding adverse health effects, Congress amended the Clean Air Act; recognizing the dominant role of motor vehicles as a pollution source, they were singled out for a 90% reduction in emissions. To assure that this reduction was actually achieved, Congress further established a comprehensive Federal Motor Vehicle Control Program.

The primary objective of this report is to assess how effectively the Federal Motor Vehicle Control Program is meeting the goals Congress set forth in the Clean Air Act and is assisting state air quality control agencies in dealing with the current ozone and carbon monoxide nonattainment problems which result largely from motor vehicle emissions. Secondary objectives are to review the important role state inspection and maintenance programs play in controlling vehicle emissions, the need for a more effective process for implementing transportation control measures in the future, and the adequacy of the Federal effort to address toxic emissions from motor vehicles.

The report concludes that since 1970, substantial progress has been made in reducing in-use auto emissions per mile, but <u>overall improvements have fallen far short of the reduction goal established by Congress</u>. As a result, vehicle emissions remain the major contributor to the problem of nonattainment of the National Ambient Air Quality Standards for ozone and carbon monoxide in most urban areas of the country. In addition, <u>the shortfall has been much greater under important real world conditions not specifically included in the EPA designed Federal Test Procedure (FTP) but associated with unhealthy air quality</u>; these conditions include low speeds, cold temperatures, high speeds, rapid acceleration, idling, and heavy loads. Furthermore, attempts to reduce emissions from other vehicle categories have been even less successful than from automobiles.

When assessing the impact of vehicle emissions on the current and future nonattainment problems, the following should be considered.

* During 1985, EPA estimates that transportation sources were responsible for 70% of the total CO emissions, 34%of HC emissions, and 45% of the nitrogen oxides (NOx) emissions nationwide. (Based on recent preliminary data regarding evaporative "running losses", the HC contribution may be substantially higher.)
* In spite of substantial emission controls, motor vehicles still contribute almost the same proportion of total emissions as they did before

controls were required in 1970; the only major exception is lead.

* Growth in vehicle miles travelled and less stringent controls on other categories of mobile sources are offsetting the reductions achieved by the automobile emissions standards.
* Motor vehicle emissions will bottom out during the 1990s and start to increase from that point unless additional controls are required and current controls are implemented more effectively.
* EPA predicts that excess in-use emissions due to manufacturer noncompliance will increase rather than decrease over the next several years.

This report recommends that <u>EPA should reverse the dramatic cutback in the motor vehicle compliance and enforcement program</u>. Since 1980, EPA has reduced recall investigations of light duty vehicles by 67%. At the same time, EPA has reduced selective enforcement audit test orders by 51%, and fuel outlet inspections by 75%. In addition, EPA has never conducted any heavy duty vehicle recall testing under the full EPA test since the introduction of significant standards. This is particularly alarming since heavy duty vehicles are self certified by manufacturers with minimal EPA oversight.

Emission factors provide the technical basis for assessing and refining the motor vehicle pollution control program (I/M decisions, emissions standards, etc.) and for the selection of attainment strategies (State Implementation Plans). <u>The program for developing vehicle emission factors has been seriously compromised</u>. The vehicle emission factor database (number of vehicles tested) for the most recent mobile projection model (MOBILE 4) is less than one tenth the original 1978 database. Since the database on newer technology vehicles has declined, projections of trends in emissions will be less reliable than in the past. Resources must be restored to this program so that a statistically robust data base is available for designing the optimal Federal and State control strategies. In addition, other vehicle categories than automobiles, other test conditions than those reflected on the FTP, and other problems such as air toxics should be given a higher priority in model development.

The major component of the state and local mobile source control program is the vehicle emissions inspection and maintenance (I/M) program. Although the number of I/M programs has increased almost tenfold since 1980, EPA's resources devoted to this area have declined. <u>EPA has been unable or unwilling to provide the technical assistance and support needed to sustain high quality I/M programs</u>. Since many of these programs have been less successful than Congress originally envisioned, EPA must make a serious effort to foster improved program performance.

To achieve this objective, EPA should modify its current I/M policy to require mandatory use of computerized analyzers wherever decentralized programs are allowed. In addition, registration enforcement rather than sticker enforcement should be required. Also, EPA should modify the waiver policy to require at least $200 in repairs for 1975 and later model cars. EPA should also expand I/M technical support by developing test procedures for NOx and diesel particulates, adding an idle and possibly other "short" tests to the FTP to ensure that properly maintained vehicles will pass I/M requirements, and providing more advanced I/M protocols to account for the changing vehicle technologies of the 1990s. Combined with this, EPA should require manufacturers to tailor their electronic controls to provide onboard vehicle diagnostics. Finally, EPA should require states to periodically reevaluate their programs, to identify and correct problems which may reduce the overall emissions reductions.

<u>The Federal Motor Vehicle Control Program suffers from EPA's inability to effectively adjust to change</u> - whether it is in fuel quality (e.g., gasoline volatility) or technological modifications of vehicles, or vehicle operating characteristics. EPA should continuously monitor the actual fuels being used by vehicles, investigate driving conditions which promote excessive emissions as well as the emissions characteristics of various technologies under these conditions, and implement measures to ensure that EPA test protocols are consistent with these conditions. These program deficiencies have hindered states' efforts to attain the National Ambient Air Quality Standards for ozone and carbon monoxide.

Although this report focuses primarily on the existing federal program, it is important to recognize that <u>tighter emission standards will be necessary in order to ensure future attainment for both ozone and carbon monoxide</u>. EPA must move quickly to finalize its proposals to reduce fuel volatility and add onboard vehicle refueling controls. Emission control technology is available to reduce light duty vehicle tailpipe standards to 0.25 grams per mile (gpm) for HC, and 0.4 gpm for NOx, while retaining 3.4 gpm for CO under FTP conditions and achieving proportional improvements in CO under cold temperatures such as 20 degrees F. Standards should be tightened to take advantage of these advances and similar reductions should be mandated for the other vehicle categories, especially light trucks.

Beyond tighter standards, <u>emission control systems should be required to last for the actual life of a vehicle</u>, or at a minimum, up to 100,000 miles; for passenger cars, this requires a change in the Clean Air Act. If the full useful life compliance were required, substantial additional emission reductions would be realized.

In many areas of the United States, mobile sources are a substantial contributor to the overall health risks associated with air toxics. A variety of studies have found that in individual metropolitan areas, mobile sources are one of the most important source categories contributing to health risks associated with air toxics. According to EPA, mobile sources may be responsible for between 629 and 1874 excess cancer cases each year. While toxic emissions from motor vehicles have been lowered as a by-product of control strategies designed mainly to reduce hydrocarbons and diesel particulate, the problem remains of sufficient magnitude that it is recommended that a specific toxics pollution program be set up within the Office of Mobile Sources.

Further, new problems and opportunities are emerging which were not foreseen in 1970; EPA can address these problems by reacting after the fact or seizing the initiative and adopting a leadership role. For example, since the US remains the largest vehicle market in the world, EPA should get out front in developing a strategy to reduce the substantial motor vehicle role in global warming, It should act rapidly to define and control the unexpectedly high amount of unburned gasoline fumes emitted by evaporation while a vehicle is running. Further, it should take steps to assure that the potential environmental benefits from alternative fuels such as methanol and natural gas are realized without creating new environmental problems.

It is clear that EPA's Federal Motor Vehicle Control Program will need both increased resources and a stronger commitment to address the environmental and public health impacts caused in whole, or in part, by motor vehicle emissions. States have a major stake in ensuring that an effective federal mobile source program is administered by EPA because, except for California, the states are preempted from regulating tailpipe emissions. EPA should establish a state program office within the Office of Mobile Sources and a state/local agency advisory board to review all major EPA mobile source program issues. This will give states a more prominent, continuous role in EPA's mobile source decisions.

Since vehicle emissions play an important role in the current nonattainment problems, and are projected to continue to contribute significantly to air quality problems in the future, each of the steps summarized above must be taken. These include upgrading and expanding the FTP, extending the useful life provision for autos to 100,000 miles, adopting tighter standards for several vehicle categories, and implementing an aggressive compliance program and an improved inspection and maintenance program. These actions will help to significantly reduce motor vehicle emissions. Without these and other controls, overall air quality will remain unhealthy throughout many areas of the country for the foreseeable future.

I. Introduction

A. Background

Motor vehicles, using petrochemical fuels, emit significant quantities of carbon monoxide, hydrocarbons, nitrogen oxides, fine particles and lead, each of which in sufficient quantities can cause adverse effects on health and the environment. Because of the growing vehicle population and high emission rates, serious air pollution problems have become an increasingly common phenomena in modern life. Initially, these problems were most apparent in center cities but recently lakes and streams and even forests have also experienced significant degradation. As more and more evidence of man made impacts on the upper atmosphere accumulates, concerns are increasing that motor vehicles are contributing to global changes which could modify the climate of the entire planet.

In an effort to minimize the motor vehicle pollution problem, emission rates from cars in the US have been limited by legislation since the 1968 model year. Frustrated with the rate of progress in controlling pollution in light of the increasing evidence of adverse effects which were occurring, Congress decided during the late 1960's to accelerate the pace of control.(1,2) Because evidence was growing that vehicles were substantially exceeding their "lenient" standards in-use, Congress also decided to pay special attention to the compliance program.

In December of 1970, the Clean Air Act was amended by Congress, "to protect and enhance the quality of the nation's air resources." The Congress took particular notice of the significant role of the automobile in the nation's effort to reduce ambient pollution levels by requiring a 90% reduction in emissions from the level previously prescribed in emissions standards for 1970 (for CO and HC) and 1971 (for NOx) models. It was clearly the Congress' intent to aid the cause of clean air by mandating levels of automotive emissions that would essentially remove the automobile from the pollution picture. In 1977, the Act was "fine tuned" by Congress, delaying and slightly relaxing the auto standards, imposing similar requirements on trucks, and specifically mandating in use directed vehicle inspection and maintenance programs in the areas with the most severe air pollution problems.

Also during 1970, in an effort to better focus the Federal efforts in addressing environmental concerns, the US Environmental Protection Agency was created. Essentially, this effort consisted of pulling together various departments from within the Department of Health, Education and Welfare and Interior as well as other Federal Agencies. Therefore, as 1970 ended, the US seemed poised to aggressively attack the problems of air pollution -- A new Agency with a clear mission, a comprehensive law which provided the Agency with broad authority to implement its mission, and widespread public support, perhaps expressed most dramatically in the Earth Day demonstrations which swept across the Country in April of that year.

B. Study Objective

The purposes of this study are to explore more deeply what Congress actually intended for motor vehicles, how this intent has been carried out, and what additional steps, if any, can be taken to improve the future situation. To put these issues in context, the next section will summarize the motor vehicle pollution problem today, the contribution to overall nationwide emissions and the adverse effects which result. Section III will review the historical background - what Congress specifically mandated, the Federal Motor Vehicle Control Program which has evolved, the technology which has been developed in response to the "technology forcing" provisions contained in the law, and the effect on emissions and air quality. Section IV will review the current test procedures and the overall compliance program while Section V assesses proposals to lower emissions. Sections VI examines Inspection and Maintenance, elements necessary to improve existing programs and I/M's potential for reducing NOx and diesel particulate. Evaporative emissions are considered in Section VII whereas EPA's treatment of fuels and fuel additives is assessed in Section VIII. Transportation control measures, modelling and the associated data base, and motor vehicle's role in the toxics problem are reviewed in Sections IX, X and XI, respectively, while Section XII explores newly emerging issues. Finally, overall conclusions are drawn and recommendations presented in Sections XIII and XIV, respectively.

II. The Mobile Source Air Pollution Problem Today

A. Air Quality Remains Poor

Almost two decades after passage of the 1970 Clean Air Act Amendments, clean air has not been achieved in most major cities in the US. For example, while ozone levels declined 10% between 1979 and 1985, and there were 15% fewer ozone nonattainment areas in 1985 than in 1980 and 38% fewer violations of the ozone standard, forty-two states still contain at least one ozone or carbon monoxide nonattainment area, and many states contain several (see Table 1). Millions of Americans still live in areas which exceed the health standards for carbon monoxide and ozone. Finally, in many areas of the country including the Northeast, air quality actually deteriorated in 1987 and some areas have already experienced worse levels in 1988 than in several years. (75)

Table 1. Areas With 1985-87 Ozone Expected Exceedances Greater Than 1.0

EPA REGION	METROPOLITAN AREA (CMSA/MSA)	DESIGN VALUE	AVG. EST. EXC/YRS	1987 2ND DAILY MAX 1-HR	1987 EST. EXC
I	Boston, MA (CMSA)	0.14	2.2	0.14	4.3
I	Conn./Mass., CT-MA (Note #4)	0.17	5.8	0.17	11.6
I	Hancock County, ME*	0.13	1.3	0.12	1.1
I	Kennebec County, ME*	0.12	1.2	0.09	0
I	Knox County, ME*	0.15	4.4	0.13	6.5
I	Lincoln County, ME*	0.13	2.4	-NO DATA-	
I	New Bedford, MA	0.14	2.4	0.12	1.0
I	Portland, ME	0.14	3.4	0.14	4.0
I	Portsmouth-Dover, NH-ME	0.13	3.2	0.13	3.2
I	Providence, RI-MA (CMSA)	0.16	6.5	0.16	7.8
I	Worcester, MA	0.13	2.1	0.11	0
I	York County, ME*	0.15	4.2	0.14	4.9
II	Atlantic City, NJ	0.14	3.4	0.14	4.0
II	Jefferson County, NY*	0.13	4.7	0.13	4.7
II	New York, NY-NJ-CT (CMSA)	0.19	7.5	0.19	19.2
III	Allentown-Bethelehem, PA-NJ	0.13	1.4	0.13	3.2
III	Baltimore, MD	0.17	7.9	0.17	11.1
III	Huntington, WV-KY-OH	0.14	3.8	0.14	5.2
III	Kent County, DE*	0.13	1.8	0.15	3.2
III	Norfolk, VA	0.13	2.0	0.13	2.0
III	Parkersburg, WV-OH	0.13	1.5	0.15	3.5
III	Philadelphia, PA-NJ-DE (CMSA)	0.16	13.6	0.18	23.2
III	Pittsburgh, PA (CMSA)	0.13	1.7	0.14	4.1
III	Richmond, VA	0.13	1.3	0.14	3.0
III	Washington, DC-MD-VA	0.15	6.2	0.16	10.5
IV	Atlanta, GA	0.17	13.5	0.17	15.0
IV	Birmingham, AL	0.15	3.2	0.14	3.1
IV	Charlotte, NC-SC	0.13	3.0	0.14	4.0
IV	Jacksonville, FL	0.16	2.1	0.12	1.1
IV	Lexington, KY	0.13	1.6	0.11	1.1
IV	Louisville, KY	0.16	4.0	0.13	2.0
IV	Memphis, TN-AR-MS	0.13	2.0	0.13	2.0
IV	Miami-Hialeah, FL (CMSA)	0.15	2.1	0.15	3.1
IV	Montgomery, AL	0.14	2.2	0.14	4.3
IV	Nashville, TN	0.14	3.2	0.14	3.2
IV	Raleigh-Durham, NC	0.13	1.4	0.13	3.2
IV	Tampa, FL	0.13	2.1	0.16	4.2

EPA REGION	METROPOLITAN AREA (CMSA/MSA)	DESIGN VALUE	AVG. EST. EXC/YRS	——1987—— 2ND DAILY MAX 1-HR	EST. EXC
V	Chicago, IL-IN-WI (CMSA)	0.17	7.4	0.18	12.8
V	Cincinnati, OH-KY-IN	0.14	1.6	0.15	2.1
V	Cleveland, OH	0.13	1.8	0.13	2.2
V	Detroit, MI (CMSA)	0.13	2.0	0.13	2.1
V	Grand Rapids, MI	0.13	1.3	0.14	3.0
V	Indianapolis, IN	0.13	1.3	0.12	1.1
V	Kewaunee County, WI	0.13	1.9	0.14	5.8
V	Milwaukee, WI (& Sheboygan, WI)	0.17	3.7	0.20	12.9
V	Muskegon, MI	0.17	6.0	0.18	11.0
VI	Baton Rouge, LA	0.14	3.0	0.16	5.1
VI	Beaumont-Port Arthur, TX	0.13	2.1	0.13	3.2
VI	Dallas-Fort Worth, TX (CMSA)	0.16	6.1	0.14	5.2
VI	El Paso, TX	0.16	9.0	0.17	11.1
VI	Houston, TX (CMSA)	0.20	19.1	0.18	20.8
VI	Iberville Parish, LA*	0.13	2.4	0.13	2.1
VI	Tulsa, OK	0.12	1.1	0.12	1.0
VII	St. Louis, MO-IL	0.16	5.4	0.17	8.0
VIII	Salt Lake City, UT	0.15	3.8	0.11	1.0
IX	Bakersfiled, CA (Note #5)	0.16	35.1	0.16	47.6
IX	Fresno, CA	0.17	30.5	0.17	42.6
IX	Kings County, CA*	0.13	5.6	0.13	5.6
IX	Los Angeles, CA (CMSA)	0.35	143.5	0.32	141.2
IX	Modesto, CA	0.15	16.2	0.15	20.8
IX	Phoenix, AZ (Note #5)	0.14	2.4	0.11	0
IX	Sacramento, CA (Note #5)	0.17	9.7	0.17	14.6
IX	San Diego, CA	0.18	12.5	0.18	26.8
IX	San Francisco, CA (CMSA)	0.14	3.4	0.15	4.1
IX	Santa Barbara, CA	0.14	1.7	0.13	3.4
IX	Stockton, CA (Note #5)	0.14	8.1	0.12	(inc.)
IX	Visalia, CA (Note #5)	0.15	11.9	0.15	21.6
X	Portland, OR-WA (CMSA)	0.15	1.8	0.11	1.2

* Not a Metropolitan Statistical Area

NOTES:

1. Metropolitan Statistical Areas are defined by the Office of Management and Budget, and include a central county and adjacent counties, if any, which interact with urban area.
2. The air quality design value is the fourth highest monitored value with 3 complete years of data since the standard allows one exceedance for each year. This value may differ from the actual SIP Control strategy value due to air quality modeling considerations such as the level of transported ozone.

3. The National Ambient Air Quality standard for ozone is 0.12 parts per million (ppm) daily maximum 1-hour average not to be exceeded more than once per year on average. The average estimated number of exceedances column shows the number of days the 0.12 ppm standard was exceeded on average at the site recording the highest design value after adjustment for incomplete, or missing days, during the three year period, 1985-87. The highest design value and the highest estimated exceedances for just 1987 are shown in the last two columns. These two values may be from two different monitoring sites.

4. Connecticut-Massachusetts includes Bristol, Hartford, Middletown, New Britain, New Haven, and New London, CT and Springfield, MA MSA's.

5. Incomplete data at this time, thus expected exceedance estimate is preliminary, however the air quality status with respect to the standard will not change.

Table 1 (Continued)
Areas with Two or More Exceedances of the
Carbon Monoxide NAAQS, 1986-87

		- 1986 -		- 1987 -	
EPA REGION	METRO. STAT. AREA (MSA)	2nd Max 8HR (ppm)	# EXC	2nd Max 8HR (ppm)	# EXC
I	Boston, MA	9.7	2	7.1	0
I	Hartford, CT	10.9	3	11.4	7
I	Manchester, NH	10.6	6	10.3	5
I	Nashua, NH	10.3	3	9.1	1
I	Springfield, MA	9.7	2	8.9	1
II	Bergen-Passaic, NJ	10.0	2	8.3	0
II	Jersey City, NJ	9.7	2	8.0	0
II	Nassau-Suffolk, NY	8.9	1	9.9	4
II	New York, NY (Note #4)	15.1	40	19.6	86
II	Newark, NJ	11.7	3	8.9	1
II	Syracuse, NY	11.3	6	9.6	2
III	Baltimore, MD	12.3	5	9.2	1
III	Pittsburgh, PA	10.4	2	8.8	1
III	Washington, DC-MD-VA	8.6	0	11.4	2
IV	Memphis, TN-AR-MS	11.9	2	10.5	2
IV	Nashville, TN	10.2	3	8.5	1
IV	Raleigh-Durham, NC	13.9	20	9.7	2
V	Cleveland, OH (Note #5)	10.1	2	6.6	0

EPA REGION	METRO. STAT. AREA (MSA)	- 1986 - 2nd Max 8HR (ppm)	# EXC	- 1987 - 2nd Max 8HR (ppm)	# EXC
V	Detroit, MI (Warren, MI)	11.9	2	9.4	1
V	Duluth, MN	9.6	2	8.5	1
V	Minneapolis-St. Paul, MN-WI	9.7	5	13.3	5
V	Steubenville-Weirton, OH-WV	9.1	0	19.1	24
VI	Albuquerque, NM	12.7	15	16.3	14
VI	El Paso, TX	12.1	10	15.4	11
VI	Houston, TX	9.8	2	8.3	0
VI	Oklahoma City, OK	10.7	3	11.4	4
VII	Lincoln, NE	9.9	3	7.2	0
VII	Springfield, MO	9.5	2	7.5	1
VII	St. Louis, MO-IL	8.6	0	10.5	2
VII	Wichita, KS	9.6	2	9.0	0
VIII	Denver, CO	25.8	33	15.6	24
VIII	Fort Collins, CO	12.4	6	12.8	5
VIII	*Great Falls, MT	9.3	1	11.0	3
VIII	Greeley, CO	11.6	4	10.5	3
VIII	*Missoula, MT	8.9	1	10.6	4
VIII	Provo-Orem, UT	14.4	24	13.3	20
VIII	Salt Lake City-Ogden, UT	11.6	9	9.8	2
IX	Anaheim-Santa Ana, CA	10.0	3	9.7	0
IX	Chico, CA	10.1	2	7.9	0
IX	Fresno, CA	15.6	8	9.9	2
IX	Las Vegas, NV	15.9	27	16.0	20
IX	Los Angeles-Long Beach, CA	18.1	54	16.9	40
IX	Modesto, CA	11.1	4	7.1	0
IX	Phoenix, AZ (Note #6)	16.0	78	11.2	11
IX	Reno, NV (Sparks, NV)	13.4	23	8.9	1
IX	Sacramento, CA (& S. Lake Tahoe)	12.5	11	12.3	9
IX	San Francisco, CA	10.4	2	8.5	1
IX	San Jose, CA	10.6	4	7.1	0
IX	Vallejo-Fairfield-Napa, CA	10.1	4	8.3	0
X	Anchorage, AK	11.7	5	11.5	4
X	Boise City, ID (Note #7)	9.7	3	8.3	0
X	*Fairbanks, AK	14.8	32	13.9	15
X	*Grant Pass, OR	10.2	2	9.7	4
X	Medford, OR	12.6	18	9.5	3
X	Seattle, WA (& Bellevue)	11.9	6	10.0	4
X	Spokane, WA	16.0	44	19.0	66
X	Tacoma, WA	12.2	6	14.8	9
X	Vancouver, WA	-NO DATA-		9.8	2
X	Yakima, WA	11.0	3	11.0	4

*Not a Metropolitan Statistical Area

NOTES:
1. Metropolitan Statistical Areas are defined by the Office of Management and Budget, and include a central county and adjacent counties, if any, which interact with the urban area.

2. The National Ambient Air Quality Standard for carbon monoxide is 9 ppm 8-hour nonoverlapping average not to be exceeded more than once per year. The rounding convention in the standard specifies that values of 9.5 ppm, or greater, are counted as exceeding thelevel of the standard.

3. The exceedances of the carbon monoxide standard listed in the table are from the same site which recorded the highest second maximum 9-hour concentration in that year.

4. The exceedances count for New York in 1986 is from the second highest site because the site with the highest value had incomplete data for that year.

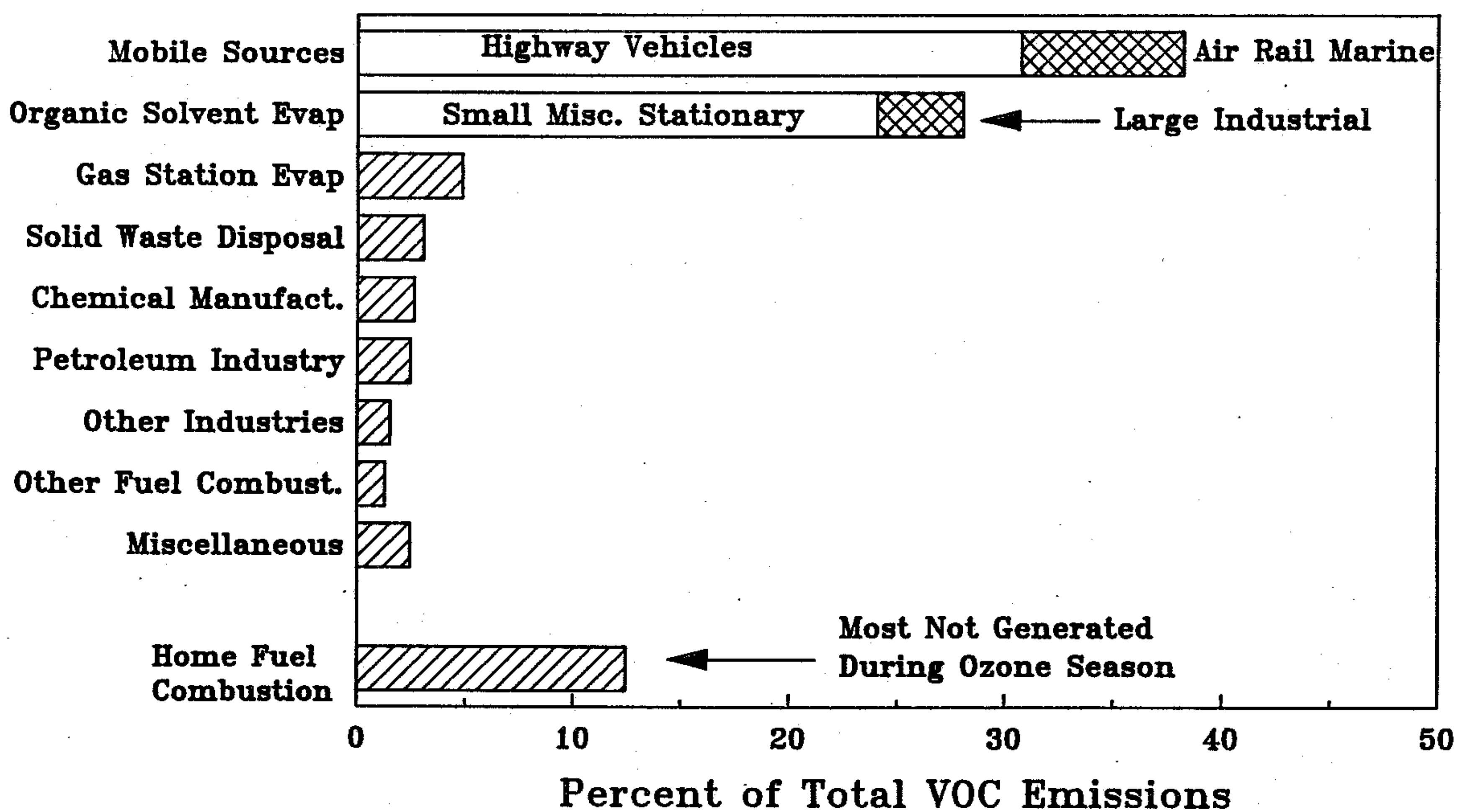
5. The monitoring site recording the violation of the standard in 1986 was discontinued early in 1986.

B. The Dominant Role of Motor Vehicle Emissions

Motor vehicles remain the dominant source of the emissions which cause these air quality problems. In 1985, nationwide, transportation sources were responsible for 70% of the carbon monoxide, 45% of the NOx, 34% of hydrocarbons (HC), 18% of the particulate, and 73% of the lead emissions. (Ozone, commonly known as smog, is produced by a photochemical reaction of hydrocarbons and NOx emissions.) In some urban areas, the contribution of mobile source emissions is even greater than these national figures. Including transportation sources other than highway vehicles (e.g., air, rail, marine), the Congressional Office of Technology Assessment (OTA) recently concluded that mobile sources were actually responsible for almost 40 percent of of total nationwide volatile organic compounds; as illustrated in Figure 1, the only other major source category which OTA found to be responsible for even close to mobile source emissions in 1985 was organic solvent evaporation.(74) (Based on recent preliminary data regarding evaporative "running losses", the HC contribution from vehicles may actually be substantially higher.)

While automobile emissions have been regulated by the Federal government since the late 1960's, the percentage contribution from mobile sources to total emissions, with the exception of lead, has not changed appreciably. Growth in vehicle miles travelled and less stringent controls on other mobile sources are reducing the overall gains from the automobile standards. In addition, the automobile standards are not achieving the full benefit intended. For example, EPA's own data show clearly that while properly maintained cars emit substantially less than normally maintained vehicles, they also show that at least <u>for CO</u>

1985 VOC EMISSIONS BY SOURCE CATEGORY



Source: April 1988 OTA

Figure 1

Walsh/NESCAUM

and HC, properly maintained cars usually exceed standards by the time they reach 30,000 miles and over their lifetimes are well in excess of the levels intended by Congress. EPA's ability to require vehicles to achieve standards for 50,000 miles, even on average, seems to be no better than it was when Congress expanded the tools available to the Agency. Further, according to the Agency's own analysis, the excess in-use emissions due to manufacturer noncompliance will increase over the next several years rather than decrease.

Therefore, because motor vehicle emissions remain such a high percentage of total emissions, significant additional reductions of pollutants from mobile sources have the potential to result in substantial overall improvements.

C. Future Projections Indicate Long Term Problems

As noted above, many areas of the country have been unable to attain healthy air quality levels. This is particularly worrisome in light of the emission projections by the US EPA, the National Acid Precipitation Assessment Program (NAPAP), and the American Lung Association (ALA) which indicate that in the absence of new control measures, carbon monoxide, hydrocarbon, and NOx emissions will begin to increase in the late 1990s. (see Figures 2-6) Additional motor vehicle controls can play a significant role in lowering these emissions; without additional motor vehicle controls, unhealthy air quality levels will prevail in the Northeast and many other areas of the country for the foreseeable future.

D. The Adverse Consequences of Excess Pollution

The adverse public health and environmental effects from vehicle emissions are far reaching. In addition to contributing substantially to the ozone and carbon monoxide nonattainment problems, emissions from vehicles are also responsible for exposing the public to other hazardous air pollutants such as fine particulates, nitrogen dioxide, and a variety of toxic air pollutants. Emissions from vehicles also adversely affect terrestrial and aquatic ecosystems, cause crop damage, contribute to the global warming phenomenon, and promote visibility impairment and depletion of the stratospheric ozone layer.

1. Ozone

The ozone problem is a special concern. First, the problem is widespread and pervasive and appears likely to be a long term problem in up to forty of our largest metropolitan areas unless significant further controls are implemented. Almost 80 million Americans currently reside in areas which exceed the current air quality standard(10, 56); many of

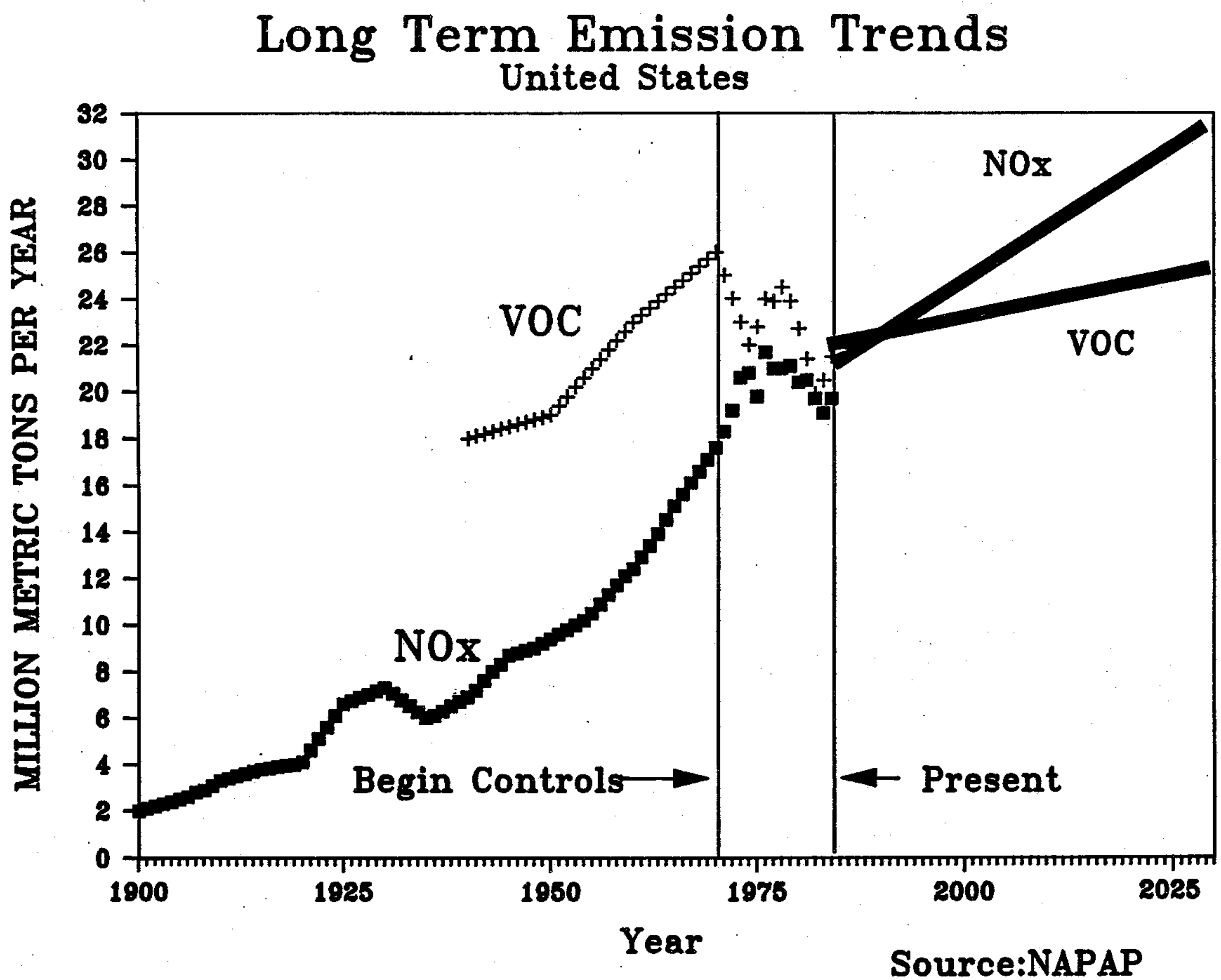
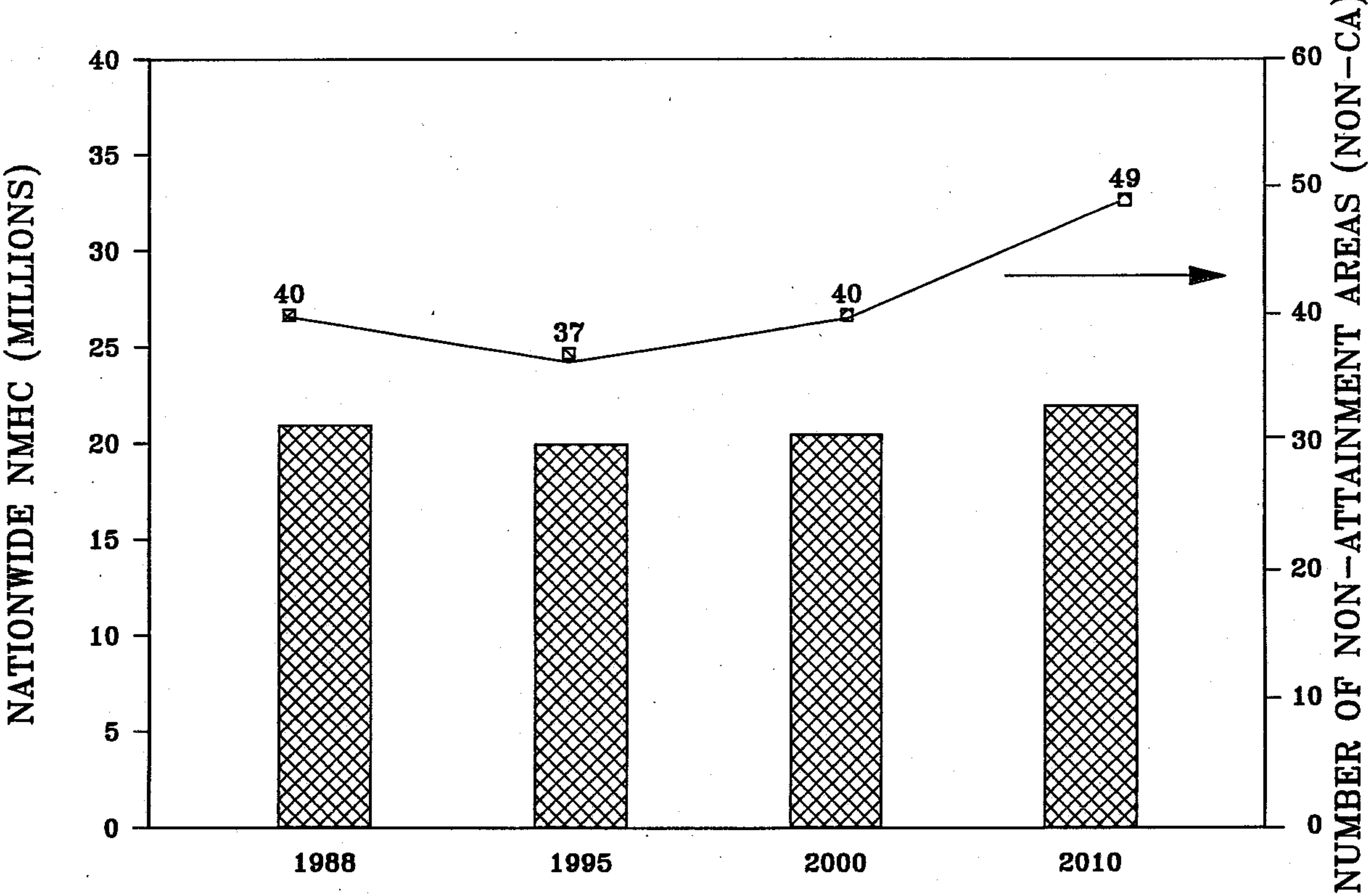


Figure 2

Walsh/NESCAUM

EMISSIONS AND NON-ATTAINMENT AREAS



SOURCE: EPA

VOC EMISSIONS TRENDS WITHOUT ADDITIONAL CONTROLS

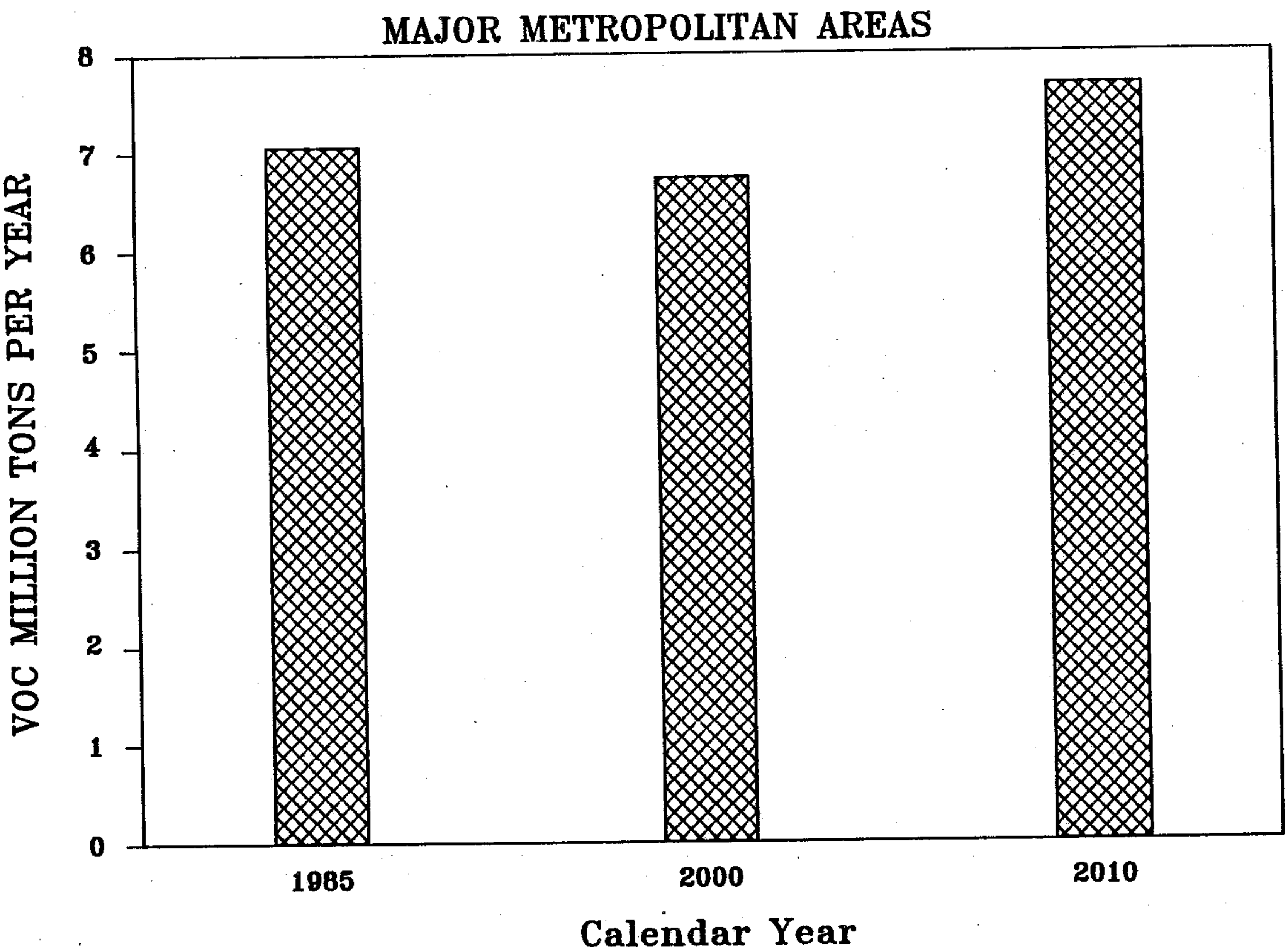
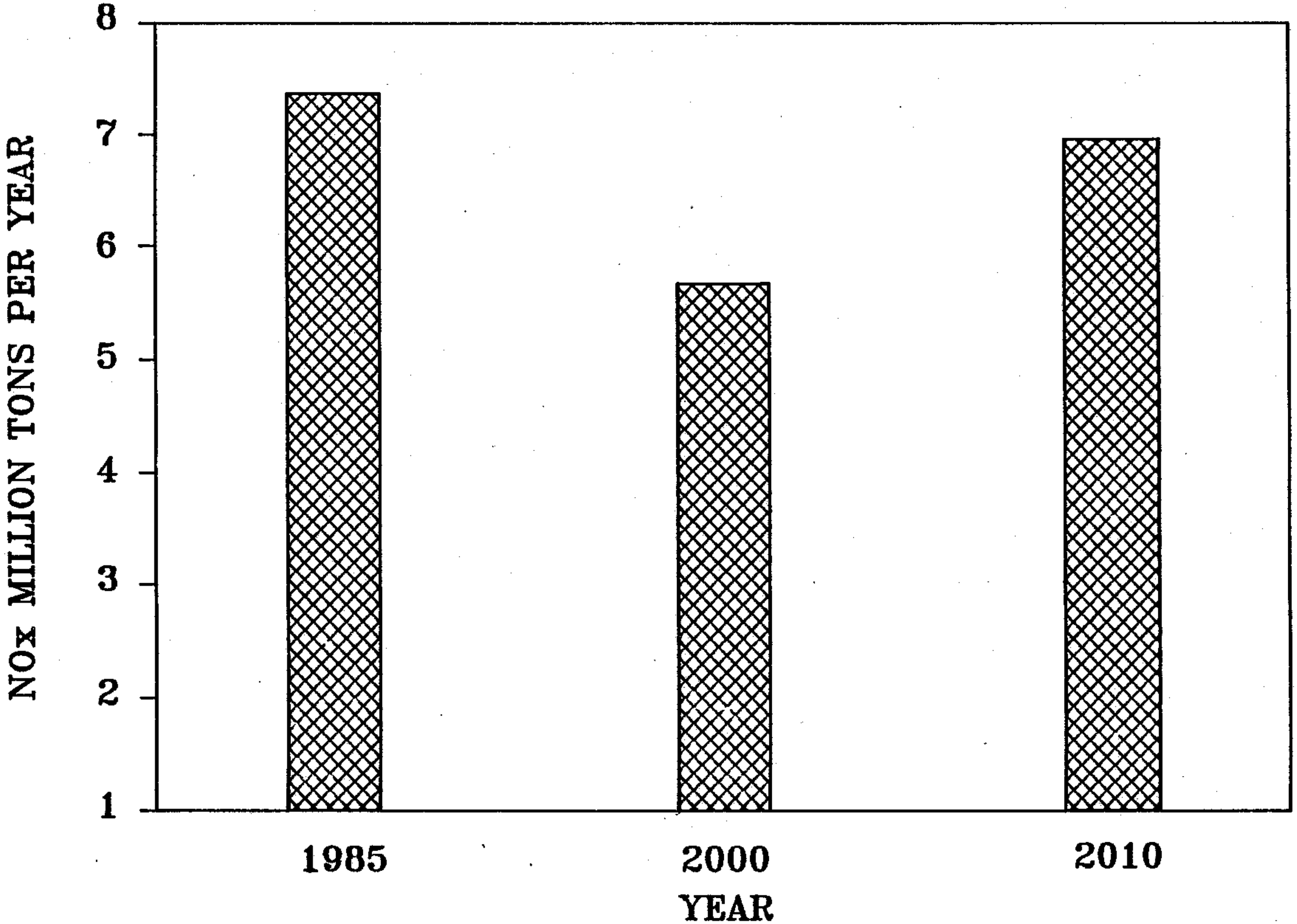


Figure 4

Walsh/NESCAUM

NOx EMISSIONS -- TRENDS WITHOUT ADDITIONAL CONTROLS

MAJOR METROPOLITAN AREAS



CO EMISSIONS TRENDS WITHOUT ADDITIONAL CONTROLS
MAJOR METROPOLITAN AREAS

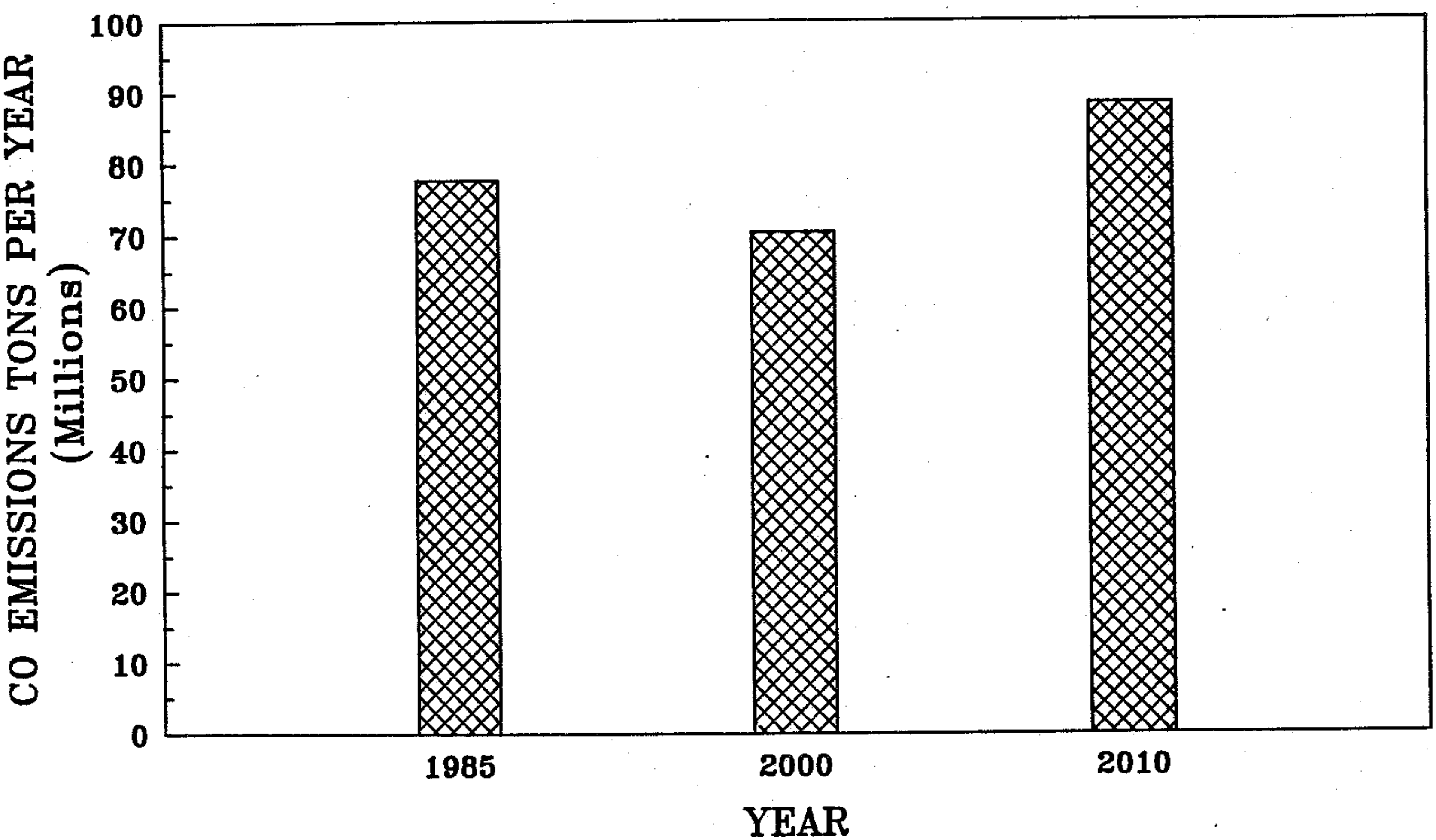


Figure 6

Walsh/NESCAUM

these individuals suffer eye irritation, cough and chest discomfort, headaches, upper respiratory illness, increased asthma attacks, and reduced pulmonary function as a result of this problem.

In addition, the current air quality standard tends to understate the health effects. For example, as noted in testimony before the Congress in 1987 by EPA Administrator Lee Thomas, new studies indicate:

> "that elevated ozone concentrations occurring on some days during the hot summers in many of our urban areas may reduce lung function, not only for people with preexisting respiratory problems, but even for people in good health. This reduction in lung function may be accompanied by symptomatic effects such as chest pain and shortness of breath. Observed effects from exposures of 1 to 2 hours with heavy exercise include measurable reductions in normal lung function in a portion (15 - 30 percent) of the healthy population that is particularly sensitive to ozone."(10)

Other studies presented at the recent US Dutch Symposium on ozone indicate that healthy young children suffer adverse effects from exposure to ozone at levels below the current air quality standard.(76)

Despite the application of emission controls on thousands of stationary sources and millions of vehicles the national composite average of the second-highest daily maximum 1-hour ozone values recorded at 242 sites decreased by only 13% between 1979 and 1986(9,56). In recent years, even this minimal level of progress has slowed. Although nationally the total number of annual ozone standard violations has decreased by 38% between 1979 and 1986, the northeastern United States experienced a 45% increase in ozone standard violations in 1987 as compared to 1986. Within the last few months, with a severe heat wave gripping much of the country, many areas have experienced the highest ozone levels in several years.(75)

The ozone problem has become so ubiquitous that background levels in rural areas frequently approach levels where adverse effects have been observed. This is due in large part to the long range transport of ozone and ozone precursor emissions which routinely occur in many areas of the country. In fact, multi-day ozone transport episodes occur relatively frequently in the northeastern United States resulting in violations of the ozone NAAQS in pristine areas, such as Acadia National Park.

Numerous studies have also demonstrated that photochemical pollutants inflict damage on forest ecosystems and seriously impact the growth of certain crops. For example, the Congressional Research Service of the US Library of Congress found that, in the United States alone, "the short-run or immediate impacts of ozone are evident in annual crop yield decreases estimated at $1.9 to $4.3 billion."(11) Substantial evidence has been collected confirming ozone induced damage to numerous indigenous forest species throughout the US.

2. Carbon Monoxide

Exposure to carbon monoxide results almost entirely from motor vehicle emissions. (In some localized areas, wood stoves also significantly affect CO levels.) There has been great progress in reducing ambient CO levels across the United States: during the last ten years, the national composite average decreased by 36% and the average number of exceedences decreased by 92%. However, the problem is far from solved. Approximately 85 major metropolitan areas with a population approaching 30 million currently exceed the carbon monoxide air quality standard. In fact, EPA Administrator Lee Thomas indicated in Congressional testimony (February 1987) that as many as 15 areas in the United States may have intermittent carbon monoxide (CO) problems that could prevent attainment for many years.(10)

The CO problem is important because of the clear evidence relating CO exposure to adverse health effects. For example, in a recent assessment conducted under the auspices of the Health Effects Institute, it was concluded that:

> "These findings demonstrate that low levels of COHb produce significant effects on cardiac function during exercise in subjects with coronary artery disease."(77)

Further, the importance of CO control was reinforced by another recent study of tunnel workers in New York City. As noted by the authors:

> "Given the magnitude of the effect that we have observed for a very prevalent cause of death, exposure to vehicular exhaust, more specifically to CO, in combination with underlying heart disease or other cardiovascular risk factors could be responsible for a very large number of preventable deaths."(11)

In addition, recent evidence indicates that CO may contribute to elevated levels of ozone.(29)

3. Oxides of Nitrogen

NOx emissions from vehicles and other sources produce a variety of adverse effects including direct health and environmental effects. NOx emissions also react chemically with other pollutants to form ozone and other highly toxic pollutants. Next to sulfur dioxide, NOx emissions are the most prominent pollutant contributing to the production and resulting effects from acidic deposition.

Exposure to nitrogen dioxide (NO_2) emissions is linked with increased susceptibility to respiratory infection, increased airway resistance in asthmatics, and decreased pulmonary function.(19) While most areas of the US currently attain the annual average national air quality standard, short term exposures to NO_2 have resulted in a wide ranging group of respiratory problems in school children (cough, runny nose and sore throat are among the most common) as well as increased sensitivity to bronchoconstrictors by asthmatics(20,21).

The World Health Organization concluded that a maximum 1 hour exposure of 190-320 micrograms per cubic meter (0.10-0.17 ppm) should be consistent with the protection of public health and that this exposure should not be exceeded more than once per month. The State of California has also adopted a short term NO_2 standard, 0.25 ppm averaged over one hour, to protect public health. If this were adopted nationwide, many more areas would be found in violation than currently exceed the annual standard.

Oxides of nitrogen have also been shown to affect vegetation adversely. Some scientists believe that NOx is a significant contributor to the dying forests throughout central Europe.(22) This adverse effect is even more pronounced when nitrogen dioxide and sulfur dioxide occur simultaneously. Further, nitrogen dioxide has been found to cause deleterious effects on a wide variety of materials (including textiles dyes and fabrics, plastics, and rubber) and is responsible for a portion of the brownish coloration in polluted air or smog.

Acid deposition results from the chemical transformation and transport of sulfur dioxide and nitrogen oxides. NOx emissions are responsible for approximately one-third of the acidity of rainfall.

Several acid deposition control plans contained in proposed federal legislation have targeted reductions in NOx emissions in addition to substantial reductions in sulfur dioxide. All of the northeastern states and several states from other areas of the country have supported these legislative proposals. Furthermore, the ten participating countries at the 1985 International Conference of Ministers on Acid Rain committed to "take measures to decrease effectively the total annual emissions of nitrogen oxides from stationary and mobile sources as soon as possible".(27)

It is important to note that NOx emissions have approximately tripled in the US since 1950.(23)

Although recently NOx emissions have begun to decline in the US, this trend is not projected to continue. In fact, NOx emissions in the US are expected to increase sharply by the turn of the century due primarily to stationary source growth and increasing mobile source emissions. (see Figure 2)

4. Lead

The extremely serious health hazard associated with lead is no longer debatable. Unfortunately, recent studies suggest that lead causes health risks at exposure levels even lower than previously believed. For example, a recent study concluded that fetuses are adversely affected by exposure to lead at concentrations well below the current US limit of 25 micrograms per deciliter of blood.(24) In tests of 249 children studied between birth and age 2, the researchers found that children born with lead levels of at least 10mg/dl scored nearly 7% lower on developmental tests than children with little or no lead in their blood.

Primarily due to the phaseout of lead in gasoline, ambient lead levels have also declined substantially during the past decade. The composite maximum quarterly average of ambient lead levels, recorded at 82 urban sites across the country, decreased by 87%.(8,56)

5. Particulate

Diesel particles are small and respirable (less than 2.5 microns) and consist of a solid carbonaceous core on which a myriad of compounds adsorb. Diesel particulates include unburned hydrocarbons, oxygenated hydrocarbons, polynuclear aromatic hydrocarbons, and inorganic species such as sulfur dioxide, nitrogen dioxide, and sulfuric acid.

Very recent studies indicate that these emissions can cause cancer and exacerbate mortality and morbidity from respiratory disease. For example, the Harvard University Health Effects Project recently concluded that "particulate pollution should be a public health concern because, even at current ambient concentrations, it may be contributing to excess mortality and morbidity. Furthermore, our recent analyses...indicate that fine particles (FP) and sulfates (SO4) are among the most harmful particles to public health."(13)

Many areas of the country experience unhealthy air quality levels for particulate (PM-10) matter. It is estimated that from 70 to as many as 160 areas violate this air quality standard. PM-10 comes from many sources, but diesel powered vehicles contribute a significant percentage in urban areas. It is also important to note that diesel NOx and sulfate emissions also contribute to ambient PM-10 levels as well as to acid deposition.

Researchers at Harvard conducted a pilot cancer of US railroad workers which indicated that the risk ratio for respiratory cancer in diesel exposed subjects relative to unexposed subjects could be as great as 1.42, i.e., individuals exposed to diesels have a 42% greater possibility of developing cancer than individuals who are not exposed.(14) The follow-up study appears to be equally alarming: "Using multiple logistic regression to adjust for smoking and asbestos exposure, workers age 64 or less at the time of death with lung cancer had increased relative odds ...of having worked in diesel exhaust exposed jobs."(15) Further, during late 1985 and 1986, the results of several new animal studies were released which reinforced these concerns regarding adverse health effects from diesel particulate emissions.(16) In particular, a study conducted under the auspices of the European automobile manufacturers, the CCMC, and conducted by Battelle-Geneva reported that unfiltered diesel exhaust produced an increase in lung tumor incidence from 1% to 40%.(17)

Beyond the adverse health effects, diesel particles are a nuisance. They degrade aesthetics and material usage through soiling and may contribute directly, or in conjunction with other pollutants, to structural damage by means of corrosion or erosion.

They also contribute to impaired visibility. Because of the composition (primarily carbon based) and size (averaging about 0.2 microns) of diesel particulates, they are very efficient light absorbers and scatterers and therefore have the potential to be especially harmful to visibility.

6. Toxics

Other toxic air pollutants, such as benzene and formaldehyde, have over recent years become an important focus of air pollution control programs.(18) Air toxic program activities have been centered on identifying pollutants of concern, evaluating sources and resulting ambient concentrations, characterizing the health impacts associated with those concentrations, and requiring a variety of sources to reduce toxic emissions.

Historically, stationary industrial sources of toxic air pollutants have been the first subject of air toxic regulations and guidelines, in part because of existing permitting authorities at the state and local level. However, in many areas of the United States, area sources, especially mobile sources, appear to be a substantial contributor to the overall health risks associated with air toxics.(18) A variety of studies have found that in individual metropolitan areas mobile sources are one of the most important and possibly the most important source category in terms of contributions to health risks associated with air toxics(18) According to EPA, mobile sources may be responsible for between 400 and 2,850 excess cancer cases per year.(57) Based on more recent data regarding 1,3 butadiene, this estimate has been lowered but is still significant.(73)

The mobile source toxics problem has traditionally not received as much attention as the "criteria" pollutants. However, as the above section indicates, this is an area deserving increased attention at both the federal and state level, not only with regard to direct emissions but also with regard to secondary pollutants which result from the transformation of these direct pollutants in actual urban air, e.g., nitrated polynuclear aromatic hydrocarbons.

E. Conclusions Regarding Adverse Effects

Health concerns continue to drive the need for greater control of HC, CO, NOx, and particulate emissions from motor vehicles. Vehicles remain the major source of most of these pollutants and the evidence of adverse health effects continues to increase. As noted by Dr. H. Ozkaynak of Harvard University in testimony presented to the Senate Committee on Environment and Public Works last June, "In in every epidemiologic investigation that we have performed over the past six years, we have repeatedly found a 2% to 5% air pollution effect on human mortality and morbidity."(58)

III. The Evolution of the Program

A. Historical Background

Almost 40 years ago, the citizens of Los Angeles began to notice more and more frequently that the beautiful mountains which surrounded the city were gradually disappearing behind a smoggy haze. When in a stroke of genius, Dr. Arie J. Haagen-Smit determined that hydrocarbons and nitrogen oxides emitted from the rapidly growing car population were mainly responsible for this new phenomena, a chain of events was set in motion which has literally transformed the worldwide motor vehicle industry. This process continues to this day.(3,4)

1. California Leadership

In 1959, California adopted legislation which called for the installation of pollution control devices as soon as three workable control devices were developed. At that time, the auto manufacturers repeatedly asserted that the technology to reduce emissions did not exist.

In 1964, the State of California was able to certify that three independent manufacturers had developed workable, add-on devices. This triggered the legal requirement that new automobiles comply with California's standards beginning with the 1966 model year. Soon afterward the major domestic manufacturers announced that they too could and would clean up their cars with technology which they had developed. Thus, independently developed devices were unnecessary. For two of the big three, Ford and General Motors, this development included a relatively simple air pump. For the third, Chrysler, it was a "clean air package" which consisted of minor changes in the fuel and carburetion system. (It was learned later that the clean air package concept dramatically increased NOx emissions.)

Subsequent to California's pioneering efforts, and as a result of recognition of the national nature of the auto pollution problem in 1964, the Congress initiated Federal motor vehicle pollution control legislation. As a result of the 1965 Clean Air Act Amendments, the 1966 California auto emission standards were applied nationally in 1968.

2. Federal Pre-Emption

In this period, the auto industry became increasingly concerned over a proliferation of proposals by States to adopt differing auto emission control requirements. Thus in 1967, the auto industry called on Congress to preempt State emission control laws.

The Congress responded and State authority to regulate emissions was preempted, though California's unique position was preserved. However, preemption was premised on the condition that the Federal standards would be sufficiently stringent to assure protection of public health in the areas of the Nation with the most severe auto related pollution problems. Thus, <u>Federal emission controls were to be based on the "worst case" principle in order to protect all areas of all States</u>.

3. Motor Vehicles A Major Source

During hearings in March of 1970, information provided to the Subcommittee on Air and Water Pollution by the Public Health Service and other witnesses defined the extent of the threat to public health associated with automotive air pollution in major cities. Those facts confirmed a sense of urgency that was expressed in the Senate Committee Report on the 1970 Clean Air Act: "The air pollution problem, is more severe, more pervasive, and growing at a more rapid rate than was generally believed."(4)

The automobile appeared to be the biggest obstacle to reversing that trend, since it was responsible for such a large part of the pollution load and was virtually impossible to control once in the hands of the consumer.

4. Technology Forcing

On the basis of available facts, the Congress decided that the timetable by which pollution control was progressing was too slow. Therefore, it decided to press the technological capability of the industry. In light of the identified dangers to public health and in light of the pervasive use of the automobile, the Congress decided that there should be an enforceable deadline for the production of a clean car. EPA's predecessor, the National Air Pollution Control Administration, indicated that reductions of approximately 90% in 1970-71 model automobile emissions of hydrocarbons, carbon monoxide, and nitrogen oxide would be necessary if the emission goals needed to achieve the national ambient air quality standards were to be reached in many major metropolitan areas.

These projections were translated into the 1970 Clean Air Act requirements that the auto industry achieve a 90% reduction from 1970 emission levels of hydrocarbons and carbon monoxide by 1975 or 1976 and a 90% reduction in 1971 levels of nitrogen oxide emissions by 1976 or 1977.

5. Vehicles In Use

Even the relatively lenient standards contained in the 1965 Act did not produce the results the Congress intended. Little progress was made by the industry to develop either a clean conventional engine or a viable alternative. And control systems installed by Detroit did not perform to the level of emission reduction for which they were certified. As NAPCA testified in Hearings before the House in March of 1970, between 75 to 80 percent of the 1968-1969 model cars exceeded standards at relatively low mileage. For hydrocarbons, which was the worst case, for example, 1968 Model Year Fords exceeded standards by 4000 miles, while GM and Chrysler cars did so at 10,000 miles.(3)

Based on the poor performance in achieving the lenient standards in effect during the 1968-69 model years, Congress realized that compliance with standards in use would require steps well beyond prototype certification. Key provisions were added to the law, designed to deal with the problem.

Under Section 206 certificates of conformity with emission requirements were required to be obtained by manufacturers prior to sale of motor vehicles. The certificates were to last for a period not in excess of one year. A certificate was only issued if EPA determined, in accordance with testing procedures representative of urban driving patterns, that a vehicle or engine would meet the emission levels specified for a particular year and would do so for a five-year or 50,000 mile useful life.

Congress recognized that the certification procedure, by definition, had a critical flaw, vehicles tested to get the certification are not the mass production cars sold to the consumer. They are pre-production "prototype vehicles" hand crafted and carefully tuned and maintained by top mechanics. Thus many of the flaws of mass production or the limitations of consumer maintenance are eliminated. Further, certification testing is done under conditions hardly representative of consumer driving.

To attempt to overcome the limitations of the certification process, section 207 of the Act was added. This required that manufacturers assure through a design warranty that their motor vehicles are designed, built and equipped to meet the standards for five years or 50,000 miles. In addition to the design warranty, the section also included a performance warranty under which automakers. were required to warrant the performance of the emission control systems of their cars for the full five years or 50,000 mile useful life. However, the performance warranty was not made effective until EPA developed an in-use test which could be correlated with the certification test.

In addition to the warranty provision, EPA was required to institute a recall of motor vehicles when it was determined that "a substantial number of any class or category of vehicles or engines" failed to conform to the emission control requirements specified in the certification for that particular model year.

B. The Program Which Has Been Developed

1. Emissions Standards

With passage of the Clean Air Act Amendments in 1970, the Congress knowingly imposed standards which could not then be achieved. To comply with the law, auto manufacturers were required to develop and commercialize technologies which existed only in research laboratories or on prototypes. The adoption of these "technology forcing" emissions standards for carbon monoxide, hydrocarbons and nitrogen oxides was complemented by a comprehensive regulatory structure for assuring compliance with these standards. Congress also charged EPA with responsibility to determine how vehicles were to be tested to assure compliance with standards. Standards adopted to date for automobiles (converted to 1975 FTP equivalents) are listed below:

Table 2
Automobile Emissions Standards (grams per mile)

Model Year	Hydro-Carbons	Carbon Monoxide	Nitrogen Oxides
Pre-1968*	8.2	90.0	3.4
1968-1971	4.1 (50)	34.0 (62)	none
1972-1974	3.0 (63)	28.0 (69)	3.1 (9)
1975-1976	1.5 (82)	15.0 (83)	3.1 (9)
1977-1979	1.5 (82)	15.0 (83)	2.0 (41)
1980	0.41(96)	7.0 (92)	2.0 (41)
1981+	0.41(96)	3.4 (96)	1.0 (76)

( ) percent reduction from uncontrolled levels
* not standards but approximate levels prior to adoption of standards.

All automobile standards in Table 2 have been expressed in terms of the 1975 Federal Emissions Test Procedure, which has been in effect since the 1975 Model Year. (The basis for this test, as well as its strengths and weaknesses will be discussed in Section IV.)

While specific numbers were not spelled out in the law, the Clean Air Act also authorized EPA to set standards for all other categories of motor vehicles. A complete listing of standards adopted to date is contained in Appendix A.

The technology necessary to meet the standards has been developed sufficiently that all 1983 and later model gasoline fueled cars have been "certified" to the most stringent levels. Without exception, all new gasoline automobiles sold in the US today and for the last several years are equipped with catalytic converters and require the use of lead free fuel.

2. Compliance Program

In addition to the standards themselves, EPA has completed implementation of the full set of enforcement tools which Congress provided to assure compliance with those standards -- most notably, Certification, Assembly Line Testing, Recall and Warranty.(5) When viewed in the aggregate, these compliance tools were intended to address in a comprehensive fashion the problem of controlling emissions from "properly maintained" in-use cars. They assure that attention is paid to vehicle design before mass production begins, place constraints on quality assurance on the assembly line and through the combination of recall and warranty impose a discipline on manufacturers to be concerned about emissions from in-use cars.

a. Certification

The Clean Air Act requires that each new vehicle sold be certified as capable of meeting applicable emission standards. Section 206(a) of the act requires EPA to certify new vehicles according to procedures prescribed by the EPA Administrator. Such procedures presently require emissions testing of prototype vehicles representative of planned production vehicles over a mileage accumulation period of up to 50,000 miles to demonstrate that the vehicle designs are capable of meeting emission standards. Mileage accumulation, maintenance, and testing are conducted by the manufacturers but EPA tests some certification vehicles on a spot check basis. Manufacturers maintenance instructions are reviewed in conjunction with this program to assure reasonableness and necessity.

The advantage of the certification program is that it can affect vehicle design before mass production. Obviously, it is better for overall air pollution control if manufacturers identify and correct problems before production actually begins when corrections are less costly. The certification process, however, must as a practical matter deal with prototype cars (sometimes almost hand made) in an artificial environment (very careful maintenance, perfect driving conditions, with well trained drivers using ideal roads or dynamometers, etc.). As a result, one can say with confidence that cars that fail to meet emission standards during certification would have certainly also failed to meet standards in use; however, the converse is not true, i.e., one cannot say with confidence that cars that pass certification will inevitably perform well in use.

More than a decade of experience suggests that the certification program has been successful in approving only those designs for production vehicles that perform reasonably well in use. While the program as it initially evolved during the 1970's had been somewhat complex and time consuming, by 1980, in conjunction with an EPA shift in focus to in use emissions performance, EPA took steps to streamline the process and reduce the administrative demands on manufacturers and the government. EPA continues to look toward certification as "an important program to the Agency because it provides assurance that emission control systems, as designed, can conceivably control emissions in the field."(6)

b. Inspections/Investigations

The inspection/investigation program involves routine inspections of the manufacturers' certification records and facilities, to be followed up, in the case of suspected noncompliance, by investigations. The program essentially supports certification and is based on sections 208 and

206(b) of the Clean Air Act which require manufacturers to provide EPA with access to records and information as well as a right to enter the manufacturers premises to conduct "tests." The inspection program was initiated in 1973 when a major domestic auto maker was alleged to be filing false certification reports.

c. Imports

The imports program which is based on Sections 203(a)(1) and 203(b) of the Act, also essentially supports certification by preventing the entry of uncertified vehicles into the United States. A limited imports program began in 1968 with the Department of Health, Education and Welfare and was devoted to the investigation of commercial importers of vehicles. In 1973, the program was expanded by EPA and the Bureau of Customs to cover all imported vehicles and engines and has been modified several times since then.

d. Selective Enforcement Auditing

The selective enforcement auditing (SEA) program was conceived in 1974 and took effect in 1976 to implement the assembly line testing authority provided in section 206(b) of the Act. Rather than testing each vehicle coming off the assembly line, EPA identifies a number of production models for assembly line testing throughout a given model year.

The goals of the program are to enable EPA to identify certified production vehicles that do not comply with applicable emissions standards, to take remedial action (such as certification revocation or recall) designed to correct the problem and to deter the manufacture of noncomplying vehicles. SEA attempts to achieve these goals by forcing manufacturers to adopt sufficient quality control programs to ensure compliance with standards.

EPA's original proposal for an assembly line testing program was based on a 10 percent acceptable quality level (AQL) (no more than 10 percent of the vehicles tested could fail) which, taking into account test-to-test variability, essentially would have required every vehicle to meet standards. Bowing to pressure from the Office of Management and Budget (OMB), EPA finalized its program with a less stringent 40 percent AQL. However, EPA made it clear that the 10 percent AQL requirement would be imposed if manufacturers' failure rates were excessive. <u>A 10% AQL, by assuring that each car coming off the assembly lines has been built to meet standards, was intended to give assurance to consumers that "they are getting what they paid for," a clean car</u>. This also buttresses the underpinnings of I/M (as does the warranty program) by assuring individuals that failures are not the result of a poorly built vehicle.

The SEA program currently requires that production cars demonstrate a compliance rate of 60 percent or greater (40 percent AQL) on deteriorated emissions in order to retain the certificate of conformity. Since EPA has the authority to require a 90 percent compliance rate (10 percent AQL) manufacturers actually tend to do much better than 60 percent.

In 1980, when a comprehensive heavy duty test program was adopted by EPA, SEA was included with a 10% AQL. Similarly, a 10% AQL was adopted for light trucks. As a result of decisions made by the Reagan-Bush Regulatory Relief Task Force, the AQL for both light and heavy trucks was subsequently relaxed to 40%.

Assembly line testing provides an additional check on mass produced vehicles to assure that the designs found adequate in certification are satisfactorily translated into production and that quality control on the assembly line is sufficient to provide reasonable assurance that cars in use will meet standards. The major advantage of the SEA program over certification is that it measures emissions from "real" production cars. However, a substantial and inevitable shortcoming in the program is that it provides no measure of vehicle performance over time or mileage.

Of the 266 audits EPA conducted from 1977 through 1987, 10 resulted in production terminations of particular models. Average vehicle failure rates among all manufacturers for assembly line testing ranged from a high of 24.5 percent in 1977 to a low of 1.1 percent in 1986., Except for an increase in vehicle failure rates in 1982, the average failure rate has continued to decrease with time.

e. Recall

The Recall Program is intended to secure modification of properly maintained vehicles found to be nonconforming in-use and to deter the manufacture of such vehicles. The program is based on Section 207(c) of the Clean Air Act and consists of four functional elements: surveillance, investigation, audit and public reporting. Surveillance includes EPA surveillance testing of a cross section of models (engine families) of cars in a given model year, occasionally supplemented by data from fleet owner contacts, state I/M data collection, manufacturer defect reporting, consumer complaints, and assembly line testing to identify potential recall classes of vehicles. Investigation of a potential recall class requires inquiries to manufacturers, generation of any necessary additional EPA testing, gathering of corroborating data, and technical and legal analysis necessary to recommend a recall order. Auditing of the manufacturer's compliance with a recall order involves remedial plan approval and monitoring of the manufacturer's implementation plan. Public reporting simply entails assimilating emission related recall activities into a form for public consumption.

The recall program measures emission from "real" cars driven by actual consumers in the "real" world and is the ultimate test under the current Act of how well manufacturers have designed and built durable emission controls. However, when a class of vehicles is subject to recall, air quality is already potentially being degraded by cars with high emissions.

The primary purpose of the recall program is to provide an incentive to manufacturers to design and build vehicles properly so that costs and burdens of recalls will be avoided. No estimate can be made regarding how many potential violations were prevented by this incentive, but the high cost and adverse publicity of recalls no doubt have encouraged manufacturers to design systems with an extra margin of safety.

In addition, the recall program has resulted in direct reductions in emissions. Between 1972 and 1980 more than 14 million automobiles were recalled, resulting in an estimated elimination of more than 120,000 tons of HC, 1.1 million tons of CO and 257,000 tons of NOx emissions.(54) To date, over 30 million vehicles have been recalled for emissions problems.

EPA's recall program has had its difficulties, however. On average, only about half of the vehicles recalled are actually brought in by their owners for repair. The lag time between identification of a nonconforming class and the manufacturers's recall notice has sometimes been well over a year. Mandatory recalls are possible only when a "substantial number" of cars in a class or category exceeds standards, which may preclude recalls of serious but less frequent failures.

In the mid 1980's, EPA permitted a manufacturer to avoid recall by agreeing to reduce emissions of subsequent model year vehicles. The Courts subsequently ruled that EPA's action undermined the deterrent purpose of recall, and that any promised future reductions in emissions was illusory; as a result the EPA action was overturned.

f. Warranty

The warranty programs are intended to provide effective recourse for consumers against manufacturers when individual vehicles do not meet standards in-use, as well as to deter the manufacture of such vehicles. The Section 207(a) Warranty is intended to assure that defects in design or workmanship that result in high emissions are remedied.

The Section 207(b) warranty in certain instances protects from liability owners who despite properly maintaining and using their automobiles fail an EPA approved I/M test. The warranty extends for five years or 50,000 miles for some parts, but only 24,000 miles or two years for others. The program was fully implemented with 1981 models.

While the Section 207(a) design and defect warranty has been in effect since the 1972 model year, little data is available upon which an assessment of its impact can be made. Warranty administration is generally carried out by the manufacturers, and EPA only becomes involved in resolving individual warranty claims when the owner lodges a complaint. For this reason, EPA and the public do not have access to data concerning the number of warranty claims made by owners, or how many of these claims have been honored.

The section 207(b) emission warranty went into effect with the 1981 model year, and it is applicable only in those locations with I/M programs. Virtually no data exists to determine the emissions impact of this program. It is difficult to isolate the environmental benefits of warranties because they are intertwined with (1) the incentive they give manufacturers to ensure that vehicles are designed and built to meet emission standards, (2) the incentive given to vehicle owners to repair emission related part failures, and (3) the role warranties play in generating public support for the motor vehicle emission control program. The Senate report which accompanied the 1977 Clean Air Act amendments estimated that the existence of the defect warranty added only a dollar to the cost of a new car. With regard to potential anti competitive effects, as recently noted by EPA, "from 1975 until 1984, there was a significant reduction in the number of new car/truck dealerships and a concomitant increase in the number of independent repair facilities. Similarly, the routine maintenance jobs which are identified...reveal a general trend toward independent repair facilities and away from dealerships."(7)

g. Aftermarket Parts

The replacement or "aftermarket" parts certification program is intended to minimize any potentially anticompetitive effects of implementing the warranty, recall, antitampering and maintenance instructions provisions of the act. Under the program, parts manufacturers can voluntarily certify upon a certain showing that their part will not cause a vehicle to exceed emissions standards. Consumers who use a certified replacement part will have their performance warranty protection preserved, even if that particular part causes their cars to fail an EPA approved I/M test.

The program began in the early 1970s as a result of industry inquiries and comments on the potential effect of the enforcement of the act on the aftermarket parts industry. EPA was mandated by the 1977 Clean Air Act Amendments to maintain such a program. <u>While the program is currently "available" to parts manufacturers, they have not chosen to certify their parts; as a result no certified parts are available to the public</u>.

h. Antitampering/Misfueling

Tampering with the emission control system and fuel switching -- using leaded gasoline which destroys the catalytic converter -- combine to pose a serious threat to the goal of realizing the full nationwide benefits of the motor vehicle emission control program. Recent EPA surveys indicate that 15 to 20 percent of all passenger cars and about 25 percent of light trucks have been subjected to some form of emission control tampering, although the prevalence is highly variable from state to state and even within a given geographical area.(55) Some forms of tampering have relatively minor impacts on emissions but, in the extreme, where catalytic converters are removed or destroyed, vehicles can emit approximately four times as much CO and three times as much HC as untampered vehicles. (Fortunately, most tampering does not involve catalyst destruction.) Equally disturbing is the finding that the overall rate for fuel switching is over 10 percent.

3. The California Program

The only other area of the United States with a fully developed motor vehicle control program is the State of California. California was given this unique status because it had adopted its own set of requirements prior to the Federal Government.

The post Certification requirements prior to vehicle sale are significantly different in California than Federally. Rather than Selective Enforcement Audit, California requires an across the board functional test on 100% of production and a 2% quality audit. Further under Title 13 of the California Code, California routinely selects samples of vehicles prior to sale for compliance testing at their own laboratories.

In addition, the California warranty differs from the federal warranty in that a failed emission control part, as opposed to failure of an emission test or standard, is the criterion for implementing the warranty. Thus the California warranty applies whether the defective part is detected during normal maintenance or as a result of failing an I/M test. The issue of whether the failed part has resulted in an exceedence of an emission standard is avoided.

C. Technological Advances

1. Initial Controls

To meet the relatively lenient HC and CO standards that applied in the late 1960's and early 1970s, auto manufacturers generally relied on enleanment of the air/fuel mixture, modification of spark timing, and other engine modifications. Attainment of initial HC and CO standards with limitations on NOx increases was generally possible without significant fuel consumption penalties. However, as emissions standards were tightened (especially in 1972 through 1974) it became more and more difficult for domestic cars employing conventional engine designs to achieve low levels of CO, HC and NOx without undesirable compromises in performance or fuel economy. As a result there was a fundamental shift in the technology to the catalytic converter.

2. Catalysts

Two basic types of catalysts have been developed - oxidation (CO and HC control only) and three way (CO, HC and NOx control). For three-way catalysts to work effectively, air-fuel mixtures must be controlled much more precisely than is needed for oxidation catalyst systems. As a result, three way catalysts are responsible for fostering improved air-fuel management systems such as advanced carburetors and throttle body fuel injection systems as well as spurring development of electronic controls.

3. Technology Trends

Figures 7 and 8 summarize the trends over the last decade in various characteristics of cars and light trucks, respectively.(8) Virtually all cars and light trucks today are equipped with catalysts, the vast majority with either three way or three way plus oxidation systems. Fuel injection has increased from minuscule proportions during the 1970's to where it is installed on approximately 3 out of four new light duty vehicles today. During the past decade, the US automobile industry has also literally undergone a revolutionary shift from mechanical to electronic controls.

Technology continues to evolve; fast flames, compact

Auto Fleet Characteristics by Model Year

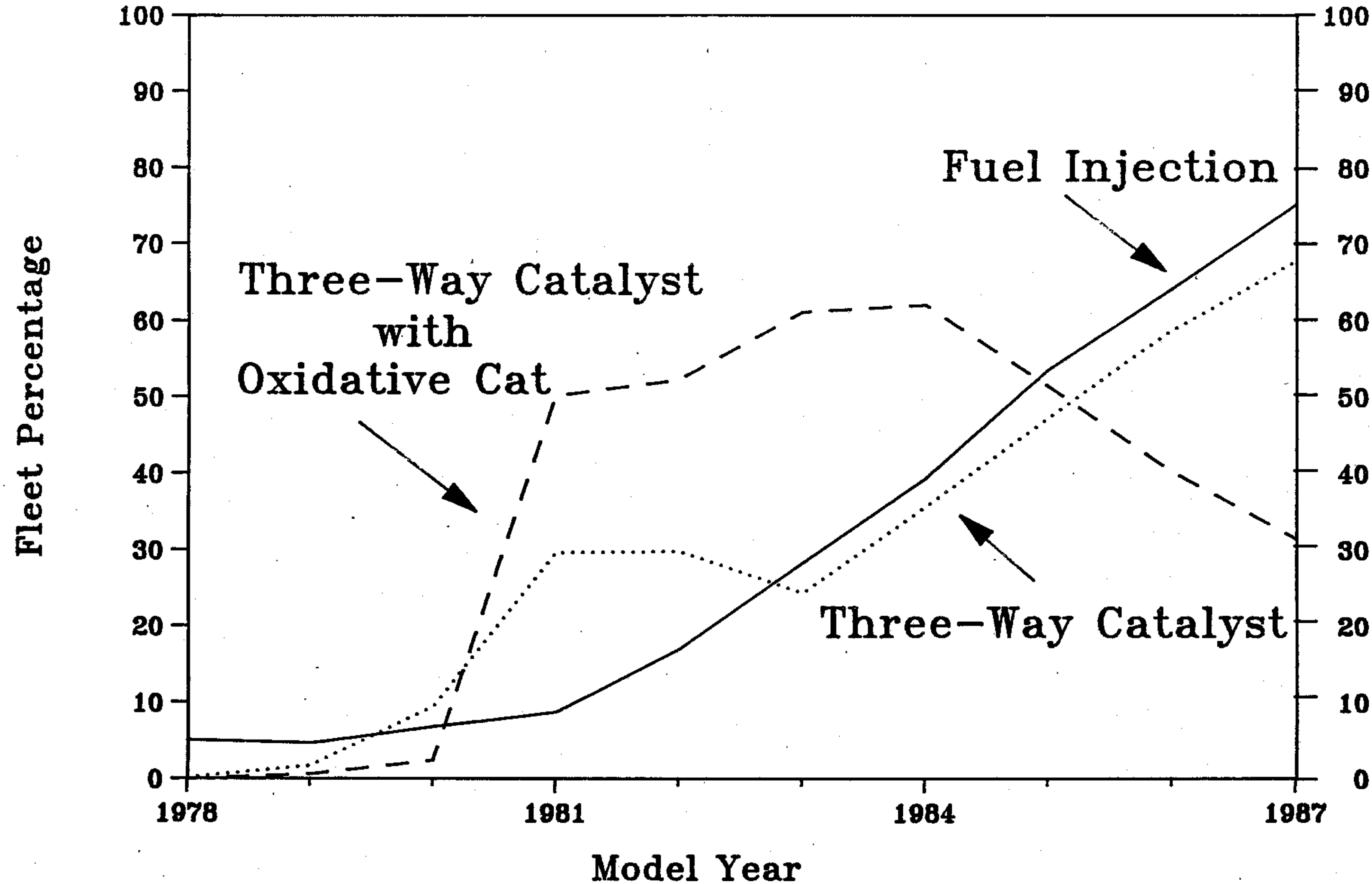


Figure 7 Walsh/NESCAUM

Light Truck Fleet Characteristics by Model Year

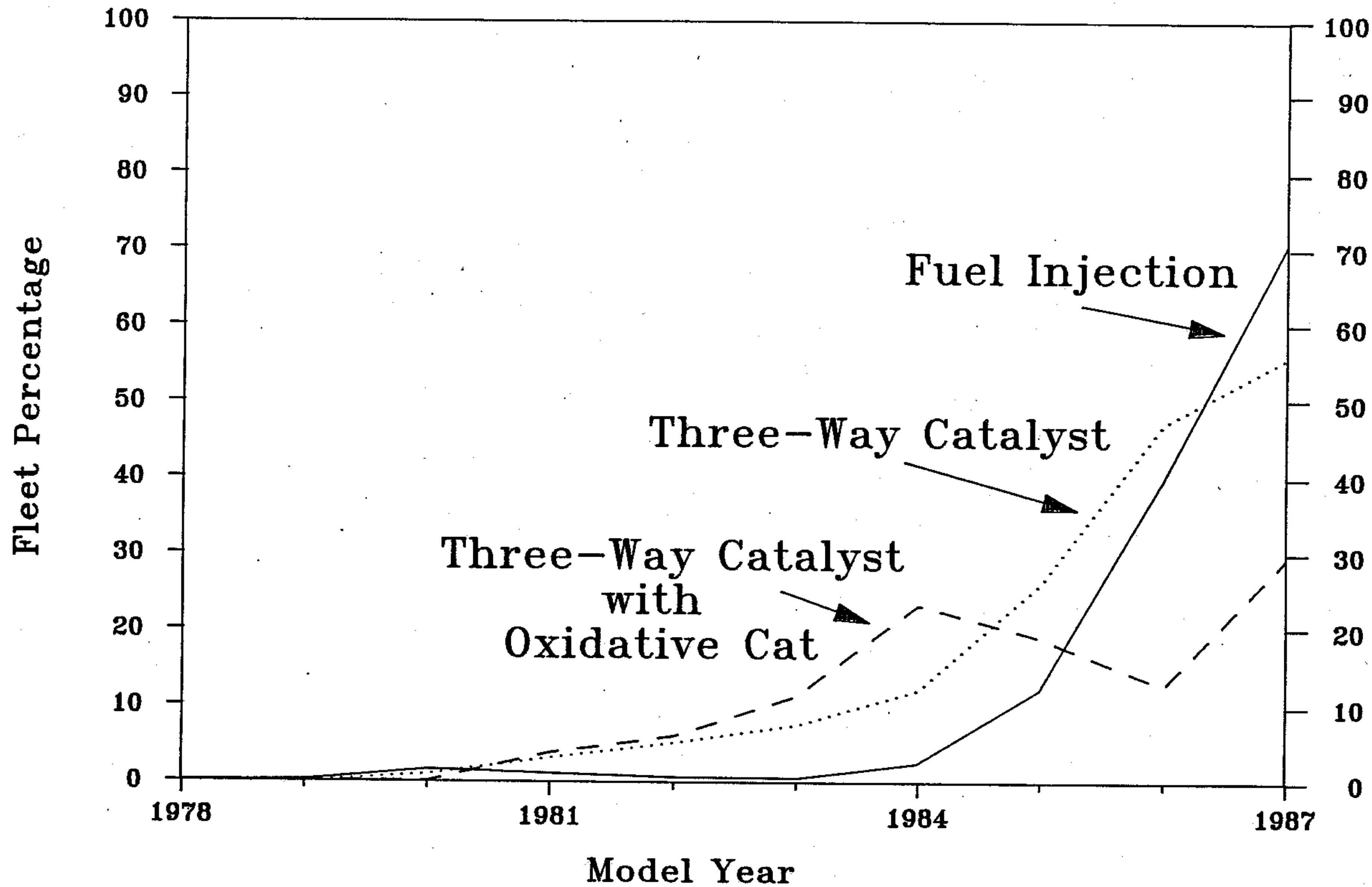


Figure 8

Walsh/NESCAUM

combustion chambers, lean air to fuel ratios and even substantially modified powerplants to optimize the benefits of alternative fuels are on the horizon.

Use of these technological advances has enabled emissions from vehicles to be lowered while simultaneously improving fuel economy, from a sales weighted fleet average of 14.9 miles per gallon (m.p.g.) in 1967 to 28.0 m.p.g. in 1987 -- an increase of 79 percent.(8) Correcting for vehicle weight reductions (i.e., had vehicle weight reductions not occurred), the improvements compared to pre-controlled cars are still about 44 percent.

Figures 9 and 10 show fuel economy and weight trends for cars and light trucks over the last decade. It is clear that the greatest gains occurred during the 70's; improvements have been minor during the last few years.

D. Emissions and Air Quality Effects

Although automobile emissions standards have been lowered significantly over the last 20 years. especially for HC and CO and to a lesser extent for NOx, and while these tighter standards have resulted in lower in use emissions, average levels have consistently been higher than the respective standards, especially for CO and HC. In use NOx performance is much closer to the standards. (In absolute terms, the shortfall between the standards and the in use vehicle performance has tended to be narrowed as the standards have been tightened.) This is illustrated in Figures 11, 12 and 13 which show the automobile emissions standards for HC, CO and NOx, respectively, along with the average in use performance of these same model year cars based on EPA's Mobile3 emissions factors model. (See Section X for a more thorough discussion of this model and its reliability.)

<u>Actual in use CO and HC emissions have not achieved the intended 90 percent reductions from 1970 levels</u>, even under the specific conditions of the FTP. (Emissions reductions outside the FTP conditions <u>have been significantly worse</u> as will be discussed in Section IV.) In addition, <u>emissions reductions from other vehicle categories have been significantly less than from autos</u> as shown in Figures 14, 15 and 16. Therefore, as illustrated in Figure 17, the overall reductions in emissions from <u>all</u> transportation sources across the US during the decade from 1976 to 1985 were 25 percent for CO, and 30 percent for HC. (These gains would have been greater but for a 26 percent increase in vehicle miles travelled during this same time period.) However, because standards for these pollutants have been more lenient or implemented later, overall reductions have been only 4 percent for NOx and there has been no reduction in particulate.

Model Year Trends of Fleet Fuel Economy

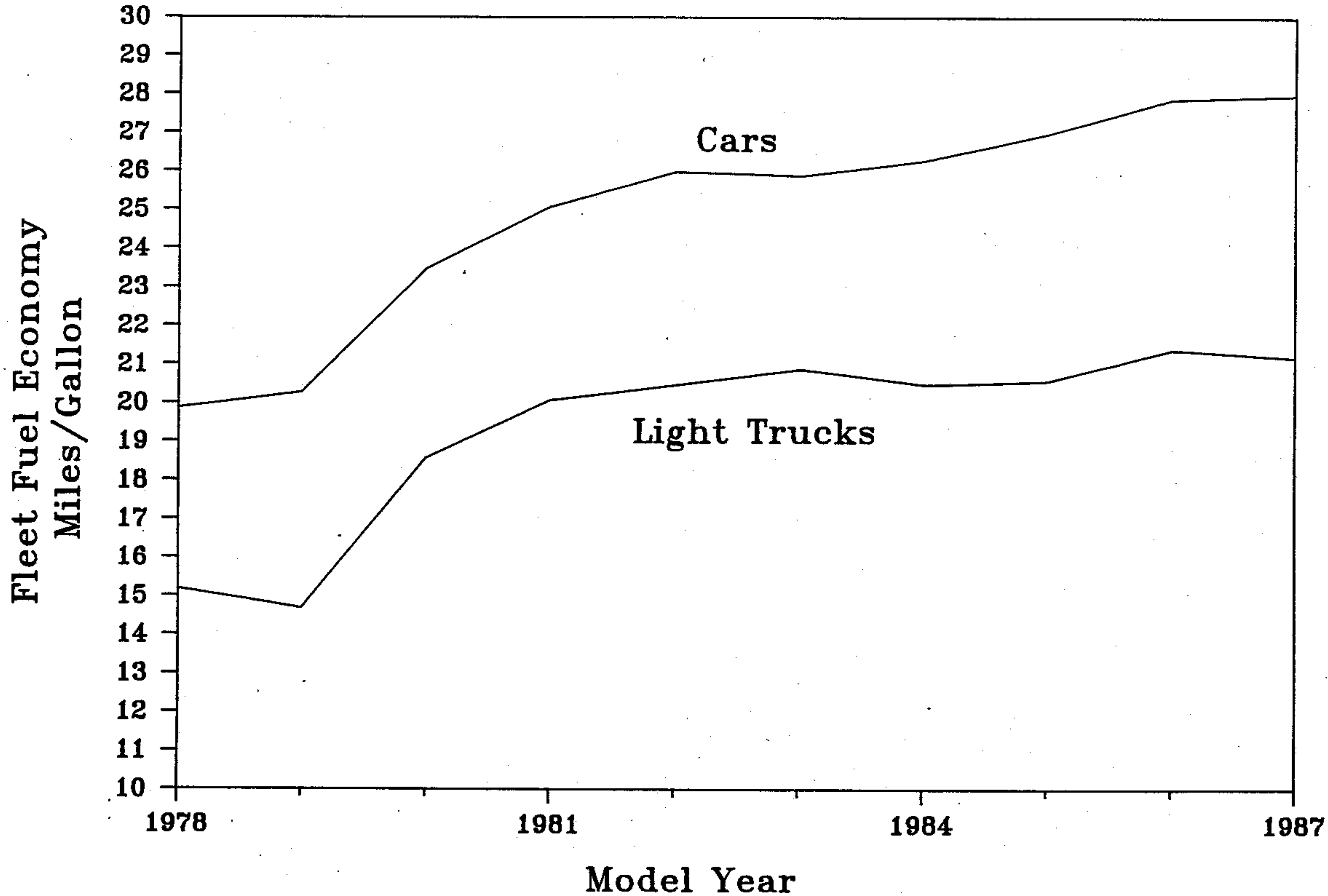


Figure 9

Walsh/NESCAUM

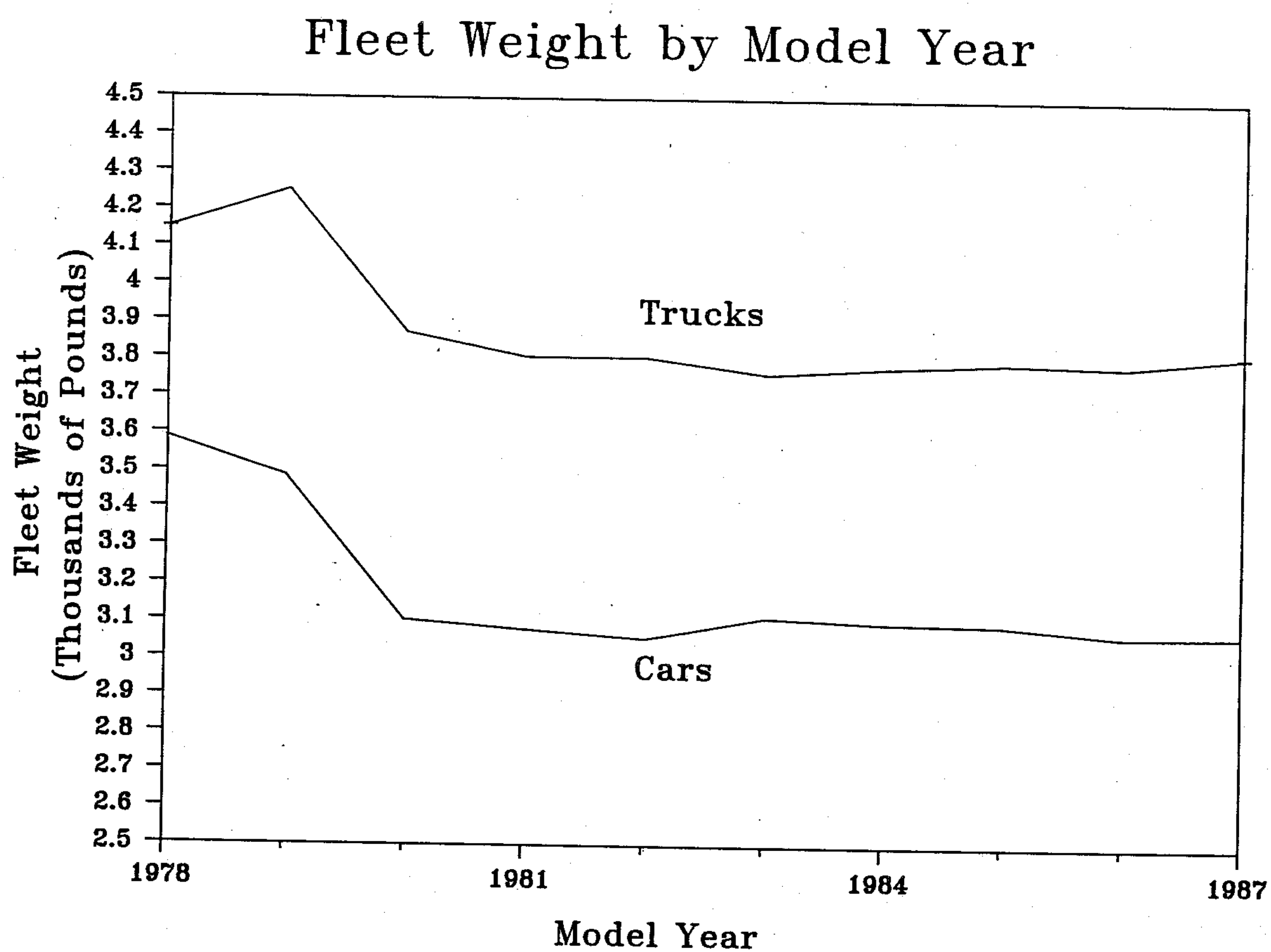


Figure 10

Walsh/NESCAUM

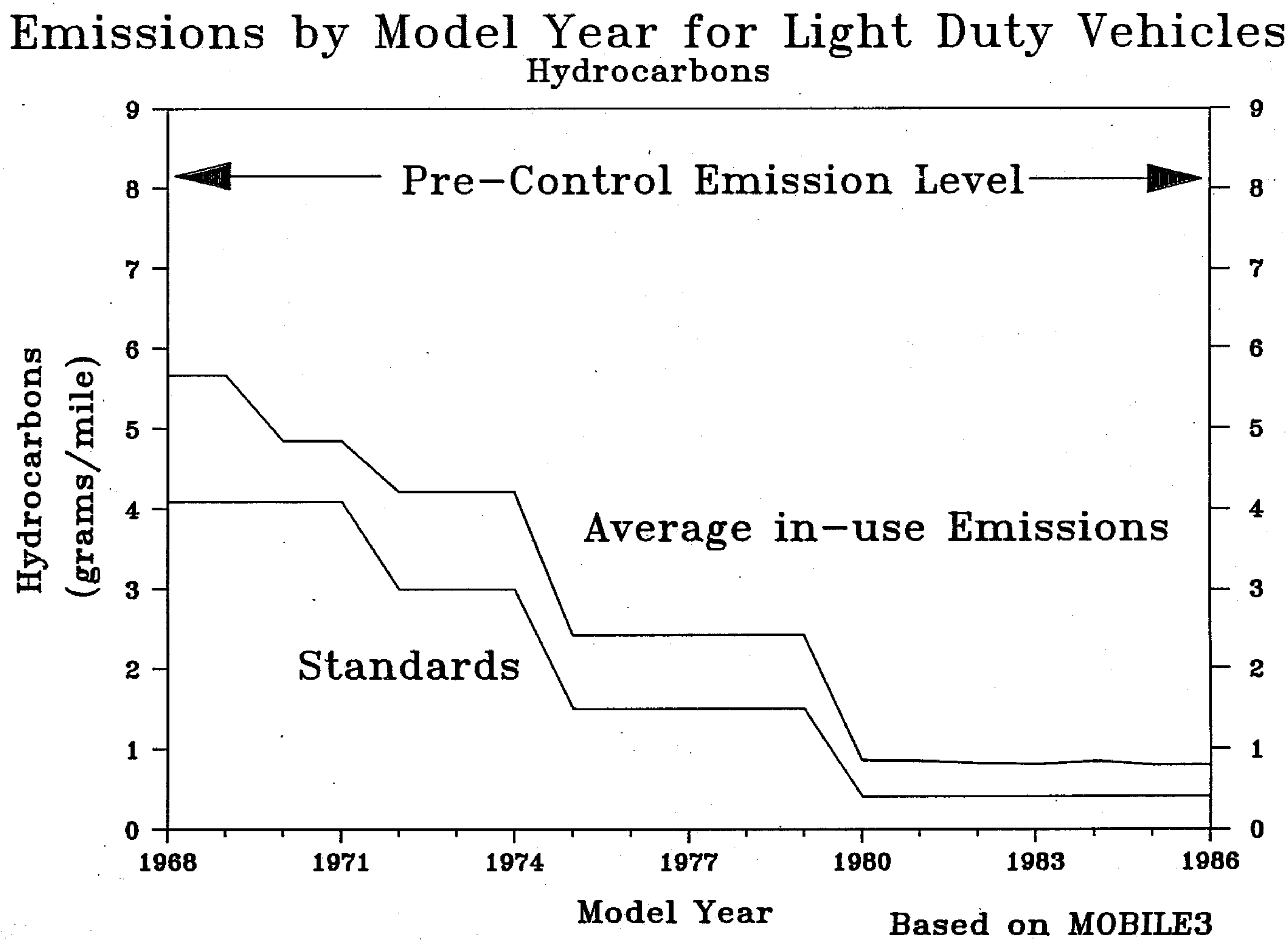


Figure 11

Walsh/NESCAUM

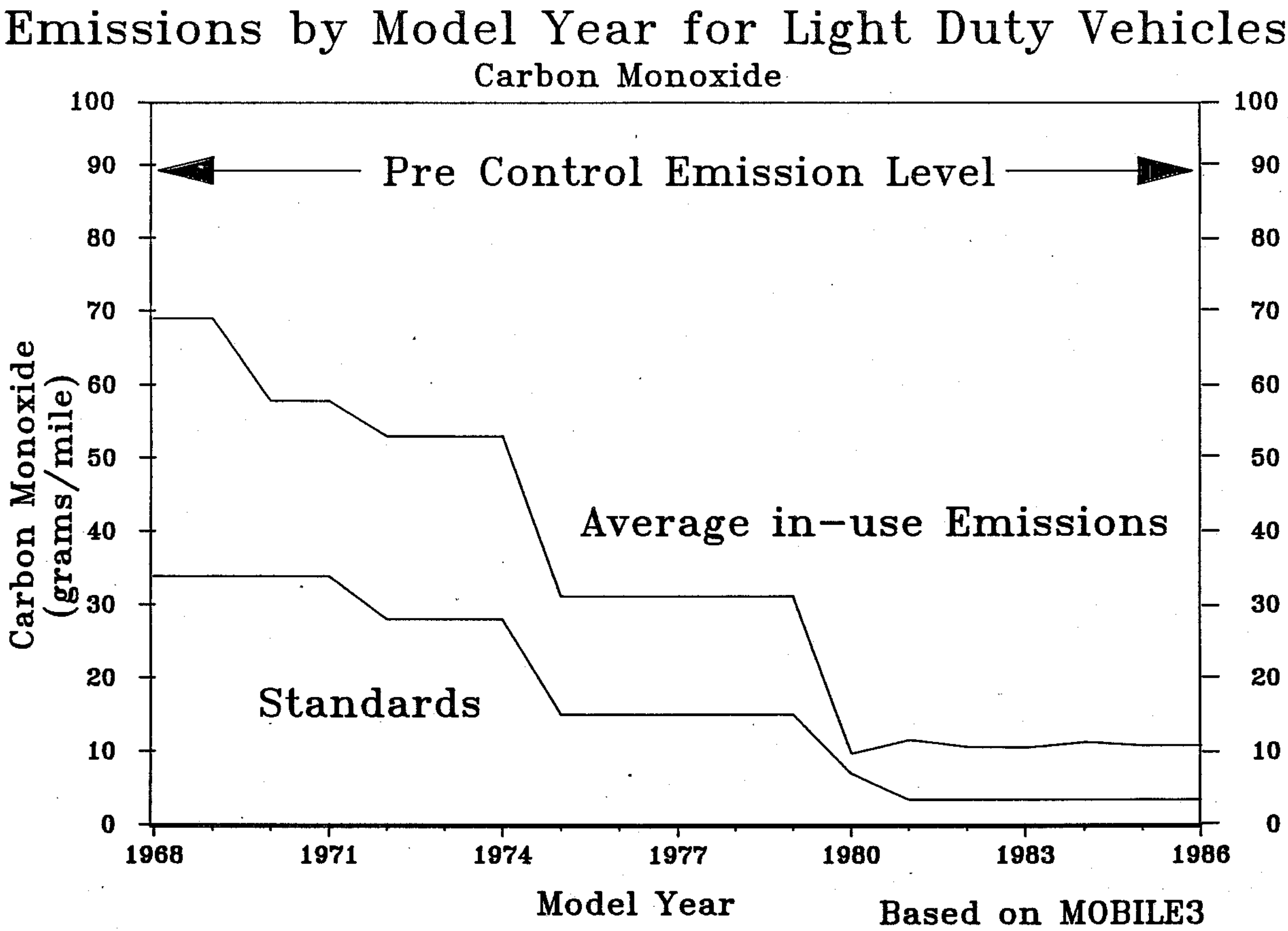


Figure 12 Walsh/NESCAUM

Emissions by Model Year for Light Duty Vehicles

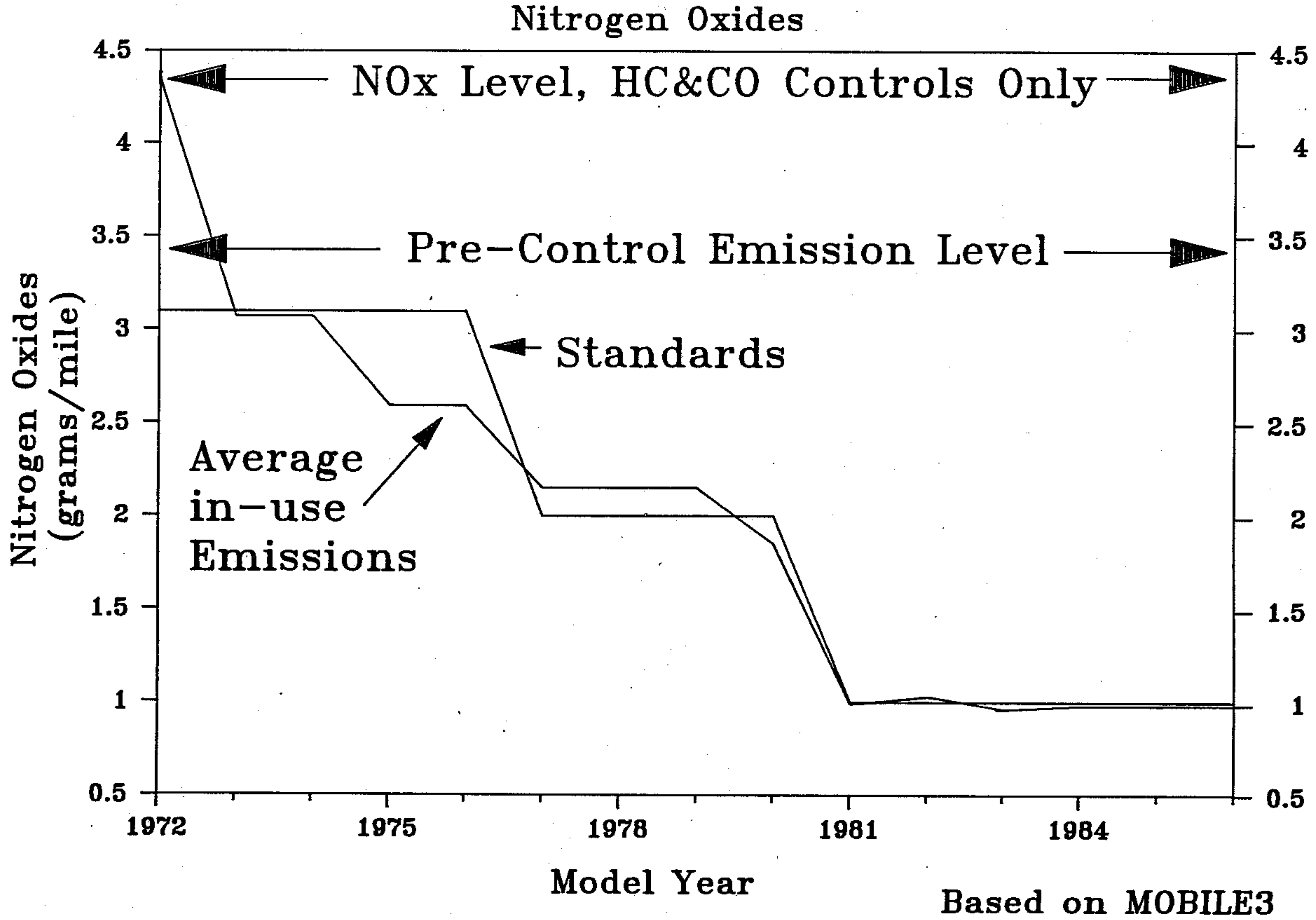
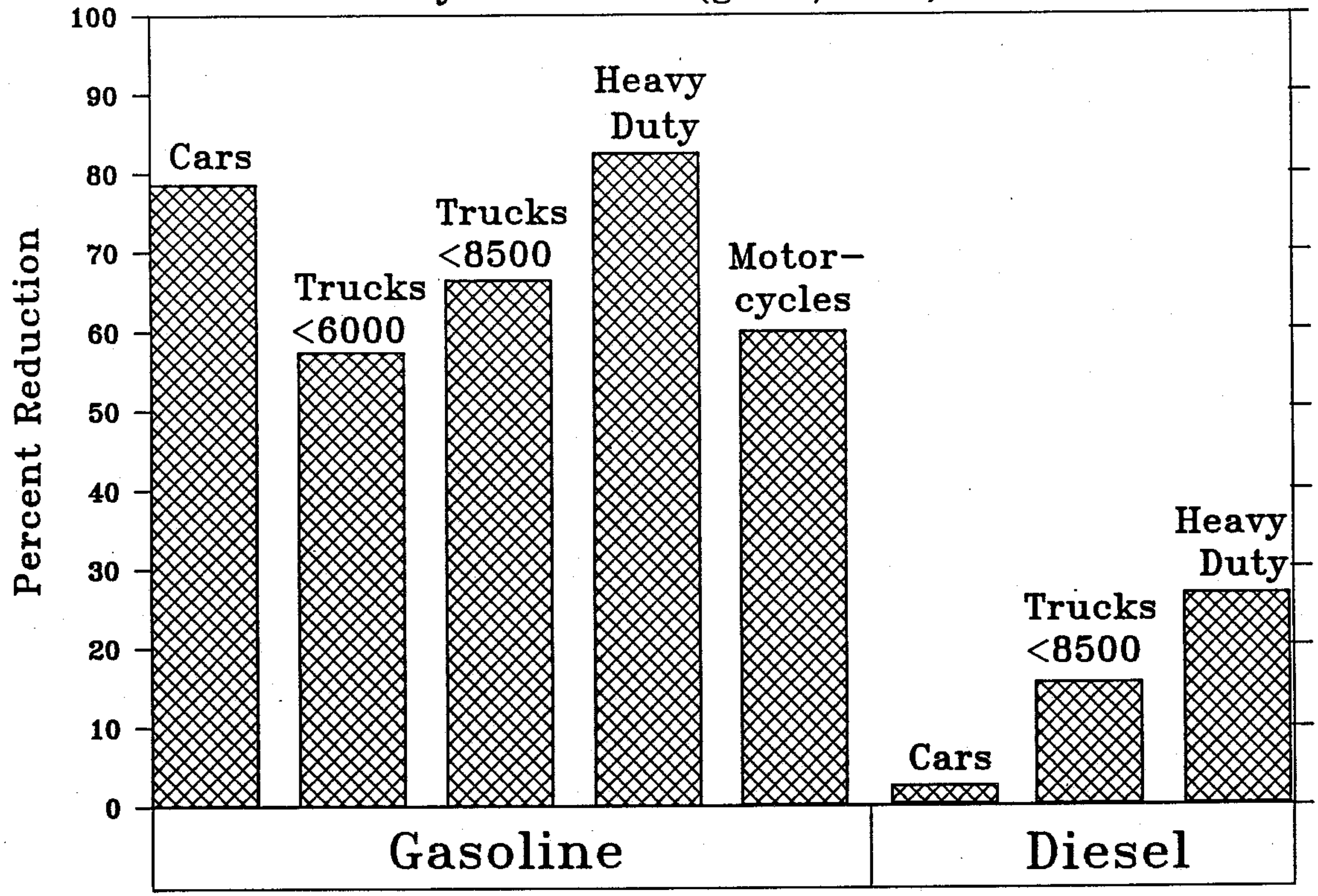


Figure 13

Walsh/NESCAUM

Emissions Reductions 1970–1990

Hydrocarbons (gram/mile)



Based on MOBILE3

Figure 14

Walsh/NESCAUM

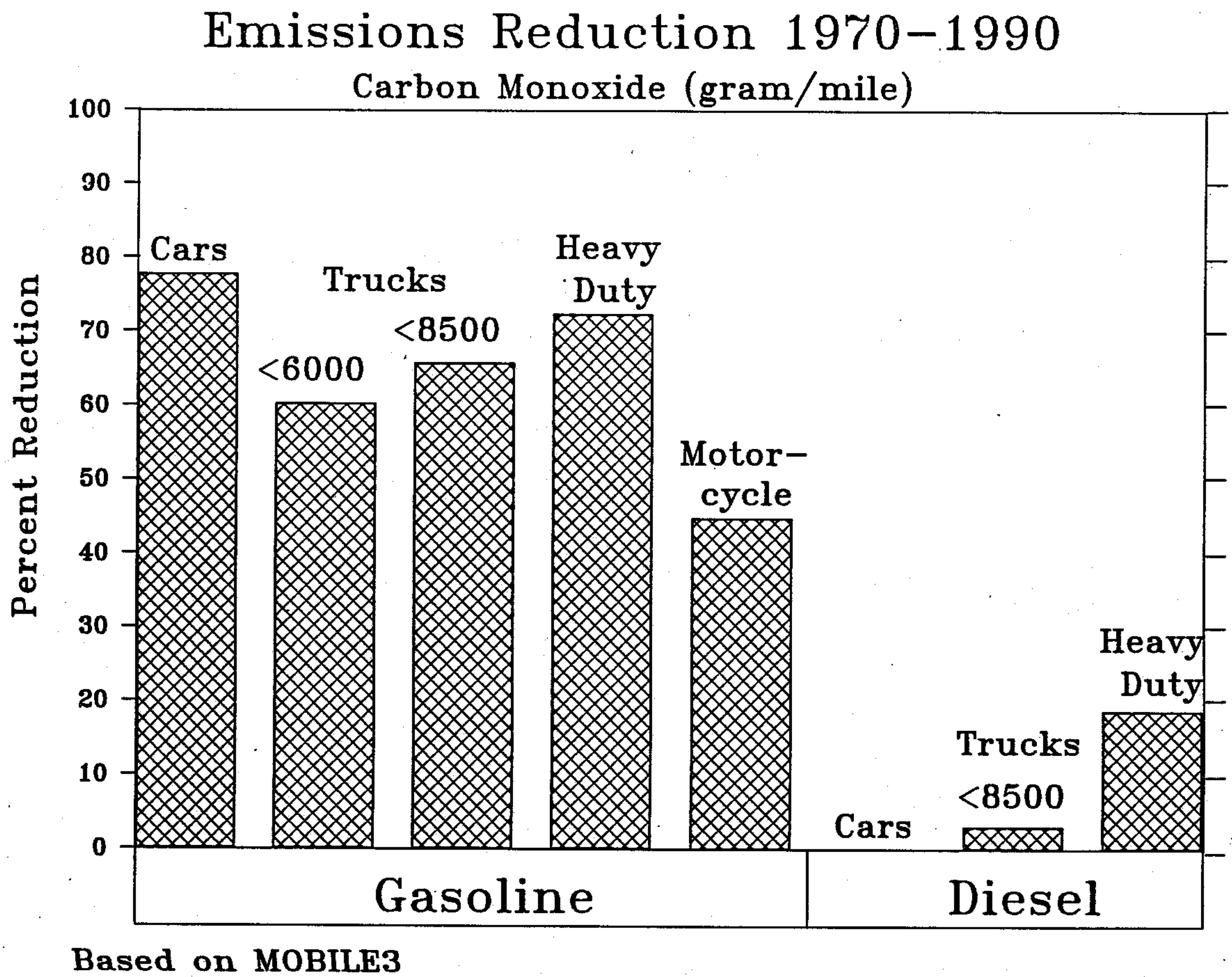
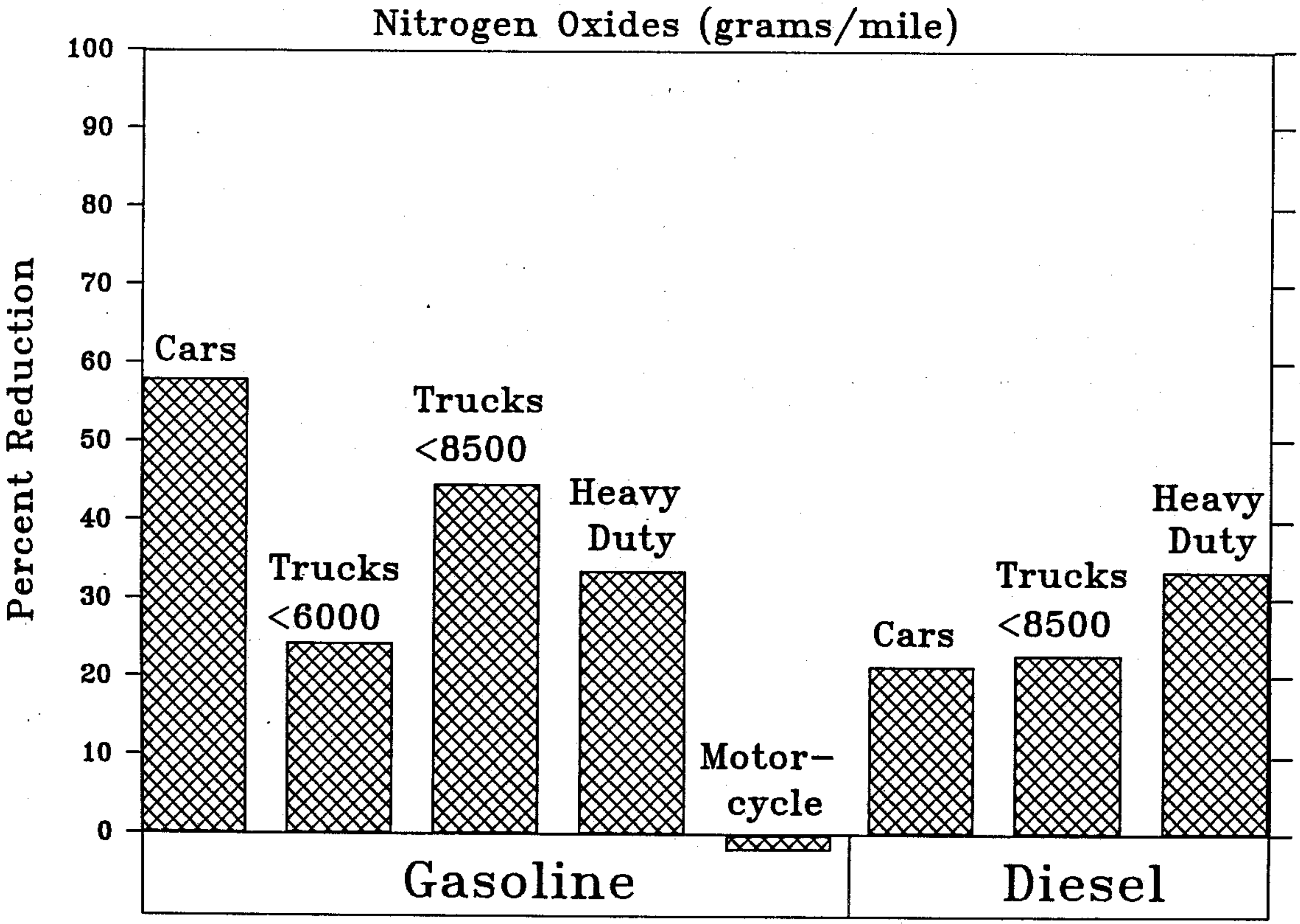


Figure 15

Walsh/NESCAUM

Emissions Reductions 1970–1990

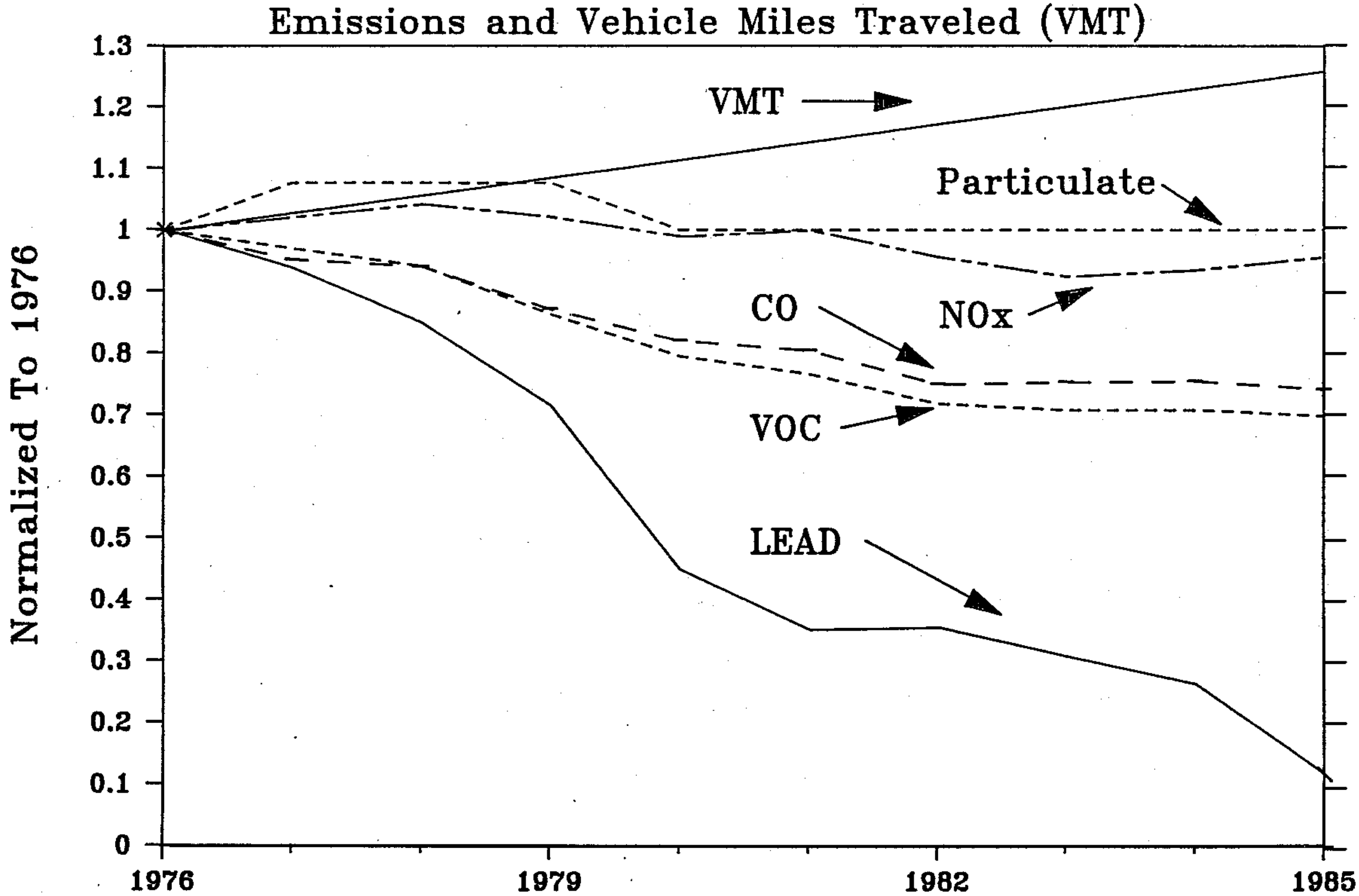


Based on MOBILE3

Figure 16

Walsh/NESCAUM

National Transportation and Emissions Trends



Source: EPA

Figure 17

Walsh/NESCAUM

Figure 18 shows that during 1985, transportation sources were still responsible for 73 percent of nationwide lead emissions, 70 percent of the CO, 34 percent of the volatile organic compounds (HC), 45 percent of the NOx, and 18 percent of the particulate. In some cities, the mobile source contribution is even higher. In effect, the percentage contribution from mobile sources to total emissions, with the exception of lead, has not changed appreciably in spite of significant passenger car controls. Growth in vehicle miles travelled, poor in use emissions performance, and less stringent controls on other mobile sources are reducing the overall gains from the automobile standards.

Similarly, while air quality has improved since adoption of the Clean Air Act Amendments of 1970, the gains have been much less than intended. With regard to carbon monoxide, air quality levels across the US have improved about 5 percent per year, with an overall reduction of 36 percent between 1976 and 1985. In recent years, the gains have slowed, however; in 1986, there was no improvement. The story is similar for NO_2. Annual average NO_2 levels measured at 108 sites increased from 1976 to 1979 then decreased through 1985.(9,56) The 1985 composite average NO_2 level is 11 percent lower than the 1976 level. Again, as with CO, in 1986, there was no improvement. Nationally, the composite average of the second-highest daily maximum 1-hour ozone values recorded at 242 sites decreased 13 percent between 1979 and 1986.(9,56) In 1986, there was only a two percent improvement. In the Northeast, ozone air quality levels were higher in 1987 than in 1986; preliminary results to date in 1988 indicate that the situation is deteriorating further.(75)

Only in the case of lead, has there been clear, significant improvement, consistent with the goals established in 1970. Lead usage in gasoline dropped 75 percent from 1975 to 1983, with positive impacts on health. Based on data collected in more than 60 United States cities by the Center for Disease Control, mean blood lead levels in children declined by 36.7 per cent from 1976 to 1980 -- roughly in proportion with the reduction in the amount of lead added to gasoline. Ambient lead levels have also declined substantially; the composite maximum quarterly average of ambient lead levels, recorded at 82 urban sites across the country, decreased 87 percent between 1977 and 1986.(9,56) By the end of 1988, EPA projects a 99 percent reduction in overall lead usage in gasoline compared to peak levels of the early 1970's.

Therefore, because motor vehicles remain the dominant pollution source across the country, significant additional reductions of these pollutants from mobile sources have the potential to result in substantial overall improvements. As

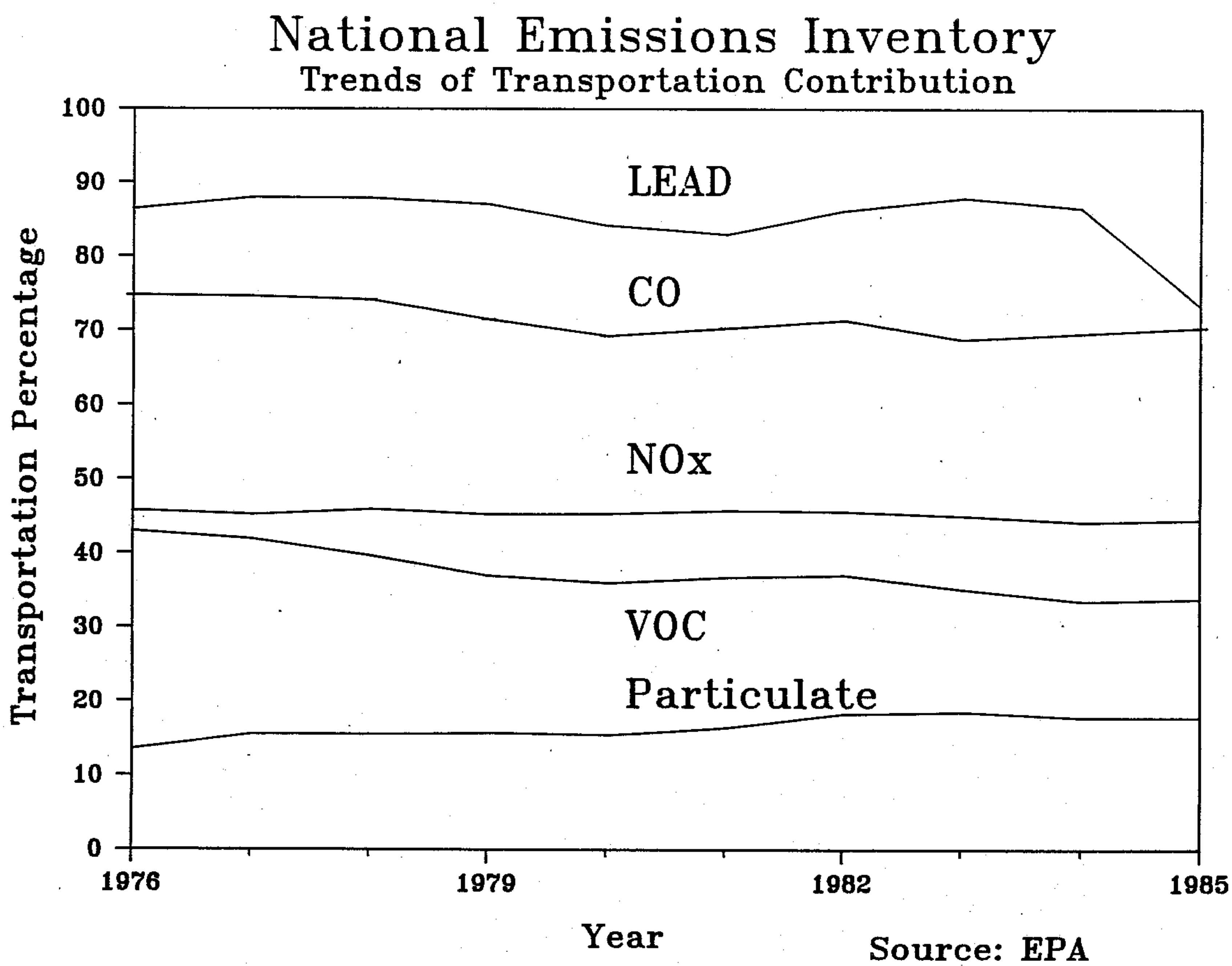


Figure 18

Walsh/NESCAUM

noted earlier, based on the assessment done for the American Lung Association and buttressed by the EPA and NAPAP studies summarized in Figures 2 and 3, substantial additional emissions reductions will be necessary to prevent future emissions deterioration, much less to attain healthy air quality levels. <u>All feasible and reasonable control is necessary and even this will likely not be sufficient for all areas to attain healthy air quality levels in the foreseeable future.</u> As the major source of carbon monoxide, hydrocarbons and nitrogen oxides, additional motor vehicle pollution control is necessary. The next several sections will explore areas where improvements may be possible. These include:

* expanding the vehicle operating modes under which controls are required,
* upgrading the manufacturer directed compliance program to maximize the gains from current standards,
* improving the effectiveness of inspection and maintenance,
* extending the useful life for which auto standards apply, and
* tightening standards for various vehicle categories.

IV. Review of Current Testing and Compliance Program

A. Adequacy of Federal Test Procedure

Beyond the standards themselves, future air quality depends on emissions controls functioning in the real world over the wide range of conditions under which vehicles are actually used and which contribute to poor air quality. Ultimately, therefore, standards are meaningless without uniform repeatable test procedures by which compliance can be measured.

An emissions test procedure consists basically of instruments that measure chemicals or analogs of chemicals in samples of exhaust gas, and a way of exercising the vehicle or engine while the sample is being collected. An ideal test procedure would have the following characteristics:

1. It should exercise the vehicle in a manner that is representative of the way the vehicle is actually exercised in use, in areas and under conditions where air pollution problems are worst.
2. It should be repeatable, accurate, quick and inexpensive. (Ideally, it would be practical as a part of or at least compatible with in-use I/M programs.)
3. It should measure all of the pollutants of concern.
4. It should be comprehensive enough to discourage selective control which could compromise the overall environmental benefit. This latter point is especially

critical with newer technology vehicles with advanced electronic controls where the potential for selective control is very high.

In actual practice, all existing test procedures reflect compromises of the above objectives. A compounding factor is that test conditions which may be appropriate for one pollutant or one type of problem, may not encompass the appropriate conditions for another pollutant or type of problem.

Congress did not specify meteorological conditions, nor differentiate between city and highway driving in setting its objectives in 1970. Therefore, the EPA had the freedom to define its own conditions and, when necessary, to modify them. California had already developed the seven-mode driving cycle for its emission control programs and the EPA had been using this cycle for earlier emission control regulation, but there were many complaints against its continued use: the California cycle did not test speeds above 50 m.p.h.; its low acceleration and deceleration rates were not representative of city driving; it was basically repetitive, testing only a few modes of vehicle operation. Looking for a new cycle, the EPA and industry focused their research on cities where air pollution was highest. The so called CAPE-10 project, jointly funded by EPA and industry, listed hundreds of driving patterns in six different cities and attempted to correlate these patterns. The report concluded that driving patterns are basically the same regardless of the city and also described several typical driving patterns.(37)

Other studies in cities from 1966 to 1968 had shown that hydrocarbon concentrations during the hours of 6-9am were directly correlated with peak oxidant levels. Since the Los Angeles basin was considered to be the worst case for photochemical oxidants in the US, EPA decided to focus its attention on that region. It attempted to simulate actual driving patterns along the LA-4 road route, a representative commuting route in Los Angeles during the hours of 6-9am.(38,39) The purpose was to represent typical emissions during those hours. The result was a 23 minute cycle subsequently printed in the November 10, 1970 Federal Register. The driving cycle followed the typical driving patterns on the LA-4 road route and the test is performed by operation on a stationary device called a chassis dynamometer.

The actual emission standards reflecting the Congressionally mandated 90% reduction were determined by measuring HC and CO emissions during the driving cycle from 1970 vehicles and NO_x emissions from 1971 vehicles. Applying a 90 percent reduction, the standard not to be exceeded by 1975 automobiles became 0.41 gpm HC, 3.4 gpm

CO, and 3.0 gpm NO_x (where gpm is gram per vehicle mile). For 1976, the standard became 0.41 gpm HC, 3.4 gpm CO, and 0.4 gpm NO_x. (The 1977 Clean Air Act Amendments delayed the date of final implementation of these standards until 1983 and relaxed the NOx standard to 1.0 grams per mile.)(40)

It should be emphasized therefore, that the emission rates reflected by the standards are based on driving the prescribed driving cycle in a manner to minimize emissions. The EPA hoped to represent actual emissions in a city by simulating actual driving conditions.

1. Existing Test Procedure Description

The 1975 Federal Test Procedure (FTP) involves collection of a diluted exhaust gas sample in a small plastic bag by means of a constant volume sampler (CVS). Hydrocarbons are measured by a flame ionization detector (FID), carbon monoxide by non-dispersive infra red (NDIR) analyzers and nitrogen oxides by chemiluminescence analyzers. The driving cycle consists of a 7.5 mile simulate trip run in a laboratory on a chassis dynamometer starting with a cold engine. Following a ten minute waiting period the trip is started again with a warmed-up engine. Overall the test has an average speed of 19.7 m.p.h., a top speed of 57 m.p.h., and 2.4 stops per mile.

In addition to the urban test on which emissions standards are based, the US EPA measures emissions on a higher speed cycle developed to simulate highway fuel economy.(41) Emission levels measured by this cycle, a higher speed, higher load cycle than the city test, are monitored to assure that manufacturers have not deliberately designed emissions controls to "shut off" outside the range of the urban test. As attention has focused more on long range transport pollutants, it has become increasingly important to assure that emissions controls continue to perform over as broad a range of conditions as possible. Since a significant proportion of total NOx emissions are generated under high speeds and loads and since these emissions can be transported large distances and participate in both photochemical smog and acid deposition, they have been especially singled out as important during the highway cycle.

The next few sections examine how well the cycle comprehensively represents actual driving conditions.

2. Implications of Driving Modes Included

The actual driving cycle is a series of accelerations and decelerations. When accelerating, the average rate is about 1.6 m.p.h./sec. which will increase one's speed from 0 to

30 m.p.h. in 19 seconds.

Once the actual driving cycle was determined, the EPA had to ensure test repeatability by defining conditions under which the test drive would be performed. The first question concerned the description of the start. The cold start (ignition off for 12 hours) is a high emitter of CO and HC and so it contributes substantially to the pollution problem. The EPA wanted to represent the worst conditions, so it decided that the driving cycle would begin with a cold start. Later, a weighting factor was determined in an attempt to weight properly emissions from the cold and hot starts (this became the 1975 FTP).

Another condition to be decided was the ambient air temperature during testing. The EPA used the following logic: some of the major pollutants are hydrocarbons which play a significant role in the photochemical cycle. During winter months, energy from sunlight is substantially decreased, thus drastically decreasing the production of harmful substances from the photochemical cycle. This reduction occurs in spite of the increased emissions from both heating fuels and colder engines. Thus, the EPA omitted winter conditions and wrote the test regulations to simulate summer driving conditions: the tests would be run with ambient air temperatures between 68° and 86°F.

3. Implications of Driving Modes Omitted

In designing the regulations in this way, EPA intended that the resulting emission control devices would substantially reduce emissions, roughly proportionately, during the other modes of operation. <u>Unfortunately, as has become clearer over time, modes not tested can also represent conditions which lead to serious emission problems</u>.

The test procedure was designed to test emissions during a trip to work in Los Angeles during a temperature regime of high photo-oxidant production. However, for CO, other factors become important. Cold engine choking to assure starting increases both CO and HC emissions; at <u>colder temperatures</u>, this is even more important. <u>Heavily congested traffic</u> leads to lower speeds and greater stop and go conditions,(42) leading to higher engine out CO and HC emissions and slower catalyst light off. The significance of this issue is illustrated in Figures 19 and 20. Figure 19 shows for example that while the per mile driven emissions reductions under FTP conditions are well below the 90 percent target envisioned by the Congress under FTP conditions, the shortfall is much greater at 20 degrees F and 10 M.P.H. average speed. If one combines the vehicles, and factors in the growth in vehicle miles travelled, Figure 20 shows that <u>the overall CO reductions under the conditions of most concern are substantially less</u>

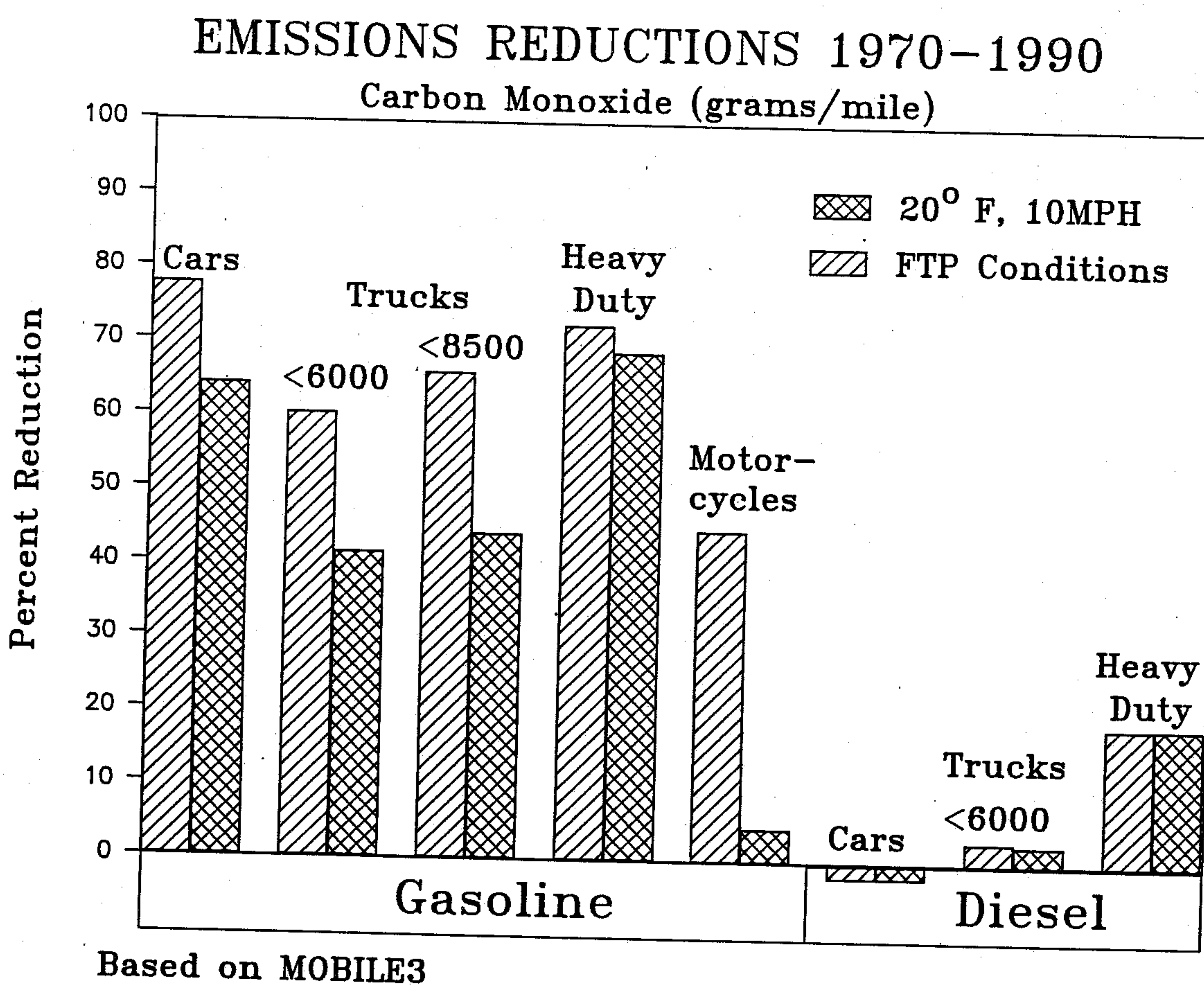


Figure 19

Walsh/NESCAUM

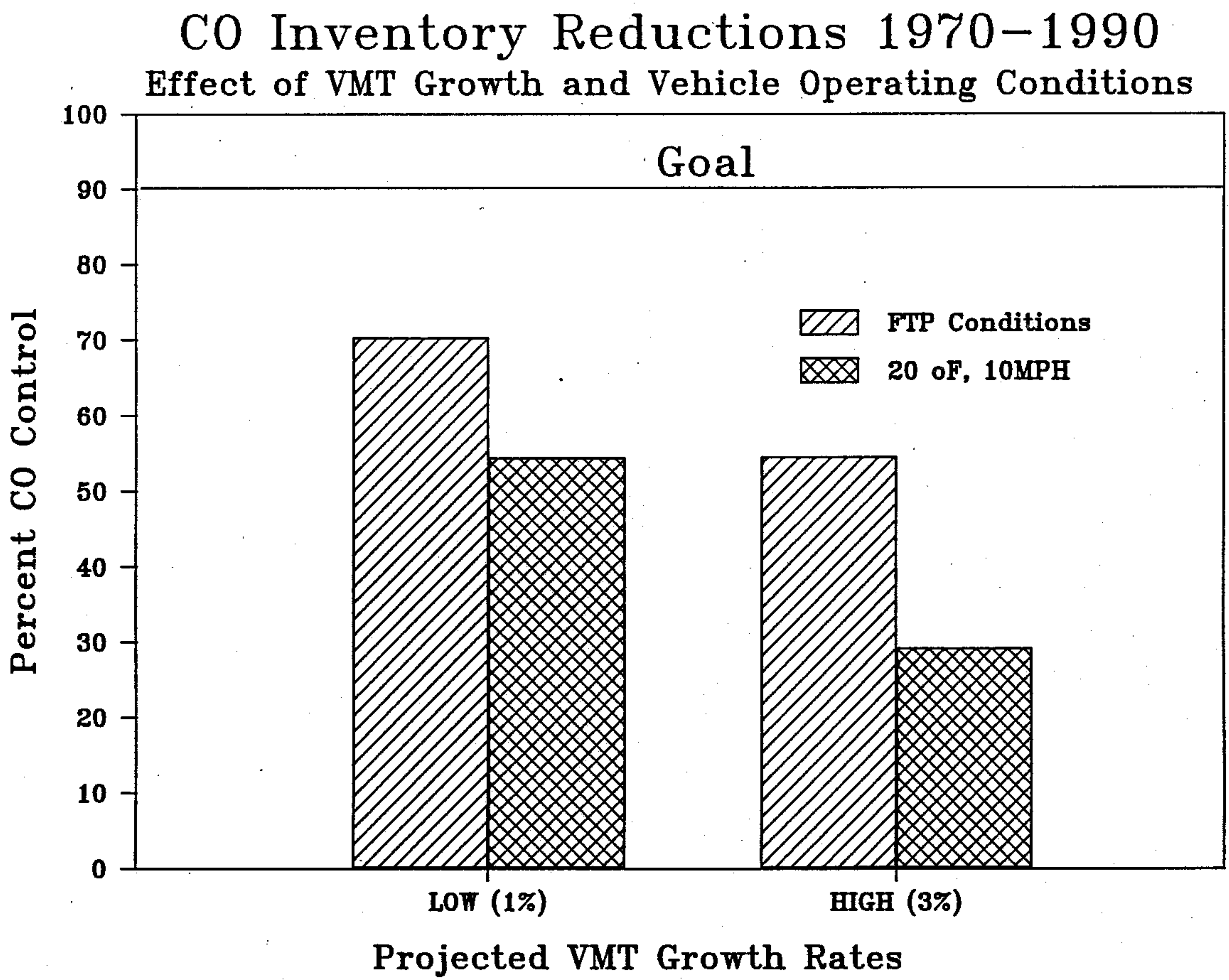


Figure 20

Walsh/NESCAUM

than the 90 percent intended. It is important to note that this does not account for the increased congestion and lower speeds associated with this growth or the dramatic increase in the low speed correction factor which EPA has estimated for the draft of Mobile 4. (See Figure 21)

On the other extreme, many vehicles in certain areas of the country drive much faster than reflected on the LA-4 cycle, where the highest speed during the cycle is 56.7 m.p.h. In fact the test cycle exceeds 40 m.p.h. for only 110 seconds in the total 1,371 second cycle. Yet, speeds on freeways often reach 60 or 65 m.p.h. or even higher. Speeds of 65 or 70 m.p.h. although possibly rare in a 20 minute drive through a city, are common on the outskirts of cities and can lead to very high NOx and HC emissions.

Another problem lies with the rates of accelerations and decelerations. Except possibly for cold starts, high accelerations and decelerations produce the highest emission rates. This fact is understandable since rapidly changing conditions in the carburetor and intake manifold cause great difficulties in accurate control of the fuel/air ratio (an important parameter for pollution control). The fastest acceleration in the Federal driving cycle is 2.88 m.p.h./sec., and that lasts only 8 seconds. (From a practical standpoint, in designing the test, EPA faced difficulty with severe accelerations because of belt and tire slippage on the early generation chassis dynamometers.)

In summary, several important conditions -- Cold Temperature, Low Speeds, High Speeds, High Loads and Rapid Accelerations -- are not adequately reflected on the current test procedure. This does not mean that the 75 FTP should be abandonmed, but rather that it should be supplemented by adding other representative driving conditions to assure that emissions controls are achieving approximately proportional reductions under these modes. This is important because in building automobiles to satisfy the regulations, manufacturers will also keep two other goals in mind: to produce the new engine at minimum additional cost and to satisfy the expectations and desires of the consumer regarding performance and driveability. Congress did in fact, intend a 90 per cent reduction throughout the range of operating conditions reflective of serious air pollution problems. Thus, to assure that this condition is met, EPA must test emissions during a larger operating temperature regime, high accelerations and decelerations, and high and low speed operation. An especial area of focus should be cold temperature, low speed conditions reflective of the conditions leading to the most severe CO problems.

Beyond CO increases, it seems clear that rich air to fuel

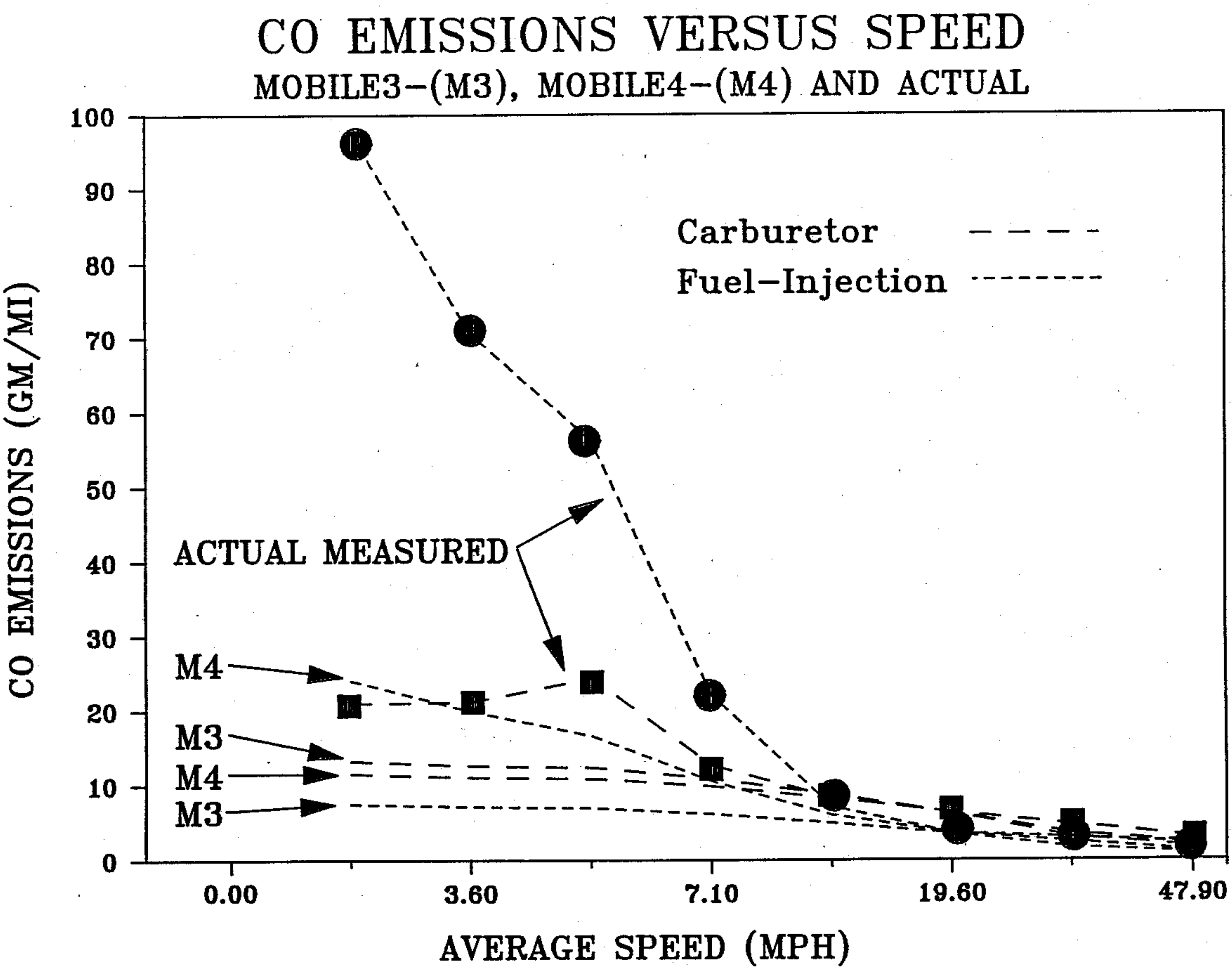

CO EMISSIONS VERSUS SPEED
MOBILE3-(M3), MOBILE4-(M4) AND ACTUAL
CO EMISSIONS (GM/MI)
100
90
80
70
60
50
40
30
20
10
0
Carburetor
Fuel-Injection
ACTUAL MEASURED
M4
M3
M4
M3
0.00
3.60
7.10
19.60
47.90
AVERAGE SPEED (MPH)

Figure 21

mixture (A/F) excursions can also increase benzene, H_2S, and other unregulated emissions. For example, "large H_2S emission levels are associated with transient vehicle operation of acceleration, deceleration, and low-speed conditions typical of stop-and-go driving in heavy traffic."(43) In addition, high speed or high load driving can also increase these emissions (if A/F is programmed to go rich to achieve maximum power) or NOx (if A/F remains at stoichiometric).

To address these concerns, it is now time to upgrade the FTP of the 1970's and 80's to the conditions of the 1990's. EPA should develop at least two new test cycles to be used in addition to the current FTP (a) focused on center city CO problems (low speeds in cold weather) and (b) high speed, high load HC and NOx problems. In developing these tests, EPA should include an idle or other short test which can routinely be included in state and local I/M programs. These additional tests should routinely be conducted as a part of all EPA compliance and monitoring programs. It is important to emphasize that under high load conditions, if vehicles are designed to operate with a rich air fuel ratio, the potential exists for significant increases in other non regulated pollutants and they should be monitored as well.

Over the past several years, for budget reasons, EPA has actually reduced the emission factor testing effort. (see discussion of this issue below in Section XV.) In the case of carbon monoxide at low temperature, especially, it is important to emphasize that it was a state effort under the leadership of Alaska which focused attention on the cold temperature question and which has returned EPA's attention to this issue. As a result, both EPA and industry are testing more vehicles under these conditions.

B. Adequacy of the Federal Compliance Program

As noted earlier, when setting its initial reduction targets in 1970, Congress substantially expanded the tools available to the Agency to assure that vehicles performed well in use. A fair question, then, would seem to be - how well has this worked? Are properly maintained cars today achieving standards for five years or 50,000 miles, as Congress intended? If not, are they at least doing a better job than they were in the early 1970's?

Figures 22 and 23 summarize the emissions performance in use as measured by EPA on properly maintained and normally maintained cars. The data show clearly that while properly maintained cars emit substantially less than normally maintained vehicles, they also show that at least for CO and HC, properly maintained cars usually exceed standards by the time they reach 30,000 miles and over their

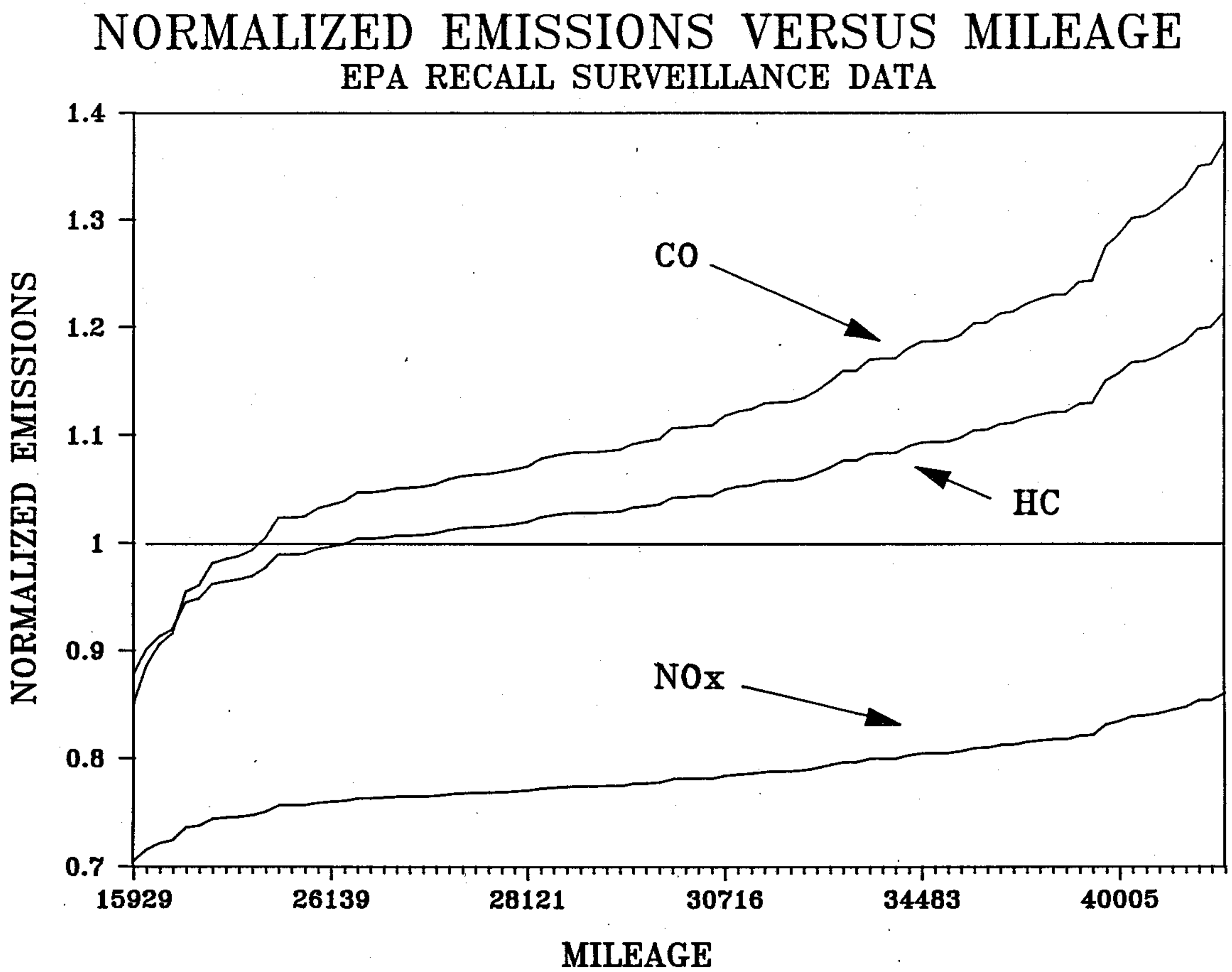


Figure 22

Walsh/NESCAUM

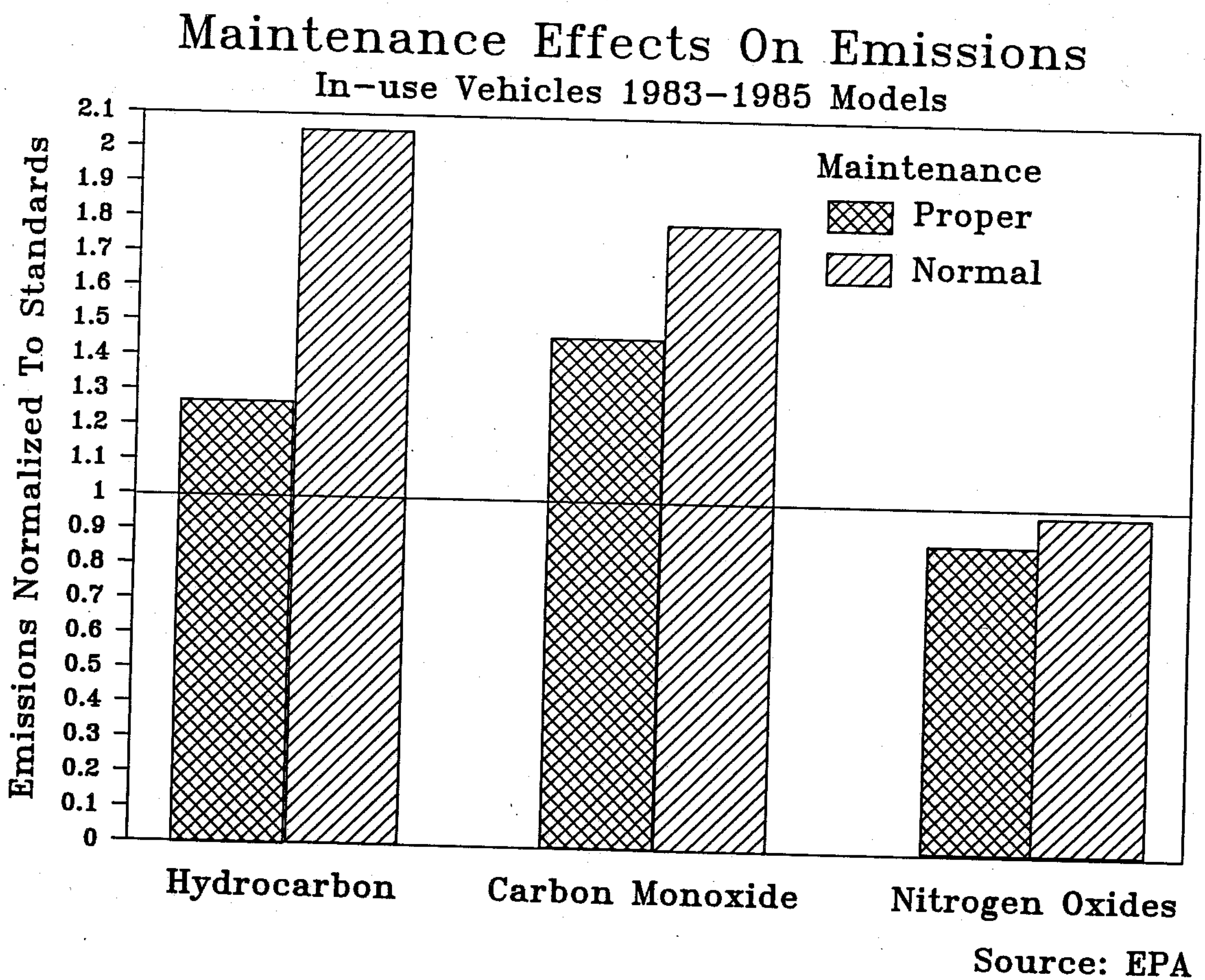


Figure 23

Walsh/NESCAUM

lifetimes are well in excess of the levels intended by Congress. EPA's ability to require vehicles to achieve standards for 50,000 miles, even on average, seems to be no better than it was when Congress expanded the tools available to the Agency. Further, according to the Agency's own analysis, the excess in-use emissions due to manufacturer noncompliance will increase over the next several years rather than decrease. (see Figures 24 and 25.)

A major reason for this is the dramatic cutback in enforcement by the Agency over the last several years. For example, since 1980, EPA's recall investigations of light duty vehicles have been reduced by 67%; SEA Test orders have simultaneously been reduced by 51%. Fuel outlet inspections have dropped by 75%. All this occurred at a time when additional enforcement responsibilities were demanded of the Agency. More stringent heavy duty vehicle standards have started to be introduced in the last few years and need to be enforced; to date, it appears that no heavy duty recall testing under the FTP is conducted by EPA. This is especially critical because heavy duty vehicles are essentially "self certified" by manufacturers with very little EPA oversight. Overall enforcement trends are summarized below.

Table 3: Mobile Source Enforcement Trends

	FY80	FY89
Recall Investigations	51	17
SEA Test Orders	39	19
Fuel Inspections	10,000	2,500

With mobile sources still responsible for major portions of the HC, CO, NOx, Lead and Toxic emissions across the country, and with state programs in this area largely preempted by Federal law, EPA must reverse the dramatic cutback in motor vehicle enforcement and return to earlier levels. To the extent that competition for available resources is contributing to the problem, the Clean Air Act should be modified to allow EPA to require manufacturers to pay for enforcement testing. The Administrator could then require the manufacturer to procure or test, or have procured or tested at the manufacturer's expense any vehicles or engines the Administrator designates and under conditions that the Administrator prescribes. The Administrator could require such testing to enable him to determine whether vehicles or engines conform to the regulations prescribed under section 202 of the Act or for other purposes as the Administrator may reasonably require to implement the Act.

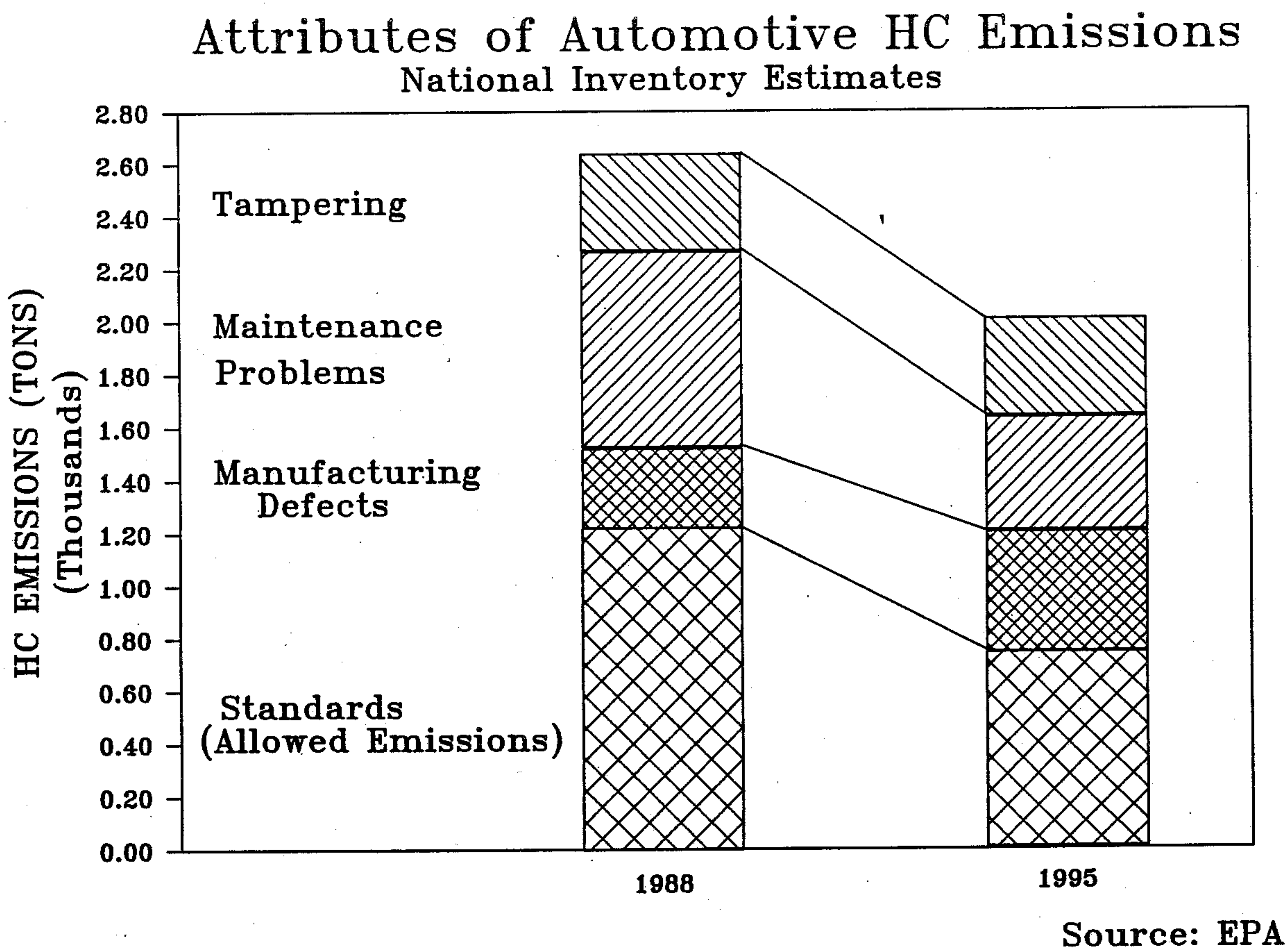


Figure 24

Walsh/NESCAUM

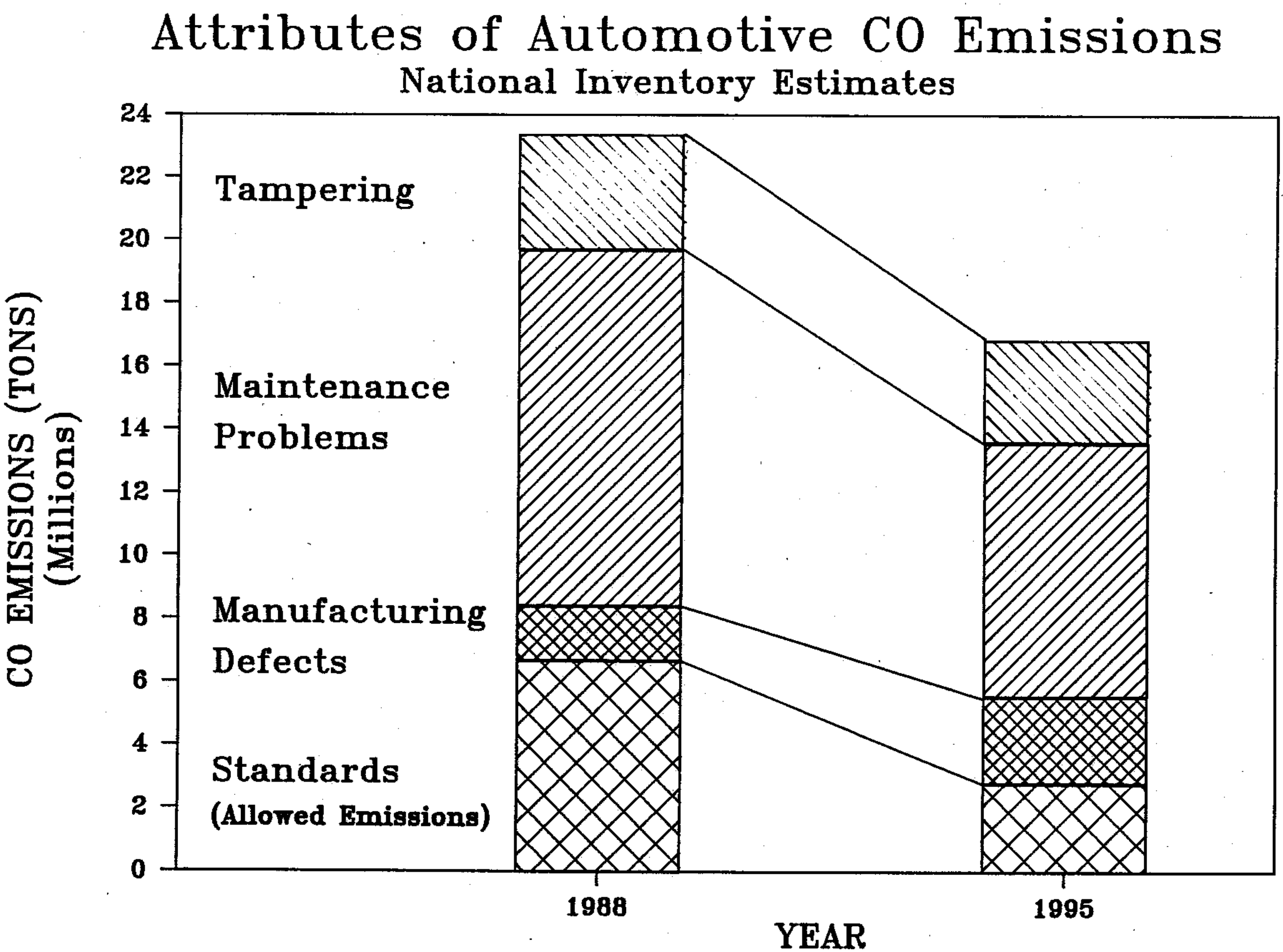


Figure 25

Walsh/NESCAUM

As noted earlier, the post Certification requirements prior to vehicle sale are significantly different in California than Federally. Rather than Selective Enforcement Audit, California requires an across the board functional test on 100% of production and a 2% quality audit. Further under Title 13 of the California Code, California routinely selects samples of vehicles prior to sale for compliance testing at their own laboratories. With the costs of such testing the responsibility of the manufacturers, these programs should be superior to the current Federal enforcement effort for new cars.

In addition, the California warranty differs from the federal warranty in that a failed emission control part, as opposed to failure of an emission test or standard, is the criterion for implementing the warranty. Thus the California warranty applies whether the defective part is detected during normal maintenance or as a result of failing an I/M test. The issue of whether the failed part has resulted in exigency of an emission standard is avoided. California is also currently involved in an effort to expand the warranty coverage for the emissions control components such as catalysts and some of the electronic controls to 10 years or 100,000 miles.

<u>EPA should support legislation which would enable it to require manufacturer funding of enforcement testing, and to adopt California assembly line testing and full life warranty requirements.</u>

An area where states can help to improve the enforcement of motor vehicle emissions standards is with regard to response to Recalls. As noted earlier, only about half the vehicles which should be returned to dealers for repair of emissions related recalls are brought in; if this were increased, the direct emissions reductions from recall would increase and even more importantly, the deterrent impact on manufacturers would go up. <u>It is recommended therefore, that states track recalls and require individuals to present vehicles for repair as a condition of annual vehicle certification. EPA should adopt this as a requirement in serious non attainment areas and develop the appropriate mechanisms by which it could be implemented</u>.

V. Review of Proposals To Lower Vehicle Emissions

A. Summary of Proposals

Because of the environmental problems noted above in Section II, numerous proposals have been put forth to lower emissions from both gasoline and diesel powered vehicles beyond current requirements. In numerous appearances before Congressional Committees, States and Cities have supported the adoption of more stringent emissions requirements. More stringent emissions standards similar to those listed below are among the major proposals.

Table 4

	Current	Proposed
Automobiles (Light Duty Vehicles)[1]	grams/mile	grams/mile
Carbon Monoxide (CO)	3.4	3.4 [2]
Hydrocarbons (HC)	0.41	0.25 [4]
Oxides of Nitrogen (NOx)	1.0	0.4
Particulates	0.2	0.08
Light Duty Trucks (Above 6000 lbs. GVW)	grams/mile	grams/mile
Carbon Monoxide (CO)	10.0	5.0
Hydrocarbons (HC)	0.8	0.50
Oxides of Nitrogen (NOx)	2.3	
	1.7 (1990)	0.5
Particulates	0.26[3]	0.08
Heavy Duty Trucks	grams/brake horsepower hour	
Oxides of Nitrogen (NOx)	10.6	
	6.0 (1990)	
	5.0 (1991)	4.0
		1.7
Motorcycles	grams/mile	grams/mile
Carbon Monoxide (CO)	19.2	17.6
Hydrocarbons (HC)	8	2.0 (under 700cc)
		4.0 (700cc and up)

Notes:

1. Modifying the definition of light duty vehicles to include most light duty trucks with a gross vehicle weight of less than 6000 lbs. GVW has also been proposed. Current standards for these vehicles are 10 gpm CO, 0.8 HC and 2.3 NOx, with the NOx level reduced to 1.2 gpm in 1988. Particulate standards for these vehicles are 0.26 gpm.
2. Approximately proportional reductions have been proposed for 20 degrees F, which is deemed roughly equivalent to 6.2 grams per mile.
3. In the Federal Register of June 4, 1987, EPA proposed a relaxation of this standard for a few years followed by a tightening. Specifically, EPA proposed 0.5 in 1987, 0.45 in 1988 through 1990 and 0.13 in 1991.
4. Some have proposed this value for total hydrocarbons and others for non methane HC only.

In addition to tighter emission standards, various proposals would:

- o Require enhanced I&M programs including antitampering emission control equipment inspections;

- Require fleet operators to make increasing use of low polluting, alternative fueled vehicles;
- Require off-road vehicles beginning in 1990 to meet the emission standards of highway vehicles of comparable horse power;
- Ban lead in gasoline beginning in 1990;
- Eliminate the use of averaging to determine compliance with standards;
- Require a 90% pass rate on EPA's assembly line testing program;
- Establish an idle test for light duty vehicles;
- Expand the class of vehicles eligible for recall;
- Extend the tampering prohibition to individuals and;
- Prohibit the manufacture and sale of emission control defeat devices.
- Extend the useful life for the auto standards to apply for the full vehicle life (10 years or 100,000 miles) rather than the current half life (5 years or 50,000 miles).

B. Impact of Proposals

Figures 26 and 27 show the potential emissions reductions estimated to be possible if auto and light truck HC and NOx standards are tightened in accordance with the standards listed in Table 4, the useful life for autos is extended to 100,000 miles and improved I/M is implemented. These results show that significant emissions reductions per mile driven are possible, on the order of 40 to 60 percent. (see Section VI for a more detailed discussion of I/M.) Figures 28 and 29 show that for the country as a whole, HC and NOx exhaust emissions would be substantially improved with this package alone, reversing increases in each pollutant that would otherwise occur.

Beyond the NOx and HC emissions reductions, the technologies fostered by tighter HC and NOx standards should also bring about reductions in CO emissions. As recently noted by the state of California Air Resources Board, "We expect that nearly all passenger cars will emit CO emissions at a rate approaching 3.4 grams per mile <u>in use</u> as a result of further NMHC (non methane hydrocarbon) control." (36)

The potential overall impacts of tighter standards, extended useful life and enhanced I/M are summarized in Figures 30, 31 and 32. Individually, for CO and HC, the improved I/M requirements are the most important followed closely by full life useful life requirements. Tighter standards also contribute significantly. With NOx, the more stringent standards are most important, followed by the full life useful life. Overall, the analysis demonstrates

POTENTIAL BENEFITS of ADDITIONAL CONTROLS

TIGHTER STANDARDS,FULL USEFUL LIFE AND IMPROVED I/M

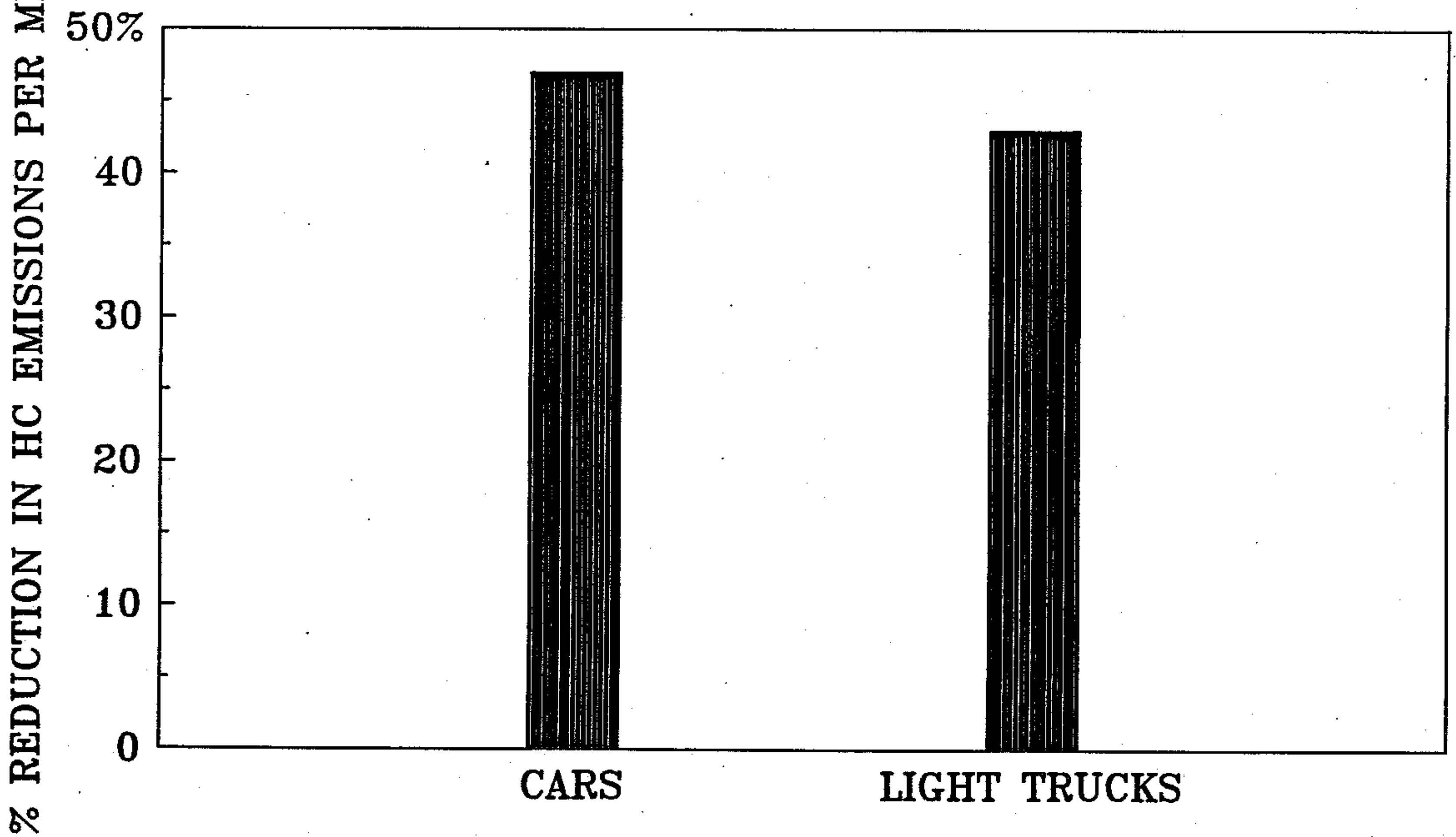


Figure 26

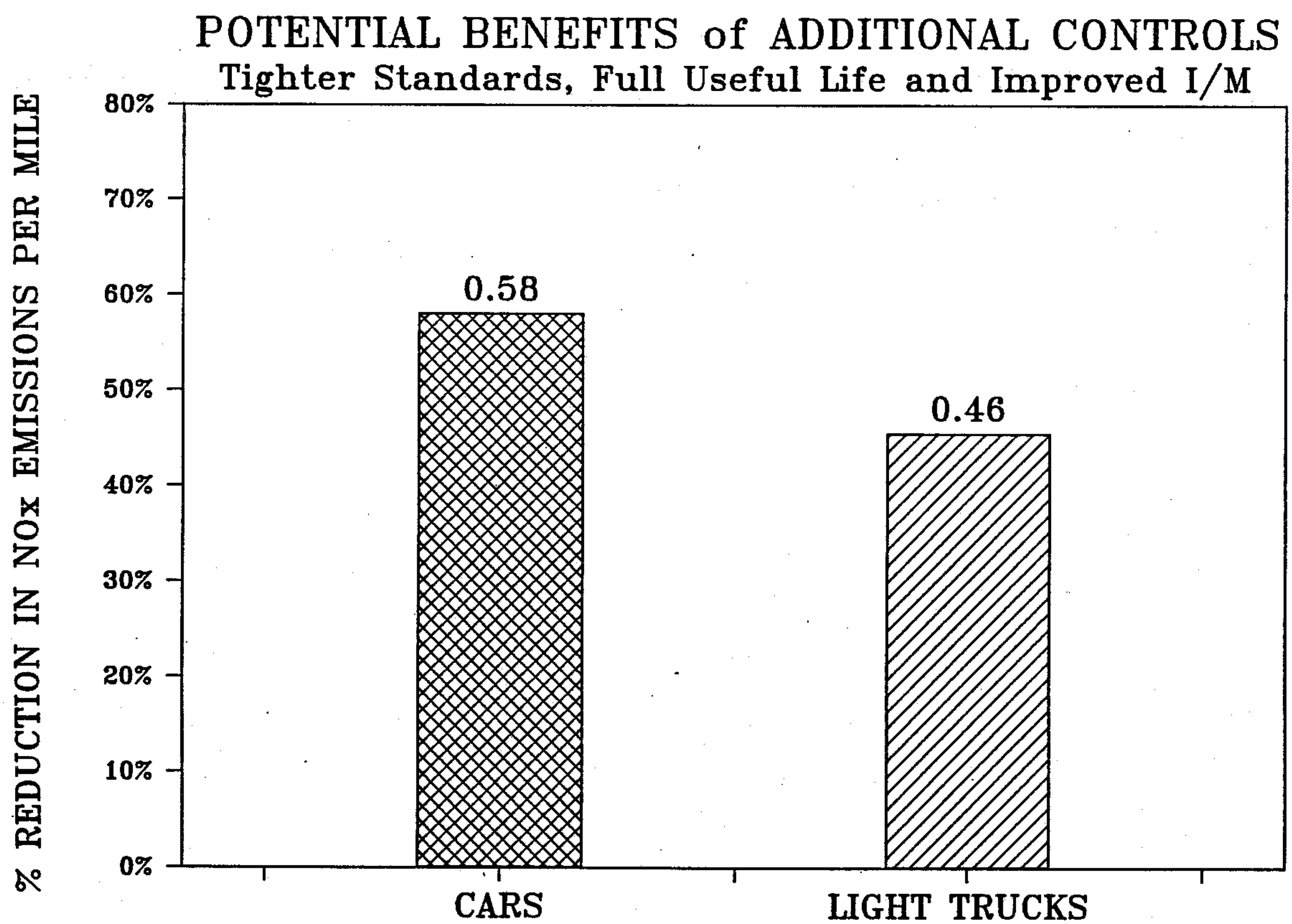
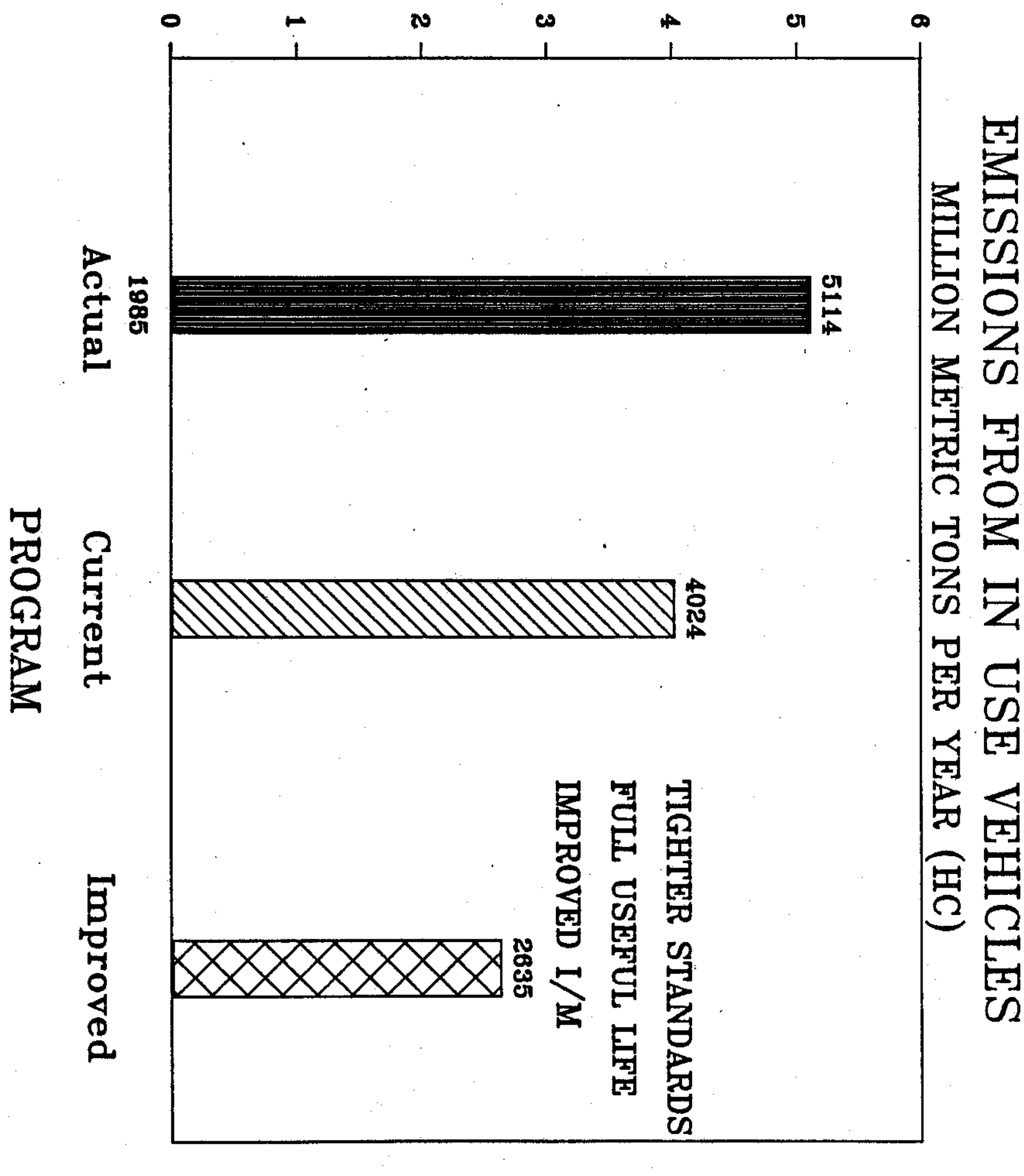


Figure 27

Walsh/NESCAUM

NATIONWIDE EMISSIONS



NATIONWIDE EMISSIONS

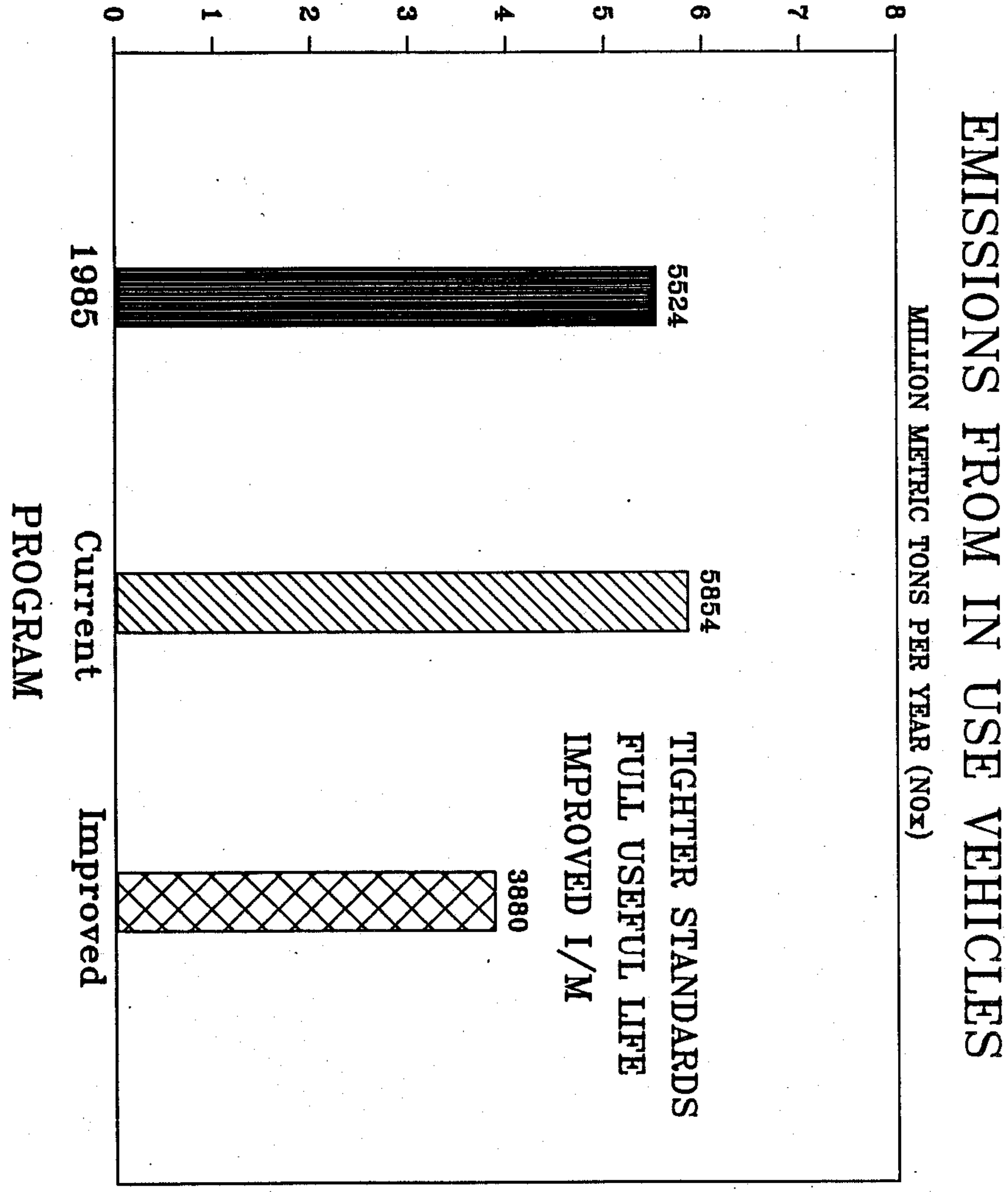
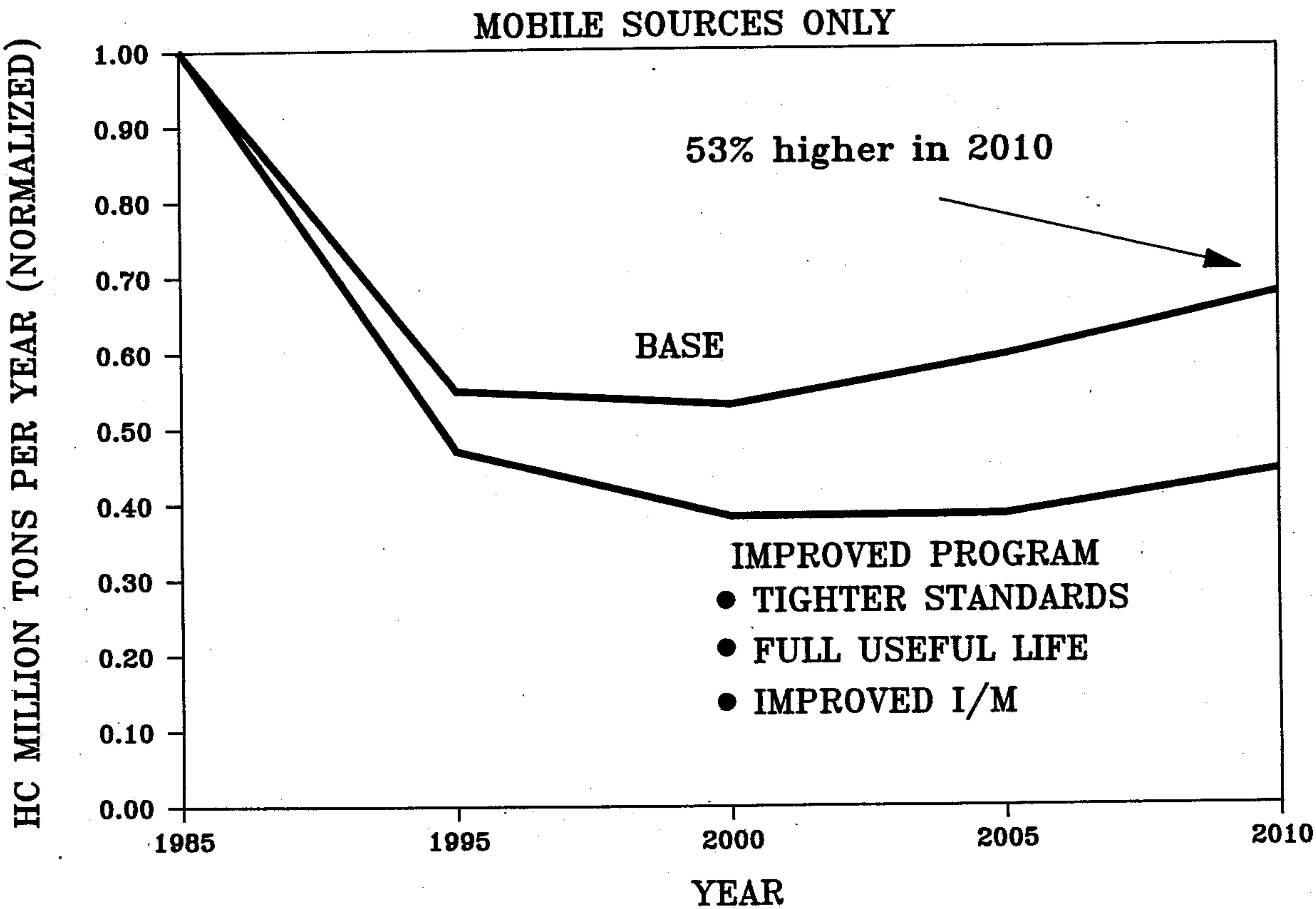
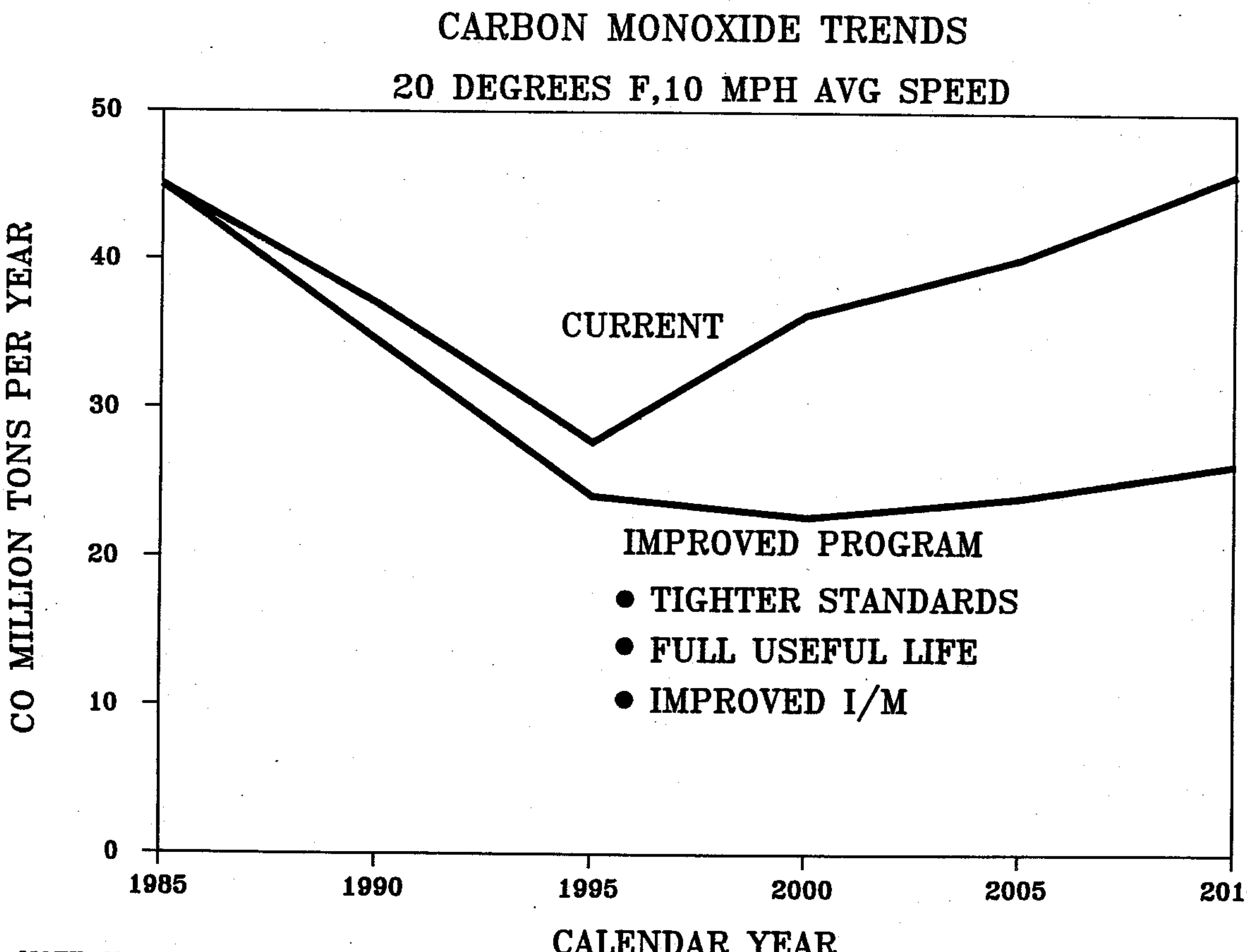


Figure 29

Walsh/NESCAUM

HC EMISSIONS -- 79 NONATTAINMENT AREAS





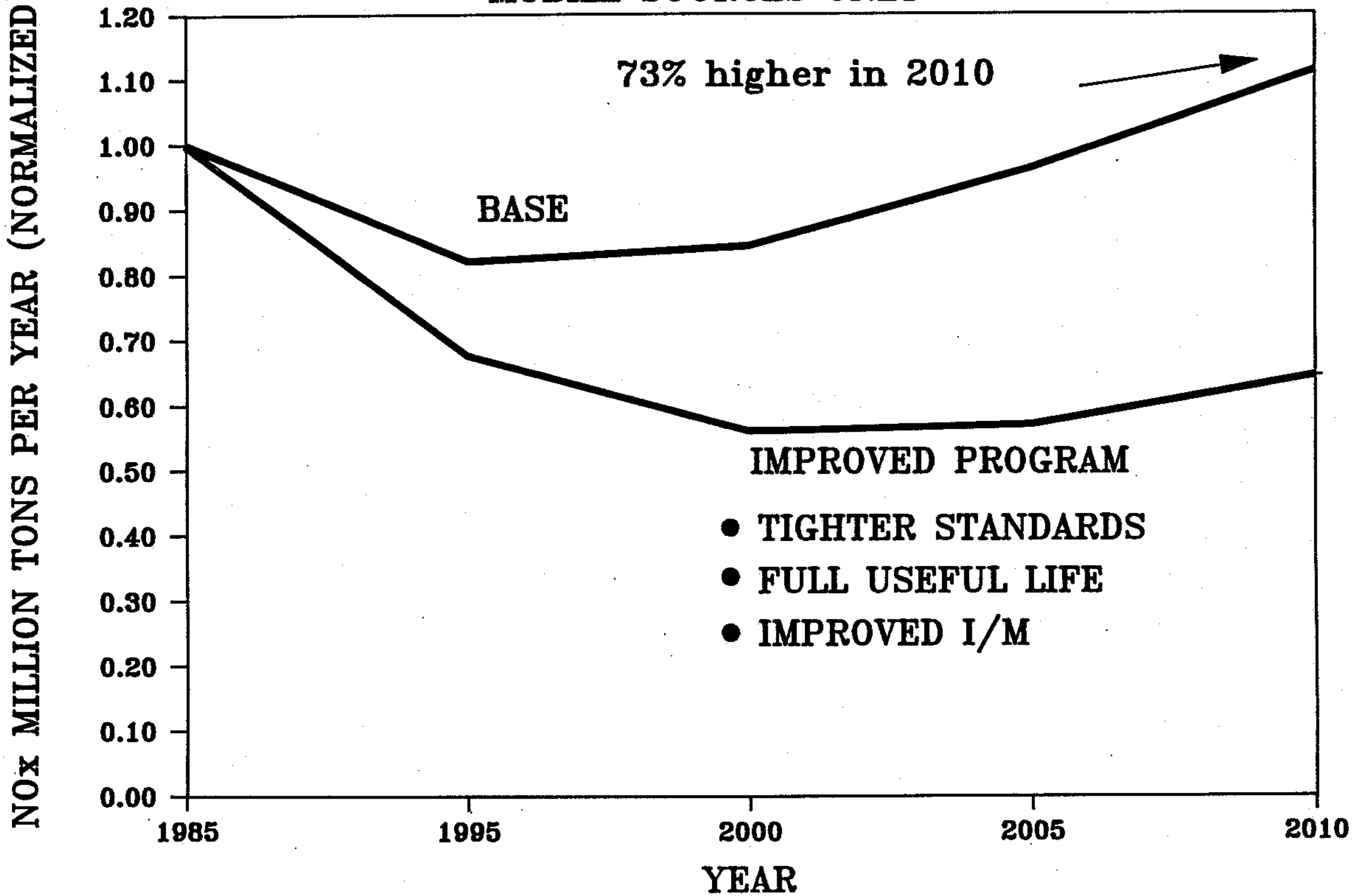
NOTE: No cold CO standard
which would add benefits

Figure 31

Walsh/NESCAUM

NOx EMISSIONS -- 79 NONATTAINMENT AREAS

MOBILE SOURCES ONLY



that the states were correct - motor vehicle emissions levels can be further reduced through a combination of tighter standards, more durable systems and improved I/M and these should be required. These provisions would continue the downward pollution trends from mobile sources well beyond the current requirements. (It is important to note that the above analysis does not include the potential impact of adopting a specific cold temperature CO standard; in conjunction with the above package, adoption of a 90 percent reduction standard for CO at 20 degrees F, has the potential to bring about significant additional CO reductions

Other controls also have the potential to significantly lower emissions. As EPA noted in its proposal regarding fuel volatility and refueling emissions, very substantial VOC control is possible in these areas.(6) Further, as illustrated in Figure 33, OTA has identified off highway vehicles and air, rail and marine vehicles as being significant sources and therefore opportunities for additional VOC control.

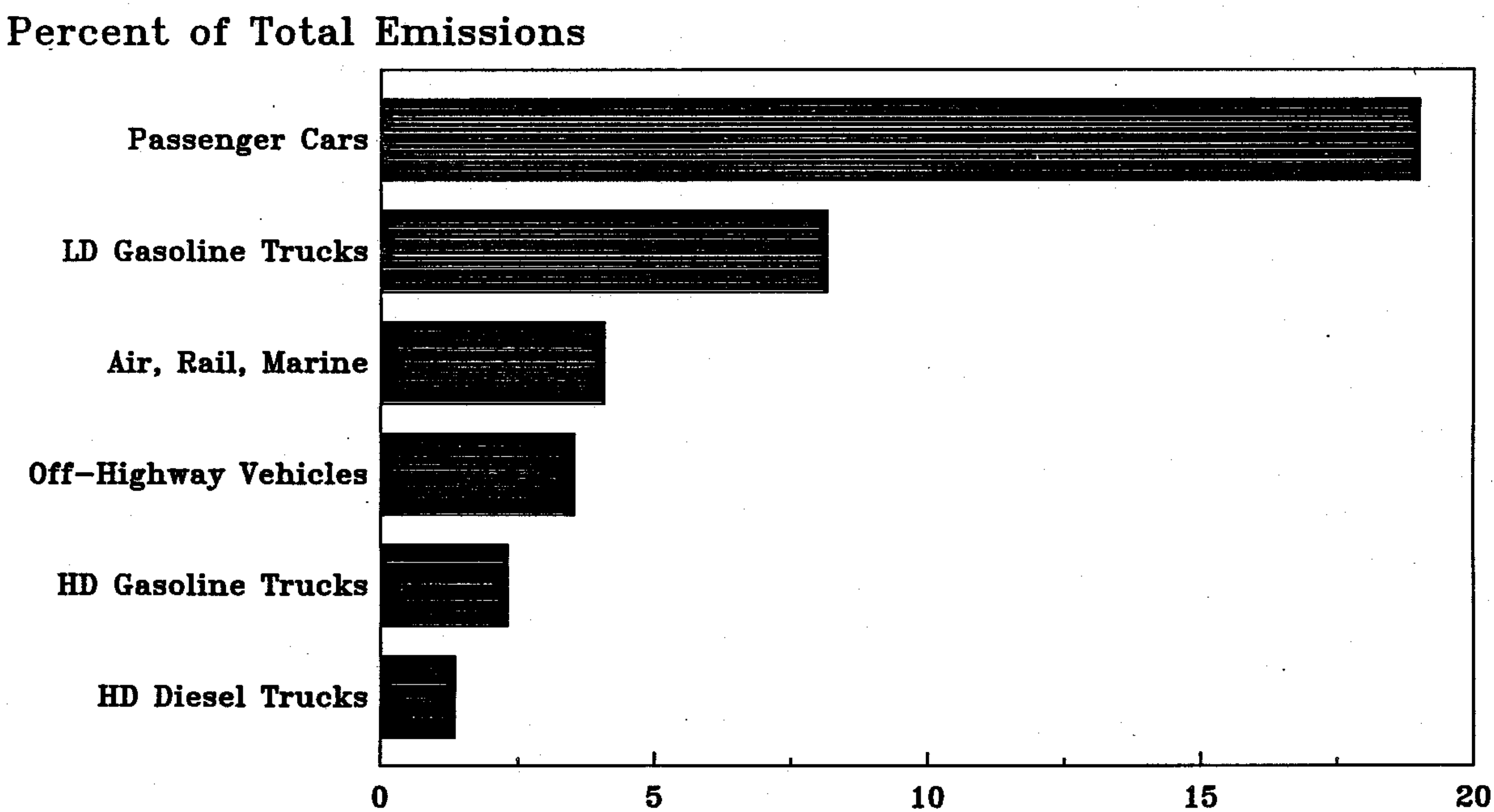
C. EPA Position

EPA's own analyses indicate that in the long term, solving the ozone air quality problem will require virtually all feasible control of HC, that the more stringent standards and full useful life requirements are generally feasible and among the easiest strategies to implement, and that the technologies which would be encouraged by more stringent HC and NOx standards would reduce evaporative emissions and make cold temperature CO control easier. For example, in an assessment of the implications of Federal implementation plans conducted by EPA last year, EPA made the following observations: (35)

> "the FMVCP is expected to "bottom out" in the 1995-2000 time frame, because by that time almost all of the vehicle fleet will be equipped with the same controls that are on the new cars. Unless further mobile source reductions are achieved, vehicle emissions will begin to increase due to increased VMT and deterioration of controls on older vehicles."
>
> "It is technically possible to reduce new car tailpipe emissions further through a more stringent hydrocarbon exhaust standard and improved 'durability'.
>
> "If large emission reductions are to be achieved in large cities, there is no alternative to severe cuts in emissions from mobile and area sources."

In the same analysis, EPA ranked eleven major categories of measures which could be used to address the ozone

1985 MOBILE SOURCE VOC EMISSIONS AS A PERCENTAGE OF TOTAL (MOBILE PLUS STATIONARY) EMISSIONS



Source: April 1988 OTA

Figure 33

Walsh/NESCAUM

nonattainment problem on a scale which ranked them according to difficulty or cost; national mobile source measures as shown below were ranked the second easiest, surpassed only by SIP rule improvements.

Table 5: RANKING OF MEASURES
<u>Order of Increasing Difficulty to Adopt or Implement</u>

- SIP Rule Improvement
- National Mobile Source Measures
- Stationary Point Source Measures
- Local Mobile Source Measures
- National Policy/Procedural Changes
- Stationary Area Source Changes
- Short Term Transportation Control Measures
- Long Term Transportation Control Measures
- Stringent Stationary Point Source Measures
- Stationary Source Growth Restrictions, Heavy Offsets, Production Caps
- Severe Mobile Source Measures

Further in its proposed rules on fuel volatility and onboard hydrocarbon controls issued in August 1987, EPA noted the following:(6)

> "For this rulemaking, nationwide VOC inventory projections as well as future air quality were made for the 61 non-California urban areas currently in nonattainment status...By the end of the projection period (i.e., 2010), emission inventories in the areas modeled apparently will be worse than in 1988. The number of areas violating the ozone NAAQS follows this trend." (See Figure 2)
>
> " VOC emission reductions of 50 to 80 percent appear necessary to bring some cities into compliance."

In spite of these conclusions, EPA has argued that more stringent tailpipe standards for cars achieve reductions which are not worthwhile and that most other changes with the exception of extending auto useful life are within the Agency's authority and will be implemented if appropriate. The Agency supports full life useful life requirements except with regard to warranty.

D. Conclusion

<u>Motor vehicle emissions will bottom out during the 1990's and start to increase from that point unless additional controls are implemented.</u> Tighter controls are therefore necessary and have been found to be potentially significant. <u>The combination of tighter standards, full life useful; life and improved Inspection and Maintenance can substantially lower motor vehicle emissions</u>; absent

these and other controls, overall air quality will remain unhealthy throughout many areas of the country including most of the Northeast for the foreseeable future.

Beyond nonattainment considerations, as important as they are, an additional benefit of lowering hydrocarbon emissions generally, and of lowering diesel particulate emissions will be to reduce urban toxic emissions throughout the country. As noted earlier, EPA has determined that mobile sources are potentially responsible for between 629 and 1874 cancer cases per year. Based primarily on more recent data regarding 1,3 butadiene, this estimate has been lowered but is still significant.(71)

VI. Review of the Current Inspection/Maintenance Program

A. Current Status

1. Background

Inspection and Maintenance (I/M) programs are intended to detect and bring about the repair of vehicles with excessive emissions levels.(44,45) They help to maximize the benefits the public realizes from the emission controls installed on their vehicles by encouraging proper vehicle maintenance, deterring tampering and misfueling and, in some cases, by identifying poorly designed or built vehicles. Without I/M, therefore, it seems clear that all elements of the in use emissions performance of vehicles are significantly weakened. Overall emissions reductions of approximately 25% of mobile source HC and CO emissions have been demonstrated to be feasible through implementation of I/M. However, most existing programs are falling well short of this goal. Further, recent studies show that significant NOx and diesel particulate reductions are also possible but such improvements have received very little Federal attention and have not yet been demonstrated in actual operating programs.

2. Clean Air Act Basis For I/M

I/M has been required as a part of the State Implementation Plans (SIPs) pursuant to Sections 110 and 172 of the act for those states unable to achieve compliance with the CO or ozone air quality standards by the end of 1982. This is consistent with the fundamental thrust of the 1970 legislation (and its subsequent amendments), to the effect that the Federal government enforces the manufacturer directed programs whereas it is left to State and Local governments to deal directly with consumers regarding the use of their vehicles. In addition, this facilitates the focus of I/M in serious nonattainment areas rather than in all areas of the country. (In hindsight, the greater understanding of the importance of transported pollutants or their precursors indicates that greater control measures outside of nonattainment areas has benefits within nonattainment areas as well.)

States unable to meet the national ambient air quality standards for ozone or CO by 1982 were eligible to receive extensions to 1987 if they adopted I/M programs. Under criteria set forth in the Clean Air Act, by the late 1970's, 28 states and the District of Columbia had been identified as requiring I/M programs. This number has gradually increased since that time as new air quality data has identified additional problem areas. By the end of 1987, most of those states had implemented the required programs. Whereas, throughout the 1970's less than 5% of the total national vehicle fleet was included in I/M, in response to the Clean Air Act Amendments of 1977, this participation rose sharply thereafter, and currently about 30% of the fleet is in some type of I/M program. (A summary of I/M programs is listed in Table 6.)

Table 6

Key Features of I/M Programs Operating in the U.S.

Program	Safety	Type	Enforcement	Tight Stds?	Underhood	Repair Cost Ceiling	Ignore Owner Repair
Alaska (Ankorage)	NO	D	R	YES	YES	$500	YES
Alaska (Fairbanks	NO	D	R	YES	YES	$300	YES
Arizona	NO	C	R	YES	LTD	50-300	NO
California	NO	D	R	YeS	YES	$ 50	YES
Colorado	NO	D	R	YES	LTD	50-200	NO
Connecticut	NO	C	S	YES	NO	$ 40	NO
Delaware	YES	C	R	NO	NO	$ 75	NO
Dis. Col.	YES	H	S	NO	LTD	NONE	NA
Georgia	NO	D	S	NO	YES	$ 50	NO
Idaho	NO	D	S/C	NO	LTD	15-30	NO
Illinois	NO	C	S/C	NO	NO	TUNE	YES
Indiana	NO	C	C	YES	NO	50-100	NO
Kentucky (Cinci)	NO	D	C	NONE	YES	NONE	NO
Kentucky (L'ville)	NO	C	C	NO	NO	12-200	NO
Louisiana	YES	D	S	NONE	LTD	NONE	NA
Maryland	YES	C	R	NO	NO	$50	NO
Massachusetts	YES	D	S	NO	LTD	$100	NO

Program	Safety	Type	Enforce-ment	Tight Stds7	Under-hood	Repair Cost Ceiling	Ignore Owner Repair
Michigan	NO	D	R	NO	NO	$ 65	NO
Missouri	YES	D	R	NO	YES	TUNE	NA
Nevada	YES	D	R	NO	YES	14-100	NO
New Jersey	YES	H	R	YES	NO	NONE	NA
New York	YES	D	R	NO	LTD	TUNE	NA
North Carolina	YES	D	S	NO	YES	$ 50	NO
Oklahoma	YES	D	S	NONE	YES	NONE	NA
Oregon	NO	C	R	YES	YES	NONE	NA
Pennsylvania	YES	D	S	YES	NO	25-50	YES
Rhode Island	YES	D	S	NO	NO	NONE	NA
Tenn. (Memphis)	YES	C	S/R	NO	NO	$ 50	YES
Tenn. (Nashville)	YES	C	R	YES	NO	NONE	YES
Texas	YES	D	S	NONE	YES	NONE	NA
Texas (El Paso)	YES	D	S	NO	YES	200-400	NO
Utah (Davis Co.)	YES	D	R	NO	LTD	60-150	YES
Utah (Salt Lake)	YES	D	R	NO	LTD	15-100	YES
Utah (Utah Co.)	YES	D	R	NO	LTD	15-100	YES
Virginia	YES	D	R	NO	NO	$ 75	NO
Washington	NO	C	R	YES	NO	$ 50	NO
Wisconsin	NO	C	R	NO	NO	$ 55	NO

<u>Legend</u>

Type: D-private garage or "decentralized"; C-centralized; H-hybrid
Enforcement: R-registration; S-sticker; C-computer matching
Repair Cost: TUNE-low emission tune-up only
Underhood Inspection: LTD-limited; not thorough

A few remaining air quality problem areas have not yet adopted I/M, and EPA has announced that it will impose a construction ban and withhold certain federal funds if they fail to make reasonable progress towards implementing a satisfactory program.

3. Importance of I/M to the Federal Program

Inspection and maintenance has a prominent role in many of the most important components of the US Motor Vehicle Control Program. To the extent that I/M identifies, relatively rapidly, vehicles which may be out of compliance this information can be fed back to the Recall and Assembly Line Test programs thereby allowing the government to focus investigations and test orders on the most appropriate vehicles. (The first performance based recall ordered by EPA was initiated on the basis of I/M test data, for example.) I/M is also key to the Warranty program by which individuals can identify equipment defects and it is a requisite for the Warranty against performance defects which are detected by a Federally prescribed short inspection test. Without I/M, all of these programs are significantly weakened.

4. The Role of I/M With Regard To Anti Tampering and Misfueling

I/M is also the major ingredient in the antitampering, anti-misfueling effort, as the threat of inspection failure is considered a strong deterrent. Tampering with the emission control system and fuel switching, i.e., using leaded gasoline which destroys the catalytic converter, combine to pose a serious threat to the goal of realizing the needed nationwide reduction of motor vehicle emissions. Recent EPA surveys indicate that 15 to 20 percent of all passenger cars and about 25 percent of light trucks have been subjected to some form of emission control tampering. The prevalence of tampering is highly variable among states and localities, with significant variability also occurring within a single geographic area.(55) Some forms of tampering have relatively minor impacts on emissions, but in the extreme, where catalytic converters are removed or destroyed, vehicles can emit approximately four times the CO and three times the HC as untampered vehicles. Fortunately, most tampering does not involve catalyst destruction, the national survey level being about 5% or less. The national level of misfueling is over 10 percent. In I/M areas these levels are reduced by from one-half to two-thirds, indicating the beneficial impact of I/M on willful disablement of controls.

5. Summary

I/M contributes critically to success in the control of motor vehicle emissions, aiding program elements that may seem far removed from the on-road fleet. The primary direct benefits of I/M are to initiate, improve, and focus vehicle maintenance, and to discourage tampering and fuel switching, with these combined influences improving emissions performance of the total fleet. If I/M realizes its full potential, it also can serve to stimulate vehicle design improvements so that the broad spectrum of vehicle ownership still yields emissions compliance, beyond the narrower confines defined in certification.

B. Improving Reductions From Existing Programs

While most I/M programs in effect in the US have been adopted in response to Federal requirements, they differ significantly in terms of implementation details. This is because EPA, in specifying the program requirements, recognized the wide variety of local conditions (e.g., labor and land costs, local - state interrelationships, existence of or lack of a safety inspection program, etc.). In this environment, three main mechanisms for implementing I/M programs have evolved. First is the so-called private garage system in which the inspection is conducted by a local gas station or repair facility which is licensed for this purpose by the government after meeting certain requirements. The most successful of these types of programs include sealed, computerized analyzers which provide increased confidence to all concerned that the inspection test is run correctly and objectively. Alternatively, state operated lanes have been installed solely to conduct inspections (often including safety as well as emissions). Finally, to avoid the expense to the state associated with building centralized facilities, private contractors can be hired to build and operate such a system at no capital cost to the government; the complete expense is paid for over time by fees charged to owners of inspected vehicles. Administrative costs for the government can also be provided by these fees.

Over the past few years, EPA has audited several of these programs to see which are working best and which are falling short of their potential. While some programs are working very well, it is clear that many programs need to be improved. The major problems are related to low failure rates (substantially fewer vehicles failing the program than anticipated based upon the test standards adopted) in decentralized I/M programs with manual analyzers. Two of the major problems leading to low identification of dirty vehicles are poor instrument quality control and the abuse of repair cost limits which allow repairs to be waived if the cost of repairing these vehicles is estimated to be greater than a predetermined value. Most waiver programs are using unrealistically low cost cut offs, based on repair cost data generated during the 1970's. Improved I/M could help to solve these problems by requiring computerized, better quality analyzers and raising the cut off for repair cost waivers. At a minimum, better enforcement, especially with sticker based programs, and a lack of commitment in some cases to try to maximize program effectiveness are also problems.

C. What EPA Should Be Doing

While many of these issues may appear to be state issues, in fact, they frequently require Federal policy corrections and Federal technical support. Only EPA can effectively develop new and better test procedures, develop a data base to support technical improvements, audit programs to identify special problems, etc. Again EPA resources devoted to I/M issues have not kept pace with the nationwide expansion in the number of programs. Although there has been an almost ten fold increase in the number of programs since 1980, EPA' s resources devoted to this area have declined. <u>EPA has been unable or unwilling to provide the technical assistance and support needed to sustain quality programs.</u>

Specific recommendations to improve the delivery of emission reductions from I/M are:

1. An ideal I/M program in the future would include extensive antitampering checks, loaded mode testing of HC, CO, NOx and diesel particulate, and take place in a centralized, carefully controlled facility. EPA should adopt appropriate policies and conduct necessary technical analyses to move the country in this direction as rapidly as possible. Such basic program elements are badly needed now, but must be labeled "ideal" and "future" considering the current EPA position on correct and acceptable I/M program concepts.

2. Modifications of the waiver policy should reflect the changing economics of automobiles. Waivers should require at least $200 of repair (not including costs to repair tampering) for 1975 and later model cars <u>and</u> strong EPA support for extending the warranty to over 100,000 miles for those components which cost over $200 to repair. A mechanism for independent verification of repairs where waivers are requested should also be included.

3. Registration enforcement rather than sticker enforcement should be mandatory. (This would enable linkage of the I/M and Recall programs in new vehicle registrations.)

4. Mandatory use of computerized analyzers and mandatory analysis of the data from these analyzers should be prerequisites for EPA approval of any remaining decentralized program designs.

5. I/M type tests should be added to the FTP to assure that vehicles are designed in a manner that when properly maintained they will pass I/M requirements.

6. New, more advanced I/M protocols should be developed to account for the changing vehicle technologies already introduced and likely to dominate the fleet of the 1990's.

D. Adding NOx and Particulate Control

As noted earlier, many areas are in need of greater reductions in NOx and particulate from existing sources. With regard to NOx, the driving force is mainly from ozone and acid rain problems. Diesel I/M is more urgently needed as a result of the change in the Total Suspended Particulate (TSP) air quality standard to PM10; because diesel particulate is all below 10 microns in size, this air quality standard change places greater emphasis on diesel contributions. Further, the public in many areas can't accept that gasoline cars must undergo I/M when the "dirty" diesels get off. Also, toxic worries continue to keep pressure on diesel particulate emissions.

1. NOx I/M

a. Potential Benefits

To date, in the US, I/M programs have been designed primarily to reduce CO and HC emissions. However, the EPA mobile 3 model indicates that I/M and anti tampering programs can reduce NOx emissions in the future. For example, the model predicts that a program started in 1987 would achieve an almost 10% reduction after just a few years. Even this estimate, however, understates the full I/M potential. For example, the potential NOx gains that could occur if NOx tampering could be eliminated would be on the order of a 25% reduction.(44)

b. Inspection Issues

Practical inspection issues to achieve maximum NOx reductions generally require centralized, loaded mode I/M and/or an on board (OBD) diagnostic system of inspection to keep inspection time requirements short and not to raise the cost of inspection beyond acceptable limits. Short of this, anti tampering protocols focused on NOx devices can result in significant gains.

2. Particulate I/M

a. Potential Benefits

A study conducted for the State of California concluded that bus I/M could reduce overall particulate by 35%.(59) (As used in this analysis, the term I/M means any method of systematic inspection and corrective maintenance including but not limited to an actual emissions test.) A more recent analysis conducted for California has found that malmaintenance and tampering increase actual particulate emissions from 76 to 85 percent.(60) Studies conducted by the Colorado Department of Health have found that smoke opacity levels can be reduced significantly through maintenance and repairs of light duty diesel vehicles.(61)

b. Inspection Issues

The identification of diesel engines in need of emissions maintenance often requires loading the engine to observe characteristic operations where high emissions occur. Just as gasoline vehicles with electronic controls now reveal less of their true emissions character during an idle-only examination, the newer generations of heavy-duty (HD) diesel engines are entering their emission control era using computer and electronic controls for engine performance maps to achieve compliance. Thus inspection issues that will accompany these complex HD engines into their long useful lives must be addressed, not after the problems arise, but in the very design of the systems and the I/M test protocols employed throughout certification. Only by joining the certification process to I/M at the time of design, can future I/M protocol specifications and emission level cut points be correctly related to expected performance. The OBD I/M issues discussed above apply equally to this combustion control technology.

Because the potential benefits and the need justify it, EPA should give high priority to development of test procedures for NOx, and Particulate from diesels (including trucks and buses) and a policy to require such tests when EPA has developed them.

E. Onboard Diagnostics

In the longer term, EPA should adopt an onboard diagnostic program similar to California's as a supplement to I/M. The intent of such regulations is to minimize the large increases in exhaust emissions which occur when emission-related malfunctions exist in in-use vehicles equipped with three-way catalyst and feedback fuel control systems. Vehicles equipped with electronic engine controls incorporate a backup set of engine operating parameters in their computers which maintain adequate vehicle driveability and performance characteristics in the event of a malfunction in the vehicle's emission control system (ECS). The vehicle operator may thus be totally unaware of an ECS malfunction since driveability is retained and the vehicle will continue to operate under high emitting conditions. An onboard diagnostic (OBD) system visually alerts the operator to any detected malfunction and causes the operator to take necessary actions to repair the malfunction. In this way air pollution from motor vehicles is reduced by insuring the ECS is quickly serviced when malfunctioning.

An additional benefit of an OBD system is in assisting the service industry to quickly and properly diagnose and repair malfunctions in the vehicle's emissions control system. Since the OBD system is an integral part of the vehicle's power plant, it senses computer electronic signals under the various vehicle operating speed and load modes and can thus detect and store intermittent faults which are very difficult to duplicate in the servicing garage. The OBD system also provides a relatively easy means for inspecting vehicles under the I/M program by monitoring the malfunction indicator lights.

Given the widespread prevalence of underhood computer controls and nonstandard diagnostics, we conclude that EPA's current efforts in this area are regrettably late and will leave the States and repair sectors in intractable positions for many years regarding achievement of cost effective emissions reduction, as these complex computer cars move inexorably into the latter stages of their lives.

VII. Review of Evaporative Emissions

In motor vehicles, fuel related evaporative emissions originate in two parts of the fuel system - the fuel tank and the fuel metering system. Significant evaporation occurs during episodes of increased temperature in these parts of the fuel system; they are known as "hot-soak" and"diurnal" emissions.

Hot soak emissions are generated by the continued heating of the fuel by the engine after it is shut off. During this period, fuel in the fuel line, the carburetor or fuel injection system, and in the fuel tank rises in temperature. The purpose of evaporative control systems is to capture the released vapors in a sealed system which feeds to the charcoal canister, where they can be adsorbed and retained on the charcoal granules.

Diurnal emissions are caused by the daily heating of the fuel tank by outside air. Again, in a properly designed and operating system, the vapors released are channeled to the charcoal canister.

The capacity of evaporative canisters to store gasoline vapors is limited by canister size, and they must be purged each time the engine is operated. To achieve this, vehicles are equipped with a purging system which draws air across the carbon granules and carries the purged vapors to the engine to be burned. This flow must be carefully controlled so that exhaust emissions are not adversely affected or driveability impaired.

Properly designed and operating systems should have no difficulty meeting the current 2 grams per test standard, when running on the fuel for which the systems were designed (generally 9 pounds per square inch). However, because actual in use fuel volatility has risen from about

9.0 lbs. per square inch (psi) RVP in the summer of 1970 to an average of almost 11 psi today, (see Figure 34) EPA testing indicates that emissions actually are 5 to 7 times the standard. In addition, EPA's data indicates that the increased purging to the engine caused by the excess vapors due to high fuel volatility leads to a small but statistically significant increase in exhaust HC and CO emissions.

Excess evaporative emissions can also result from disabled systems, either as a result of tampering or defective components. A recently discovered source of vehicle evaporative emissions, are "running losses", which occur when a vehicle's fuel tank heats up while the vehicle is running. Limited, recently collected data on 11 vehicles indicates that many of these vapors escape through the gas cap or evaporative canister while the vehicle is running. This is especially a problem with tampered vehicles but overall emissions will increase from these vehicles with higher volatility fuel. (See Section VIII)

Another source of evaporative losses from a vehicle is displacement of fuel tank vapors during vehicle refueling. There are two sources of hydrocarbon emissions associated with vehicle refueling operations, displacement and spillage. Displacement losses refer to the gasoline vapors in the fuel tank of the vehicle that are displaced by the incoming liquid fuel and directly emitted to the atmosphere. Spillage losses refer to gasoline that is unintentionally spilled during refueling, which then evaporates.

About 90 percent of all refueling emissions consist of vapors displaced from the vehicle fuel tank by the incoming gasoline. The mass of these emissions depends on the volume of vapor displaced and its density, which in turn are determined by the temperature of the fuel being dispensed and of that already in the tank, the tank size and geometry, the volatility of the fuel, and a number of other minor factors.

These factors have been included in a regression model that expresses the displacement component of refueling emissions in grams per gallon (g/gal) of fuel dispensed.

EF_d=-5.909-0.0949(delta T)+0.0884(T_d)+).485(RVP), where

EF_d = displacement component of refueling emissions (g/gal)

delta T = difference in temperatures of residual fuel, T_r, and dispensed fuel, T_d (degrees F), and

RVP = volatility of the dispensed fuel, in terms of Reid vapor pressure (psi).

The appropriate input values for use in this equation depend on the geographic area and local conditions for which the refueling emissions are to be estimated. Nationally representative values for May to September estimated by EPA include:

$$\text{delta } T = 8.4\ ^{o}F$$
$$T_d = 78.8\ ^{o}F$$
$$RVP = 11.3 \text{ psi}$$

The use of these values results in an estimate of 5.6 grams per gallon for the displacement component of refueling emissions. EPA's best judgement of typical spillage losses is 0.03 grams per gallon. The emission factor determined in this way (5.9 g/gal.) is combined with vehicle fuel economy data to obtain gram per mile emissions factors for each vehicle type, using the following equation:

$$HC_r = EF * FC$$

where,

HC_r = total refueling HC emission factor (g/mile)

$EF = EF_d + 0.03$ = total refueling emission factor, (g/gal), and

FC = fuel consumption (gal/mile) = 1/M.P.G.

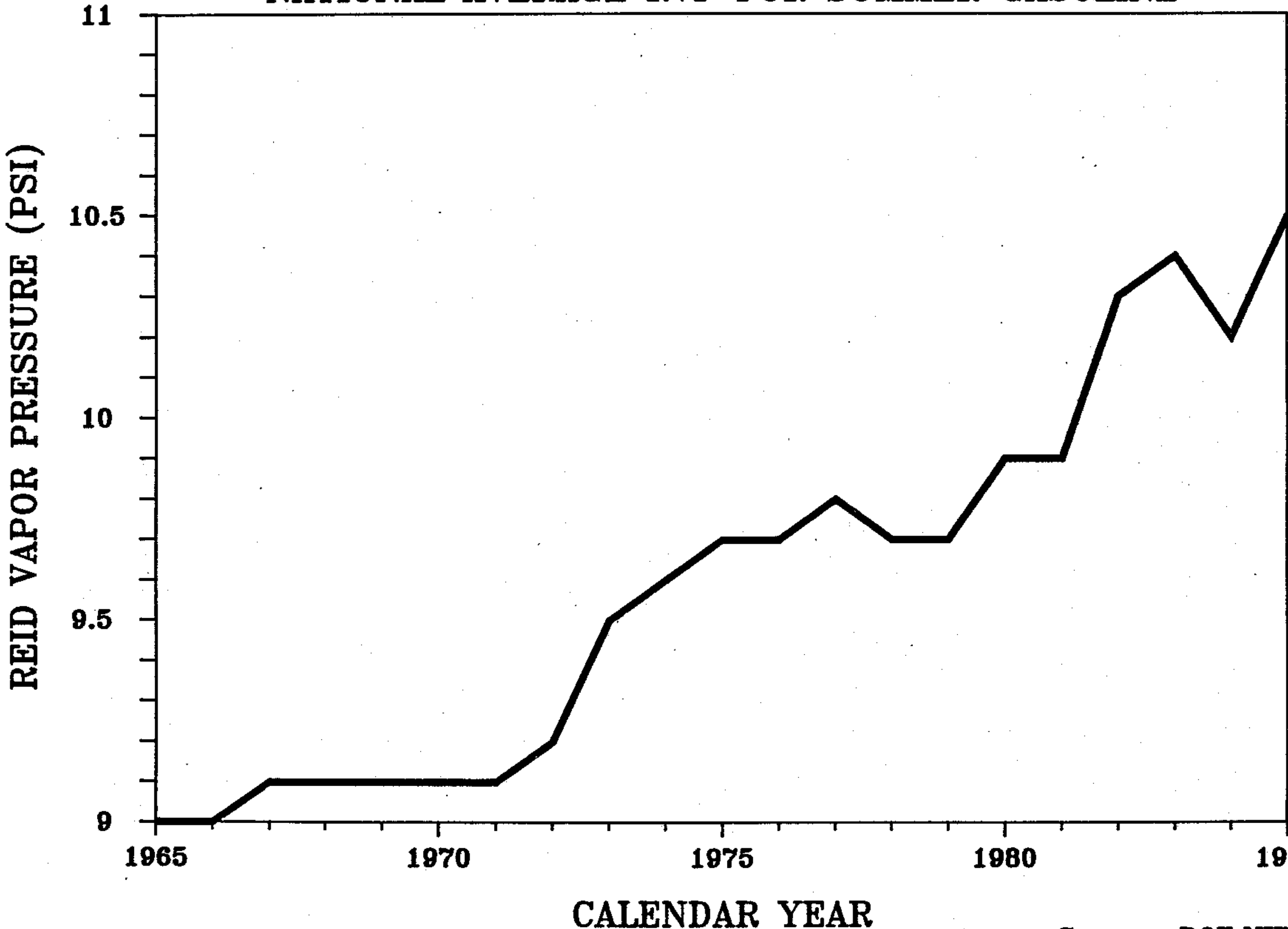
In summary, evaporative emissions from actual in use vehicles are substantially greater than measured during Certification. While in part, this is due to the higher deterioration and tampering which are inherently unrepresented in Certification, the primary shortcoming is related to fuel volatility changes which have occurred since EPA adopted the initial regulation. (See Figures 34 and 35) Again, EPA failed to carry out a periodic "reality" check, to assure that test conditions retained a close linkage to actual in use conditions. Of course, the Agency has proposed to address this problem by restricting fuel volatility, but it has run into strong industry opposition. On this issue (as well as the companion issue of onboard HC controls), states should strongly support the EPA proposal. In a more general sense, however, it illustrates the ongoing EPA problem of not adjusting to changing conditions. As a routine matter, EPA should have sufficient resources devoted to investigating the differences between in use vehicles and their fuels compared to routine EPA test protocols so that ongoing adjustments can be made.

VIII. Review of Fuels And Fuel Additives

The greatest success of the motor vehicle control program has been in the tremendous reduction in lead emitted into the air; this has resulted from the substantial reduction

INCREASING FUEL VOLATILITY

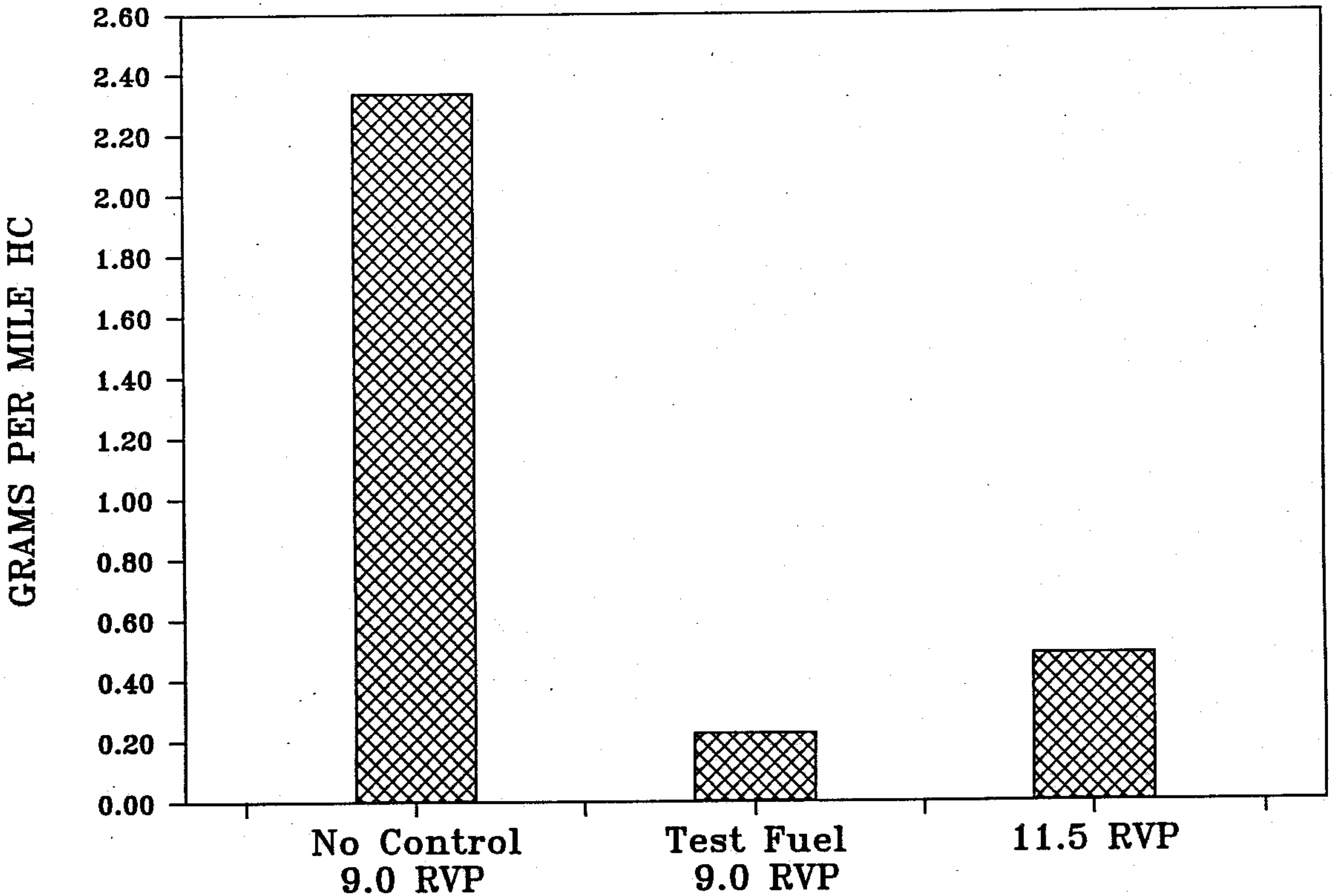
NATIONAL AVERAGE RVP FOR SUMMER GASOLINE



Source: DOE:NIPER
Walsh/NESCAUM

Figure 34

EVAPORATIVE HC REDUCTIONS 1970–1990



in lead contained in leaded gasoline as well as the increasing proportion of vehicles required to operate on unleaded fuel. Unfortunately, the move toward the complete elimination of lead has stalled over the issue of potential valve problems with farm tractors. In light of the serious health concerns that have now been well established for very low levels of lead, and the continuing potential for lead in gasoline to damage existing catalytic converters which are the preeminent component in the control of CO, HC and NOx, it is recommended that EPA proceed with a ban on leaded gasoline. For those few engines, which may still require lead, EPA should encourage the introduction of alternative substitutes which can be added to the fuel of these vehicles alone.

There are many other potential concerns related to fuels, however.

A. Gasoline

Partly in response to this pressure on lead and partly in response to energy needs, greater amounts of alcohols and ethers -- either as high octane blending components or as substitutes for gasoline -- are being used. Other likely changes include the processing of heavier crudes and the likely decline in residual fuel demand. These changes could cause significant changes in emissions characteristics.

B. Impact of Blend Fuels on Emissions

The addition of oxygenates (low level blends of approximately 6% oxygenates or less) to gasoline will alter the stoichiometric air/fuel ratio compared to pure gasoline. The leaner mixture may either reduce or increase the level of pollutants in the exhaust gas, depending on the carburetor setting. The leaning out effect, provided the carburetor setting is unchanged, may reduce the emissions of CO and HC but may increase NOx. If the mixture becomes too lean, the HC emissions could increase considerably due to misfiring. There is a tendency towards increased evaporative emissions and photochemically reactive aldehydes.

The State of Colorado has initiated a program to mandate the addition of oxygenates to gasoline during winter months when high ambient CO tends to occur. The success of this effort has encouraged other areas to consider oxygenate blends as a CO control strategy.

C. Pure Alcohol Vehicles

The use of neat alcohol engines will result in exhaust emissions with only a few components compared to gasoline. Generally hazardous aromatic hydrocarbons including benzene are not formed and PAH emissions are very low. The characteristic emission components are carbon monoxide, unburned alcohol, nitrogen oxides and aldehydes. Engines designed for neat methanol tend to have low emissions of CO, NOx and unburned fuel. Evaporative emissions are also low.

Aldehyde emissions, however, can be 4 to 8 times higher than for gasoline vehicles. These compounds tend to be highly photochemically reactive and to contribute directly to eye irritation. There is significant evidence that formaldehyde is a human carcinogen. (It is important to note that most aldehydes including formaldehyde, which exist in ambient air are formed photochemically in the atmosphere and are not directly emitted.) Fortunately, the data indicate that these compounds are effectively reduced by catalysts.

Emission characteristics of alcohol fueled diesel engines are also good. They feature low emissions of NOx and PAH and virtually no particulates. Both concepts can be used together with an oxidation catalyst to effectively reduce the unburned fuel and aldehydes.

D. Diesel Fuel

Probably the most important characteristic of diesel fuel is the amount of sulfur present. High sulfur emissions increase exhaust particulate and sulfates. High aromatic content can also increase the hazards of diesel particulate.

Another important characteristic is ignition quality which is indicated by cetane number. A major challenge regarding diesel fuel will be in maintaining current cetane number levels. This will be difficult in the future because of the expected reduction in the quality of crude oils and the increasing demand for diesel fuel.

Fuel issues for diesel engines revolve around fuel purity and its relationship to diesel particulate control. Impurities in diesel fuel are a concern in and of themselves, particularly metals like chromium, because of the potential for direct emission in the exhaust. With respect to diesel particulate control, fuel additives may also be important. One type of trap oxidizer systems which is being explored includes self regeneration by means of metallic fuel additives. Such additives could be a source of significant concern with regard to unregulated pollutants depending on the fuel additive used; environmentally benign materials such as cerium are considered more attractive environmentally than metals such as lead or copper.

E. Conclusions Regarding Fuels and Fuel Additives

Beyond the lead phasedown program, very few other positive steps have been taken with regard to fuels and fuel additives by EPA. In spite of specific authority provided in 1970 and a specific mandate provided in 1977, the Agency has still not developed or even proposed regulations regarding fuels and fuel additives. This is in spite of the fact that fuels are changing rapidly at this time due to the reduced availability of domestic oil reserves and the differing refinery feedstocks. Therefore, it is recommended that EPA proceed with the development and introduction of fuel and fuel additive regulations as Congress mandated.

IX. Transportation Control Measures

Whatever success is achieved in reducing per mile emissions from vehicles can be eventually eroded by continued high growth rates in the number and use of vehicles. Throughout the country, transportation controls to reduce this growth have been a failure, at least in part due to a Federal rollback in the early 80's following a strong push in the late 70's. This should be reversed.

It is now clear that technological solutions to the motor vehicle pollution problem are increasingly offset by growth in the vehicle population. Therefore, long term solution of the nonattainment problem is dependent on coming to grips with the overall growth issue. In addition, growth has serious implications for the toxic and global motor vehicle concerns. Therefore, it is recommended that EPA restore transportation controls as a specific priority within the Office of Mobile Source Air Pollution Control.

High growth impacts on emissions in two ways. Not only does it directly increase emissions (more miles driven = more pollution), it leads to more congestion which further increases emissions.

The Federal government frequently encourages greater use of vehicles through the Federal Highway Administration funding efforts to increase road capacity, thereby increasing the use of vehicles. Federal consistency is necessary.

X. Review of Adequacy of Mobile Source Predictive Models

A. The Mobile Models

In the 1970s the Office of Mobile Sources developed a computer modeling system for predicting the effect on air quality of improvements in emission control on motor vehicles.(48-52) The model used data from tests performed on vehicles taken at random from the in-use fleet to assess the effectiveness of the control technology and project the impact of that effectiveness on long term air quality attainment goals. This model has undergone a number of significant changes over the last ten years to account for innovations in technology, improved understanding of the emissions process, and changes in assumption about the in-use fleet composition.

The Table below provides a brief summary of each of the model versions, identifying the major changes.

Table 7
Changes in the Mobile Model

A. MOBILE1 - 1978

1. Modeled exhaust and evaporative emissions.
2. I/M Program benefits calculated.
3. Covered light duty cars and trucks and heavy duty vehicles.

B. MOBILE2 - 1981

1. Emission factor and mileage data updated.
2. Light duty diesel cars and trucks added.

C. MOBILE3 - 1984

1. Emission factor and mileage data updated.
2. Effects of tampering and antitampering programs added.
3. Commercial fuel used to estimate evaporative emissions.
4. Separate version of Mobile3 developed for particulate modeling.

D. MOBILE4 - 1988 (projected)

1. Emission factor and mileage data updated.
2. Refueling and running loss evaporative emissions added.
3. Effects of fuel volatility control, Stage II and Onboard added.
4. Tampering data updated and based on larger sample.

In 1978 EPA released MOBILE 1 the first of its series of mobile source models. The models are a working reflection of the information presented in the AP-42 document, Compilation of Air Pollutant Emission Factors: Highway Mobile Sources. This is a collection of the in-use emission factors that EPA has obtained through its test programs. The models use the data tabulated in the AP-42 to perform emission calculations, that are effected by user inputs, to provide composite results. New versions of the model have been released to accommodate: 1) Changes in regulations. 2) More data about current technology. 3) Better forecasts of future technology and behavior. The models have been used to prepare State Implementation Plans (SIPs), Environmental Impact Statements (EISs) and estimate real world benefits for EPA regulatory proposals.

1. MOBILE1 - 1978

MOBILE1 calculated emissions for any given year on July 1. Emissions were calculated by type of pollutant (HC, CO and NO_x) for the per mile output of a vehicle. The model identified emissions from several vehicle classes: light duty gasoline vehicles (LDGVs - cars), light duty gasoline trucks (LDGTs), heavy duty gasoline vehicles (HDGVs), heavy duty diesel vehicles (HDDVs) and motorcycles (MCs). The number of grams per mile was given for each vehicle class and for each pollutant and a figure for total fleet emissions per mile travelled was calculated for each pollutant by weighting each output by the proportion of annual vehicle miles travelled (VMT) for that class. Outputs reflected a composite of exhaust (VMT) for that class. Outputs reflected a composite of exhaust and evaporative emissions. Hydrocarbon (HC) emissions were differentiated as total HC or non-methane HC in the outputs. The data for various HC fractions came from several sources that did not include actual in-use testing.

2. MOBILE2 - 1981

The changes fell mainly into two categories: calculation methodologies and emission data.

The changes in calculating methodology were:

- The emissions factors for a particular year were calculated for January 1 instead of July 1. This approach has been carried forward through the most current revision of the model.

- Evaporative emissions were calculated based on the source of their production (crankcase, diurnal, and hot soak losses). No such differentiation was made in MOBILE1, which used a composite estimate of evaporative emissions.

- The computation of speed and temperature effects was modified to more closely reflect the growing body of data resulting from Agency test programs.

- The effects of air conditioning were modified from a best estimate of use to a temperature/comfort factor estimate.

- The power to displacement correction factor for HDVs was dropped in favor of a more accurate method of calculation.

- A different approach was incorporated to estimate the future in-use vehicle fleet emissions. The new approach more accurately reflected actual data collected since the previous version.

The changes in emission data were:

- More evaporative HC data was included.

- New and more extensive exhaust and idle emission data was added to the model covering the most recent model years and all vehicle classes.

- Current registration mix and mileage accrual data was used to update the travel weighting fractions.

- New data was included about non-methane HC emissions which was based on in-use testing from the Emission Factors Program.

- More temperature correction factor data for LDGVs was incorporated.

- New data on the effects of air conditioning on emissions was utilized.

3. MOBILE3 - 1984

MOBILE3 probably had fewer changes in it than MOBILE2 but some of the bigger changes involved the addition of emissions due to control system disablements (tampering offsets) and some changes in the handling of evaporative emissions.

Changes in the calculation methodology:

- The method of calculating cold start CO emissions changed from having an additive effect on emissions to a multiplicative effect. This is again a result of more accurate knowledge gained through testing.

- Tampering offsets in gm/mi were estimated from several inputs and added to the base, untampered emission rates. National average tampering rates from the Tampering Surveys and data from vehicle disablement testing provided data for these calculations.

- Closely related to the previous item, the model included the means to estimate the effects an antitampering and/or an I/M program has on correcting and deterring tampering.

- Heavy duty diesel mileage vs. age distribution was modified to reflect the effects of increased diesel sales.

- Non-methane emissions were estimated from a subtractive rather than a multiplicative model.

Changes in emission data:

- Evaporative emission rates were based on a representative commercial fuel instead of the previously used low volatility test fuel. This more closely represented actual in-use fuel volatility.

- More data for basic exhaust emissions, especially for the latest model years (1981 and later) were added.

- Fleet registration and mileage vs. age data were updated.

- New estimates on heavy duty vehicle emissions were incorporated and changes were allowed in the future projections to allow for improved fuel economy of new trucks and increased sales in the lower weight classes.

- More temperature and speed correction factor data were incorporated for LDGVs and LDGTs.

4. <u>MOBILE4</u> - 1988 or 1989

MOBILE4 had been due for release in the spring of 1988 but that date has slipped. It will be the model used to prepare the post 1987 attainment plans for nonattainment areas and for the preparation of the new SIPS. Some of the changes <u>planned</u> are as follows:

- The new model will account for refueling and other types of evaporative emissions on an expanded scale. This will include the ability to predict emissions based on regional volatility standards and ambient temperatures. The ability to model the effect of volatility, onboard, and Stage II controls is also planned.

- National tampering rates will be included based on a more complete data base than was used for MOBILE3.

- The credits modelled for I/M program and antitampering program (ATP) benefits will be updated.

- The effect on fleet emissions of new technologies (i.e. the increased sales of fuel injected vehicles) will be addressed in the new version.

- As before, data on fleet character will be updated or added.

- Data reflecting new knowledge about fuel volatility, emission factors, driving characteristics and others will also be included.

The Agency, through its mobile source models, has made an attempt to describe and predict emissions that come from the national vehicle fleet. As the above discussion indicates, over the course of the last 15 years, the methodology available for estimating in use vehicle emissions has advanced significantly. First generation models tended to be extremely optimistic in terms of future model year vehicle in use emissions and tended to make gross projections based almost entirely on regressions of emissions versus mileage. Crude corrections based on limited data were applied for such parameters as vehicle speeds. Over time, the model has become more sophisticated as have the EPA staff in projecting emissions from new technology vehicles. Factors such as tampering rates, misfueling, speeds, temperatures, accessories, and various I/M alternatives are now accounted for in the model. A fair assessment would certainly conclude that mobile 3 is significantly improved over the initial AP-42 projections.

B. Inputs To The Models

In spite of the improvements in the models, three problem areas tend to continue to plague the development of motor vehicle emissions projections; (1) the generic problem which can be summarized as some problems cannot be known or even anticipated until they occur, (2) the absence of comprehensive data and corrections for non standard FTP conditions, and (3) the dwindling resources available to answer the emerging questions.

Motor vehicle emissions estimates are inherently difficult for several reasons. First, the technology is continuously changing in very significant ways. Cars today, as indicated earlier in this study, are much different than just a few years ago - catalysts, electronics, unleaded fuel, fuel injection - can each profoundly effect emissions rates and were largely non existent for US cars when the 1970 Clean Air Act Amendments were passed. The electronics revolution which has been sweeping the industry is still not fully appreciated in the laboratory much less on the road. Simultaneously, fuels are changing as the entire world adjusts to the twin energy shocks of the 1970's. Very few, for example, outside the energy industry even heard of gasohol, methanol, MTBE, TBA etc. a decade ago. Predicting the vehicle technologies and fuels of the future, much less their emissions performance in the hands of consumers over a wide range of conditions is inherently uncertain.

The advanced, computer controlled technologies in use today (and certainly even more so in the future) are capable of being carefully programmed to switch on and off in response to a variety of sensors - to ambient or engine temperature, engine speed, road speed, engine load, time in mode, etc. to name a few - and can profoundly affect emissions. This problem was reinforced by data made available by Canada at the recent EPA CO workshop. As a result, it is critically important that EPA conduct much more testing under non standard conditions to assure that controls are not deliberately sacrificed (defeat devices) or ignored. Further the impact of failure modes on emissions must be assessed.

Unfortunately, at the very time that the need for in use testing has increased to assess changing fuels and vehicle technologies, the actual EPA testing has decreased significantly. Whereas in 1980, EPA tested 900 vehicles for the emissions factor testing program, current testing is at the rate of only 200 vehicles per year. The extent of the declining data base can be seen in the following Table.

Table 8
Inputs To the Mobile Models

	Vehicles Tested in Database* Increase	Vehicles Tested in Database* Total	Latest Model Year
A. MOBILE1 - 1978	5,300	5,300	1976
B. MOBILE2 - 1981	3,400	8,700	1980
C. MOBILE3 - 1984	2,500	11,200	1982
D. MOBILE4 - 1988 (projected)	400	11,600	1986

* Does not include data from light-duty trucks, 300 of which were tested for the Mobile4 update. LDT testing was negligible prior to this most recent update.

Additionally, due to resource cutbacks, EPA is increasingly relying on emission factor data supplied by the vehicle manufacturing industry. The use of data supplied by the regulated community as a basis for critical regulatory decisions is, of course, highly undesirable, and potentially undermines the credibility of the entire program.

As a result of the declining data base on newer technology vehicles, in spite of improved modeling, future projections must be seen as less reliable than in the past and, most likely, will understate future emission factor projections. The primary reasons for these understated projections are as follows:

1) Statistically, the sample size should be increasing due to the widening disparity in vehicle emission rates that has occurred in recent years, resulting in a smaller number of vehicles accounting for an increasing proportion of the emission inventory.

2) Non FTP driving cycle emissions such as extended idling, high and low temperatures and heavy load conditions, are potentially accounting for a higher percentage of the overall mobile source inventory and are not adequately reflected in current modeling.

3) Current information indicates that running losses may account for a significant proportion of the mobile source VOC inventory. (See Emerging Issues) However, to date, EPA does not have an adequate data base to incorporate running losses in the Mobile 4 model.

4) Recent evidence suggests an increased rate of degradation in in-use emission performance due to declining use of secondary air injection and lower catalyst loading ratios.

5) Most of the new data for use with mobile 4, including virtually all of the industry supplied data, is based on testing of vehicles with less than 50,000 accumulated miles; because of the factors discussed above, it is expected that overall emissions and deterioration rates will be higher in the second half of a vehicle's life than in the first half.

The EPA emission factors are the fulcrum upon which most of the remainder of the motor vehicle pollution control program revolves - State Implementation Plans, I/M decisions, emission standards etc.; it must be as solidly grounded as technically feasible. Therefore, restoration of this program to its earlier priority is recommended. In addition, similar levels of effort should be initiated for other vehicle categories.

More specifically, EPA must incorporate the following factors in Mobile 4 prior to final release:

1) increase the number of vehicles tested as part of the emission factor testing program to 2,000 per year, at a minimum, without using industry generated data;

2) incorporate running loss emission factors into the

evaporative model; to do this properly, it is necessary to expand the running loss testing program and data base to increase the statistical validity of the emission factors; and

3) account in the model for non FTP driving cycle modes that significantly impact emissions, including but not limited to low speeds, high accelerations, high speeds (above 55 M.P.H.) and cold temperatures.

XI. Review of Mobile Source Toxic Emissions

As noted earlier, toxic emissions from mobile sources are a serious problem. While substantial improvements in certain toxics have resulted as a by-product of the overall motor vehicle pollution control program - lower exhaust benzene and PNA's from catalysts, lower diesel organics from particulate controls - the Agency has not specifically focused on the motor vehicle toxics problem as a priority concern. In many areas of the United States, mobile sources are a substantial contributor to the overall health risks associated with air toxics. A variety of studies have found that in individual metropolitan areas mobile sources are one of the most important and possibly the most important source category in terms of contributions to health risks associated with air toxics. According to EPA, mobile sources may be responsible for between 629 and 1874 cancer cases per year.(57)

A. Potentially Significant Toxics From Mobile Sources

1. Diesel Particulate

As noted earlier, uncontrolled diesels emit approximately 30 to 70 times more particulate than gasoline-fueled engines equipped with catalytic converters and burning unleaded fuel. These particles are small and respirable (less than 2.5 microns) and consist of a solid carbonaceous core on which a myriad of compounds adsorb. These include:

* unburned hydrocarbons
* oxygenated hydrocarbons
* polynuclear aromatic hydrocarbons
* inorganic species such as sulfur dioxide, nitrogen dioxide and sulfuric acid.

These emissions may cause cancer and exacerbate mortality and morbidity from respiratory disease (62). As noted in the Harvard project (63) "most of the toxic trace metals, organics, or acidic materials emitted from automobiles or fossil fuel combustion are highly concentrated in the fine particle fraction".

2. Aldehydes

Formaldehyde and other aldehydes are emitted in the exhaust of both gasoline- and diesel-fueled vehicles. Formaldehyde is of particular interest both due to its photochemical reactivity in ozone formation and suspected carcinogenicity. Formaldehyde can also be a short-term respiratory and skin irritant, especially for sensitive individuals.(64) Aldehyde exhaust emissions from motor vehicles correlate reasonable well with exhaust hydrocarbon (HC) emissions, and diesel vehicles generally produce aldehydes at a greater HC composition percentage rate than gasoline vehicles. Formaldehyde can also be generated by photochemical reactions involving other organic emissions.

3. Benzene

Benzene is present in both exhaust and evaporative emissions. Several epidemiology studies on workers have identified benzene as a carcinogen causing leukemia in humans.(65) Mobile sources (including refueling emissions) dominate the nationwide benzene emission inventory, with roughly 70.2% of the total benzene emissions (66). Of the mobile source contribution, 70% comes from exhaust and 14% from evaporative emissions (65).

4. Non-Diesel Organics

Gasoline-fueled vehicles emit far less particulate than their diesel counterparts. However, the mutagenicity of the gasoline soluble organic fraction (SOF), expressed as revertants/ug SOF, is greater than diesel SOF. Also, unlike diesel SOF, the mutagenic activity of gasoline SOF increases with the addition of S9 activation, (indicating indirect-acting activity). This situation suggests that the non-nitro PAH's may be responsible for the mutagenicity of gasoline SOF, rather than the nitro-PAH's. In any event, given that the overall mutagenicity and emissions of gasoline fueled vehicle exhaust particulate is less than that of diesel particulate per mile driven, the overall impact from gasoline particulate might be significant, given the substantial travel (Vehicle Miles Travelled or VMT) of gasoline fueled vehicles. It should be noted that the emissions factors and unit risk estimates for gasoline particulate are far more uncertain than those for diesel fueled vehicles.

5. Asbestos

Asbestos is used in brake linings, clutch facings and automatic transmissions. About 22 percent of the total asbestos used in the US in 1984 was used in motor vehicles. Health impacts of asbestos exposure have been known for some time, including cancer, asbestosis, and mesothelioma.(67,68)

6. Metals

Toxicological impacts of metals, especially heavy metals, have been studied for some time.(69) In addition, many are now being analyzed for their carcinogenic potential,including several for which unit risk values have been published. EPA has identified mobile sources as a significant contributor to nationwide metals inventories (66) including 1.4% of beryllium and 8.0% of nickel. The California Air Resources Board is also analyzing these metals as mobile resource pollutants, as well as arsenic, manganese and cadmium (70). Because of a relatively high unit risk value, emissions of chromium may also be a concern although the health risk tends to be associated with hexavalent chromium which doesn't appear to be prevalent in mobile source emissions.

B. Conclusions Regarding Toxics

Unregulated mobile source emissions represent a potentially significant source of toxic compounds. Fortunately, control of exhaust and evaporative hydrocarbons generally lowers toxic emissions as well; catalytic converters tend to selectively eliminate a greater proportion of the more biologically active compounds and therefore are very beneficial for toxic control. However, metallic additives are not desirable because of potential toxic effects and in some cases carcinogenicity. Further, while alcohol fuel blends are of some benefit for exhaust emissions, they may actually increase aldehydes. Neat methanol has the potential to substantially lower toxic emissions from diesel and gasoline fueled vehicles.

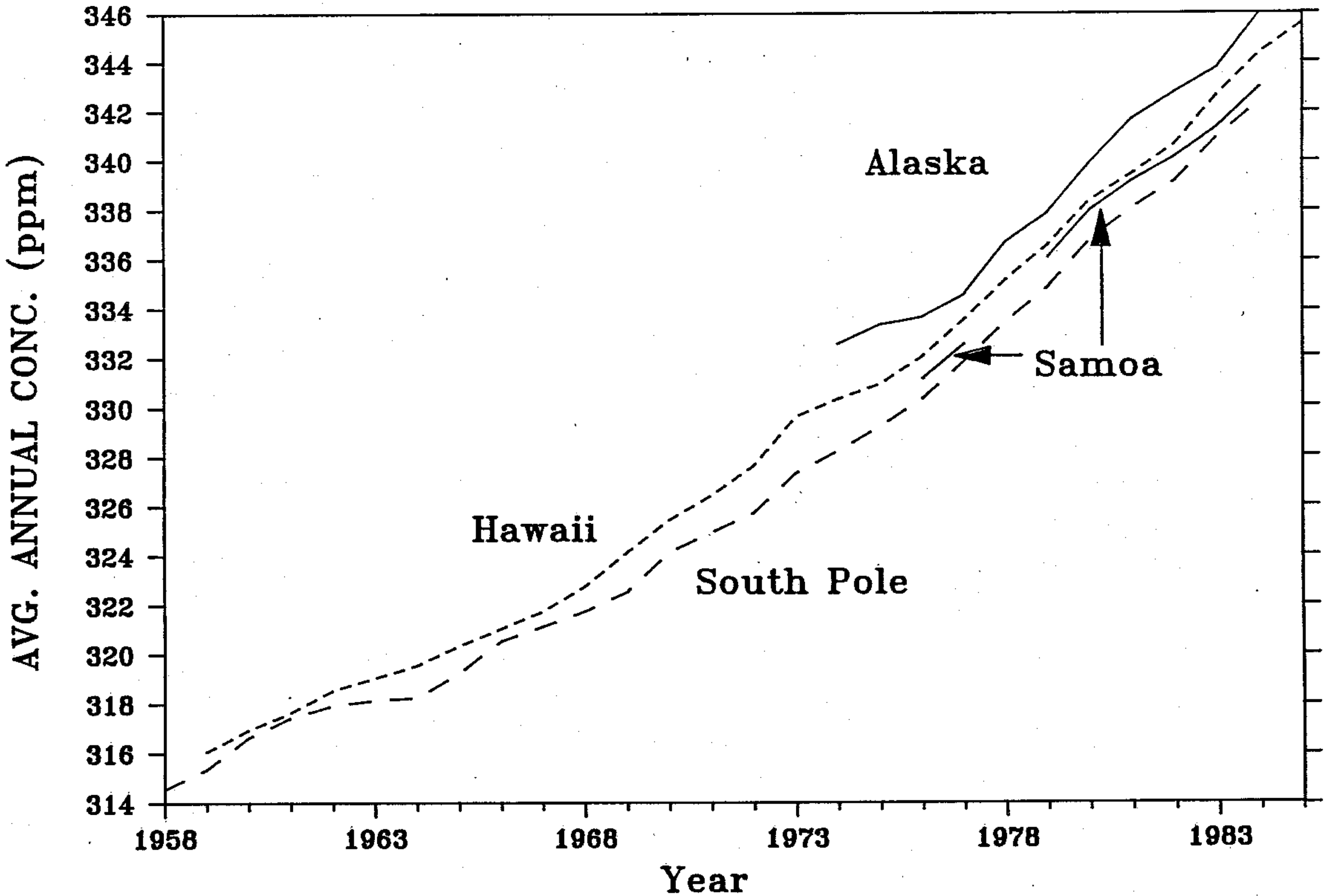
Accordingly, this area deserves increased attention from EPA not only with regard to direct emissions but also with regard to secondary pollutants which result from the transformation of these direct pollutants in actual urban air, e.g., nitrated polynuclear aromatic hydrocarbons. It is recommended that a specific toxics pollution program be set up within the Office of Mobile Source Air Pollution Control.

XII. Emerging Mobile Source Issues

A. Global Warming

As shown in Figure 36, a gradual build up of CO_2 is occurring, raising the specter of significant global warming in the next century unless the rate of increase can be slowed.(28) As a major consumer of fossil fuels, especially oil, transportation must be singled out as one of the major contributors to global CO_2 emissions, as well as some of the other gases, e.g. CH_4, N_2O, which

CARBON DIOXIDE CONCENTRATIONS



play a role in global warming.

Some evidence indicates that carbon monoxide also may indirectly contribute to global warming. As pointed out by Dr. Gordon MacDonald at a recent World Resources Institute Symposium, "Carbon monoxide could thus be indirectly responsible for increasing greenhouse warming by 20 to 40% through raising the levels of methane and ozone...Carbon monoxide participates in the formation of ozone, and also in the destruction of hydroxyl radicals, which are principal sinks for ozone and methane greenhouse gases. Because carbon monoxide reacts rapidly with hydroxyl, increased levels of carbon monoxide will lead to higher regional concentrations of ozone and methane. Measures to reduce carbon monoxide emissions will assist in controlling greenhouse warming."(29)

Further, the class of compounds known as chlorofluorocarbons (CFC's) are increasingly implicated in depleting the stratospheric ozone. Almost 40 percent of the CFC-12 produced in the US goes for charging and servicing motor vehicle air conditioning systems.(30) Other CFC's are used in vehicle seat cushions and padding and in producing electronic components.

Extensive and severe heat waves throughout the Northern Hemisphere in recent years suggest that we may already be experiencing the effects of global warming.(31,32)

Global warming can also have a significant impact on local air pollution problems. As recently pointed out by the American Lung Association, "the increase in ultraviolet B radiation resulting from even a moderate loss in the total ozone column can be expected to result in a significant increase in peak ground based ozone levels." The ALA continued, "these high peaks will occur earlier in the day and closer to the populous urban areas in comparison to current experience, resulting in a significant, though quantitatively unspecified, increase in the number of people exposed to these high peaks." (33)

EPA has the opportunity and the responsibility to play a leadership role in addressing this issue. One way to do so, is to directly define the potential for further control of the various gases which contribute to global warming and to minimize them as much as is technologically feasible. With regard to CO_2 specifically, no other country of the world has developed standards designed to reduce this pollutant from the perspective of addressing the global warming problem. (Of course, many countries including the US have taken steps to reduce fuel consumption, but for other reasons. However, in the US especially, as well as in other countries, this effort has waned in recent years as oil prices have declined and the power of OPEC has diminished.)

CO_2 emissions can be influenced by fuel consumption as well as the source of the fuel consumed (e.g., coal, oil, natural gas, biomass, etc.). Annual vehicle miles travelled can also have a significant effect. Rather than waiting until the country and the planet are <u>forced</u> to deal with restrictions on CO_2, and other greenhouse gases in a crises situation, EPA should initiate efforts now to show the world how this problem can be responsibly addressed.

B. Running Losses

As noted earlier, unburned gasoline emitted from a vehicle other than from the tailpipe are an increasingly substantial contributor to overall hydrocarbon emissions. Evaporative standards, Stage 2 and onboard refueling systems, lower volatility fuel, etc. are each important elements of an overall evaporative emissions control strategy.

Very recently, however, a new source of evaporative emissions, so called running losses have been identified, which may be as significant or even more significant than all these evaporative sources combined. Based on very limited data, it appears that at least some vehicles, on hot summer days (which tend to coincide with peak ozone levels), emit very high HC concentrations due to heating of the fuel in the fuel tank and in the fuel lines while the vehicle is running. One recent analysis estimated that running losses account for 29 percent of current hydrocarbon emissions from gasoline powered vehicles; even if fuel volatility were lowered to 9.0 psi (which would lower emissions from these vehicles by approximately 30 percent according to this analysis), running losses would account for over 20 percent of the remainder.(73) Since exhaust emissions rates <u>per mile driven</u> are declining in the future due to vehicle turnover, running losses will likely account for an even greater percentage of gasoline vehicle hydrocarbon emissions in the future than today.

These emissions are potentially so significant that EPA should undertake an <u>intensive</u> effort to define the problem, identify the causes (fuel volatility, inadequate charcoal canister design, faulty fuel line insulation or placement, poorly designed fuel caps, are each possible targets), and initiate corrective steps.

C. Alternative Fuels

As noted earlier, in response to both environmental and energy pressures, significant efforts are underway to introduce new, alternative fuels into the marketplace. In pursuing the most attractive of these alternatives, it is critically important that EPA not only explore the potentially attractive features, but assure that new problems are not created. Whether it be aldehydes from alcohol fuels or CO_2 from coal derived fuels, or new toxic compounds, EPA should place equal priority on assuring that alternative fuels will not create or exacerbate new problems as in assuring that they address existing problems. Only by aggressively pursuing potential adverse effects will EPA assure the safe use of appropriate alternatives; only by aggressively pursuing potential adverse effects, will state and local governments have confidence that they should pursue potentially attractive alternatives in the confidence that new problems will not be created by this action.

XIII. Discussion and Conclusions

A careful review of the US Federal Motor Vehicle Pollution Control Program in the context of the intent of Congress at the time it adopted the Clean Air Act Amendments of 1970 leads to several conclusions:

A. Motor Vehicle Emissions Remain A Serious Problem

While great progress has occurred in reducing emissions from passenger cars and light trucks per mile driven, proving sound the fundamental concept of technology forcing embodied in the 1970 Clean Air Act, vehicles in use continue to exceed standards. There are two aspects of the problem.

1)properly maintained vehicles (a relatively minor proportion of the vehicle fleet) emit above standards, on average, very early in their actual life, and well before the 5 years or 50,000 miles required in the Act. The in use performance of these vehicles relative to their standards is actually no better today than it was at the time the 1970 Amendments were adopted.

2) the more serious problem is that "normally" maintained vehicles are well above standards; coupled with tampering and misfueling, this leads to HC and CO levels substantially above standards in use.

Outside the specific conditions of the FTP, as developed and defined by EPA, the in use emissions reductions are much worse. This is critical because many of these actual operating conditions are the cause of severe health and environmental problems. For example, CO emissions under the conditions most representative of high ambient levels, cold temperatures and low speed stop and go driving, are much higher in absolute terms and have been reduced much less than under the FTP conditions. The same can be said of other important conditions such as high speeds.

EPA has been slow to apply similar, albeit not fully effective, requirements on other vehicle categories where they have been given the authority. The message is clear: Congress is much better able to force technology than is the EPA.

B. Overall Mobile Source Emissions Will Turn Up During the 1990's Without Additional Controls

While the exact date of the turn upward depends on the individual pollutant and the control mix and growth rates in a given area, studies conducted by EPA, NAPAP and the Lung Association have all reached the same conclusion. Additional control will therefore be needed.

C. I/M Programs Remain Crucial But Most Fall Short of Potential

While EPA has successfully fostered I/M programs across the country, these programs have been much less successful in many areas than Congress originally envisioned. With regard to HC and CO, while technology has continued to evolve, EPA has failed to develop better, more effective or more efficient in-use tests than those which applied during the 1970's and early 1980's. Further, no significant effort appears to have been expended on the development of good effective in use tests for NOx or Diesel Particulate.

D. Greatest Success is Reduced Lead

The greatest success of the motor vehicle control program has been in the tremendous reduction in lead emitted into the air; this has resulted from the substantial reduction in lead contained in leaded gasoline as well as the increasing proportion of vehicles required to operate on unleaded fuel. Unfortunately, very few other positive steps have been taken with regard to fuels and fuel additives by EPA. In spite of specific authority provided in 1970 and a specific mandate provided in 1977, the Agency has still not developed or even proposed regulations regarding fuels and fuel additives.

E. EPA Has Ignored Motor Vehicle CO_2 Emissions

In spite of the growing concern with global warming which the Agency has been quick to recognize, EPA has not taken any positive steps to reduce CO_2 emissions from vehicles, a major and growing source.

F. The EPA Enforcement Program Has Been Cut Back

Whereas in FY 1980, EPA conducted 51 Recall Investigations of light duty vehicles, in FY 1989 only 17 are planned, a 67% reduction. SEA Test orders have simultaneously been reduced from 39 to 19, a 51% reduction. Fuel outlet inspections have dropped from 10,000 to 2,500, a 75% drop. All this occurred at a time when additional enforcement responsibilities were demanded of the Agency. Stringent heavy duty vehicle standards should be enforced; to date, it appears that no heavy duty recall testing under the FTP is conducted by EPA. This is especially critical because heavy duty vehicles are essentially self certified by manufacturers with very little EPA oversight.

G. The Data Base Underlying Emissions Projections Has Been Reduced

At the very time that the need for in use testing has increased to assess changing fuels and vehicle technologies, the actual EPA testing has decreased significantly. Whereas in 1980, EPA tested 900 vehicles for the emissions factor testing program, current testing is at the rate of only 200 vehicles per year. As a result, future projections must be seen as less reliable rather than more reliable.

XIV. Recommendations

This review of the FMVCP recommends that EPA and state agencies take actions to correct deficiencies in the current programs for controlling emissions from motor vehicles. The recommendations can be grouped into three categories: program, legislative, and administrative. Program recommendations include actions that are within EPA's authority. Legislative recommendations require revisions in the Clean Air Act that must be made by the US Congress. Administrative recommendations suggest ways to improve the existing programs by changing federal priorities.

A. Program Recommendations

The following recommendations represent actions that can be taken by EPA now. These actions could occur without additional legislative or regulatory authority, and could greatly improve the effectiveness of the FMVCP.

* Expand the Federal Test Procedure (FTP) for the vehicle compliance and emissions factor testing to include a more appropriate range of driving conditions. These additional driving conditions must include simulations of:

    a. lower speeds
    b. higher speeds
    c. cold temperatures and low speeds
    d. vehicle stress conditions, such as rapid acceleration and heavy loads, and
    e. idling conditions

* Reduce evaporative emissions by controlling vehicle running losses, and by limiting summertime gasoline volatility to a maximum Reid Vapor Pressure of 9.0 pounds per square inch in the northeast or equivalent controls in other areas of the country according to their summertime temperatures. Further, refueling emissions should be minimized by adoption of onboard controls.

* Implement federal measures to increase the effectiveness of I/M programs including:

  a. Requiring onboard diagnostics for emission control components similar to California's standards.
  b. Adding an idle test and/or other short tests to the FTP to ensure that all new models are capable of passing an I/M tailpipe test.
  c. Encouraging states to petition EPA for vehicle recalls based on I/M test data and to require recalled vehicles to be fixed as a condition of annual registration.
  d. Require states to routinely evaluate their I/M programs, to assess strengths and weaknesses, and to initiate steps to correct problem areas.
* Complete the phase out of leaded gasoline.

B. Legislative Recommendations

The following recommendations represent actions that Congress should take to change the Clean Air Act. EPA and the states will be responsible for enforcing these programs.

* Ensure more durable vehicle emission control systems by extending the full life/useful life provisions for automobiles to 10 years or 100,000 miles.

* Implement more restrictive tailpipe standards for cars, light trucks, heavy trucks and motorcycles, reflecting at a minimum standards already found to be feasible by the State of California, requiring equivalent reductions at low temperature (20 degrees F), and forcing the development of more advanced technology for NOx control of heavy duty vehicles. (It is important to note that while EPA has the authority to adopt many of these changes, it has not done so.)

C. Administrative Recommendations

The following recommendations suggest mechanisms for improving the effectiveness of existing EPA programs within the Office of Mobile Sources. All require expanding the resources available for mobile source control programs or reallocating existing EPA resources.

* Implement an aggressive recall testing program for more engine families and vehicle classes, including heavy duty vehicles.

* Restore Mobile Source Program resources at EPA in order to:

  a. Reverse the dramatic cutbacks in manufacturer directed enforcement, especially with regard to Recall investigations; a key element should be much greater reliance on in-use vehicle emission testing.
  b. Restore the emission factor test and development program for cars and other vehicle categories, with expanded emphasis on non FTP conditions.
  c. Expand I/M technical support to state and local agencies (e.g., better guidance on test quality, waivers and increased attention to new test development including procedures for NOx and particulate.).
  d. Issue consistent guidance on transportation control measures (TCMs), including a conformity agreement with US Department of Transportation.
  e. Elevate the toxics problem to a higher priority by establishing a specific program element within the Office of Mobile Source Air Pollution Control.

* Increase state involvement in the FMVCP by:

  a. Establishing a state program office within EPA's Office of Mobile Sources.
  b. Establishing a state and local advisory board on mobile source control to review all major EPA program decisions.

These recommendations suggest ways for EPA and the state air quality management divisions to achieve reductions in the emissions of mobile sources. EPA and the state agencies must make a serious commitment to improving the mobile source program. Without improvements in the FMVCP, states will be unable to attain the carbon monoxide and ozone ambient standards, and the air quality will remain unhealthy in many areas of the US.

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