ANALYSIS OF COSTS AND BENEFITS OF A NATIONAL LOW EMISSION VEHICLE PROGRAM

Prepared for:

Vehicle Programs and Compliance Division
U.S. Environmental Protection Agency
Office of Mobile Sources
Washington, DC 20460

Prepared by:

E.H. Pechan & Associates, Inc.
5537-C Hempstead Way
Springfield, VA 22151

November 15, 1996

EPA Contract No. 68-D3-0035
Work Assignment II-67

Pechan Report No. 96.04.003/1767 (Rev.)

EXECUTIVE SUMMARY

This report compares and contrasts two potential motor vehicle emission control scenarios: (1) the continuation of the Federal Motor Vehicle Emission Control Program with Tier 1 exhaust emission standards in all States except the Northeast Ozone Transport Region (OTR) States, where either the Ozone Transport Commission (OTC)-Low Emission Vehicle (LEV) or CAL-LEV programs apply (the Base Case), and (2) a national LEV program in all States. The national LEV program includes a provision for adopting LEV-program standards in the OTR beginning with the 1997 model year. In States outside the OTR, the national LEV program starts with model year 2001 light-duty vehicles (LDVs).

By 2015, a year when the full benefits of the LEV program are realized, a national LEV program is expected to reduce highway vehicle nonmethane organic gas (NMOG) emissions nationally by 6 percent, and oxides of nitrogen (NO_x) emissions by 8 percent, when compared with the OTC-LEV program. By 2007, when most areas must attain the ozone standard, national NMOG and NO_x emissions are estimated to be 3 to 4 percent lower compared with those from the current program (Tier 1 plus OTC-LEV).

The national LEV program provides benefits beyond the reductions achieved in criteria pollutants; reductions in NMOG associated motor vehicle-emitted air toxic compounds such as benzene, formaldehyde, acetaldehyde, and 1,3-butadiene are also achieved. Reductions in NO_x and NMOG are also estimated to reduce secondary particulate formation, which would be expected to provide regional reductions in PM_{10} and fine particle levels. Improved visibility through reduced nitrogen dioxide (NO_2) concentrations and secondary particulate nitrate formation is also expected.

The approximate national cost difference between the two cases is $600 million.

Within the OTC States, the two programs essentially provide equivalent emission benefits. The benefits of the national LEV program are achieved at about $56 less per vehicle. At expected 2005 sales levels within the Northeast OTR, this would result in a cost savings of $150 million per year.

A Regulatory Flexibility Analysis (RFA) was performed to evaluate the potential economic impacts on small businesses of a national LEV program. By comparing dealerships, no difference was found in the effects for small versus large dealerships. Costs as a percentage of sales ranged from 0.1 to 0.8 percent with national LEV.

CONTENTS

TABLES

Page

ACRONYMS AND ABBREVIATIONS

AMS	Area and Mobile Source Subsystem
CAA	Clean Air Act
CARB	California Air Resources Board
CO	carbon monoxide
EPA	U.S. Environmental Protection Agency
FAC	fractional aerosol coefficient
FHWA	Federal Highway Administration
FTP	Federal test procedure
GVWR	Gross Vehicle Weight Rating
HC	hydrocarbon
HDDVs	heavy-duty diesel vehicles
HDGVs	heavy-duty gasoline vehicles
HDVs	heavy-duty vehicles
HPMS	Highway Performance Monitoring System
I/M	inspection and maintenance
IARC	International Agency for Research on Cancer
IRS	Internal Revenue Service
kgs	kilograms
LDDTs	light-duty diesel trucks
LDDVs	light-duty diesel vehicles
LDGTs	light-duty gasoline trucks
LDGVs	light-duty gasoline vehicles
LDTs	light-duty trucks
LDVs	light-duty vehicles
LEV	low emission vehicle
MPH	miles per hour
NH_3	ammonia
NMOG	nonmethane organic gas
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
OMS	Office of Mobile Sources
ORD	Office of Research and Development
OTC	Ozone Transport Commission
OTR	Ozone Transport Region
RFA	Regulatory Flexibility Analysis
RfC	reference concentration for chronic inhalation exposure
RIA	Regulatory Impact Analysis
RVP	Reid vapor pressure
SBA	Small Business Act
SIC	Standard Industrial Classification
SIPs	State Implementation Plans
SO_2	sulfur dioxide
SOA	secondary organic aerosol

TIUS	*Truck Inventory and Use Survey*
TLEV	transitional low emission vehicle

ACRONYMS AND ABBREVIATIONS (continued)

TOG	total organic gases
ULEV	ultra-low emission vehicle
VMT	vehicle miles traveled
VOCs	volatile organic compounds
ZEV	zero emission vehicle

CHAPTER I
INTRODUCTION

On December 19, 1994, the U.S. Environmental Protection Agency (EPA) announced its final determination that reduction of new motor vehicle emissions throughout the Northeast OTR is necessary to mitigate the effects of air pollution transport, and to bring nonattainment areas in the OTR into attainment (including maintenance) of the national ambient air quality standard for tropospheric ozone (smog). Through this determination, EPA promulgated a rule under Sections 184 and 110 of the Clean Air Act (CAA) that requires emission reductions from new motor vehicles in the OTR to be equivalent to the reductions that would be achieved by the OTC-LEV program.

States would be relieved of their obligations under this requirement if EPA were to find that all automakers had opted into a LEV equivalent new motor vehicle control program deemed acceptable by EPA through rulemaking. EPA believes that such a program, which would be far better than the OTC-LEV, could be agreed upon and adopted in the near future. (Because neither EPA nor the States could mandate such a program, it can become effective only upon agreement of a variety of parties.)

This report is a supporting document for a Regulatory Impact Analysis (RIA) for a LEV program to be implemented nationwide. It provides estimates of emission reductions, cost, and potential small business impacts (RFA). This report compares and contrasts two potential motor vehicle emission control scenarios: (1) continuation of the Federal Motor Vehicle Emission Control Program with Tier I exhaust emission standards in all States except the OTR States, where either the OTC-LEV or CAL-LEV programs apply, and (2) a national LEV in all States.

The emission benefit calculations and comparisons utilized in this study are presented in Chapter II. This is followed by the cost and cost effectiveness analyses in Chapter III. The Regulatory Flexibility Analysis is presented in Chapter IV.

CHAPTER II
EMISSION BENEFITS OF THE NATIONAL LEV PROGRAM

This chapter presents estimates of highway vehicle emissions both inside the OTR and nationally as would be expected to occur under two cases: a Base Case with Tier I exhaust emission standards outside the OTR and OTC-LEV inside the OTR; and a National LEV Case with national LEV in all States. In both cases, the State-adopted programs were applied in New York, Massachusetts, and Connecticut. However, in the National LEV Case, the LEV programs for these three States were replaced by the national LEV program beginning with the start year of the national LEV program. California was not included in either of these cases. Emission estimates are presented for the two severe ozone nonattainment area attainment dates – the years 2005 and 2007 – and a year when full benefits of the national LEV program are observed – 2015.

Modeling methods that are common to both modeling cases are presented in the first section of this chapter. This is followed by descriptions of the modeling assumptions specific to the Base Case and National LEV Cases. Results are presented after the modeling methods discussions.

A. ASSUMPTIONS COMMON TO BOTH CASES

1. Vehicle Miles Traveled (VMT)

VMT growth rates were developed using national VMT projections from the MOBILE4.1 Fuel Consumption Model (EPA, 1991) and State-level Bureau of Economic Analysis population projections (BEA, 1990). The MOBILE4.1 Fuel Consumption Model estimates national VMT through the year 2020. The following methodology was used to calculate State-specific VMT growth rates. First, the 1990 national VMT estimate from the MOBILE4 fuel consumption model was allocated to States based on their 1990 population. Next, the projection year national VMT estimate from the MOBILE4 fuel consumption model was allocated to States based on their estimated projection year population. Finally, State-specific VMT average annual growth rates were calculated using the following formula:

$$AAGR_{BYPY} = \left[\left(\frac{VMT_{PY}}{VMT_{BY}} \right)^{\frac{1}{PY-BY}} - 1 \right] * 100$$

where:

$AAGR_{BYPY}$ = average annual VMT growth rate from the base year to the projection year (percent)

VMT_{PY} = VMT in the projection year

VMT_{BY} = VMT in the base year

State-specific VMT growth rates are listed in Table II-1.

Table II-1
VMT Growth Rates by State

State	Annually Compounded VMT Growth Rate Percentages from 1990 to:		
	2005	**2007**	**2015**
Alabama	1.8	1.8	1.8
Alaska	2.1	2.0	1.9
Arizona	3.1	3.0	2.7
Arkansas	2.0	2.0	1.9
Colorado	2.7	2.6	2.4
Connecticut	2.2	2.2	2.1
Delaware	2.7	2.6	2.4
District of Columbia	1.8	1.8	1.8
Florida	2.9	2.8	2.6
Georgia	2.5	2.4	2.3
Hawaii	2.8	2.8	2.5
Idaho	2.1	2.1	2.0
Illinois	2.1	2.1	2.0
Indiana	2.1	2.0	2.0
Iowa	2.0	2.0	1.9
Kansas	2.0	1.9	1.9
Kentucky	1.9	1.9	1.8
Louisiana	1.6	1.6	1.6
Maine	2.2	2.2	2.1
Maryland	2.4	2.4	2.2
Massachusetts	2.2	2.2	2.1
Michigan	2.0	2.0	1.9
Minnesota	2.2	2.2	2.0
Mississippi	1.9	1.9	1.8
Missouri	2.0	2.0	1.9
Montana	1.8	1.8	1.8
Nebraska	2.0	2.0	1.9
Nevada	3.5	3.4	3.0
New Hampshire	2.6	2.6	2.4

Table II-1 (continued)

State	Annually Compounded VMT Growth Rate Percentages from 1990 to:		
	2005	2007	2015
New Jersey	2.3	2.3	2.2
New Mexico	2.5	2.4	2.3
New York	1.9	1.8	1.8
North Carolina	2.2	2.2	2.1
North Dakota	1.9	1.9	1.9
Ohio	1.9	1.9	1.8
Oklahoma	1.9	1.9	1.8
Oregon	2.4	2.3	2.2
Pennsylvania	2.0	1.9	1.9
Rhode Island	2.2	2.2	2.1
South Carolina	2.1	2.1	2.0
South Dakota	2.0	1.9	1.9
Tennessee	2.3	2.3	2.1
Texas	2.1	2.1	2.0
Utah	2.7	2.6	2.4
Vermont	2.4	2.3	2.2
Virginia	2.6	2.6	2.4
Washington	2.6	2.5	2.3
West Virginia	1.6	1.6	1.7
Wisconsin	2.1	2.0	2.0
Wyoming	1.6	1.6	1.6
National Average	2.2	2.2	2.1

The VMT data, used as the base VMT that were grown to the projection years, were the 1990 VMT data developed for the 1990 Regional Interim Emission Inventory (EPA, 1993a). The primary sources of data used in developing this VMT data base were the Highway Performance Monitoring System (HPMS) areawide data base (FHWA, 1992a) and the Bureau of the Census *Truck Inventory and Use Survey* (TIUS) (BOC, 1990). Travel data from the MOBILE4.1 Fuel Consumption Model were used to divide light-duty vehicle VMT into its gasoline and diesel components. The VMT were classified by six vehicle types: light-duty gasoline vehicles (LDGVs), light-duty gasoline trucks (LDGTs), heavy-duty gasoline vehicles (HDGVs), light-duty diesel vehicles (LDDVs), light-duty diesel trucks (LDDTs), and heavy-duty diesel vehicles (HDDVs). The final VMT data base was at the county/vehicle type/roadway type level.

2. MOBILE Model Inputs

All motor vehicle emission factors used in this analysis were calculated using EPA's MOBILE5a emission factor model (EPA, 1994a). The criteria pollutants modeled were NMOG, NO_x, and carbon monoxide (CO).

a. Vehicle Speeds

Each of the 12 Area and Mobile Source Subsystem (AMS) roadway classifications was assigned a speed by vehicle type. The speeds modeled were derived from the average overall speed output from the HPMS 1990 impact analysis (FHWA, 1992b). To determine the actual speeds to use in modeling the emission factors, HPMS vehicle types were chosen to represent the speeds for each of the vehicle types modeled in this analysis as follows:

- Passenger cars – used for LDVs;
- Pickup trucks and vans – used for light-duty trucks (LDTs); and
- Multi-trailer trucks with five or more axles – used for heavy-duty vehicles (HDVs).

The number of speeds modeled was then reduced by rounding the HPMS speeds to the nearest 5 miles per hour. Local speeds, which were not included in the HPMS impact analysis output, were assumed to be the same as minor collector speeds for rural roads and collector speeds for urban roads. Table II-2 lists the average speeds used for each roadway type/vehicle type combination.

b. Temperature

A single temperature condition was used in modeling all of the emission factors for this analysis. The average daily minimum temperature modeled was 75°F and the average daily maximum temperature modeled was 95°F. These temperatures are representative of typical ozone season or July temperatures in most parts of the country.

c. Reid Vapor Pressure (RVP)

Phase II RVP limits were modeled for all areas. In areas with a 9.0 psi Phase II RVP limit, 8.7 psi was the modeled RVP, allowing for a 0.3 psi margin of safety. In areas

Table II-2
Average Speeds by Road Type and Vehicle Type
(MPH)

	Rural						**Urban**					
	Interstate	Principal Arterial	Minor Arterial	Major Collector	Minor Collector	Local	Interstate	Other Freeways & Expressways	Principal Arterial	Minor Arterial	Collector	Local
LDV	60	45	40	35	30	30	45	45	20	20	20	20
LDT	55	45	40	35	30	30	45	45	20	20	20	20
HDV	40	35	30	25	25	25	35	35	15	15	15	15

where reformulated gasoline was modeled, the MOBILE5a model overrides the input RVP values with appropriate RVP values for reformulated gasoline.

d. Registration Distribution

The registration distributions modeled were representative of the composition of the vehicle fleet in the projection years. EPA's Dynamic Registration Preprocessor to MOBILE5a (EPA, 1994b) was used to convert the MOBILE5a default national registration distribution to distributions for 2005, 2007, and 2015. Only the LDV registration distribution is affected by this model. Registration distributions for the remaining vehicle types represent national 1990 distributions.

e. Operating Mode

All emission factors were modeled using the Federal test procedure (FTP) operating mode. Under this operating mode, 20.6 percent of VMT is assumed to accumulate in the cold-start mode, 27.3 percent of VMT is assumed to accumulate in the hot-start mode, and 52.1 percent of VMT is assumed to accumulate in the stabilized mode.

3. Inspection and Maintenance (I/M) Programs

Enhanced and basic I/M programs were modeled in the counties that are either required to have such a program under the CAA or that have formally chosen to adopt such a program. Table II-3 lists the counties where an enhanced I/M program was modeled. The same set of model inputs was used to model the enhanced I/M program in each of these counties. The program modeled was based on EPA's enhanced I/M performance standard. The specifics of this program as modeled for this analysis are shown in Table II-4. Although the status of many States' I/M programs is changing due to changes in EPA's I/M policy, the modeling here represents I/M coverage based on EPA's I/M rulemaking published in the *Federal Register* on November 5, 1992 (57FR52950, 1992). This is also consistent with the assumptions made for the OTC-LEV RIA.

Using up-to-date I/M program information would have reduced the number of counties where maximum LEV credits were granted. This would occur because it appears that some counties within the OTR, where enhanced I/M programs were required under the November 5, 1992 I/M Program Requirements, will either not have I/M programs, or have ones that do not meet the enhanced I/M performance standard. Proposed revisions to the November 5, 1992 I/M rule allow States more flexibility in designing programs as long as they meet EPA's performance standard. Many States are currently in the process of studying alternative I/M program designs, and because it is unclear how well these programs will do in identifying excess emissions from LEV technology vehicles, it was decided to retain the previous assumptions about I/M program effectiveness until the States and EPA evaluate new program designs.

4. Reformulated Gasoline

Federal reformulated gasoline was modeled in the counties in the OTR that are listed in the *Federal Register* notice detailing the final rulemaking on reformulated gasoline

(59FR7716, 1994). In addition to these counties, reformulated gasoline was also modeled in Orange and Putnam Counties in New York (both are in ozone nonattainment areas).

Table II-3
Counties Modeled with Enhanced I/M

State/County	State/County	State/County	State/County
Alaska	Indiana	Nevada	New York (cont.)
Anchorage Ed	Lake Co	Clark Co	Orange Co
Colorado	Porter Co	New Hampshire	Orleans Co
Adams Co	Louisiana	Hillsborough Co	Oswego Co
Arapahoe Co	Ascension Par	Merrimack Co	Putnam Co
Boulder Co	East Baton Rouge Par	Rockingham Co	Queens Co
Denver Co	Iberville Par	Strafford Co	Rensselaer Co
Douglas Co	Livingston Par	New Jersey	Richmond Co
Jefferson Co	Pointe Coupee Par	Atlantic Co	Rockland Co
Connecticut	West Baton Rouge Par	Bergen Co	Saratoga Co
Fairfield Co	Maine	Burlington Co	Schenectady Co
Hartford Co	Androscoggin Co	Camden Co	Suffolk Co
Litchfield Co	Cumberland Co	Cape May Co	Tioga Co
Middlesex Co	Kennebec Co	Cumberland Co	Warren Co
New Haven Co	Knox Co	Essex Co	Washington Co
New London Co	Lincoln Co	Gloucester Co	Wayne Co
Tolland Co	Sagadahoc Co	Hudson Co	Westchester Co
Windham Co	York Co	Hunterdon Co	Pennsylvania
Delaware	Maryland	Mercer Co	Allegheny Co
Kent Co	Allegany Co	Middlesex Co	Beaver Co
New Castle Co	Anne Arundel Co	Monmouth Co	Berks Co
District of Columbia	Baltimore Co	Morris Co	Blair Co
Washington	Calvert Co	Ocean Co	Bucks Co
Georgia	Carroll Co	Passaic Co	Cambria Co
Cherokee Co	Cecil Co	Salem Co	Centre Co
Clayton Co	Charles Co	Somerset Co	Chester Co
Cobb Co	Frederick Co	Sussex Co	Cumberland Co
Coweta Co	Harford Co	Union Co	Dauphin Co
De Kalb Co	Howard Co	Warren Co	Delaware Co
Douglas Co	Montgomery Co	New York	Erie Co
Fayette Co	Prince Georges Co	Albany Co	Lackawanna Co
Forsyth Co	Washington Co	Bronx Co	Lancaster Co
Fulton Co	Baltimore	Broome Co	Lebanon Co
Gwinnett Co	Massachusetts	Dutchess Co	Lehigh Co
Henry Co	Barnstable Co	Erie Co	Luzerne Co
Paulding Co	Berkshire Co	Greene Co	Lycoming Co
Rockdale Co	Bristol Co	Herkimer Co	Mercer Co
Illinois	Dukes Co	Kings Co	Montgomery Co
Cook Co	Essex Co	Livingston Co	Northampton Co
Du Page Co	Franklin Co	Madison Co	Philadelphia Co
Grundy Co	Hampden Co	Monroe Co	Washington Co
Kane Co	Hampshire Co	Montgomery Co	Westmoreland Co
Kendall Co	Middlesex Co	Nassau Co	York Co
Lake Co	Nantucket Co	New York Co	
McHenry Co	Norfolk Co	Niagara Co	
Will Co	Plymouth Co	Oneida Co	
	Suffolk Co	Onondaga Co	
	Worcester Co	Ontario Co	

Table II-3 (continued)

State/County	State/County	State/County	State/County
Rhode Island	Utah	Virginia	Washington
Bristol Co	Utah Co	Arlington Co	King Co
Kent Co	Vermont	Fairfax Co	Pierce Co
Newport Co	Chittenden Co	Loudoun Co	Snohomish Co
Providence Co	Grand Isle Co	Prince William Co	Spokane Co
Washington Co		Stafford Co	Wisconsin
Texas		Alexandria	Kenosha Co
Brazoria Co		Fairfax	Milwaukee Co
Chambers Co		Falls Church	Ozaukee Co
El Paso Co			Racine Co
Fort Bend Co			Washington Co
Galveston Co			Waukesha Co
Hardin Co			
Harris Co			
Jefferson Co			
Liberty Co			
Montgomery Co			
Orange Co			
Waller Co			

Table II-4
Enhanced I/M Program Modeling Assumptions

	Enhanced I/M Program Characteristics	
I/M Program:		
Start year:	1983	1983
Pre-1981 MYR stringency rate:	20%	20%
Model years covered:	1968 - 2020	1986 - 2020
Waiver rate (pre-1981):	3%	3%
Waiver rate (1981 and newer):	3%	3%
Compliance rate:	96%	96%
Inspection type:	Centralized	Centralized
Inspection frequency:	Annual	Annual
Vehicle types covered:	LDGV, LDGT 1 & 2	LDGV, LDGT 1 & 2
1981 & later MYR test type:	2500/Idle	Transient
$HC/CO/NO_x$ cutpoints (g/mi)		0.80/20.0/2.0
Anti-tampering Program:		
Start year:	1983	
Model years covered:	1984 - 2020	
Vehicle types covered:	LDGV, LDGT 1 & 2	
Inspection type:	Centralized	
Inspection frequency:	Annual	
Compliance rate:	96.0%	
Tampering inspections performed:	Air pump system, catalyst, fuel inlet restrictor	
Evaporative System Pressure Test:		
Start year:	1983	
Model years covered:	1983-2020	
Vehicle types covered:	LDGV, LDGT 1 & 2	
Inspection type:	Centralized	
Inspection frequency:	Annual	
Compliance rate:	96%	
Functional Purge Test:		
Start year:	1983	
Model years covered:	1986 - 2020	
Vehicle types covered:	LDGV, LDGT 1 & 2	
Inspection type:	Centralized	
Inspection frequency:	Annual	
Compliance rate:	96%	

NOTE: The start year indicates the calendar year that the testing is to begin, while the model years covered indicate which model year vehicles are to be included in the program. Although no area had an IM240 program in place in 1983, 1983 is specified as the program start year for the enhanced I/M program performance standard. The enhanced I/M performance standard is used to calculate the emission benefit that enhanced I/M programs must achieve in areas with existing I/M programs.

Although only portions of some counties are required to implement a reformulated gasoline program, these entire counties were modeled as having reformulated gasoline.

The final rulemaking for reformulated gasoline includes a reduction requirement for NO_x emissions in Phase 2 of the program. The MOBILE5a model does not include any NO_x benefits from reformulated gasoline. Therefore, the MOBILE5a NO_x emission factors were reduced to reflect this requirement. Based on conversations with Office of Mobile Sources (OMS) staff about the possible emission benefits of this NO_x requirement, the NO_x reductions from reformulated gasoline were modeled as follows: 1986 and later LDGVs should receive a 6 percent NO_x reduction, while older model year LDGVs should get no NO_x reduction; 1990 and later model year LDGTs should get a 6 percent reduction in NO_x emissions from reformulated gasoline, while earlier model year LDGTs should get no benefit; and HDGVs should get no NO_x benefit from reformulated gasoline.

5. Permanent Migration Effects

Both cases were modeled to include the effects of permanent migration (i.e., people who change their State of residence). This was done to account for the difference that would occur in the composition of the vehicle fleet inside and outside the OTR with the implementation of the different LEV programs. To estimate the effects of migration on emissions inside and outside the OTR, estimates of the amount of in-migration and out-migration occurring relative to the OTR were based on Internal Revenue Service (IRS) 1991 to 1992 data (IRS, 1994). These data show the changes in residence by State that occurred between these 2 years. From these IRS files, EPA estimated the number of people who had moved out of the OTR and the number who had moved into the OTR during these 2 years. The percentage change in exemptions listed on IRS tax returns was used as a surrogate for the percentage change in number of vehicles. In other words, the percentage of the number of exemptions listed with a change of residence into the OTR from 1991 to 1992 was used as the percentage of vehicles newly registered in the OTR, and similarly for the percentage moving out of the OTR. This analysis was only targeted at determining the effects of migration on the OTR, without separately analyzing the effects of vehicles moving into or out of Massachusetts or New York. EPA's analysis showed an in-migration rate of 0.877 percent and an out-migration rate of 1.556 percent per year. The cumulative effect of migration was estimated by EPA as 6.45 percent of the 2005 vehicle fleet in the OTR made up of vehicles from outside the OTR.

A similar calculation was performed for this analysis to determine the fraction of the fleet outside the OTR made up of vehicles from the OTR. Using EPA's methodology, it was estimated that the annual in-migration rate (to States outside the OTR) from Massachusetts and New York was 0.18 percent, from Connecticut was 0.04 percent, and from the remaining OTR States was 0.28 percent. The annual out-migration rate from States outside the OTR to OTR States was 1.56 percent. The cumulative effect of migration from OTR States to States outside the OTR is as follows: 1.41 percent of the vehicle fleet in States outside of the OTR are vehicles from New York or Massachusetts, 0.29 percent are vehicles from Connecticut, and 2.21 percent are vehicles from the remaining OTR States.

In order to incorporate the effects of permanent migration on vehicle emissions, all emission factors were first calculated ignoring the effects of migration. The emission factors representing States inside the OTR were multiplied by 0.9355 and were weighted with the corresponding emission factors from outside the OTR, multiplied by 0.0645. Emission factors were matched by I/M program, reformulated gas program, and RVP. Emissions inside the OTR were then calculated using this adjusted set of emission factors. A similar procedure was performed to calculate emissions outside the OTR incorporating effects of migration from the OTR. Emission factors representative of the area outside the OTR were multiplied by 0.9614 and weighted with 0.0139 multiplied by the Massachusetts/New York factors, 0.0028 multiplied by the Connecticut factors, and 0.0219 multiplied by the OTR factors. This analysis assumes that migrant vehicles that have moved into an enhanced I/M area in the OTR from an area with no I/M program or a basic I/M program would receive full benefits of the enhanced I/M program, as though the vehicle had always been subject to enhanced I/M, and vice versa. In actuality, EPA has found that this would not necessarily occur until the vehicle had passed two cycles of enhanced I/M inspections. Thus, actual emissions in the OTR may be slightly higher than are calculated here, and emissions outside the OTR may be slightly lower than calculated here.

B. BASE CASE MODELING ASSUMPTIONS

The Base Case is representative of the emissions that would occur with the adoption of the program included in the OTC-LEV petition. State programs in effect as of February 15, 1996 were included in this analysis, specifically the Massachusetts, New York, Connecticut, and New Jersey LEV programs. However, since the New Jersey program applies to 1999 and later model years, this program has no effect on modeling assumptions, because the OTC-LEV program applies to the same model years. Motor vehicle control measures associated with the 1990 CAA Amendments were modeled as phased-in by MOBILE5a, including the Federal Tier I tailpipe standards for States outside of the OTR.

1. Implementation Schedules for Massachusetts, New York, and Connecticut

Massachusetts, New York, and Connecticut were modeled with their own LEV programs in the Base Case because these States have already adopted regulations to implement an LEV program. Therefore, their existing programs would be expected to proceed with or without approval of the OTC-LEV petition or the adoption of a national LEV program. Both the New York and Massachusetts programs follow the implementation schedule of the California LEV program including the zero emission vehicle (ZEV) mandate. Unlike New York and Massachusetts, Connecticut did not adopt the ZEV sales mandate. Therefore, the LEV modeling for Connecticut follows the OTC-LEV program implementation schedule, with a program start date of 1998.

The LEV program implementation schedules for Massachusetts and New York are shown in Table II-5 for LDGVs and LDTG1as and in Table II-6 for LDGT1bs. The LEV program implementation schedule for LDGVs and LDGT1as in Connecticut is shown in Table II-7. The Connecticut implementation schedule for LDGT1bs is the same as that shown for Massachusetts and New York in Table II-5, with the exception that the 1996 and 1997 model years would be 100 percent Tier I vehicles.

These LEV programs apply only to LDGVs and LDGTs that would be included in the MOBILE5a LDGT1 category. The LDGT1 category includes light-duty trucks up to 6,000

Table II-5
Base Case LEV Program Implementation Schedule for LDGVs and LDGT1as in Massachusetts and New York

	Implementation Rate (Percent)							
Model Year	**Federal Tier I**	**Inter-mediate TLEV***	**TLEV**	**Inter-mediate LEV***	**LEV**	**Inter-mediate ULEV***	**ULEV**	**ZEV**
1996	80	0	20	0	0	0	0	0
1997	73	0	0	25	0	2	0	0
1998	48	0	0	48	0	2	0	2
1999	23	0	0	0	73	0	2	2
2000	0	0	0	0	96	0	2	2
2001	0	0	0	0	90	0	5	5
2002	0	0	0	0	85	0	10	5
2003 and later	0	0	0	0	75	0	15	10

NOTE: *The California LEV program includes intermediate compliance standards for transitional low emission vehicles (TLEVs), LEVs, and ultra-low emission vehicles (ULEVs) that are less stringent than the final TLEV, LEV, and ULEV standards. The LEV program emission factors calculated with the MOBILE5a model include the effect of these less stringent standards. LDGT1as are light-duty trucks of up to 3,750 lbs loaded vehicle weight and up to 6,000 lbs GVWR.

Table II-6
Base Case LEV Program Implementation Schedule for LDGT1bs in Massachusetts and New York

	Implementation Rate (Percent)						
Model Year	**Federal Tier I**	**Inter-mediate TLEV***	**TLEV**	**Inter-mediate LEV***	**LEV**	**Inter-mediate ULEV***	**ULEV**
1996	80	0	20	0	0	0	0
1997	73	0	0	25	0	2	0
1998	48	0	0	50	0	0	2
1999	23	0	0	0	75	0	2
2000	0	0	0	0	98	0	2
2001	0	0	0	0	95	0	5
2002	0	0	0	0	90	0	10
2003 and later	0	0	0	0	85	0	15

NOTE: *The California LEV program includes intermediate compliance standards for TLEVs, LEVs, and ULEVs that are less stringent than the final TLEV, LEV, and ULEV standards. The LEV program emission factors calculated with the MOBILE5a model include the effect of these less stringent standards. LDGT1bs are light-duty trucks of more than 3,750 lbs loaded vehicle weight and up to 5,750 lbs loaded vehicle weight and up to 6,000 lbs GVWR.

Table II-7
Base Case LEV Program Implementation Schedule for LDGVs and LDGT1a's in Connecticut

	Implementation Rate (Percent)		
Model Year	**Federal Tier I**	**LEV**	**ULEV**
1998	47	51	2
1999	22	76	2
2000	0	94	6
2001	0	86	14
2002	0	80	20
2003 and later	0	63	37

NOTE: LDGT1as are light-duty trucks of up to 3,750 lbs loaded vehicle weight and up to 6,000 lbs GVWR.

lb Gross Vehicle Weight Rating (GVWR) and a loaded vehicle weight of up to 5,750 lbs. Implementation schedules and emission rates vary within the LDGT1 class of trucks, with LDGT1s of up to 3,750 lbs loaded vehicle weight (LDGT1as) following the schedule and standards of LDGVs, while LDGT1s of greater than 3,750 lbs loaded vehicle weight (LDGT1bs) follow a slightly different implementation schedule, and have different emission standards.

2. OTC-LEV Implementation Schedule

For the OTC-LEV petition analysis, the ZEV component of the California LEV program was removed. The petition approval specifically did not require the adoption of the ZEV sales mandate as part of a State's adopted LEV program. Instead, each OTC State was given the option to adopt the ZEV component on its own. Therefore, it was decided not to include ZEVs in this analysis. With ZEVs eliminated from the LEV program, the implementation schedule of the California LEV program was changed so that the overall emission standards required for each model year would still be met. This revised implementation schedule is the same as that shown in Table II-7 for Connecticut, except that the 1998 model year was replaced with 100 percent Tier I vehicles for the OTC-LEV program. The implementation schedule for the LDGT1b class of trucks does not change from the schedule in Table II-6 since there is no ZEV requirement for LDGT1bs. However, for all OTC States except New York and Massachusetts, only 1999 and later model years are affected.

3. LEV Credits

Nonattainment areas cannot claim credits in their State Implementation Plans (SIPs) for the maximum benefits of the LEV program without an *appropriate* I/M program. The requirements of an *appropriate* I/M program are described in a memo produced by EPA's Office of Mobile Sources entitled "Emission Reduction Credits for California Low Emission Vehicles" (Lorang, 1994). In accordance with this guidance, the MOBILE5a input files were set up so that the *appropriate* I/M credits flag for the LEV program was turned on in areas with an enhanced I/M program. In all areas without an enhanced I/M program, this *appropriate* I/M credits flag for the LEV program was set so that the minimum LEV credit would be modeled in these areas.

C. NATIONAL LEV CASE MODELING ASSUMPTIONS

The National LEV Case is representative of the emission benefits that would occur with the adoption of a national LEV program in all States. Massachusetts and New York are assumed to proceed with their State-adopted LEV programs until the start of the national LEV program (in 1997), which would then replace these State LEV programs. The start date of the Connecticut LEV program is 1998. Therefore, since the national LEV program begins in 1997, in Connecticut, there are no years of differential effects.

The national LEV program includes a provision for early adoption of LEV program vehicles in the OTR. The implementation schedule of the national LEV program within the OTR is shown in Table II-8. In States outside of the OTR, all new cars and light-duty trucks sold, starting with the 2001 model year, would be LEV category vehicles. The implementation schedule for Massachusetts and New York for the National LEV case is shown in Table II-9.

Table II-8
Implementation Schedule for the National LEV Program in the OTR (Excluding Massachusetts and New York)

	Implementation Rate (Percent)		
Model Year	**Federal Tier I**	**TLEV**	**LEV**
1997	60	40	0
1998	60	40	0
1999	30	40	30
2000	0	40	60
2001 and later	0	0	100

NOTE: Implementation schedule applies to all LDGVs and LDGT1s (up to 6,000 lb GVWR).

Table II-9
Implementation Schedule for the National LEV Program in Massachusetts and New York

	Implementation Rate (Percent)		
Model Year	**Federal Tier I**	**TLEV**	**LEV**
1996	80	20	0
1997	60	40	0
1998	60	40	0
1999	30	40	30
2000	0	40	60
2001 and later	0	0	100

NOTE: Implementation schedule applies to all LDGVs and LDGT1s (up to 6,000 lb GVWR).

D. RESULTS

The criteria pollutant emissions from these analyses are summarized in Table II-10 for 2005, 2007, and 2015. By 2015, a year when the full benefits of the LEV program should be realized, a national LEV program would reduce highway vehicle NMOG emissions nationally by 6 percent and national NO_x emissions by 8 percent, when compared with the OTC-LEV program.

The OTC-LEV program (modeled in the Base Case) is somewhat more stringent than the national LEV program, when comparing fleet average emission standards by model year. However, the earlier start date of the national LEV program, coupled with the difference in migration effects from Tier I vehicles sold outside the OTR, cause the national LEV program to have lower emissions than the OTC-LEV program inside the OTR. In the case of NO_x in 2005, the difference in the fleet average emission factors between the two cases for the 1997 and later model years in New York and Massachusetts (with the fleet average standards of the Base Case being the lower of the two) is more significant than the reduction in the OTR due to the migration of LEV vehicles from outside the region. As a result, the 2005 NO_x emissions for the OTR increase from the Base Case to the National LEV Case. If the New York and Massachusetts results were isolated in 2007, the same trend of higher NO_x emissions in the National LEV Case would be apparent. However, the reductions that occur elsewhere in the OTR, primarily due to the effects of lower migration emissions in the National LEV Case, cause the total 2007 NO_x emissions in the OTR to decrease from the Base Case to the National LEV Case.

NMOG emission differences between the Base Case and the National LEV Case are small – less than one percent within the Northeast OTR – and in the range of 2 to 3 percent nationally for the analysis years examined. Both programs result in a majority of the vehicles meeting LEV category standards (with an NMOG exhaust emission standard of 0.075 grams per mile). While the ULEV category lowers the NMOG standard to 0.04 grams per mile, this provides little additional NMOG reduction as the emission standards only affect the exhaust portion of total NMOG emissions. Again, eliminating migration effects through having all vehicles meeting a single set of emission standards ultimately provides more overall emissions benefit than having about one-third of the within OTC vehicle fleet meeting a lower exhaust NMOG standard.

E. MOTOR VEHICLE EMITTED AIR TOXICS

In April 1993, EPA released its *Motor Vehicle-Related Air Toxics Study*, which was an assessment of the need for, and feasibility of, controlling emissions of toxic air pollutants that are unregulated under the CAA and associated with motor vehicles and motor vehicle fuels (EPA, 1993b). Specific pollutants or pollutant categories that are discussed in this report include benzene, formaldehyde, 1,3-butadiene, acetaldehyde, diesel particulate matter, gasoline particulate matter, and gasoline vapors as well as selected metals and motor vehicle-related pollutants identified in Section 112 of the CAA. The focus of the EPA report was on carcinogenic risk. The discussion of noncarcinogenic effects is less quantitative because of the lack of available methods and health data. This section of the report summarizes the health evidence presented in EPA's *Motor Vehicle-Related Air Toxics Study* for each compound. Cancer and non-cancer effects are described.

Table II-10
Highway Vehicle Emissions Summary, 2005, 2007, and 2015

			Ozone Season Weekday Emissions (tons/day)	
Year	**Pollutant**	**Region**	**Base Case**	**National LEV Case**
2005	NMOG	OTR Total	1,491	1,483
		National Total	12,308	12,029
	NO_x	OTR Total	2,385	2,389
		National Total	15,250	14,850
	CO	OTR Total	11,750	11,574
		National Total	93,395	89,639
2007	NMOG	OTR Total	1,361	1,353
		National Total	12,243	11,844
	NO_x	OTR Total	2,218	2,212
		National Total	15,239	14,639
	CO	OTR Total	11,021	10,792
		National Total	94,647	89,345
2015	NMOG	OTR Total	1,152	1,144
		National Total	12,885	12,107
	NO_x	OTR Total	1,943	1,894
		National Total	16,327	15,078
	CO	OTR Total	9,889	9,603
		National Total	104,136	94,413

NOTES: Base Case includes Tier I outside the OTR and OTC-LEV inside the OTR, except for CT, MA, and NY.
MA and NY are modeled with CAL-LEV with a start year of 1996, and CT is modeled with OTC-LEV with a start year of 1998.
Effects of permanent vehicle migration are included in both cases.
California is not included in either case.

1. Benzene

Long-term exposure to high levels of benzene in air has been shown to cause cancer of the tissues that form white blood cells (leukemia), based on epidemiology studies with workers. Leukemias and lymphomas (lymphoma is a general term for growth of new tissue in the lymphatic system of the body), as well as other tumor types, have been observed in experimental animals that have been exposed to benzene by inhalation or oral administration. Exposure to benzene has also been linked with genetic changes in humans and animals. Based on these data, EPA has concluded that benzene is a Group A, known human carcinogen. The International Agency for Research on Cancer (IARC) has also classified benzene as a human carcinogen. EPA calculated a cancer unit risk factor for benzene of $8.3x10^{-6}$ $(\mu g/m^3)^{-1}$ based on the results of three epidemiological studies in benzene-exposed workers in which an increased incidence of nonlymphocytic leukemia was observed. EPA's Office of Research and Development (ORD) has just recently started the process to review the benzene risk assessment. (Note that unlike the other pollutants addressed in this study, the cancer unit risk estimate for benzene is based on human data.)

A number of adverse noncancer health effects have also been associated with exposure to benzene. Benzene is known to cause disorders of the blood. People with long-term exposure to benzene at levels that generally exceed 50 ppm (162,500 $\mu g/m^3$) may experience harmful effects on the blood-forming tissues, especially the bone marrow. These effects can disrupt normal blood production and cause a decrease in important blood components, such as red blood cells and blood platelets, leading to anemia and a reduced ability to clot. Exposure to benzene at comparable or even lower levels can be harmful to the immune system, increasing the chance for infection and perhaps lowering the body's defense against tumors by altering the number and function of the body's white blood cells. Exposure to benzene may also cause damage to the reproductive organs. Studies with pregnant animals show that breathing 10-300 ppm (32,500-975,000 $\mu g/m^3$) benzene has adverse effects on the developing fetus, including low birth weight, delayed bone formation, and bone marrow damage.

2. Formaldehyde

Studies in experimental animals provide sufficient evidence that long-term inhalation exposure to formaldehyde causes an increase in the incidence of squamous cell carcinomas of the nasal cavity. Epidemiological studies in occupationally exposed workers suggest that long-term inhalation of formaldehyde may be associated with tumors of the nasopharyngeal cavity, nasal cavity, and sinus. Based on this information, EPA has classified formaldehyde as a Group B1, probable human carcinogen. IARC concurs that formaldehyde is probably carcinogenic to humans. EPA calculated the present, and still official, cancer unit risk factor of $1.3x10^{-5}$ $(\mu g/m^3)^{-1}$ for formaldehyde based on the results of a study in rats in which an increase in the incidence of nasal tumors was observed. In a 1990 update of this 1987 cancer risk assessment (still in draft), EPA modified the cancer risk estimate to $6x10^{-7}$ $(\mu g/m^3)^{-1}$ by incorporating recent data on the quantification of DNA-protein cross-links (DPX) caused by formaldehyde in monkey nasal tissue. The binding of DNA to protein to which formaldehyde is bound, forming a separate entity that can be quantified, is considered a more accurate way to measure the amount of formaldehyde that is present inside a tissue. Cancer incidence estimates in this report use the 1987 unit risk factor, since the updated one is still not an official estimate and may change.

Noncancer adverse health effects associated with exposure to formaldehyde in humans and experimental animals include irritation of the eyes, nose, throat, and lower airway at low levels (0.05-10 ppm or 123-12,300 µg/m^3). There is also suggestive, but not conclusive, evidence in humans that formaldehyde can affect immune function. Studies in experimental animals indicate that formaldehyde does not cause birth defects. Adverse effects on the liver and kidney have also been noted in experimental animals exposed to higher levels of formaldehyde.

3. 1,3-Butadiene

Long-term inhalation exposure to 1,3-butadiene has been shown to cause tumors in several organs in experimental animals. Studies in humans exposed to 1,3-butadiene suggest that this chemical may cause cancer. These epidemiological studies of occupationally exposed workers are inconclusive with respect to the carcinogenicity of 1,3-butadiene in humans, however, because of a lack of adequate exposure information and concurrent exposure to other potentially carcinogenic substances. Based on the limited human data and sufficient animal data, EPA has concluded that 1,3-butadiene is a Group B2, probable human carcinogen. IARC has classified 1,3-butadiene as a possible human carcinogen. EPA calculated a cancer unit risk factor of 2.8×10^{-4} $(\mu g/m^3)^{-1}$ for 1,3-butadiene based on the results of a study in mice in which an increase in the incidence of tumors in the lung and blood vessels of the heart, as well as lymphomas were observed. A special factor was incorporated into these calculations to account for the actual amount of 1,3-butadiene that is absorbed following inhalation. EPA's ORD has just recently started the process to review the 1,3-butadiene risk assessment. (Note that the cancer unit risk estimate for 1,3-butadiene is based on animal data and is considered an upper bound estimate for human risk. True human cancer risk may be as low as zero.)

Exposure to 1,3-butadiene is also associated with adverse noncancer health effects. Exposure to high levels (on the order of hundreds to thousands ppm) of this chemical for short periods of time can cause irritation of the eyes, nose, and throat, and exposure to very high levels can cause effects on the brain leading to respiratory paralysis and death. Studies of rubber industry workers who are chronically exposed to 1,3-butadiene suggest other possible harmful effects including heart disease, blood disease, and lung disease. Studies in animals indicate that 1,3-butadiene at exposure levels of greater than 1,000 ppm (2.2×10^6 µg/m^3) may adversely affect the blood-forming organs. Reproductive toxicity has also been demonstrated in experimental animals exposed to 1,3-butadiene at levels greater than 1,000 ppm.

4. Acetaldehyde

There is sufficient evidence that acetaldehyde produces cytogenic damage in cultured mammalian cells. Although there are only three studies in whole animals, they suggest that acetaldehyde produces similar effects *in vivo*. Thus, the available evidence indicates that acetaldehyde is mutagenic and may pose a risk for somatic cells (all body cells excluding the reproductive cells). Current knowledge, however, is inadequate with regard to germ cell (reproductive cell) mutagenicity because the available information is insufficient to support any conclusions about the ability of acetaldehyde to reach mammalian gonads and produce heritable genetic damage.

Studies in experimental animals provide sufficient evidence that long-term inhalation exposure to acetaldehyde causes an increase in the incidence of squamous cell carcinomas of the nasal cavity. One epidemiological study, in occupationally exposed workers, was insufficient to suggest that long-term inhalation of acetaldehyde may be associated with an increase in total cancers. Based on this information, EPA has classified acetaldehyde as a Group B2, probable human carcinogen. EPA calculated the cancer unit risk factor of 2.2×10^{-6} $(\mu g/m^3)^{-1}$ for acetaldehyde based on the results of the two studies in rats in which an increase in the incidence of nasal tumors was observed.

Non-cancer effects in studies with rats and mice showed acetaldehyde to be moderately toxic by the inhalation route, oral, and intravenous routes. Acetaldehyde is a sensory irritant that causes a depressed respiration rate in mice. In rats, acetaldehyde increased blood pressure and heart rate after exposure by inhalation. The primary acute effect of exposure to acetaldehyde vapors is irritation of the eyes, skin, and respiratory tract. At high concentrations, irritation and ciliastatic effects can occur, which could facilitate the uptake of other contaminants. Clinical effects include reddening of the skin, coughing, swelling of the pulmonary tissue, and localized tissue death. Respiratory paralysis and death have occurred at extremely high concentrations. It has been suggested that voluntary inhalation of toxic levels of acetaldehyde would be prevented by its irritant properties, since irritation occurs at levels below 220 ppm (360,000 $\mu g/m^3$).

The new genotoxicity studies, which utilize lower concentrations of acetaldehyde, do not produce chromosomal aberration and/or cellular mutations.

Acetaldehyde is only one of two air toxics in EPA's *Motor Vehicle-Related Air Toxics Study* with a reference concentration for chronic inhalation exposure (RfC). This RfC was recently determined to be 9×10^{-3} mg/m^3. An RfC is an estimate of the daily exposure to the human population that is likely to be without deleterious effects during a lifetime. As such, it is useful in evaluating non-cancer effects.

5. Diesel Particulate Matter

Studies in experimental animals provide sufficient evidence that long-term inhalation exposure to high levels of diesel exhaust causes an increase in the induction of lung tumors in two strains of rats and two strains of mice. In two key epidemiological studies on railroad workers occupationally exposed to diesel exhaust, it was observed that long-term inhalation of diesel exhaust produced an excess risk of lung cancer. Collectively, the epidemiological studies show a positive, though limited, association between diesel exhaust exposure and lung cancer.

Recently published, or soon to be completed studies have concentrated on the hypothesis that the carbon core of diesel particulate matter is the causative agent in the genesis of lung cancer. By exposing rats to carbon black and diesel soot and comparing the results to diesel exhaust itself, the tumor response to diesel exhaust and carbon black is qualitatively similar. Also, as a result of extensive studies, the direct-acting mutagenic activity of both particle and gaseous fractions of diesel exhaust has been shown. Based on the above information, EPA has classified diesel exhaust as a Group B1, probable human carcinogen. IARC concurs that diesel exhaust is probably carcinogenic to humans. EPA calculated a cancer unit risk factor for diesel exhaust based only on exposure to the carbon core of the particle from three rat inhalation studies. The unit risk (though still draft and subject to change) of $1.7x10^{-5}$ $(\mu g/m^3)^{-1}$ was determined from a geometric mean of the unit risks from these three studies.

A number of adverse noncancer health effects have also been associated with exposure to acute, subchronic, and chronic diesel exhaust at levels found in the ambient air. Most of the effects observed through acute and subchronic exposure are respiratory tract irritation and diminished resistance to infection. Increased cough and phlegm and slight impairments in lung function have also been documented. Animal data indicate that chronic respiratory diseases can result from long-term (chronic) exposure to diesel exhaust. It appears that normal, healthy adults are not at high risk to serious noncancer effects of diesel exhaust at levels found in the ambient air. The data base is inadequate to form conclusions about sensitive subpopulations.

The RfC for diesel particulate matter has only recently been established. This RfC was recently determined to be $5.0x10^{-3}$ mg/m^3 per day, over a lifetime.

6. Gasoline Particulate Matter

The information on the actual carcinogenicity of gasoline particulate matter is based mainly on *in vitro* and *in vivo* bioassays. This information is based on gasoline particulate matter collected from two vehicles, one using leaded fuel and the other using unleaded fuel. The organic material was extracted from the particles and used in the bioassays. In the four *in vitro* bioassays conducted to determine DNA damage (recombination, chromatid exchanges, unscheduled DNA repair, and sister chromatid exchanges), the gasoline particulate organics did produce DNA strand breaks and sister chromatid exchanges. There was no evidence to support chromosomal aberrations in any of the related studies.

In the *in vivo* bioassays, the organics extracted from the gasoline particles were able to transform embryonic cells into malignant cells. The most critical of the *in vivo* bioassays, skill tumor initiation in mice, produced both benign and malignant tumors. This assay is critical because of the fact that it is used to determine a unit risk for gasoline particulate matter using the comparative potency method.

At the present time, there is only a unit risk based on the comparative potency method (no human data) and an EPA classification does not exist. The comparative potency method utilizes epidemiological data from coke oven emissions, roofing tar emissions, and cigarette smoke, and develops a correlation with the gasoline particulate organics based on the relative potencies in the mouse skin tumor initiation assay. This process then determines the unit risk. For the automobile with a catalyst using unleaded fuel, the unit risks are $1.2x10^{-4}$ $(\mu g \text{ organic matter}/m^3)^{-1}$ and $5.1x10^{-5}$ $(\mu g \text{ particulate matter}/m^3)^{-1}$. For the automobile without a catalyst using leaded fuel, the unit risk is $1.6x10^{-5}$ $(\mu g \text{ particulate matter}/m^3)^{-1}$. IARC has no potency for gasoline engine exhaust but has classified gasoline engine exhaust as a Group 2B carcinogen, i.e., possibly carcinogenic to humans.

7. Gasoline Vapors

Studies in experimental animals provide sufficient evidence that long-term inhalation exposure to wholly vaporized gasoline induced a significant increase in renal carcinomas in the kidney cortex of male rats and also a significant increase in liver carcinomas in female mice. Female rats and male mice had no significant treatment related induction of tumors at any organ site. The incidence of renal carcinomas was significantly increased only at the highest dose tested. Epidemiological studies in occupationally exposed workers suggest that long-term inhalation of gasoline vapors may be associated with certain types of cancer. However, the epidemiologic evidence for evaluating gasoline as a potential carcinogen is considered inadequate. Mutational bioassays performed *in vivo* in animals and epidemiological studies provided negative or inconclusive results on the mutagenicity of gasoline vapors. Based on this information, EPA has classified gasoline vapors as a Group B2, probable human carcinogen. EPA calculated a range of unit risk factors of 2.1×10^{-3} to 3.5×10^{-3} $(ppm)^{-1}$ for gasoline vapors based on the results of a study indicating an increase in the incidence of kidney tumors in male rats exposed to wholly vaporized gasoline.

F. AIR TOXIC EMISSION ESTIMATION METHODS

Air toxic pollutants of interest in this study include benzene, formaldehyde, 1,3-butadiene, and acetaldehyde. These compounds are all organics, so this study estimates toxic emissions as fractions of total organic gases (TOG). These fractions are applied to MOBILE5a-generated TOG emission factors for each modeling scenario to calculate toxic grams per mile emission factors.

All of the compounds of interest are present in exhaust TOG emissions. Benzene is also present in evaporative TOG emissions. The one assumption that was made in this analysis was that emission relationships characteristic of three-way-plus oxidation catalyst technology would be applied for all analysis years. This assumption will not affect estimates for the year 2000 and beyond, or introduce any bias in the emission estimates for the different scenarios.

Table II-11 shows the TOG emission percentages that are applied in this study to estimate motor vehicle air toxic emissions for the scenarios of interest.

Table II-11
Air Toxic Emission Calculations

	Percentages of Exhaust TOG Emissions			
Fuel	**Benzene**	**1,3-Butadiene**	**Formaldehyde**	**Acetaldehyde**
Baseline Gasoline	2.87%	0.44%	1.37%	0.45%
Federal Reform - Phase 1	2.04	0.44	1.64	0.45
Federal Reform - Phase 2	2.04	0.44	1.64	0.45

SOURCE: EPA, 1993b.

The toxic compound emission reduction benefits of the LEV program were estimated as a fraction of national NMOG emissions. The example shown is for 2005. The relative benefits in other projection years are expected to be consistent with the 2005 results.

For the air toxics analysis, because the emission benefits analysis provides estimates of combined exhaust and evaporative NMOG emissions, it was necessary to estimate the fraction of total NMOG that is exhaust emissions. Year 2005 NMOG emission factors were examined for areas with no, basic, and enhanced I/M programs and with and without Federal reformulated gasoline. It was found the exhaust component of total NMOG emissions in 2005 ranges from 51 to 62 percent. Based on this distribution, it was estimated that the exhaust portion of national NMOG emissions was 60 percent. It was further assumed that NMOG emission differences between the two cases are all attributable to exhaust emission changes. Using these assumptions and the toxic emission fractions shown in Table II-11, the toxic compound emissions for the two cases were estimated as shown in Table II-12.

Table II-12
National Highway Vehicle Air Toxic Compound Emissions (2005)
(tons per day)

Cases	Benzene	1,3-Butadiene	Formaldehyde	Acetaldehyde
Base Case	194	32.3	106	33.0
National LEV	187	31.1	102	31.8

The above values take into account the fact that approximately 27 percent of all travel in 2005 will be in vehicles using Federal reformulated gasoline.

G. SECONDARY PARTICULATE REDUCTION BENEFITS

PM has been associated with numerous serious health effects in epidemiological and toxicological studies. The epidemiological studies provide both prospective evaluations of human health effects in cohorts that have been tracked over time, and retrospective studies of effects, based on reviews of hospital records and reporting of mortality. These studies have identified compelling evidence that PM is associated with respiratory illness such as pneumonia, chronic obstructive pulmonary disease, chronic bronchitis, and general respiratory illnesses including lower and upper respiratory illnesses. There is also a clear association between increased PM *episodes* and overall increased mortality due to cardiovascular disease in the elderly. PM has also been associated with an aggravation of asthma episodes and increased restricted activity days.

Investigations of atmospheric aerosols over the past several years have revealed that most of the aerosol volume and mass is distributed in two modes: a fine mode centered at about 0.3 um and a coarse mode centered at 5 to 30 um. The source of much of the fine mode particles is atmospheric transformation of reactive gases (e.g., sulfur dioxide [SO_2], NO_x, volatile organics, ammonia [NH_3]) into aerosols such as sulfates, nitrates, particulate organics, and ammonium compounds. Such transformed substances are called secondary particles. Other important fine mode sources include direct or primary particle emissions from combustion and industrial processes. Coarse mode particles usually are derived from mechanical processes such as grinding operations or plowing. High winds can suspend large quantities of coarse particles.

Because LEV standards will reduce emissions of two pollutants (NO_x and volatile organic compounds [VOCs]) that are key contributors to secondary particulate formation, this section quantifies the expected particulate reduction benefit that might occur through controlling NO_x and VOC emissions. These potential reductions are estimated using *effective* PM_{10} (or $PM_{2.5}$) emission relationships that were developed for a recent EPA-sponsored study of regional particulate control strategies (Pechan, 1994). Such a technique should be considered an approximation of the air quality benefit of secondary contributors to PM_{10} (or $PM_{2.5}$). Analyses of the benefits of VOC or NO_x control to secondary pollutant formation in any particular location should make use of the source/receptor relationships appropriate to the site.

Effective PM_{10} (or $PM_{2.5}$) reductions attributable to NO_x emission reductions are estimated according to the following relationship:

$$PM_{10}(effective) = 0.05 * NO_x * 1.35$$

The 0.05 multiplier for NO_x is the gaseous to particulate conversion efficiency for NO_x (i.e., 5 percent of NO_x emissions convert to nitrate), and 1.35 is the molecular weight adjustment (to ammonium nitrate). Therefore, for every ton of NO_x reduced from motor vehicle emissions via the national LEV program, particulate loadings are effectively reduced by 0.0675 tons.

Secondary organic aerosol (SOA) emissions are estimated as VOC $*$ source-specific fractional aerosol coefficient (FAC). For LDGV (exhaust), the source-specific FAC = 0.0056.

FAC is a measure of the fraction of emissions that may form SOA. FACs are based on the reactivity of an organic compound with atmospheric oxidants and the vapor pressure of the resulting products. The FAC is expressed as a dimensionless fraction that can be multiplied by the total mass of the organic compound released, resulting in a mass of secondary aerosol formed.

When the above effective PM_{10} (or $PM_{2.5}$) algorithms are applied with the NMOG and NO_x emission benefits listed in Table II-10, the national LEV case is estimated to have a 28.6 ton per day effective PM_{10} (or $PM_{2.5}$) benefit when compared with the Base Case. This estimate is computed from the national highway vehicle 2005 emissions. Most of the effective PM_{10} (or $PM_{2.5}$) benefit is attributable to the NO_x emission reductions (27 tons per day).

CHAPTER III
COST ANALYSIS

This cost analysis uses the California Air Resources Board (CARB) estimates of LEV program vehicle costs as the basis for this analysis. California has recently lowered its cost estimate for vehicles certified to the LEV standard (Albu, 1996). This revision was made to account for the likely use of welded exhaust systems as well as improvements in emission control technology (no electrically heated catalysts are now expected to be required to meet LEV standards for 4 and 6 cylinder cars). As CARB is only concerned with the cost of the program in its own State, its cost estimates (CARB, 1994) are based on a single manufacturer producing 100,000 vehicles per year.

For the purposes of this analysis, the costs estimated using nationwide sales volumes are assumed to be the appropriate ones for estimating the cost of a national LEV program. However, for comparison with the OTC-LEV program, it was also necessary to estimate per vehicle costs at the sales volumes that might be expected with the LEV program adopted in the OTC States as well as in California. To this end, adjustments were made to the California only values to estimate an intermediate sales volume more representative of the OTC situation.

There appear to be two principal reasons for California versus nationwide cost differences. One is the economy of scale in production volumes (i.e., how many vehicles of a certain model or engine family are produced that would be designed to meet LEV standards). The other issue is how costs are allocated, such as those for research and development, among the number of vehicles being produced. The magnitude of this number is affected by how many years these costs are distributed over. CARB allocates these costs over 8 years.

In examining the effect of vehicle production volumes on vehicle production costs, there is evidence that economies of scale effects can be estimated as the ratio of the logarithm of expected sales volumes (EEA, 1994). Lindgren (1977) expresses the relationship between production volumes and cost per unit for single emission control technologies as a percentage reduction in cost for every doubling of production. It was decided to apply the Lindgren concept to the California-only cost values as an approximation of OTC-LEV specific costs as well as national sales volumes. This was done assuming that the approximate annual sales by region are 1 million in California, another 2 million in the OTC, and 10 million total nationwide. The results of these adjusted per vehicle cost estimates based on different expected sales volumes are shown in Table III-1.

The total annual cost of the national LEV program in States other than California is estimated using expected new car registrations by State and the per vehicle costs in Table III-1. Based on a year with 12.5 million new car registrations in the 49 affected States, national LEV program costs are estimated to be $950 million annually. This contrasts with an estimated OTC-LEV Base Case program annual cost of $350 million. The data used in the total annual program cost calculation are shown in more detail in Chapter IV (see Table IV-4).

Table III-1
Retail Price Increase
Used in Cost Calculations

	California Sales Volumes	OTC Sales Volumes	National Sales Volumes
TLEV	$61	$53	$45
LEV	96	84	76
ULEV	221	205	190

In applying the Kolb-Scheraga approach to an evaluation of the OTC-LEV petition, most of the complexity is in estimating the annual emission reduction benefits and discounting them. Costs are discounted assuming that the average lifetime of the associated pollution control equipment is 10 years. Thus, retail price increases are converted to levelized annual costs by multiplying by a factor of 0.14239 (the annuity whose present value is 1 at 7 percent for 10 years). This annuity is then converted back to a present value by multiplying by a factor of 8.53 (the present value of an annuity at 3 percent for 10 years).

Emission reduction benefits for each category of LEV program vehicle were estimated using mileage accumulation rates by vehicle age from MOBILE5a, emission factor equations with appropriate I/M benefits included for Federal Tier I standard cars and LEVs, survival rates by age, and discount factors to convert the stream of emission reduction benefits to a net present value (using the consumption rate of interest). Emission factor equations used to estimate emission differences between Tier I and LEV program vehicles are listed below for hydrocarbon (HC) and NO_x:

	HC		NO_x	
Category	Zero Mile	Deterioration Per 10K Miles	Zero Mile	Deterioration Per 10K Miles
Tier I	0.184	0.028	0.178	0.044
LEV	0.056	0.0073	0.087	0.0217

The above equations were applied using the per year mileage accumulation figures in Table III-2, which are from MOBILE5a. The cumulative mileage accumulation figures are used along with the above emission factor equations to estimate the average per vehicle emission rate for each model year vehicle. These emission rates were then converted to annual emission differences by category of standard by subtracting LEV emission rates from Tier I emission rates by year, and then multiplying them by the per year mileage. This yields a stream of emission benefits for a LEV compared with a Tier I standard vehicle. These values are then weighted by the expected sales percentages in future years (in this case, 100 percent LEVs), survival rates and discounting factors applied, and total HC or NO_x benefits are computed. For the 100 percent LEV case, total net present value HC benefits are estimated to be 28.0 kilograms (kgs), while NO_x benefits are estimated to be 25.3 kgs. The net present value cost is $92 per vehicle.

Table III-2
Passenger Car Mileage Accumulation by Age

Vehicle Age	Per Year Mileage Accumulation	Cumulative Mileage Accumulation
1	14,390	14,390
2	13,612	28,002
3	12,875	40,877
4	12,180	53,057
5	11,522	64,579
6	10,899	75,478
7	10,310	85,788
8	9,751	95,539
9	9,225	104,764
10	8,726	113,490
11	8,254	121,744
12	7,807	129,551
13	7,386	136,937
14	6,987	143,924
15	6,608	150,532
16	6,251	156,783
17	5,913	162,696
18	5,594	168,290
19	5,291	173,581
20	5,005	178,586
21	4,735	183,321
22	4,478	187,799
23	4,237	192,036
24	4,007	196,043
25	3,790	199,833

SOURCE: MOBILE5a.

Note that the above analysis uses passenger car, or light-duty gasoline-powered vehicle, emissions and costs to represent the expected costs of the OTC-LEV program. Similar results would be expected had the calculations been performed for light-duty trucks.

With the wide range of cost estimates reported in the literature, it is important to note the uncertainty associated with the calculations presented here. One of the key assumptions relates to the baseline from which emission reductions and costs are measured. The standard for comparison in this analysis is a vehicle meeting the Federal Tier I emission standards with emission characteristics as estimated by MOBILE5a equations. Other authors have used pre-CAA vehicles as their baseline, so their cost estimates will differ. The assumption that all vehicles in either the Federal or California programs have deterioration rates consistent with an appropriate I/M program is an important one as it affects the expected lifetime emission benefits. This assumption was made to place all emission standard categories on the same basis. The result is that the Federal baseline emission rate is lower than would be expected to occur with the I/M programs that are currently planned in the OTC States (those meeting the enhanced I/M performance standard).

In order to compare the national cost and emission reductions associated with the Base Case and the national LEV program, a different calculation technique is applied. This is done because the programs differ in geographic applicability as well as in the standards that apply. The year 2005 emission estimates show a combined HC plus NO_x emission benefit of 679 tons per day for the national LEV case, when compared with the Base Case. The approximate cost difference between the two cases, on an annual basis, is $600 million. A daily cost – comparable to the emissions value – is $1.5 million.

Within the OTC States, the two programs being examined (OTC-LEV and national LEV) essentially provide equivalent emission benefits. The benefits of the national LEV program, though, are achieved at a lower cost per vehicle. The average car price under the national LEV program is estimated to be approximately $56 less than would be expected with an OTC-LEV program. With the adoption of the national LEV, as compared to the OTC-LEV, the total savings within the OTC States in 2005 are estimated to be $150 million.

CHAPTER IV
REGULATORY FLEXIBILITY ANALYSIS

The Regulatory Flexibility Act requires that a RFA be performed for each regulation that will have a significant economic effect on a substantial number of small entities. EPA believes that this requirement does not apply to the National LEV program since the program will directly regulate automobile manufacturers, specifically only those manufacturers who will opt into the program. This group of manufacturers would not qualify as small businesses within the meaning of the Regulatory Flexibility Act as they are in the largest and most established manufacturers in the U.S. market. Nevertheless, EPA has included an analysis on the effects the National LEV program could have on new and used car dealerships in response to comments the Agency received during the OTC LEV rulemaking process. EPA believes it is useful to continue to include this analysis for illustrative purposes, even though such analysis is not required because these businesses would not be directly regulated under the rule.

The first step in determining whether a National LEV program will have an adverse impact on small businesses is to develop a profile of businesses likely to be affected by the rule, which for purposes of this analysis are new and used car dealerships. These businesses are categorized in Standard Industrial Classification (SIC) code 551, *New and Used Car Dealerships*. According to Section 3 of the Small Business Act (SBA), a small business is generally defined as any business that is independently owned and operated, and is not dominant in its field as defined in Section 13 of the *Code of Federal Regulations* Part 121. SBA's most recent standards stipulate that a small automobile dealership that is not dominant in its field has annual receipts below $21 million (59FR16513, 1994).

The purpose of this analysis is to evaluate the likely economic burdens of a national LEV program on small entities. An RFA should, to the extent practicable, compare the effects of regulation on small businesses to those of large businesses to determine if small entities are affected disproportionately. The analysis should consider the ability of small entities to pass on these costs in the form of price increases and the effects on profitability. Of the measures that EPA suggests for determining if small businesses are likely to be adversely affected by regulation, a comparison of total annual costs to sales was deemed the most feasible approach for this analysis.

A. POTENTIAL IMPACT OF NATIONAL LEV PROGRAM COSTS ON DEALERSHIP SALES

For the purposes of this analysis, an establishment is defined as a business at a single physical location, and is referred to in this chapter as a dealership. Although time and data limitations prevent any extensive financial modeling or detailed analysis of potential small business impacts, a preliminary study provides an indication of the potential for a national LEV program to adversely affect small dealerships. The most logical method of analyzing the potential impact on small and large dealerships given available data is to compare costs to sales.

The number of new car dealerships in each State is listed in Table IV-1. For the purposes of this analysis, the Washington, DC metropolitan area is treated in the same manner as each of the 49 States (excluding California). The dealerships reported for the District of Columbia metropolitan area in Table IV-1 represent the total number of dealerships located in the District as well as Maryland and Virginia dealerships within the boundaries of the Washington, DC nonattainment area. The reason for this approach is that a small number of dealerships were reported for the District of Columbia relative to the high number of new car registrations, which indicates that cars registered in Washington, DC are purchased in neighboring counties. The dealerships reported for Maryland and Virginia in Table IV-1 represent the number of dealerships in each of these States, excluding those that are located in the DC metropolitan area. The purpose of this analysis is to evaluate the potential impact of a national LEV program on dealerships nationwide (excluding California). As shown in the table, there were 21,610 dealerships located in the 49 States and the District of Columbia in 1992. States with the highest number of dealerships are Texas, New York, and Illinois.

Automobile dealerships are independently owned and operated. According to the National Automobile Dealers Association, on a national average, approximately one-third of all dealers operate a chain of two or more dealerships, with the remaining dealers operating only one establishment. Because of the large percentage of single-dealership owners, it is unlikely that any one dealership in particular is dominant in the market, such that it could exert a significant influence on automobile prices.

National data provide an indication of the percentage of dealerships that fall below the SBA size threshold of sales under $21 million. Table IV-2 lists the national distribution of dealerships by sales category. According to the data in the table, nearly 61 percent of the domestic dealerships report annual sales below $10 million, and nearly 86 percent report sales below $25 million. Thus, on a national level, between 61 and 86 percent of automobile dealerships classify as small businesses. For dealerships classified below an annual sales range of $25 million in Table IV-2, the average sales per establishment were below the SBA standard of $21 million. The total number of firms and establishments shown in this table also support the statement by the National Automobile Dealers Association that most dealers operate single-dealership operations.

Table IV-3 reports the average sales per dealership for each State affected by the national LEV program. These data are as reported by the U.S. Department of Commerce, *Census of Retail Trade* for SIC code 551 (DOC, 1992). SIC code 551 includes data on establishments engaged in the retail sale of new automobiles, in addition to new pickup trucks and vans which are not affected by the LEV program. The average sales figures in the table, therefore, also incorporate new truck and van sales. A total sales figure for each State was estimated by multiplying the average sales per dealership by the number of dealerships in each State that were listed in Table IV-1. Total estimated sales for all dealerships affected by the national LEV program each year are $275 billion.

Because sales of new cars were not available on a State basis, new car registrations are assumed to be a reasonable proxy for the number of new cars sold in this analysis.

Registrations of new cars were available for each of the affected States, and the District of Columbia, and are presented in Table IV-4. The incremental retail cost estimates available from CARB that are presented in Chapter III are used to develop a per vehicle price increase, which is then used to calculate total LEV program costs by State. By

Table IV-1
Automobile Dealerships by State, 1992

State	Number of Dealerships
Alabama	380
Alaska	35
Arizona	210
Arkansas	305
Colorado	270
Connecticut	370
Delaware	70
District of Columbia[2]	271
Florida	920
Georgia	600
Hawaii	64
Idaho	130
Illinois	1,205
Indiana	630
Iowa	490
Kansas	345
Kentucky	360
Louisiana	345
Maine	185
Maryland[1]	203
Massachusetts	565
Michigan	875
Minnesota	532
Mississippi	275
Missouri	575
Montana	150
Nebraska	250
Nevada	80
New Hampshire	181
New Jersey	745
New Mexico	133

Table IV-1 (continued)

State	Number of Dealerships
New York	1,375
North Carolina	720
North Dakota	131
Ohio	1,090
Oklahoma	370
Oregon	284
Pennsylvania	1,455
Rhode Island	89
South Carolina	325
South Dakota	142
Tennessee	436
Texas	1,375
Utah	150
Vermont	100
Virginia[1]	479
Washington	365
West Virginia	230
Wisconsin	670
Wyoming	75
TOTAL	21,610

NOTES: [1]Excludes dealerships located within the boundaries of the Washington, DC metropolitan area.
[2]Includes all establishments located in Virginia, Maryland, and Washington, DC which comprise the Washington, DC metropolitan area.

SOURCE: MVMA, 1992; DOC, 1993.

Table IV-2
National Distribution of Dealerships and Annual Sales by Sales Category, 1987

Sales Range (Million $)	Firms	Establishments	Percentage Distribution of Establishments	Total Sales (Million $)	Percentage Distribution by Sales
<$0.25	1,101	1,102	4.2%	$164	0.1%
$0.25 to $0.49	1,051	1,052	4.0%	$378	0.2%
$0.5 to $0.9	1,267	1,271	4.9%	$931	0.3%
$1 to $2.49	2,834	2,846	10.9%	$4,916	1.8%
$2.5 to $4.99	4,146	4,171	16.0%	$15,322	5.6%
$5.0 to $9.99	5,320	5,391	20.7%	$38,591	14.0%
$10.0 to $24.9	6,435	6,688	25.7%	$101,577	36.9%
$25.0 to $49.9	2,017	2,262	8.7%	$67,069	24.2%
$50.0 to $99.9	454	723	2.8%	$29,966	10.9%
$100.0 to $249.9	82	312	1.2%	$11,110	4.0%
≥ $250.0	13	217	0.8%	$5,616	2.0%
Total	24,720	26,035		$275,640	100.0%

SOURCE: DOC, 1987.

Table IV-3
Average and Total Sales per Dealership by State, 1992

State	Average Sales per Dealership[1] (Million $)	Total Sales (Million $)
Alabama	$13.2	$5,008
Alaska	$16.9	$591
Arizona	$20.1	$4,223
Arkansas[1]	$5.8	$1,778
Colorado	$19.2	$5,178
Connecticut	$12.1	$4,466
Delaware	$15.6	$1,093
District of Columbia	$13.1	$3,544
Florida	$25.5	$23,439
Georgia	$14.2	$8,538
Hawaii[1]	$17.0	$1,087
Idaho	$11.7	$1,517
Illinois	$13.4	$16,122
Indiana	$12.1	$7,593
Iowa	$7.7	$3,766
Kansas	$10.1	$3,498
Kentucky	$9.7	$3,497
Louisiana	$14.4	$4,952
Maine	$8.3	$1,538
Maryland	$17.7	$3,593
Massachusetts	$11.9	$6,749
Michigan[1]	$12.2	$10,651
Minnesota	$11.5	$6,100
Mississippi	$9.7	$2,671
Missouri	$10.8	$6,201
Montana[1]	$4.5	$679
Nebraska	$8.9	$2,224
Nevada	$20.5	$1,637
New Hampshire	$10.0	$1,803
New Jersey	$14.4	$10,706

Table IV-3 (continued)

State	Average Sales per Dealership[1] (Million $)	Total Sales (Million $)
New Mexico[1]	$7.7	$1,021
New York	$11.8	$16,280
North Carolina	$11.3	$8,104
North Dakota	$7.9	$1,039
Ohio[1]	$10.0	$10,940
Oklahoma	$11.1	$4,117
Oregon	$14.0	$3,967
Pennsylvania	$10.0	$14,482
Rhode Island	$10.5	$935
South Carolina	$11.4	$3,699
South Dakota	$8.1	$1,149
Tennessee[1]	$11.4	$4,955
Texas	$18.8	$25,838
Utah[1]	$8.9	$1,340
Vermont	$7.2	$717
Virginia	$13.9	$6,651
Washington	$15.4	$5,623
West Virginia	$8.1	$1,858
Wisconsin	$11.0	$7,383
Wyoming	$7.4	$556
TOTAL	--	$275,094

NOTE: [1]Sales data from the 1987 *Census of Retail Trade* were grown to 1992 levels using Bureau of Economic Analysis earnings data by State for SIC code 55, since 1992 sales data were unavailable.

SOURCE: DOC, 1987; BEA, 1990; DOC, 1992.

Table IV-4
New Car Registrations and LEV Program Costs by State, 1992

State	New Car Registrations	Total Cost (Million $)
Alabama	96,679	$7.3
Alaska	11,022	$0.8
Arizona	89,275	$6.8
Arkansas	51,758	$3.9
Colorado	112,158	$8.5
Connecticut	122,970	$9.3
Delaware	34,066	$2.6
District of Columbia[2]	148,668	$11.3
Florida	820,251	$62.3
Georgia	208,266	$15.8
Hawaii	55,394	$4.2
Idaho	18,010	$1.4
Illinois	475,321	$36.1
Indiana	134,908	$10.3
Iowa	59,299	$4.5
Kansas	56,835	$4.3
Kentucky	81,742	$6.2
Louisiana	108,396	$8.2
Maine	30,061	$2.3
Maryland[1]	129,141	$9.8
Massachusetts	200,921	$15.3
Michigan	383,776	$29.2
Minnesota	117,333	$8.9
Mississippi	44,730	$3.4
Missouri	153,758	$11.7
Montana	15,653	$1.2
Nebraska	34,139	$2.6
Nevada	51,477	$3.9
New Hampshire	45,037	$3.4
New Jersey	318,087	$24.2
New Mexico	39,425	$3.0

Table IV-4 (continued)

State	New Car Registrations	Total Cost (Million $)
New York	486,033	$36.9
North Carolina	185,268	$14.1
North Dakota	11,674	$0.9
Ohio	379,414	$28.8
Oklahoma	73,528	$5.6
Oregon	80,905	$6.1
Pennsylvania	368,038	$28.0
Rhode Island	24,893	$1.9
South Carolina	98,288	$7.5
South Dakota	12,640	$1.0
Tennessee	150,533	$11.4
Texas	498,961	$37.9
Utah	39,027	$3.0
Vermont	17,868	$1.4
Virginia[1]	165,975	$12.6
Washington	117,743	$8.9
West Virginia	42,849	$3.3
Wisconsin	144,862	$11.0
Wyoming	8,494	$0.6
TOTAL	7,155,549	$544.0

NOTES: [1]Excludes registrations in the Washington, DC nonattainment area.
[2]Includes District of Columbia registrations, in addition to registrations from Maryland and Virginia totals, which were allocated to the Washington, DC nonattainment area based on the percentage of State dealerships located in the Washington, DC nonattainment area.

The source of new car registration figures is MVMA, 1993.

2003, all new vehicles will be required to be LEVs, which are expected to increase the retail price of a vehicle by $76 based on national sales volumes. This analysis assumes a worst case scenario in which dealerships incur 100 percent of this price increase rather than passing it on to consumers. The ability of dealerships to pass through cost increases is addressed later in this chapter. The total costs of the national LEV program are estimated using the new car registrations in Table IV-4. The estimated total incremental cost of a national LEV program based on a per vehicle price increase of $76 is $544 million. Note that the national LEV program will result in some cost savings to dealerships as well. These savings will come from reduced inventory and mechanic training costs associated with servicing one type of vehicle due to the nationwide introduction of LEV vehicles.

Using the total sales data by State in Table IV-3 and the total cost data in Table IV-4, potential impacts on small dealerships are compared with those for large dealerships. Because data were not readily available that could provide an indication of the distribution of dealerships by size in each State, the national distribution that was presented in Table IV-2 was used. Since the distribution of national establishments by sales range is not consistent with the SBA standard of $21 million, it is assumed that in the Department of Commerce's sales range of $10 million to $24.9 million, 50 percent of the establishments report sales below $21 million and 50 percent report sales above $21 million. According to the percentage distribution by sales in Table IV-2, 40 percent of industry sales are reported by small dealerships. The total sales figures in Table IV-3 are distributed based on this 40 percent - 60 percent distribution. Costs are allocated between small and large establishments based on the distribution of establishments by size as reported in Table IV-2.

Table IV-5 presents the results of analyzing the impacts of a national program on sales at small and large dealerships in each State based on a $76 per vehicle price increase. In the affected 49 States and the District of Columbia, costs as a percentage of sales range from 0.2 percent to 0.7 percent at small dealerships, and from 0.1 percent to 0.2 percent for large dealerships. Taken alone, costs do not appear to represent a large fraction of sales at small or large dealerships. Since EPA is required to evaluate the effects of the LEV program on small dealerships relative to the impacts on large dealerships, however, the results in Table IV-5 need to be evaluated in terms of the differential impacts. Before such a comparison can be made, there are two important factors to take into account. The ratios in Table IV-5 represent high estimates of impacts in that they are based on the assumption that all program costs are borne by the dealerships (or no price increases occur as the result of the LEV program). As a result, these cost-to-sales ratios are likely to be overstated, since dealerships are not likely to incur all of the cost increase per vehicle. This issue is discussed further in the following section. The second factor that would affect the ratios in the table is that there is also a potential for variance in terms of the distribution of sales volumes between new and used vehicles at small and large dealerships. Additional analysis would need to be undertaken to determine the extent to which these ratios would be lower after these two factors were taken into account.

B. OTHER ISSUES

There are other issues that are important to raise in qualifying the results in Table IV-5. Automobile manufacturers could be expected to absorb a portion of the LEV costs,

Table IV-5
National LEV Program Costs as a Percentage of Sales at Small and Large Automobile Dealerships

	Cost to Sales Ratio		
State	**Small Dealerships**	**Large Dealerships**	**Incremental Difference**
Alabama	0.3%	0.1%	0.2%
Alaska	0.3	0.1	0.2
Arizona	0.3	0.1	0.2
Arkansas	0.4	0.1	0.3
Colorado	0.3	0.1	0.2
Connecticut	0.4	0.1	0.3
Delaware	0.4	0.1	0.3
District of Columbia	0.6	0.2	0.5
Florida	0.5	0.1	0.4
Georgia	0.4	0.1	0.3
Hawaii	0.7	0.2	0.5
Idaho	0.2	0.1	0.1
Illinois	0.4	0.1	0.3
Indiana	0.3	0.1	0.2
Iowa	0.3	0.1	0.2
Kansas	0.3	0.1	0.2
Kentucky	0.3	0.1	0.2
Louisiana	0.3	0.1	0.2
Maine	0.3	0.1	0.2
Maryland	0.5	0.1	0.4
Massachusetts	0.4	0.1	0.3
Michigan	0.5	0.1	0.4
Minnesota	0.3	0.1	0.2
Mississippi	0.3	0.1	0.2
Missouri	0.4	0.1	0.3
Montana	0.3	0.1	0.2
Nebraska	0.3	0.1	0.2
Nevada	0.4	0.1	0.3
New Hampshire	0.4	0.1	0.3

Table IV-5 (continued)

	Cost to Sales Ratio		
State	**Small Dealerships**	**Large Dealerships**	**Incremental Difference**
New Jersey	0.4	0.1	0.3
New Mexico	0.5	0.1	0.4
New York	0.4	0.1	0.3
North Carolina	0.3	0.1	0.2
North Dakota	0.2	0.1	0.1
Ohio	0.5	0.1	0.4
Oklahoma	0.3	0.1	0.2
Oregon	0.3	0.1	0.2
Pennsylvania	0.4	0.1	0.3
Rhode Island	0.4	0.1	0.3
South Carolina	0.4	0.1	0.3
South Dakota	0.2	0.1	0.1
Tennessee	0.4	0.1	0.3
Texas	0.3	0.1	0.2
Utah	0.4	0.1	0.3
Vermont	0.4	0.1	0.3
Virginia	0.4	0.1	0.3
Washington	0.3	0.1	0.2
West Virginia	0.3	0.1	0.2
Wisconsin	0.3	0.1	0.2
Wyoming	0.2	0.1	0.1
National Average	0.4%	0.1%	0.3%

as has been seen in the early years of the California LEV program. For the purposes of this analysis, however, the results are based on the assumption that dealerships will absorb 100 percent of the price increase. In reality, dealerships are likely to pass a portion of, or the entire increase in, automobile prices on to consumers. Assuming a price increase of $76, the assumption that new car sales will not be affected is reasonable. A more significant price increase, however, may cause consumers to postpone new vehicle purchases. Sierra Research used a model that was designed to estimate the effect of LEV-induced price increases on new vehicle purchases. This model assumed a -1.0 price elasticity of demand for automobiles, which can be interpreted as: a 10 percent increase in automobile prices will result in a 10 percent reduction in new car purchases (Sierra, 1994). If a worst case scenario is assumed for consumers in which consumers, rather than dealerships, absorb the price increase, the effect on dealerships is two-fold. First, dealerships may experience lower sales levels as some consumers react to the price increase by postponing new car purchases. Second, the decrease in sales may be counteracted by the increase in revenues attributable to the higher price per automobile sold.

The implication of dealerships passing LEV costs on to automobile purchasers is that the costs incurred by the dealerships would be lower, but to the extent that consumers postpone new car purchases, sales revenues could fall. Because most dealerships are single-establishment firms, it is unlikely that the nature of this industry is such that one dealership could pass through costs and increase prices without suffering from a loss in sales. The implication for this analysis is that any effect of higher prices on new motor vehicle sales will not affect small and large dealerships disproportionately. In addition, allocating costs by sales rather than by the number of small establishments results in smaller differentials in the effects on small and large dealerships than those shown in Table IV-5. As a result, the incorporation of lower sales due to higher prices will not significantly affect the results of the RFA.

REFERENCES

Albu, 1996: Albu, Steve, 1995 Low Emission Vehicle Cost Update, California Air Resources Board, El Monte, CA, Reference Number AF-96-004, letter to Andy Brooks, U.S. Environmental Protection Agency, Washington, DC, April 17, 1996.

BEA, 1990: Bureau of Economic Analysis, *1990 BEA Regional Projections to 2040, Volume 1: States*, U.S. Department of Commerce, Washington, DC, June 1990.

BOC, 1990: Bureau of the Census, *1987 Census of Transportation, Truck Inventory and Use Survey*, U.S. Department of Commerce, Washington, DC, August 1990.

CARB, 1994: California Air Resources Board, Staff Report, "1994 Low-Emission Vehicle and Zero Emission Vehicle Program Review," prepared by Mobile Source Division, April 1994.

DOC, 1987: U.S. Department of Commerce, *Census of Retail Trade*, Washington, DC, 1987.

DOC, 1992: U.S. Department of Commerce, *Census of Retail Trade*, Washington, DC, 1992.

EEA, 1994: Energy and Environmental Analysis, Inc., "Documentation of the Fuel Economy, Performance and Price Impact of Automobile Technologies," Arlington, VA, prepared for Martin Marietta, July 1994.

EPA, 1991: U.S. Environmental Protection Agency, Office of Mobile Sources, "MOBILE4.1 Fuel Consumption Model (Draft)," Ann Arbor, MI, August 1991.

EPA, 1992: U.S. Environmental Protection Agency, *Revised Guidelines for Implementing the Regulatory Flexibility Act*, Washington, DC, April 9, 1992.

EPA, 1993a: U.S. Environmental Protection Agency, *Regional Interim Emission Inventories (1987-1991), Volume 1: Development Methodologies*, EPA-454/R-93-021a, Office of Air Quality Planning and Standards, Research Triangle Park, NC, May 1993.

EPA, 1993b: U.S. Environmental Protection Agency, *Motor Vehicle-Related Air Toxics Study*, Office of Mobile Sources, Office of Air and Radiation, April 1993.

EPA, 1994a: U.S. Environmental Protection Agency, Office of Mobile Sources, *User's Guide to MOBILE5 (Mobile Source Emission Factor Model)*, EPA-AA-AQAB-94-01, Ann Arbor, MI, May 1994.

EPA, 1994b: U.S. Environmental Protection Agency, Office of Mobile Sources, *MOBILE5 User's Guide: Dynamic Registration Preprocessor*, Ann Arbor, MI, December 1994.

REFERENCES (continued)

FHWA, 1992a: Federal Highway Administration, Highway Performance Monitoring System, 1990 data files, U.S. Department of Transportation, Washington, DC, February 1992.

FHWA, 1992b: Federal Highway Administration, Highway Performance Monitoring System Impact Analysis Output, received from FHWA, U.S. Department of Transportation, Washington, DC, April 1992.

57FR52950, 1992: *Federal Register,* U.S. Environmental Protection Agency, "Inspection/ Maintenance Program Requirements," final rule, November 5, 1992.

59FR16513, 1994: *Federal Register*, U.S. Small Business Administration, "Revisions to Small Business Size Standards," April 7, 1994.

59FR7716, 1994: *Federal Register*, U.S. Environmental Protection Agency, "Regulation of Fuels and Fuel Additives: Standards for Reformulated and Conventional Gasoline," final rule, February 16, 1994.

IRS, 1994: Internal Revenue Service, computer files of 1991-1992 migration, received from Office of Mobile Sources, U.S. Environmental Protection Agency, November 1994.

Lindgren, 1977: Lindgren, LeRoy H., "Cost Estimations for Emission Control Related Components/Systems and Cost Methodology Description," EPA-460/3-78-002 (PB279195), Rath & Strong, Inc., Lexington, MA, December 1977.

Lorang, 1994: Lorang, Phil, Director, Emission Planning and Strategies Division, Office of Air and Radiation, U.S. Environmental Protection Agency, Ann Arbor, MI, "Emission Reduction Credits for California Low Emission Vehicles (LEVs)," memorandum, April 1994.

MVMA, 1993: Motor Vehicle Manufacturers Association, "Facts & Figures '93," Detroit, MI, 1993.

Pechan, 1994: E.H. Pechan & Associates, Inc., "Development of the OPPE Particulate Programs Implementation Evaluation System," prepared for U.S. Environmental Protection Agency, Office of Policy, Planning, and Evaluation, Washington, DC, September 1994.

Sierra, 1994: Sierra Research, Inc., "The Cost Effectiveness of Further Regulating Mobile Source Emissions," prepared for American Automobile Manufacturers Association, February 28, 1994.

TECHNICAL REPORT ABSTRACT

REPORT TITLE: Analysis of Costs and Benefits of a National Low Emission Vehicle Program

REPORT DATE: July 1996

CONTRACT NO.: 68-D3-0035

PRIME CONTRACTOR: E.H. Pechan & Associates, Inc.

WORK ASSIGNMENT NO./DELIVERY ORDER NO. (if applicable): II-67

PROJECT OFFICER: Mary Wilkins

PROJECT OFFICER ADDRESS: U.S. EPA, MD-12, RTP, NC 27711 TEL: (919) 541-5229

PROGRAM OFFICE: Office of Mobile Sources

NO. OF PAGES IN REPORT: 48

DOES THIS REPORT CONTAIN CONFIDENTIAL BUSINESS INFORMATION

YES______________ NO______X_______

REPORT ABSTRACT - Include a brief (200 words or less) factual summary of the scope and nature of the work performed and referenced in the report.

This report is a supporting document for a Regulatory Impact Analysis (RIA) for a LEV program to be implemented nationwide. It provides estimates of emission reductions, cost, and potential small business impacts (RFA). This report compares and contrasts two potential motor vehicle emission control scenarios: (1) continuation of the Federal Motor Vehicle Emission Control Program with Tier I exhaust emission standards in all States except the OTR States, where either the OTC-LEV or CAL-LEV programs apply, and (2) a national LEV in all States.

KEY WORDS/DESCRIPTORS - Select the scientific or engineering terms that identify the major concept of the research and are sufficiently specific and precise to be used as index entries for cataloging.

motor vehicles; regulatory analysis