SECTION 5.0
LEAD EMISSIONS METHODOLOGY

5.1 INTRODUCTION

The methodology used to estimate the lead emissions presented in the *Trends* reports for the years 1970 to 1996 was based on the 1940-1984 Methodology. This section describes, in detail, the procedures used to create these estimates.

5.1.1 Background

The lead emissions methodology was based on a "top-down" approach where national information was used to create a national inventory of lead emissions. The emissions were estimated based on the source of the emissions and, in the case of combustion sources, the fuel type. The national activity of a process producing lead emissions was measured by the consumption of fuel, the throughput of raw materials, or an alternative production indicator. An emission factor was then applied to activity data to determine the amount of lead emitted from a specific process. For some categories, the lead content of the fuel was incorporated into the estimating procedure as part of the emission factor. The final element used to estimate emissions was the control efficiency, which quantifies the amount of lead not emitted due to the presence of control devices.

The lead emissions were presented in the 1997 *Trends* report by Tier categories, but in the lead emissions methodology, emissions were estimated by a different set of source categories. The source categories or subcategories contributing to lead emissions were regrouped into the Tier categories. The estimation procedures are presented in this section by Tier II category. The correspondence between the Tier II categories and the lead emissions methodology source categories is presented in Table 5.1-1. Within the description of the procedures for each Tier II category, the correlation between the categories is reiterated.

5.1.2 General Procedure

Lead emissions were calculated according to Equation 5.1-1.

$$Lead\ Emissions_{i,\,j} = A_{i,\,j} \times EF_{i,\,j} \times [1 - CE_{i,\,j}] \qquad \text{(Eq. 5.1-1)}$$

where:

where:	A	=	activity
	EF	=	emission factor
	CE	=	control efficiency
	I	=	year
	j	=	source category

As an aid in the calculation of emissions by the lead methodology, two Excel spreadsheets were created for each year and are collectively referred to as the *Trends* spreadsheets. The spreadsheets were entitled TRENDSxx.XLS and MGTMPxx.XLS, where xx represents the year. The required data were entered into the TRENDSxx.XLS spreadsheet, after which the MGTMPxx.XLS spreadsheet was opened and the necessary calculations were made to estimate the national emissions. This procedure was designed to simplify the process of estimating emissions for a new year. By using the TRENDSxx.XLS spreadsheets from the previous year as templates, the spreadsheets for the new year were created by editing only the data requiring updating.

The calculations utilized within the TRENDSxx.XLS spreadsheets required specific units for the activity indicators and the emission factors. The required units are specified within the procedures for each Tier II category. In general, the units for activity indicators were short tons for solids, gallons for liquids, and cubic feet for gases. Emission factors were expressed in units of metric pounds of pollutant per unit consumption or throughput. Control efficiencies were expressed as a dimensionless decimal fraction. By using these units, the emissions calculated within the spreadsheets were expressed in metric tons. Raw data used as the basis for activity indicators or emission factors were often expressed in units which required conversion to the appropriate units. The following conversion factors were used in many cases.

1 ton (metric)	=	1.1023 tons (short)
1 ton (long)	=	1.1016 tons (short)
1 ton (short)	=	0.9072 tons (metric)
1 bbl	=	42 gal

The emission factors used to estimate lead emissions were based on the most recent information available. For many categories, the most recent emission factor was used to estimate the emissions for all years.

When the emissions were estimated for 1996, not all of the activity information was available. In order to make a preliminary emissions estimate, activity data from preceding years were used to estimate the activity data for 1996. This was done using several different methods. The first method used a quadratic equation and the past 20 years of activity data. Data for 1976-1995 were used, and the previous ten year's data (1986-1995) was repeated. The second method used a linear regression and the past 7 years of activity data. Data from 1989-1995 were used, 1993-1995 data were repeated, and the 1995 data were repeated a third time. The third method, used in cases where the first method resulted in a negative activity value, calculated the average of the activity data over the past 5 years. Table 5.1-2 presents by general source category the method used to estimate activity data for generating 1996 emissions. For general source categories not listed, activity data for the current year were available at the time the emissions were estimated.

5.1.3 Organization of Procedures

The methodology used to estimate lead emissions is described by Tier II category except for the On-road vehicles category which is described at the Tier I level. For each category, the procedure is divided into four sections, reflecting the data required to generate the estimates: (1) technical approach, (2) activity indicator, (3) emission factor, and (4) control efficiency. The procedures for obtaining activity indicators, emission factors or control efficiencies are arranged in a variety of ways, depending on the specific requirements of the category. The procedures could be arranged by process, fuel type, or other subcategory.

References are provided at the end of the description of the procedure for each Tier II category. Many of the references are published annually as part of a series. In some cases, several references are provided for the same information, reflecting a change or discontinuation of one source and its replacement by another. The specific source used would depend on the specific year for which information is needed. All tables and supporting data immediately follow the description of the procedure for each Tier II category.

Table 5.1-1. Correspondence Between Tier II Categories and Lead Emissions Methodology Categories

Tier I Category	Tier II Category	Tier I/Tier II Code	Lead Emissions Methodology Category	Lead Emissions Methodology Subcategory
Fuel Combustion - Electric Utility	Coal	01-01	Bituminous Coal and Lignite	Electric Utility
			Anthracite Coal	Electric Utility
	Oil	01-02	Residual Oil	Electric Utility
			Distillate Oil	Electric Utility
Fuel Combustion - Industrial	Coal	02-01	Bituminous Coal and Lignite	Industrial
			Anthracite Coal	Industrial
	Oil	02-02	Residual Oil	Industrial
			Distillate Oil	Industrial
Fuel Combustion - Other	Commercial and Institutional Coal	03-01	Bituminous Coal and Lignite	Commercial and Institutional
			Anthracite Coal	Commercial and Institutional
	Commercial and Institutional Oil	03-02	Residual Oil	Commercial and Institutional
			Distillate Oil	Commercial and Institutional
	Miscellaneous Fuel Combustion (except residential)	03-04	Residual Oil	Waste Oil
	Residential Other	03-06	Bituminous Coal and Lignite	Residential
			Anthracite Coal	Residential
			Residual Oil	Residential
			Distillate Oil	Residential

Table 5.1-1 (continued)

Tier I Category	Tier II Category	Tier I/Tier II Code	Lead Emissions Methodology Category	Lead Emissions Methodology Subcategory
Chemical and Allied Product Manufacture	Inorganic Chemical Manufacturing	04-02	Industrial Processes	Secondary Metals (lead oxide/pigment)
Metals Processing	Nonferrous	05-01	Industrial Processes	Nonferrous Metals (copper, zinc, and lead production) Secondary Metals (lead, copper, and battery production) Miscellaneous Process Sources [miscellaneous products (can soldering and cable covering)]
	Ferrous	05-02	Industrial Processes	Iron and Steel Industry Nonferrous Metals (ferroalloy production) Secondary Metals Industry (grey iron foundries)
	Not Elsewhere Classified	05-03	Industrial Processes	Mineral Products (ore crushing) Miscellaneous Process Sources [miscellaneous products (type metal production)]
Other Industrial Processes	Mineral Products	07-05	Industrial Processes	Mineral Products (cement manufacturing and glass production, lead-glass)
	Miscellaneous Industrial Processes	07-10	Industrial Processes	Miscellaneous Process Sources (lead alkyl production - electrolytic process, sodium lead alloy, and miscellaneous products (ammunition)]
Waste Disposal and Recycling	Incineration	10-01	Solid Waste Disposal	Incineration
On-road vehicles	All Categories (Light-Duty Gas Vehicles and Motorcycles, Light-Duty Gas Trucks, and Heavy-Duty Gas Vehicles)	11	On-road vehicles	Gasoline (leaded and unleaded)
Non-road engines and vehicles	Nonroad Gasoline Aircraft	12-01 12-03	Other Non-road engines and vehicles Vessels Aircraft	Gasoline Gasoline Aviation Gasoline

Table 5.1-2. Method Used for Estimating 1996 Activity Data

General Source Category	Activity Data Estimation Method
Non-road engines and vehicles	Quadratic equation method
All Anthracite Coal Categories	Linear regression method
Fuel Combustion, excluding Electric Utility	
Bituminous Coal	Linear regression method
Residual Oil	Quadratic equation method
Distillate Oil	Linear regression method
Solid Waste	Quadratic equation method
Industrial Process Sources	Linear regression method

5.2 FUEL COMBUSTION ELECTRIC UTILITY - COAL: 01-01

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (See Table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Bituminous Coal and Lignite	Electric Utility
Anthracite Coal	Electric Utility

5.2.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million short tons for bituminous coal, and in thousand short tons for anthracite coal. Emission factors were expressed in metric pounds/thousand short tons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.2.2 Activity Indicator

The activity indicator for the combustion of coal at electric Utility was the anthracite coal receipts at electric Utility obtained from Reference 1a or 1b.

The activity indicator for the combustion of bituminous coal and lignite was calculated as the difference between the total national consumption of coal by electric Utility and the anthracite coal consumption at electric Utility as determined above. The total national consumption of coal was obtained from Reference 2a or Reference 3.

5.2.3 Emission Factor

The emission factors for the combustion of anthracite coal and of bituminous coal and lignite were obtained from Reference 4a.

5.2.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from the sources included in this Tier II category.

5.2.5 References

1. *Cost and Quality of Fuels for Electric Utility Plants*. DOE/EIA-0191(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
    a. Appendix A
    b. Table entitled, "Receipts and Average Delivered Cost of Coal By Rank, Census Division, and state, 19xx."

2. *Electric Power Annual*. DOE/EOA-0348(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
    a. Volume I. Table entitled, "Consumption of Fossil Fuels and End-year Stocks of Coal and Petroleum at U.S. Utility."

3. *Quarterly Coal Report: January - March*. DOE/EIA-0121(xx/1Q). Energy Information Administration, U.S. Department of Energy, Washington, DC. Quarterly.

4. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
    a. Appendix E

5.3 FUEL COMBUSTION ELECTRIC UTILITY - OIL: 01-02

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Residual Oil	Electric Utility
Distillate Oil	Electric Utility

5.3.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/million gallons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.3.2 Activity Indicators

The activity indicators for the combustion of residual and distillate oils were the consumption of these fuel types by electric Utility. The distillate oil consumption was assumed to be equal to the "adjusted" distillate fuel oil sales to electric Utility obtained from Reference 1a or Reference 2. The residual fuel oil consumption was obtained from "adjusted" residual fuel sales in Reference 1a. When this reference was unavailable, the residual oil consumption was calculated as the difference between the total oil consumption and the distillate oil consumption. The total annual oil consumption was obtained from Reference 3.

5.3.3 Emission Factors

The emission factors for the combustion of residual oil and of distillate oil by electric Utility were obtained from Reference 4a.

5.3.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from the sources included in this Tier II category.

5.3.5 References

1. *Fuel Oil and Kerosene Sales 19xx*. DOE/EIA-0535(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Adjusted Sales of Distillate Fuel Oil By End Use in the U.S."
   b. Table entitled, "Adjusted Sales of Residual Fuel Oil By End Use in the U.S."

2. *Petroleum Marketing Annual*. DOE/EIA-0389(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

3. *Electric Power Annual*. DOE/EOA-0348(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

4. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

5.4 FUEL COMBUSTION INDUSTRIAL - COAL: 02-01

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Anthracite Coal	Industrial
Bituminous Coal and Lignite	Industrial

5.4.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trends* spreadsheets, the activity indicators were expressed in million short tons for bituminous coal, and in thousand short tons for anthracite coal. The emission factors were expressed in metric pounds/thousand short tons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.4.2 Activity Indicator

The activity indicator for the industrial combustion of anthracite coal was the distribution of anthracite coal from Pennsylvania (i.e. District 24) obtained from Reference 1a under the category “Industrial Plants (except coke).”

The activity indicator for the combustion of bituminous coal and lignite was based on total national coal consumption obtained from Reference 2a under the category “Industrial Plants (except coke).” The sum of coal consumption by cement plants and lime plants was subtracted from the total coal consumption. The coal consumption by cement plants was obtained from Reference 3 or Reference 4a. The coal consumption by lime plants was estimated by multiplying the lime production value obtained from Reference 5 by the conversion factor, 0.1 tons coal/ton lime produced. If Reference 4 was unavailable, the previous year’s data was used.

5.4.3 Emission Factors

The emission factors for the industrial combustion of anthracite coal and of bituminous coal and lignite were obtained from Reference 6a.

5.4.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from the sources included in this Tier II category.

5.4.5 References

1. *Coal Distribution January-December 19xx*. DOE/EIA-0125(xx/4Q). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Domestic Distribution of U.S. Coal by Origin, Destination, and Consumer: January-December 19xx."

2. *Quarterly Coal Report: January - March*. DOE/EIA-0121(xx/1Q). Energy Information Administration, U.S. Department of Energy, Washington, DC. Quarterly.
   a. Table entitled, "U.S. Coal Receipts By End-Use Sector"

3. *Minerals Industry Surveys*, Cement. Bureau of Mines, U.S. Geological Survey, Washington, DC. Monthly.

4. Minerals Yearbook, Cement. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual
   a. Table entitled, "Clinker Produced and Fuel Consumed by the Portland Cement Industry the U.S. by process."

5. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

6. *Compilation of Air Pollutant Emission Factors*, *Third Edition*, *Supplements 1 through 14*, *AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

5.5 FUEL COMBUSTION INDUSTRIAL - OIL: 02-02

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Residual Oil	Industrial
Distillate Oil	Industrial

5.5.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/million gallons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.5.2 Activity Indicator

The activity indicator for industrial combustion of residual oil was based on the adjusted quantity of residual oil sales for industrial and oil company use obtained from Reference 1 or 2a. The total of three statistics was subtracted from this value to obtain the activity indicator. The first statistic was two-thirds of the quantity of oil consumed by cement plants reported in Reference 3 or 4a. The second statistic was the quantity of residual oil consumed by petroleum refineries reported in Reference 5a. The third statistic was the quantity of residual oil consumed by steel mills; this value was calculated by multiplying the quantity of raw steel production obtained from Reference 6a or 7, by $0.00738 * 10^6$ gal/10^3 ton steel. The conversion factor between the gallons of oil and the tons of steel was updated in 1982 based on Reference 8.

The activity indicator for industrial combustion of distillate oil was based on the adjusted quantity of distillate oil sales to industrial and oil companies obtained from Reference 1 or 2a. The total of two statistics was subtracted from this value to obtain the activity indicator for distillate oil. The first statistic was one-third of the quantity of oil consumed by cement plants, expressed in gallons, reported in Reference 3 or 4a. The second statistic was the quantity of distillate oil consumed by petroleum refineries, expressed in gallons, reported in Reference 5a or 5b.

5.5.3 Emission Factor

The lead emission factor for the industrial combustion of residual oil and of distillate oil were obtained from Reference 9a.

5.5.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from the sources included in this Tier II category.

5.5.5 References

1. *Petroleum Marketing Monthly*. DOE/EIA-0380(xx/01). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Fuel Oil and Kerosene Sales 19xx*. DOE/EIA-0535(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Adjusted Sales of Residual Fuel Oil by End-Use in the U.S."

3. *Minerals Industry Surveys*, Cement. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Monthly.
   a. Table entitled, "Clinker Produced and Fuel Consumed by the Portland Cement Industry in the U.S. By Process."

4. Minerals Yearbook, Cement. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual
   a. Table entitled, "Clinker Produced and Fuel Consumed by the Portland Cement Industry in the U.S. By Process."

5. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Fuel Consumed at Refineries by PAD District."
   b. Table entitled, "Refinery Fuel Use and Losses by PAD District."

6. *Survey of Current Business*. Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC.
   a. Table containing information on metals and manufactures.

7. Mineral Industry Surveys. Iron and Steel. US Geological Survey (formerly Bureau of Mines).
   a. Table entitled, "Salient Iron and Steel Statistics."

8. *Census of Manufactures (Fuels and Electric Energy Consumed)*. Bureau of the Census, U.S. Department of Commerce, Washington, DC. 1982.

9. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

5.6 FUEL COMBUSTION OTHER - COMMERCIAL/INSTITUTIONAL COAL: 03-01

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Anthracite Coal	Commercial / Institutional
Bituminous Coal and Lignite	Commercial / Institutional

5.6.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trends* spreadsheets, the activity indicators were expressed in million short tons for bituminous coal, and in thousand short tons for anthracite coal. The emission factors were expressed in metric pounds/thousand short tons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.6.2 Activity Indicator

The activity indicators for the combustion of anthracite and bituminous coal and lignite were the consumption of each coal type by commercial and institutional users. Determination of these activity indicators required activity data for both anthracite and bituminous residential coal combustion.

The commercial/institutional consumption of anthracite coal was obtained by subtracting the residential anthracite consumption from residential and commercial/institutional anthracite consumption. Residential and commercial/institutional consumption of anthracite coal was obtained from Reference 1a for District 24 only. This calculation is shown in Equation 5.6-1.

$$Anthracite\ Coal_{C/I} = Anthracite\ Coal_{R\ and\ C/I} - Anthracite\ Coal_{R} \qquad \text{(Eq. 5.6-1)}$$

where: R = residential consumption
C / I = commercial/institutional consumption

Residential consumption of anthracite coal was determined by extrapolating the consumption of the previous year based on the change in the number of dwelling units in the Northeastern United States having coal as the main fuel for space heating. Data concerning the number of dwelling units were obtained from Reference 2. The calculation of the residential anthracite coal consumption is summarized in Equation 5.6-2.

$$Anthracite\ Coal_{R,\ i} \ = \ Anthracite\ Coal_{R,\ i-1} \times \frac{Dwelling\ Units_{i}}{Dwelling\ Units_{i-1}} \qquad \text{(Eq. 5.6-2)}$$

where: R = residential consumption
I = year under study

Commercial/institutional consumption of bituminous coal was obtained by subtracting the residential bituminous consumption from the residential and commercial/institutional bituminous consumption. Residential and commercial/institutional consumption of bituminous coal was calculated by subtracting residential and commercial/institutional consumption of anthracite coal from residential and commercial/institutional consumption of all types of coal. These two consumption values were obtained from Reference 1a and excluded coal from District 24 which represents anthracite coal consumption. This calculation is summarized in Equation 5.6-3.

$$Bituminous\ Coal_{C/I} = (All\ Coal_{R\ and\ C/I} - Anthracite\ Coal_{R\ and\ C/I}) - Bituminous\ Coal_{R} \qquad \text{(Eq. 5.6-3)}$$

where: R = residential consumption
C / I = commercial/institutional consumption

The residential consumption of bituminous coal was determined by estimating the quantity of all coal consumed by all dwelling units using coal as the main fuel and subtracting from this value the residential consumption of anthracite coal calculated above. The quantity of all coal consumed was calculated using the number of dwelling units using coal as the main fuel for space heating obtained from Reference 2 and a factor estimating the average annual consumption of coal per dwelling unit. This calculation is summarized in Equation 5.6-4.

$$Bituminous\ Coal_{R} \ = \ (Dwelling\ Units \times 6.73\ tons\ burned/dwelling/year) - Anthracite\ Coal_{R} \qquad \text{(Eq. 5.6-4)}$$

where: R = residential consumption

5.6.3 Emission Factors

The emission factors for the commercial/institutional combustion of anthracite coal and of bituminous coal and lignite were obtained from Reference 3a.

5.6.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from the sources included in this Tier II category.

5.6.5 References

1. *Coal Distribution January-December 19xx*. DOE/EIA-0125(xx/4Q). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Domestic Distribution of U.S. Coal to the Residential and Commercial Sector by Origin."

2. *American Housing Survey, Current Housing Reports, Series H-150-83*. Bureau of the Census, U.S. Department of Commerce, Washington DC. Biennial.

3. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

5.7 FUEL COMBUSTION OTHER - COMMERCIAL/INSTITUTIONAL OIL: 03-02

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Residual Oil	Commercial / Institutional
Distillate Oil	Commercial / Institutional

5.7.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/million gallons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.7.2 Activity Indicator

The activity indicator for the commercial/institutional combustion of residual oil was the "adjusted" total quantity of residual oil sales for commercial and military use obtained from Reference 1 or Reference 2a.

The activity indicator for the combustion of distillate oil was the "adjusted" total quantity of distillate oil sales for commercial and military use (not including military diesel fuel) obtained from Reference 1, or commercial and military use obtained from Reference 2b minus military diesel fuel use obtained from Reference 2c.

5.7.3 Emission Factor

The emission factors for the commercial/institutional combustion of residual oil and of distillate oil were obtained from Reference 3a.

5.7.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from the sources included in this Tier II category.

5.7.5 References

1. *Petroleum Marketing Monthly*. DOE/EIA-0380(xx/01). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Fuel Oil and Kerosene Sales 19xx*. DOE/EIA-0535(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Adjusted Sales of Residual Fuel Oil by End Use in the US."
   b. Table entitled, "Adjusted Sales of Distillate Fuel Oil by End Use in the US."
   c. Table entitled, "Adjusted Sales for Military, Non-road engines and vehicles, and All Other Uses: Distillate Fuel Oil, Residual Fuel Oil and Kerosene."

3. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

5.8 FUEL COMBUSTION OTHER - MISCELLANEOUS FUEL COMBUSTION (EXCEPT RESIDENTIAL): 03-04

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Residual Oil	Waste Oil

5.8.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trend*s spreadsheets, the activity indicator was expressed in million gallons and the emission factor was expressed in metric pounds/million gallons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1996.

5.8.2 Activity Indicator

The activity indicator for the combustion of residual waste oil was assumed to be a constant annual consumption of 500 x 10^6 gallons of waste oil.

5.8.3 Emission Factor

The emission factor for the combustion of residual waste oil was calculated as 75 lb/1,000 gal multiplied by the average percentage of lead. It was assumed that the percentage of lead had a constant value of 0.5333 up to the year 1975; after which, it was assumed that the lead percentage steadily decreased. After 1984, the value has remained constant at 0.0213. The average lead percentage values are presented in Table 5.8-1.

5.8.4 Control Efficiency

No control efficiency was applied to activity data to estimate lead emissions from the combustion of waste oil.

5.8.5 References

None.

Table 5.8-1. Annual Percentage Lead Content

Year	Percent Lead
1975	0.5333
1976	0.4702
1977	0.407
1978	0.3439
1979	0.2807
1980	0.2176
1981	0.1545
1982	0.0913
1983	0.0282
1984	0.0213

5.9 FUEL COMBUSTION OTHER - RESIDENTIAL OTHER: 03-06

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Anthracite Coal	Residential
Bituminous Coal and Lignite	Residential
Residual Oil	Residential
Distillate Oil	Residential

5.9.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trend*s spreadsheets, the activity indicators were expressed in million tons for bituminous coal and in thousand tons for anthracite coal. The emission factors for these categories were expressed in metric pounds/thousand tons. Activity indicators for residual and distillate oils were expressed in million gallons and emission factors were expressed in metric pounds/million gallons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.9.2 Activity Indicator

The activity indicator for the residential combustion of anthracite coal was the residential consumption of anthracite coal. This value was determined by extrapolating the residential consumption of anthracite coal during the previous year based on the change in the number of dwelling units in the Northeastern United States having coal as the main fuel for space heating. Data concerning the number of dwelling units were obtained from Reference 1. The calculation of the residential anthracite coal consumption is summarized in Equation 5.9-1.

$$Anthracite\ Coal_{R,\ i} = Anthracite\ Coal_{R,\ i-1} \times \frac{Dwelling\ Units_{i}}{Dwelling\ Units_{i-1}} \qquad \text{(Eq. 5.9-1)}$$

where: R = residential consumption
I = year under study

The activity indicator for the combustion of bituminous coal and lignite was the residential consumption of bituminous coal and lignite. This value was determined by estimating the quantity of all coal consumed by all dwelling units using coal as the main fuel and subtracting from this value the residential consumption of anthracite coal calculated above. The quantity of all coal consumed was calculated using the number of dwelling units using coal as the main fuel for space heating obtained from Reference 1 and a factor estimating the average annual consumption of coal per dwelling unit. This calculation is summarized in Equation 5.9-2.

$$Bituminous\ Coal_R = (Dwelling\ Units \times 6.73\ tons\ burned/dwelling/year) - Anthracite\ Coal_R \qquad \text{(Eq. 5.9-2)}$$

where: R = residential consumption

The activity indicator for the residential combustion of residual oil was assumed to be zero. The activity indicator for the combustion of distillate oil was the sum of the "adjusted" sales (or deliveries) for residential use of distillate oil and for farm use of other distillates as reported in Reference 2 or Reference 3a and 3b.

5.9.3 Emission Factors

The emission factor for the residential combustion of anthracite coal was obtained from Reference 4.

The emission factor for the combustion of bituminous coal and lignite and for distillate oil was obtained from Reference 5a.

No emission factor was required for the combustion of residual oil because the activity was assumed to be zero.

5.9.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from the sources included in this Tier II category.

5.9.5 References

1. *American Housing Survey, Current Housing Reports, Series H-150-83*. Bureau of the Census, U.S. Department of Commerce, Washington DC. Biennial.

2. *Petroleum Marketing Monthly*. DOE/EIA-0380(xx/01). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

3. *Fuel Oil and Kerosene Sales 19xx*. DOE/EIA-0535(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Adjusted Sales of Distillate Fuel Oil by End Use in the U.S."
   b. Table entitled, "Adjusted Sales for Gram Use: Distillate Fuel Oil and Kerosene; Sales for Electric Utility and Oil Company Uses; Distillate Fuel Oil and Residual Fuel Oil."

4. *Development of HATREMS Data Base and Emission Inventory Evaluation*. EPA-450/3-77-011. U.S. Environmental Protection Agency, Research Triangle Park, NC. April 1977.

5. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

5.10 CHEMICAL AND ALLIED PRODUCT MANUFACTURE - INORGANIC CHEMICAL MANUFACTURE: 04-02

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Industrial Processes - Lead Emissions	Secondary Metals (lead oxide/pigment)

5.10.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in thousand tons and emission factors were expressed in metric pounds/tons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.10.2 Activity Indicator

Activity indicators for the of barton pot (litharge and leady oxide), red lead, and white lead were the respective quantities of each produced (using the lead content) as reported in Reference 1. If the litharge and red lead are reported together, the last known distribution was used to distribute the activity. If the value for white lead was withheld, the previous year's data was used.

5.10.3 Emission Factor

The lead emission factors for barton pot, red lead, and white lead were obtained from Reference 2a.

5.10.4 Control Efficiency

No control efficiencies were applied to activity data to estimate lead emissions from the sources included in this Tier II category.

5.10.5 References

1. *Minerals Yearbook*, Lead. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, "Production & Shipments of Lead Pigments and Oxides in the U.S."

2. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Table 7.16-1

5.11 METALS PROCESSING - NONFERROUS: 05-01

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Industrial Processes - Lead Emissions	Nonferrous Metals (copper, zinc, and lead production)
	Secondary Metals (lead, copper, and battery production)
	Miscellaneous Process Sources [miscellaneous products (can soldering and cable covering)]

5.11.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emissions factor, and control efficiency, where applicable. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in thousand tons and emission factors were expressed in metric pounds/tons. All control efficiencies were expressed as dimensionless fractions.

The following procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1970 through 1995.

5.11.2 Activity Indicator

5.11.2.1 Nonferrous Metals

The activity indicator for copper roasting was based on the primary copper smelter production from domestic and foreign ores from Reference 1a. Copper smelter production was expressed in units of blister copper produced. It was assumed that of the 4 tons of copper concentrate/ton of blister, only half was roasted. Therefore, the amount of blister copper produced multiplied by 2 resulted in the activity indicator for the roasting process.

Activity indicators for copper smelting and converting were assumed to be equivalent. Activity data were calculated in the same manner as for the roasting process, except it was assumed that all of the blister copper produced was smelted and converted. Therefore, units of blister copper produced multiplied by 4 resulted in the activity indicators for the smelting and converting process.

Activity data for zinc sintering was based on the redistilled slab zinc production obtained from Reference 2a. The activity indicator for the horizontal retort process was assumed to be zero. The activity indicator for the vertical retort process was assigned the same value as used for zinc sintering.

The activity indicators for lead sintering, blast furnaces, and reverberatory furnaces were assumed to be equal to the primary refined lead production from domestic and foreign ores as listed in Reference 3.

5.11.2.2 Secondary Metals

Activity data for three copper-producing processes were obtained from Reference 1b. The production level of high-leaded tin bronze was used as the basis for high Lead (58%) activity. The production level of yellow brass was used as the basis for red-yellow brass (15%) activity. Other alloys (7%) activity was based on the production level of leaded red brass and semi-red brass.

Activity indicators for three lead-producing furnace types and fugitive lead processes were obtained from Reference 3 or 4a. The pot furnace activity was estimated as 90 percent of the total consumption of lead scrap by all consumers obtained from Reference 4a. The activity indicator for reverberatory furnaces was estimated by multiplying the total consumption of lead scrap by the ratio between the quantity of lead recovered as soft lead (obtained from Reference 3b) and the total lead recovered from scrap. The activity indicator for blast furnaces was estimated by multiplying the total consumption of lead scrap by the ratio between lead recovered as antimonial lead and the total lead recovered from scrap. Fugitive lead activity was assumed to be equal to the total quantity of lead recovered.

Battery production consists of five processes: (1) grid casting, (2) paste mixing, (3) lead oxide mill, (4) three process operations, and (5) lead reclamation furnace. The number of batteries produced was used as the activity indicator for each process. The total weight of lead used to produce storage batteries was obtained from Reference 3c. This value was converted from metric tons to English units and was used to calculate the number of batteries produced, expressed in thousands of batteries, as shown in Equation 5.11-1.

$$Number\ of\ Batteries = \frac{Weight_{Pb} \times 1.10231 \times 2{,}000\ lb/ton}{1{,}000 \times 26\ lb/battery} \qquad \text{(Eq. 5.11-1)}$$

The activity indicator for lead reclamation furnaces was 1 percent of the number of batteries produced as calculated above.

5.11.2.3 Miscellaneous Process Sources

The activity indicator for can soldering was the can soldering consumption as listed in Reference 3c. If this activity indicator was not available, the previous year's value was used. The activity indicator for cable covering was based on the value for cable covering consumption, also obtained from Reference 3c, which was multiplied by 10 to account for recycling.

5.11.3 Emission Factor

5.11.3.1 Nonferrous Metals

The emission factors for primary copper and lead smelting processes were obtained from References 5a and 5b, respectively. The emission factors for processes associated with primary zinc smelting were obtained from Reference 6a. Values for these emission factors were established as the midpoint of the emission factor ranges reported in the references cited.

5.11.3.2 Secondary Metals

The emission factors for secondary lead processing were obtained from Reference 6a. The emission factors for secondary copper processing were obtained from Reference 5c. Battery production emission factors were reported in Reference 5d.

5.11.3.3 Miscellaneous Process Sources

The emission factors for can soldering and can covering were obtained from Reference 5e.

5.11.4 Control Efficiency

5.11.4.1 Nonferrous Metals

The control efficiencies for all copper, zinc, and lead production processes for the years 1970 through 1984 were equivalent to the TSP control efficiencies for the same processes. The TSP control efficiencies were derived from Reference 7 or Reference 8 using Equation 5.11-2. Values for the control efficiency were assumed constant after the year 1984.

$$CE = \left[\frac{(UE - AE)}{UE}\right] \qquad \text{(Eq. 5.11-2)}$$

where:
- CE = control efficiency
- UE = emissions before control
- AE = emissions after control

5.11.4.2 Secondary Metals

The control efficiencies for the secondary lead production processes were obtained from Reference 9.

5.11.4.3 Miscellaneous Process Sources

The control efficiencies for can soldering and cable covering were obtained from Reference 9.

5.11.5 References

1. *Minerals Yearbook*, Copper. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, "Copper: World Smelter Production, by Country."
   b. Table entitled, "Production of Secondary Copper & Copper Alloy Products in the U.S. by Item Produced From Scrap."

2. *Minerals Yearbook*, Zinc. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, "Salient Zinc Statistics" (production of slab zinc from scrap).

3. *Minerals Yearbook*, Lead. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, "Salient Lead Statistics."
   b. Table entitled, "Pb Recovered from Scrap Processed in the U.S., by Kind of Scrap and Form of Recovery."
   c. Table entitled, "U.S. Consumption of Lead, by Product."

4. *Minerals Yearbook*, Recycling of Nonferrous Materials. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, "Stocks and Consumption of New and Old Lead Scrap in the U.S. by Type of Scrap."

5. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Table 7.3-10
   b. Table 7.6-1
   c. Table 7.9-1
   d. Table 7.15-1
   e. Table 7.17-1

6. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

7. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

8. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

9. *Control Techniques for Lead Air Emissions, Volumes 1 and 2*. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1977.

5.12 METALS PROCESSING - FERROUS: 05-02

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Industrial Processes - Lead Emissions	Iron and Steel Industry (coke, blast furnace, sintering, open hearth, BOF (Basic Oxygen Furnace), and electric arc furnace)
	Nonferrous Metals (ferroalloy production)
	Secondary Metals Industry (grey iron foundries)

5.12.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emissions factor, and control efficiency, where applicable. In order to utilize these values in the *Trend*s spreadsheets, activity indicators for all source categories, except those in the iron and steel industry, were expressed in thousand tons. For the iron and steel industry source categories, activity indicators were expressed in million tons. All emission factors were expressed in metric pounds/tons. All control efficiencies were expressed as dimensionless fractions.

The following procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1970 through 1995.

5.12.2 Activity Indicator

5.12.2.1 Iron and Steel

The activity indicator for coke production was the oven production figure obtained from Reference 1a. The activity for coke production was assumed to be zero for all years including and following 1994. The activity indicator for blast furnaces was the total pig iron production as reported in Reference 1b, Reference 2a, or Reference 3. This value included exports. The activity indicator for the windbox sintering process was the total production of pig iron, divided by 3 (two other processes [discharge, sinter-fugitive] to not contribute to Pb emissions).

The activity indicators for open hearth, basic oxygen, and electric arc furnaces were based on the total scrap and pig iron consumption. Reference 4 contained the total scrap and pig iron consumed by each furnace type by manufacturers of pig iron and raw steel and castings. The fraction of the combined quantity of scrap and pig iron consumed by each of the three furnace types was calculated. Total raw steel production reported in Reference 1b or Reference 2a was multiplied by each fraction to obtain the raw steel production for each furnace type.

5.12.2.2 Nonferrous Metals

The activity indicator for ferrosilicon production was the net gross weight production obtained from Reference 5a or 6a. Silicon manganese activity was assumed to be 42.1 percent of the net production of ferrosilicon. Production of ferromanganese by electric furnaces was assumed to be 57.9 percent of the net production of ferrosilicon. Production of silicon metal was obtained from Reference 6a. For ferromanganese from blast furnaces and for Ferro-Mang (std), the activity indicators were assumed to be zero.

Ferrochrome-silicon activity was obtained from Reference 5a or 7, and activity data for High Carbon Ferro production was obtained from Reference 5a or 8. If these data were not available, values for the previous year were used.

5.12.2.3 Secondary Metals

The activity indicator for cupola furnaces in grey iron foundries was based on the combined quantity of scrap and pig iron consumed by cupola furnaces. This value was obtained from Reference 4a under the category of iron foundries and miscellaneous users. The final activity was determined by adjusting this production value to account for this category's respective emission factor, which was expressed in terms of the charged quantity, and not the fresh feed quantity. This adjustment required dividing the production value by 0.78.

The activity indicator for electric induction was based on the combined quantity of iron and steel scrap and pig iron consumed in electric furnaces. This value was obtained from Reference 4a under the category of iron foundries and miscellaneous users. The amount consumed was adjusted to account for recycling by dividing the consumption value by 0.78.

5.12.3 Emission Factor

5.12.3.1 Iron and Steel

The emission factors for all processes were obtained from Reference 9a. The emission factor used for by-product coke was the same as that established for metallurgical coke manufacturing.

5.12.3.2 Nonferrous Metals

The emission factors for all processes were set equal to the midpoint of the emission factor ranges reported in Reference 10a.

5.12.3.3 Secondary Metals - Grey Iron Foundries

The emission factors for all processes were reported in Reference 10b.

5.12.4 Control Efficiency

The control efficiencies for all processes included in this Tier II category for the years 1970 through 1984 were equivalent to the TSP control efficiencies for the same processes. The TSP control efficiencies were derived from Reference 11 or Reference 12 using Equation 5.12-1. Values after the year 1984 were assumed constant.

$$CE = \left[\frac{(UE - AE)}{UE} \right] \qquad \text{(Eq. 5.12-1)}$$

where:
- CE = control efficiency
- UE = emissions before control
- AE = emissions after control

5.12.5 References

1. *Survey of Current Business*. Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC.
   a. Table containing information on “Petroleum, Coal, and Products.” SCC = 3-03-003
   b. Table containing information on “Metals and Manufactures.”

2. Minerals Yearbook, Iron and Steel. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, “Salient Iron and Steel Statistics.”
   b. Table entitled, “U.S. Consumption of Iron and Steel Scrap, Pig Iron, and Direct-Reduced Iron (DRI) in 19xx, by Type of Furnace and Other Use.”

3. *Minerals Industry Surveys*, Iron Ores. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Monthly.

4. *Minerals Industry Surveys*, Iron and Steel Scrap. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Monthly.
   a. Table on consumption of iron and steel scrap and pig iron in the United States by type of furnace or other use.

5. *Minerals Yearbook*, Ferroalloys. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, “Table 2. Ferroalloys Produced and Shipped from Furnaces in the U.S.”

6. *Minerals Yearbook*, Silicon. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. “Table 1. Production, Shipments, and Stocks of Silvery Pig Iron, Ferrosilicon, and Silicon Metal in the U.S. in 19xx”

7. *Minerals Yearbook*, Chromium. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.

8. *Minerals Yearbook*, Iron and Steel. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.

9. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
    a. Appendix E

10. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
    a. Table 7.4-5
    b. Table 7.10-3

11. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

12. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

5.13 METALS PROCESSING - NOT ELSEWHERE CLASSIFIED: 05-03

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Industrial Processes - Lead Emissions	Mineral Products (ore crushing)
	Miscellaneous Process Sources [miscellaneous products (type metal production)]

5.13.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emissions factor, and control efficiency, where applicable. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in thousand tons and emission factors were expressed in metric pounds/tons. All control efficiencies were expressed as dimensionless fractions.

The following procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1970 through 1995.

5.13.2 Activity Indicator

The activity indicator for lead ore production was the gross weight of lead ore produced on a dry weight basis as reported in Reference 1a or 1b. If this value is not reported on a dry weight basis, the dry weight is estimated from the Pb ore production, in terms of recoverable Pb content, divided by 0.0799. The activity indicator for Zn, Cu, Cu-Zn ores was estimated as the sum of the "ore produced" listed in Reference 2a, and "all other sources" listed in Reference 1a. The activity data for Pb-Zn, Cu-Pb, Cu-Pb-Zn ores was assumed to be zero. If Reference 1a is not available, Zn, Cu, Cu-Zn ores are estimated using the following equation:

$$1.4291(x) - 49736.557 \qquad \text{(Eq. 5.13-1)}$$

where: x = value for copper ore produced, in short tons.

The activity indicator for type metal production was based on the consumption of lead for type metal production obtained from Reference 1. In accordance with procedures provided in Reference 3, this value was multiplied by 330 to account for recycling. If the value is withheld, use the most recent available year.

5.13.3 Emission Factor

The emission factors for ore crushing and grinding processes were obtained from Reference 4a. The emission factors for type metal production were obtained from Reference 4b.

5.13.4 Control Efficiency

The control efficiencies for ore crushing and grinding processes and type metal production were obtained from Reference 3. No control efficiencies were applied to the activity data to estimate emissions from type metal production.

5.13.5 References

1. *Minerals Yearbook*, Lead. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
    a. Table entitled, "Production of Lead and Zinc in Terms of Recoverable Metals, in U.S. in 19xx, by State."
    b. Table Entitled, "Salient Lead Statistics."

2. *Minerals Yearbook*, Copper. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
    a. Table entitled, "Salient Copper Statistics."

3. *Control Techniques for Lead Air Emissions, Volumes 1 and 2*. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1977.

4. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
    a. Table 7.6-1
    b. Table 7.17-1

5.14 OTHER INDUSTRIAL PROCESSES - MINERAL PRODUCTS: 07-05

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Industrial Processes - Lead Emissions	Mineral Products [Cement Manufacturing (wet kiln/cooler, wet dryer/grinder, dry kiln/cooler and dry dryer/grinder) and Glass Production (lead-glass)]

5.14.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emissions factor, and control efficiency, where applicable. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in thousand tons and emission factors were expressed in metric pounds/tons. All control efficiencies were expressed as dimensionless fractions.

The following procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1970 through 1995.

5.14.2 Activity Indicator

The activity indicators for wet kiln/cooler and wet dryer/grinder used in cement manufacturing were assumed to be equal. The value used was the sum of two categories: "wet" clinker produced and "both" clinker produced, reported in Reference 1a or Reference 2a. The activity indicators for dry kiln/cooler and dry dryer/grinder were both estimated to be the sum of "dry" clinker produced and "both" clinker produced, as reported in Reference 1a. The activity indicator for lead-glass production was assumed to be zero.

5.14.3 Emission Factor

The emission factors for cement manufacturing processes were obtained from Reference 3a. The emission factor for glass production was obtained from Reference 3b.

5.14.4 Control Efficiency

The control efficiencies for the wet and dry kiln/cooler used in cement manufacturing for the years 1970 through 1984 were equivalent to the TSP control efficiencies for kilns. The control efficiencies for the wet and dry dryer/grinders for the years 1970 through 1984 were equivalent to the TSP control efficiencies for grinders. These TSP control efficiencies were derived from Reference 4 or Reference 5 using Equation 5.14-1. All control efficiencies for the years following 1984 were assumed constant.

$$CE = \left[\frac{(UE - AE)}{UE}\right] \qquad \text{(Eq. 5.14-1)}$$

where: CE = control efficiency
UE = emissions before control
AE = emissions after control

No control efficiencies were applied to activity data to estimate emissions from lead-glass production.

5.14.5 References

1. *Minerals Industry Surveys*, Cement. US Geological Survey (formerly Bureau of Mines), Washington, DC. Monthly.
   a. Table entitled, "Clinker Produced and Fuel Consumed by the Portland Cement Industry."

2. Minerals Yearbook, Cement. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual
   a. Table entitled, "Clinker Produced and Fuel Consumed by the Portland Cement Industry in the U.S. by process."

3. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Table 8.6-1
   b. Table 8.13-1

4. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

5. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

5.15 OTHER INDUSTRIAL PROCESSES - MISCELLANEOUS INDUSTRIAL PRODUCTS: 07-10

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Industrial Processes - Lead Emissions	Miscellaneous Process Sources [Lead Alkyl Production (electrolytic process), Sodium Lead Alloy (recovery furnace, TEL process vents, TML process vents, and sludge pits), and Miscellaneous Products (ammunition)]

5.15.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emissions factor, and control efficiency, where applicable. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in thousand tons and emission factors were expressed in metric pounds/tons. All control efficiencies were expressed as dimensionless fractions.

The following procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1970 through 1995.

5.15.2 Activity Indicator

The activity indicator for lead alkyl production by the electrolytic process was based on the quantity of lead consumed in anti-knock manufacturing obtained from Reference 1a. This quantity of lead was converted to a quantity of additive by multiplying by 1.76. The activity indicator for this category was assumed to be 10 percent of the quantity of additive consumed based on Reference 2. As of 1992, it was assumed that there were no producers of lead alkyl products in the United States. All emissions after 1992 for this category are zero.

The activity indicator for sodium lead alloy production processes was based on the remaining 90 percent of the quantity of additive consumed as determined above for lead alkyl production. The activity for recovery furnaces and sludge pits was assumed to be equal to the remaining quantity of additive. The activity of TEL (TetraEthyl Lead) process vents and TML (TetraMethyl Lead) process vents was 63 percent and 37 percent, respectively, of the remaining quantity of additive. These apportionments were based on Reference 2. As of 1992, it was assumed that there were no producers of sodium lead alloy products in the US. All emissions after 1992 for this category are zero.

The activity indicator for ammunition production was the sum of lead consumption for the following uses: (1) caulking lead (building construction), (2) total pipes, traps, and other extruded products, (3) total sheet lead, and (4) other metal products. The consumption information was obtained from Reference 1.

5.15.3 Emission Factor

The emission factors for lead alkyl and sodium lead alloy production processes were obtained from Reference 3a. The emission factors for ammunition production were obtained from Reference 3b.

5.15.4 Control Efficiency

The control efficiencies for ammunition production were obtained from Reference 2. No control efficiencies were applied to estimate emissions from the other sources included in this Tier II category.

5.15.5 References

1. *Minerals Yearbook,* Lead. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, "U.S. Consumption of Lead, by Product."

2. *Control Techniques for Lead Air Emissions, Volumes 1 and 2*. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1977.

3. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Table 5.22-1
   b. Table 7.17-1

5.16 WASTE DISPOSAL AND RECYCLING : 10-01

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	Subcategory:
Solid Waste Disposal	Incineration (Municipal, Residential, Commercial/Institutional, and Conical Woodwaste)

5.16.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in million tons and emission factors were expressed in metric pounds/thousand tons.

The following procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1970 through 1995.

5.16.2 Activity Indicator

The activity indicator for municipal incineration was the sum of the operating rates for the SCCs 5-01-001-01 and 5-01-001-02 obtained from Reference 1 or 2. The activity for 1995 was calculated by multiplying the 1990 activity by the ratio of 1995 combustion to 1990 combustion from Reference 3.

The activity indicator for residential incineration was the operating rate for residential on-site incineration obtained from Reference 4. The activity for 1995 and 1996 was calculated by multiplying the 1994 activity obtained from reference 4 by the ratio of 1994 activity to 1995 or 1996 activity obtained from Reference 5.

Commercial/industrial incineration was based on the sum of the operating rates provided in Reference 1 or 2 for the following SCCs: 5-02-001-01, 5-02-001-02, 5-03-001-01, and 5-03-001-02. The previous year's activity data reported in the *Trends* spreadsheet was scaled based on the ratio of the total operating rate for the current year to the total for the previous year. This calculation is shown in Equation 5.16-1.

$$A_i = A_{i-1} \times \left(\frac{\sum_{SCCs} OR_i}{\sum_{SCCs} OR_{i-1}} \right) \qquad \text{(Eq. 5.16-1)}$$

where: A = activity indicator
I = year
OR = operating rates for SCCs 5-02-001-01, 5-02-001-02, 5-03-001-01, and 5-03-001-02

The activity for commercial/industrial incineration for the years 1995 and 1996 was calculated by multiplying the 1994 activity obtained from Reference 1 by the ratio of 1994 emissions to 1995 or 1996 emissions obtained from Reference 5.

The activity indicator for conical woodwaste incineration was the sum of the operating rates for the SCCs 5-02-001-05 and 5-03-001-05 obtained from Reference 1 or 2.

5.16.3 Emission Factor

The emission factors for municipal, residential, and commercial/institutional incineration were obtained from Reference 6a or Reference 7a.

The emission factor for conical woodwaste incineration (SCC 5-02-001-05) was assumed to be zero.

5.16.4 Control Efficiency

The control efficiency associated with municipal incineration was obtained from Reference 1 or 2 for SCC 5-01-001.

No control efficiencies were applied to the activity data to estimate emissions from the remaining types of incineration (i.e., residential, commercial/institutional, and conical woodwaste).

5.16.5 References

1. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

2. *Computer Retrieval, NE257 report, by Source Classification Code (SCC) from the National Emission Data System (NEDS)*. Unpublished computer report. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. February 9, 1980.

3. *Characterization of Municipal Solid Waste in the United States. (1996 Update)* Municipal and Industrial Solid Waste Division, U.S. Environmental Protection Agency, Washington, DC. June 1997.

4. *Computer Retrieval, NE260 report, by Source Classification Code (SCC) from the National Emission Data System (NEDS)*. Unpublished computer report. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. February 9, 1980.

5. *National Emission Trends Report.* Draft Report. Prepared by E.H. Pechan and Associates, Inc. under contract No. 68-D3-0035, work assignment III-102 for Emission Factor and Inventory Group, U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1997.

6. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Table 2.1-1.

7. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

5.17 ON-ROAD VEHICLES: 11

The emissions for all Tier II categories under this Tier I category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
On-road vehicles	Gasoline (leaded, unleaded)

5.17.1 Technical Approach

The lead emissions included in these Tier II categories were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/gallons. The total lead emissions for the Tier I category were allocated to the Tier II categories by the relative fraction of vehicle miles traveled (VMT) for the appropriate vehicle types.

The following procedures for determining activity indicators, emission factors, and allocation to the Tier II categories were used for the years 1970 through 1996.

5.17.2 Activity Indicator

The activity indicator for On-road vehicles was the gasoline consumption by all On-road vehicles as reported in Reference 1a. If this consumption value was not available, the previous year's consumption was adjusted based on the vehicle miles traveled (VMT) obtained from Reference 2a using Equation 5.17-1:

$$GC_i = GC_{i-1} \times \frac{VMT_i}{VMT_{i-1}} \qquad \text{(Eq. 5.17-1)}$$

where: GC = total gasoline consumption by all On-road vehicles
I = year of interest
VMT = vehicle miles traveled

The percentage of total unleaded gasoline was obtained from Reference 3a, and this value was applied to the total consumption of gasoline, resulting in unleaded gasoline use. This procedure was repeated to obtain leaded gasoline activity.

5.17.3 Emission Factor

The lead emission factors for On-road vehicles were reported in Reference 4 to be 1.5(Y) lb/ton, where Y is the number of grams of lead/gasoline. Y values are shown in Table 5.17-1. The values for Y were obtained from Reference 5.

5.17.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from On-road vehicles.

5.17.5 Allocation of Emissions to the Tier II Categories

The total lead emissions were the sum of the emissions from leaded gasoline and from unleaded gasoline. Lead emissions from these two types of gasolines were calculated by multiplying the activity indicator by the emission factor. In order to allocate the total lead emissions to the Tier II categories, the relative fraction of the VMT for each of the three vehicle classifications was determined. The VMT data for this purpose were obtained from a variety of sources. Relative VMT fractions used for the years 1940 through 1993 for each of the vehicle classifications are given in Table 5.17-2.

5.17.6 References

1. *On-road vehicles Statistics*. Federal On-road vehicles Administration, U.S. Department of Transportation, Washington, DC. Annual.
    a. Table MF-21, "Motor Fuel Use"

2. Welty, K. On-road vehicles Information Management, Federal On-road vehicles Administration, US Department of Transportation, personal communications with E.H. Pechan and Associates, Inc., Durham, NC, 1997. (Information received on floppy diskette.)

3. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
    a. Table entitled, "Finished Motor Gasoline Supply and Disposition."

4. *Control Techniques for Lead Air Emissions, Volumes 1 and 2*. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1977.

5. *Motor Gasolines*. National Institute for Petroleum and Energy Research, IIT Research Institute, Barltesville, OK. Summer 1987 and Summer 1990.

Table 5.17-1. Number of Grams of Lead/Gasoline (Y)

Year	Leaded Gasoline	Unleaded Gasoline
1970	2.43	NA
1971	2.59	NA
1972	2.63	NA
1973	2.2	0.014
1974	2.07	0.014
1975	1.82	0.014
1976	2.02	0.014
1977	2.03	0.014
1978	1.76	0.01
1979	1.76	0.016
1980	1.33	0.028
1981	1.01	0.009
1982	1.02	0.005
1983	0.83	0.003
1984	0.84	0.006
1985	0.59	0.002
1986	0.37	0.002
1987	0.15	0.001
1988	0.15	0.001
1989	0.08	0.002
1990	0.08	0.0004
1991	0.0002	0.0002
1992	0.0002	0.0002
1993	0.0002	0.0002
1994	0.0002	0.0002
1995	0.0002	0.0002
1996	0.0002	0.0002

Table 5.17-2. Relative VMT Fractions for Each Tier II Category

Year	Light-Duty Gas Vehicles and Motorcycles	Light-Duty Gas Trucks	Heavy-Duty Gas Trucks
1970	0.83	0.13	0.04
1971	0.83	0.13	0.03
1972	0.82	0.14	0.03
1973	0.82	0.14	0.03
1974	0.82	0.15	0.03
1975	0.82	0.15	0.03
1976	0.81	0.16	0.03
1977	0.80	0.17	0.03
1978	0.80	0.17	0.03
1979	0.79	0.18	0.03
1980	0.78	0.19	0.03
1981	0.76	0.21	0.03
1982	0.79	0.19	0.02
1983	0.78	0.20	0.02
1984	0.77	0.21	0.02
1985	0.76	0.22	0.02
1986	0.75	0.23	0.02
1987	0.74	0.24	0.02
1988	0.75	0.24	0.02
1989	0.75	0.24	0.02
1990	0.75	0.24	0.02
1991	0.75	0.24	0.01
1992	0.75	0.24	0.01
1993	0.75	0.24	0.01
1994	0.75	0.24	0.01
1995	0.75	0.24	0.01
1996	0.75	0.24	0.01

5.18 NON-ROAD ENGINES AND VEHICLES - NONROAD GASOLINE: 12-01

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Other Non-road engines and vehicles	Gasoline (Farm Tractors, Other Farm Equipment, construction, Snowmobiles, Small Utility Engines, Heavy Duty General Utility Engines, Motorcycles)
Vessels	Gasoline
Aircraft	Aviation Gasoline

5.18.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/thousand gallons.

The following procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1970 through 1995.

5.18.2 Activity Indicator

The activity indicator for gasoline-powered farm tractors was based on the 1973 gasoline consumption by farm tractors reported in Reference 1. The adjustment factor applied to the 1973 data was the ratio of the quantity of gasoline consumed by all agricultural equipment in 1973 and in the year under study as reported in Reference 2a. It is assumed that this procedure was used for the years both before 1973 and after 1973. Equation 5.18-1 summarizes this procedure.

$$GC_{Tractor,\ i} = GC_{Tractor,\ 1973} \times \frac{GC_{Agriculture,\ i}}{GC_{Agriculture,\ 1973}} \qquad \text{(Eq. 5.18-1)}$$

where: GC = gasoline consumption
I = year under study

The activity indicator for other gasoline-powered farm equipment was also based on gasoline consumption. It was assumed that the gasoline consumption by other farm equipment was equivalent to 8.52 percent of the quantity of gasoline consumed by farm tractors as determined by the preceding procedure. Activity for other farm equipment is considered zero for the year 1991 and all subsequent years.

The activity indicator for gasoline-powered construction equipment was the total gasoline consumption by construction equipment as reported in Reference 2.

Activity data for snowmobiles were based on the 1973 gasoline consumption by snowmobiles, as reported in Reference 1. An adjustment factor was applied to the 1973 value to account for the ratio of the number of snowmobile registrations in 1973 and in the year under study as reported in Reference 3. It is assumed that this procedure was used for the years both before 1973 and after 1973. Equation 5.18-2 summarizes this procedure.

$$GC_{Snowmobiles,\ i} = GC_{Snowmobiles,\ 1973} \times \frac{N_{Snowmobiles,\ i}}{N_{Snowmobiles,\ 1973}} \qquad \text{(Eq. 5.18-2)}$$

where: GC = gasoline consumption
I = year under study
N = number of registered vehicles

Activity data for small utility gasoline engines was based on the 1980 value for gasoline consumption by small engines (533 x 10^6 gallons). An adjustment factor was applied to the 1980 data to account for the ratio of the number of single unit dwellings in 1980 and in the year under study. The number of single unit dwellings in 1980 was obtained from Reference 4. For the year under study, the number of single unit dwellings was estimated by adding or subtracting the number of new one-family structures started each year between 1980 and the year under study to the number of single unit dwellings in 1980. The number of new one-family structures started was obtained from Reference 5 for each year. It is assumed that this procedure was used for the years both before 1973 and after 1973. Equation 5.18-3 summarizes this procedure.

$$GC_{Small Engines,\ i} = \left(533 \times 10^6\ gal\right) \times \frac{Single\ Unit\ Dwellings_i}{Single\ Unit\ Dwellings_{1980}} \qquad \text{(Eq. 5.18-3)}$$

where: GC = gasoline consumption
I = year under study

The activity indicator for heavy duty general gasoline utility engines was the total gasoline consumed by the industrial/commercial category obtained from Reference 2.

The activity indicator for motorcycles was calculated from the number of motorcycles, the average annual Non-road engines and vehicles mileage traveled, and the median estimated average miles per gallon. The motorcycle population and the Non-road engines and vehicles mileage were obtained from Reference 6. The average miles per gallon (MPG) was assumed to be 44.0 miles/gallon. Activity for motorcycles was considered zero for the year 1995 and all subsequent years because no leaded gasoline was consumed by motorcycles after this year. Equation 5.18-4 summarizes this calculation.

$$GC_{Motorcycles} = N_{Motorcycles} \times \frac{M_{Motorcyles,\ Off-highway}}{MPG} \quad \text{(Eq. 5.18-4)}$$

where:

where:	GC	=	gasoline consumption
	N	=	number of motorcycles
	M	=	mileage
	MPG	=	miles/gallon

The activity indicator for aircraft was the total national quantity of aviation gasoline supplied as reported in Reference 7a, Reference 8a, or Reference 9a. Reference 7a was used for the years 1970 through 1978. Reference 8a was used for the years 1979 and 1980. Reference 9a was used for the years 1981 through 1995.

5.18.3 Emission Factor

The lead emission factor for the combustion of gasoline in Non-road engines and vehicles was reported in Reference 10 to be 1.5(Y) lb/ton, where Y is the number of grams of lead/gasoline. It was assumed that all gasoline used for these engines was leaded. The value of Y was obtained from Reference 11 for the years 1970 to 1988 and Reference 12 for the years 1989 to 1996.

The lead emission factor for aircraft was reported in Reference 13 to be the lead content of aviation gasoline multiplied by the percent of lead emitted. Therefore, the emission factor is 2g/gal times 0.75.

5.18.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from Non-road engines and vehicles.

5.18.5 References

1. *Exhaust Emissions from Uncontrolled Vehicles and Related Equipment Using Internal Combustion Engines*. U.S. Environmental Protection Agency. Prepared by Southwest Research Institute, San Antonio, TX, under Contract No. EHS-70-108. October 1973.

2. *On-road vehicles Statistics*. Federal On-road vehicles Administration, U.S. Department of Transportation, Washington, DC. Annual.
   a. Table MF-24

3. International Snowmobile Industry Association, 7535 Little River Turnpike, Suite 330, Annandale, VA.

4. *American Housing Survey, Current Housing Reports, Series H-150-83*. Bureau of the Census, U.S. Department of Commerce, Washington DC. Biennial.

5. *Survey of Current Business*. Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC.

6. *19xx Motorcycle Statistical Annual*. Motorcycle Industry Council, Inc., Costa Mesa, CA. Annual.

7. *Annual Energy Review*. DOE/EIA-0384(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table Entitled, “Petroleum Products Supplied to the Transportation Sector, Electric Utilities, and Total, 1949-19xx.”

8. *Energy Data Report*. DOE/EIA-0109(80/12). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, “Comparative Supply of Disposition Statistics.”

9. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table Entitled, “U.S. Supply, Disposition, and Ending Stocks of Crude Oil and Petroleum Products, 19xx.”

10. *Control Techniques for Lead Air Emissions, Volumes 1 and 2*. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1977.

11. Gray, C.L. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. “Transmittal of Revised Lead Mobile Source Emission Factors.” Internal Memorandum to D. Tyler.

12. *Motor Gasolines*. National Institute for Petroleum and Energy Research, IIT Research Institute, Barltesville, OK. Summer 1987 and Summer 1990.

13. *Locating and Estimating Air Emissions from Sources of Lead and Lead Compounds.* Draft Report. U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1996.

SECTION 6.0
NATIONAL CRITERIA POLLUTANT ESTIMATES PROJECTIONS METHODOLOGY

6.1 INTRODUCTION

The general approach for developing the projections estimates involved using the 1995 emissions estimates as the base year and applying growth factors and control efficiencies, as appropriate. The following sections describe the specific procedures used for each section of the inventory: nonutility point sources; utilities; area sources; highway mobile sources; and non-road mobile sources.

6.2 NONUTILITY POINT SOURCE PROJECTIONS

6.2.1 Growth Factors

U.S. Environmental Protection Agency (EPA) guidance for projecting emissions lists the following economic variables (in order of preference) for projecting emissions:[1]

- product output
- value added
- earnings
- employment

In the absence of product output projections, EPA guidance recommends value added projections. *Value added* is the difference between the value of industry outputs and inputs. U.S. Department of Commerce Bureau of Economic Analysis (BEA) gross state product (GSP) projections represent a measure of value added and are a fuller measure of growth than BEA's earnings projections because earnings represent only one component of GSP. GSP measures reflect the value added to revenue from selling a product minus the amounts paid for inputs from other firms. By incorporating inputs to production, GSP reflects future changes in production processes, efficiency, and technological changes. BEA's GSP projections are available by state at the 2-digit Standard Industrial Classification (SIC) code level.[2]

Growth factors were developed for each projection year and each 2-digit SIC from BEA GSP data for the base year (1995) and the projection years, using the following equation:

$$GF_y = (GSP_y)/(GSP_{95})$$

where:
- GF_y = growth factor for year *y*
- GSP_y = gross state product for year *y*
- GSP_{95} = gross state product for base year 1995

A file containing the growth factors used to develop Trends emission projections can be found on the following EPA Web page: http://www.epa.gov/ttn/chief/ei_data.html.

6.2.2 Control Assumptions/Factors

Controls applied to the projected emissions are those mandated under the Clean Air Act Amendments of 1990 (CAAA). CAAA provisions affecting nonutility industrial point sources include:

- National volatile organic compound (VOC) rules
- Benzene national emission standards for hazardous air pollutants (NESHAPs)
- Title III 2-year and 4-year maximum achievable control technology (MACT) standards
- VOC and oxides of nitrogen (NO_x) reasonably available control technology (RACT) requirements in ozone nonattainment areas
- New Control Techniques Guidelines (CTGs)
- Ozone rate-of-progress requirements

Controls assumed for each pollutant to project emissions are described in the following sections.

6.2.2.1 VOC Controls

Control measures for VOC include RACT, new CTGs, and Title III MACT controls. The stringency of the Title III MACT standard is based on draft or final standards where available. The promulgation and compliance dates for the 2-year and 4-year MACT standards are listed in table 6.2-1. For other sources, emission standards (expressed as percentage reductions in emissions) are based on technology transfer from other categories and engineering judgement. Title III MACT controls are generally as stringent, or more stringent, than RACT controls and are thus the dominant control option for many source categories. VOC control efficiencies are summarized in table 6.2-2. A 100 percent rule effectiveness (RE) is assumed for all control measures.

The Trends projections estimates **do not** include the following provisions which could further reduce VOC emissions in ozone nonattainment areas:

- Ozone nonattainment areas and the northeast ozone transport region (OTR) are subject to offset requirements for major new source growth and major modifications.

- Areas must attain the ozone standard by deadlines set according to their nonattainment classification. The mix of VOC and NO_x reductions chosen as the attainment strategy is determined through Urban Airshed Modeling. These reduction requirements are area-specific and are unknown for many areas at this time.

6.2.2.2 NO_x Controls

Industrial point source NO_x controls include NO_x RACT. Major stationary source NO_x emitters in marginal and above nonattainment areas and in the northeast OTR are required to install RACT-level controls under the ozone nonattainment related provisions of Title I. RACT control levels are specified by each state. Representative RACT levels were chosen for each source type (see table 6.2-3) in order to model the reductions associated with this requirement. These control levels were based on EPA Alternative Control Techniques documents (ACTs) and an assumed RE of 100 percent. Note that NO_x

RACT was already implemented by 1996 for all nonattainment areas except Louisville, Kentucky. NO_x RACT controls in Louisville were modeled in 1996 and beyond.

6.2.2.3 CO, SO_2, and PM Controls

No CO controls were applied to the projected emissions, although some CO nonattainment areas may have adopted controls for specific point sources within the nonattainment areas. Sulfur dioxide (SO_2) nonattainment provisions of the CAA do not specify any mandatory controls for SO_2 emitters, although individual states or nonattainment areas may require further controls. No SO_2 controls were applied to the Trends projected emissions. Possible control initiatives for particulates under the CAAA would result from the Title I provisions related to particulate matter less than 10 microns in diameter (PM-10) nonattainment. Because review of the draft SIPs available indicate that the controls are mainly targeting area source emitters, no PM controls were applied to the projected emissions.

6.2.3 Other Issues

An emission cap of 5.6 million tons of SO_2 per year was set by the CAAA for industrial sources. If this cap is exceeded, the Administrator may promulgate new regulations. To reflect improved fuel efficiency for combustion sources, adjustments were made to the projected industrial, commercial/ institutional and residential combustion emissions. The adjustments to industrial emissions projections are described below. Similar adjustments were made to the commercial/institutional and residential emissions projections and are described in section 6.2.3.2.

6.2.3.1 Industrial Emissions Adjustments

Adjustments were made to the projected emissions for combustion sources in the industrial sector by assuming increases in fuel efficiencies for future years. Efficiency adjustment factors (EAFs) were developed from data on energy consumption per unit output from the U.S. Department of Energy (DOE) publication *Annual Energy Outlook 1997*.[4] Using 1995 as the base year, the EAFs were calculated for each fuel (e.g., natural gas, steam coal, residual fuel, etc.) as the ratio between the base year consumption per unit output and the projection year consumption per unit output, as shown below:

$$EAF_y = C_y / C_{95}$$

where:

EAF_y	=	efficiency adjustment factor for projection year *y*
C_y	=	consumption per unit output for projection year *y*
C_{95}	=	consumption per unit output for base year 1995

Table 6.2-4 shows the industrial sector EAFs calculated for each fuel for each projection year.

Source classification codes (SCCs) for the industrial sector were identified from the Tier categories and each SCC was assigned to one of the fuel categories. These assignments were performed electronically for most SCCs, however, some assignment had to be performed manually for certain SCCs.

Appropriate EAFs were applied to growth-factor based emissions projections for all pollutants for each SCC to develop the revised emissions projections. Note that no adjustments were made to the electricity fuel sector.

6.2.3.2 Commercial/Institutional and Residential Emission Adjustments

Adjustments were made to the projected emissions for combustion sources in the commercial/ institutional and residential sectors by assuming increases in fuel efficiencies for future years. Efficiency adjustment factors (EAFs) were developed from data on energy consumption by fuel type and square footage obtained from the DOE publication *Annual Energy Outlook 1997*.[1] It was assumed that fuel efficiency increases if square footage increases and fuel consumption decreases. Consumption factors (CFs) were developed for each fuel for each year by multiplying the square footage (total floor space for commercial/institutional and average house square footage for residential) by the delivered energy consumption by fuel.

Using 1995 as the base year, the EAFs were calculated for each fuel (e.g., natural gas, coal, etc.) as the ratio between the base year CF and the projection year CF, as shown below:

$$EAF_y = CF_y / CF_{95}$$

where: EAF_y = efficiency adjustment factor for projection year *y*
CF_y = consumption factor for projection year *y*
CF_{95} = consumption factor for base year 1995

Table 6.2-5 shows the commercial/institutional and residential sector EAFs calculated for each fuel for each projection year.

SCCs for the commercial/institutional and residential sectors were identified from the Tier categories and each SCC was assigned to one of the fuel categories. These assignments were performed electronically for most SCCs, however, some assignments had to be performed manually for certain SCCs. Appropriate EAFs were applied to the growth factor based emissions projections for all pollutants for each SCC to develop the revised emissions projections. Note that no adjustments were made to the electricity fuel sector.

6.2.4 References

1. *Procedures for Preparing Emissions Projections*, EPA-450/4-91-019, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1991.

2. *Regional State Projections of Economic Activity and Population to 2045*, U.S. Department of Commerce, Bureau of Economic Analysis, Washington, DC, July 1995.

3. *National Air Quality and Emissions Trends Report, 1995*, EPA-454/R-96-005, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, July 1996.

4. *Annual Energy Outlook 1997 with Projections to 2015*, DOE/EIA-0383(97), U.S. Department of Energy, Energy Information Administration, Washington, DC, December 1996.

Table 6.2-1. Compliance Dates for Promulgated 2-Year and 4-Year MACT Standards[3]

Source Category	Promulgation Date	Compliance Date
2-Year Standards:		
Hazardous Organic National Emission Standards for Hazardous Air Pollutants (NESHAP) (HON)	February 1994	October 1994
Commercial (point/area) and Industrial Dry-cleaning	September 1993	December 1993
4-Year Standards:		
Aerospace Industries	July 1995	September 1998
Chromic Acid Anodizing (point/area)	November 1994	January 1996
Coke Ovens: Charging, Top Side, & Door Leaks	October 1993	November 1993
Commercial Sterilization Facilities (point/area)	November 1994	December 1997
Decorative and Hard Chromium Electroplating (point/area)	November 1994	January 1996
Gasoline Distribution-Stage I	November 1994	December 1997
Halogenated Solvent Cleaners (point/area)	November 1994	December 1997
Industrial Process Cooling Towers	July 1994	March 1996
Magnetic Tapes (Surface Coating)	November 1994	December 1996
Marine Vessel Loading	July 1995	September 1999
Off-site Waste Operations	May 1996	July 1999
Petroleum Refineries - other sources not distinctly listed	July 1995	August 1998
Polymers/Resins Group I	July 1996	July 1999
Polymers/Resins Group II	February 1995	March 1998
Polymers/Resins Group IV	May 1996	September 1999
Printing/Publishing (Surface Coating)	May 1996	May 1999
Secondary Lead Smelting (point)	May 1995	June 1997
Shipbuilding and Ship Repair (Surface Coatings)	November 1995	December 1997
Wood Furniture	November 1995	November 1997

Table 6.2-2. Point Source VOC Controls

Source Category	VOC Control Efficiency (%)
National Rules	
Marine vessel loading: petroleum liquids	80
TSDFs	96
Benzene NESHAP (national)	
By-product coke mfg	85
By-product coke - flushing-liquor circulation tank	95
By-product coke - excess-ammonia liquor tank	98
By-product coke mfg. - tar storage	98
By-product coke mfg. - light oil sump	98
By-product coke mfg. - light oil dec/cond vents	98
By-product coke mfg. - tar bottom final cooler	81
By-product coke mfg. - naphthalene processing	100
By-product coke mfg. - equipment leaks	83
By-product coke manufacture - other	94
By-product coke manufacture - oven charging	94
Coke ovens - door and topside leaks	94
Coke oven by-product plants	94
2-Year MACT (national)	
Synthetic Organic Chemical Manufacturing Industry (SOCMI) HON	
– SOCMI processes	79
– VOL storage	95
– SOCMI fugitives (equipment leak detection and repair)	60
– SOCMI wastewater	0
– Ethylene oxide manufacture	98
– Phenol manufacture	98
– Acrylonitrile manufacture	98
– Polypropylene manufacture	98
– Polyethylene manufacture	98
– Ethylene manufacture	98
Dry Cleaning	
– Perchloroethylene	95
– Other	70
4-Year MACT (national)*	
TSDFs (offsite waste operations)	96
Shipbuilding and repair	24
Polymers and resins II	78
Polymers and resins IV	70
Styrene-butadiene rubber manufacture (polymers & resins group I)	70
Wood furniture surface coating	30
Aircraft surface coating (aerospace)	60

Table 6.2-2 (continued)

Source Category	VOC Control Efficiency (%)
Petroleum Refineries: other sources	
– Fixed roof petroleum product tanks	98
– Fixed roof gasoline tanks	96
– External floating roof petroleum product tanks	90
– External floating roof gasoline tanks	95
– Petroleum refinery wastewater treatment	72
– Petroleum refinery fugitives	72
– Petroleum refineries - Blowdown w/o control	78
– Vacuum distillation	72
Halogenated Solvent Cleaners	
– Open top degreasing - halogenated	63
– In-line (conveyorized) degreasing - halogenated	39
Printing	
– Flexographic	32
– Gravure	27
Gasoline Marketing	
– Storage	5
– Splash loading	99
– Balanced loading	87
– Submerged loading	99
– Transit	5
– Leaks	39
7/10-Year MACT (national)	
Paint and varnish manufacture	35
Rubber tire manufacture	70
Green tire spray	90
Automobile surface coating	79
Beverage can surface coating	57
Paper surface coating	78
Flatwood surface coating	90
Fabric printing	80
Metal surface coating	90
Plastic parts surface coating	45
Pulp and paper production	70
Agricultural chemical production	79
Pharmaceutical production	79
Polyesters	70
Fabric coating	70
Petroleum refineries - fluid catalytic cracking	70
Oil and natural gas production	90
Explosives	70

Table 6.2-2 (continued)

Source Category	VOC Control Efficiency (%)
Plywood/particle board	70
Reinforced plastics	70
7/10-Year MACT (national) (continued)	
Publicly-owned treatment works (POTWs)	70
Phthalate plasticizers	70
Polymers and resins III	78
Rayon production	70
Polyvinyl chloride	70
Spandex production	70
Nylon 6 production	70
Alkyd resins	70
Polyester resins	70
Chelating agents	70
New CTGs (moderate and above)	
SOCMI reactor	85
SOCMI distillation	85
Printing - lithographic	44
Non-CTG and Group III CTG RACT (moderate and above)**	
Carbon black manufacture	90
Whiskey fermentation - aging	85
Charcoal manufacturing	80
Cold cleaning	63
Bakeries	95
Urea resins - general	90
Organic acids manufacture	90
Leather products	90
CTG RACT (marginal and above)**	
Terephthalic acid manufacture	98
Cellulose acetate manufacture	54
Vegetable oil manufacture	42
Dry cleaning - stoddard	70
Stage I - splash unloading	95
Stage I - submerged unloading	95
Open top degreasing	42
In-line (conveyorized) degreasing	42
Petroleum refineries - blowdown	98

NOTE(S): *Compliance dates for 2- and 4-year MACT standards are listed by source category in 6.2-2.
**RACT controls are effective in 1995 or 1996, depending on the geographic area.

Table 6.2-3. NO_x Nonutility Point Source RACT Controls*

Source Category	Control Strategy	NO_x Percentage Reduction
ICI Boilers - Coal	LNB	50
ICI Boilers - Residual Oil	LNB	50
ICI Boilers - Distillate Oil	LNB	50
ICI Boilers - Natural Gas	LNB	50
ICI Boilers - Wood/Bark	None	0
ICI Boilers - Cyclone	NGR	53
ICI Boilers - Stoker	SNCR	55
Internal Combustion Engines - Oil	IR	25
Internal Combustion Engines - Gas	AF + IR	30
Gas Turbines - Oil	Water Injection	68
Gas Turbines - Natural Gas	LNB	84
Process Heaters - Distillate Oil	ULNB	74
Process Heaters - Residual Oil	ULNB	73
Process Heaters - Natural Gas	ULNB	75
Adipic Acid Manufacturing	Thermal Reduction	81
Nitric Acid Manufacturing	Extended Absorption	95
Glass Manufacturing - Container	LNB	40
Glass Manufacturing - Flat	LNB	40
Glass Manufacturing - Pressed/Blown	LNB	40
Cement Manufacturing - Dry	Mid-Kiln Firing	25
Cement Manufacturing - Wet	Mid-Kiln Firing	25
Iron & Steel Mills - Reheating	LNB	66
Iron & Steel Mills - Annealing	LNB	50
Iron & Steel Mills - Galvanizing	LNB	50
Municipal Waste Combustors	SNCR	45
Medical Waste Incinerators	SNCR	45
Open Burning	None	0

LNB = Low NO_x burners
LNC2 = Low NO_x burners plus overfire air
NGR = Natural gas reburning
SNCR = Selective noncatalytic reduction
IR = Ignition timing retardation
AF = Air/Fuel adjustment
ULNB = Ultra-low NO_x burners

NOTE: *RACT controls are effective in 1995 or 1996, depending on the geographic area.

Table 6.2-4. EAFs for Industrial Sector

RATIO CODE	NAME	1999	2000	2002	2005	2007	2008	2010
SC	Steam Coal - Industrial	0.977	0.977	0.953	0.907	0.884	0.884	0.860
RO	Residual Oil - Industrial	0.667	0.778	0.778	0.778	0.778	0.667	0.667
DO	Distillate Oil - Industrial	1.000	1.000	1.000	0.968	0.935	0.935	0.935
NG	Natural Gas - Industrial	0.976	0.970	0.943	0.902	0.879	0.868	0.845
RE	Renewables (hydroelectric, wood, wood waste, solid waste) - Industrial	0.979	0.979	0.979	0.979	0.957	0.957	0.957
MCC	Metallurgical Coal and Coke - Industrial	0.880	0.840	0.760	0.680	0.640	0.640	0.600
OP	Other Petroleum (pet. Coke, asphalt, road oil, lubricants, gasoline) - Industrial	0.991	0.973	0.945	0.900	0.873	0.864	0.836
LP	LPG - Industrial	0.927	0.909	0.909	0.873	0.836	0.836	0.818

Table 6.2-5. EAFs for Commercial and Residential Sector

RATIO CODE	NAME	1999	2000	2002	2005	2007	2008	2010
RDO	Distillate Oil - Residential	0.937	0.913	0.857	0.803	0.773	0.763	0.727
RNG	Natural Gas - Residential	1.005	0.995	0.973	0.949	0.933	0.930	0.916
RRE	Renewables (Wood) - Residential	0.949	0.935	0.895	0.860	0.823	0.813	0.795
ROF	Other Fuels (kerosene and coal) - Residential	0.876	0.863	0.841	0.741	0.722	0.713	0.697
RLP	LPG - Residential	0.996	1.005	0.979	0.963	0.939	0.948	0.927
CDO	Distillate Oil - Commercial	0.866	0.859	0.821	0.801	0.766	0.760	0.748
CNG	Natural Gas - Commercial	1.017	1.012	1.003	0.993	0.988	0.983	0.981
CRE	Renewables (Wood) - Commercial	1.000	1.000	1.000	1.000	1.000	1.000	1.000
COF	Other Fuels (kerosene, coal, lpg, residual fuel oil) - Commercial	0.850	0.870	0.855	0.834	0.846	0.840	0.826

6.3 UTILITY PROJECTIONS

6.3.1 Existing Unit Projections

Electric utility generation projections were based on the 1995 Trends utility database. This file was summed to the boiler level and compared to generation data found on DOE, Energy Information Administration (EIA) Forms 759[1] and 767[2] to find one-to-one boiler to generator matches. Where these matches were found, generation data were taken from Form 767 and where a one-to-one correspondence was not available, a heat input (MMBtu) boiler to plant, fuel type ratio was established for use in allocating Form 759 plant level/fuel type generation to the boilers.

Heat input of the base file was totaled to the fuel/plant level and a boiler to plant level ratio was calculated for each point. The base file was then mapped by plant to the Form 759 plant level generation file and the boiler/plant ratio was multiplied by the Form 759 generation data to estimate boiler generation allocation.

Additionally, boilers were mapped into the Form 767 file and when a one-to-one boiler to generator correspondence was determined, the Form 767 generation value was used. Only in cases where plant level generation was positive and where boiler level generation was zero *or* where a one-to-one boiler to generator correspondence was not established was the Form 759 generation allocation used. The noted exception occurred at Warrick (ORIS 6705). The baseline file for this plant showed it had several boilers in the inventory base year. However, only Boiler 4 was determined to have operated during this period. The additional boilers were therefore eliminated from the file.

Once base year generation was established for each of the inventory's boilers, an operating profile type was associated based on the calculated capacity utilization factor. This factor was calculated at the boiler level using the following equation:

Capacity Factor Utilization = Generation (GW-hr)/[Boiler Capacity (MW) x 8.76]

where: 8.76 is the product of the 8,760 operating hours per year and the 10^{-3} factor converting MW to GW.

Previously, historical capacity utilization factors were used to estimate utility profiles, however, because generation data were available for the operating years 1990 and 1995, only the actual operating data for that year (1995) were used. Within each profile, a maximum change in capacity factor was established (as part of the Ozone Transport Assessment Group [OTAG] process and used in ERCAM-NO_x) to estimate future year fuel use, emissions, and generation for each unit. Table 6.3-1 presents the profile types and their associated maximum change in capacity factors.

Total projected generation from these existing units was compared to NERC region-fuel generation demands and new units were brought on-line or capacity utilization at existing units was decreased in order to meet total generation.

6.3.2 Planned Units

Listings of electric utility units expected to begin operation over the next 10 years are published annually by the DOE.[3] Available unit-specific data for these planned units include the unit's location, capacity, primary fuel type, and expected year of startup. These data were downloaded from the DOE's web site and converted to dBase format.

In most cases, the planned unit data include the county that the unit is expected to be sited in. For these units, latitude and longitude coordinates were assigned to planned units corresponding to the centroid of the county listed for the unit. Planned units without a county designation were sited as described below for siting generic units. The following additional unit parameters were assigned to planned units.

	Coal-Fired Units	Oil-Fired Units	Gas-Fired Units
Heat Rate (Btu/kWh)	10,070	9,680	9,680
Capacity Utilization Factor	0.90	0.20	0.90

6.3.3 Generic Units

Additional generation capacity, above that which is expected to be provided by existing and planned utility units, will be needed in projection years to meet electricity demand. This generation demand is assumed to be filled by units termed "generic units." Generic units were created in the utility data base to meet the generation demands in the projection years that will not be met by existing and planned units. Generic units are essentially place-holders used to account for emissions caused by the generation of electricity expected to be needed in each state beyond the generation that will be provided by existing and planned units.

Total generation demand is projected by DOE by region and fuel type. These generation forecasts are also broken down by utility generation and nonutility generation. Table 6.3-2 presents these generation forecasts by NERC region and fuel type. The procedure used to estimate the unmet generation in the projection years is described below.

- Generation from the electric utility units existing in the 1995 Trends inventory and the known planned units was estimated for the projection years by multiplying the 1995 generation at these units by the ratio of the future capacity factor (calculated as discussed above) to the 1995 capacity factor. Units projected to retire in the future have a future year capacity factor of 0.

- The 1995 generation from the fossil-fuel fired utility units included in the Trends inventory were totaled by state and fuel type and by federal DOE region and fuel type.

- The DOE regional/fuel type generation projections for 1990, 2000, and 2010 were interpolated to give generation estimates by region and fuel type for 1996, 1999, 2005, 2007, and 2008.
- The projected generation from the existing and planned units at the regional/fuel level was subtracted from the corresponding generation demand projection to give the generation requirement that would need to be filled by generic units.

- Generation from generic units at the regional/fuel level was allocated at the state/fuel level based on the fraction of each state's generation for a specific fuel type in the specific projection year out of the total generation for that fuel in that region for the specific projection year.

- The total generic generation needed for a state was divided into individual generic combined cycle (CC) and combustion turbine (CT) units with assumed capacities of 200 MW for oil, 450 MW for gas, and 500 MW for coal units. Other characteristics of generic units were assumed to be the same as those listed above for planned units.

Combined cycle and combustion turbine plants have proven to be superior in terms of low emissions, improved heat rates, low cost, load flexibility, and are showing increasing use in the electric generating sector. As a result of these trends, it was assumed that generic units would shift to CCs (oil) and CTs (natural gas), rather than coal-fired boilers.

The generic units were sited at existing fossil-fuel fired plant sites. When possible, generic units were not sited in nonattainment areas. Because of the large number of generic units in some states and the limited number of existing plant sites to choose from, a hierarchy was developed for siting the generic units. First, in attainment areas only, generic units were sited to replace units scheduled to retire by the projection year. Second, generic units were sited at plant sites that were constructed in 1970 or later. New utility units generally tend to be added to sites with other relatively new units, rather than with older units. Third, if necessary, generic units were sited at plant sites older than 1970. If additional generic units remained to be sited after all available existing sites in attainment areas were filled, the above hierarchy was repeated using sites in nonattainment areas.

6.3.4 Control Assumptions

Both NO_x and SO_2 controls were applied to the utility projections.

6.3.4.1 NO_x Controls

Controlled NO_x emissions at electric utility units were estimated by applying ERCAM-NO_x control strategies to meet emission rate limits. Emission rates for certain coal-fired boiler types are specified in the CAAA's Title IV. Additional rates for units required to apply RACT controls under Title I are specified in the NO_x Supplement to the Title I General Preamble. These include emission rate limits for oil- and gas-fired boilers. New units sited in nonattainment areas or the OTR are subject to NSR and, therefore, more stringent emission limits. The control limits applied encompass controls specified by Title I, Title IV, the Ozone Transport Commission's memorandum of understanding (MOU) Phase II limits, and New Source Performance Standard (NSPS) NO_x regulations.

Existing units located in ozone nonattainment areas or located within the OTR may be subject to Title I requirements which include RACT for electric generating units.

Under Title IV, coal-fired boilers are subject to certain NO_x emission rate limits based on their bottom and firing types. No limits have been established for Group II boilers, however, actual emission rate data from EPA's Acid Rain Division were used. Table 6.3-3 presents NO_x emission rate limits for Group I and II boilers as modeled. Some oil and gas plants were also subject to emission rate limit requirements and the limits modeled in this study are included in this table. Title IV limits are applied to boilers in ozone nonattainment areas, boilers in the OTR if unit level emissions exceed 100 tons NO_x per year, and to any Phase I unit.

In 1994, the OTR's MOU was signed by 10 northeastern states and the District of Columbia, which required NO_x controls beyond RACT on major sources (in some states). Beginning in 1999, major sources located within the OTR's inner corridor are required to reduce NO_x emissions to either 0.20 lbs/MMBtu or achieve a 65 percent reduction from 1990 baseline levels, as specified in the Phase II round of control. Outer region units are required to reduce emissions to either the 0.20 lbs/MMBtu or a 55 percent emission reduction under this plan. These reductions were modeled in projection year emission estimates.

6.3.4.2 SO_2 Controls

The electric utility SO_2 reductions were developed using B2-SO2, a system built on the AIRCOST system, which was used extensively to analyze proposed utility SO_2 controls leading up to Title IV of the CAAA. B2-SO2 develops least cost control measures at the unit/boiler level to meet a target emissions reduction tonnage input by the user.

National reductions were developed from pre-control estimates of plant emissions and Title IV Phase I and II emissions targets as shown below.

Year	SO_2 Emission Target (kilotons/year)	SO_2 National Reduction Requirement
1999	11,060	2,730
2000	10,216	3,610
2002	10,329	3,512
2005	10,442	3,311
2007	10,295	3,551
2008	10,148	3,367
2010	10,002	3,453

Candidate SO_2 controls were developed for each of the coal burning units in the data file which showed high enough SO_2 emissions to make controls cost-effective. Three types of controls were possible: (1) coal fuel switching; (2) wet flue gas desulfurization (FGD); and (3) 100 percent natural gas conversion by coal plants.

Costs of the fuel switching control options were estimated using the most recent DOE data on cost and quality of fuel at electricity utility plants (FERC Form 423 for 1993, 1994, and 1995).[4] The FGD options were estimated using engineering cost parameters in a format similar to the Electric Power Research Technology (EPRI) Technology Assessment Guide approach, with cost parameters updated to reflect the most recent information on costs. Capital costs for FGD were developed from the results of IAPCS model for standardized units. Operating and maintenance (O&M) cost parameters were based on experience with six retrofit scrubbers as outlined in a recent paper by DOE.[5] Finally, state-level cost adjustment factors were applied, varying from 85 to 118 percent, representing regional differences in construction costs.

While the actual cost factors for wet scrubbing are rather complex, the algorithm results in the following costs for a 90 percent removal scrubber on a 500 megawatt unit:

Capital recovery factor	0.11 (11 percent per year)
Capital	154.26 $/kW (1995 dollars)
O&M (total fixed + variable)	1.93 mils/kWh

The percentage reduction for the FGD options is a user-stipulated variable. However, it was found that the maximum, 97 percent, was the least cost removal level, and was selected for all of the FGD units the model built.

The cost fuel switching module applied different costs and modeling approaches for bituminous as opposed to sub-bituminous coals. Fuel switching "down-rank," from bituminous to sub-bituminous, was modeled separately.

All candidate unit control options are input to a data file and sorted by increasing incremental cost per ton of SO_2 removed. The model then selects options for each unit up to the level at which total reductions just exceed the desired target reduction tonnage. The most expensive option selected for the each boiler (if any) by this procedure is the control reported for the unit.

The B2-SO2 system is applied to all units, excluding those known to be retiring prior to the scenario date. The files include known planned start-ups, and "generic" units required to meet generation forecasts by fuel type. However, the planned and generic units will not normally be controlled, since they must meet the Phase II standards, and any further reductions are typically found to be uneconomic.

6.3.5 Other Issues

6.3.5.1 Particulate Matter Emissions

When fuel switching control options are applied to utility boilers to control SO_2 emissions, PM emissions change, depending on the fuel type and quality. Percent ash content of fuel was found to directly influence the amount of PM emitted by a boiler. For this reason, ash content algorithms were established to estimate the percent ash content in fuels chosen by the SO_2 reduction model. In conjunction with reported percent ash content in the Trends baseline file, new percent ash content values were directly ratioed to calculate new PM emission levels. This was done for both PM-10 and for every boiler where fuel switching occurred.

6.3.6 References

1. *Form 759*, U.S. Department of Energy, Energy Information Administration, Washington, DC.

2. *Form 767*, U.S. Department of Energy, Energy Information Administration, Washington, DC.

3. *Supplement to the Annual Energy Outlook 1997,* U.S. Department of Energy, Energy Information Administration, Washington, DC, electronic download, 1997.

4. *Form 423*, U.S. Department of Energy, Washington, DC, electronic download, 1997.

5. *The Effects of Title IV of the Clean Air Act Amendments of 1990 on Electric Utilities: An Update*, DOE/EIA-0582(97), U.S. Department of Energy, Washington, DC, March 1997.

Table 6.3-1. Profile Types and Maximum Change in Capacity Factors

Historical Average Capacity Factor	Profile Type	Maximum Change in Capacity Factor
>90%	Base	No change
78 - 90%	Base with moderate turndown	Increase capacity factor to 90%
66 - 77%	Base with significant turndown	Increase capacity factor to 77%
47 - 65%	Intermediate	Increase capacity factor to 65%
20 - 46%	Peaking with long runtime	Increase capacity factor to 46%
<20%	Peaking with short runtime	No change

Table 6.3-2. Utility Projections by NERC Region and Fuel Type[3] (Generation in Billions of kWh)

Region	Fuel Type	1995	1996	1999	2002	2005	2007	2010
ECAR	Coal	450.36	451.71	477.00	477.26	494.36	514.49	515.09
	Oil	1.56	2.44	1.46	1.44	1.86	2.49	2.47
	Natural Gas	3.62	8.88	8.26	12.85	20.09	25.00	46.47
ERCOT	Coal	93.86	98.23	99.06	104.95	105.04	115.66	117.07
	Oil	2.24	0.59	0.48	0.40	0.43	0.38	0.32
	Natural Gas	80.34	95.70	105.58	111.71	125.07	123.24	133.63
MAAC	Coal	104.45	98.70	103.58	104.34	101.99	106.41	106.35
	Oil	6.40	7.33	4.79	2.38	2.65	2.21	2.19
	Natural Gas	11.29	15.16	32.27	54.60	79.26	76.31	83.43
MAIN	Coal	127.70	131.75	142.19	136.55	121.81	126.31	124.81
	Oil	1.07	1.58	0.78	0.73	0.67	0.84	0.74
	Natural Gas	4.12	10.09	17.04	20.97	54.21	63.30	73.93
MAPP	Coal	108.65	99.98	112.64	117.32	121.84	124.30	124.81
	Oil	0.70	0.89	0.90	1.00	0.88	1.01	1.13
	Natural Gas	1.35	3.63	4.45	5.59	14.05	17.27	24.60
NPCC/NY	Coal	25.84	23.25	24.70	24.37	24.39	26.64	26.95
	Oil	7.86	4.70	6.65	2.18	1.75	2.02	2.39
	Natural Gas	23.43	17.18	18.98	18.85	27.98	31.23	39.34
NPCC/NE	Coal	16.22	16.11	15.49	15.50	15.70	15.70	15.70
	Oil	11.20	9.00	13.37	20.40	20.88	20.84	17.88
	Natural Gas	13.76	15.05	14.95	18.54	23.65	28.65	39.99
SERC/FL	Coal	58.84	60.32	61.61	63.87	67.23	67.61	70.10
	Oil	21.58	22.71	17.47	13.30	14.66	15.11	14.20
	Natural Gas	35.39	28.19	34.90	42.44	52.03	55.85	63.33
SERC	Coal	340.16	342.22	363.05	378.50	396.01	398.45	397.28
	Oil	2.16	5.30	4.33	2.52	3.97	4.36	4.39
	Natural Gas	9.58	13.52	32.68	73.42	83.84	98.63	133.58
SPP	Coal	154.55	159.73	172.28	176.71	177.87	178.03	180.88
	Oil	0.90	0.92	0.45	0.56	0.53	0.54	0.51
	Natural Gas	83.54	74.38	70.24	86.15	103.21	116.09	127.09
WSCC/NWP	Coal	74.07	72.33	82.44	83.92	85.93	85.93	86.37
	Oil	0.11	0.08	0.58	0.69	0.45	1.24	1.35
	Natural Gas	5.73	2.46	26.26	35.12	43.03	51.24	55.12
WSCC/RA	Coal	83.33	89.18	88.94	91.27	93.18	93.08	95.29
	Oil	0.12	0.18	0.18	0.16	0.13	0.13	0.13
	Natural Gas	5.27	11.81	19.90	24.15	32.99	37.02	40.87
WSCC/CNV	Coal	32.51	36.37	35.80	35.52	47.80	62.67	81.07
	Oil	1.37	0.85	1.22	0.96	0.96	0.95	0.89
	Natural Gas	41.38	26.97	53.24	47.72	41.79	36.35	26.49

Table 6.3-3. Title IV or RACT NO_x Emission Rate Limits

	Source Category	NO_x Emission Rate Limit (lbs/MMBtu)*
Coal-Fired Boilers		
	Dry bottom, wall-fired	0.45
**	Dry bottom, wall-fired (Phase I)	0.50
	Dry bottom, tangentially-fired	0.38
**	Dry bottom, tangentially-fired (Phase I)	0.45
	Wet bottom	0.86
	Cyclone	0.94
	Vertically-fired	0.80
	Fluidized bed combustor	0.29
	Cell burner	0.68
	Other	1.00
Oil/Gas-Fired Boilers		
	Wall-fired	0.30
	Tangentially-fired	0.20

* These rates are based on the draft Title IV NO_x rulemaking.
** Group I boilers; all others are Group II.

6.4 AREA SOURCE PROJECTIONS

Area source projections include small stationary sources not included in the point source data base (e.g., dry cleaners, graphic arts, industrial fuel combustion, gasoline marketing, etc.) and solvent use (e.g., consumer solvents, architectural coatings). Highway mobile and non-road mobile are described in sections 6.5 and 6.6, respectively.

6.4.1 Growth Factors

As with the nonutility point sources, area source growth factors were developed for each year and each 2-digit SIC from BEA GSP data for the base year (1995) and projection years. A file containing the growth factors used to develop Trends emission projections can be found on the following EPA Web page: http://www.epa.gov/ttn/chief/ei_data.html.

6.4.2 Control Assumptions/Factors

Controls applied to the projected area source emissions are those mandated under the CAAA and address VOC, NO_x, and PM emissions as described below.

6.4.2.1 VOC Controls

Control measures for VOC include RACT, new CTGs, Stage II vapor recovery, federal consumer solvent controls, and Title III MACT standards. VOC percent reduction and rule effectiveness are summarized in table 6.4-1.

6.4.2.2 NO_x Controls

As with point sources, NO_x RACT had already been implemented in the 1995 emission estimates for every nonattainment area except for the Louisville nonattainment area. NO_x RACT controls were added for Louisville for the projections. Table 6.4-2 shows the area source industrial fuel combustion NO_x RACT penetration rates.

6.4.2.3 PM Controls

For the area source projections, PM controls were implemented in PM nonattainment areas. The controls modeled depend on the severity of PM nonattainment and the level of emissions from source categories for which controls are available. Table 6.4-3 shows the area source PM-10 control measures.

6.4.3 Other Issues

Efficiency adjustment factors were applied to area source fuel combustion sources within the industrial, commercial/institutional, and residential sectors. These factors were calculated using the same procedure used for efficiency adjustment factors for nonutility point sources described in sections 6.2.3.1 and 6.2.3.2.

Table 6.4-1. Area Source VOC Control Measures

Control Measure	VOC Percentage Reduction	VOC Rule Effectiveness
Federal Control Measures (National)		
Consumer Solvents	25	100
Architectural and Industrial Maintenance (AIM) Coatings	25	100
Onboard Refueling Vapor Recovery Systems	*	
Treatment, Storage, and Disposal Facilities	94	100
Municipal Solid Waste Landfills	82	100
Title III MACT (National)		
Wood Furniture Surface Coating	30	100
Aerospace Surface Coating	60	100
Marine Vessel Surface Coating	24	100
Halogenated Solvent Cleaners	63	80
Autobody Refinishing	37	100
Perchloroethylene Dry Cleaning	44	100
Petroleum Refinery Fugitives	78	100
SOCMI Fugitives	60	100
Title I RACT (Ozone NAAs)		
Synthetic Fiber Manufacture	54	80
Pharmaceutical Manufacture	37	80
Petroleum Dry Cleaning	44	80
Bulk Terminals	51	80
Paper Surface Coating	78	80
Oil and Natural Gas Production Fields	37	80
Service Stations - Stage I	95	80
Cutback Asphalt	100	80
New CTGs (Moderate and Above)		
SOCMI Batch Reactor	78	80
Web Offset Lithography	80	80
Stage II Vapor Recovery (Serious and Above, OTR)	*	

*The effects of onboard vapor recovery and Stage II are modeled using MOBILE5a. Because MOBILE5a does not model the phase-in schedule for onboard, a series of runs were performed with different start dates and a weighted gram per gallon emission factor was calculated.

Table 6.4-2. Area Source Industrial Fuel Combustion NO_x RACT Penetration Rates

	NO_x Penetration Rate (%)		
RACT Size Cutoff	Coal	Oil	Gas
Moderate	23	8	11
Serious and Above	45	16	22
LNB Control Efficiencies	21	Residual: 42	31
		Distillate: 36	

Table 6.4-3. Area Source PM-10 Control Measures

Category	Serious	Moderate
Paved Roads	Vacuum sweeping - urban and rural roads - 2 times per month to achieve 79% control level. Penetration factor varies by road type.	Vacuum sweeping - urban roads - 2 times per month to achieve 79% control level. Penetration factor varies by road type.
Unpaved Roads	Pave urban unpaved roads (96% control and 50% penetration). Water rural roads (96% control and 25% penetration)	Pave urban paved roads (96% control and 50% penetration)
Construction	Dust control plan (50% control, 75% penetration)	Dust control plan (50% control, 75% penetration)
Cattle Feedlots	Watering (50% control)	Watering (50% control)
Residential Wood Combustion	Switch to natural gas (44% reduction in 2000, 74% reduction in 2010)	EPA Phase II stoves (41% reduction in 2000, 63% reduction in 2010)
Agricultural Burning	Propane and bale/stack burning (control level varies from 50% to 63 % by state according to the types of crop)	Propane and bale/stack burning (control level varies from 50% to 63% by state according to the types of crop)

6.5 HIGHWAY MOBILE SOURCE PROJECTIONS

This section describes how highway mobile source emissions were projected to future years. Note that this section does not provide guidance for using the MOBILE5b model. MOBILE5b guidance is available in Reference 1.

6.5.1 VMT Projection Methodologies

The 1995 vehicle miles traveled (VMT) data were used as the starting point for calculating the projection year VMT estimates. Growth factors used in the projection year VMT calculations were developed at the Metropolitan Statistical Area (MSA) level by vehicle class. These VMT growth factors were calculated by multiplying national vehicle class growth factors, calculated from national VMT projection data by vehicle type output by EPA's MOBILE4.1 Fuel Consumption Model (FCM),[2] by the ratio of MSA-specific population growth to national population growth. The equation below illustrates how the projection year VMT growth factors were calculated.

$$VMTGF_{PY,VT,M} = \frac{VMT_{PY,VT,US}}{VMT_{95,VT,US}} x \frac{POP_{PY,M}}{POP_{95,M}} x \frac{POP_{95,US}}{POP_{PY,US}}$$

where:

where:	$VMTGF_{PY, VT, M}$	=	1995 to projection year PY growth factor for vehicle type VT and MSA M
	$VMT_{PY, VT, US}$	=	U.S. total projection year VMT for vehicle type VT obtained from the MOBILE4.1 Fuel Consumption Model
	$VMT_{95, VT, US}$	=	U.S. total 1995 VMT for vehicle type VT obtained from the MOBILE4.1 Fuel Consumption Model
	$POP_{PY, M}$	=	Projection year population for MSA M obtained from the BEA population projections
	$POP_{95, M}$	=	1995 population for MSA M obtained from BEA data
	$POP_{95, US}$	=	U.S. total population for 1995 from BEA data
	$POP_{PY, US}$	=	U.S. total population for projection year PY from BEA population projections

An electronic file was developed, containing the resultant VMT growth factors for each projection year by MSA and vehicle type. Due to the vehicle classes used in the FCM, the light-duty gasoline truck (LDGT) 1 and LDGT2 growth factors are identical, and motorcycles are assigned the same growth factors as light-duty gasoline vehicles (LDGVs). Also, in determining these growth factors, heavy-duty diesel vehicles (HDDVs) are treated as a single vehicle class.

A county correspondence file was developed that indicated which counties are included in each MSA and rest-of-state area. Each data point in the 1995 VMT file at the county/vehicle type/road type level was then multiplied by the corresponding VMT growth factor projected at the MSA/vehicle type level for each projection year. These resulting projected annual VMT at the county/roadway type/vehicle type level of detail were then temporally allocated by month. The temporal allocation procedure used the same temporal allocation factors used for the 1995 VMT allocation. Table 6.5-1 summarizes the VMT data for the projection years by vehicle type. State-level VMT totals for the same years are shown in table 6.5-2.

6.5.2 Registration Distribution for Projection Years Used as MOBILE5b Inputs

Due to the uncertainties and shifts in the automobile and truck sales markets, creating projection year registration distributions result in a high degree of uncertainty. Several methodologies were considered for projecting the registration distributions. In consultation with EPA's Office of Mobile Sources (OMS), it was determined that the default MOBILE5b and PART5 registration distributions would provide sufficiently reasonable values to use as the registration distributions for the projection years. However, because the State-provided distributions include valuable information on local trends in fleet turnover, any county modeled with a State-supplied registration distribution in 1995 and 1996 was modeled with the same distribution in the projection years. All other counties were modeled with the MOBILE5b and PART5 registration distribution defaults.

6.5.3 Additional MOBILE5b Inputs

Additional MOBILE5b inputs include Reid vapor pressure (RVP), temperature, speed data, operating mode, altitude, MONTH flag, and control program data. These inputs for the projection years inventories are described in this section.

6.5.3.1 RVP Values

The RVP values calculated for 1996 for all months except May through September were used in all of the projection years. For the months from May through September, the RVP values were replaced with the appropriate Phase II RVP limit, using 8.7 psi in 9.0 psi areas to account for the allowable margin of safety in meeting the RVP limits. Table 6.5-3 lists the RVP modeled by month for all areas in the projection years.

6.5.3.2 Temperature Data

Actual temperature data are not available for the projection years. Also, due to the variability in temperature patterns from year to year, selecting a single historical year's data to model in the projection years would be inappropriate. Therefore, 30-year average temperature data are used in the projection year estimates. The average minimum and maximum daily temperature for each month and state were obtained from the Statistical Abstracts.[3] A single site within each state was chosen to be representative of the temperature conditions within the entire state. As with the temperature data for historical years, California was modeled with two temperature regions. Table 6.5-4 shows the temperatures modeled by state and month in the projection years.

6.5.3.3 Speed Data

The 1990 speeds used for 1995 and 1996 (obtained from the HPMS impact analysis output[4]) were also used for the projection years. Table 6.5-5 presents the average speed used for each road type/vehicle type combination.

6.5.3.4 Operating Mode

The operating mode assumptions of the Federal Test Procedure (FTP) were used for 1995 and 1996 were also used in the projection years MOBILE5b input files.

6.5.3.5 Altitude

The entire states of Colorado, Nevada, New Mexico, and Utah were modeled as high altitude areas for the projection years. All other states were modeled as low altitude areas.

6.5.3.6 MONTH Flag

When modeling months from January through June for the projection years, the MONTH flag within the MOBILE5b input files was set to "1" to simulate January registration distributions. For months from July through December, the flag was set for "2" to model July registration distributions.

6.5.3.7 Additional Inputs from OTAG

In addition to the inputs described above, several additional MOBILE5b inputs (trip length distributions, alcohol fuel market shares, and diesel sales shares) were supplied by the states for the OTAG modeling and were incorporated into the Trends MOBILE5b input files. Specifically, State-supplied trip length distribution data were applied in the 1995, 1996, and in the projection years. Table 6.5-6 summarizes the state-supplied trip length distribution data.

6.5.3.8 Control Program Inputs

6.5.3.8.1 Inspection and Maintenance Programs — The primary sources of data describing inspection and maintenance (I/M) program inputs for the 1999, 2000, and 2002 projection years was the latest OMS I/M program summary sheet.[5] In consultation with OMS, it was agreed that the stringency rate inputs, waiver rate inputs, and compliance rate inputs should be standardized for all areas. Stringency rate were set to 20 percent, waiver rates were set to 3 percent, and compliance rates were set to 96 percent. These rates are consistent with the corresponding rates included in EPA's enhanced I/M performance standard and are by far the most common rates claimed in the modeling demonstrations submitted to EPA by the states. There is very little variance from these rates in state I/M program plans. States may change these rates at some time in the future, but for now they should be considered accurate. The specific inputs modeled for each area's I/M program in 1999, 2000, and 2002 are shown in table 6.5-7. This table also indicates which year or years the inputs were modeled in. Table 6.5-8 shows which counties each set of I/M program inputs were applied to.

For the 2005, 2007, 2008, and 2010 projection years, the area-specific inputs were replaced with the corresponding EPA I/M program performance standards (i.e., it was assumed that any area that is supposed to have enhanced I/M receives full credit for it). EPA's rationale behind this approach is that in that time frame, by whatever means, EPA is assuming I/M programs would improve to the point where higher credits are appropriate. The split between 2002 and 2005 was a semi-arbitrary split between current/near term years and later years. The specific inputs modeled for each of the I/M program performance standards are shown in table 6.5-9. Table 6.5-10 shows which counties each set of I/M program inputs were applied to.

I/M program coverage for the projection years was based on data collected by EPA for OTAG and Section 812 emission projections.[6, 7] During this data collection process, each state was contacted to confirm which counties in that state would be implementing an I/M program. Each state was also asked to indicate which of the EPA I/M program types the program would most closely resemble–high enhanced, low enhanced, basic, or OTR low enhanced. Responses were collected from each state with a planned CAAA I/M program. These data were used in the Trends emission projection calculations by assigned the I/M programs defined in the OMS I/M program summary for a given state to the counties within that state listed as having a projected I/M program.

6.5.3.8.2 Reformulated Gasoline — Table 6.5-11 lists the areas that participated in the federal reformulated gasoline program. The only change in coverage between 1995 and 1996 and the projection years is the addition of the Phoenix, Arizona nonattainment area. This area opted in to the program in 1997 and therefore was modeled with reformulated gasoline in the projection years, but not in 1995 or 1996.

6.5.3.8.3 Oxygenated Fuel — The areas modeled with oxygenated fuel for the projection years were the same as those modeled with oxygenated fuel for 1995 and 1996.

6.5.3.8.4 National Low Emission Vehicle Program — A National Low Emission Vehicle (NLEV) program was modeled in the projection years using EPA's most current (at the time the modeling was performed) assumptions about the characteristics of the proposed NLEV program. This program was modeled as starting in the Northeast Ozone Transport Commission (OTC) states in 1999 and in the remaining (non-California) states in 2001. The implementation schedule of the NLEV program is shown below.

Model Year	Federal Tier I Standards	Transitional LEV Standards	LEV Standards
1999	30%	40%	30%
2000		40%	60%
2001 and later			100%

States in the OTC that had already adopted a LEV program on their own at this time were modeled with the characteristics of the OTC-LEV program until the start date of the NLEV program. These states included Massachusetts, New York, and Connecticut. The programs in Massachusetts and New York began with the 1996 model year. The Connecticut program began with the 1998 model year. The implementation schedule followed by these states prior to 1999 (the start year of the NLEV program) was based on the implementation schedule of the OTC-LEV program, and is shown below. Only the 1998 model year is applicable in Connecticut.

Model Year	Federal Tier I Standards	TLEV Standards	Intermediate LEV Standards	LEV Standards	Intermediate ULEV Standards	ULEV Standards
1996	80%	20%				
1997	73%		25%		2%	
1998	47%			51%		2%

These implementation schedules differ from the MOBILE5b default LEV implementation schedule, which was designed to model the California LEV program. For the model to access the implementation schedule of the NLEV program, the PROMPT flag in the applicable MOBILE5b input files was set to "5" and the name of the file containing the NLEV implementation schedule was entered when prompted by MOBILE5b. In addition to setting the PROMPT flag, the REGION flag was set to "4" to properly model the NLEV program in the MOBILE5b input files. The setting of "4" for the REGION flag indicates that an additional line is being added to the input file to model a LEV program. The necessary inputs for this additional program line include the start year of the LEV program and whether an "appropriate" I/M program will be implemented in conjunction with the LEV program. The start year of the LEV program was set to "96" for input files modeling Massachusetts and New York, "98" for input files modeling Connecticut, "99" for input files modeling all other states within the OTC (including the Washington, DC nonattainment area portion of Virginia), and "01" for all remaining States (including the remainder of Virginia), except California.

With an "appropriate" I/M program, maximum benefits of the LEV program are modeled by MOBILE5b, implementing a lower set of deterioration rates (DRs). For the modeling projection years 1999, 2000, and 2002, areas implementing an IM240 program were assumed to meet this requirement and were modeled with the maximum LEV program benefits (flag setting of "2"). These I/M programs are identified in table 6.5-8 with an asterisk following the I/M program name. In addition, for the 2005 and later emission projections, all areas modeled with the enhanced I/M program performance standard were modeled with this same setting. All other areas in all projection years were modeled to receive the minimum LEV program benefits (i.e., a flag setting of "1").

The following table shows the emission standards of the Federal Tier 1 program, the transitional LEV (TLEV) standards, the LEV standards, and the Ultra-Low Emission Vehicle (ULEV) standards. These standards apply to the LDGV and LDGT1a classes of vehicles, according to the implementation schedules shown above. The LDGT1b category is also included in the NLEV program, but the emission standards for these vehicles are slightly less stringent than those listed below for the lighter vehicles.

Emission Standard	Nonmethane Organic Gas (NMOG)	CO	NO_x
Federal Tier 1	0.250 grams/mile nonmethane hydrocarbon (NMHC)	3.4 grams/mile	0.40 grams/mile
Transitional LEV (TLEV)	0.125 grams/mile	3.4 grams/mile	0.40 grams/mile
LEV	0.075 grams/mile	3.4 grams/mile	0.20 grams/mile
ULEV	0.040 grams/mile	1.7 grams/mile	0.20 grams/mile

The REGION flag, used to indicate that a LEV program is being modeled in a MOBILE5b input file, is the same flag that is used to indicate that an area is a high altitude area. An area cannot be modeled as being both a high altitude area and having a LEV program simultaneously. Thus, when the NLEV program was modeled for the four high altitude states, the standards modeled for LDGT2s, HDGVs, and all diesel vehicles are those for low altitude areas. To correct this, two sets of input files were created for the high altitude areas for projection years 2002 and beyond. In the first set, the REGION flag was set to "4" and the additional line was added for each scenario to model the NLEV program. In the second set, the REGION flag was set to "2" to model the high altitude standards. The LDGV and LDGT1 emission factors from the first set of files, including the effects of the NLEV program, were then combined with the LDGTs, HDGV, light duty diesel vehicle (LDDV), light duty diesel truck (LDDT), HDDV, and motorcycle (MC) emission factors from the second set of files, which included the effects of the high altitude standards. This was done by replacing the LDGV and LDGT1 emission factors created by the second, or high altitude, set of files with the LDGV and LDGT1 emission factors created by the first, or NLEV, set of files.

6.5.3.8.5 Heavy Duty Diesel Engine Corrections and Controls —

Basic Emission Rate Corrections. The same input corrections for the basic emission rates (BERs) for HDDVs and HDGVs used in the 1995 and 1996 input files were used for the projection year input files. The zero mile level (ZML) and DR inputs are given below.

		NO_x		VOC	
Vehicle Category	Model Year	ZML (g/bhp-hr)	DR (g/bhp-hr/10k mi)	ZML (g/bhp-hr)	DR (g/bhp-hr/10k mi)
HDGV	1998 +	3.19	0.045		
HDGV	1994 +			0.364	0.023
HDDV	1994 - 2003			0.283	0.000

HDDV Controls. EPA has determined that additional reductions in NO_x and NMHC emissions are needed at the national level from heavy duty vehicles. In response, EPA has issued more stringent emission standards for HDDVs starting with the 2004 model year. These standards are found in 40 CFR, 62, No. 203, 54694-54730, October 21, 1997. This new standard, referred to as the HDDV 2.0 g/bhp-hr NO_x standard, is not incorporated in MOBILE5b. To simulate the effects of the new HDDV standard, BERs for heavy-duty diesel vehicles were input to MOBILE5b, as shown below. This input line was included in the projection year files for 2005 and beyond, for both low and high altitude areas. These input files also included the heavy-duty vehicle (HDV) BER corrections as documented above. As with the files that only included the BER corrections, NEWFLG was set to "2."

Vehicle Category	Model Year	NO_x ZML (g/bhp-hr)	NO_x DR (g/bhp-hr/10k mi)	VOC ZML (g/bhp-hr)	VOC DR (g/bhp-hr/10k mi)
HDDV	2004 +	1.84	0.000	0.257	0.000

6.5.3.8.6 California-specific Inputs — Because California's highway vehicle fleet has been subject to different emission standards than the rest of the county, an EPA-modified version of MOBILE5a, referred to as CALI5, was used for California. Input files used with this model are essentially identical to MOBILE5a input files, and the model internally handles the different emission standards.

Phase II of California's reformulated gasoline program began on June 1, 1996. This was modeled by setting the reformulated gasoline flag to "5" starting with the June 1996 scenarios in the CALI5 input files and in all of the projection year files. The RVP value modeled for California in all projection years was 7.0 psi, following EPA guidance.

California's low emission vehicle program began in 1994. This was modeled in the CALI5 input files indicating a start year of 1994 for this program and minimum LEV credits. Because MOBILE5a did not include LDGT2s in the LEV modeling, this was carried forward to CALI5. However, California's LEV program does include LDGT2s. To model the LDGT2s in the LEV program, additional BER input lines were added to model the ZML and DR of the California LEV program standard for LDGT2s. Two sets of BERs were developed–one modeling the maximum LEV benefits for LDGT2s and the other modeling the minimum benefits. The maximum LEV benefits were applied in areas modeled with the high enhanced I/M program beginning in 2005. Table 6.5-12 shows the ZMLs and DRs modeled for both areas.

6.5.4 Additional PART5 Model Inputs

The HDDV VMT splits used in 1995 and 1996 were also used for the projection years. In addition, the values developed for the average number of wheels per vehicle per vehicle class were used for all years, including the projection years.

6.5.5 Calculation of Highway Vehicle Emission Inventories

Emissions from highway vehicles were calculated the same way (multiplying the appropriate emission factors by the corresponding VMT values) for all years, including the projection years.

6.5.6 References

1. *MOBILE5b Users Manual*, U.S. Environmental Protection Agency, Office of Mobile Sources, Ann Arbor, MI.

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

3. *Statistical Abstract of the United States - 1993*, U.S. Department of Commerce, Bureau of the Census, Washington, DC, 1994.

4. *Highway Performance Monitoring System Field Manual*, U.S. Department of Transportation, Federal Highway Administration, Washington, DC, December 1987.

5. *Major Modeling Elements for Operating I/M Programs*, table provided by Joseph Somers, U.S. Environmental Protection Agency, Office of Mobile Sources, to E.H. Pechan & Associates, Inc., February 25, 1997.

6. *Ozone Transport Assessment Group (OTAG) Emission Inventory Development Report–Volume III: Projections and Controls*, Draft report prepared by E.H. Pechan & Associates, Inc., for the U.S. Environmental Protection Agency, Research Triangle Park, NC, June 1997.

7. *Emission Projections for the Clean Air Act Section 812 Prospective Analysis*, External draft report prepared by E.H. Pechan & Associates, Inc., for Industrial Economics, Inc., Cambridge, MA, February 1997.

Table 6.5-1. National Annual Highway Vehicle VMT Projections by Vehicle Type

Vehicle Type	National Annual Highway Vehicle VMT Projections (million miles/year)						
	1999	**2000**	**2002**	**2005**	**2007**	**2008**	**2010**
LDGV	1,720,746	1,750,598	1,809,586	1,901,018	1,963,516	1,995,184	2,059,873
LDGT1	451,510	465,153	491,886	531,881	558,639	572,088	599,170
LDGT2	230,022	236,973	250,592	270,967	284,599	291,450	305,248
HDGV	57,188	58,881	62,357	67,627	71,539	73,547	77,537
LDDV	7,970	5,983	3,529	2,107	678	463	65
LDDT	2,931	2,569	2,028	1,753	1,427	1,327	1,264
HDDV	154,067	159,931	171,272	188,361	199,580	205,211	216,487
2B HDDV	*191*	*198*	*213*	*233*	*248*	*256*	*270*
Light HDDV	*4,049*	*4,203*	*4,502*	*4,951*	*5,246*	*5,395*	*5,692*
Medium HDDV	*15,646*	*16,241*	*17,393*	*19,128*	*20,267*	*20,840*	*21,985*
Heavy HDDV	*126,374*	*131,184*	*140,484*	*154,504*	*163,704*	*168,320*	*177,569*
Buses	*7,808*	*8,105*	*8,680*	*9,546*	*10,114*	*10,400*	*10,972*
MC	11,281	11,476	11,862	12,460	12,868	13,076	13,499
TOTAL	***2,422,820***	***2,691,564***	***2,803,112***	***2,976,174***	***3,092,846***	***3,152,346***	***3,273,141***

Table 6.5-2. Annual State VMT Totals by Year (million miles/year)

State	1995	1999	2000	2002	2005	2007	2008	2010
Alabama	50,628	54,366	55,342	57,342	60,408	62,557	63,663	65,874
Alaska	4,121	4,531	4,638	4,845	5,169	5,376	5,480	5,695
Arizona	39,653	44,759	46,100	48,637	52,591	55,188	56,522	59,235
Arkansas	26,653	28,946	29,541	30,725	32,550	33,786	34,427	35,704
California	276,372	304,433	311,847	326,719	349,935	365,126	372,854	388,693
Colorado	35,059	39,045	40,086	42,116	45,288	48,401	48,474	50,672
Connecticut	28,043	29,969	30,483	31,620	33,372	34,592	35,210	36,454
Delaware	7,517	8,201	8,383	8,731	9,274	9,641	9,829	10,212
DC	3,467	3,805	3,896	4,077	4,356	4,546	4,642	4,838
Florida	127,809	142,451	147,558	155,709	168,402	176,919	181,271	190,143
Georgia	85,384	94,812	97,288	102,031	109,442	114,430	116,957	122,143
Hawaii	7,945	8,636	8,816	9,178	9,742	10,122	10,315	10,711
Idaho	12,297	13,696	14,063	14,718	15,735	16,406	16,743	17,436
Illinois	94,189	101,036	102,847	106,583	112,439	116,339	118,353	122,367
Indiana	64,551	69,136	70,334	72,786	76,570	79,206	80,544	83,254
Iowa	25,986	27,673	28,107	29,041	30,481	31,465	31,969	32,985
Kansas	25,152	27,252	27,801	28,877	30,530	31,645	32,209	33,362
Kentucky	41,095	44,047	44,816	46,420	48,884	50,600	51,468	53,218
Louisiana	38,647	41,494	42,246	43,779	46,156	47,751	48,570	50,212
Maine	12,590	13,554	13,804	14,358	15,208	15,790	16,089	16,693
Maryland	44,881	48,812	49,837	51,907	55,101	57,268	58,363	60,606
Massachusetts	48,054	51,484	52,403	54,334	57,306	59,376	60,407	62,536
Michigan	85,702	90,695	91,988	94,707	98,878	101,810	103,298	106,314
Minnesota	44,072	47,907	48,906	50,888	53,936	55,966	57,000	59,083
Mississippi	29,558	31,803	32,383	33,540	35,317	36,546	37,166	38,421
Missouri	59,347	64,007	65,222	67,713	71,568	74,175	75,512	78,211
Montana	9,440	10,392	10,639	11,114	11,853	12,339	12,590	13,094
Nebraska	15,808	17,086	17,412	18,072	19,088	19,772	20,121	20,822
Nevada	13,974	16,239	16,832	17,954	19,702	20,858	21,451	22,657
New Hampshire	10,643	11,509	11,738	12,207	12,928	13,424	13,673	14,185
New Jersey	61,013	65,465	66,633	68,986	72,629	75,103	76,370	78,932
New Mexico	21,149	23,615	24,265	25,514	27,466	28,754	29,412	30,752
New York	115,091	121,278	122,919	126,199	131,250	134,739	136,501	140,085
North Carolina	76,054	83,957	86,034	89,991	96,136	100,321	102,464	106,815
North Dakota	6,545	6,991	7,108	7,342	7,701	7,949	8,074	8,328
Ohio	100,788	107,151	108,831	112,240	17,499	121,143	123,024	126,769
Oklahoma	38,490	41,622	42,446	44,055	46,550	48,249	49,111	50,865
Oregon	30,034	33,144	33,955	35,562	38,055	39,710	40,548	42,256
Pennsylvania	94,518	100,641	102,206	1055,545	110,671	114,280	116,115	119,828
Rhode Island	6,894	7,332	7,443	7,698	8,098	8,371	8,516	8,803
South Carolina	38,722	42,371	43,329	45,266	48,273	50,297	51,340	53,440
South Dakota	7,668	8,388	8,576	8,948	9,530	9,913	10,112	10,506
Tennessee	56,213	61,530	62,920	65,559	69,667	72,454	73,870	76,742
Texas	181,096	199,555	204,410	213,615	227,923	237,359	242,198	252,007
Utah	18,781	21,249	21,903	23,179	25,180	26,474	27,144	28,493
Vermont	6,206	6,788	6,939	7,245	7,716	8,035	8,199	8,528
Virginia	69,811	75,784	77,357	80,599	85,615	89,082	90,839	94,403
Washington	49,248	54,652	56,073	59,005	63,582	66,614	68,151	71,312
West Virginia	17,422	18,493	18,772	19,341	20,210	20,836	21,162	21,813
Wisconsin	51,396	55,304	56,307	58,420	61,678	63,902	65,030	67,326
Wyoming	7,045	7,628	7,784	8,080	8,538	8,843	8,996	9,309
Total	***2,422,820***	***2,635,715***	***2,691,564***	***2,803,112***	***2,976,174***	***3,092,846***	***3,152,346***	***3,273,141***

Table 6.5-3. Monthly RVP Values Modeled in Projection Years (in psi)

State	Nonattainment Area or Other Applicable Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AL	Birmingham	12.4	12.4	9.5	9.5	7.8	7.8	7.8	7.8	7.8	9.5	9.5	12.4
AL	Rest of State	12.4	12.4	9.5	9.5	8.7	8.7	8.7	8.7	8.7	9.5	9.5	12.4
AK	Entire State	14.1	14.1	14.1	14.1	9.5	9.5	9.5	9.5	9.5	14.1	14.1	14.1
AZ	Phoenix	8.7	7.9	7.2	7.2	7.8	7.8	7.8	7.8	7.8	6.8	7.2	7.9
AZ	Rest of State	8.7	7.9	7.2	7.2	8.7	8.7	8.7	8.7	8.7	6.8	7.2	7.9
AR	Entire State	13.7	13.7	9.8	9.8	8.7	8.7	8.7	8.7	8.7	9.8	13.7	13.7
CA	Entire State	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
CO	Entire State	13.2	12.1	10.7	10.7	8.7	8.7	8.7	8.7	8.7	9.6	10.7	12.1
CT	Entire State	13.0	13.0	10.8	10.8	8.7	8.7	8.7	8.7	8.7	10.8	10.8	13.0
DE	Entire State	13.5	13.5	11.1	11.1	8.7	8.7	8.7	8.7	8.7	7.9	11.1	13.5
DC	Entire State	12.8	10.3	10.3	7.0	7.8	7.8	7.8	7.8	7.8	7.0	10.3	12.8
FL	Miami-Ft Laud-W Plm Bea	11.8	11.8	7.4	7.4	7.8	7.8	7.8	7.8	7.8	7.4	7.4	11.8
FL	Tampa-St Petersbg-Clrwtr	11.8	11.8	7.4	7.4	7.8	7.8	7.8	7.8	7.8	7.4	7.4	11.8
FL	Rest of State	11.8	11.8	7.4	7.4	8.7	8.7	8.7	8.7	8.7	7.4	7.4	11.8
GA	Atlanta	12.4	12.4	9.4	9.4	7.8	7.8	7.8	7.8	7.8	9.4	9.4	12.4
GA	Rest of State	12.4	12.4	9.4	9.4	8.7	8.7	8.7	8.7	8.7	9.4	9.4	12.4
HI	Entire State	10.0	10.0	10.0	10.0	9.5	9.5	9.5	9.5	9.5	10.0	10.0	10.0
ID	Entire State	13.9	12.3	12.3	10.2	8.7	8.7	8.7	8.7	8.7	8.6	10.2	12.3
IL	Entire State	14.1	14.1	11.4	11.4	8.7	8.7	8.7	8.7	8.7	7.8	11.4	14.1
IN	Entire State	14.5	14.5	12.0	12.0	8.7	8.7	8.7	8.7	8.7	8.7	12.0	14.5
IA	Entire State	14.9	14.9	13.3	11.2	8.7	8.7	8.7	8.7	8.7	11.2	13.3	14.9
KS	Entire State	14.0	12.1	9.5	9.5	8.7	8.7	8.7	8.7	8.7	7.6	9.5	12.1
KY	Entire State	14.2	11.7	11.7	8.4	8.7	8.7	8.7	8.7	8.7	8.4	11.7	14.2
LA	Baton Rouge	12.4	12.4	9.6	9.6	7.8	7.8	7.8	7.8	7.8	9.6	9.6	12.4
LA	Lake Charles	12.4	12.4	9.6	9.6	7.8	7.8	7.8	7.8	7.8	9.6	9.6	12.4
LA	Rest of State	12.4	12.4	9.6	9.6	8.7	8.7	8.7	8.7	8.7	9.6	9.6	12.4
ME	Entire State	13.2	13.2	11.0	11.0	8.7	8.7	87.7	8.7	8.7	11.0	1.0	13.2
MD	Baltimore	13.2	13.2	10.8	10.8	7.8	7.8	7.8	7.8	7.8	7.5	10.8	13.2
MD	Phila-Wilmington-Trenton	13.2	13.2	10.8	10.8	7.8	7.8	7.8	7.8	7.8	7.5	10.8	13.2
MD	Washington DC	13.2	13.2	10.8	10.8	7.8	7.8	7.8	7.8	7.8	7.5	10.8	13.2
MD	Kent & Queen Anne Cos	13.2	13.2	10.8	10.8	7.8	7.8	7.8	7.8	7.8	7.5	10.8	13.2
MD	Rest of State	13.2	13.2	10.8	10.8	8.7	8.7	8.7	8.7	8.7	7.5	10.8	13.2
MA	Entire State	12.9	12.9	10.7	10.7	8.7	8.7	8.7	8.7	8.7	10.7	10.7	12.9
MI	Entire State	14.1	14.1	11.2	11.2	8.7	8.7	8.7	8.7	8.7	11.2	11.2	14.1
MN	Entire State	14.9	14.9	12.6	12.6	8.7	8.7	8.7	8.7	8.7	9.6	12.6	14.9
MS	Entire State	13.7	13.7	9.8	9.8	8.7	8.7	8.7	8.7	8.7	9.8	9.8	13.7
MO	St. Louis	13.9	11.9	11.9	9.2	7.8	7.8	7.8	7.8	7.8	9.2	11.9	11.9
MO	Rest of State	13.9	11.9	11.9	9.2	8.7	8.7	8.7	8.7	8.7	9.2	11.9	11.9
MT	Entire State	13.8	13.8	12.3	10.2	8.7	8.7	8.7	8.7	8.7	10.2	12.3	13.8
NE	Entire State	14.5	14.5	12.7	10.4	8.7	8.7	8.7	8.7	8.7	8.6	10.4	12.7
NV	Reno	10.5	9.2	8.2	8.2	7.8	7.8	7.8	7.8	7.8	7.6	8.2	9.2
NV	Rest of State	10.5	9.2	8.2	8.2	8.7	8.7	8.7	8.7	8.7	7.6	8.2	9.2
NH	Entire State	12.9	12.9	10.7	10.7	8.7	8.7	8.7	8.7	8.7	10.7	10.7	12.9
NJ	Entire State	13.7	13.7	11.3	11.3	8.7	8.7	8.7	8.7	8.7	11.3	11.3	13.7
NM	Entire State	11.7	11.7	10.2	9.1	8.7	8.7	8.7	8.7	8.7	9.1	10.2	11.7
NY	Entire State	14.3	14.3	11.9	11.9	8.7	8.7	8.7	8.7	8.7	11.9	11.9	14.3
NC	Charlotte-Gastonia	12.4	12.4	12.4	9.4	7.8	7.8	7.8	7.8	7.8	9.4	12.4	12.4
NC	Greensboro	12.4	12.4	12.4	9.4	7.8	7.8	7.8	7.8	7.8	9.4	12.4	12.4
NC	Raleigh-Durham	12.4	12.4	12.4	9.4	7.8	7.8	7.8	7.8	7.8	9.4	12.4	12.4
NC	Rest of State	12.4	12.4	12.4	9.4	8.7	8.7	8.7	8.7	8.7	9.4	12.4	12.4
ND	Entire State	14.9	14.9	13.3	13.3	8.7	8.7	8.7	8.7	8.7	11.2	13.3	14.9
OH	Entire State	14.6	14.6	12.1	12.1	8.7	8.7	8.7	8.7	8.7	8.7	12.1	14.6
OK	Entire State	13.9	13.9	10.1	10.1	8.7	8.7	8.7	8.7	8.7	7.2	10.1	13.9
OR	Portland-Vancouver	13.1	10.8	10.8	10.8	7.8	7.8	7.8	7.8	7.8	7.7	10.8	13.1
OR	Rest of State	13.1	10.8	10.8	10.8	8.7	8.7	8.7	8.7	8.7	7.7	10.8	13.1

Table 6.5-3 (continued)

State	Nonattainment Area or Other Applicable Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PA	Entire State	14.4	14.4	12.0	12.0	8.7	8.7	8.7	8.7	8.7	12.0	12.0	14.4
RI	Entire State	12.9	12.9	10.7	10.7	8.7	8.7	8.7	8.7	8.7	10.7	10.7	12.9
SC	Cherokee Co SC	12.4	12.4	12.4	9.4	7.8	7.8	7.8	7.8	7.8	9.4	12.4	12.4
SC	Rest of State	12.4	12.4	12.4	9.4	8.7	8.7	8.7	8.7	8.7	9.4	12.4	12.4
SD	Entire State	14.9	14.9	13.3	11.2	8.7	8.7	8.7	8.7	8.7	9.6	11.2	13.3
TN	Knoxville	12.7	12.7	12.7	9.5	7.8	7.8	7.8	7.8	7.8	9.5	12.7	12.7
TN	Memphis	12.7	12.7	12.7	9.5	7.8	7.8	7.8	7.8	7.8	9.5	12.7	12.7
TN	Nashville	12.7	12.7	12.7	9.5	7.8	7.8	7.8	7.8	7.8	9.5	12.7	12.7
TN	Rest of State	12.7	12.7	12.7	9.5	8.7	8.7	8.7	8.7	8.7	9.5	12.7	12.7
TX	Beaumont-Port Arthur	12.2	12.2	10.0	10.0	7.8	7.8	7.8	7.8	7.8	8.3	10.0	12.2
TX	Dallas-Fort Worth	12.2	12.2	10.0	10.0	7.8	7.8	7.8	7.8	7.8	8.3	10.0	12.2
TX	El Paso	12.2	12.2	10.0	10.0	7.8	7.8	7.8	7.8	7.8	8.3	10.0	12.2
TX	Houstn-Galvestn-Brazonia	12.2	12.2	10.0	10.0	7.8	7.8	7.8	7.8	7.8	8.3	10.0	12.2
TX	Rest of State	12.2	12.2	10.0	10.0	8.7	8.7	8.7	8.7	8.7	8.3	10.0	12.2
UT	Salt Lake City	13.2	12.1	12.1	10.7	7.8	7.8	7.8	7.8	7.8	9.6	10.7	12.1
UT	Rest of State	13.2	12.1	12.1	10.7	8.7	8.7	8.7	8.7	8.7	9.6	10.7	12.1
VT	Entire State	14.9	14.9	12.6	12.6	8.7	8.7	8.7	8.7	8.7	12.6	12.6	14.9
VA	Norfolk-Virginia	12.6	10.2	10.2	7.1	7.8	7.8	7.8	7.8	7.8	7.1	10.2	12.6
VA	Richmond-Petersburg	12.6	10.2	10.2	7.1	7.8	7.8	7.8	7.8	7.8	7.1	10.2	12.6
VA	Washington DC	12.6	10.2	10.2	7.1	7.8	7.8	7.8	7.8	7.8	7.1	10.2	12.6
VA	Smyth Co VA	12.6	10.2	10.2	7.1	7.8	7.8	7.8	7.8	7.8	7.1	10.2	12.6
VA	Rest of State	12.6	10.2	10.2	7.1	8.7	8.7	8.7	8.7	8.7	7.1	10.2	12.6
WA	Entire State	14.0	14.0	11.6	11.6	8.7	8.7	8.7	8.7	8.7	8.5	11.6	14.0
WV	Entire State	14.6	14.6	12.1	12.1	8.7	8.7	8.7	8.7	8.7	8.8	12.1	14.6
WI	Entire State	14.6	14.6	12.2	12.2	8.7	8.7	8.7	8.7	8.7	9.0	12.2	14.6
WY	Entire State	13.5	13.5	12.1	10.2	8.7	8.7	8.7	8.7	8.7	8.8	10.2	12.1

Table 6.5-4. Projection Year Monthly Temperature Inputs (F)

	January			February			March			April			May			June		
State	**Max**	**Min**	**Ambient**	**Max**	**Min**	**Ambient**	**Max**	**Min**	**Ambient**	**Max**	**Min**	**Ambient**	**Max**	**Min**	**Ambient**	**Max**	**Min**	**Ambient**
Alabama	60	40	49.9	64	43	53.2	71	50	60.5	78	57	67.8	85	64	74.5	90	71	80.4
Alaska	29	19	24.2	34	23	28.4	39	27	32.7	47	32	39.7	55	39	47.0	61	45	53.0
Arizona	66	41	53.6	71	45	57.7	76	49	62.2	84	55	69.9	94	64	78.8	104	73	88.2
Arkansas	49	29	39.1	54	33	43.6	64	42	53.1	73	51	62.1	81	59	70.2	89	67	78.4
California (LA)	66	48	56.8	66	49	57.6	66	50	58.0	67	53	60.1	69	56	62.7	72	60	65.7
California (SF)	56	42	48.7	59	45	52.2	61	46	53.3	64	47	55.6	66	50	58.1	70	53	61.5
Colorado	43	16	29.7	47	20	33.4	52	26	39.0	62	34	48.2	71	44	57.2	81	52	66.9
Connecticut	33	16	24.5	36	19	27.5	47	28	37.5	60	38	48.7	72	48	59.6	80	57	68.5
Delaware	39	22	30.6	42	25	33.4	52	33	42.6	63	42	52.2	73	52	62.6	81	62	71.5
DC	42	27	34.6	46	29	37.5	56	38	47.1	67	46	56.6	76	57	66.4	85	66	75.6
Florida	75	59	67.2	76	60	68.5	79	64	71.7	82	68	75.1	85	72	78.7	88	75	81.4
Georgia	50	32	41.0	55	34	44.8	64	42	53.4	73	50	61.5	80	59	69.2	86	66	76.0
Hawaii	80	66	72.9	80	65	73.0	82	67	74.4	83	69	75.8	85	70	77.5	86	72	79.4
Idaho	36	22	29.0	44	28	35.9	53	32	42.4	61	37	49.1	71	44	57.5	81	52	66.5
Illinois	29	13	21.0	34	17	25.4	46	28	37.2	59	39	48.6	70	48	58.9	80	58	68.6
Indiana	34	17	25.5	38	21	29.6	51	32	41.4	63	42	52.4	74	52	62.8	83	61	71.9
Iowa	28	11	19.4	34	16	24.7	47	28	37.3	62	40	50.9	73	52	62.3	82	61	71.7
Kansas	40	19	29.5	46	24	34.8	57	34	45.4	68	44	56.4	77	54	65.6	87	65	75.7
Kentucky	40	23	31.8	45	26	35.7	56	36	46.3	67	45	56.4	76	55	65.4	84	63	73.2
Louisiana	61	42	51.3	64	44	54.3	72	52	61.6	78	58	68.5	84	65	74.8	89	71	80.0
Maine	30	11	20.9	33	14	23.3	41	24	33.0	52	34	43.2	63	43	53.3	73	52	62.4
Maryland	40	23	31.8	44	26	34.8	54	34	44.1	64	42	53.4	74	53	63.4	83	62	72.5
Massachusetts	36	22	28.7	38	23	30.3	46	31	38.6	56	40	48.1	67	50	58.2	76	59	67.7
Michigan	30	16	23.0	33	18	25.5	44	27	35.7	58	37	47.3	70	47	58.4	79	56	67.6
Minnesota	21	3	11.8	27	9	17.9	39	23	31.0	56	36	46.4	69	48	58.5	79	58	68.2
Mississippi	56	33	44.2	60	36	47.9	69	44	56.7	77	52	64.7	84	60	72.0	91	67	78.9
Missouri	35	17	25.7	41	22	31.2	53	33	42.7	65	44	54.5	74	54	64.1	83	63	73.2
Montana	31	12	21.1	38	17	27.4	44	23	33.3	55	32	43.6	65	41	53.1	75	49	61.6
Nebraska	31	11	21.1	37	17	26.9	49	28	38.6	64	40	51.9	74	51	62.5	84	60	72.1
Nevada	45	21	32.9	52	24	38.0	56	29	42.8	64	33	48.5	73	40	56.5	83	47	65.0
New Hampshire	30	7	18.6	33	10	21.7	43	22	32.5	56	32	43.9	69	41	55.2	77	51	64.3
New Jersey	40	21	30.9	42	24	33.0	52	31	41.5	61	39	50.0	71	50	60.4	80	59	69.4
New Mexico	47	22	34.3	54	26	40.0	61	32	46.8	71	40	55.2	80	49	64.2	90	58	74.2
New York	38	25	31.5	40	27	33.6	50	35	42.4	61	44	52.5	72	54	62.7	80	63	71.6
North Carolina	49	29	38.9	53	31	42.0	62	39	50.4	72	46	59.0	79	55	67.0	85	64	74.3
North Dakota	20	0	9.3	26	5	15.8	38	18	28.2	55	31	43.0	68	42	55.0	77	52	64.4

Table 6.5-4 (continued)

	January			February			March			April			May			June		
State	**Max**	**Min**	**Ambient**	**Max**	**Min**	**Ambient**	**Max**	**Min**	**Ambient**	**Max**	**Min**	**Ambient**	**Max**	**Min**	**Ambient**	**Max**	**Min**	**Ambient**
Ohio	34	18	26.3	38	21	29.6	50	31	40.9	62	40	51.0	72	50	61.2	80	58	69.2
Oklahoma	47	25	36.0	52	30	40.9	62	38	50.3	72	49	60.4	79	58	68.4	87	66	76.7
Oregon	45	11	28.4	51	14	32.3	56	24	40.3	61	34	47.4	67	43	55.3	74	52	63.1
Pennsylvania	38	23	30.4	41	25	32.9	52	33	42.4	63	42	52.4	73	53	62.9	82	62	71.8
Rhode Island	37	19	27.9	38	21	29.6	46	29	37.5	57	38	47.4	67	47	57.3	77	57	66.9
South Carolina	55	32	43.7	59	34	46.8	68	42	55.2	76	49	63.0	84	58	70.9	89	66	77.4
South Dakota	24	3	13.8	30	10	19.7	42	23	32.5	59	35	46.9	71	46	58.3	80	56	68.3
Tennessee	46	26	36.2	51	30	40.4	61	39	50.2	71	48	59.2	79	57	67.7	86	65	75.6
Texas	54	33	43.4	59	37	47.9	68	46	56.7	76	55	65.5	83	63	72.8	92	70	81.0
Utah	36	19	27.9	44	25	34.1	52	31	41.8	61	38	49.6	72	46	58.8	83	55	69.1
Vermont	25	8	16.3	28	9	18.2	39	22	30.7	54	34	43.9	67	45	56.3	76	55	65.2
Virginia	46	26	35.7	49	28	38.7	60	36	47.9	70	45	57.3	78	54	66.0	85	63	73.9
Washington	45	35	40.1	50	37	43.5	53	38	45.6	57	41	49.2	64	46	55.1	70	52	60.9
West Virginia	41	23	32.1	45	26	35.5	57	35	45.9	67	43	54.8	76	52	63.5	83	60	71.5
Wisconsin	26	12	18.9	30	16	23.0	40	26	33.3	53	36	44.4	64	45	54.6	75	55	65.0
Wyoming	38	15	26.5	40	18	29.3	45	22	33.5	55	30	42.4	65	39	52.0	74	48	61.4

Table 6.5-4 (continued)

	July			August			September			October			November			December		
State	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient
Alabama	91	73	82.3	90	73	81.7	87	69	77.8	80	57	68.4	70	49	59.7	63	43	53.0
Alaska	64	48	56.0	63	47	55.0	56	43	49.4	47	37	42.2	37	27	32.0	32	23	27.1
Arizona	106	81	93.5	104	79	91.5	98	73	85.6	88	61	74.5	75	49	61.9	66	42	54.0
Arkansas	92	72	82.0	91	70	80.6	85	64	74.1	75	51	63.0	63	42	52.1	52	33	42.8
California (LA)	75	63	69.1	77	64	70.4	77	63	69.9	74	59	66.8	70	53	61.6	66	48	56.9
California (SF)	72	54	62.8	72	55	63.7	74	55	64.4	70	52	61.0	62	47	54.8	56	43	49.4
Colorado	88	59	73.4	86	57	71.4	77	48	62.3	66	36	51.4	52	25	39.0	44	17	31.0
Connecticut	85	62	73.6	83	60	71.6	75	52	63.3	64	41	52.2	51	33	41.9	38	21	29.4
Delaware	86	67	76.4	84	66	75.0	78	58	68.0	67	46	56.2	56	37	46.3	44	28	35.8
DC	88	71	80.0	87	70	78.5	80	62	71.3	69	50	59.7	58	41	49.7	47	32	39.4
Florida	89	76	82.6	89	77	82.9	88	76	81.9	84	72	78.3	80	67	73.6	77	62	69.1
Georgia	88	70	78.8	87	69	78.1	82	64	72.7	73	52	62.3	63	43	53.1	54	35	44.5
Hawaii	88	74	80.5	89	74	81.5	88	74	81.0	87	72	79.6	84	70	77.2	81	67	74.1
Idaho	90	58	74.0	88	57	72.5	77	48	62.6	65	39	51.8	49	31	39.9	38	22	30.1
Illinois	84	63	73.2	82	62	71.7	75	54	64.4	63	42	52.8	48	32	40.0	34	19	26.6
Indiana	86	65	75.4	84	63	73.2	78	56	66.6	66	44	54.7	52	34	43.0	38	23	30.9
Iowa	87	66	76.6	84	64	73.9	76	54	65.1	64	43	53.5	48	30	39.0	33	16	24.4
Kansas	93	70	81.4	91	68	79.3	81	59	70.3	71	47	58.6	55	34	44.6	43	23	33.0
Kentucky	87	67	77.2	86	66	75.8	80	59	69.5	69	46	57.5	57	37	47.1	45	29	36.9
Louisiana	91	73	81.9	90	73	81.5	87	70	78.1	79	59	69.1	71	51	61.1	64	45	54.6
Maine	79	58	68.6	77	57	67.3	69	49	59.1	59	38	48.5	47	30	38.7	35	18	26.5
Maryland	87	67	77.0	85	66	75.6	78	58	68.5	67	46	56.6	56	37	46.8	45	28	36.7
Massachusetts	82	65	73.5	80	64	71.9	73	57	64.8	63	47	54.8	52	38	45.3	40	27	33.6
Michigan	83	61	72.3	81	60	70.5	74	52	63.2	62	41	51.2	48	32	40.2	35	21	28.3
Minnesota	84	63	73.6	81	60	70.5	71	50	60.5	59	39	48.8	41	25	33.1	26	10	17.9
Mississippi	92	70	81.5	92	70	80.9	88	64	75.9	79	50	64.7	69	42	55.8	60	36	47.8
Missouri	89	68	78.5	86	66	76.1	78	57	67.5	68	46	56.6	53	34	43.1	39	22	30.4
Montana	83	53	68.3	82	52	66.9	70	44	56.6	59	36	47.6	44	24	33.9	33	15	23.9
Nebraska	88	66	76.9	85	63	74.1	76	54	65.1	66	41	53.4	49	29	39.0	35	16	25.1
Nevada	92	51	71.6	90	50	69.6	80	41	60.4	69	33	50.8	54	27	40.3	46	20	32.7
New Hampshire	82	56	69.5	80	55	67.3	72	46	58.8	61	35	47.8	47	27	37.1	34	14	24.3
New Jersey	84	65	74.7	83	64	73.4	77	56	66.1	66	44	54.9	56	36	45.8	45	26	35.8
New Mexico	92	64	78.5	89	63	75.8	82	55	68.6	71	43	57.0	57	31	44.3	48	23	35.3
New York	85	68	76.8	84	67	75.5	76	60	68.2	65	50	57.5	54	41	47.6	42	31	36.6
North Carolina	88	68	78.1	87	68	77.2	81	61	71.1	72	48	60.0	63	40	51.2	53	32	42.6
North Dakota	84	56	70.4	83	54	68.3	71	43	57.0	59	32	45.6	39	18	28.6	24	3	13.9

Table 6.5-4 (continued)

	July			August			September			October			November			December		
State	**Max**	**Min**	**Ambient**	**Max**	**Min**	**Ambient**	**Max**	**Min**	**Ambient**	**Max**	**Min**	**Ambient**	**Max**	**Min**	**Ambient**	**Max**	**Min**	**Ambient**
Ohio	84	63	73.2	82	61	71.5	76	55	65.5	64	43	53.7	51	34	42.9	39	25	31.9
Oklahoma	93	71	82.0	92	70	81.1	84	62	73.0	74	50	62.0	60	39	49.5	50	29	39.3
Oregon	80	58	69.1	80	57	68.7	75	49	61.8	64	38	51.2	53	30	41.5	46	18	31.7
Pennsylvania	86	67	76.7	85	66	75.5	78	59	68.2	66	46	56.4	55	38	46.4	43	28	35.8
Rhode Island	82	63	72.7	81	62	71.3	74	54	64.1	64	43	53.6	53	35	44.0	41	24	32.8
South Carolina	92	70	80.8	90	69	79.7	85	63	74.2	76	50	63.2	68	42	54.7	59	35	46.9
South Dakota	86	62	74.3	83	59	71.4	73	49	60.9	61	36	48.6	43	23	33.0	28	9	18.3
Tennessee	90	69	79.2	88	68	78.1	82	61	71.8	72	48	60.4	60	40	50.0	50	31	40.6
Texas	96	74	85.3	96	74	84.9	88	67	77.4	78	56	67.2	67	45	56.1	58	36	46.9
Utah	92	64	78.0	89	62	75.6	79	51	65.1	66	40	53.2	51	31	40.9	38	22	29.7
Vermont	81	60	70.5	78	58	67.9	69	49	58.9	57	39	47.8	44	30	36.8	30	16	23.0
Virginia	88	68	78.0	87	66	76.8	81	59	70.0	71	46	58.6	61	38	49.6	50	30	40.1
Washington	75	55	65.2	75	56	65.5	69	52	60.6	60	46	52.8	50	40	45.3	45	36	40.5
West Virginia	86	64	75.1	84	63	73.9	79	56	67.7	68	44	56.2	57	36	46.8	46	28	37.0
Wisconsin	80	62	71.0	78	61	69.3	71	53	61.7	59	42	50.3	45	31	37.7	31	18	24.4
Wyoming	82	55	68.4	80	53	66.4	71	44	57.4	60	34	47.0	47	24	35.3	39	17	27.8

Table 6.5-5. Average Speeds by Road Type and Vehicle Type (MPH)

Rural						
	Interstate	Principal Arterial	Minor Arterial	Major Collector	Minor Collector	Local
LDV	60	45	40	35	30	30
LDT	55	45	40	35	30	30
HDV	40	35	30	25	25	25

Urban						
	Interstate	Other Freeways & Expressways	Principal Arterial	Minor Arterial	Collector	Local
LDV	45	45	20	20	20	20
LDT	45	45	20	20	20	20
HDV	35	35	15	15	15	15

Table 6.5-6. State-Supplied Trip Length Distribution Inputs

	Percentage of Total VMT Accumulated in Trips of:					
Nonattainment Area	**< 10 Minutes**	**11 to 20 Minutes**	**21 to 30 Minutes**	**31 to 40 Minutes**	**41 to 50 Minutes**	**> 50 Minutes**
Washington, DC/MD/VA	16.6	33.9	23.4	13.3	6.1	6.7
Baltimore	15.1	31.7	26	13.3	6.5	7.4
Houston	14.8	27.9	22.4	14.3	8.5	12.1
Dallas	9.8	19	23.8	19.4	13.6	14.4

Table 6.5-7. State-Specific I/M Program Inputs - Projection Years

I/M Program Name	AKIM991	AKIM992	AZIM991	AZIM992
I/M Program Control Flag Record				
Technical Training and Certification Program				
Remote Sensing Device Inspections Program				
I/M Program Parameters				
Program Start Year	1986	1986	1978	1978
Model Years Covered	1968-2020	1975-2020	1967-1980	1967-2020
Program Type	TRC	TRC	TO	TO
Inspection Frequency	Biennial	Biennial	Annual	Biennial
Vehicle Types Inspected				
LDGV	YES	YES	YES	YES
LDGT1	YES	YES	YES	YES
LDGT2	YES	YES	YES	YES
HDGV	NO	NO	YES	YES
Test Type	2500/Idle Test	2500/Idle Test	Idle Test	Idle Test
I/M Cutpoints	220/1.2/999	220/1.2/999	220/1.2/999	220/1.2/999
Effectiveness Rates (% HC/CO/NO_x)	0.85/0.85/0.85	0.85/0.85/0.85	1.00/1.00/1.00	1.00/1.00/1.00
I/M Program Parameters				
Program Start Year			1978	
Model Years Covered			1981-2020	
Program Type			TO	
Inspection Frequency			Biennial	
Vehicle Types Inspected				
LDGV			YES	
LDGT1			YES	
LDGT2			YES	
HDGV			YES	
Test Type			Transient Test	
I/M Cutpoints			1.20/20.0/3.00	
Effectiveness Rates (% HC/CO/NO_x)	0.85/0.85/0.85	0.85/0.85/0.85	1.00/1.00/1.00	1.00/1.00/1.00
Anti-Tampering Program Parameters				
Program Start Year	1986	1986	1977	1977
Model Years Covered	1968-2020	1975-2020	1975-2020	1975-2020
Program Type	TRC	TRC	TO	TO
Effectiveness Rate	0.85	0.85	1.00	1.00
Vehicle Types Inspected				
LDGV	YES	YES	YES	YES
LDGT1	YES	YES	YES	YES
LDGT2	YES	YES	YES	YES
HDGV	NO	NO	YES	YES
Inspection Frequency	Biennial	Biennial	Biennial	Biennial
Inspections Performed				
Air Pump System	YES	YES	YES	YES
Catalyst	YES	YES	YES	YES
Fuel Inlet Restrictor	NO	NO	NO	NO
Tailpipe Lead Deposit Test	NO	NO	NO	NO

Table 6.5-8. Counties Included in State-Specific I/M Projection Year Programs

I/M Program Name	Included Counties
AKIM991	Anchorage Ed
AKIM992	Fairbanks Ed
AZIM991	Maricopa Co
AZIM992	Pima Co
CAIM991	Alameda Co, Butte Co, Contra Costa Co, El Dorado Co, Merced Co, Orange Co, Placer Co, Riverside Co, San Bernardino Co, Solano Co, Stanislaus Co, Sutter Co, Yolo Co, Marin Co, Monterey Co, San Mateo Co, Sonoma Co, Fresno Co, Kern Co, Los Angeles Co, Napa Co, Sacramento Co, San Diego Co, San Francisco Co
CAIM992	Colusa Co, Glenn Co, Kings Co, Madera Co, Nevada Co, San Benito Co, San Joaquin Co, Santa Clara Co, Shasta Co, Tehama Co, Tulare Co, Ventura Co, Yuba Co, San Luis Obispo Co, Santa Barbara Co, Santa Cruz Co
COIM991*	Adams Co, Arapahoe Co, Boulder Co, Douglas Co, Jefferson Co, Denver Co
COIM992	Pitkin Co, El Paso Co, Larimer Co, Weld Co
CTIM99	Fairfield Co, Hartford Co, Litchfield Co, Middlesex Co, New Haven Co, New London Co, Tolland Co, Windham Co
DCIM99*	Washington
DEIM991	Kent Co, Sussex Co
DEIM992	New Castle Co
FLIM99	Broward Co, Dade Co, Duval Co, Hillsborough Co, Palm Beach Co, Pinellas Co
GAIM001	Cobb Co, De Kalb Co, Fulton Co, Gwinnett Co
GAIM002	Cherokee Co, Clayton Co, Coweta Co, Douglas Co, Fayette Co, Forsyth Co, Henry Co, Paulding Co, Rockdale Co
GAIM021	Cobb Co, De Kalb Co, Fulton Co, Gwinnett Co
GAIM022	Cherokee Co, Clayton Co, Coweta Co, Douglas Co, Fayette Co, Forsyth Co, Henry Co, Paulding Co, Rockdale Co
GAIM991	Cobb Co, De Kalb Co, Fulton Co, Gwinnett Co
GAIM992	Cherokee Co, Clayton Co, Coweta Co, Douglas Co, Fayette Co, Forsyth Co, Henry Co, Paulding Co, Rockdale Co
IDIM99	Ada Co
ILIM991*	Cook Co, Du Page Co, Lake Co, Madison Co, St. Clair Co
ILIM992*	Kane Co, Kendall Co, McHenry Co, Will Co, Monroe Co
INIM99*	Clark Co, Floyd Co, Lake Co, Porter Co
KYIM991	Boone Co, Campbell Co, Kenton Co
KYIM992	Jefferson Co
KYIM993	Boyd Co, Greenup Co
LAIM99	Ascension Par, East Baton Rouge Par, Iberville Par, Livingston Par, Pointe Coupee Par, West Baton Rouge Par
MAIM99	Barnstable Co, Berkshire Co, Bristol Co, Dukes Co, Essex Co, Franklin Co, Hampden Co, Hampshire Co, Middlesex Co, Nantucket Co, Norfolk Co, Plymouth Co, Suffolk Co, Worcester Co
MDIM001*	Anne Arundel Co, Baltimore Co, Carroll Co, Harford Co, Howard Co, Baltimore, Montgomery Co, Prince Georges Co
MDIM002*	Calvert Co, Cecil Co, Queen Annes Co, Charles Co, Frederick Co, Washington Co

Table 6.5-8 (continued)

I/M Program Name	Included Counties
MDIM021*	Anne Arundel Co, Baltimore Co, Carroll Co, Harford Co, Howard Co, Baltimore, Montgomery Co, Prince Georges Co
MDIM022*	Calvert Co, Cecil Co, Queen Annes Co, Charles Co, Frederick Co, Washington Co
MDIM991*	Anne Arundel Co, Baltimore Co, Carroll Co, Harford Co, Howard Co, Baltimore, Montgomery Co, Prince Georges Co
MDIM992*	Calvert Co, Cecil Co, Queen Annes Co, Charles Co, Frederick Co, Washington Co
MEIM99	Cumberland Co
MNIM00	Anoka Co, Carver Co, Dakota Co, Hennepin Co, Ramsey Co, Scott Co, Washington Co
MNIN02	Anoka Co, Carver Co, Dakota Co, Hennepin Co, Ramsey Co, Scott Co, Washington Co
MNIN99	Anoka Co, Carver Co, Dakota Co, Hennepin Co, Ramsey Co, Scott Co, Washington Co
MOIM02	Jefferson Co, St. Charles Co, St. Louis Co, St. Louis
MOIM99	Jefferson Co, St. Charles Co, St. Louis Co, St. Louis
NCIM991	Mecklenburg Co
NCIM992	Durham Co, Wake Co
NCIM993	Forsyth Co, Guilford Co, Gaston Co
NCIM994	Cabarrus Co, Union Co, Orange Co
NHIM99	Hillsborough Co, Rockingham Co
NJIM99	Atlantic Co, Cape May Co, Warren Co, Burlington Co, Camden Co, Cumberland Co, Gloucester Co, Salem Co, Bergen Co, Essex Co, Hudson Co, Hunterdon Co, Middlesex Co, Monmouth Co, Morris Co, Ocean Co, Passaic Co, Somerset Co, Sussex Co, Union Co, Mercer Co
NMIM99	Bernalillo Co
NVIM99	Clark Co, Washoe Co
NYIM001	Bronx Co, Kings Co, Nassau Co, New York Co, Queens Co, Richmond Co, Rockland Co, Suffolk Co, Westchester Co
NYIM002	Orange Co
NYIM021	Bronx Co, Kings Co, Nassau Co, New York Co, Queens Co, Richmond Co, Rockland Co, Suffolk Co, Westchester Co
NYIM022	Orange Co
NYIM993	Albany Co, Allegany Co, Broome Co, Cattaraugus Co, Cayuga Co, Chautauqua Co, Chemung Co, Chenango Co, Clinton Co, Columbia Co, Cortland Co, Delaware Co, Erie Co, Essex Co, Franklin Co, Fulton Co, Genessee Co, Greene Co, Hamilton Co, Herkimer Co, Jefferson Co, Lewis Co, Livingston Co, Madison Co, Monroe Co, Montgomery Co, Niagara Co, Oneida Co, Onondaga Co, Ontario Co, Orleans Co, Oswego Co, Otsego Co, Rensselaer Co, St. Lawrence Co, Saratoga Co, Schenectady Co, Schoharie Co, Schuyler Co, Seneca Co, Steuben Co, Sullivan Co, Tioga Co, Tompkins Co, Ulster Co, Warren Co, Washington Co, Wayne Co, Wyoming Co, Yates Co, Duchess Co, Putnam Co
OHIM001*	Clermont Co, Geauga Co, Medina Co, Portage Co, Summit Co, Warren Co, Butler Co, Hamilton Co, Lake Co, Lorain Co, Cuyahoga Co
OHIM002*	Clark Co, Greene Co, Montgomery Co
OHIM021*	Clermont Co, Geauga Co, Medina Co, Portage Co, Summit Co, Warren Co, Butler Co, Hamilton Co, Lake Co, Lorain Co, Cuyahoga Co
OHIM022*	Clark Co, Greene Co, Montgomery Co
OHIM991*	Clermont Co, Geauga Co, Medina Co, Portage Co, Summit Co, Warren Co, Butler Co, Hamilton Co, Lake Co, Lorain Co, Cuyahoga Co
OHIM992*	Clark Co, Greene Co, Montgomery Co
ORIM991*	Jackson Co, Josephine Co

Table 6.5-8 (continued)

I/M Program Name	Included Counties
ORIM992*	Clackamas Co, Multnomah Co, Washington Co
PAIM991	Lehigh Co, Northampton Co
PAIM992	Berks Co, Clair Co, Cambria Co, Centre Co, Cumberland Co, Dauphin Co, Lackawanna Co, Lancaster Co, Lebanon Co, Luzerne Co, Lycoming Co, York Co, Erie Co, Mercer Co
PAIM993	Bucks Co, Chester Co, Delaware Co, Montgomery Co, Philadelphia Co
PAIM994	Allegheny Co, Beaver Co, Washington Co, Westmoreland Co
RIIM99	Bristol Co, Kent Co, Newport Co, Providence Co, Washington Co
TNIM991	Davidson Co
TNIM992	Shelby Co
TNIM993	Rutherford Co, Sumner Co, Williamson Co, Wilson Co
TXIM001	Harris Co
TXIM002	Dallas Co, Tarrant Co
TXIM003	El Paso Co
TXIM021	Harris Co
TXIM022	Dallas Co, Tarrant Co
TXIM023	El Paso Co
TXIM991	Harris Co
TXIM992	Dallas Co, Tarrant Co
TXIM993	El Paso Co
UTIM991	Utah Co
UTIM992	Weber Co
UTIM993	Davis Co, Salt Lake Co
VAIM991	Arlington Co, Fairfax Co, Prince William Co, Alexandria, Manassas, Manassas Park, Fairfax, Falls Church
VAIM992	Loudoun Co, Stafford Co
VTIM99	Addison Co, Bennington Co, Caledonia Co, Chittenden Co, Essex Co, Franklin Co, Grand Isle Co, Lamoille Co, Orange Co, Orleans Co, Rutland Co, Washington Co, Windham Co, Windsor Co
WAIM001	King Co, Snohomish Co
WAIM002	Pierce Co, Clark Co
WAIM003	Spokane Co
WAIM021	King Co, Snohomish Co
WAIM022	Pierce Co, Clark Co
WAIM023	Spokane Co
WAIM991	King Co, Snohomish Co
WAIM992	Pierce Co, Clark Co
WAIM993	Spokane
WIIM991*	Kenosha Co, Milwaukee Co, Ozaukee Co, Racine Co, Washington Co, Waukesha Co
WIIM992*	Sheboygan Co

*Indicates that the maximum LEV benefits were applied.

Table 6.5-9. I/M Performance Standard Program Inputs

I/M Program Name	Basic I/M Performance Standard	Low Enhanced I/M Performance Standard	High Enhanced I/M Performance Standard
I/M Program Parameters			
Program Start Year	1983	1983	1983
Stringency Level (Percent)	20	20	20
Model Years Covered	1968-2020	1968-2020	1968-1985
Waiver Rate for Pre-1981 Model Years (%)	0	3	3
Waiver Rate for 1981 and Later Models (%)	0	3	3
Compliance Rate (%)	100	96	96
Program Type	TO	TO	TO
Inspection Frequency	Annual	Annual	Annual
Vehicle Types Inspected			
LDGV	YES	YES	YES
LDGT1	NO	YES	YES
LDGT2	NO	YES	YES
HDGV	NO	NO	NO
Test Type	Idle Test	Idle Test	2500/Idle Test
I/M Cutpoints	220/1.2/999	220/1.2/999	220/1.2/999
Effectiveness Rates (% HC/CO/NO_x)	1.00/1.00/1.00	1.00/1.00/1.00	1.00/1.00/1.00
I/M Program Parameters			
Program Start Year			1983
Stringency Level (Percent)			20
Model Years Covered			1986-2020
Waiver Rate for Pre-1981 Model Years (%)			3
Waiver Rate for 1981 and Later Models (%)			3
Compliance Rate (%)			96
Program Type			TO
Inspection Frequency			Annual
Vehicle Types Inspected			
LDGV			YES
LDGT1			YES
LDGT2			YES
HDGV			NO
Test Type			Transient Test
I/M Cutpoints (g/mi HC/CO/NO_x)			0.80/20.0/2.00
			1.00/1.00/1.00
Anti-Tampering Program Parameters			
Program Start Year		1995	1995
Model Years Covered		1972-2020	1984-2020
Vehicle Types Inspected			
LDGV		YES	YES
LDGT1		YES	YES
LDGT2		YES	YES
HDGV		NO	NO
Program Type		TO	TO
Effectiveness Rate		1.00	1.00
Inspection Frequency		Annual	Annual
Compliance Rate (%)		96	96
Inspections Performed			
Air Pump System		NO	NO
Catalyst		NO	YES
Fuel Inlet Restrictor		NO	YES
Tailpipe Lead Deposit Test		NO	NO
EGR System		YES	NO
Evaporative Emission Control System		NO	NO
PCV System		NO	NO
Gas Cap		NO	NO

Table 6.5-9 (continued)

I/M Program Name	Basic I/M Performance Standard	Low Enhanced I/M Performance Standard	High Enhanced I/M Performance Standard
Functional Pressure Test Program			
Parameters			1995
Program Start Year			1983-2020
Model Years Covered			1.00
Effectiveness Rate			
Vehicle Types Tested			YES
LDGV			YES
LDGT1			YES
LDGT2			NO
HDGV			TO
Program Type			Annual
Inspection Frequency			96
Compliance Rate (%)			
Purge Test Program Parameters			1995
Program Start Year			1986-2020
Model Years Covered			1.00
Effectiveness Rate			
Vehicle Types Tested			YES
LDGV			YES
LDGT1			YES
LDGT2			NO
HDGV			TO
Program Type			Annual
Inspection Frequency			96
Compliance Rate (%)			
	05, 07, 08, 10	05, 07, 08, 10	05, 07, 08, 10
Years of Program Usage			

Notes: TO = Test Only
TRC = Test and Repair (Computerized)

Table 6.5-10. States Modeled with I/M Performance Standard Inputs in 2005, 2007, 2008, and 2010

I/M Performance Standard Modeled	State	County
Basic	Alaska	Fairbanks Ed
	Arizona	Pima Co
	Colorado	Pitkin Co, El Paso Co, Larimer Co, Weld Co
	Florida	Broward Co, Dade Co, Duval Co, Hillsborough Co, Palm Beach Co, Pinellas Co
	Idaho	Ada Co
	Kentucky	Boyd Co, Greenup Co, Boone Co, Campbell Co, Kenton Co, Jefferson Co
	Minnesota	Anoka Co, Carver Co, Dakota Co, Hennepin Co, Ramsey Co, Scott Co, Washington Co
	New Mexico	Bernalillo Co
	North Carolina	Cabarrus Co, Union Co, Orange Co, Forsyth Co, Guilford Co, Durham Co, Gaston Co, Mecklenburg Co, Wake Co
	Tennessee	Rutherford Co, Sumner Co, Williamson Co, Wilson Co, Davidson Co, Shelby Co
Low Enhanced	Delaware	Kent Co, New Castle Co, Sussex Co
	Louisiana	Ascension Par, East Baton Rouge Par, Iberville Par, Livingston Par, Pointe Coupee Par, West Baton Rouge Par
	Nevada	Clark Co, Washoe Co
	Pennsylvania	Berks Co, Blair Co, Cambria Co, Centre Co, Cumberland Co, Dauphin Co, Lackawanna Co, Lancaster Co, Lebanon Co, Luzerne Co, Lycoming Co, York Co, Allegheny Co, Beaver Co, Washington Co, Westmoreland Co, Erie Co, Mercer Co, Lehigh Co, Northampton Co
	Texas	El Paso Co
	Utah	Davis Co, Salt Lake Co, Utah Co, Weber Co
	Washington	Pierce Co, Clark Co, King Co, Snohomish Co, Spokane Co
High Enhanced	Alaska	Anchorage Ed
	Arizona	Maricopa Co
	California	Alameda Co, Butte Co, Colusa Co, Contra Costa Co, El Dorado Co, Glenn Co, Kings Co, Madera Co, Merced Co, Nevada Co, Orange Co, Placer Co, Riverside Co, San Benito Co, San Bernardino Co, San Joaquin Co, Santa Clara Co, Shasta Co, Solano Co, Stanislaus Co, Sutter Co, Tehama Co, Tulare Co, Ventura Co, Yolo Co, Yuba Co, Marin Co, Monterey Co, San Luis Obispo Co, San Mateo Co, Santa Barbara Co, Santa Cruz Co, Sonoma Co, Fresno Co, Kern Co, Los Angeles Co, Napa Co, Sacramento Co, San Diego Co, San Francisco CO
	Colorado	Adams Co, Arapahoe Co, Boulder Co, Douglas Co, Jefferson Co, Denver CO
	Connecticut	Fairfield Co, Hartford Co, Litchfield Co, Middlesex Co, New Haven Co, New London Co, Tolland Co, Windham Co
	DC	Washington

Table 6.5-10 (continued)

I/M Performance Standard Modeled	State	County
High Enhanced (continued)	Georgia	Cherokee Co, Clayton Co, Coweta Co, Douglas Co, Fayette Co, Forsyth Co, Henry Co, Paulding Co, Rockdale Co, Cobb Co, De Kalb Co, Fulton Co, Gwinnett Co
	Illinois	Cook Co, Du Page Co, Lake Co, Kane Co, Kendall Co, McHenry Co, Will Co, Madison Co, St. Clair Co, Monroe Co
	Indiana	Clark Co, Floyd Co, Lake Co, Porter Co
	Maryland	Anne Arundel Co, Baltimore Co, Carroll Co, Harford Co, Howard CO, Baltimore, Calvert Co, Cecil Co, Queen Annes Co, Charles Co, Frederick Co, Montgomery Co, Prince Georges CO, Washington Co
	Massachusetts	Barnstable Co, Berkshire Co, Bristol Co, Dukes Co, Essex Co, Franklin Co, Hampden Co, Hampshire Co, Middlesex Co, Nantucket Co, Norfolk Co, Plymouth Co, Suffolk Co, Worcester Co
	Missouri	Jefferson Co, St. Charles Co, St. Louis Co, St. Louis
	New Hampshire	Hillsborough Co, Rockingham Co, Strafford Co
	New Jersey	Atlantic Co, Cape May Co, Warren Co, Burlington Co, Camden Co, Cumberland Co, Gloucester Co, Salem Co, Bergen Co, Essex Co, Hudson Co, Hunterdon Co, Middlesex Co, Monmouth Co, Morris Co, Ocean Co, Passaic Co, Somerset Co, Sussex Co, Union Co, Mercer Co
	New York	Bronx Co, Kings Co, Nassau Co, New York Co, Queens Co, Richmond Co, Rockland Co, Suffolk Co, Westchester Co, Orange Co
	Ohio	Clark Co, Clermont Co, Geauga Co, Greene Co, Medina Co, Montgomery Co, Portage Co, Summit Co, Warren Co, Butler Co, Hamilton Co, Lake Co, Lorain Co, Cuyahoga Co
	Oregon	Clackamas Co, Jackson Co, Multnomah Co, Washington Co, Josephine Co
	Pennsylvania	Bucks Co, Chester Co, Delaware Co, Montgomery Co, Philadelphia Co
	Rhode Island	Bristol Co, Kent Co, Newport Co, Providence Co, Washington Co
	Texas	Dallas Co, Tarrant Co, Harris Co
	Virginia	Arlington Co, Fairfax Co, Loudoun Co, Prince William Co, Stafford Co, Alexandria, Manassas, Manassas Park, Fairfax, Falls Church
	Wisconsin	Kenosha Co, Milwaukee Co, Ozaukee Co, Racine Co, Washington Co, Waukesha Co, Sheboygan

Table 6.5-11. Counties Modeled with Federal Reformulated Gasoline

State (ASTM Class*)/ Nonattainment Area	County
Arizona (B)	
Phoenix**	
	Maricopa Co
Connecticut (C)	
Greater Connecticut	
	Hartford Co
	Litchfield Co
	Middlesex Co
	New Haven Co
	New London Co
	Tolland Co
	Windham Co
New York-Northern New Jersey-Long Island	
	Fairfield Co
District of Columbia (B)	
Washington DC	
	Washington
Delaware (C)	
Philadelphia-Wilmington-Trenton	
	Kent Co
	New Castle Co
Sussex County	
	Sussex Co
Illinois (C)	
Chicago-Gary-Lake County	
	Cook Co
	Du Page Co
	Grundy Co
	Kane Co
	Kendall Co
	Lake Co
	McHenry Co
	Will Co
Indiana (C)	
Chicago-Gary-Lake County	
	Lake Co
	Porter Co
Kentucky (C)	
Cincinnati-Hamilton	
	Boone Co
	Campbell Co
	Kenton Co
Maine (C)	
Knox & Lincoln Counties	
	Knox Co
	Lincoln Co
Lewiston-Auburn	
	Androscoggin Co
	Kennebec Co
Portland	
	Cumberland Co
	Sagadahoc Co
	York Co
Maryland (B)	
Baltimore	
	Anne Arundel Co
	Baltimore
	Baltimore Co
	Carroll Co
	Harford Co
	Howard Co
Kent & Queen Annes Counties	
	Kent Co
	Queen Annes Co
Philadelphia-Wilmington-Trenton	
	Cecil Co
Washington DC	
	Calvert Co
	Charles Co
	Frederick Co
	Montgomery Co
	Prince Georges Co
Massachusetts (C)	
Boston-Lawrence-Worcester-Eastern MA	
	Barnstable Co
	Bristol Co
	Dukes Co
	Essex Co
	Middlesex Co
	Nantucket Co
	Norfolk Co
	Plymouth Co
	Suffolk Co
	Worcester Co

Table 6.5-11 (continued)

State (ASTM Class*)/ Nonattainment Area	County
Louisville	
	Bullitt Co
	Jefferson Co
	Oldham Co
New Hampshire (C)	
Manchester	
	Hillsborough Co
	Merrimack Co
Portsmouth-Dover-Rochester	
	Rockingham Co
	Strafford Co
New Jersey (C)	
Allentown-Bethlehem-Easton	
	Warren Co
Atlantic City	
	Atlantic Co
	Cape May Co
New York-Northern New Jersey-Long Island	
	Bergen Co
	Essex Co
	Hudson Co
	Hunterdon Co
	Middlesex Co
	Monmouth Co
	Morris Co
	Ocean Co
	Passaic Co
	Somerset Co
	Sussex Co
	Union Co
Philadelphia-Wilmington-Trenton	
	Burlington Co
	Camden Co
	Cumberland Co
	Gloucester Co
	Mercer Co
	Salem Co
New York (C)	
New York-Northern New Jersey-Long Island	
	Bronx Co
	Kings Co
	Nassau Co
	New York Co
Springfield/Pittsfield-Western MA	
	Berkshire Co
	Franklin Co
	Hampden Co
	Hampshire Co
New York (C)	
Poughkeepsie	
	Dutchess Co
	Putnam Co
Pennsylvania (C)	
Philadelphia-Wilmington-Trenton	
	Bucks Co
	Chester Co
	Delaware Co
	Montgomery Co
	Philadelphia Co
Rhode Island (C)	
Providence	
	Bristol Co
	Kent Co
	Newport Co
	Providence Co
	Washington Co
Texas (B)	
Dallas-Fort Worth	
	Collin Co
	Dallas Co
	Denton Co
	Tarrant Co
Houston-Galveston-Brazoria	
	Brazoria Co
	Chambers Co
	Fort Bend Co
	Galveston Co
	Harris Co
	Liberty Co
	Montgomery Co
	Waller Co
Virginia (B)	
Norfolk-Virginia Beach-Newport News	
	Chesapeake
	Hampton
	James City Co
	Newport News

Table 6.5-11 (continued)

State (ASTM Class*)/ Nonattainment Area	County	State (ASTM Class*)/ Nonattainment Area	County
	Orange Co		Norfolk
	Queens Co		Poquoson
	Richmond Co		Portsmouth
	Rockland Co		Suffolk
	Suffolk Co		Virginia Beach
	Westchester Co		Williamsburg
			York Co
Virginia (B)		Wisconsin (C)	
Richmond-Petersburg		Milwaukee-Racine	
	Charles City Co		Kenosha Co
	Chesterfield Co		Milwaukee Co
	Colonial Heights		Ozaukee Co
	Hanover Co		Racine Co
	Henrico Co		Washington Co
	Hopewell		Waukesha Co
	Richmond		
Washington DC			
	Alexandria		
	Arlington Co		
	Fairfax		
	Fairfax Co		
	Falls Church		
	Loudoun Co		
	Manassas		
	Manassas Park		
	Prince William Co		
	Stafford Co		

Notes: * ASTM Class B areas are subject to the Southern reformulated gasoline region requirements while ASTM Class C areas are subject to the Northern reformulated gasoline region requirements.

** Reformulated gasoline was only modeled in Phoenix beginning with the projection years, as the opt-in date for Phoenix was 1997. California reformulated gasoline was modeled statewide in California.

Table 6.5-12. California Basic Emission Rate Limits

Vehicle Type	Pollutant	LEV Credits	Model Years Covered	Zero Mile Level (HDVs: g/bhp-hr) (LDVs: g/mi)	Deterioration Rate	
					<50,000 mi (HDVs: G/bhp-hr/10 kmi) (LDVs: g/mi/10 kmi)	>50,000 mi (HDVs: g/bhp-hr/10 kmi) (LDVs: g/mi/10 kmi)
HDGV	NO_x	N/A	1998 - 2003	3.1900	0.0450	0.0450
	NO_x	N/A	2004 +	1.6600	0.0210	0.0210
	NO_x	N/A	1991 - 1997	4.6000	0.0000	0.0000
	NO_x	N/A	1998 - 2003	3.6800	0.0000	0.0000
	NO_x	N/A	2004 +	1.8400	0.0000	0.0000
	VOC	N/A	1994 - 2003	0.3640	0.0230	0.0230
	VOC	N/A	2004 +	0.2770	0.0180	0.0180
	VOC	N/A	1994 - 2003	0.2830	0.0000	0.0000
	VOC	N/A	2004 +	0.2570	0.0000	0.0000
LDGT2	VOC	Minimum	1995 - 1997	0.2413	0.0720	0.2730
	VOC	Minimum	1998	0.2345	0.0720	0.2730
	VOC	Minimum	1999	0.2297	0.0720	0.2730
	VOC	Minimum	2000	0.1780	0.0720	0.2730
	VOC	Minimum	2001	0.1547	0.0720	0.2730
	VOC	Minimum	2002	0.1522	0.0720	0.2730
	VOC	Minimum	2003 +	0.1403	0.0720	0.2730
	CO	Minimum	1995 - 1997	2.9111	1.4480	3.4340
	CO	Minimum	1998	2.9823	1.4480	3.4340
	CO	Minimum	1999	3.0957	1.4480	3.4340
	CO	Minimum	2000	3.2091	1.4480	3.4340
	CO	Minimum	2001	2.8523	1.4480	3.4340
	CO	Minimum	2002	2.5961	1.4480	3.4340
	CO	Minimum	2003 +	2.3399	1.4480	3.4340
	NO_x	Minimum	1995 - 1997	0.3744	0.0830	0.1860
	NO_x	Minimum	1998	0.3594	0.0830	0.1860
	NO_x	Minimum	1999	0.3454	0.0830	0.1860
	NO_x	Minimum	2000	0.3315	0.0830	0.1860
	NO_x	Minimum	2001 +	0.2125	0.0830	0.1860
LDGT2	VOC	Maximum	1995 - 1997	0.2413	0.0272	0.0272
	VOC	Maximum	1998	0.2345	0.0263	0.0263
	VOC	Maximum	1999	0.2297	0.0257	0.0257
	VOC	Maximum	2000	0.1780	0.0190	0.0190
	VOC	Maximum	2001	0.1547	0.0159	0.0159
	VOC	Maximum	2002	0.1522	0.0156	0.0156
	VOC	Maximum	2003 +	0.1403	0.0140	0.0140
	CO	Maximum	1995 - 1997	2.9111	0.3398	0.3398
	CO	Maximum	1998	2.9823	0.3585	0.3585
	CO	Maximum	1999	3.0957	0.3718	0.3718
	CO	Maximum	2000	3.2091	0.3850	0.3850
	CO	Maximum	2001	2.8523	0.4373	0.4373
	CO	Maximum	2002	2.5961	0.4596	0.4596
	CO	Maximum	2003 +	2.3399	0.4819	0.4819
	NO_x	Maximum	1995 - 1997	0.3744	0.0931	0.0931
	NO_x	Maximum	1998	0.3594	0.0894	0.0894
	NO_x	Maximum	1999	0.3454	0.0859	0.0859
	NO_x	Maximum	2000	0.3315	0.0825	0.0825
	NO_x	Maximum	2001 +	0.2125	0.0528	0.0528

6.6 NON-ROAD MOBILE SOURCES

Non-road emissions were projected to 1999, 2000, 2002, 2005, 2007, 2008, and 2010. The Trends 1995 emission estimates were used as the base year for the emission projections.

6.6.1 Growth Factors

1995 emissions were projected to each projection year using BEA GSP projections by state and industry[1] as a surrogate for growth. These growth factors were applied in much the same manner as the growth factors were applied to the 1990 data to estimate 1995 and 1996 emissions. There were several minor differences in the procedures used to project future year emissions. First, since the BEA GSP projection data were already in constant dollars, no adjustments to account for inflation were needed. Second, the BEA GSP projection data did not contain data points for all years of interest. The BEA data project GSP for the following years: 1998, 2000, 2005, 2010, 2015, 2025, and 2040. Data points for 1999, 2002, 2007, and 2008 were developed by assuming linear growth between the two closest surrounding years.

The crosswalk between SCC and growth factors is the same as the one used for the 1995 and 1996 estimates, and is shown in table 6.6-1. Zero growth was assumed for all railroad SCCs. This assumption is based on information that shows railroad use and earning increasing, but fuel use remaining constant due to efficiency gains in locomotive design.[2] For the 1995 and 1996 estimates, Federal Aviation Administration (FAA) landing-takeoff (LTO) data were used as the growth surrogates for commercial aircraft. The FAA LTO data included all years of interest except 2010. 2010 LTO estimates were developed assuming straight line growth in air carrier LTOs from 1996 through 2010. Table 6.6-2 lists the 1999 through 2010 growth factors by state and SIC.

6.6.2 Control Factors

The impact of the following four non-road control programs are included in the emission projections: 1) Phase I of the compression ignition standards for diesel engines, 2) Phase I of the spark ignition standards for gasoline engines, 3) recreational marine vessel controls, and 4) reformulated gasoline. The impact of the compression ignition standards and the recreational marine controls were incorporated in the adjustments to emissions from non-road diesel engines and recreational marine engines based on the OMS national emission estimates. The procedure for adjusting emissions based on the OMS national emission estimates is described below.

Emission reductions resulting from Phase I of the spark ignition standard were modeled using overall percentage reductions estimated by OMS.[3]

6.6.3 Use of OMS National Emissions Estimates

OMS supplied national emission estimates from its rulemaking analyses that were used to develop emissions for each projection year. The OMS emission estimates (for 1992) were developed by taking per capita emissions values from one of 27 areas and then applying these estimates to the remainder of the country (applied at the county level). This method provides total non-road emissions for each county. The emissions from OMS were provided in 27 7-digit SCCs. The percent of the total emissions represented by each of these 27 SCCs was calculated for each of the 27 areas for which OMS provided detailed emission inventories. These percentages were then applied to the total emissions for each county based on the per capita emissions scaling described above in order to apportion the total emissions to the 27 SCCs. New national totals for each year (including the projection years) were obtained by using the growth factors described above.

OMS also used the EPCD non-road model to calculate new national non-road diesel values for all years. These diesel emissions did not reflect the proposed Phase II standards. For the non-road diesel estimates, a factor reflecting the "final/initial" ratio for all years was developed for the eight diesel 7-digit SCCs. These eight ratios were then applied to the initial county estimates to develop final county emission estimates. The only difference in the way these data were applied was for the emissions from railroads. Railroad emissions for all pollutants were held constant after 1996 for all projection years.

Some of the emissions data used as the basis for the projections was obtained directly from States. As part of the OTAG effort, 24 States provided actual data for these sources (17 States provided complete State data, 7 provided partial State data). The data provided as part of the OTAG effort were generally daily emissions data. The daily data were converted to annual data.

Finally, the national diesel non-road agriculture emissions were allocated to the county using information on the acreage of crops harvested, rather than population.

6.6.4 References

1. *Regional Projections to 2045*, data files, U.S. Department of Commerce, Bureau of Economic Analysis, Washington, DC, August 1995.

2. Notice of Proposed Rulemaking (40 CFR, 62, No. 28, 6366-6405), February 11, 1995.

3. *Fleet Average Annual Emission Reduction Percentages Small Gasoline Engines Phase I*, E-mail sent to Sharon Nizich, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, from U.S. Environmental Protection Agency, Office of Mobile Sources, July 23, 1997.

Table 6.6-1. SCC-SIC Crosswalk

SCCs	Non-road Segment	SIC	SIC Name
2260001, 2265001, 2270001	Recreational Vehicles	999*	Population
2260002, 2265002, 2270002	Construction	15	Construction
2260003, 2265003, 2270003	Industrial	998*	Total Manufacturing
2260004, 2265004, 2270004	Lawn and Garden	999*	Population
2260005, 2265005, 2270005	Farm	01	Farm
2260006, 2265006, 2270006	Light Commercial	998*	Total Manufacturing
2260007, 2265007, 2270007	Logging	07	Agricultural Services, Forestry, Fisheries, and Other
2260008, 2265008, 2270008	Airport Service	45	Transportation by Air
2275 (except 2275001 and 2275002)	Aircraft (except Military and Commercial)	45	Transportation by Air
2275001	Military Aircraft	992*	Federal, military
2275002	Commercial Aircraft	LTO*	Landing-Takeoff Operations
2280	Commercial Marine Vessels	44	Water Transportation
2282	Recreational Marine Vessels	999*	Population
2283	Military Marine Vessels	992*	Federal, military
2285**	Railroads	40	Railroad Transportation

NOTES: *Growth factor does not correspond to an SIC.
**E-GAS growth factors used for 1995 and 1996 NO_x emissions. Zero growth assumed after 1996 for all pollutants.

Table 6.6-2. 1999 - 2010 Growth Factors

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
01	01	Farm	1.092	1.123	1.166	1.231	1.268	1.286	1.324
01	07	Agricultural services, forestry, fisheries, and other	1.214	1.259	1.365	1.523	1.627	1.679	1.783
01	15	Construction	1.044	1.046	1.064	1.092	1.111	1.121	1.140
01	40	Railroad Transportation	1.136	1.170	1.243	1.353	1.419	1.452	1.518
01	44	Water Transportation	1.007	1.008	1.011	1.014	1.020	1.022	1.028
01	44	Water Transportation	1.237	1.296	1.396	1.547	1.649	1.701	1.803
01	992*	Federal, military	0.949	0.939	0.947	0.960	0.971	0.976	0.988
01	998*	Total Manufacturing	1.114	1.136	1.183	1.254	1.300	1.323	1.369
01	999*	Population	1.030	1.036	1.048	1.067	1.082	1.089	1.103
01	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
02	01	Farm	1.131	1.166	1.217	1.297	1.343	1.366	1.411
02	07	Agricultural services, forestry, fisheries, and other	1.172	1.212	1.294	1.417	1.495	1.533	1.611
02	15	Construction	1.087	1.083	1.110	1.151	1.177	1.190	1.216
02	40	Railroad Transportation	1.000	1.000	1.000	1.000	1.000	1.000	1.000
02	44	Water Transportation	1.058	1.072	1.078	1.086	1.093	1.096	1.103
02	45	Transportation by air	1.156	1.195	1.261	1.360	1.424	1.457	1.521
02	992*	Federal, military	0.946	0.942	0.948	0.957	0.966	0.971	0.980
02	998*	Total Manufacturing	1.045	1.070	1.106	1.160	1.196	1.213	1.248
02	999*	Population	1.057	1.071	1.095	1.131	1.153	1.163	1.185
02	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
04	01	Farm	1.154	1.202	1.251	1.324	1.365	1.386	1.427
04	07	Agricultural services, forestry, fisheries, and other	1.229	1.280	1.393	1.564	1.677	1.734	1.848
04	15	Construction	1.140	1.154	1.199	1.267	1.309	1.331	1.373
04	40	Railroad Transportation	1.213	1.266	1.360	1.500	1.589	1.633	1.722
04	44	Water Transportation	1.140	1.158	1.175	1.211	1.228	1.246	1.263
04	45	Transportation by air	1.196	1.245	1.328	1.454	1.536	1.577	1.659
04	992*	Federal, military	0.988	0.993	0.999	1.008	1.017	1.021	1.030
04	998*	Total Manufacturing	1.145	1.172	1.229	1.314	1.366	1.392	1.445
04	999*	Population	1.084	1.104	1.139	1.190	1.223	1.240	1.272
04	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
05	01	Farm	1.029	1.045	1.080	1.132	1.162	1.177	1.206
05	07	Agricultural services, forestry, fisheries, and other	1.210	1.259	1.366	1.526	1.632	1.685	1.791
05	15	Construction	1.064	1.070	1.090	1.119	1.138	1.148	1.167
05	40	Railroad Transportation	1.168	1.210	1.286	1.399	1.467	1.502	1.570
05	44	Water Transportation	1.162	1.198	1.216	1.243	1.261	1.270	1.288
05	45	Transportation by air	1.262	1.327	1.413	1.540	1.624	1.667	1.751
05	992*	Federal, military	0.877	0.870	0.870	0.871	0.876	0.877	0.882
05	998*	Total Manufacturing	1.125	1.145	1.194	1.267	1.315	1.339	1.386
05	999*	Population	1.035	1.042	1.056	1.078	1.093	1.101	1.116
05	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
06	01	Farm	1.076	1.105	1.145	1.204	1.237	1.253	1.286
06	07	Agricultural services, forestry, fisheries, and other	1.176	1.219	1.313	1.453	1.544	1.590	1.680
06	15	Construction	1.046	1.066	1.109	1.173	1.212	1.231	1.271
06	40	Railroad Transportation	1.162	1.203	1.272	1.376	1.438	1.469	1.532
06	44	Water Transportation	0.984	0.980	0.978	0.975	0.976	0.977	0.978
06	45	Transportation by air	1.164	1.205	1.289	1.415	1.497	1.538	1.620
06	992*	Federal, military	0.905	0.894	0.900	0.908	0.916	0.920	0.929
06	998*	Total Manufacturing	1.084	1.113	1.154	1.215	1.254	1.274	1.313
06	999*	Population	1.055	1.072	1.099	1.140	1.166	1.178	1.204
06	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
08	01	Farm	1.123	1.157	1.203	1.274	1.316	1.337	1.379
08	07	Agricultural services, forestry, fisheries, and other	1.242	1.292	1.408	1.581	1.696	1.754	1.870
08	15	Construction	1.116	1.121	1.149	1.189	1.217	1.230	1.257
08	40	Railroad Transportation	1.242	1.303	1.410	1.570	1.672	1.722	1.824
08	44	Water Transportation	1.114	1.143	1.200	1.257	1.286	1.314	1.343
08	45	Transportation by air	1.226	1.283	1.386	1.541	1.645	1.697	1.801
08	992*	Federal, military	0.962	0.955	0.963	0.974	0.985	0.990	1.000

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
08	998*	Total Manufacturing	1.120	1.145	1.193	1.265	1.312	1.335	1.381
08	999*	Population	1.073	1.089	1.119	1.164	1.193	1.207	1.236
08	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
09	01	Farm	1.114	1.147	1.194	1.263	1.303	1.323	1.362
09	07	Agricultural services, forestry, fisheries, and other	1.211	1.257	1.356	1.504	1.600	1.649	1.745
09	15	Construction	1.039	1.050	1.071	1.102	1.123	1.134	1.155
09	40	Railroad Transportation	1.000	1.000	1.000	1.000	1.000	1.000	1.000
09	44	Water Transportation	1.005	1.005	1.012	1.022	1.031	1.037	1.046
09	45	Transportation by air	1.165	1.206	1.288	1.412	1.494	1.535	1.617
09	992*	Federal, military	0.924	0.917	0.924	0.935	0.945	0.950	0.960
09	998*	Total Manufacturing	1.053	1.065	1.087	1.120	1.140	1.151	1.171
09	999*	Population	1.023	1.032	1.047	1.071	1.087	1.096	1.112
09	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
10	01	Farm	0.978	0.995	1.014	1.044	1.059	1.066	1.082
10	07	Agricultural services, forestry, fisheries, and other	1.208	1.250	1.351	1.502	1.599	1.649	1.747
10	15	Construction	1.049	1.076	1.097	1.127	1.148	1.158	1.178
10	40	Railroad Transportation	1.263	1.328	1.439	1.605	1.711	1.765	1.871
10	44	Water Transportation	0.982	0.977	0.982	0.991	1.000	1.000	1.009
10	45	Transportation by air	1.145	1.182	1.271	1.402	1.492	1.534	1.623
10	992*	Federal, military	1.002	1.011	1.018	1.029	1.040	1.045	1.055
10	998*	Total Manufacturing	1.036	1.045	1.073	1.114	1.142	1.155	1.183
10	999*	Population	1.047	1.059	1.080	1.110	1.131	1.141	1.162
10	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
11	01	Farm	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	07	Agricultural services, forestry, fisheries, and other	1.282	1.350	1.476	1.670	1.796	1.854	1.981
11	15	Construction	0.937	0.926	0.926	0.925	0.926	0.927	0.928
11	40	Railroad Transportation	1.311	1.388	1.502	1.675	1.781	1.834	1.940
11	44	Water Transportation	1.283	1.348	1.337	1.315	1.315	1.304	1.304
11	45	Transportation by air	1.135	1.167	1.228	1.321	1.381	1.409	1.470
11	992*	Federal, military	0.959	0.951	0.951	0.952	0.956	0.957	0.961
11	998*	Total Manufacturing	1.007	1.010	1.019	1.033	1.042	1.047	1.056
11	999*	Population	0.976	0.974	0.970	0.965	0.966	0.966	0.967
11	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
12	01	Farm	1.149	1.188	1.241	1.320	1.364	1.386	1.429
12	07	Agricultural services, forestry, fisheries, and other	1.203	1.252	1.356	1.512	1.615	1.667	1.769
12	15	Construction	1.105	1.127	1.163	1.218	1.252	1.269	1.304
12	40	Railroad Transportation	1.189	1.236	1.332	1.475	1.563	1.607	1.695
12	44	Water Transportation	1.068	1.085	1.117	1.166	1.196	1.211	1.241
12	45	Transportation by air	1.225	1.282	1.359	1.474	1.547	1.584	1.657
12	992*	Federal, military	0.911	0.902	0.908	0.918	0.927	0.931	0.941
12	998*	Total Manufacturing	1.117	1.143	1.191	1.263	1.307	1.330	1.374
12	999*	Population	1.075	1.095	1.131	1.184	1.218	1.235	1.270
12	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
13	01	Farm	1.043	1.062	1.095	1.144	1.171	1.185	1.212
13	07	Agricultural services, forestry, fisheries, and other	1.227	1.273	1.382	1.546	1.653	1.707	1.814
13	15	Construction	1.090	1.093	1.123	1.168	1.198	1.213	1.244
13	40	Railroad Transportation	1.130	1.162	1.232	1.337	1.401	1.432	1.496
13	44	Water Transportation	1.032	1.040	1.047	1.058	1.068	1.072	1.082
13	45	Transportation by air	1.152	1.190	1.255	1.353	1.416	1.448	1.512
13	992*	Federal, military	0.989	0.990	0.998	1.011	1.022	1.028	1.039
13	998*	Total Manufacturing	1.118	1.140	1.187	1.257	1.302	1.325	1.370
13	999*	Population	1.059	1.072	1.097	1.133	1.158	1.170	1.194
13	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
15	01	Farm	1.157	1.212	1.291	1.410	1.481	1.517	1.588
15	07	Agricultural services, forestry, fisheries, and other	1.197	1.251	1.355	1.510	1.612	1.663	1.765
15	15	Construction	1.049	1.070	1.089	1.118	1.137	1.147	1.166
15	40	Railroad Transportation	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
15	44	Water Transportation	1.041	1.051	1.066	1.088	1.104	1.112	1.128
15	45	Transportation by air	1.130	1.163	1.232	1.336	1.403	1.437	1.505
15	992*	Federal, military	0.965	0.965	0.971	0.980	0.990	0.994	1.004
15	998*	Total Manufacturing	1.007	1.012	1.027	1.051	1.068	1.077	1.094
15	999*	Population	1.053	1.068	1.093	1.129	1.154	1.166	1.190
15	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
16	01	Farm	1.116	1.147	1.195	1.268	1.310	1.331	1.373
16	07	Agricultural services, forestry, fisheries, and other	1.226	1.278	1.392	1.564	1.678	1.735	1.850
16	15	Construction	1.087	1.090	1.105	1.128	1.144	1.152	1.169
16	40	Railroad Transportation	1.142	1.178	1.249	1.355	1.419	1.452	1.516
16	44	Water Transportation	1.056	1.056	1.093	1.148	1.185	1.204	1.241
16	45	Transportation by air	1.248	1.310	1.415	1.572	1.678	1.732	1.838
16	992*	Federal, military	0.965	0.953	0.960	0.972	0.982	0.987	0.998
16	998*	Total Manufacturing	1.182	1.216	1.288	1.394	1.463	1.497	1.566
16	999*	Population	1.067	1.080	1.102	1.134	1.155	1.165	1.186
16	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
17	01	Farm	0.970	0.994	1.021	1.062	1.085	1.096	1.119
17	07	Agricultural services, forestry, fisheries, and other	1.195	1.239	1.345	1.504	1.609	1.662	1.767
17	15	Construction	1.038	1.045	1.062	1.088	1.105	1.113	1.130
17	40	Railroad Transportation	1.158	1.198	1.258	1.347	1.400	1.427	1.479
17	44	Water Transportation	1.118	1.148	1.156	1.168	1.179	1.183	1.194
17	45	Transportation by air	1.199	1.249	1.327	1.444	1.521	1.559	1.636
17	992*	Federal, military	0.912	0.901	0.905	0.911	0.918	0.922	0.929
17	998*	Total Manufacturing	1.102	1.119	1.151	1.201	1.231	1.247	1.278
17	999*	Population	1.027	1.035	1.049	1.070	1.084	1.091	1.105
17	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
18	01	Farm	1.038	1.068	1.118	1.193	1.236	1.257	1.301
18	07	Agricultural services, forestry, fisheries, and other	1.218	1.266	1.380	1.549	1.662	1.718	1.830
18	15	Construction	1.055	1.059	1.077	1.105	1.124	1.133	1.152
18	40	Railroad Transportation	1.166	1.207	1.283	1.397	1.467	1.502	1.571
18	44	Water Transportation	1.064	1.080	1.106	1.145	1.172	1.185	1.212
18	45	Transportation by air	1.292	1.364	1.474	1.638	1.748	1.803	1.913
18	992*	Federal, military	0.944	0.930	0.939	0.952	0.964	0.970	0.981
18	998*	Total Manufacturing	1.121	1.140	1.179	1.238	1.275	1.294	1.331
18	999*	Population	1.027	1.033	1.045	1.063	1.076	1.083	1.096
18	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
19	01	Farm	0.955	1.006	1.050	1.116	1.153	1.172	1.210
19	07	Agricultural services, forestry, fisheries, and other	1.191	1.234	1.331	1.477	1.572	1.620	1.715
19	15	Construction	1.057	1.060	1.077	1.103	1.119	1.127	1.144
19	40	Railroad Transportation	1.166	1.208	1.278	1.384	1.447	1.479	1.543
19	44	Water Transportation	1.132	1.160	1.188	1.236	1.264	1.271	1.299
19	45	Transportation by air	1.207	1.258	1.338	1.459	1.536	1.574	1.651
19	992*	Federal, military	0.967	0.952	0.961	0.974	0.986	0.992	1.003
19	998*	Total Manufacturing	1.115	1.132	1.171	1.230	1.267	1.285	1.322
19	999*	Population	1.015	1.019	1.027	1.039	1.048	1.053	1.062
19	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
20	01	Farm	1.013	1.032	1.067	1.119	1.148	1.163	1.192
20	07	Agricultural services, forestry, fisheries, and other	1.225	1.276	1.391	1.563	1.677	1.734	1.848
20	15	Construction	1.048	1.048	1.066	1.092	1.109	1.118	1.135
20	40	Railroad Transportation	1.145	1.182	1.256	1.366	1.433	1.467	1.534
20	44	Water Transportation	1.150	1.150	1.150	1.200	1.200	1.250	1.250
20	45	Transportation by air	1.198	1.248	1.337	1.473	1.561	1.606	1.694
20	992*	Federal, military	0.976	0.973	0.979	0.988	0.997	1.002	1.011
20	998*	Total Manufacturing	1.107	1.128	1.171	1.236	1.277	1.297	1.338
20	999*	Population	1.032	1.041	1.055	1.075	1.089	1.096	1.110
20	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
21	01	Farm	1.066	1.100	1.153	1.233	1.280	1.304	1.351

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
21	07	Agricultural services, forestry, fisheries, and other	1.201	1.248	1.356	1.518	1.626	1.679	1.786
21	15	Construction	1.062	1.068	1.086	1.112	1.130	1.139	1.157
21	40	Railroad Transportation	1.077	1.097	1.148	1.224	1.267	1.289	1.332
21	44	Water Transportation	0.964	0.955	0.961	0.970	0.979	0.983	0.992
21	45	Transportation by air	1.222	1.277	1.370	1.509	1.603	1.650	1.744
21	992*	Federal, military	0.970	0.967	0.974	0.985	0.995	0.999	1.009
21	998*	Total Manufacturing	1.114	1.132	1.170	1.226	1.263	1.281	1.318
21	999*	Population	1.028	1.034	1.047	1.065	1.079	1.086	1.100
21	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
22	01	Farm	1.042	1.071	1.112	1.173	1.208	1.226	1.261
22	07	Agricultural services, forestry, fisheries, and other	1.192	1.235	1.332	1.478	1.572	1.620	1.714
22	15	Construction	1.035	1.041	1.062	1.093	1.113	1.124	1.144
22	40	Railroad Transportation	1.176	1.220	1.294	1.406	1.474	1.508	1.576
22	44	Water Transportation	0.992	0.990	0.989	0.988	0.990	0.991	0.993
22	45	Transportation by air	1.122	1.153	1.210	1.296	1.351	1.378	1.433
22	992*	Federal, military	0.916	0.913	0.922	0.935	0.947	0.952	0.964
22	998*	Total Manufacturing	1.075	1.090	1.125	1.178	1.212	1.229	1.263
22	999*	Population	1.024	1.030	1.042	1.061	1.073	1.080	1.092
22	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
23	01	Farm	1.102	1.142	1.198	1.282	1.332	1.356	1.406
23	07	Agricultural services, forestry, fisheries, and other	1.143	1.175	1.250	1.363	1.433	1.469	1.539
23	15	Construction	1.042	1.053	1.073	1.104	1.124	1.134	1.154
23	40	Railroad Transportation	1.076	1.093	1.147	1.228	1.277	1.300	1.349
23	44	Water Transportation	1.043	1.051	1.060	1.077	1.085	1.094	1.102
23	45	Transportation by air	1.388	1.484	1.595	1.760	1.871	1.928	2.039
23	992*	Federal, military	0.863	0.848	0.854	0.863	0.872	0.876	0.885
23	998*	Total Manufacturing	1.080	1.098	1.131	1.180	1.212	1.228	1.260
23	999*	Population	1.026	1.035	1.050	1.074	1.091	1.100	1.116
23	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
24	01	Farm	1.010	1.035	1.074	1.132	1.164	1.180	1.212
24	07	Agricultural services, forestry, fisheries, and other	1.197	1.240	1.341	1.493	1.591	1.639	1.737
24	15	Construction	1.024	1.028	1.042	1.062	1.076	1.083	1.097
24	40	Railroad Transportation	0.998	0.998	1.027	1.070	1.091	1.101	1.122
24	44	Water Transportation	0.949	0.936	0.928	0.916	0.913	0.910	0.906
24	45	Transportation by air	1.193	1.241	1.346	1.503	1.608	1.662	1.768
24	992*	Federal, military	0.954	0.946	0.950	0.956	0.963	0.967	0.974
24	998*	Total Manufacturing	1.044	1.052	1.073	1.103	1.123	1.133	1.153
24	999*	Population	1.043	1.054	1.074	1.104	1.124	1.133	1.153
24	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
25	01	Farm	1.110	1.142	1.189	1.260	1.301	1.321	1.362
25	07	Agricultural services, forestry, fisheries, and other	1.141	1.177	1.253	1.367	1.439	1.475	1.547
25	15	Construction	1.088	1.097	1.118	1.149	1.169	1.179	1.200
25	40	Railroad Transportation	1.232	1.290	1.384	1.526	1.613	1.656	1.744
25	44	Water Transportation	1.023	1.028	1.035	1.044	1.052	1.057	1.065
25	45	Transportation by air	1.172	1.215	1.294	1.413	1.491	1.530	1.609
25	992*	Federal, military	0.881	0.857	0.864	0.876	0.886	0.891	0.901
25	998*	Total Manufacturing	1.059	1.072	1.091	1.119	1.137	1.146	1.164
25	999*	Population	1.025	1.031	1.046	1.068	1.083	1.091	1.107
25	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
26	01	Farm	1.055	1.082	1.125	1.188	1.224	1.242	1.278
26	07	Agricultural services, forestry, fisheries, and other	1.206	1.249	1.355	1.516	1.621	1.674	1.779
26	15	Construction	1.048	1.048	1.064	1.088	1.104	1.112	1.128
26	40	Railroad Transportation	1.119	1.149	1.200	1.277	1.323	1.346	1.392
26	44	Water Transportation	1.078	1.097	1.113	1.135	1.151	1.160	1.176
26	45	Transportation by air	1.152	1.190	1.254	1.350	1.413	1.444	1.507
26	992*	Federal, military	0.869	0.847	0.851	0.859	0.866	0.870	0.878
26	998*	Total Manufacturing	1.082	1.090	1.115	1.152	1.177	1.190	1.215

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
26	999*	Population	1.017	1.021	1.029	1.041	1.050	1.055	1.064
26	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
27	01	Farm	0.976	1.035	1.103	1.205	1.262	1.291	1.349
27	07	Agricultural services, forestry, fisheries, and other	1.191	1.234	1.334	1.483	1.580	1.629	1.725
27	15	Construction	1.051	1.061	1.080	1.109	1.127	1.136	1.154
27	40	Railroad Transportation	1.154	1.193	1.254	1.345	1.399	1.426	1.479
27	44	Water Transportation	0.947	0.934	0.927	0.918	0.915	0.915	0.913
27	45	Transportation by air	1.110	1.138	1.211	1.321	1.393	1.429	1.502
27	992*	Federal, military	0.950	0.946	0.953	0.965	0.975	0.981	0.991
27	998*	Total Manufacturing	1.125	1.148	1.194	1.262	1.306	1.327	1.370
27	999*	Population	1.037	1.046	1.062	1.086	1.101	1.109	1.125
27	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
28	01	Farm	0.980	0.991	1.029	1.087	1.121	1.138	1.172
28	07	Agricultural services, forestry, fisheries, and other	1.200	1.244	1.346	1.498	1.599	1.648	1.749
28	15	Construction	1.115	1.118	1.143	1.179	1.203	1.215	1.239
28	40	Railroad Transportation	1.157	1.196	1.261	1.359	1.418	1.447	1.505
28	44	Water Transportation	1.000	0.999	1.000	1.001	1.006	1.009	1.013
28	45	Transportation by air	1.259	1.324	1.431	1.592	1.700	1.754	1.863
28	992*	Federal, military	1.027	1.027	1.035	1.047	1.058	1.064	1.075
28	998*	Total Manufacturing	1.119	1.142	1.191	1.264	1.310	1.334	1.381
28	999*	Population	1.026	1.031	1.041	1.057	1.069	1.075	1.086
28	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
29	01	Farm	1.021	1.061	1.105	1.171	1.209	1.228	1.266
29	07	Agricultural services, forestry, fisheries, and other	1.201	1.246	1.346	1.497	1.595	1.644	1.742
29	15	Construction	1.056	1.051	1.069	1.095	1.113	1.121	1.139
29	40	Railroad Transportation	1.161	1.201	1.275	1.387	1.455	1.489	1.556
29	44	Water Transportation	0.835	0.794	0.776	0.748	0.735	0.729	0.715
29	45	Transportation by air	1.032	1.040	1.084	1.150	1.191	1.212	1.253
29	992*	Federal, military	0.929	0.918	0.925	0.935	0.945	0.950	0.959
29	998*	Total Manufacturing	1.083	1.097	1.130	1.179	1.211	1.227	1.258
29	999*	Population	1.032	1.040	1.055	1.077	1.092	1.100	1.116
29	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
30	01	Farm	1.155	1.173	1.237	1.334	1.392	1.421	1.479
30	07	Agricultural services, forestry, fisheries, and other	1.225	1.278	1.388	1.555	1.666	1.721	1.832
30	15	Construction	1.095	1.109	1.139	1.185	1.213	1.227	1.255
30	40	Railroad Transportation	1.199	1.249	1.322	1.433	1.500	1.533	1.600
30	44	Water Transportation	1.000	1.000	1.000	1.200	1.200	1.400	1.400
30	45	Transportation by air	1.207	1.259	1.351	1.487	1.578	1.622	1.713
30	992*	Federal, military	1.001	0.994	1.001	1.011	1.021	1.026	1.036
30	998*	Total Manufacturing	1.060	1.077	1.107	1.152	1.181	1.196	1.226
30	999*	Population	1.056	1.069	1.091	1.125	1.146	1.157	1.178
30	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
31	01	Farm	1.022	1.045	1.079	1.130	1.158	1.172	1.200
31	07	Agricultural services, forestry, fisheries, and other	1.200	1.246	1.349	1.503	1.604	1.654	1.755
31	15	Construction	1.097	1.105	1.132	1.172	1.196	1.208	1.233
31	40	Railroad Transportation	1.177	1.222	1.304	1.428	1.504	1.542	1.618
31	44	Water Transportation	1.000	1.000	1.000	1.043	1.043	1.043	1.043
31	45	Transportation by air	1.191	1.238	1.320	1.443	1.522	1.562	1.642
31	992*	Federal, military	0.893	0.887	0.894	0.904	0.914	0.919	0.929
31	998*	Total Manufacturing	1.117	1.133	1.174	1.235	1.274	1.294	1.333
31	999*	Population	1.028	1.036	1.048	1.067	1.080	1.086	1.099
31	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
32	01	Farm	1.183	1.237	1.292	1.375	1.424	1.448	1.497
32	07	Agricultural services, forestry, fisheries, and other	1.240	1.283	1.404	1.585	1.706	1.767	1.888
32	15	Construction	1.194	1.212	1.257	1.323	1.366	1.387	1.429
32	40	Railroad Transportation	1.178	1.222	1.293	1.400	1.465	1.496	1.561
32	44	Water Transportation	1.197	1.246	1.279	1.344	1.377	1.410	1.443

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
32	45	Transportation by air	1.217	1.271	1.367	1.511	1.611	1.661	1.761
32	992*	Federal, military	0.970	0.972	0.977	0.984	0.992	0.995	1.003
32	998*	Total Manufacturing	1.198	1.225	1.295	1.398	1.466	1.500	1.568
32	999*	Population	1.114	1.137	1.185	1.257	1.302	1.325	1.370
32	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
33	01	Farm	1.084	1.104	1.150	1.218	1.258	1.277	1.317
33	07	Agricultural services, forestry, fisheries, and other	1.210	1.257	1.367	1.533	1.642	1.697	1.806
33	15	Construction	1.069	1.079	1.104	1.140	1.164	1.177	1.201
33	40	Railroad Transportation	1.090	1.101	1.157	1.236	1.281	1.315	1.360
33	44	Water Transportation	1.069	1.086	1.103	1.121	1.138	1.138	1.155
33	45	Transportation by air	1.433	1.542	1.705	1.950	2.115	2.198	2.363
33	992*	Federal, military	0.963	0.949	0.959	0.973	0.986	0.990	1.002
33	998*	Total Manufacturing	1.110	1.130	1.169	1.227	1.262	1.280	1.315
33	999*	Population	1.045	1.057	1.077	1.107	1.128	1.138	1.158
33	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
34	01	Farm	1.085	1.115	1.160	1.227	1.266	1.285	1.324
34	07	Agricultural services, forestry, fisheries, and other	1.180	1.215	1.297	1.421	1.499	1.538	1.616
34	15	Construction	1.055	1.066	1.087	1.119	1.139	1.149	1.169
34	40	Railroad Transportation	1.177	1.220	1.289	1.392	1.453	1.484	1.545
34	44	Water Transportation	0.962	0.952	0.941	0.925	0.918	0.915	0.909
34	45	Transportation by air	1.236	1.295	1.387	1.523	1.614	1.659	1.749
34	992*	Federal, military	0.934	0.930	0.937	0.949	0.959	0.964	0.975
34	998*	Total Manufacturing	1.028	1.035	1.049	1.071	1.085	1.092	1.106
34	999*	Population	1.033	1.042	1.057	1.080	1.096	1.103	1.119
34	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
35	01	Farm	1.114	1.142	1.196	1.277	1.325	1.349	1.397
35	07	Agricultural services, forestry, fisheries, and other	1.240	1.300	1.426	1.615	1.736	1.797	1.918
35	15	Construction	1.152	1.167	1.208	1.270	1.310	1.330	1.370
35	40	Railroad Transportation	1.161	1.201	1.273	1.382	1.448	1.481	1.547
35	44	Water Transportation	1.250	1.250	1.375	1.500	1.500	1.625	1.625
35	45	Transportation by air	1.322	1.402	1.523	1.705	1.828	1.890	2.013
35	992*	Federal, military	0.985	0.981	0.987	0.996	1.005	1.010	1.019
35	998*	Total Manufacturing	1.207	1.241	1.312	1.418	1.485	1.518	1.585
35	999*	Population	1.062	1.076	1.102	1.141	1.165	1.178	1.203
35	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
36	01	Farm	1.063	1.097	1.142	1.210	1.248	1.268	1.307
36	07	Agricultural services, forestry, fisheries, and other	1.162	1.199	1.276	1.391	1.460	1.495	1.565
36	15	Construction	0.996	0.999	1.004	1.011	1.017	1.020	1.025
36	40	Railroad Transportation	1.130	1.162	1.220	1.306	1.356	1.381	1.431
36	44	Water Transportation	0.912	0.890	0.857	0.809	0.784	0.771	0.747
36	45	Transportation by air	1.084	1.105	1.146	1.206	1.243	1.262	1.299
36	992*	Federal, military	0.959	0.949	0.960	0.976	0.989	0.996	1.009
36	998*	Total Manufacturing	1.014	1.019	1.027	1.039	1.047	1.051	1.059
36	999*	Population	1.010	1.013	1.017	1.023	1.029	1.031	1.037
36	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
37	01	Farm	1.020	1.043	1.067	1.103	1.123	1.132	1.152
37	07	Agricultural services, forestry, fisheries, and other	1.219	1.265	1.373	1.536	1.643	1.696	1.804
37	15	Construction	1.103	1.118	1.149	1.195	1.226	1.242	1.273
37	40	Railroad Transportation	1.102	1.127	1.183	1.268	1.318	1.343	1.393
37	44	Water Transportation	0.988	0.984	1.004	1.033	1.053	1.064	1.084
37	45	Transportation by air	1.192	1.240	1.326	1.455	1.542	1.585	1.672
37	992*	Federal, military	1.008	1.010	1.018	1.031	1.043	1.048	1.060
37	998*	Total Manufacturing	1.107	1.127	1.168	1.229	1.269	1.288	1.328
37	999*	Population	1.054	1.067	1.090	1.123	1.146	1.157	1.180
37	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
38	01	Farm	0.918	0.932	0.969	1.025	1.057	1.074	1.106
38	07	Agricultural services, forestry, fisheries, and other	1.207	1.252	1.354	1.509	1.610	1.661	1.763

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
38	15	Construction	1.097	1.109	1.135	1.173	1.197	1.208	1.232
38	40	Railroad Transportation	1.256	1.320	1.418	1.566	1.655	1.700	1.790
38	44	Water Transportation	1.000	1.000	1.000	1.000	1.000	1.000	1.000
38	45	Transportation by air	1.227	1.284	1.382	1.527	1.615	1.662	1.751
38	992*	Federal, military	0.963	0.952	0.957	0.966	0.974	0.979	0.987
38	998*	Total Manufacturing	1.182	1.211	1.271	1.360	1.416	1.444	1.500
38	999*	Population	1.012	1.016	1.023	1.032	1.040	1.044	1.052
38	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
39	01	Farm	1.028	1.056	1.098	1.162	1.199	1.217	1.253
39	07	Agricultural services, forestry, fisheries, and other	1.192	1.236	1.339	1.492	1.593	1.644	1.745
39	15	Construction	1.073	1.079	1.098	1.126	1.144	1.154	1.172
39	40	Railroad Transportation	1.112	1.141	1.185	1.253	1.290	1.309	1.346
39	44	Water Transportation	1.006	1.008	1.014	1.025	1.034	1.039	1.048
39	45	Transportation by air	1.170	1.213	1.287	1.399	1.473	1.510	1.583
39	992*	Federal, military	0.933	0.923	0.930	0.942	0.953	0.958	0.968
39	998*	Total Manufacturing	1.091	1.105	1.137	1.186	1.217	1.233	1.264
39	999*	Population	1.019	1.023	1.031	1.045	1.055	1.060	1.070
39	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
40	01	Farm	1.105	1.142	1.195	1.276	1.323	1.347	1.395
40	07	Agricultural services, forestry, fisheries, and other	1.237	1.293	1.418	1.606	1.732	1.795	1.921
40	15	Construction	1.085	1.098	1.121	1.157	1.180	1.192	1.215
40	40	Railroad Transportation	1.114	1.143	1.201	1.288	1.339	1.364	1.416
40	44	Water Transportation	1.151	1.189	1.208	1.245	1.283	1.283	1.321
40	45	Transportation by air	1.173	1.216	1.294	1.409	1.485	1.523	1.599
40	992*	Federal, military	0.981	0.983	0.990	1.001	1.012	1.017	1.027
40	998*	Total Manufacturing	1.129	1.153	1.199	1.268	1.311	1.332	1.375
40	999*	Population	1.030	1.038	1.052	1.072	1.086	1.093	1.108
40	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
41	01	Farm	1.031	1.049	1.096	1.167	1.208	1.229	1.271
41	07	Agricultural services, forestry, fisheries, and other	1.189	1.228	1.324	1.468	1.561	1.607	1.701
41	15	Construction	1.092	1.103	1.133	1.178	1.207	1.222	1.250
41	40	Railroad Transportation	1.183	1.229	1.301	1.408	1.473	1.505	1.570
41	44	Water Transportation	1.004	1.004	1.000	0.993	0.993	0.992	0.992
41	45	Transportation by air	1.233	1.291	1.399	1.562	1.670	1.725	1.833
41	992*	Federal, military	0.966	0.958	0.966	0.979	0.990	0.996	1.007
41	998*	Total Manufacturing	1.097	1.117	1.158	1.219	1.258	1.278	1.318
41	999*	Population	1.055	1.067	1.091	1.125	1.147	1.158	1.181
41	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
42	01	Farm	1.041	1.070	1.114	1.180	1.218	1.237	1.275
42	07	Agricultural services, forestry, fisheries, and other	1.183	1.226	1.318	1.457	1.546	1.590	1.679
42	15	Construction	1.020	1.023	1.032	1.047	1.057	1.062	1.072
42	40	Railroad Transportation	1.188	1.235	1.297	1.391	1.445	1.473	1.527
42	44	Water Transportation	0.973	0.966	0.963	0.958	0.959	0.959	0.959
42	45	Transportation by air	1.210	1.262	1.341	1.460	1.539	1.578	1.657
42	992*	Federal, military	0.931	0.922	0.929	0.939	0.948	0.953	0.962
42	998*	Total Manufacturing	1.061	1.070	1.090	1.120	1.139	1.149	1.168
42	999*	Population	1.017	1.023	1.032	1.045	1.056	1.061	1.072
42	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
44	01	Farm	1.105	1.129	1.167	1.225	1.258	1.274	1.307
44	07	Agricultural services, forestry, fisheries, and other	1.133	1.166	1.242	1.356	1.428	1.464	1.536
44	15	Construction	1.049	1.059	1.078	1.107	1.127	1.136	1.156
44	40	Railroad Transportation	1.134	1.165	1.216	1.299	1.351	1.371	1.423
44	44	Water Transportation	0.954	0.939	0.939	0.934	0.934	0.934	0.934
44	45	Transportation by air	1.215	1.269	1.358	1.493	1.582	1.627	1.716
44	992*	Federal, military	0.917	0.910	0.916	0.927	0.936	0.941	0.951
44	998*	Total Manufacturing	1.068	1.083	1.108	1.146	1.171	1.183	1.208
44	999*	Population	1.017	1.025	1.038	1.058	1.072	1.079	1.093

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
44	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
45	01	Farm	1.060	1.085	1.120	1.173	1.202	1.216	1.245
45	07	Agricultural services, forestry, fisheries, and other	1.201	1.248	1.349	1.499	1.597	1.647	1.745
45	15	Construction	1.081	1.100	1.133	1.183	1.215	1.231	1.264
45	40	Railroad Transportation	1.096	1.119	1.184	1.280	1.338	1.367	1.425
45	44	Water Transportation	1.023	1.029	1.043	1.065	1.079	1.086	1.101
45	45	Transportation by air	1.215	1.268	1.382	1.551	1.664	1.720	1.832
45	992*	Federal, military	0.906	0.907	0.914	0.924	0.934	0.939	0.949
45	998*	Total Manufacturing	1.139	1.172	1.231	1.319	1.375	1.402	1.458
45	999*	Population	1.044	1.056	1.077	1.109	1.130	1.141	1.162
45	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
46	01	Farm	1.018	1.041	1.076	1.130	1.162	1.177	1.209
46	07	Agricultural services, forestry, fisheries, and other	1.195	1.232	1.325	1.463	1.553	1.597	1.687
46	15	Construction	1.083	1.092	1.116	1.150	1.172	1.183	1.205
46	40	Railroad Transportation	1.213	1.267	1.342	1.455	1.524	1.557	1.626
46	44	Water Transportation	1.000	1.000	1.000	1.000	1.000	1.000	1.000
46	45	Transportation by air	1.220	1.273	1.360	1.493	1.583	1.627	1.717
46	992*	Federal, military	0.960	0.948	0.959	0.974	0.987	0.993	1.006
46	998*	Total Manufacturing	1.225	1.265	1.353	1.485	1.570	1.612	1.697
46	999*	Population	1.037	1.047	1.064	1.089	1.106	1.114	1.130
46	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
47	01	Farm	1.045	1.076	1.124	1.196	1.238	1.260	1.302
47	07	Agricultural services, forestry, fisheries, and other	1.218	1.264	1.375	1.541	1.650	1.705	1.815
47	15	Construction	1.091	1.103	1.128	1.166	1.191	1.204	1.229
47	40	Railroad Transportation	1.122	1.152	1.217	1.315	1.373	1.402	1.460
47	44	Water Transportation	1.063	1.078	1.100	1.134	1.156	1.166	1.188
47	45	Transportation by air	1.212	1.265	1.366	1.519	1.618	1.668	1.768
47	992*	Federal, military	0.949	0.944	0.952	0.964	0.975	0.981	0.992
47	998*	Total Manufacturing	1.123	1.146	1.191	1.257	1.299	1.320	1.363
47	999*	Population	1.048	1.060	1.079	1.108	1.127	1.137	1.157
47	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
48	01	Farm	1.108	1.133	1.187	1.269	1.317	1.341	1.388
48	07	Agricultural services, forestry, fisheries, and other	1.207	1.253	1.362	1.526	1.634	1.688	1.796
48	15	Construction	1.073	1.087	1.115	1.156	1.183	1.196	1.222
48	40	Railroad Transportation	1.201	1.252	1.335	1.461	1.538	1.577	1.654
48	44	Water Transportation	1.025	1.032	1.037	1.044	1.052	1.056	1.064
48	45	Transportation by air	1.209	1.261	1.352	1.489	1.581	1.627	1.718
48	992*	Federal, military	0.998	0.998	1.002	1.009	1.018	1.022	1.030
48	998*	Total Manufacturing	1.112	1.134	1.180	1.248	1.292	1.314	1.358
48	999*	Population	1.056	1.068	1.090	1.123	1.144	1.154	1.175
48	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
49	01	Farm	1.094	1.128	1.174	1.243	1.282	1.302	1.342
49	07	Agricultural services, forestry, fisheries, and other	1.264	1.319	1.450	1.646	1.779	1.846	1.979
49	15	Construction	1.150	1.167	1.219	1.297	1.347	1.372	1.421
49	40	Railroad Transportation	1.179	1.224	1.304	1.423	1.497	1.534	1.608
49	44	Water Transportation	1.150	1.150	1.150	1.200	1.200	1.250	1.250
49	45	Transportation by air	1.246	1.308	1.412	1.567	1.672	1.725	1.830
49	992*	Federal, military	0.953	0.951	0.957	0.967	0.976	0.980	0.989
49	998*	Total Manufacturing	1.186	1.225	1.302	1.418	1.490	1.527	1.599
49	999*	Population	1.087	1.108	1.147	1.206	1.242	1.260	1.295
49	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
50	01	Farm	1.064	1.097	1.144	1.215	1.256	1.276	1.317
50	07	Agricultural services, forestry, fisheries, and other	1.202	1.253	1.358	1.516	1.619	1.670	1.774
50	15	Construction	1.072	1.087	1.110	1.143	1.165	1.176	1.198
50	40	Railroad Transportation	1.127	1.155	1.211	1.289	1.331	1.359	1.401
50	44	Water Transportation	1.000	1.000	1.000	1.019	1.038	1.038	1.058
50	45	Transportation by air	1.283	1.350	1.448	1.601	1.704	1.753	1.857

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
50	992*	Federal, military	1.007	1.005	1.018	1.037	1.050	1.059	1.073
50	998*	Total Manufacturing	1.085	1.110	1.146	1.200	1.234	1.251	1.285
50	999*	Population	1.041	1.053	1.072	1.100	1.120	1.130	1.150
50	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
51	01	Farm	0.948	0.967	0.991	1.028	1.048	1.058	1.078
51	07	Agricultural services, forestry, fisheries, and other	1.213	1.256	1.363	1.524	1.631	1.684	1.790
51	15	Construction	1.067	1.074	1.100	1.138	1.164	1.177	1.203
51	40	Railroad Transportation	1.164	1.205	1.286	1.406	1.481	1.518	1.592
51	44	Water Transportation	0.996	0.994	1.003	1.017	1.028	1.033	1.045
51	45	Transportation by air	1.174	1.218	1.292	1.404	1.478	1.515	1.589
51	992*	Federal, military	0.963	0.963	0.971	0.982	0.993	0.998	1.008
51	998*	Total Manufacturing	1.062	1.075	1.108	1.158	1.190	1.207	1.240
51	999*	Population	1.043	1.054	1.074	1.104	1.125	1.135	1.156
51	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
53	01	Farm	1.013	1.020	1.065	1.132	1.172	1.193	1.233
53	07	Agricultural services, forestry, fisheries, and other	1.146	1.186	1.272	1.400	1.481	1.522	1.604
53	15	Construction	1.053	1.068	1.096	1.137	1.164	1.177	1.203
53	40	Railroad Transportation	1.201	1.251	1.331	1.449	1.523	1.559	1.632
53	44	Water Transportation	0.996	0.995	1.002	1.012	1.022	1.027	1.036
53	45	Transportation by air	1.137	1.171	1.249	1.366	1.442	1.481	1.557
53	992*	Federal, military	0.981	0.979	0.986	0.997	1.008	1.013	1.023
53	998*	Total Manufacturing	1.062	1.079	1.125	1.193	1.238	1.261	1.306
53	999*	Population	1.064	1.079	1.109	1.154	1.183	1.197	1.226
53	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
54	01	Farm	1.144	1.192	1.278	1.407	1.485	1.525	1.603
54	07	Agricultural services, forestry, fisheries, and other	1.233	1.286	1.408	1.591	1.714	1.774	1.897
54	15	Construction	1.069	1.073	1.082	1.097	1.108	1.114	1.126
54	40	Railroad Transportation	1.109	1.136	1.199	1.293	1.349	1.377	1.433
54	44	Water Transportation	1.011	1.014	1.017	1.022	1.028	1.034	1.039
54	45	Transportation by air	1.164	1.205	1.276	1.380	1.451	1.486	1.557
54	992*	Federal, military	0.979	0.995	1.005	1.022	1.034	1.042	1.054
54	998*	Total Manufacturing	1.035	1.040	1.060	1.090	1.109	1.119	1.139
54	999*	Population	1.014	1.018	1.024	1.032	1.041	1.046	1.055
54	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
55	01	Farm	1.014	1.060	1.130	1.233	1.288	1.316	1.371
55	07	Agricultural services, forestry, fisheries, and other	1.214	1.265	1.373	1.535	1.642	1.695	1.802
55	15	Construction	1.064	1.075	1.096	1.128	1.150	1.160	1.181
55	40	Railroad Transportation	1.206	1.258	1.325	1.426	1.486	1.516	1.576
55	44	Water Transportation	1.000	1.000	0.996	0.991	0.991	0.991	0.991
55	45	Transportation by air	1.188	1.235	1.322	1.452	1.539	1.583	1.670
55	992*	Federal, military	0.971	0.957	0.967	0.983	0.996	1.003	1.016
55	998*	Total Manufacturing	1.120	1.140	1.183	1.247	1.287	1.308	1.348
55	999*	Population	1.032	1.041	1.055	1.078	1.093	1.101	1.117
55	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
56	01	Farm	1.138	1.162	1.218	1.301	1.350	1.374	1.423
56	07	Agricultural services, forestry, fisheries, and other	1.228	1.279	1.395	1.568	1.684	1.741	1.857
56	15	Construction	1.075	1.083	1.108	1.146	1.171	1.183	1.208
56	40	Railroad Transportation	1.162	1.203	1.282	1.402	1.476	1.513	1.587
56	44	Water Transportation	1.071	1.071	1.071	1.143	1.143	1.143	1.143
56	45	Transportation by air	1.209	1.257	1.340	1.461	1.545	1.581	1.665
56	992*	Federal, military	1.047	1.071	1.079	1.090	1.100	1.106	1.116
56	998*	Total Manufacturing	1.116	1.139	1.184	1.253	1.297	1.319	1.363
56	999*	Population	1.039	1.048	1.064	1.088	1.103	1.110	1.126
56	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387