VOLUME X

EMISSION PROJECTIONS

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Prepared by:
The Pechan-Avanti Group
a unit of E.H. Pechan & Associates, Inc.
5528-B Hempstead Way
Springfield, Virginia 22151

Prepared for:
Projections Committee
Emission Inventory Improvement Program

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

ABBREVIATIONS

ACT	Alternative Control Technology Guideline
AP-42	EPA's *Compilation of Air Pollutant Emission Factors*
ASC	Area Source Category Codes
ASEM	Area Source Emissions Model
BACT	best available control technology
BEA	Bureau of Economic Analysis
CAAA	Clean Air Act Amendments
CARB	California Air Resources Board
CATC	Clean Air Technology Center
CEFS	California Emission Forecasting System
CEM	Continuous Emissions Monitoring
CHIEF	Clearinghouse for Inventories and Emission Factors
CO	carbon monoxide
CTC	Control Technology Center
CTG	Control Techniques Guideline
DOE	Department of Energy
EDMS	Emission Dispersion Modeling System
E-GAS	Economic Growth Analysis System
EFIG	Emission Factor and Inventory Group
EIA	Energy Information Administration
EIIP	Emission Inventory Improvement Program
EPA	U.S. Environmental Protection Agency
FAA	Federal Aviation Administration

ABBREVIATIONS, ACRONYMS, AND SYMBOLS (CONTINUED)

FHWA	Federal Highway Administration
FIP	Federal Implementation Plan
FIRE	Factor Information Retrieval System
GDP	gross domestic product
GNP	gross national product
GSP	gross state product
HC	hydrocarbons
HDDV	heavy duty diesel vehicles
HDGV	heavy duty gasoline vehicles
HP	horsepower
I/M	inspection and maintenance
IPM	Integrated Planning Model
IRS	U.S. Internal Revenue Service
KW	kilowatt
LDDT	light duty diesel trucks
LDDV	light duty diesel vehicles, up to 6,000 lb. gross vehicle weight
LDGT1	light duty gasoline trucks, up to 6,000 lb. gross vehicle weight
LDGT2	light duty gasoline trucks, from 6,001 to 8,500 lb. gross vehicle weight
LDGV	light duty gasoline vehicles
LTO	landing and takeoff
MC	motorcycles
MPO	metropolitan planning organization

ABBREVIATIONS, ACRONYMS, AND SYMBOLS (CONTINUED)

MPS	Multiple Projections System
MSA	metropolitan statistical area
MVEI	Motor Vehicle Emission Inventory
MWC	municipal waste combustors
NAICS	North American Industry Classification System
NLEV	National Low Emission Vehicle
NMHC	non-methane hydrocarbons
NO_X	nitrogen oxides
NSR	new source review
OAR	Office of Air and Radiation
OMB	Office of Management and Budget
OMS	Office of Mobile Sources
OSHA	Occupational Safety and Health Administration
PM	particulate matter
POTW	publicly owned treatment works
QA	quality assurance
QC	quality control
RC	regulation control
RE	rule effectiveness
REMI	Regional Economic Models, Inc.
RP	rule penetration
RVP	Reid vapor pressure

Abbreviations, Acronyms, and Symbols (continued)

SCC	Source Classification Code
SDC	State Data Center
SIC	Standard Industrial Classification
SIP	state implementation plan
SO_2	sulfur dioxide
TDM	travel demand model
TRENDS	National Air Pollutant Emission Trends Report
TSDF	treatment, storage, and disposal facility
TTN	Technology Transfer Network
VMT	vehicle miles traveled
VOC	volatile organic compound

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OVERVIEW OF PROJECTION METHODS

The focus of this report is to provide information and procedures to State and local agencies for projecting future air pollution emissions for the following emitting sectors: point, area, onroad and nonroad mobile. The goal in developing emission projections is to attempt to account for as many of the important variables that affect future year emissions as possible. Emission projections provide a basis for developing control strategies for State Implementation Plans (SIPs), conducting attainment analyses, and tracking progress towards meeting air quality standards.

Emission projections are a function of change in activity (growth or decline) combined with changes in the emission rate or controls applicable to the source. To a large extent, projection inventories are based on forecasts of industrial growth, population growth, changes in land use patterns, and transportation growth. Changes in the emission rate of sources can be influenced by such causes as technological advances, environmental regulations, age or deterioration, how the source is operated, and fuel formulations.

In general, stationary and area source projections will be based on the following equation:

$$E_{fy} = E_{by} * G * C \qquad \text{(Equation 1-1)}$$

where E_{fy} = projection year emissions
E_{by} = base year emissions
G = growth factor
C = control factor, accounting for changes in emission factors or controls

For mobile sources, the general equation is:

$$E_{fy} = A_{by} * G * F \qquad \text{(Equation 1-2)}$$

where E_{fy} = projection year emissions
A_{by} = base year activity
G = growth factor
F = projection year emission factor

In this equation, the projection year emission factor accounts for the effect of any new regulations as well as technological changes.

There are complicating issues which go beyond the parameters explained in these two equations, so a specific projection calculation should be developed for each sector in each area. For example, within the point source sector, industry growth and the addition of new plants are often accompanied by the retirement of aging facilities. Projections should reflect this because net growth can only be determined after retirement is defined, and emission rates often differ for the new sources that replace existing ones. Other sectors may also require such adjustments to the generalized equations listed above.

The purpose of the emission projections may influence the methodology selected. If control cost analyses will be performed, source specific information may need to be retained. Grid-based air quality models also require source specific information, including location and stack parameters. Other efforts may also require county/source category level information, so that emissions can be aggregated for projection purposes.

This document contains four chapters describing projection methods in more detail for point, area, onroad and nonroad mobile sources respectively. Inventories are based on source classification systems that identify the sector as well as the specific process (e.g., pulverized coal-fired utility boiler, rotogravure printing, light-duty gasoline vehicles).

Areas should also examine the source types that currently dominate its inventory or that are expected to dominate in future years. This may suggest source categories where more emphasis should be placed on the development of methods and data for emission projections, depending on available resources.

Source Classification Codes (SCCs) are used by EPA and by many State and local agency emissions data systems to describe the types of processes within a point source inventory. Area, nonroad, and onroad mobile sources are generally classified by Area Source Category Codes (ASCs). The latest posted SCC and ASC code lists are available in various formats at: **http://www.epa.gov/ttn/chief/scccodes.html**.

The U.S. Office of Management and Budget publishes the list of Standard Industrial Classification (SIC) codes used to classify businesses by the type of activity in which they are engaged. These codes are used to facilitate the collection, tabulation, presentation, and analysis of data relating to establishments and are identified by codes of 2 to 4 digits. The Office of Management and Budget's Economic Classification Policy Committee is currently working on producing a new industry classification system. The North American Industry Classification System (NAICS), which will replace the SIC classification system, is projected to be completed in 2002. The NAICS web site provides information on this new classification system: **http://www.naics.com**.

The following site provides links to pages maintained by OSHA and other agencies regarding the SIC codes and their replacement NAICS codes: **http://www.epa.gov/ttn/chief/eiip/eicrepts.htm#techpapers**.

SCCs are used to identify the type of process and can be used to determine the associated controls. SICs indicate the type of industry and are important for selecting growth factors. Some area and mobile source categories do not have associated SICs (industries). For these categories, surrogates such as population, vehicle miles traveled (VMT), and engine populations are used to estimate activity growth. For certain area source categories, such as wood furniture surface coating, the link between ASC and SIC is straightforward. Others, such as open top vapor degreasing, may be a combination of several industries, so the link is not straightforward and may require using surrogate data representing a cross-section of industries.

Point source inventories generally include SICs for individual plants and points. In cases where SICs are not included in a point source inventory, SCCs and SICs must be linked to apply growth data. As for area sources, there is no perfect mapping scheme between the SCC and SIC, particularly for the industrial fuel combustion SCCs, which can be associated with many industries.

Additional detail on selecting growth surrogates and the link between SCCs, ASCs, and SICs, is provided in the specific chapters in this report.

1.1 GROWTH FACTOR

The growth factor accounts for changes (increases or decreases) in the emission-generating activity. In selecting the growth factor, the most important considerations are how closely the surrogate data approximates or relates to changes in the emission-generating activity; how closely it relates to the activity indicator used to develop the base year emissions; and the locality (how well it characterizes the activity in the area of interest versus a larger geographical area). Potential growth indicators include employment, earnings, value added, and product output.

1.1.1 EMPLOYMENT

Employment level is a direct measure of growth, since, theoretically, as employment increases, production will increase until diminishing returns begin to have an effect on markets, and therefore, on production. But the employment level is a direct measure of growth, only if the stock of natural resources and capital, as well as the level of technology are held constant. Technological change has its impact primarily on the efficiency with which factors of production are used.

Employment data is considered a more accurate growth indicator than population data, since higher levels of employment reflect economic growth, which in turn reflect rises in pollution-generating activity levels. However, employment figures alone would not be convenient measures of the efficiency with which labor is being used in production. If technological improvement occurs, more output can be produced with the same quantity of labor, holding all other factors constant. Employment, for instance, could feasibly remain constant, while the real gross national product (GNP) increases as a result of technological improvements. Thus the employment level alone therefore is not an effective growth indicator in most cases.

1.1.2 Earnings

A measure of earnings, rather than employment data, would better reflect the efficiency with which labor has been used in production. Real earnings data are thus preferred to employment figures for an industry, because earnings data capture productivity improvements that are not apparent from employment trends. As an example of the difference between using earnings and employment as the basis for projections, 1990 BEA earnings projections for the Texas chemical industry show an expected increase in earnings of $3.16 billion to $3.65 billion from 1988 to 2000 - an increase of 15.5 percent over that period. Employment for this industry/state combination, on the other hand, is only expected to increase by 2.7 percent over this time period.

1.1.3 Value Added

Value added is defined as the value of a product sold by a firm less the value of the goods purchased and used by the firm to produce the product, and equal to the revenue which can be used for wages, rent, interest, and profits. Consider the following example: the manufacture of a $20,500 car requires $8,000 worth of steel, which in turn requires $2,000 of coal and $5,000 of iron to manufacture. The mines sell $7,000 worth of output to the steel firm, which adds $1,000 in capital and labor costs to produce $8,000 of steel. In addition to $9,000 of other inputs, the auto manufacturer adds $3,000 to make an auto for $20,000, and the dealer adds $500 in services to sell at $20,500 to the customer. In this example, each producer adds value to the final product. Total value added is $7,000 by the mines, $1,000 by the steel manufacturer, $9,000 by other manufacturers, $3,000 by the auto manufacturer, and $500 by the dealer, for a total cost of $20,500. The price of the final output reflects the value of each input, or the total value added.

Consider the steel firm that bought $7,000 of output from the mines. The $1,000 of capital and labor costs that were added also represent the firm’s income after selling $8,000 of steel to the auto manufacturer. This $1,000 income figure is then used to pay the firm’s factors of production. The sum of each firm's income in this simple example equals $20,500 ($7,000 for mines, $1,000 for steel firm, etc.), which is also equal to total value added and is reflected on the income side of GNP. The national income figure in total GNP is both a measure of production and a measure of money income. It represents the factor costs of current output and the money earned by the factors of production. Used as a growth indicator, value added would therefore encompass substitution among factors of production, and would indirectly reflect technological change. Data representing total value added ($12,500 in this case) are reflected in the national income figure of GNP, since the sum of all income (wages, interest, rent, and profit) is equal to the total value added, and, therefore, to the total (final) product.

The periodic Census of Manufacturers is a source of published data on value added. This survey is performed by the U.S. Department of Commerce, Bureau of the Census, and is available at: **http://www.census.gov/econ/www/manumenu.html**.

1.1.4 PRODUCT OUTPUT

Finally, the most direct indicator of future emissions activity is product output, a direct measure of the amount of product being produced. All four of the factors mentioned above, employment, resource availability, capital growth, and technology, are directly related to product output level. Output is a good indicator of the prevailing employment situation, as well as of the resources and capital available to producers. The actual output level is determined by the efficiency with which these resources are being used, which is in turn a reflection of technological change. Population changes should also be taken into account when using product output levels, since product output per capita is the most meaningful growth indicator. Any regional projections of future product would thus be preferable to any of the above indicators, if it is available.

1.1.5 GROWTH DATA SETS

The data used to project activity growth depend on the sector of analysis. Onroad mobile projections may use Vehicle Miles Traveled (VMT) data. Point and area source projections are usually based on the U.S. Department of Commerce's Bureau of Economic Analysis (BEA), Economic Growth Analysis System (E-GAS), or Regional Economic Models, Inc. (REMI) data, as well as data from local metropolitan planning organizations. Table 1.1-1 contains references for several national, state, and local growth data sources.

Future changes in activity level will be the result of complex interactions between human population growth, changes in national and local economic factors, and changes in the markets for the sector being examined and the products it produces. Historically, EPA has often used projections of economic indicators as surrogates for growth in activity for the purpose of estimating future emissions. Developing projections from these data sets can be accomplished in many ways. The most common and simplistic method is through the use of extrapolations of collected historic data. Historic extrapolations to project economic activity should be carried out using accepted statistical and economic techniques, such as multiple regression analysis, moving averages or autoregression.

However, this use of economic indicators to predict growth in a sector has its drawbacks. Projections based on historic extrapolations capture long-term trends and may not accurately represent year-to-year fluctuations and changes in activity. Economic indicators, at best, can only predict growth broadly across the economy, and therefore cannot identify market trends within individual sectors. Another drawback is that economic indicators may not be able to adequately predict the effects of substitution of equipment for labor in the market.

The development of local or state economic growth data, specific to the local economic and demographic characteristics, can mitigate the effects of the aforementioned drawbacks. The California Air Resources Board (CARB) has developed an approach that combines state-level data with national growth indicators to project emissions for the nonroad sector. CARB developed a "top-down" and a "bottom-up" approach for developing State and county estimates. Because of the unavailability of detailed long term data and CARB's desire for consistency across a large number of geographic areas (the State's 58 counties), CARB commonly used the top-down approach. In this case, an annual activity measure for a given category was estimated at the state level based upon existing state or national data, then distributed across counties on the basis of related data for which a county breakdown was available. The bottom-up approach employed by CARB was carried out for cross-section studies for short-term analyses, when detailed data was available by county. As an example of this bottom-up approach, CARB was able to accomplish this approach successfully with aviation, for which extensive data and forecasts were available by airport, which could then be assigned to the individual counties. The CARB website has more information on how the State uses its data (**http://www.arb.ca.gov**).

1.2 CONTROL FACTOR/EMISSION FACTOR

Control strategy projections are estimates of future year emissions that also include the expected impact of modified or additional control regulations. State and local planners should determine if any future scheduled regulations, whether at the Federal, State, or local level, apply to sources in their area.

Future year emissions may also be affected by fuel switching, fuel efficiency improvements, improvements in performance due to economic influences, or any occurrence that alters the emission-producing process. Programs other than those aimed at reducing the emissions of the criteria pollutants of interest may affect the future year emissions. These may include energy efficiency programs, pollution prevention programs, and greenhouse gas or global warming initiatives. These should all be reflected in the projections through the future year control factor, emission factor, or in some cases, by adjusting the activity growth forecast.

Control factors and emission factors vary by source category and are continuously being revised and improved based on field and laboratory measurements. State and local agencies should maintain close coordination with the appropriate EPA Regional Office to ensure that all factors reflect current EPA guidance. States must also examine the future year control factor or emission factor in relation to the base year value to ensure any existing controls are not double-counted by taking additional credit in the future year. The control factor and emission factor may also be a weighted composite in some cases, such as diesel construction engines versus each individual equipment type within the category.

Technical documents from EPA, including Alternative Control Techniques (ACT) documents and Control Techniques Guidelines (CTG) documents, are collected at the Clean Air Technology Center on EPA's TTN web site: **http://www.epa.gov/ttn/catc/products.html**. ACT documents provide technical information, based on data collected from model plants, for use by State and local agencies to develop and implement regulatory programs to control emissions. The model plants in the ACT documents represent typical emitters; area-specific factors may cause discrepancies and deviations and should be accounted for when comparing ACT document costs to actual performance. CTG documents provide federal guidelines to State and local agencies to assist those areas when formulating a plan to meet federal air quality requirements.

In determining the future year control factor or emission factor, three basic parameters must be quantified: regulation control, rule effectiveness, and rule penetration. Regulation control is the level of reduction expected by assuming a fully complied measure. Rule effectiveness accounts for the level of expected compliance with the regulation. Rule penetration indicates the fraction of emissions within a source category which are subject to the regulation, accounting for size cutoffs and other exemptions.

The control factor can be described as:

$$C = 1 - [(RC/100) * (RE/100) * (RP/100)] \qquad \text{(Equation 1.2-1)}$$

where C = control factor
RC = regulation control
RE = rule effectiveness
RP = rule penetration

Note that the control factor is 1 minus the combination of control efficiency, rule effectiveness, and rule penetration.

For mobile sources where emission factors are generally used in the projections, models are available which calculate the future year emission factor (see NONROAD and MOBILE models listed in the respective chapters).

1.2.1 REGULATION CONTROL

The regulation control reflects the expected reduction for an individual source category or subject to a measure, assuming full compliance. The regulation controls on a point source are not the same as the control equipment efficiency used to calculate base year emissions. The source may choose various options available to them to control emissions in the future to meet the rule requirements.

1.2.2 RULE EFFECTIVENESS

The concept of rule effectiveness has evolved from the observations that most regulatory programs are less than 100 percent effective. Several factors should be taken into account when estimating the effectiveness of a regulatory program: the nature of the regulation, the nature of the compliance procedures, the performance of the source in maintaining compliance over time, and the performance of the implementing agency in assuring compliance. Given that the effectiveness of control measures can vary from source to source, rule effectiveness should be tracked at the source category level.

The base year inventory may or may not include rule effectiveness in emission calculations. The estimated rule effectiveness value obtained in the base year calculations can be used to develop a future year rule effectiveness value. To prepare projections for categories subject to rules with future implementation dates, the estimated net controls for the rule (controls specified in the rules and the estimated rule effectiveness) are required. Some sources in the category may comply before a rule's specified implementation date, while others may comply after the implementation date.

For forecasting emissions, all source categories subject to a rule should track the controls specified by the rule and the rule effectiveness. The estimated rule effectiveness should account for rule penetration if the source category contains some sources that are exempt from the rule. This adjustment to rule effectiveness to account for rule penetration is not needed if the exempt sources are grouped under a different source category showing no controls.

1.2.3 RULE PENETRATION

In addition to rule effectiveness, rule penetration quantifies the extent to which a regulation may cover emissions within a source category. When a rule for a source category is adopted with a stated level of control, some sources may be exempted or may have limits setting higher or lower levels of control. This can lower the overall control achieved for a source category subject to a rule. Frequently, some sources in a category will not comply or will be late in complying with the limits in the rule. All of these factors should be considered when determining the rule penetration for a source category. The net control for the source category is then obtained by multiplying the rule penetration, the control percentage, and the rule effectiveness.

1.2.4 MEASURING THE IMPACT OF MULTIPLE CONTROL MEASURES

More than one control measure can affect the emissions in a single emission category. The methodology addressing the affects of multiple control measures must reflect each control measure’s level of control, and how many pollutants will be affected. In some cases, a new measure can be adopted on top of the control measure already in place, leading to a greater combined emission reduction. In these cases, it is imperative that any reductions credited by the new control measure configuration reflect the emission reductions due to new controls. In all cases, emission reductions should be correctly assigned to the control measures.

1.3 MEASURING THE EFFECTIVENESS OF CONTROL PROGRAMS

The previous sections discussed the two major elements of an emission projection: the growth or activity projection and the future year control or emission factor. It is important to note that control programs may in some cases affect either or both of these parameters. Installing a control device or making other modifications may impact the control factor. Nonroad engine standards may impact the future year emission factor. Seasonal bans may reduce the level of emission generating activity and, therefore, should be incorporated into the projection by either adjusting the activity projection, or including a control factor. Efficiency improvements in a plant may reduce the need for steam, thereby reducing the amount of fuel which must be burned to supply the steam. This can also be reflected through adjustments to the activity projection, or through the use of a control factor which will account for the reduced fuel usage (though the former is preferred).

In many cases, it will also be necessary to account for multiple programs which affect the same source category. Industrial boiler emission projections may be affected by both new regulations requiring the installation of controls as well as efficiency improvements. Onroad mobile emissions may be affected by tailpipe standards, inspection and maintenance programs, as well as transportation initiatives aimed at reducing vehicle miles traveled. Therefore, expected controls should be calculated for each action and applied appropriately on the stated dates.

Other programs are complex and determining appropriate control factors or adjustments to activity forecasts for specific source categories is not straightforward. For example, initiatives to reduce energy use, such as the EPA Green Lights program, are aimed at reducing electricity demand. This, in turn, is tied to reductions in emissions from individual utility boilers. Emission caps or allowance programs set overall constraints on future emission levels, but this must also be translated into reductions at individual units in most cases. For trading programs, a simplified approach may be to constrain emissions at individual units to the level used to calculate the emission budget. More complex approaches would examine how individual units will respond – by controlling emissions or purchasing credits.

1.4 OTHER CONSIDERATIONS

There are several other factors which should be considered in performing emission projections, particularly when air quality modeling will be performed using the projection. This includes potential changes in the spatial, temporal, and/or speciation profiles of the emissions. Additional information on spatial, temporal, and speciation considerations can be found in the respective EIIP emission inventory development documents (**http://www.epa.gov/ttn/chief/eiip/techrep.htm**) .

1.4.1 Spatial Considerations

In performing emission projections, it is important to account for any geographic shifts in emissions. Changes in land use patterns may lead to shifts in the location of emissions or may result in higher growth in some areas as opposed to others.

Changes in land use patterns may also influence the types of sources emitting in an area. For example, suburbanization of rural areas may result in decreases in the agricultural sector activities and increases in activity of population-based emission sources such as lawn and garden, consumer solvents, and highway vehicles.

1.4.2 Temporal Considerations

The temporal profile (when the pollution is emitted, including seasonal, monthly, daily, and hourly differences) is important, because meteorology also impacts the dispersion of pollution and the chemical transformations to species of concern (ozone, fine particles). Control strategies should be reviewed to determine whether any will have a seasonal impact, or result in shifts in the time period of emissions.

1.4.3 Speciation Considerations

Emission modeling systems speciate criteria pollutant emissions. VOC emissions are dispersed into many different compounds with varying degrees of reactivity. In projecting emissions, changes in fuel and solvent formulations should be reviewed to identify changes in the projection year speciation profiles. Changes may be the result of regulations such as the control of toxic pollutants (especially VOC) or economic incentives (e.g., cost of solvents).

1.5 Quality Assurance

The functions of quality assurance include the following:

1. Ensure reasonableness of the emission projections and data used,
2. Ensure validity of the assumptions and methods used,
3. Ensure mathematical correctness (e.g., ensure calculations were performed correctly),
4. Ensure valid data were used,
5. Assess the accuracy of the estimates.

Projected emissions should be compared with base year emissions to identify any anomalies which might indicate calculation or data errors. The QA reviewer should verify reasons for trends towards higher or lower emissions. For example, if projected emissions are lower than those in the base year, the reviewer might examine the activity projection versus the change in projection year emission factors to ensure that the magnitude of these changes support the overall change in emissions from the base year. Comparisons of contributions of different source categories to total emissions in the base year and in the projection year should also be reviewed and any significant changes explained.

Projected emissions should be compared with those made using an alternative methodology, such as the National Emission Trends projections, to identify any anomalies which might indicate calculation or data errors. Again, any major differences should be evaluated by examining differences in the input data (e.g., did the local population estimates differ significantly from the national defaults).

Hand-calculations should be completed using a sample of data to ensure mathematical correctness.

The preparer should verify that the data being used are the most current and best available data.

1.6 REFERENCES

CARB, 1994: California Air Resources Board, *A Study To Develop Projected Activity for "Non-Road Mobile" Categories in California, 1970-2020*, California Environmental Protection Agency, California Air Resources Board, October 1994.

EPA, 1991: U.S. Environmental Protection Agency, *Procedures for Preparing Emissions Projections*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, July 1991.

EPA, 1993: U.S. Environmental Protection Agency, *Guidance for Growth Factors, Projections, and Control Strategies for the 15 Percent Rate-of-Progress Plans*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, March, 1993.

EPA, 1998: U.S. Environmental Protection Agency, *Emission Inventories and Proper Use of Rule Effectiveness*, U.S. Environmental Protection Agency, Emission Inventory Improvement Program, Point Sources Committee, September 23, 1998.

TABLE 1.1-1

PROJECTION RESOURCES

Resource	Where To Go	Brief Description
National		
Economic Growth Analysis System (E-GAS)	**http://www.epa.gov/ttn/chief/ei_data.html#EGAS**	Provides economic growth factors in a way that allows States to use their own estimates of national and regional economic activity.
BEA Data (from U.S. Department of Commerce's Bureau of Economic Analysis)	**http://www.bea.doc.gov/**	BEA's national and regional economic accounts present basic information on issues such as U.S. economic growth and regional economic development.
Standard & Poor's DRI Regional Economic Service	**http://www.dri.mcgraw-hill.com/regional/index.htm**	Standard & Poor forecasts of key economic and demographic concepts for 50 states, 310 metropolitan areas, and over 3000 counties, along with U.S. regional models which provide current projections of interest rates, GDP, inflation, and other economic indicators.
DOE/EIA's Annual Energy Outlook 1999	**http://www.eia.doe.gov/oiaf/forecasting.html**	Overview forecasts of annual energy supply, demand, and prices through 2020 based on results of EIA's National Energy Modeling System (NEMS). Site also contains information on climate change and other projections.
WEFA	**http://www.wefa.com/**	Provides data at the state, MSA, and census tract level for the United States. Statistics range from general macro-economic indicators to company-specific detail.
Regional Economic Models, Inc. (REMI)	**http://www.remi.com/**	REMI constructs regional and national economic forecasting models based on the effects of policy initiatives and programs.

Resource	Where To Go	Brief Description
State and Local		
Office of State Planning of North Carolina	**http://www.ospl.state.nc.us/sdn/**	North Carolina State Data Center (SDC) is a consortium of state and local agencies that provides information and data about the State and its component geographic areas - the SDC program is a cooperative effort between the U. S. Bureau of the Census and the State

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POINT SOURCE EMISSION PROJECTIONS

Point sources are large, stationary, identifiable sources of emissions and are typically manufacturing or production plants. Based on resources, emission size cutoffs are generally established to determine which stationary sources will be identified as point sources (versus area sources) within an inventory.

Point source emissions data are typically retained at the plant, point, and source level. A source is generally identified by its source classification code (SCC). Table 2-1 presents a list of 3-digit SCCs common to point sources. A complete catalog of 3, 6, and 8-digit SCCs can be found at: **http://www.epa.gov/ttn/chief/scccodes.html**.

EPA's *Compilation of Air Pollutant Emission Factors* (AP-42) contains extensive data on point sources, including the types of industries and sources and the types of pollutants produced by them, and can be found at: **http://www.epa.gov/ttn/chief/ap42.html**.

Further information on point sources can be found at the EIIP Point Source Committee site: **http://www.epa.gov/ttn/chief/eiip/eiip_pt.htm**.

2.1 OVERVIEW OF PROJECTION METHODS

Emission projections for point sources are dependent upon changes in source level activity and changes in the emission factor or controls applicable to the source. The approach utilized to project point source emissions may be dependent on the level of detail necessary in the projection year file. For SIP tracking, it is appropriate to sum emissions by county and source category and apply the appropriate growth and control estimates. This method is generally used since growth, retirement, and other factors are usually area and source category specific, but not available at the unit or facility level. If unit-specific information is required for air quality modeling, then projections must be performed at this level using county-source category level projections.

For point sources, several factors must be incorporated into an overall emission projection equation. The equation listed below represents a typical emission projection equation for point sources:

$$E_{fy} = E_{by} * GF_{(s)} * RF_{(s)} * [\, CF_{(m_1, p)} * CF_{(m_2, p)} * ... * CF_{(m_I, p)}] \quad \text{(Equation 2.1-1)}$$

where E_{fy} = Emissions in the future year
E_{by} = Emissions in the base year
G = Growth Factor (ratio of two activity levels at the end-point years)
R = Retirement Factor (ratio of two activity levels at the end-point years)
C = Control Factor (ratio of two control levels at the end-point years)

subscript variables s = the source category (SCC/SIC)
p = the pollutant
m = the control measure
I = the ith control measure

The above equation can easily be applied to perform point source projections at the source category level. The control factors should account for rule effectiveness and rule penetration as well as the regulation controls. The control factor can account for technological or efficiency changes, process changes such as fuel reformulations, and/or add-on controls.

2.1.1 GROWTH AND RETIREMENT

Changes in point source emissions are accounted for by a combination of growth and retirement rates. Growth rates are applied to estimate the overall change in activity, while retirement rates are applied to estimate the decrease in emissions activity from existing sources. Retirement (and replacement of these sources with new sources) must be considered due to the fact that regulations affecting new sources may differ from those affecting existing sources. Retirement rates are developed from equipment turnover rates and depreciation tables by the Department of Energy (DOE) and Internal Revenue Service (IRS). Table 2.1-1 delineates potential sources of retirement rate information.

Two methods exist to estimate the effect of growth and retirement. One approach is to use detailed, source level growth and plant retirements where available. State and local agencies can use their own detailed information based on their surveys of individual facilities. The other approach utilizes surrogates for growth and retirement. These are generally characterized by industry type. These can be applied directly if the projection approach is based on aggregating emissions by county and source category. Otherwise, all facilities within the industry must be “grown” at the same rate and a portion of the emissions at each facility retired to reflect the overall rate of retirement. Also important for the point source sector is the level of growth that can occur at existing facilities by increasing capacity utilization versus increases requiring major modifications on new sources, which may be subject to more stringent control requirements.

For the point source sector, growth in activity may vary dramatically from industry to industry. Economic indicators which may be used to project growth include product output, value added, earnings, and employment (further information on economic indicators is included in the Overview chapter). EPA suggests that all local growth data be checked versus a national activity projection to ensure that widely differing growth data is not used at the local level. When assigning growth factors, potential differences by emission type should be considered. For example, process emissions may track well with industry GSP, while fugitive and combustion emissions may not, or equipment leaks will not necessarily increase with increased production.

2.1.2 CONTROL FACTOR

The projection year control factor accounts for both changes in emission factors due to technology improvements and new levels of control required by regulations. The control factor accounts for three variables: regulation control, rule effectiveness, and rule penetration. These are described in more detail in the Overview chapter.

Control factors are closely linked to the type of emission process (identified by SCC) and secondarily to the type of industry identified by SIC. Point source projections should account for Federal, State, and local regulations affecting these categories. For federally-mandated controls, the EPA documents and the models referenced in the following sections will be the best available resources for determining the appropriate control factor to apply in projected inventories.

Technical documents from EPA, including Alternative Control Techniques (ACT) documents and Control Techniques Guidelines (CTG) documents, are collected at the Clean Air Technology Center on EPA's TTN web site: **http://www.epa.gov/ttn/catc/products.html**. ACT documents provide technical information, based on data collected from model plants, for use by State and local agencies to develop and implement regulatory programs to control emissions. CTG documents provide federal guidelines to State and local agencies to assist those areas in planning and meeting federal air quality requirements.

The latest regulatory actions from the Office of Air and Radiation (OAR) can be found at: **http://www.epa.gov/ttn/oarpg/new.html**.

OAR also provides a page devoted to policy, guidance, and regulations, sorted by the Title of the Clean Air Act Amendments (CAAA) to which they apply: **http://www.epa.gov/ttn/oarpg/amend.html**.

2.1.3 COMBINING GROWTH AND CONTROL

When a State or local agency needs to estimate the combined effect of activity growth and emissions control on air pollution emissions for a projection year, there are several options available depending on the desired level of detail of the calculations. The two options discussed below are not the only approaches available, but they represent methods that have been tested and accepted.

The first option aggregates all base year emissions and control information by county and source category and performs projections at that level. The second option retains source level information, projecting emissions on a source-by-source basis.

These two options have inherent advantages and disadvantages. The first option is the most computationally efficient, and allows emission changes to be tracked more easily. The second option retains individual source characteristics which may be required for input to air quality modeling. However, it is more time-consuming method, because all source-level data must be accounted for and generalizations are not possible.

If facility or unit-specific detail is necessary, options include applying a standard equation and then retiring a fraction of each unit or developing more complicated methods which attempt to predict which sources will retire and where new sources and modifications will be located. It is important to determine whether the applicable growth factors are "net," accounting for the net change in an industry, counting both new sources and retirements. In these cases, retirements must be replaced so that overall changes in emissions are consistent with the "net" growth estimates.

2.1.4 OTHER CONSIDERATIONS

When projecting point source emissions, several other factors should be considered. Certain areas must take into account emission trading, budgets, or allowances. There are three general approaches to performing projections while accounting for such trading schemes. The first option is to optimize control levels across an entire domain based on the cost of alternative controls. The second option is to survey individual sources to determine how they will comply (will they apply controls and sell or buy allowances) and use this as the basis for the future year control level. The third option is to apply the control level used to establish the budget to all affected sources and ignore which sources may choose to buy or sell credits/allowances.

Another complicating factor is the requirement for emission offsets in nonattainment areas through New Source Review requirements. This may be accounted for by 1) restricting growth under the assumption that it will be offset; 2) applying across the board reductions selected to source categories to account for emission growth which must be offset; or 3) selecting the individual sources, based on a cost analysis, from which offsets are likely to come.

Other factors include programs, such as fuel switching, designed to provide flexibility in having sources meet future air quality requirements. Fuel switching refers to instances where a unit historically burned one primary fuel, such as coal, and under a "fuel switching" program the unit would burn an alternate fuel, such as natural gas, during a certain period of time and may switch back to the "historic" fuel for some or all of the non-ozone season. Fuel switching is often done in cases where sources average their emissions to meet federal mandates. The variance in emissions over the course of the year that will be caused by fuels switching must be calculated properly during projections.

Repowering is another example of a planned change in emission rates which should be taken into consideration. In this case, the unit may be switching entirely from coal to gas or may be completing a major modification which would lower the emission rate.

Spatial allocation is another factor which must be considered, particularly if air quality modeling will be performed using the projection. For point sources, the important questions are where facilities will retire and where new growth will occur. There are more options in locating growth in basic industries versus nonbasic industries, such as drycleaning, which are dependent on local economics. Changes in land use patterns may also impact the location of point source emissions. As undeveloped and rural areas become suburban and urban areas, the number of point sources in that area will increase.

2.1.5 AVAILABLE MODELS AND RESOURCES

Table 2.1-2 delineates available resources and models related to point source emission projections.

2.2 ALTERNATIVE METHODS

The two basic methods for projecting point source emissions are:

(1) Aggregate emissions by source category and apply growth, retirement, and control factors.

(2) Retain source specific emissions and apply average growth, retirement, and control factors to each source or develop source-specific factors.

Alternative 1 is the preferred approach for SIP tracking purposes, since emission changes (due to controls, process changes, retirements, replacements, etc.) can be tracked more easily with the control factors.

There may be individual sectors where information is more readily available for use in a facility-specific approach. For the utility sector, information on planned units, expected retirements, future utilization of existing units, and plans for controls, fuel switching, and repowering is often available. In this case, unit or facility specific projections may be more appropriate.

2.3 REFERENCES

ERG, 1997: Eastern Research Group, Inc., *Introduction to Stationary Point Source Emission Inventory Development*, Eastern Research Group, Inc., Prepared for: Point Sources Committee, Emission Inventory Improvement Program, July 1997.

EPA, 1991b: U.S. Environmental Protection Agency, *Procedures for Preparing Emissions Projections*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, July 1991.

EPA, 1993: U.S. Environmental Protection Agency, *Guidance for Growth Factors, Projections, and Control Strategies for the 15 Percent Rate-of-Progress Plans*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, March, 1993.

EPA, 1995: U.S. Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors: Fifth Edition*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, January 1995.

EPA, 1995: U.S. Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors: Fifth Edition*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, January 1995.

Pechan-Avanti, 1997: The Pechan-Avanti Group, *The Emission Reduction and Cost Analysis Model for* NO_x *(ERCAM-*NO_x*)*, E.H. Pechan & Associates, Inc, prepared for the U.S. Environmental Protection Agency, Ozone Policy and Strategies Group, September 1997.

TABLE 2-1

POINT SOURCE CATEGORIES BY 3-DIGIT SOURCE CLASSIFICATION CODE

3-Digit SCC	Source Category		3-Digit SCC	Source Category
101	Electric Generation		399	Miscellaneous Manufacturing Industries
102	Industrial		401	Organic Solvent Evaporation
103	Commercial/Industrial		402	Surface Coating Operations
105	Space Heaters		403	Petroleum Product Storage at Refineries
201	Electric Generation		404	Bulk Terminals/Plants
202	Industrial		405	Printing/Publishing
203	Commercial/Institutional		406	Transportation and Marketing of Petroleum Products
204	Engine Testing		407	Organic Chemical Storage
301	Chemical Manufacturing		408	Organic Chemical Transportation
302	Food and Agriculture		490	Organic Solvent Evaporation
303	Primary Metal Production		501	Solid Waste Disposal - Government
304	Secondary Metal Production		502	Solid Waste Disposal - Commercial/Institutional
305	Mineral Products		503	Solid Waste Disposal - Industrial
306	Petroleum Industry		504	Site Remediation
307	Pulp and Paper and Wood Products		625	Food and Agricultural Processes
308	Rubber and Miscellaneous Plastics Products		631	Agricultural Chemicals Production
309	Fabricated Metal Products		641	Styrene or Methacrylate Based Resins
310	Oil and Gas Production		644	Cellulose-based Resins
312	Machinery, Miscellaneous		645	Miscellaneous Resins
313	Electrical Equipment		646	Vinyl-based Resins
314	Transportation Equipment		648	Miscellaneous Polymers
315	Photographic Equipment		649	Fibers Production Processes
320	Leather and Leather Products		651	Inorganic Chemicals Manufacturing
330	Textile Products		681	Consumer Product Manufacturing Facilities
360	Printing and Publishing		682	Miscellaneous Processes
385	Cooling Tower		684	Miscellaneous Processes (Chemicals)
390	In-process Fuel Use		685	Miscellaneous Processes (Chemicals)

TABLE 2.1-1

SOURCES OF RETIREMENT DATA

Resource	Where To Go	Brief Description
Retirement		
Retirement Data from the Internal Revenue Service (IRS)	**http://www.eia.doe.gov/oiaf/aeo99/homepage.html**	Industry retirement rates developed from IRS Depreciation Guidelines - presented in DOE's Annual Energy Outlook

NOTE: Sources for growth information are provided in Chapter 1.

TABLE 2.1-2

AVAILABLE MODELS AND RESOURCES

Resource	Where To Go	Brief Description
National Air Pollutant Emission Trends Report (Trends)	**http://www.epa.gov/oar/aqtrnd97**	Report contains a general approach for developing projections estimates for national criteria pollutants.
Integrated Planning Model (IPM)	**http://www.epa.gov/capi/**	Used in EPA's regulatory analyses - projections completed on a model plant level and disaggregated to the unit level.
Multiple Projections System (MPS)	**http://www.epa.gov/ttn/chief/ei_data.html#PS**	Stand-alone computer program designed to facilitate the projection of future emissions of ozone precursors, specifically carbon monoxide (CO), volatile organic compounds (VOCs), and oxides of nitrogen (NO_x).
California Emission Forecasting System (CEFS)	**http://www.arb.ca.gov/emisinv/pubs/pubs.htm**	Computer analysis program capable of predicting future emission levels in the State of California (for use only in that State).

3

AREA SOURCE EMISSION PROJECTIONS

Area sources collectively represent individual sources that have not been inventoried as specific point or mobile sources. These sources are typically too small, numerous, or difficult to inventory using the methods for the other classes of sources. Area sources represent a collection of emission points for a specific geographic area, most commonly at the county level; however, any area can be used to define the boundaries of an area source.

Area sources are both natural and manmade sources of pollution and can encompass such wide ranging activities as consumer solvents, agricultural burning, roadway paving, residential heaters, wildfires, and wind erosion. Area source emissions are typically identified at the county level by its Area Source Classification code (ASC). A complete listing of 10-digit ASCs can be found at: **http://www.epa.gov/ttn/chief/scccodes.html**.

EPA's *Compilation of Air Pollutant Emission Factors* (AP-42) contains extensive data on area sources (referred to in the document as "miscellaneous sources"), including types of area sources and pollutants produced by them, and can be found at: **http://www.epa.gov/ttn/chief/ap42.html**.

Further information on area sources can be found at the EIIP Area Source Committee site: **http://www.epa.gov/ttn/chief/eiip/eiip_ar.htm**.

3.1 OVERVIEW OF PROJECTION METHODS

Emission projections for area sources depend upon the change in source level activity and changes in the emission factor applicable to the source. For area sources, the most appropriate equation used to project emissions is:

$$E_{fy} = E_{by} * G * C \qquad \text{(Equation 3.1-1)}$$

where E_{fy} = projection year emissions
E_{by} = base year emissions
G = growth factor
C = control factor, accounting for changes in emission factors or controls

The base year activity (fuel use, employment, population) will vary depending on the source category. The growth activity indicator should align with the base year activity indicator as closely as possible.

The above equation is only an example of the necessary calculation for emission projections; further complicating factors required for an accurate projection may require the development of a more vigorous equation.

3.1.1 GROWTH FACTOR

As with point sources, area source projections can be made using local studies or surveys or through surrogate growth indicators, such as E-GAS, to approximate the rise and fall in expected activity. The most commonly used surrogate growth indicators are those parameters typically projected by local metropolitan planning organizations (MPOs) such as population, housing, land use, and employment. The Overview Chapter references several common surrogate growth indicators.

Area sources rarely have detailed information based on surveys of individual emitters. Generally surrogate growth rates, as characterized by source type, must be used. While surrogate growth indicators such as GSP, employment, and population are reasonable estimators of future air pollution generating activity for traditional area source emitters (manufacturing, population-based activities), other indicators may be more appropriate for non-traditional emitters. Policy changes which may lead to increased or decreased activity in a category must also be considered. For example, future emissions from agricultural tilling will be affected by trends towards conservation tillage as well as total acres tilled. Projections of total acres tilled may not trend with agricultural earnings or GSP as operations due to changes in crop yields. The amount of prescribed burning which takes place each year is driven by the policy of Federal and State forest and land management agencies. There is currently an agreement to significantly increase the amount of prescribed burning by the year 2010. This will impact future projections of prescribed burning emissions as well as emissions from wildfires. For these non-traditional area source emitters, Federal, State, and local trade associations and agencies should be consulted to identify the best indicators of future activity.

Table 3.1-1 references specific growth indicators for projecting emissions for various area source categories.

3.1.2 CONTROL FACTORS

The projection year control factor for area sources should account for both changes in emissions due to new levels of control required by regulations and process modifications or technology improvements. Emitters in the manufacturing sector, such as industrial, commercial, and institutional fuel combustion, may be assigned a traditional control measure to limit emissions. However, for many area sources, conventional control methods are often inapplicable; instead, control of area source emissions may involve process modifications such as limiting agricultural burning practices, paving with emulsified asphalt or concrete, or stabilization of dirt roads. The control factors should also account for market-driven process changes, such as the move toward lower-solvent or water-based paints (this can be both market and regulatory-driven) and conservation tillage.

Technical documents from EPA, including Alternative Control Techniques (ACT) documents and Control Techniques Guidelines (CTG) documents, are collected at the Clean Air Technology Center on EPA's TTN web site: **http://www.epa.gov/ttn/catc/products.html**. ACT documents provide technical information, based on data collected from model sites, for use by State and local agencies to develop and implement regulatory programs to control emissions. The model sites in the ACT documents represent typical emitters; area-specific factors may cause discrepancies and deviations and should be accounted for when comparing ACT document costs to actual performance. CTG documents provide federal guidelines to State and local agencies to assist those areas in planning and meeting federal air quality requirements.

Area source projections should account for Federal, State, and local regulations. For federally-mandated controls, the EPA documents and the models referenced in the following sections will be the best available resources for determining the appropriate emission factor to apply in projected inventories.

The latest regulatory actions from the Office of Air and Radiation (OAR) can be found at: **http://www.epa.gov/ttn/oarpg/new.html**.

OAR also provides a page devoted to policy, guidance, and regulations, sorted by the Title of the Clean Air Act Amendments (CAAA) to which they apply: **http://www.epa.gov/ttn/oarpg/amend.html**.

3.1.3 OTHER CONSIDERATIONS

Spatial issues may also impact area source projections. Urban sprawl may result in decreases in area source emissions related to farming, such as agricultural tillage and managed burning. Conversely, urban sprawl may then result in increases in other area source emissions associated with residential areas, such as dry cleaning and consumer solvent use.

3.1.4 AVAILABLE MODELS AND RESOURCES

Table 3.1-2 delineates available resources and models related to area source emission projections.

3.2 ALTERNATIVE METHODS

Area sources are normally calculated using a variety of estimation procedures that include related, but cumbersome, estimation tools to derive either a "top-down" estimate or a county-level "bottom-up" emissions inventory for area sources. An area source emission estimation model, named the Area Source Emissions Model (ASEM), consolidating these methods is under development. An alpha test version that provides estimates for a few categories has been completed and a beta version is currently under development. The beta test version is designed to combine existing calculation methods into a consolidated model with an easy to use user interface and report generator. The model will estimate area source emissions and will facilitate: 1) the use of consistent methodologies and the use of consistent activity data to estimate emissions from area sources and will enable the user to vary selected parameters and recalculate the emissions estimate for one or more categories; 2) ease of calculation when using location-specific data; and 3) development of summary outputs and exchange of the data among States and with EPA. By inputting appropriate activity data and control factors, later versions of the ASEM can be used by EPA, State, and local agencies to estimate emission projections for certain area source categories.

3.3 REFERENCES

ERG, 1996: Eastern Research Group, Inc., *Introduction to Area Source Emission Inventory Development*, Eastern Research Group, Inc., Prepared for: Area Sources Committee, Emission Inventory Improvement Program, August 1996.

EPA, 1991b: U.S. Environmental Protection Agency, *Procedures for Preparing Emissions Projections*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, July 1991.

EPA, 1993: U.S. Environmental Protection Agency, *Guidance for Growth Factors, Projections, and Control Strategies for the 15 Percent Rate-of-Progress Plans*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, March, 1993.

EPA, 1995: U.S. Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors: Fifth Edition*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, January 1995.

Pechan-Avanti, 1997: The Pechan-Avanti Group, *The Emission Reduction and Cost Analysis Model for NOx (ERCAM-NOx)*, E.H. Pechan & Associates, Inc, prepared for the U.S. Environmental Protection Agency, Ozone Policy and Strategies Group, September 1997.

TABLE 3.1-1

GROWTH INDICATORS FOR PROJECTING EMISSIONS FOR AREA SOURCE CATEGORIES

Source Category	Growth Indicators	Information Sources
Gasoline Marketing	projected gasoline consumption	MOBILE5 fuel consumption model
Dry Cleaning	population; retail service employment	solvent suppliers; trade associations
Degreasing (Cold Cleaning)	industrial employment	trade associations
Architectural Surface Coating	population or residential dwelling units	local MPO
Automobile Refinishing	industrial employment	BEA or E-GAS
Small Industrial Surface Coating	industrial employment	BEA or E-GAS
Graphic Arts	population	state planning agencies; local MPO
Asphalt Use - Paving	consult industry	consult industry
Asphalt Use - Roofing	industrial employment	local industry representatives
Pesticide Applications	historical trends in agricultural operations	state department of agriculture; local MPO
Commercial/Consumer Solvent Use	population	local MPO; state planning agencies
Publicly Owned Treatment Works (POTWs)	site-specific information	state planning agencies
Hazardous Waste Treatment, Storage and Disposal Facilities (TSDFs)	state planning forecasts	state planning agencies; local MPO
Municipal Solid Waste Landfills	state waste disposal plan	local MPO; state planning agencies
Residential Fuel Combustion	residential housing units or population	local MPO
Commercial/Institutional Fuel Combustion	commercial/institutional employment; population	local MPO; land use map projections
Industrial Fuel Combustion	industrial employment; or industrial land use	local MPO; land use projections; state planning agencies
On-site Incineration	based on information gathered from local regulatory agencies	local regulating agencies and MPO; state planning agencies
Open Burning	based on information gathered from local regulatory agencies	local regulating agencies and MPO; state planning agencies
Fires: Managed Burning, Agricultural Field Burning, Frost Control (Orchard Heaters)	areas where these activities occur	U.S. Forest Service, state agricultural extension office
Forest Wildfires	historical average	local, state, and federal forest management officials
Commercial Bakeries	population	U.S. Census Data
Paved Roads/Unpaved Roads	Vehicle Miles Traveled (VMT)	U.S. Census Data
Agricultural Tilling	historical trends in agricultural operations	state department of agriculture; local MPO
Construction Activity	construction employment	local MPO; consult industry
Structural Fires	population	local MPO; state planning agencies

TABLE 3.1-2

AVAILABLE MODELS AND RESOURCES

Resource	Where To Go	Brief Description
National Air Pollutant Emission Trends Report (Trends)	**http://www.epa.gov/oar/aqtrnd97**	Report contains a general approach for developing projections estimates for national criteria pollutants.
Multiple Projections System (MPS)	**http://www.epa.gov/ttn/chief/ei_data.html#PS**	Stand-alone computer program designed to facilitate the projection of future emissions of ozone precursors, specifically carbon monoxide (CO), volatile organic compounds (VOCs), and oxides of nitrogen (NOx).
California Emission Forecasting System (CEFS)	**http://www.arb.ca.gov/emisinv/pubs/pubs.htm**	Computer analysis program capable of predicting future emission levels in the State of California.

4

HIGHWAY VEHICLE EMISSION PROJECTIONS

Highway vehicles include all vehicles registered to use the public roadways. The predominant emissions source in this category is the automobile, although trucks and buses, and to a lesser extent, motorcycles, are also significant sources of emissions. The total highway vehicle population can be characterized by eight individual vehicle type categories:

- Light duty gasoline powered vehicles (LDGV);
- Light duty gasoline powered trucks, up to 6,000 lb. gross vehicle weight (LDGT1);
- Light duty gasoline powered trucks, from 6,001 to 8,500 lb. gross vehicle weight (LDGT2);
- Heavy duty gasoline powered vehicles (HDGV);
- Light duty diesel powered vehicles, up to 6,000 lb. gross vehicle weight (LDDV);
- Light duty diesel powered trucks (LDDT);
- Heavy duty diesel powered vehicles (HDDV);
- Motorcycles (MC).

Emission projections for highway vehicles are usually based on the product of two fundamental measures: travel and the average rate of pollutants emitted in the course of travel. Both measures reflect complex patterns of behavior. The Environmental Protection Agency (EPA) and the Department of Transportation's Federal Highway Administration (FHWA) (**http://www.fhwa.dot.gov/**) have developed a series of tools/models to estimate the rate of emissions produced by vehicles per mile of travel and the amount of travel itself.

EPA's *Compilation of Air Pollutant Emission Factors- Mobile Sources* (AP-42) contains extensive data on highway vehicle sources, including the classification of highway vehicles and pollutants produced by them, and can be found at: **http://www.epa.gov/oms/ap42.htm**.

Further information on highway vehicle sources can be found at the EIIP Mobile Sources Committee site: **http://www.epa.gov/ttn/chief/eiip/eiip_ms.htm**.

4.1 OVERVIEW OF PROJECTION METHODS

Emission projections for highway vehicles depend upon vehicle, fuel use, engine and emission control system technologies, applicable regulations and emission standards, test procedures, and in-use emission levels and the factors that influence them. For highway vehicle sources, the general equation used to project emissions is:

$$E_{fy} = A_{by} * G * F_{fy} \qquad \text{(Equation 4.1-1)}$$

where E_{fy} = projection year emissions
A_{by} = base year activity
G = growth factor
F_{fy} = projection year emission factor

In this case, the projection year emission factor accounts for the effect of any new regulations as well as technological changes. The base year activity for calculating the emissions of highway vehicles is generally vehicle miles traveled (VMT).

For highway vehicles, there are other factors which should be considered in performing emission projections which lead to more complicated algorithms than that given in Equation 4.1-1. Examples include the number of trips, stops and starts, and trip lengths. Incorporating these additional parameters into the base year and projection year emissions generally requires the use of sophisticated area-specific transportation models. EPA is currently working to revise and improve its MOBILE highway vehicle emission factor model to facilitate the use of transportation models in the development of emission inventories.

4.1.1 GROWTH FACTOR

The most commonly used growth indicators for highway vehicles are derived from expected changes in VMT. VMT growth is affected by factors other than population increases. Roadway improvements, mass transit, and other factors will impact future year VMT in an area. For this reason, travel demand models (TDMs) are the preferred method for performing VMT projections. Areas using zonal-based network travel demand models to forecast VMT growth must validate those models against recent traffic counts (usually at a sample of roadway points with statistical expansion to represent the universe of all roadways in the area). VMT projections can be made with these models under different scenarios, such as no roadway improvements versus with planned roadway improvements.

Another acceptable procedure for estimating future year VMT is to apply a trend projection method. This can be done by quantifying road mileage and associated VMT (stratified by county, rural/urban area, and roadway functional class), and using the relationship between road mileage and VMT for historical years to estimate future year VMT. The hypothesis underlying this technique is that for each roadway functional class within a specified geographical area, historical trends reasonably represent short-range future growth. When calculating long-range growth, other procedures must be applied.

There is no accepted standardized model for performing traffic simulation or travel demand forecasting, so it is important that each area documents its methods and procedures when preparing VMT projections and emission forecasts. The EIIP document "Use of Locality Specific Transportation Data for the Development of Mobile Source Emission Inventories," available on the EIIP web site (**http://www.epa.gov/ttn/chief/eiip**) provides guidance for identifying non-TDM and TDM procedures designed to more accurately predict future VMT of passenger and commercial vehicles. It also provides summaries of the state-of-the-practice analytical models, data sets, and procedures available to generate locality-specific future VMT forecasts for areas with and without TDMs.

4.1.2 EMISSION FACTORS

The projection year emission factors for highway vehicle sources should account for changes in emission levels due to new national emission control standards, such as the National Low Emission Vehicle (NLEV) program, the new 2004 heavy-duty diesel NO_x and non-methane hydrocarbons (NMHC) standard, and others which can be found on EPA's Office of Mobile Sources (OMS) site (**http://www.epa.gov/oms/**). Projection year emission factors should also account for specific local control programs such as motor fuel regulations and inspection and maintenance (I/M) programs. Emission factors for VOC, NO_x, and CO should be calculated using the currently accepted version of the OMS MOBILE model (**http://www.epa.gov/oms/models.htm**), except in California (see Table I), and emission factors for PM and SO_2 should be calculated using PART5 (**http://www.epa.gov/oms/part5.htm**). Note that the MOBILE model can provide factors for different organic species (VOC, NMHC, HC, etc.) depending on options selected by the model user. Component emission factors are also provided for exhaust versus evaporative emissions for hydrocarbons. Locality specific parameters (such as vehicle age distribution, ambient temperatures, vehicle speeds, and fuel parameters) should be used as inputs to these models.

Highway vehicle projections should account for the impacts of all applicable Federal, State, and local regulations. For federally-mandated controls, the EPA documents and the models referenced in the following sections will be the best available resources for determining the appropriate emission factor to apply in future year inventories.

The latest regulatory actions from the Office of Air and Radiation (OAR) can be found at: **http://www.epa.gov/ttn/oarpg/new.html**. Specifically for highway vehicle sources, a chronological list of all OMS Regulations can be found at: **http://www.epa.gov/oms/url-fr.htm.**

OAR also provides a page devoted to policy, guidance, and regulations, sorted by the Title of the Clean Air Act Amendments (CAAA) to which they apply (Title II in the case of highway vehicle sources): **http://www.epa.gov/ttn/oarpg/amend.html**.

4.1.3 OTHER CONSIDERATIONS

Control programs vary by year and base year conditions might differ from future year conditions (for factors such as fuel characteristics, fleet composition, and I/M programs). These changes in future control programs should be incorporated into the emission factor modeling.

Temporal and spatial issues may also impact highway vehicle projections. Activity levels vary by month, day of the week, and time of day. Allocating activity to the appropriate county and roadway type is also important since these would generally affect the modeled speeds as well as local control programs.

Accounting for issues like urban sprawl will affect projections of highway vehicle emissions. Urban sprawl will generally result in emission increases due to the fact that more vehicles will be operated within an area. In addition, if areas become more congested from an increase in traffic, speeds will be decreased and idling of vehicles will be increased, again generally leading to an increase in emissions.

Future year vehicle mix may differ from current year vehicle mix as well. Trends in the last few years have been towards more sports utility vehicles, increasing the percent share of light-duty gasoline trucks in the total vehicle population. The MOBILE model includes default profiles; areas should consider updating to profiles specific to their area.

For highway vehicle emissions, temperature plays an important role in any projection calculation. For annual projections of highway vehicle emissions, temperature data may be collected from a long term average (with a wide range of temperatures) for each area, either collected from State or local data, or from a national source (such as the National Climatic Data Center: **http://www.ncdc.noaa.gov/**). For episodic emission projections for highway vehicles, EPA has a series of guidelines on proper temperature ranges to properly reflect the weather conditions (guidelines can be found at: **http://www.bts.gov/smart/cat/AQP.html**).

4.1.4 AVAILABLE MODELS AND RESOURCES

Table 4.1-1 delineates available resources and models related to highway vehicle source emission projections. It should be noted that California's emission factor model is approved for use only in California. The MOBILE model should be used to generate emission factors in all other areas.

As indicated in Table 4.1-1, MOBILE5a is the current official release of EPA's MOBILE model. It is to be replaced by MOBILE6 some time in 2000. EPA will include provisions for the transition to the newer model. Modelers are strongly encouraged to visit the OMS web site regularly for updates (**http://www.epa.gov/oms/**), and to subscribe to the EPA-MOBILENEWS listserver (instructions available at: **http://www.epa.gov/oms/models/mobillst.txt**).

Additional information on TDMs and mobile source inventories can be found in the EIIP emission inventory documents and EPA's Procedures for Emissions Inventory Preparation, Volume IV: Mobile Sources.

4.2 ALTERNATIVE METHODS

The level of detail required for highway vehicle projections will vary by what kind of area is being examined. For example, an attainment area may require a significantly less detailed projection than would a serious nonattainment area.

In general, the alternative methods for developing projections include the less detailed approach of projecting VMT and multiplying the VMT by the appropriate MOBILE emission factors versus applying sophisticated transportation models.

4.3 REFERENCES

EPA, 1991a: U.S. Environmental Protection Agency, *Supplement A to Compilation of Air Pollutant Emission Factors, Volume II: Mobile Sources*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, January 1991.

EPA, 1991b: U.S. Environmental Protection Agency, *Procedures for Preparing Emissions Projections*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, July 1991.

EPA, 1992: U.S. Environmental Protection Agency, *Procedures for Emissions Inventory Preparation, Volume IV: Mobile Sources*, U.S. Environmental Protection Agency, Emission Planning and Strategies Division Office of Mobile Sources, 1992.

EPA, 1993: U.S. Environmental Protection Agency, *Guidance for Growth Factors, Projections, and Control Strategies for the 15 Percent Rate-of-Progress Plans*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, March, 1993.

TABLE 4.1-1

AVAILABLE MODELS AND RESOURCES

Resource	Where To Go	Brief Description
MOBILE6 (In Development)	**http://www.epa.gov/oms/m6.htm**	The latest update of EPA's highway vehicle emission factor model, currently under development.
MOBILE5a	**http://www.epa.gov/oms/m5.htm**	The current official version of EPA's highway vehicle emission factor model, to be updated by MOBILE6.
PART5	**http://www.epa.gov/oms/part5.htm**	Highway vehicle particulate emission modeling software.
Motor Vehicle Emission Inventory (MVEI) Models	**http://arbis.arb.ca.gov/msei/mvei/mvei.htm**	Series of models used by California Air Resources Board (CARB) to estimate on-road highway vehicle emissions.
EIIP Document Series on Mobile Sources	**http://www.epa.gov/ttn/chief/eiip/eiip_ms.htm**	Documents from EIIP's Mobile Source Committee. The documents include information on HPMS, developing locality-specific data for TDMs, and VMT forecasts.
Procedures for Emissions Inventory Preparation, Volume IV: Mobile Sources	**http://www.epa.gov/ttn/chief/ei_guide.htm#egmemo**	EPA's document on emissions inventory development for mobile sources.

5

NONROAD EMISSION PROJECTIONS

5.1 CATEGORY DESCRIPTION

The nonroad mobile source category consists of all nonroad engines and equipment including lawn & garden, recreational, construction, logging, agricultural, industrial, light commercial, airport service, and recreational marine equipment, as well as commercial marine operation, aircraft, and locomotives. The category covers both gasoline (2-stroke and 4-stroke) and diesel engines. The area source categories (ASCs) covered by this category include:

2260	Off-Highway Vehicle Gasoline: 2-Stroke
2265	Off-Highway Vehicle Gasoline: 4-Stroke
2270	Off-Highway Vehicle Diesel
2275	Aircraft
2280	Marine Vessels, Commercial
2282	Marine Vessels, Recreational
2285	Railroads

Included within each of the first three categories above (2260, 2265, and 2270) are several nonroad equipment subcategories:

001	Recreational Vehicles (e.g., 2260001xx)
002	Construction Equipment
003	Industrial Equipment
004	Lawn & Garden Equipment
005	Farm Equipment
006	Light Commercial
007	Logging Equipment
008	Airport Service Equipment

Within each equipment type, there are several individual types of equipment such as rollers, scrapers, and cranes under construction. A complete listing of the 10-digit ASCs can be found on EPA's TTN under the CHIEF site: **http://www.epa.gov/ttn/chief/.**

5.2 OVERVIEW OF PROJECTION METHODS

The projection of nonroad emissions is a function of the change in activity (equipment population, usage) combined with changes in the emission factors of the engines. Changes in the emission factors of engines can be influenced by technological advances, environmental regulations (nonroad engine standards), age or deterioration, how the engine is operated (capacity factor or load) and fuel formulations. The emission factor is therefore dependent on fleet turnover and engine use. For the nonroad sector, the most appropriate equation used to project emissions is:

$$E_{fy} = A_{by} * G * F \qquad \text{(Equation 5.2-1)}$$

where E_{fy} = projection year emissions
A_{by} = base year activity
G = growth factor
F = projection year emission factor (in same units as used for base year calculations)

The base year activity will vary depending on the source category. For most nonroad categories, the activity is the engine population multiplied by the average power (horsepower), load factor (fraction of available power), and engine activity (hours/year). For aircraft, the activity is generally the number of landings and takeoffs (LTOs). For railroads, the activity is fuel use (gallons/year).

The projection year average emission factor accounts for the effect of any new regulations -- including reduction in engine efficiency due to age, as well as improvements in efficiency due to technological advancements.

This type of algorithm is used in the Office of Mobile Sources' NONROAD model and in California's OFFROAD model. In the NONROAD model, engine population is used as the surrogate for changing activity, assuming a constant level of load and use by equipment type for different parts of the country and for each and every year. The equation for projecting emissions becomes:

$$E_{fy} = [P_{by} \text{ x HP x LF x HRS}] * G * F_{fy} \qquad \text{(Equation 5.2-2)}$$

where E_{fy} = projection year emissions
P_{by} = base year engine population
HP = average horsepower (hp)
LF = load factor
HRS = engine activity (hours/year)
G = engine population growth factor

F_{fy} = projection year emission factor

Emission factors for gasoline engines are modified to account for deterioration as well as emission standards for new engines. Scrappage is also incorporated for each equipment type. Emission factors are specific to each equipment type and are multiplied by the projected engine population, activity (hours/year), load factor, and average horsepower for that equipment type. The total inventory for the specific equipment type is then aggregated to the category level (e.g., construction equipment) and then to the total inventory.

For SIP tracking, it may be necessary to apply the following equation to project emissions for all sectors using a consistent algorithm:

$$E_{fy} = E_{by} * G * C \qquad \text{(Equation 5.2-3)}$$

where E_{fy} = projection year emissions
E_{by} = base year emissions
G = growth factor
C = control factor, accounting for changes in emission factors or controls

In this case, the control factor would be computed based on the base and future year emission factor derived from the NONROAD model or other source. It may also be used to compare the impact of alternative levels of control when the future year emission factor is not known or when it is not effective to utilize the more detailed emission factor based approach.

5.2.1 GROWTH FACTOR

The growth factor accounts for changes (increases or decreases) in the emission-generating or source activity. In selecting surrogates for growth factors to track growth in source activity, the most important considerations are how closely the surrogate data approximates or relates to changes in the source activity; how closely it relates to the activity indicator used to develop the base year emissions; and the locality (how well it characterizes the activity in the area of interest versus a larger geographical area) of the data.

For the nonroad sector, engine use is the emission-generating activity. Therefore, projections of equipment population, combined with hours of operation and load factors, are most appropriate for projecting future year activity. Base year emissions for the nonroad sector are usually generated based on estimates of equipment population (rather than surrogates such as construction employment), so engine population projections will be consistent with the base year emission methods. If growth rate data for the source activity are not available, then the surrogate growth data which more closely approximates the source activity should be chosen. Ideally, the projections of activity should be representative of the local area, rather than using national or State surrogates.

5.2.2 EMISSION FACTOR

The projection year emission factor (or the emission factor by model year) accounts for changes in the per engine emission factor due to new emission standards, equipment deterioration, penetration of engine standards (e.g., only affects engines in certain horsepower classes and equipment categories), and changes in fuel formulations. EPA documents and the models referenced in the following sections will be the best available resources for determining the appropriate emission factor to apply in projected inventories.

5.2.3 OTHER CONSIDERATIONS

Time/mode considerations are also important for the nonroad sector. For example, increased LTOs at airports may increase the taxi time of the planes, leading to increased emissions. This is usually included in the emission factor calculations -- increasing the taxi or idle time component associated with each LTO.

Projections of nonroad engines are usually based projected growth in engine populations. Changes in the load factor and engine activity (hours/year) may also impact future emissions. For example, newer engines may be used more than older engines. Because it is difficult to project how these variables might change in the future, they are generally held constant at base year levels.

Spatial issues may also impact nonroad projections. For example, urban sprawl may result in decreases in farmland thus affecting emissions from farm equipment. This may also result in increasing emissions from other equipment, such as lawn and garden and construction equipment.

Information on temporal profiles for categories covered by the NONROAD model is available through OMS. There may be changes in the temporal profiles of nonroad emissions as a result of regulations which might restrict or bar certain activities during peak ozone periods.

5.2.4 AVAILABLE MODELS AND RESOURCES

EPA's Office of Mobile Sources (OMS) has developed the NONROAD model (currently draft, with an interim draft final release in the Spring of 1999 and the final version at the end of 1999) for estimating current, historic, and projection year estimates of emissions from nonroad engines. It covers all of the nonroad categories except commercial marine vessels, aircraft, and locomotives. Information on this model can be found on the OMS website: **http://www.epa.gov/oms/nonrdmdl.htm**. The model uses national growth rates for each category of equipment, based on historical trends in equipment population changes, and can be used directly to project emissions for the nonroad engine categories covered by the model. In addition, locality-specific information (such as equipment populations) can be incorporated into the model. Alternatively, information from the model can be used to develop growth factors, temporal allocation factors, and future year emission factors for nonroad engines to aid in the application of the algorithms above. Background documents on these supporting data are also available on the web site.

The OMS web site (**http://www.epa.gov/oms/**) has information specific to all nonroad categories, including information on emission factors, nonroad regulations, certification data, and equipment populations. More detail is given in the next section.

The California Air Resources Board (CARB) has developed the OFFROAD model for projecting emissions from nonroad engines. For California purposes, this model is used to generate growth and control factors as outputs which are then fed into their statewide emission forecasting system (the California Emission Forecasting System or CEFS). CEFS utilizes algorithms similar to equation 5.2-2 above for SIP tracking purposes. The OFFROAD model uses algorithms which employ projections of activity and by model year emission factors, similar to the equation 5.2-1 given above. The data in the OFFROAD model is specific to the State of California and should not be used for other areas unless the supporting data are modified for another State. See the CARB web site for more details: **http://www.arb.ca.gov/**.

5.3 ALTERNATIVE METHODS

The alternative methods for projecting emissions for nonroad equipment include:

1. Apply the NONROAD model;
2. Apply an alternative model, such as CARB's OFFROAD model;
3. Apply the algorithms (equations 5.2-1 or 5.2-2) directly.

In all of these methods, selection of the appropriate data is important, with preference given to local data rather than applying national defaults. For equipment not covered by the NONROAD model (or other available models), method 3 should be utilized. For categories covered by the NONROAD model, it is expected that this model will be used, unless the State or area has already developed their own models or data.

The NONROAD Model currently covers all nonroad equipment types, except commercial marine (SCC 2280), locomotive (SCC 2285), and aircraft (SCC 2275). So for these categories, equations 5.2-1 or 5.2-2 must be applied to project emissions. These equipment types may be included in later versions of the NONROAD Model. Check the OMS web site for the most recent information on the NONROAD Model as well as information on growth and control: **http://www.epa.gov/oms/**.

The first part of the following section discusses the use of the NONROAD model, with references to the OMS website for obtaining the most recent information as this model is updated. The second part discusses available data sources for growth. The third section addresses resources for information on future year emission factors or control factors, including those categories not covered by the

NONROAD model. Even if the NONROAD model is applied, States should review the sections to determine if there are better locality-specific data which may be substituted for the defaults in the NONROAD model.

5.3.1 NONROAD MODEL

OMS's NONROAD Model, user's guides, and documentation can be downloaded from the OMS web site: **http://www.epa.gov/oms/nonrdmdl.htm**.

The model estimates projection year emissions based on the following input data:

– equipment population for the base year grown to a future year distributed by age, power, fuel type, and application;
– average load factor expressed as an average fraction of available power;
– activity in hours of use per year; and
– emission factor with deterioration and/or new standards.

Emissions are then temporally and geographically allocated using appropriate allocation factors (Environ, 1998).

There are default input files provided for all of the basic data needed to perform the calculations: emission factors, base year equipment population, activity, load factor, average lifetime, scrappage function, growth estimates, and geographic and temporal allocation. ***The data in the NONROAD model can be replaced with information from local sources or state sources***. It is recommended that input data be replaced, particularly for equipment population, geographic allocation, and activity estimates (hours/year), as well as growth estimates, where local data may be available and result in a more accurate inventory estimate.

Background information on the input data used in the NONROAD Model can be found on OMS's web site (**http://www.epa.gov/oms/**). Technical documents are available for the following:

– Nonroad Engine Growth Estimates (NR-008)
– Exhaust Emission Factors – Spark Ignition (NR-010a) (NR-010b will be released when Tier 2 on-highway rule is signed.)
– Calculation of Age Distributions – Growth and Scrappage (NR-007)
– Basic Evaporative and Crankcase Emission Rates (NR-012)
– Exhaust Emission Factors – Compression-Ignition (NR-009a)
– Nonroad Equipment Population Estimates (NR-006a)
– Average Life, Annual Activity, and Load Factor Values (NR-005a)
– Seasonal and Monthly Activity Allocation Fractions (NR-004)
– HC Conversion Factors: VOC/TOG/ROG/etc (NR-002)

- Exhaust Emission Effects of Fuel Sulfur and Oxygen on Gasoline Nonroad Engines (NR-003)
- RVP and Temperature Corrections (NR-001)
- Geographical Allocation of State Level Nonroad Engine Population Data to the County Level (NR-014)
- Emission Deterioration Factors for the NONROAD Emissions Model (NR-011)
- Refueling Emissions for Nonroad Engine Modeling (NR-013)

5.3.2 SELECTION OF THE APPROPRIATE GROWTH FACTOR

Criteria in the selection of the growth factor are:

- consistency with the activity indicator used to estimate base year emissions
- consistency with the activity which generates emissions
- geographic consistency: local versus state versus regional and national data

For categories covered by the NONROAD Model, information on national growth surrogates can be found in the background documents on growth (see OMS website -- Nonroad Engine Growth Estimates (NR-008) and Task 2 Report: Comparison of Methods for Projecting Nonroad Equipment Activity Levels). For other categories, EPA's Projection Guidance (EPA, 1991) provides details on alternatives to consider. Table 5.3-1 summarizes growth indicators and available data sources by category.

Growth factors for nonroad equipment populations are likely to be much different than they are for industrial point sources, and be more related to such things as building starts, highway construction, and number of single family households. BEA GSP and population projections as well as factors from EPA's Economic Growth Analysis System (value-added factors), have been used in EPA's national projections, however, projections of equipment population are preferable over these types of indicators. It should be noted that 1995 is the last year of available BEA projections and that these factors will not longer be supported.

The Office of Mobile Sources (OMS) completed a detailed review of alternative methods for projecting activity levels for nonroad engines in support of development of the EPA NONROAD emission inventory model (Dolce, 1998 and Pechan-Avanti, 1997). The comparison included methods currently in use: the BEA GSP projections, E-GAS, and the data selected for use in the California Air Resources Board's (CARB) nonroad model OFFROAD. The comparison also examined other potential methods including time-series regression of fuel sales or consumption, *Annual Energy Outlook* fuel use projections, and BLS output or employment projections.

OMS concluded that the use of economic indicators may not adequately predict the effects of substitution of equipment for labor in the market and that they may tend to under-predict growth in nonroad equipment populations and activity. As an example, total projected BEA growth between 1990 and 1996 was 9.3%, while the change in actual 1990 and 1996 equipment populations from the Power Systems Research PartsLink database was 18.1%. In addition, the economic indicators predict growth within a sector of the economy and would not account for differences in growth of diesel versus gasoline equipment. OMS proposes to use a time series analysis of historical nonroad engine populations as the basis for the NONROAD emissions model, but is currently taking comment on the growth factors. Additional details on the growth factors used in the NONROAD Model can be found on OMS' web site, specifically in documents found under the following page: **http://www.epa.gov/oms/nonrdmdl.htm**.

For aircraft, BEA GSP projections have been used in national-level projections. EPA's Projections Guidance (EPA, 1991) recommends that major airports be queried individually to determine specific growth plans (if any), and suggests that this information be incorporated in emission projections. Growth is likely to be area-specific, so national trends in aircraft activity may not be suitable for urban scale analyses. Projections of LTOs are needed as passenger miles may not capture the impact of adding larger planes capable of carrying more passengers.

For railroads, EPA indicates that the best source of information is the railroads themselves, either the companies that operate in the area, or through the American Association of Railroads. EPA's regulatory document on locomotive standards assumed no growth in fuel consumption for railroad engines. While total tons of freight carried have more than doubled over the long term, fuel consumption has remained relatively constant or decreased slightly. This is a result of continual progress in increasing the efficiency of the engines.

For commercial marine vessels, cargo tonnage is indicated as a surrogate for projecting emission growth. Local port authorities should be consulted for activity projections. Other data sources include the U.S. Maritime Administration and the U.S. Army Corps of Engineers.

Time/mode changes must also be considered for the nonroad sector. For example, increased LTOs at airports may result in longer taxi times for the aircraft, resulting in an increase in emissions.

5.3.3 DETERMINING THE FUTURE YEAR CONTROL FACTOR OR EMISSION FACTOR

Table 5.3-2 summarizes regulations expected to impact future year emission factors or control factors for nonroad engines. The OMS web site provides additional background information on these regulations. This site also provides information on the latest available emission factors for nonroad equipment, which is important for developing projections for sources not covered by the nonroad model. Eventually, this information will be compiled into a new edition of AP-42. The latest available emission factor data can be found at **http://www.epa.gov/oms/models/nonrdmdl/**. Look for updates to AP-42 at **http://www.epa.gov/oms/ap42.htm**.

The NONROAD emissions model accounts for deterioration (in the case of gasoline engines) as well as new engine standards. Variations in emission factors due to temperature and fuel (RVP, fuel reformulations) are also being considered. Emission factors from a particular type of equipment are combined with the equipment populations (distributed by age, power, fuel type, and application), average load factor (fraction of available power), and activity (hours of use per year) to estimate emissions.

Prior to the development of the NONROAD model, projections may have been based on a more simplistic approach using equation 5.2-2 with an estimated future year control factor. An average base year emission factor is compared with the engine standard, yielding a control factor that reflects complete fleet turnover. Phase-in schedules and equipment life can be factored in to estimate the impact in the intermediate years before complete fleet turnover occurs. This type of approach ignores deterioration as well as differences in load factors or equipment use.

If a State prefers to utilize their own modeling system to project emissions from nonroad sources, emission factors can be extracted from the NONROAD model by equipment type for use in the State's projections using an algorithm similar to equation 5.2-1 in Section 5.2. Comparison of outputs for 'no control' and 'with control' projections can be used to estimate an overall control factor for use in equation 5.2-2 above.

For categories not covered by the NONROAD model, the future year emission factors should be calculated taking into consideration fleet turnover, current and new standards, as well as other control programs (e.g., retrofit programs). Future year emission factors or control factors must be calculated or determined based on background documents on the regulations affecting the nonroad category or by applying emission factors based on the expected fleet composition in the projection year. Table 5.3-2 includes the EPA resources available for determining future year emission factors for these categories.

5.4 QUALITY ASSURANCE

The functions of quality assurance include the following:

1. Ensure reasonableness of the emission projections and data used,
2. Ensure validity of the assumptions and methods used,
3. Ensure mathematical correctness (e.g., ensure calculations were performed correctly),
4. Ensure valid data were used,
5. Assess the accuracy of the estimates.

Projected emissions should be compared with base year emissions to identify any anomalies which might indicate calculation or data errors. The QA reviewer should verify reasons for trends towards higher or lower emissions. For example, if projected emissions are lower than base year, the reviewer might examine the activity projection versus the change in projection year emission factors to ensure that the magnitude of these changes support the overall change in emissions from the base year. Comparisons of contributions of different equipment classifications to total emissions in the base year versus projection year should also be reviewed and any significant changes explained.

Projected emissions should be compared with projections using an alternative methodology, such as projections from OMS's NONROAD Model using default assumptions, to identify any anomalies which might indicate calculation or data errors. Again, any major differences should be explained in terms of examining differences in the input data (e.g., did the local population estimates differ significantly from the national defaults).

Hand-calculations should be completed on a sample of data to ensure mathematical correctness.

The preparer should verify that the data being used are the most current and best available data.

5.5 REFERENCES

Dolce, 1998: Gary J. Dolce, "Nonroad Engine Growth Estimates", Nonroad Emissions Modeling Team, Assessment and Modeling Division, Office of Mobile Sources, U.S. Environmental Protection Agency, March 6, 1998.

ENVIRON, 1998: "User's Guide for the National Nonroad Emissions Model Draft Version," ENVIRON International Corporation, prepared for the U.S. Environmental Protection Agency, National Vehicle and Fuel Emissions Laboratory, June 1998.

EPA, 1991: U.S. Environmental Protection Agency, "Procedures for Preparing Emission Projections," EPA-450/4-91-019, July 1991.

Janssen and Wilcox, 1997: Greg Janssen and Rich Wilcox, "Seasonal and Monthly Activity Allocation Fractions for Nonroad Engine Emissions Modeling," Report No. NR-004, Nonroad Engine Emission Modeling Team, Assessment and Modeling Division, Office of Mobile Sources, U.S. Environmental Protection Agency, December 9, 1997.

Pechan-Avanti, 1997: The Pechan-Avanti Group, Comparison of Methods for Projecting Nonroad Equipment Activity Levels," E.H. Pechan & Associates, Inc, prepared for the U.S. Environmental Protection Agency, Office of Mobile Sources, September 1997.

TABLE 5.3-1

DATA SOURCES FOR GROWTH INDICATORS BY NONROAD CATEGORY

Engine Category	Growth Indicators	Information Sources[a]
Aircraft - Commercial	landings & takeoffs	local airport authorities, commercial carriers, FAA
Aircraft - General	landings & takeoffs	local airport authorities
Aircraft - Military	landings & takeoffs	local airport authorities, appropriate military agencies
Railroads	fuel consumption, revenue ton-miles (if revenue-ton-miles are used, changes in fuel and engine efficiency should be considered)	American Association of Railroads, local carriers.
Commercial Marine Vessels	cargo tonnage	local port authorities, U.S. Maritime Administration, U.S. Army Corps of Engineers
Recreational Marine Vessels	equipment population, general population	local MPO, NONROAD model
Recreational Vehicles	equipment population, general population	local MPO, NONROAD model
Construction Equipment	equipment population, construction GSP, earnings, employment	local MPO, NONROAD model
Industrial Equipment	equipment population, industrial GSP, earnings, employment	local MPO, NONROAD model
Lawn & Garden Equipment	equipment population, single-unit housing, general population	local MPO, NONROAD model
Farm Equipment	equipment population, agricultural land use, farm GSP, earnings, employment	local MPO, NONROAD model, Census of Agriculture
Light Commercial Equipment	equipment population, commercial GSP, earnings, employment, population	local MPO, NONROAD model
Logging Equipment	equipment population, logging industry GSP, earnings, employment	local MPO, NONROAD model
Airport Service Equipment	equipment population, LTOs, airport GSP, earnings, employment	local airport authority, commercial carriers, NONROAD model, FAA Emission Dispersion Modeling System (EDMS)

[a]E-GAS and BEA are additional data sources for value-added, GSP, earnings, and employment data.

TABLE 5.3-2

REGULATIONS AND OTHER FACTORS AFFECTING FUTURE YEAR EMISSION/CONTROL FACTORS

Source Category	Applicable Regulations and Emission Factor Resources
Aircraft	May 8,1997 rulemaking consistent with standards set by the United National International Civil Aviation Organization. FAA Aircraft Engine Emission Database (refer to the FAA website for more information or contact FAA). This includes emission factors for commercial, civil, and some military aircraft engines. FAA's Emission Dispersion Modeling System (EDMS) see **http://www.epa.gov/oms/aviation.htm**
Railroads	Final emission standards published April 16, 1998. The Fact sheet "Emission Factors for Locomotives" provides projection year emission factor information, taking into account the new standards. see **http://www.epa.gov/oms/locomotv.htm**
Commercial Marine	NPRM issued for compression ignition marine engines. see **http://www.epa.gov/oms/marine.htm**
Recreational Marine	Final rule published October 4, 1996. Affects spark ignition recreational marine vessels. Aimed at reducing VOC emissions. see **http://www.epa.gov/oms/marine.htm**
Recreational Vehicles	
Compression Ignition (all nonroad categories)	Tier 1 standards promulgated for engines > 50 HP in 1994. Tier 1 standards for small engines and tier 2 standards for all engines promulgated in August of 1998. see **http://www.epa.gov/oms/equip-hd.htm**
Spark Ignition (all nonroad categories)	Phase 1 promulgated July 1995 for small engines (at or below 19 kW/25 HP). Phase 2 proposed December 1997, final phase 2 standards for nonhand-held small engines are expected in the first part of 1999. see **http://www.epa.gov/oms/equip-ld.htm**

EPA's NONROAD model data files and documentation also provide background information on future year emission factors for nonroad engines (**http://www.epa.gov/oms/models/nonrdmdl/**).

Refer to the OMS web site for the latest available emission factor data at **http://www.epa.gov/oms/models/nonrdmdl/**. Look for updates to AP-42 as well under **http://www.epa.gov/oms/ap42.htm.**