Appendix D

Nonroad Mobile Sources Emissions Inventory Documentation

(This page intentionally left blank)

Table of Contents

1. INTRODUCTION AND SCOPE 1

2. OVERALL METHODOLOGY 2

2.1 Source Category Identification 2

2.2 Nonroad Mobile Source Emission Estimation Approach 2

3. 2002 NONROAD MOBILE SOURCE EMISSION INVENTORY 3

3.1 NONROAD Model Sources 3

3.2 Aircraft Engines 4

3.3 Railroad Locomotives 5

4. 2008 NONROAD MOBILE SOURCE EMISSION INVENTORY 6

4.1 Projection of NONROAD Model Sources 6

4.2 Projection of Non-NONROAD Model Sources 7

(This page intentionally left blank)

1. INTRODUCTION AND SCOPE

The reasonable further progress (RFP) demonstration State Implementation Plan (SIP) for the Charlotte-Gastonia-Rock Hill, NC-SC 8-hour ozone nonattainment area (referred to as the Metrolina area) is built upon the regional haze modeling done by the Southeast Regional Planning Organization, Visibility Improvement State and Tribal Association of the Southeast (VISTAS) and the fine particulate matter (PM2.5) and ozone modeling being done by the Association of Southeastern Integrated Planning (ASIP). VISTAS and ASIP are run by the ten Southeast states (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia and West Virginia).

The 2002 base year emissions inventory from the attainment demonstration was the starting point for the RFP demonstration. The majority of nonroad emission sources were developed for both 2002 and 2008 using the NONROAD model. For the other sources that are part of the nonroad mobile source category, 2002 emissions were grown using growth and control factors.

Portions of the emissions inventories were developed by the North Carolina Division of Air Quality (NCDAQ) and by the VISTAS/ASIP contractors. In all cases, the emission estimates were calculated in tons per year. Tons per average summer day were obtained by processing the inventories through the Sparse Matrix Operator Kernel Emissions Modeling System (SMOKE) model. Section 3 documents the development of the 2002 base year nonroad mobile source emissions inventory. Section 4 documents development of the nonroad mobile source emissions inventory for 2008.

2. OVERALL METHODOLOGY

2.1 Source Category Identification

Nonroad mobile sources were identified from the United States Environmental Protection Agency (USEPA) guidance document EPA-450/4-91-016, *Procedures for the Preparation of Emissions Inventories for Carbon Monoxide and Precursors of Ozone* (Procedures document). Nonroad mobile source emissions are estimated by the methodologies suggested in the USEPA document, EPA-454/R-05-001, *Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations*; EPA-450/4-81-026d (Revised), *Procedures for Emission Inventory Preparation, Volume IV; Mobile Sources* (Mobile Source Procedures), and from the USEPA's NONROAD2005c model released March 21, 2006.

2.2 Nonroad Mobile Source Emission Estimation Approach

Nonroad mobile sources, sometimes referred to as off-road mobile, are those sources that can move but do not use the highway system. They generally have internal combustion engines. Nonroad mobile sources are further divided into NONROAD model sources, railroad locomotives, aircraft engines, and commercial marine vessels (CMV). The estimation of emissions from nonroad mobile sources, like area sources, involves multiplying an activity level by an emission factor.

The majority of the off-road mobile emissions were estimated by using the USEPA's NONROAD2005c model. Direct emissions are generated with this model. For aircraft engine emissions see the detailed description below. For railroad locomotive emissions, emission factors were obtained from the Mobile Source Procedures document and the activity level was obtained from the various railroad companies. There are no CMV emissions in the Metrolina nonattainment area.

Note that emissions are developed as annual values. In order to produce the average summer day emissions, the annual emission values are processed through the SMOKE model which applies appropriate temporal adjustments.

3. 2002 NONROAD MOBILE SOURCE EMISSION INVENTORY

Development of emission estimates for nonroad mobile sources is documented in the MACTEC, Inc. document titled *Documentation of the Base G 2002 Base Year, 2009 and 2018, Emission Inventories for VISTAS* (Appendix G).

Nonroad mobile sources are those sources that can move but do not use the highway system. Examples include lawn mowers, agricultural equipment, construction equipment, aircraft engines, railroad locomotives, powerboats, and commercial marine vessels (CMV). All but the aircraft engines, railroad locomotive emissions and commercial marine activity were estimated using the USEPA's off-road mobile model NONROAD2005c, which was released March 21, 2006. Direct emissions are generated with this model. This version incorporates all the USEPA final nonroad mobile engine emission standards, including the recreational and large spark-ignition engines rules that were published in the Federal Register in November 2002. Although this model is considered to be a final model, an updated version is planned that may incorporate revised inputs for the small spark-ignition (SI) (<19 kW) and recreational marine SI categories in conjunction with additional promulgated nonroad mobile engine standards.

Nonroad mobile sources calculated through the NONROAD model are discussed in Section 3.1. Aircraft and railroad emissions are discussed in Sections 3.2 and 3.3 respectively. There is no CMV activity in the Metrolina area.

3.1 NONROAD Model Sources

The nonroad mobile source category includes a diverse collection of equipment such as lawn mowers, chain saws, tractors, all terrain vehicles, forklifts and construction equipment. The USEPA NONROAD2005c model generates emissions directly and includes more than 80 different types of equipment. To facilitate analysis and reporting, the USEPA grouped the equipment types into ten equipment categories. These include:

Agricultural equipment	Lawn and garden equipment
Airport ground support equipment	Logging equipment
Commercial equipment	Railroad maintenance equipment
Construction equipment	Recreational marine equipment
Industrial equipment	Recreational equipment

Additionally, the emissions are broken out by five different engine types. These include: 2-stroke and 4-stroke spark engines, diesel engines, liquid petroleum gas (LPG) and compressed natural gas (CNG) fueled engines.

One of the default input files was edited to reflect North Carolina specific information. In the "SEASON.DAT" file, the region representative of North Carolina was changed from Mid-Atlantic to Southeast. This was done after an evaluation of the meteorological data in the two regions and comparing it to that of Charlotte. Default data was used for the remaining input files used in the NONROAD model.

3.2 Aircraft Engines

Aircraft engines, like other engines, emit pollutants whenever the engines are in operation. However, the only emissions that are of concern for this inventory are the portion of the operation that occurs below the mixing layer. This is because the emissions tend to disperse whenever the aircraft is above the mixing layer and therefore has little or no effect on ground level ozone.

The aircraft operations of interest are termed the landing and takeoff (LTO) cycle. The cycle begins when the aircraft approaches the airport, descending below the mixing layer, lands and taxis to the gate. It continues as the aircraft idles at the gate and then taxis back out to the runway for the subsequent takeoff and climb out as it heads back to cruising altitudes, above the mixing layer.

Aircraft can be categorized by use into four classifications: commercial, air taxis, general aviation and military. Commercial aircraft include those used for scheduled service transporting passengers and/or freight. Air taxis, or commuter aircraft, also fly scheduled service carrying passengers and/or freight but usually are smaller aircraft and operate on a more limited basis than commercial carriers. General aviation includes all other non-military aircraft used for recreational flying, personal transportation, and various other activities. Military aircraft cover a wide range of sizes, uses and operating missions. The military aircraft are treated as a separate classification since the LTO operations reported at the airports groups all military aircraft together.

Emission factors are available for the many aircraft and engine combinations that exist. Factors for each aircraft exist for four operating modes in the LTO cycle. Emissions are calculated by obtaining data for the number of LTO cycles of the various aircraft at each airport in question, multiplying by the appropriate factors, and summing the results for the year under consideration.

Development of the 2002 aircraft emissions are described in the MACTEC document titled *Documentation of the Base G 2002 Base Year, 2009 and 2018 Emission Inventories for VISTAS* . This document refers back to a document titled *"Development of the VISTAS Draft 2002 Mobile Source Emission Inventory (February 2004 Version)"* prepared by E.H. Pechan & Associates, Inc. Both of these documents are included in Appendix G.

The starting point for development of aircraft emissions estimates is the 1999 National Emission Inventory (1999 NEI) prepared by the USEPA. These emissions were grown to appropriate values for 2002 using growth factors developed by the USEPA for the Clean Air Interstate Rule (CAIR). Along the way there was input by the various States including North Carolina to arrive at more accurate emission estimates.

3.3 Railroad Locomotives

Railroads are categorized by size (Class I, Class 2) and passenger service (Amtrak and North Carolina Department of Transportation (NCDOT) Rail Division). Class I railroads are long haul operations, consisting of Norfolk Southern Corporation and CSX Corporation in North Carolina. Class II and Class III railroads are short lines, serving localized markets. Passenger service is provided by Amtrak and the NCDOT Rail Division in North Carolina. These entities lease trackage from Class I railroads.

Development of railroad emissions is described in the MACTEC document titled *Documentation of the Base G 2002 Base Year, 2009 and 2018 Emission Inventories for VISTAS*. The VISTAS/ASIP railroad emission estimates started with 1999 emission estimates developed for the USEPA's 1999 NEI Version 2 as base year estimates for the VISTAS region. Additional information is provided in *"Development of the VISTAS Draft 2002 Mobile Source Emission Inventory (February 2004 Version)"* prepared by E.H. Pechan & Associates, Inc.

Projected emissions for 2002 were developed in two steps as described below. For 1999 to 2001, State-level rail fuel consumption was obtained from the Department of Energy, Energy Information Administration's (EIA's) *Fuel Oil and Kerosene Sales.* For 2001 to 2002, VISTAS applied national growth factors developed from fuel consumption projections in EIA's *Annual Energy Outlook.* A growth factor of 1.4 was used for locomotives and applied to 1999 emissions to first develop 2001 emissions. Table 3.3-1 lists the growth factors used to generate 2002 emissions.

Table 3.3-1 2002 National Rail Transportation Energy Use by Fuel Type (Trillion BTU)

	2001	2002	Growth Factor (GF)
Intercity Rail (Electric)	10.17	10.40	1.0226
Intercity Rail (Diesel)	16.60	16.88	1.0169
Transit Rail (Electric)	46.36	47.40	1.0224
Intercity/Transit Rail Average (SCC 2285002008)			**1.0206**
Commuter Rail (Electric)	16.13	16.49	1.0223
Commuter Rail (Diesel)	26.31	26.76	1.0171
Commuter Rail Average (SCC 2285002009)			**1.0197**
Freight Rail (Distillate) (SCCs 2285002000, 2285002005, 2285002006, 2285002007, 2285002010)	512.81	492.32	0.9600

Source: Department of Energy, Energy Information Administration, Annual Energy Outlook 2003: Table 34. Transportation Sector Energy Use by Fuel Type Within a Mode

4. 2008 NONROAD MOBILE SOURCE EMISSION INVENTORY

The subsections that follow describe the projection process used to develop 2008 nonroad mobile source projection estimates for sources found in the NONROAD model and those sources estimated outside of the model (locomotives and airplanes).

4.1 Projection of NONROAD Model Sources

NONROAD model input files were prepared based on the 2002 base year inventory input files with appropriate updates for the projection year. Other specific updates for the projection year for the NONROAD model sources consist of:

1. Revise the emission inventory year in the model (as well as various output file naming commands) to be reflective of the projection year.

2. Revise the fuel sulfur content for gasoline and diesel powered equipment.

3. Implement any local control program changes (national control program changes are handled internally within the NONROAD model, so explicit input file changes are not required). The only change was to designate North Carolina as a Southeastern state rather than a Mid Atlantic state in the NONROAD model. This was done because climate conditions in North Carolina are more like the other Southeastern states than Mid Atlantic states.

All equipment population growth and fleet turnover impacts are handled internally within the NONROAD model, so that explicit input file changes are not required. Diesel fuel sulfur values chosen for the land based diesels were 2500 parts per million (ppm) sulfur in 2002 and 500 ppm sulfur in 2008.

4.2 Projection of Non-NONROAD Model Sources

For the aircraft and railroad emissions for 2008, the 2009 emissions developed for the VISTAS modeling was used. This is conservative since airport activity and railroad freight tonnage were on upward trends.

Using the VISTAS 2002 base year emissions inventory for aircraft and locomotives prepared as described earlier in this document, corresponding emission projections for 2009 were developed. The projection factors were based on growth and control factors developed by MACTEC. A detailed description of the process may be found in the MACTEC document titled *Documentation of the Base G 2002 Base Year, 2009 and 2018 Emission Inventories for VISTAS*. Briefly, the methodology relies on growth and control factors developed from inventories used in support of the USEPA CAIR rulemakings and then matched to the 2002 inventory. The steps in this procedure follow:

(a) Begin with the 2002 base year emission estimates for aircraft and locomotives.

(b) Detailed inventory data (both before and after controls) for these same emission sources for 1996 and 2020 were obtained from the USEPA's CAIR Technical Support Document. Using these data, combined growth and control factors for the period 2002-2009 were estimated using straight line interpolation between 1996 and 2020 (for 2009). This is done at the State-county-SCC-pollutant level of detail.

(c) The USEPA growth and control data are matched against the 2002 VISTAS base year data using State-county-SCC-pollutant as the match key. Ideally, there would be a one-to-one match and the process would end at this point. Unfortunately, actual match results were not always ideal, so additional matching criteria were required. For subsequent reference, this initial (highest resolution) matching criterion is denoted as the “CAIR-Primary” criterion.

(d) A second matching criterion is applied that utilizes a similar, but higher-level SCC (lower resolution) matching approach. For example, SCC 2275020000 (commercial aircraft) in the 2002 base year inventory data would be matched with SCC 2275000000 (all aircraft) in the CAIR data. This criterion is applied to records in the 2002 base year emissions file that are not matched using the “CAIR-Primary” criterion, and is also performed at the State-county-SCC-pollutant level of detail. For subsequent reference, this is denoted as the “CAIR-Secondary” criterion. At the end of this process a number of unmatched records continued to remain, so a third level matching criterion was required.

(e) In the third matching step, the most frequently used SCC in the USEPA CAIR files for each of the aircraft and locomotive sectors is averaged at the State level to produce a “default” State and pollutant-specific growth and control factor for the sector. The resulting factor is used as a “default” growth factor for all unmatched county-SCC-pollutant level data in each State. In effect, State-specific growth data are applied to county level data for which an explicit match between the VISTAS 2002 base year data and the USEPA CAIR data could not be developed. The default growth and control SCCs are 2275020000 (commercial aircraft) for the aircraft sector and 2285002000 (railroad equipment diesel total) for the locomotive sector. Matches made using this criterion are denoted as “CAIR-Tertiary” matches.

(f) The CAIR matching criteria were overridden for any record for which States provided local growth data. Only North Carolina provided these forecasts, as North Carolina has provided specific growth factors for airport emissions in four counties. Because the provided data were based on forecasted changes in landings and takeoffs at major North Carolina airports, the factors were applied only to commercial (SCC 2275020000) and air taxi (SCC 2275060000) emissions. Emissions forecasts for military and general aviation aircraft operations, as well as all aircraft operations in counties other than the four identified in the North Carolina growth factor submission, continued to utilize the growth factors developed according to steps (b) through (f) above. The locally generated growth factor (2002 to 2009) applied in Mecklenburg County was 1.15.