Emissions Inventory Assistance: 2005 Base Year

Biogenic and Other (non-LADCO) State Emissions

Preparation and Delivery of Non-MRPO

Emission Files

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Acronyms and Abbreviations

CENRAP	Central Regional Air Planning Association
CMV	Commercial Marine Vessels
CE	Control Efficiency
EPA	Environmental Protection Agency
EGU	Electric Generating Unit
FTP	File transfer protocol
IDA	Inventory Data Analyzer
MANE-VU	Mid-Atlantic/Northeast Visibility Union
NH_3	Ammonia
NIF	National Emission Inventory Format
NMIM	National Mobile Inventory Model
NONROAD	no acronym (model name)
SIP	State Implementation Plan
SMOKE	Sparse Matrix Operator Kernel Emissions Model
VISTAS	Visibility Improvement State and Tribal Association of the Southeast
WRAP	Western Regional Air Partnership

Introduction

The Lake Michigan Air Directors Consortium (LADCO) States are conducting photochemical modeling to support the development of State Implementation Plans (SIPs) for ozone, PM2.5, and regional haze. A new round of modeling is planned with a more recent base year (2005). To support this modeling, an emissions inventory for 2005 (and relevant future years – 2009 and 2018) is needed on an expeditious schedule.

To address this need, Alpine Geophysics (Alpine) and MACTEC have teamed together to deliver and prepare a number of base and projection year emission files for regional planning organizations outside of the Midwest state domain. These RPOs include the Mid-Atlantic/Northeast Visibility Union (MANE-VU), Visibility State and Tribal Association of the Southeast (VISTAS), Central Regional Air Planning Association (CENRAP), and Western Regional Air Partnership (WRAP). Alpine and MACTEC were uniquely qualified to provide these files having already prepared or obtained base year and emission projections for each of these RPOs under other contracts.

Through other contracts recently completed or currently in place with the Alpine/MACTEC Team, 2002, 2005, 2009, and 2018 emission inventories (in NIF3.0 or SMOKE IDA format) were in-house for each of the non-LADCO States and for each of the major source sectors (EGU, non-EGU point, stationary area, nonroad MAR, NONROAD sources, and onroad activity and input files). These data sets were either developed directly by the Study Team (VISTAS and MANE-VU all years, CENRAP 2009, WRAP 2009) or obtained directly from the RPOs for processing emissions on the national 36km domain.

1.0 Provision of Unmodified Files

1.1 EGU, Non-EGU and Stationary Area Sources for MANE-VU and VISTAS

Several of the required files required no additional work other than to compile the files and make them available to LADCO for their use. MACTEC gathered the EGU, non-EGU, and stationary area source files for both MANE-VU and VISTAS and placed them on the AirToxics FTP site as delivery to LADCO. No modifications of these files were made. Files delivered included EGU, non-EGU and stationary area source files for 2002, 2009 and 2018 for VISTAS and MANE-VU. Each of these files was in National Inventory Format (NIF) version 3.0. In addition, each of these files contained the annual emissions estimates only and did not provide seasonal emission estimates.

2.0 Provision of Modified Files

2.1 Nonroad

As part of the proposal provided to LADCO by MACTEC and AG, the team had indicated that while not prepared in this manner, seasonal and monthly emission estimates for the nonroad sector (excluding commercial marine, aircraft and railroads – [MAR]) could be prepared from the NONROAD05/NMIM model runs used to develop these emissions. In addition the team had indicated that 2005 emission estimates at the seasonal/monthly level could also be created from these runs by interpolation of the 2002 and 2009 files. This section describes the development of the nonroad emission files for 2002, 2005, 2009 and 2018 for each RPO. The development of the 2002, 2005, 2009 and 2018 MAR component of the inventory at an annual level is described. The temporal level developed varied by RPO.

For VISTAS and the WRAP, the initial and resulting modeling files had been prepared at the seasonal level, thus only seasonal estimates were prepared for this work. For MANE-VU, the initial annual estimates had been prepared using NMIM which generates estimates at a monthly level. Thus MANE-VU estimates were developed at the monthly level. CENRAP emissions were available at an annual level and therefore provided as such. The approaches used for each RPO are described below.

2.1.1 Development of MANEVU Monthly Nonroad Estimates

As indicated above, the original annual NIF files prepared for MANE-VU for NONROAD model sources were developed using the NMIM model, with the exception of emissions for 2002 from Maine and the District of Columbia, which were prepared using the NONROAD model. For 2009 and 2018, all NONROAD model sources were estimated using NMIM. MACTEC's

task was to convert the raw files developed from NMIM into monthly emissions in NIF format for 2002, 2009 and 2018. From those files, MACTEC would then use the 2002 and 2009 files to provide an interpolation of emissions to obtain an estimate for 2005.

NMIM output is stored in MySQL database tables. The first step was to obtain the raw output in MySQL. Since MACTEC had prepared the 2009 and 2018 files for MANE-VU those tables were already in-house. However another contractor prepared the 2002 estimates for MANE-VU. MACTEC/AG contacted MANE-VU and obtained the MySQL data tables for the 2002 NMIM run for MANE-VU. However, since Maine and the District of Columbia 2002 emissions were not developed using NMIM, we also obtained the 2002 annual estimates in NIF format. These annual estimates were later converted to monthly estimates. Details on that conversion are described later in this section.

The native output of the NMIM model is to produce monthly emissions. Thus the MySQL tables already contained the monthly emission estimates. However the MySQL format is not NIF 3.0. To obtain NIF 3.0 format, the reporting tool in NMIM must be used to generate monthly emissions. MACTEC used the MySQL tables from the 2002, 2009 and 2018 emission projections along with the NMIM reporting tool to format the data into NIF 3.0 format. These files are TXT format files that correspond to the CE, EM, EP, PE and TR tables in the NIF format. Once the files were output into TXT format, MACTEC used the NIF version 3.0 Microsoft Access database shell to import the files into Microsoft Access for additional manipulation and in order to perform quality assurance checks on the data. Output

2.1.1.1 Conversion of 2002 Annual Emissions for ME and DC to Monthly

As mentioned above, the 2002 NMIM MySQL tables did not include Maine and the District of Columbia since they were estimated using NONROAD05. As a consequence, before a 2005 estimate could be prepared, the annual ME and DC estimates had to be converted to monthly values. In order to do this, MACTEC developed MANE-VU wide monthly fractions from the 2002 file. These fractions were then applied to the annual values for DC and ME to obtain a monthly record from the annual value. Monthly entries for each pollutant for the EM table were generated from an average monthly fraction from all other MANE-VU States for 2002. In addition, monthly records were added to the PE table.

2.1.1.2 Calculation of the 2005 Estimates for MANE-VU

Once DC and ME monthly emissions had been calculated and added to the monthly emissions available for the other MANE-VU States from the NMIM runs, the remaining step was to calculate 2005 emissions based on an interpolation of emissions between 2002 and 2009. In order to calculate these emissions the State, County, SCC and Pollutant in each EM table was

matched in 2002 and 2009. In doing this, MACTEC identified that there were over 700 records in the 2009 file that did not exist in the 2002 file. All of these records were for DC and ME and all were for the pollutant NH3. As a consequence, MACTEC decided to add the 2009 records to the 2002 file for these missing records with no change in emissions levels. The records are marked in the database using one of the BLANK fields in the EM table. Thus they can be easily identified.

Once the records matched between 2002 and 2009 at the State, County, SCC and Pollutant level, the interpolated emissions were calculated. The calculation was as follows:

$$((2009 - 2002) * (3/7)) + 2002$$

Where:

2002	=	2002 emissions
2009	=	2009 emissions
3/7	=	multiplier to determine 2005 emissions as a linear interpolation between 2002 and 2009

Once the 2005 emissions were calculated, appropriate changes were made to the EM, PE and TR table to reflect a 2005 emission inventory year. In addition, a similar calculation was applied to throughput values in the PE table.

Finally, when all changes to the Access tables had been made, the NIF tables were exported into TXT format, compressed using WinZip and placed on AG's FTP site for delivery to LADCO.

2.1.2 Development of VISTAS Seasonal Nonroad Estimates

VISTAS seasonal estimates were prepared in a similar manner to the MANE-VU monthly estimates. In the preparation of the 2002, 2009 and 2018 files for VISTAS, the NONROAD05 model had been utilized to estimate seasonal emissions. During preparation of the annual NIF files the fractions for each season found in the EP table were determined from the seasonal emissions calculated by the NONROAD05 runs. Thus the seasonal percentages in the annual files in the EP table were not based on defaults but were based on actual calculated seasonal emissions. As a consequence, these seasonal percentages were used to calculate seasonal emissions for 2002, 2009 and 2018.

Thus to calculate seasonal emissions, the annual value was multiplied by the seasonal percentage to obtain a seasonal value for winter, spring, summer and fall.

However, because the winter season includes December, January and February, two entries for the EM and PE tables were prepared for winter estimates, one for December and one for the January through February portion. In order to calculate these separate values, the number of days of the total season in each of these portions was used to apportion the winter season emissions to each entry. For example, the winter season for each year (none of which are leap years) contains 90 days total (31 in December, 31 in January and 28 in February). Thus to get the December winter value, the annual emission value was multiplied by the winter seasonal fraction and by 31/90 (the number of days in December divided by the total number of days in the season). Similarly for the Jan/Feb entry the annual value was multiplied by the seasonal percentage and by 59/90 (the number of days in Jan/Feb and the total number of days in the season). Matching seasonal records for each entry were added to the PE table and seasonal throughput values were calculated in a similar manner.

2.1.3 Development of CENRAP/WRAP Nonroad Estimates

As part of their responsibilities for other modeling conversion contracts, Alpine staff have converted emission inventories and associated emissions modeling files into a variety of formats, including NIF 3.0, SMOKE IDA, and RPO Data Exchange Protocol. Our proposed and approved method was to use the same procedures and scripts used to convert the emission files from those contracts in the conversion to the NIF data format in this study. Emissions as provided on temporal scales (annual, seasonal, or daily) were used to populate the NIF emission fields in the converted file.

Nonroad emission files for CENRAP and WRAP were converted and aggregated into a single nonroad series of NIF tables for each year of conversion (2002, 2009, and 2018). Within each EM table provided per year, annual, seasonal, and daily emission periods exist, based on the original obtained modeling file from the individual RPO.

Our quality assurance in this task was dedicated to the assertion that the reformatting of these data did not invalidate the integrity of the original inventories. As such, QA on these files included the comparison of reformatted data to the original SMOKE IDA files ensuring that specific required fields had been appropriately converted to the field type, length, and unit requirements of the NIF structure.

2.1.3.1 Calculation of the 2005 Estimates for other RPOs

2005 emission values were calculated for VISTAS, CENRAP, and WRAP using the same equation as in section 2.1.1.2. Values for 2002 and 2009 were interpolated to obtain a 2005 value for temporal allocation available for the RPO.

2.2 MAR

For each of the non-MRPO RPOs, 2002, 2009 and 2018 estimates for MAR sources were provided at the annual level. The MAR estimates were provided by extracting all MAR sources from the annual nonroad files which contained annual emissions from both MAR and NONROAD model sources. Appropriate records from the CE, EM, EP and PE tables were extracted and placed into an Access database solely containing MAR emissions. Once the files were compiled they were then used to calculate 2005 MAR emissions.

For CENRAP and WRAP emissions, additional conversions were made to convert SMOKE IDA formatted files into the NIF 3.0 structure as noted in the sections above. These emissions for MAR sources are included for these two RPOs in the nonroad emission converted files.

2.2.1 Development of 2005 MAR Emissions

The 2005 MAR emissions were calculated using the 2002 and 2009 emissions and performing a straight line interpolation of emissions using the same equation as provided in section 2.1.1.2. This approach was also used on the CE table control efficiencies. While the NONROAD model sources did not contain any CE entries (NMIM does not generate any CE table entries), CE tables did contain some entries in a few of the RPO reported files. These values were given a straight line interpolation using the equation in section 2.1.1.2.

2.3 EGU Point Source Files

Electric generating utility (EGU) point source files have been prepared by RPOs using a variety of methods. For base year emissions data, CEM emissions and heat input values are used to derive inventories and other unit level characteristics for modeling. Recently, ICF's proprietary Integrated Planning Model (IPM) has been utilized by many of the RPOs to derive future year emission estimates for this source category. In this project, both types of data were obtained from the RPOs and converted to the NIF 3.0 format for LADCO's modeling needs.

2.3.1 2002, 2009, and 2018 EGU Emissions for CENRAP/WRAP

EGU point source emissions files for CENRAP and WRAP RPOs were obtained for 2002, 2009 and 2018 in SMOKE IDA format. Identical to the methods identified above, these files were translated to the NIF 3.0 format for this project. For both RPOs and all years, annual emission estimates were available in the modeling files and were converted to NIF annual emission records.

Similar to the other SMOKE to NIF file conversions, our quality assurance in this task was dedicated to the assertion that the reformatting of these data did not invalidate the integrity of the original inventories. As such, QA on these files included the comparison of reformatted data to

the original SMOKE IDA files ensuring that specific required fields had been appropriately converted to the field type, length, and unit requirements of the NIF structure.

2.3.2 2005 EGU Emissions

EGU point source emissions files for 2005 for all the non-LADCO RPOs were developed under separate contract by Alpine using CEM reported emissions, heat input, and control characteristics. For the CEM reported pollutants NOx and SO2, emissions were taken directly from the reported values when available. For non-CEM pollutants, the CEM reported heat input was applied to 2002 calculated emission rates (from the original RPO 2002 base year EGU files) to estimate annual emissions from these pollutants. In cases where it was determined that incremental controls had been applied between the 2002 and 2005 base year, control efficiencies (as noted by EPA documentation) were assigned to the unit and emission reductions were calculated accordingly. For units which were new in 2005 (and not found in 2002 or 2009 emission inventories), methods established by EPA and published on the NEI development website were used to prepare emission estimates and other unit level characteristics for these sources. In contrast to the 2002 EGU emissions provided by the RPOs and noted in the previous section, the EGU file for 2005 contains only emission sources which reported under the CEM program and were found in the EPA CEM databases.

Identical to the conversion methods identified for other source sectors, these files were translated to the NIF 3.0 format for this project. For all 2005 EGU emission sources, annual emission estimates were available and were converted to NIF annual emission records.

Similar to the other SMOKE to NIF file conversions, our quality assurance in this task was dedicated to the assertion that the reformatting of these data did not invalidate the integrity of the original inventories. As such, QA on these files included the comparison of reformatted data to the original SMOKE IDA files ensuring that specific required fields had been appropriately converted to the field type, length, and unit requirements of the NIF structure.

2.4 Non-EGU Point and Stationary Area Source Files

Non-EGU point and stationary area source emissions files for CENRAP and WRAP RPOs were obtained for 2002, 2005, 2009 and 2018 in SMOKE IDA format. Using methods already established by Alpine for projects of emission conversion for EPA, the RPOs, and other clients, these files were translated to the NIF 3.0 format for this project. For both RPOs and all years, annual emission estimates were available in the modeling files and were converted to NIF annual emission records. The exception to annual emissions reporting was for some fugitive dust related categories in CENRAP and WRAP domains (road dust, agricultural dust, etc.) where seasonal emission files in IDA format were provided. In these instances, the seasonal temporal variability

was maintained in the conversion and appropriate seasonal emission records were developed for the NIF CE tables.

Non-EGU point source files were prepared by subtracting out the EGU emissions portion as estimated and noted in section 2.3 above. For 2002, 2009, and 2018, this was based on EGU files provided directly from the RPOs. For 2005, this subtraction was based on Alpine review of 2005 CEM-reporting emission sources and removal of CEM reporting units from the non-EGU file.

Similar to the nonroad file conversion, our quality assurance in this task was dedicated to the assertion that the reformatting of these data did not invalidate the integrity of the original inventories. As such, QA on these files included the comparison of reformatted data to the original SMOKE IDA files ensuring that specific required fields had been appropriately converted to the field type, length, and unit requirements of the NIF structure.

2.5 Quality Assurance Steps

For the emission estimates and data conversions described above, the following quality assurance (QA) steps were performed:

1. Sample calculations were checked by hand including database calculations. Database calculations were performed using a SELECT query before performing an UPDATE query to change values
2. Total region-wide seasonal/monthly emission estimates were checked to compare to annual region-wide estimates at the pollutant level to ensure that values closely matched.
3. In most cases, the EPA Basic Format and Content Checker tool was used to QA the databases developed prior to export of the files to TXT format. In a few cases this could not be performed due to the large size of the databases (the VISTAS seasonal database contained over 8 million records in the EM table alone). In all cases at least one of the databases was checked with the tool, however.
4. Summaries of emissions at the State/County/SCC/pollutant level were developed to compare 2002, 2005 and 2009 values.
5. Confirmed that the reformatting of these data did not invalidate the integrity of the original inventories.
6. We compared RPO provided emission summaries to the emission summaries generated from the reformatted (NIF 3.0) data sets to ensure that all emissions have been accounted for in the conversion process.