**Introduction**

In an effort to move from the 2011/2018 Alpha modeling platform to the 2011/2017 Beta modeling platform, the Mid-Atlantic Regional Air Management Association (MARAMA) requested that the Maryland Department of the Environment (MDE) make updates to the Eastern Regional Technical Advisory Committee Electric Generation Unit Forecasting Tool’s (ERTAC EGU) ERTAC Additional Controls File.

Currently, the ERTAC EGU tool produces annual base year and future year emissions for Oxides of Nitrogen (NOx) and Sulfur Dioxide (SO2). For the purposes of creating photochemical modeling input files, emissions from other pollutants must also be allocated to each unit. These additional pollutants include:

1. Carbon Monoxide (CO)
2. Carbon Dioxide (CO2)
3. Ammonia (NH3)
4. Coarse Particulates (PM10)
5. Fine Particulates (PM2.5)
6. Volatile Organic Compounds (VOC)

The ERTAC Additional Controls File is one of the input files in the ERTAC-to-SMOKE conversion code that will allocate the additional pollutants to each unit. It does this by multiplying the heat input from the ERTAC EGU results by the unit specific emission factor for the pollutant as identified in the ERTAC Additional Controls File. The ERTAC Additional Controls File contains information such as:

1. Emission Rate Start Date
2. Emission Rate End Date
3. Base Year Rate
4. Emission Rate
5. Control Efficiency
6. Control Programs
7. Control Descriptions

The ERTAC Additional Controls File developed by MDE was created by matching ERTAC units to the Sabo Additional Controls File, which contains 2011 and future year emission factors calculated by Ed Sabo (SRA International, Inc), or to the MDE Interim Stack File, which will calculate emission factors from the mass reported by the unit in the 2011 National Emissions Inventory (NEI) and the heat input reported to the U.S. EPA’s Clean Air Markets Division (CAMD). The following section describes how each of these files were used to create the ERTAC Additional Controls File.

**Building the ERTAC Additional Controls File**

The ERTAC Additional Controls File must have the following columns:

|  |  |  |  |
| --- | --- | --- | --- |
| 1. orispl\_code | 4. factor\_end\_date | 7. emission\_rate | 10. control\_description |
| 2. unitid | 5. pollutant\_code | 8. control\_efficiency | 11. submitter\_email |
| 3. factor\_start\_date | 6. base\_year\_rate | 9. control\_program |  |

Depending on the number of pollutants the unit reported to the 2011 NEI, It is possible for a single unit to have up to six rows of data (i.e. one oris-unit-pollutant per line) in the ERTAC Additional Controls File. Every unit that could be linked to the 2011 NEI through the PUSP File work (see PUSP documentation) has a calculated emission factor (minus any QA scrubbing – see below)for at least one of the pollutants listed above.

The ERTAC Additional Controls File is built in Microsoft Access by establishing a list of units and basic data about those units (columns 1-2) from the Annual Unit Summary File for the associated ERTAC EGU Model run – in this case ERTAC 2.5. The remaining data (columns 3-10) are assigned to each unit by left joining the Annual Unit Summary File to the Sabo Additional Controls File and the MDE Interim Stack File. Preference is given to data in the Sabo Additional Controls File (as the data compiled by Ed Sabo has already been through a QA/QC process for the MARAMA Alpha Modeling Platform). If the necessary data is missing or unavailable in the Sabo Additional Controls file it is filled in by data in the MDE Interim Stack File. Additional steps were taken to ensure that the calculated emission rate was appropriate – any unit that had emission rates that appeared to be overly anomalous either had the calculated emission rate overridden or was removed from consideration and therefore received generic default emission factors.

The following steps show the process that was used to develop the ERTAC Additional Controls File. Full SQL queries can be found in Appendix A.

**Repairing Fuel Switch Start/End Dates in the Sabo Additional Controls File**

1. Import the Annual Unit Summary Report into Access.
2. Import the Sabo Additional Controls File into Access.
3. All emission factor start dates are 1/1/2012 – update to 1/1/2011 to reflect the correct base year.
4. Update the emission factor start and end dates for fuel switch units that provide base year and future year emission rates. All emission factor start dates are 1/1/2011 and all emission factor end dates are 1/1/2030. Emission factor end dates for the base year fuel are found in the ERTAC Annual Unit Summary Output Report – they are the date the original unit retired. Emission factor start dates for the future year fuel are one date following the end date for the base year fuel. Update to:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ORIS ID | Unit ID | Fuel Unit Type | Emission Factor Start | Emission Factor End |
| 3775 | 1 | Coal | 1/1/2011 | 4/16/2016 |
| 3775 | 1 | Boiler Gas | 4/17/2016 | 1/1/2030 |
| 3775 | 2 | Coal | 1/1/2011 | 4/16/2016 |
| 3775 | 2 | Boiler Gas | 4/17/2016 | 1/1/2030 |
| 3796 | 3 | Coal | 1/1/2011 | 12/29/2014 |
| 3796 | 3 | Boiler Gas | 12/30/2014 | 1/1/2030 |
| 3796 | 4 | Coal | 1/1/2011 | 12/29/2014 |
| 3796 | 4 | Boiler Gas | 12/30/2014 | 1/1/2030 |

1. To ensure complete joins, transform from one ORIS ID-Unit ID-Pollutant one line format to one ORIS-ID-Unit ID format. This will move pollutants and their emission factors from one column to six columns (i.e. one column for each pollutant).
2. Run a Make Table query to preserve the changes.

**Update the MDE Interim Stack File**

1. Import the MDE Interim Stack File into Access.
2. Remove all entries where multiple units share a single set of EIS Identifiers (i.e. EIS Facility ID, Unit ID, Release Point and Process). The calculated emission factor for these units will either be overestimated or underestimated and is therefore inappropriate. Generic emission factors from the ERTAC Additional Variables File will be used for these units.
3. Remove all entries where the facility level NOx mass does not agree between the NOx mass reported to the 2011 NEI and the NOx mass reported to CAMD in 2011. Using NOx mass as a surrogate, if the NOx masses do not agree within +/- 10% at the facility level, it is reasonable to believe that there is an error in the mass reporting. It is also reasonable to believe that if the NOx mass reporting is erroneous then the mass reporting for the other pollutants is also erroneous. It is likely inappropriate to calculate emission factors for units at these facilities. Generic emission factors from the ERTAC Additional Variables File will be used for these units.
4. Inner Join the MDE Interim Stack File to the Annual Unit Summary. Match on ORIS ID and Unit ID. Add 2011 Heat Input and Fuel-Unit Type Bin from the Annual Unit Summary to the MDE Interim Stack File.
5. Sum the pollutant mass for CO, NH3, PM10, PM2.5 and VOC. CO2 is not included in the 2011 NEI and therefore is not included for units in the MDE Interim Stack File; it is included for units covered by the Sabo Additional Controls file likely because that data was included from a different dataset. Group by State, ORIS ID, Unit ID, Facility Name, Heat Input and Fuel-Unit Type Bin.
6. Calculate the emission factors. This is calculated by dividing the sum of the pollutant mass (converted from tons to pounds) by the heat input.
7. Run a Make Table query to preserve the changes.

**Fill Emission Factors from the Sabo Additional Controls File**

1. Left join the Annual Unit Summary file to the repaired Sabo Additional Controls File. Match on ORIS ID and Unit ID. This establishes a list of every single unit in the ERTAC EGU outputs that requires an emission factor.
2. From the Annual Unit Summary File, add data for columns 1-2 as well as the Fuel-Unit Type Bin. From the Sabo Additional Controls File, add data for columns 3-6 and comments for column 10. Use the “Group By” function to ensure all units are matched.
   1. The 4 previously identified fuel-switch units doubled their entries – this is because they must match on fuel-unit type, which is not included in the Sabo Additional Controls File.
3. Run a Make Table query to preserve the changes.
4. Remove the second entry for both the base year and the future year for the 4 identified fuel-switch units. This must be done after the Make Table query because it is not possible to run a Delete query on a query in Access.

**Fill Emission Factors from the MDE Interim Stack File**

1. Left join the Annual Unit Summary-Sabo Additional Controls File to the updated MDE Interim Stack File. Match on ORIS ID, Unit ID and Fuel-Unit Type Bin. Fill data for columns 5-6. Use the “Group By” function to ensure all units are matched. Include in the fill query that if the data for units already matched/filled from the Sabo Additional Controls File is missing to fill that missing value from the updated MDE Interim Stack File.
2. Run a Make Table query to preserve the changes. This emission factor table now has an emission factor for at least one pollutant for every unit where the emission rate was provided in the repaired Sabo Additional Controls or where it could be filled with the calculated emission rate in the updated MDE Interim Stack File

**Update the Emission Factor File**

1. Update the emission factor start date and end date where they are missing (1/1/2011 for the missing start date and 1/1/2030 for the missing end date). Note that if a year past 2029 is being run, the emission factor end date must be extended to that future year.
2. Update to remove entries for units where all pollutant factors are blank. This occurs where there is not any emission factors for the unit in the Sabo Additional Controls File or when an emission factor could not be calculated for the unit in the MDE Interim Stack File (likely because it cannot be linked to the 2011 NEI). Generic emission factors from the ERTAC Additional Variables File will be used for these units.
3. Update the emission factor end date for retired or fuel-switch (base year fuel) units. Left Join the Emission Factor File to the Annual Unit Summary. Match on ORIS ID, Unit ID, and Fuel-Unit Type Bin. Update the emission factor end date to equal the retirement date in the Annual Unit Summary.
4. Update the emission factor start date for new and fuel-switch (future year fuel) units. The emission factor start date for new units is the online date in the ERTAC EGU Unit Availability File. Note that new units with supplied emission factors are only in states covered by the Sabo Additional Controls File. For new units in other states, an entry is not included for the emission factor as a future year emission rate cannot be calculated; the generic emission factor will be used for those units. The emission factor start date for fuel-switch units is one day after the retirement of the base year fuel. Note that in this case the new fuel emission factor start date did not have to be updated as the only fuel-switch units that provided a new fuel emission factor have already been covered in the Sabo Additional Controls File. For the remaining fuel-switch units, as they did not provide a future year emission rate, the base year fuel emission rate will end when the base year fuel retires and the generic emission factor found in the ERTAC   
   Additional Variables File will apply to the future year fuel. The updated emission factor start dates are:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ORIS ID | Unit ID | Start date | ORIS ID | Unit ID | Start date | ORIS ID | Unit ID | Start date |
| 1626 | N25001 | 6/1/2016 | 6156 | NHHS2 | 1/1/2012 | 56964 | CD402 | 1/1/2012 |
| 1626 | N25002 | 6/1/2016 | 6156 | NHHS3 | 1/1/2012 | 56964 | CD502 | 1/1/2012 |
| 2404 | 131 | 1/1/2012 | 6156 | NHHS4 | 1/1/2012 | 56964 | CD602 | 1/1/2012 |
| 2404 | 132 | 1/1/2012 | 55375 | CT3 | 1/1/2012 | 56964 | CD702 | 1/1/2012 |
| 2404 | 133 | 1/1/2012 | 55375 | CT4 | 1/1/2012 | 56964 | CD802 | 1/1/2012 |
| 2404 | 134 | 1/1/2012 | 55524 | 1 | 1/1/2012 | 57029 | ES1 | 1/1/2013 |
| 2404 | 141 | 1/1/2012 | 55524 | 2 | 1/1/2012 | 57029 | ES2 | 1/1/2013 |
| 2404 | 142 | 1/1/2012 | 55524 | 3 | 1/1/2012 | 57029 | ES3 | 1/1/2013 |
| 2434 | U11 | 1/1/2012 | 55524 | 5 | 1/1/2012 | 57029 | ES4 | 1/1/2013 |
| 2709 | 1A | 1/1/2013 | 55524 | 6 | 1/1/2012 | 58260 | 1 | 1/1/2016 |
| 2709 | 1B | 1/1/2013 | 55524 | 7 | 1/1/2012 | 58260 | 2 | 1/1/2016 |
| 2709 | 1C | 1/1/2013 | 55939 | 1 | 1/1/2015 | 58260 | 3 | 1/1/2016 |
| 2713 | 01A | 12/1/2013 | 55939 | 2 | 1/1/2015 | 991001 | N10001 | 1/1/2015 |
| 2713 | 01B | 12/1/2013 | 55939 | 3 | 1/1/2015 | 993402 | 1 | 5/1/2015 |
| 2720 | 11C | 1/1/2012 | 56292 | ES6-A | 1/1/2013 | 993402 | 2 | 5/1/2015 |
| 2720 | 12C | 1/1/2012 | 56292 | ES6-B | 1/1/2013 | 993403 | 1 | 5/1/2015 |
| 2721 | 6 | 1/1/2013 | 56671 | 001 | 1/1/2012 | 993403 | 2 | 5/1/2015 |
| 2723 | 8C | 12/1/2012 | 56798 | U1 | 1/1/2012 | 995102 | 1 | 1/1/2017 |
| 2723 | 9C | 12/1/2012 | 56798 | U2 | 1/1/2012 | 995102 | 2 | 1/1/2017 |
| 3152 | N42001 | 1/1/2015 | 56808 | 1 | 1/1/2012 | 59004 | 1 | 1/1/2017 |
| 3152 | N42002 | 1/1/2015 | 56808 | 2 | 1/1/2012 | 59004 | 2 | 1/1/2017 |
| 3152 | N42003 | 1/1/2015 | 56964 | CD102 | 1/1/2012 | 7962 | 2 | 1/1/2012 |
| 3176 | CT5 | 1/1/2012 | 56964 | CD202 | 1/1/2012 | 56963 | E101 | 5/1/2015 |
| 3176 | CT6 | 1/1/2012 | 56964 | CD302 | 1/1/2012 | 56963 | E102 | 5/1/2012 |

1. Remove the second entry for fuel-switch units in the Sabo states that did not provide a future year emission rate. Because the Sabo Additional Controls file cannot match on fuel type, the provided base year fuel is also applied to the future year fuel. Note that this does not appear as an anomalous entry increase because there are not multiple emission rates for the unit in the Sabo Additional Controls File – this anomaly must be searched for. Because the states did not provide an emission factor for the future year fuel, the new fuel will receive generic emission factors found in the ERTAC Additional Variables File. The units that need to have the anomalous future year emission factor removed (i.e. the base year emission factor applied to a new future year fuel) because a correct future year emission factor was not provided are:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2403 | 2 | Boiler Gas | 1/1/2015 | 2682 | 10 | Boiler Gas | 6/1/2014 |
| 2408 | 1 | Boiler Gas | 1/1/2013 | 3140 | 1 | Boiler Gas | 1/1/2017 |
| 2408 | 2 | Boiler Gas | 1/1/2013 | 3140 | 2 | Boiler Gas | 1/1/2017 |
| 2411 | 1 | Boiler Gas | 1/1/2015 | 3140 | 3 | Boiler Gas | 1/1/2017 |
| 2411 | 2 | Boiler Gas | 1/1/2015 | 3138 | 3 | Boiler Gas | 1/1/2017 |
| 2411 | 3 | Boiler Gas | 1/1/2015 | 3138 | 4 | Boiler Gas | 1/1/2017 |
| 2411 | 4 | Boiler Gas | 1/1/2015 | 3138 | 5 | Boiler Gas | 1/1/2017 |
| 2480 | 1 | Boiler Gas | 1/1/2015 | 3131 | 1 | Boiler Gas | 1/1/2017 |
| 2480 | 2 | Boiler Gas | 1/1/2015 | 3131 | 2 | Boiler Gas | 1/1/2017 |
| 2480 | 3 | Boiler Gas | 1/1/2015 | 3131 | 3 | Boiler Gas | 1/1/2017 |
| 2480 | 4 | Boiler Gas | 1/1/2015 | 3131 | 4 | Boiler Gas | 1/1/2017 |
| 2682 | 9 | Boiler Gas | 6/1/2014 |  |  |  |  |

1. Run a Make Table query to preserve the changes.

**Quality Assure Calculated Emission Rates**

1. Calculate the 95th and 5th percentiles for each pollutant emission rates by Fuel-Unit Type Bin. Because percentiles cannot be calculated in Access, export the Emission Factor Table into Microsoft Excel to calculate the percentiles. Copy the percentiles into a separate table and import that percentile table back into Access.
2. Inner Join the Emission Factor File to the Annual Unit Summary File. Match on ORIS ID, Unit ID and Fuel-Unit Type Bin. Update the Emission Factor File to add State and Facility Name.
3. Inner Join the Emission Factor File to the 95th-5th Percentiles Table. Match on Fuel-Unit Type Bin.
4. By Pollutant and percentile, update the emission factor to the 95th percentile if it is above the 95th percentile or update the emission factor to the 5th percentile if it is below the 5th percentile. Run these update queries for units in states not covered by the Sabo Additional Controls File (i.e. not CT, DE, MA, MD, ME, NC, NH, NJ, NY, PA, RI, VA, VT and WV). Add a comment when the emission rate is overridden to the 95th or 5th percentile rate.
5. Run a Make Table query to preserve.

**Create the ERTAC Additional Controls File**

1. Run a Union query from the QA’d Emission Factor File to change the file format into the readable format for the ERTAC to SMOKE code. This involves changing the layout from one ORIS ID-Unit ID layout, with the six pollutants in individual columns to one ORIS ID-Unit ID-Pollutant, with all six pollutants in one column. Also change column headers to the text necessary for the ERTAC to SMOKE code. Lastly, add in columns 7, 8, 9 and 11 – these are blank and will remain blank unless the state provides data for these columns. Run a make table query to preserve.
2. Remove all entries where the emission factor for the pollutant is blank.
3. Convert the emission factors to text with five significant digits. When exporting the ERTAC Additional Controls file into an Excel or Comma Separated Value table, truncation occurs that can slightly alter the emission factor. Converting the emission factor values to text with five significant digits prevents this from occurring.
4. Run Make Table query to preserve. Table is named ERTAC Additional Controls.

**Results**

A draft version of the ERTAC Additional Controls File was presented to the ERTAC EGU Leadership on April 11, 2016. No Leadership Committee Member objected to using the calculated emission factors in lieu of the automatically applied generic emission factors. As the emissions factors are directly calculated from the NEI mass and the CAMD heat input, in the same manner that ERTAC EGU calculates NOx an SO2 rates, it was decided not to request comments on changing or removing any of the calculated emission rates.

The ERTAC Additional Controls file was completed on April 28, 2016. Of the 4,681 units in ERTAC EGU, 3,402 units have emission factors either supplied by Ed Sabo or calculated from the 2011 NEI data. All emission factors are within the 5th and 95th percentile boundaries based on pollutant and fuel-unit types. The remaining units that do not have emission factors and will receive generic emission factors are those units that are either new in the future year, could not be linked to the 2011 NEI to calculate an emission factor or are those where the calculated emission factor was inappropriate likely due to a mass reporting error. The ERTAC Additional Controls File was finalized on May 10, 2016 and submitted to MARAMA for inclusion

**Appendix A – Building the ERTAC Additional Controls File Queries**

**Appendix B – Results Details**

**Appendix B – Results Details Tables**