BART Modeling Protocol:

Plant Mitchell

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Contents

List of Tables

List of Figures

1.0 Introduction

1.1 Objectives

The Regional Haze Rule requires Best Available Retrofit Technology (BART) for any BART-eligible source that ''emits any air pollutant which may reasonably be anticipated to cause or contribute to any impairment of visibility" in any mandatory Class I federal area. Pursuant to federal regulations, states have the option of exempting a BART-eligible source from the BART requirements based on dispersion modeling demonstrating that the source cannot reasonably be anticipated to cause or contribute to visibility impairment in a Class I area. In addition, the Environmental Protection Agency (EPA) has promulgated a rule allowing states subject to the Clean Air Interstate Rule (CAIR) to determine that CAIR satisfies the BART requirements for SO_2 and NO_x for electric generating units (EGUs). Preliminary feedback from the Georgia Environmental Protection Division indicates that they anticipate making the decision that CAIR satisfies BART for SO_2 and NO_x for EGUs. Therefore, this modeling protocol focuses on performing the BART modeling analysis for particulate matter (PM) only.

Unit 3 at Plant Mitchell, located near Albany, which is owned and operated by Georgia Power Company, has been identified as a BART-eligible source. The purpose of this document is to summarize the procedures by which a modeling analysis will be conducted for this source. The modeling procedures outlined will be used to determine whether the source is subject to BART requirements (exemption modeling). If it is determined that the source is subject to BART, then the procedures will be used to evaluate the visibility improvement factor in the BART determination step (determination modeling). The modeling procedures are consistent with those outlined in the updated final VISTAS common BART modeling protocol (dated December 22, 2005, revision 2 – 3/9/06), available at http://www.vistas-sesarm.org/BART/BARTModelingProtocol_rev2_9Mar2006.pdf. This source-specific BART modeling protocol references relevant portions of the common VISTAS modeling protocol.

1.2 Location of source vs. relevant Class I Areas

The Georgia Environmental Protection Division, which is in charge of the state's BART program, has determined that unit 3 at Plant Mitchell is BART-eligible for PM. Figure 1-1 shows a plot of Plant Mitchell relative to nearby Class I Areas. There are three Class I areas within 300 km of the plant: Okefenokee, Saint Marks, and Wolf Island. The BART exemption modeling will be conducted for each of these Class I areas in accordance with the referenced VISTAS common BART modeling protocol and the procedures described in this source-specific BART modeling protocol. If necessary, visibility improvement modeling for the BART determination step will be performed for those Class I areas where the exemption modeling shows a greater than 0.5 deciview impact.

1.3 Organization of protocol document

Section 2 of this protocol describes the source emissions that will be used as input to the BART exemption modeling and, if necessary, the BART determination modeling. Section 3 describes the input data to be used for the modeling including the modeling domain, terrain and land use, and meteorological data. Section 4 describes the air quality modeling procedures and Section 5 discusses the presentation of modeling results. Since all of the references cited are also included in the VISTAS common BART modeling protocol (Section 7.), no additional references section is included in this document. Appendix A and B provide additional information on the baseline source emissions.

Figure 1-1 Location of Class I Areas in Relation to Plant Mitchell

2.0 Source description and emissions data

2.1 Unit-specific source data

The emissions data used to assess the visibility impacts at the Class I areas within 300 km of Plant Mitchell is discussed in this section. As noted earlier, indications from the Georgia Environmental Protection Division are that they will issue rules stating that CAIR will suffice for EGU BART for SO_2 and NO_x. Therefore, this protocol focuses only on PM_{10}. Since various components of PM_{10} emissions have different visibility extinction efficiencies, the PM_{10} emissions are divided, or "speciated," into several components (VISTAS common protocol Sections 4.3.3 and 4.4.2). The VISTAS protocol (Section 5.) allows for the use of source-specific emissions and speciation factors or default values from AP-42. The PM_{10} emissions and speciation approach to be used for the modeling described in this protocol is indicated in the bullets below. Where default speciation values are used, the data represents a unit where current (baseline) emission controls include electrostatic precipitators (ESPs), but no post-combustion NO_x or SO_2 control equipment exists.

- Total PM_{10} is comprised of filterable and condensable emissions.
- Baseline filterable PM_{10} emissions are based on the highest stack test for the most recent 3-year period (2003-2005). This stack test is combined with the highest 24 hour heat input value for this period from CEMS data to calculate the "maximum 24 hour average emission rate" as required by the VISTAS protocol.
- Filterable PM_{10} will be subdivided by size category consistent with the default approach from AP-42 Table 1-1.6, and as noted on pages 41 and 42 of the VISTAS common BART modeling protocol. The AP-42 Table 1-1.6 specifies for the emission controls indicated above that 55.6% of filterable PM_{10} emissions is coarse (greater than 2.5 microns in size) and 44.4% is fine. Of the fine portion, 3.7% is elemental carbon and the remainder is inorganic fine particulates (soil).
- Condensable PM_{10} consists of inorganic and organic compounds. The inorganic portion is by default assumed to be H_2SO_4, although other non-sulfate inorganic condensables could be present. The organic portion is modeled as secondary organic aerosols.
- Baseline H_2SO_4 emissions are calculated consistent with the method used by Southern Company to derive these emissions for TRI purposes. This approach assumes that the H_2SO_4 emissions released from the stack are proportional to SO_2 emissions from combustion and are dependent on the fuel type and the removal of H_2SO_4 by downstream equipment (i.e., ESP and air heater). For eastern bituminous coal the baseline H_2SO_4 release rate is in the range of 0.3 to 0.4% of the SO_2 emissions. Appendix A will provide the basis for the site-specific value used.
- Baseline emissions of secondary organic aerosols (the remaining portion of condensable PM_{10}) are derived based on the supporting field observational information in Appendix A and will be a function of SO_2 emitted.

In practice, CALPUFF allows for the user to input certain components of PM_{10} as separate species and separate sizes, which will result in more accurate wet and dry deposition velocity results and also more accurate effects on light scattering. As noted above, the particle size distribution information is provided in AP-42 Table 1-1.6, and will be used for the BART exemption modeling as well as the BART determination modeling, if needed.

Table 2-1 provides a summary of the modeling emission parameters to be used in the BART CALPUFF modeling, consistent with the source emissions data presented in Appendix A for the baseline. All of the emissions in Table 2-1 were extracted from CEMS data for the 2003 to 2005 period and represent the maximum 24-hour average lb/hr rates (excluding days where startup, shutdown, or malfunctions occurred). For NO_x and SO_2 the values are directly from CEMS. Filterable PM_{10} emissions were calculated using the

Table 2-1 Plant Mitchell modeling emission parameters

Case	Source / Unit	Location UTM (Zone 16 NAD-83)		Stack Ht	Base Elev.	Dia-meter	Gas Exit Vel.	Stack Gas Exit Temp.	Emissions[1]			Particle Speciation[2]					
		UTM East	UTM North						SO_2	NO_X	PM_{10}	Filt. PM_{10}	Fine PM	EC	Cond. PM_{10}	H_2SO_4	Organic
		km	km	m	ft	m	m/s	deg K	lbs/hr	lbs/hr	lbs/hr	lbs/hr	lbs/hr	lbs/hr	lbs/hr	lbs/hr	lbs/hr
Plant Mitchell current																	
Baseline	Unit 3	772,550	3,482,419	152.4	174	6.4	9.2	421.9	4408	1033	49.7	36.7	16.3	0.6	Note 3	13.0	Note 3
Plant Mitchell future, if BART is required[4]																	
Control 1	Unit 3																
↓	Unit 3																
Control n	Unit 3																

[1] SO_2 and NO_x emissions are not BART-applicable for EGU sources in CAIR states, if the state agency agrees with EPA's interpretation of the BART final rule. The emissions for SO_2 and NO_x are provided for information purposes, and for reference in the computation of certain particle species such as H_2SO_4.

[2] Elemental carbon (EC) and Fine PM are a part of Filterable PM_{10} and H_2SO_4 and Organics are a part of Condensable PM_{10}.

[3] Total Condensable PM_{10} = H_2SO_4 + Organic. The Organic emission value will be provided later.

[4] This data will be provided later if a BART determination analysis is required.

highest stack test over the 2003 to 2005 period and multiplying these value times the maximum 24-hour average heat input derived from CEMS. These values were then adjusted using AP-42 factors from Table 1.1-6 that indicate that PM_{10} is 67% of total PM for a PC unit with an ESP. PM_{10} speciation was then performed as indicated above.

If the BART exemption modeling indicates that a BART determination is required, then one or more particulate matter control options will be considered for the modeling to determine visibility improvement from the baseline case. The BART engineering analysis will provide the justifications for the selected, technically feasible options and the species-specific control efficiencies. Table 2-1 will be updated to provide the modeling parameters for these feasible options and resubmitted to the Georgia Environmental Protection Division for review. Any site-specific deviations from the default particulate matter speciation guidance would be outlined at that time.

3.0 Input data to the CALPUFF model

3.1 General modeling procedures:

VISTAS has developed five sub-regional 4-km CALMET meteorological databases for three years (2001-2003) (VISTAS common protocol Section 4.4.2). The sub-regional modeling domains are strategically designed to cover all potential BART eligible sources within VISTAS states and all PSD Class I areas within 300 km of those sources (to the nearest edge). The extents of the 4-km sub-regional domains are shown in Figure 4-4 of the VISTAS common BART modeling protocol. The BART modeling for Plant Mitchell will be done using the 4-km subdomain 4.

USGS 90-meter Digital Elevation Model (DEM) files were used by VISTAS to generate the terrain data at 4-km resolution for input to the 4-km sub-regional CALMET run. Likewise, USGS 90-meter Composite Theme Grid (CTG) files were used by VISTAS to generate the land use data at 4-km resolution for input to the 4-km sub-regional CALMET run.

Three years of MM5 data (2001-2003) were used by VISTAS to generate the 4-km sub-regional meteorological datasets. See Sections 4.3.2 and 4.4.2 in the VISTAS common BART modeling protocol for more detail on these issues.

It is intended that all of the modeling for Plant Mitchell will use the 4-km subdomain 4. However, if the results indicate that the modeling could be improved with a CALPUFF run using a finer grid, then refinements in the modeling procedures will be considered and the Georgia Environmental Protection Division will be asked to approve these refinements.

In the event that a finer grid resolution is used, CALMET must be rerun. Other modifications to inputs of CALMET would include the extent of the modeling domain, the resolution of the terrain and land use data, and other relevant settings. The same MM5 data and observations as used for the 4-km sub-regional CALMET simulations would be used. The extent of the modeling domain may need to be changed because of disk space restrictions. The size of the CALMET output is directly proportional to the grid resolution of the run. The domain would be limited to the source and the exclusive Class I area(s) being assessed with a higher grid resolution, including a 50-km buffer in all directions.

If CALMET needs to be run at even a finer grid resolution, then the appropriate model setting/files (specifically the GEO.DAT file) will be modified. A summary of these modifications would be provided to the Georgia Environmental Protection Division for review and approval.

3.2 Air quality database (background ozone and ammonia)

Hourly measurements of ozone from all non-urban monitors, as generated by VISTAS and available on the VISTAS CALPUFF page on the Earth Tech web site (http://www.src.com/verio/download/sample_files.htm), will be used as input to CALPUFF. For ammonia, the approach recommended by VISTAS will be followed. However, since only PM emissions are being modeled, ozone and ammonia data is not really needed given that this data has no affect on PM results in CALPUFF.

3.3 Natural conditions and monthly f(RH) at Class I Areas

For each of the applicable Class I areas, natural background conditions must be established in order to determine a change in natural conditions related to a source's emissions. The modeling described by this protocol document intends to use annual average natural background light extinction (EPA 2003 values).

To determine the input to CALPUFF, it is first necessary to convert the deciviews to extinction using the equation:

Extinction (Mm-1) = 10 exp(deciviews/10).

For example, the EPA guidance document indicates for Great Smoky Mountains National Park that the deciview value for the average of the days is 7.60. This is equivalent to an extinction of 21.38 inverse megameters (Mm-1).

This extinction includes the default 10 Mm-1 for Rayleigh scattering. The remaining extinction is due to naturally occurring particles, and should be held constant for the entire year's simulation. Therefore, the data provided to CALPOST for Great Smoky Mountains would be the total natural background extinction minus 10 (expressed in Mm-1), or 11.38. This is most easily input as fine soil concentrations (11.38 µg/m3) in CALPOST, since the extinction efficiency of soil (PM-fine) is 1.0 and there is no f(RH) component. The concentration entries for all other particle constituents would be set to zero, and the fine soil concentration would be kept the same for each month of the year. The monthly values for f(RH) that CALPOST needs will be taken from "Guidance for Tracking Progress Under the Regional Haze Rule" (EPA, 2003) Appendix A, Table A-3.

4.0 Air quality modeling procedures

This section provides a summary of the modeling procedures outlined in the VISTAS protocol that will be used for the refined CALPUFF analysis to be conducted for Plant Mitchell.

4.1 Model selection and features

As noted in the VISTAS protocol (Summary, Recommendations Section II.), VISTAS will use CALPUFF Version 5.754 and CALMET Version 5.7, which can be obtained at http://www.src.com/verio/download/download.htm#VISTAS_VERSION. These versions contain enhancements funded by the Minerals Management Service (MMS) and VISTAS. They were developed by Earth Tech, Inc. and they are maintained on Earth Tech's Atmospheric Studies Group CALPUFF website for public access. This release includes CALMET, CALPUFF, CALPOST, CALSUM, and POSTUTIL as well as CALVIEW.

The major features of the CALPUFF modeling system, including those of CALMET and the post processors (CALPOST and POSTUTIL), are referenced in Section 3 of the VISTAS protocol.

4.2 Modeling domain and receptors

The initial Plant Mitchell BART runs will use the sub-domain 4, 4-km CALMET data to be supplied by VISTAS, as discussed above. This domain includes all Class I areas within 300 km of the source, plus a 50-km buffer. If there is the need for a refined analysis with a finer grid, a supplement to this modeling protocol will be provided describing the proposed procedures.

The receptors used for each of the Class I areas are based on the NPS database of Class I receptors, as recommended by the VISTAS common protocol (Section 4.3.3).

The BART exemption modeling will be conducted for Mitchell unit 3 (BART eligible unit) for each Class I area within 300 km of the source. If necessary, unit 3 will be modeled for the visibility improvement modeling for the BART determination step for the Class I areas where exemption modeling shows a greater than 0.5 deciview impact.

4.3 Technical options used in the modeling

CALMET modeling for the VISTAS-provided 4-km subdomains will be performed per the procedures specified in the VISTAS common BART modeling protocol. If it is decided to conduct additional modeling with a finer grid than 4 km, this modeling protocol will be updated to specify the technical options to be used in the CALMET run, in order to allow for state agency review and approval .

For CALPUFF model options, Plant Mitchell will follow the VISTAS common BART modeling protocol (Section 4.4.1), which states that we should use IWAQM (EPA, 1998) guidance. The VISTAS protocol (Section 4.3.3) also notes that building downwash effects are not required to be included unless the state directs the source to include these effects. Since Plant Mitchell is more than 50 km from the nearest Class I area, building downwash effects will not be included in the CALPUFF modeling.

The POSTUTIL utility program (VISTAS common protocol Section 4.4.2) will be used to repartition HNO3 and NO3 using VISTAS-provided ammonia concentrations derived from previous 2002 CMAQ modeling conducted by EPA or the alternate ammonia concentrations approach recommended by VISTAS, if the CMAQ data is unavailable. As indicated earlier, since only PM emissions are being modeled, the treatment of ammonia should not have an affect on PM results from CALPUFF.

4.4 Light extinction and haze impact calculations

The CALPOST postprocessor will be used as prescribed in the VISTAS protocol for the calculation of the impact from the modeled source's primary and secondary particulate matter concentrations on light extinction. The formula that is used is the existing (not the November 2005 revised) IMPROVE/EPA formula, which is applied to determine a change in light extinction due to increases in the particulate matter component concentrations. Using the notation of CALPOST, the formula is the following:

b_{ext} = 3 f(RH) [(NH4)2SO4] + 3 f(RH) [NH4NO3] + 4[OC] + 1[Soil] + 0.6[Coarse Mass] + 10[EC] + b_{Ray}

The concentrations, in square brackets, are in ug/m3 and b_{ext} is in units of Mm-1. The Rayleigh scattering term (b_{Ray}) has a default value of 10 Mm-1, as recommended in EPA guidance for tracking reasonable progress (EPA, 2003a). However, as recommended in the VISTAS protocol (Section 6.2.4), for refined 4-km grid (or smaller) CALPUFF runs, the Rayleigh scattering term will be modified for the specific elevation of the Class I area receptors. The Rayleigh term for estimating natural background will also, be adjusted to be consistent with this approach.

The assessment of visibility impacts at the Class I areas will use CALPOST Method 6 (VISTAS common protocol Section 4.3.2). Each hour's source-caused extinction is calculated by first using the hygroscopic components of the source-caused concentrations, due to ammonium sulfate and nitrate, and monthly Class I area-specific f(RH) values. The contribution to the total source-caused extinction from ammonium sulfate and nitrate is then added to the other, non-hygroscopic components of the particulate concentration (from coarse and fine soil, secondary organic aerosols, and from elemental carbon) to yield the total hourly source-caused extinction.

The BART rule significance threshold for the contribution to visibility impairment is 0.5 deciviews. The VISTAS protocol (Section 4.3.2) indicates that with the use of the 4-km sub-regional CALMET database, a source does not cause or contribute to visibility impairment if the 98th percentile (or 8th highest) day's change in extinction from natural conditions does not exceed 0.5 deciviews for any of the modeled years (an added check is: the 22nd highest prediction over the three years modeled should also not exceed 0.5 deciviews for a source to be exempted from a BART determination). Both the 98th percentile (or 8th highest) day's change in extinction from natural conditions for any modeled year and the 22nd highest prediction over the three years modeled will be evaluated. The maximum impact from each method must should not exceed 0.5 deciviews for the source to be exempted from a BART determination.

Figure 4-1 of the VISTAS common BART modeling protocol presents a flow chart showing the components of that modeling protocol for the analysis to determine whether a source is subject to BART. Again, it should be noted that the modeling for Plant Mitchell will focus on Subregional Fine-Scale modeling as depicted in the lower half of the figure.

If the exemption modeling demonstrates that Plant Mitchell does not cause or contribute to visibility impairment, then the source will not be subject to BART requirements, and no further analysis is needed. Otherwise, the source will proceed to perform BART determination modeling for the baseline and each control option in a similar manner as has been described in this document. This protocol will be supplemented with a revised Table 2-1 if the source is determined to be subject-to-BART.

5.0 Presentation of modeling results

The BART exemption and, if necessary, the BART determination modeling results for Plant Mitchell will be provided to the state agency in a manner as described in the VISTAS protocol (Section 4.5). A report will be produced that includes the following elements (as suggested in the VISTAS protocol):

1. A map of the source location and Class I areas within 300 km of the source.

2. For the CALPUFF modeling domain, a table listing all Class I areas in the VISTAS domain and those in neighboring states and impacts from the BART 4-km grid exemption modeling at those Class I areas within 300 km of the source, as illustrated in Table 4-3 of the VISTAS protocol.

3. A discussion of the number of Class I areas with visibility impairment due to source emissions for the 98th percentile days in each year (and the 98th percentile over all three years modeled) greater than 0.5 dv.

4. For the Class I area with the maximum impact, a discussion of the number of days beyond those excluded (e.g., the 98th percentile for refined analyses) that the impact of the source exceeds 0.5 dv, the number of receptors in the Class I area where the impact exceeds 0.5 dv, and the maximum impact.

5. For any finer grid CALPUFF exemption modeling, results for those Class I areas for which impacts of the source exceeded 0.5 dv in the 4-km initial modeling. We would report the same type of results as provided for 4-km exemption modeling.

The BART determination modeling will be performed for those Class I areas shown in the exemption modeling to exceed 0.5 dv impact. The extent of the BART determination modeling results will depend on the number of technically viable controls identified in the engineering analysis phase of the BART assessment. The results presented will be a comparison of the 98^{th} percentile value for the baseline and each control strategy derived as is outlined above for the exemption modeling. The same statistics as those mentioned above in Steps 3 and 4 would be provided, and a summary of the relative results among all emission scenarios run would be produced.

Additionally, the appropriate electronic files used to conduct the CALPUFF modeling will be submitted on CD-ROM or DVD media.

Appendix A

Basis for Source-Specific Sulfuric Acid Emissions for BART Baseline Case

Appendix A

Basis for Source-Specific Sulfuric Acid Emissions for BART Baseline Case

Sulfuric Acid (H2SO4) Emissions

During the combustion of sulfur-containing fuels, a percentage of the SO_2 formed is further oxidized to SO_3. As the flue gas cools across the air heater, this SO_3 combines with flue gas moisture to form vapor-phase and/or condensed sulfuric acid (H_2SO_4). The baseline H_2SO_4 emissions shown in Table 2-1 of this BART modeling protocol were calculated consistent with the method used by Southern Company to derive these emissions for Toxics Release Inventory (TRI) purposes. This method is documented in a report entitled Estimating Total Sulfuric Acid Emissions from Stationary Power Plants: Revision 3 (2005) prepared by Keith Harrison and Dr. Larry Monroe (Southern Company Services) and Edward Cichanowicz (Consultant). The approach described in this report assumes that H_2SO_4 emissions released from the stack are proportional to SO_2 emissions from combustion and are dependent on the fuel type and the removal of H_2SO_4 by downstream equipment (i.e., ESP and air heater).

The calculations below show baseline sulfuric acid emissions that are expected. Since this facility does not contain post combustion emissions controls, the baseline sulfuric acid emissions estimate only accounts for the manufacture of H_2SO_4 through combustion and loss or removal within the system.

Sulfuric Acid Manufactured from Combustion (EMComb):
EMComb = K x F1 x E2
where,
EMComb = total sulfuric acid manufactured from combustion, lbs/yr
K = Molecular weight and units conversion constant = 98.07 / 64.04 * 2000 = 3,063
(98.07 = Molecular weight of sulfuric acid; 64.04 = Molecular weight of SO2; Conversion from tons per year to pounds per year – multiply by 2000.)
F1 = Fuel Impact Factor (from the emissions estimating report)
E2 = Sulfur dioxide emissions, tons (from CEMS data).

Sulfuric Acid Manufactured from Combustion is:
Mitchell 3:
EMComb = 3,063 x 0.008 x 4,408.4 lbs/hr / 2000 = 54.0 lbs/hr

Sulfuric Acid Released from Combustion (ERComb)
ERComb = EMComb x F2 (technology impact factors for air heater and ESP)
ERComb = EMComb x (0.49) x (0.49)
Mitchell 3:
ERComb = 54.0 lbs/hr x (0.24) = 13.0 lbs/hr

Appendix B

Field Observational Information for Secondary Organic Aerosols (To Be Provide Later)