Golder Associates

BART CONTROL ANALYSIS
SMURFIT-STONE CONTAINER ENTERPRISES, INC.
FERNANDINA BEACH MILL

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LIST OF ACRONYMS AND ABBREVIATIONS

AAQS	Ambient Air Quality Standards
AOR	annual operating report
APH	air preheater
B&W	Babcock & Wilcox
BACT	Best Available Control Technology
Btu/gal	British thermal units per gallon
Btu/lb	British thermal units per pound
CAA	Clean Air Act
CFR	Code of Federal Regulations
CO	carbon monoxide
DNCG	dilute non-condensable gas
EPA	U.S. Environmental Protection Agency
ESP	electrostatic precipitator
F	fluoride
°F	degrees Fahrenheit
ft/s	feet per second
F.A.C.	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FGR	flue gas recirculation
FR	fuel reburning
gal/hr	gallons per hour
gal/yr	gallons per year
GEP	Good Engineering Practice
H_2O	water
HAP	hazardous air pollutant
HCl	hydrogen chloride
Hg	mercury
HSH	highest, second-highest
km	kilometer
LAER	lowest achievable emission rate
lb/hr	pounds per hour

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LIST OF ACRONYMS AND ABBREVIATIONS (cont'd)

lb/MMBtu	pounds per million British thermal units
LEA	less excess air
LNB	low-NO_x burner
LVHC	low volume high concentration
m	meter
MACT	Maximum Achievable Control Technology
MMBtu/hr	million British thermal units per hour
MMBtu/yr	million British thermal units per year
$MMft^3$	million cubic feet
MMscf/yr	million standard cubic feet per year
N_2	nitrogen
NAAQS	National Ambient Air Quality Standards
NCG	non-condensable gas
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NSPS	New Source Performance Standards
NSR	new source review
NWA	National Wilderness Area
O_2	oxygen
OAQPS	Office of Air Quality Planning and Standards
OFA	overfire air
PCP	pollution control project
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter equal to or less than 10 micrometers
ppmv	parts per million by volume
PSD	prevention of significant deterioration
RBLC	RACT, BACT, LAER Clearinghouse
SAM	sulfuric acid mist
scf/hr	standard cubic foot per hour
SCR	selective catalytic reduction

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LIST OF ACRONYMS AND ABBREVIATIONS (cont'd)

SIL	significant impact level
SIP	State Implementation Plan
SNCR	selective non-catalytic reduction
SOG	stripper off gas
SO_2	sulfur dioxide
SO_3	sulfur trioxide
SSCE	Smurfit-Stone Container Enterprises
SR	State Road
TPD	tons per day
TPH	tons per hour
TPY	tons per year
TRS	total reduced sulfur
TSM	total selected metals
µm	micrometer
$\mu g/m^3$	micrograms per cubic meter
VOC	volatile organic compound

1.0 INTRODUCTION

Smurfit-Stone Container Enterprises, Inc. (SSCE) operates a kraft linerboard mill in Fernandina Beach, Nassau County, Florida. The Fernandina Beach Mill consists of two power boilers, two recovery boilers, two smelt dissolving tanks, lime kiln, tall oil plant, brownstock washer system, pulping system, a package boiler, and ancillary equipment to produce kraft linerboard. The Fernandina Beach Mill is currently operating under Title V Permit No. 0890003-009-AV.

Under the regional haze regulations, contained in Title 40, Part 51 of the Code of Federal Regulations (40 CFR 51), Subpart P – Protection of Visibility, the U.S. Environmental Protection Agency (EPA) has issued final rules and guidelines, dated July 6, 2005, for Best Available Retrofit Technology (BART) determinations [Federal Register (FR), Volume 70, pages 39104-39172]. BART applies to certain large stationary sources known as BART-eligible sources. Sources are BART-eligible if they meet the following three criteria:

- Contains emissions units that are one of the 26 listed source categories in the guidance;
- Contains emissions units that were put in place between August 7, 1962 and August 7, 1977; and
- Potential emissions from the emissions units of at least 250 tons per year (TPY) of a visibility-impairing pollutant [sulfur dioxide (SO_2), nitrogen oxides (NO_x), and direct particulate matter (PM) of equal to or less than 10 microns (PM_{10})].

The Fernandina Mill has been identified as a BART-eligible source with multiple BART-eligible emissions units.

The Florida Department of Environmental Protection (FDEP) has adopted EPA's visibility protection rules and guidelines contained in 40 CFR 51, Subpart P. The newly adopted rules become effective on January 31, 2007.

The basic tenet of the regional haze program is the achievement of natural visibility conditions in Prevention of Significant Deterioration (PSD) Class I areas by the year 2064. Florida has four PSD Class I areas while Georgia has two PSD Class I areas that can be affected by Florida sources [i.e., located in Florida or within 300 kilometers (km) of Florida].

BART requirements potentially apply to any BART-eligible source that, pursuant to the FDEP BART regulations, emits an air pollutant that may "reasonably be anticipated to cause or contribute to any impairment of visibility in any Class I area." The BART guidelines establish a threshold value of 0.5 deciview (dv) for any single source (facility) for determining whether the source contributes to visibility impairment. The term "BART-eligible emissions unit" is defined as any single emissions unit that meets the criteria described above, except for the 250 TPY criterion, which applies to the entire BART-eligible source. A "BART-eligible source" is defined as the collection of all BART-eligible emissions units at a single facility. If a source has several emissions units, only those that meet the BART-eligible criteria are included in the definition of "BART-eligible source."

SSCE submitted a BART applicability analysis and the initial modeling protocol to the FDEP on September 30, 2006, for the Fernandina Mill. An updated modeling protocol for this facility was submitted to FDEP in January 2007 (see Appendix A). The report identified the BART-eligible emissions units, and determined that the BART-eligible source was not exempt from BART based on its potential visibility impacts on the Class I areas. Based on that analysis, the final list of BART-eligible, non-fugitive emissions units for the Fernandina Mill are as follows:

- No. 5 Power Boiler (EU006)
- No. 4 Recovery Boiler (EU007)
- No. 4 Smelt Dissolving Tank (EU013)

Each of these emissions units requires an analysis of BART control options and a BART determination. This BART control analysis addresses these requirements and is organized into four additional sections, followed by appendices. A description of the BART-eligible emissions units, including air emission rates and air pollution control equipment, is presented in Section 2.0. The BART exemption modeling analysis results are presented in Section 3.0. The procedural requirements for the analysis of BART control options are presented in Section 4.0. The BART analysis for each emissions unit is presented in Section 5.0. The revised BART modeling protocol is presented in its entirety in Appendix A.

2.0 DESCRIPTION OF BART-ELIGIBLE EMISSIONS UNITS

The Fernandina Beach Mill is located in Fernandina Beach, Nassau County, Florida. An area map showing the facility location and PSD Class I areas located within 300 km of the facility is presented in Figure 1-1 of the revised BART modeling protocol (see Appendix A). The PSD Class I areas and their distances from the Fernandina Beach Mill are as follows:

- Okefenokee National Wildlife Area (NWA) - 66 km,
- Wolf Island NWA - 71 km,
- Chassahowitzka NWA - 242 km, and
- Saint Marks NWA - 249 km.

Bradwell Bay PSD Class I area is located within 300 km of the facility, but visibility impairment is not required to be addressed for this area (40 CFR 81, Subpart D).

The Universal Transverse Mercator (UTM) coordinates of the Fernandina Beach Mill are approximately 456.2 km east and 3,394.1 km north in UTM Zone 17.

A description of each of these emissions units is presented in the following sections.

2.1 No. 5 Power Boiler (EU 006)

The No. 5 Power Boiler (No. 5 PB) at the Fernandina Mill has a maximum heat input of 805 MMBtu/hr. The unit is permitted to combust carbonaceous fuel and No. 6 fuel oil (including on-spec used oil). Low volume, high concentration (LVHC) non-condensable gases (NCG) from the batch digester system, continuous digester system, turpentine recovery system, evaporator systems and foul condensate collection tank are combusted in this boiler as a back-up to the No. 4 Lime Kiln for compliance with 40 CFR 63, Subpart S. The No. 5 PB began operation in 1968.

PM/PM$_{10}$ emissions from the No. 5 PB are controlled by a cyclone followed by an electrostatic precipitator (ESP). This emissions unit is regulated under Rules 62-296.404, 62-296.405, 62-296.410, and 62-204.800 of the Florida Administrative Code (F.A.C.); 40 CFR 61, Subpart E; and 40 CFR 63, Subpart DDDDD.

PM emissions from No. 5 PB are limited to 0.3 pounds per million British thermal units (lb/MMBtu) of heat input for carbonaceous fuels, and 0.1 lb/MMBtu heat input for fossil fuels. Total mass emissions are also limited to 137.1 pounds per hour (lb/hr) and 598.9 TPY.

SO_2 emissions are limited to 1,733.7 lb/hr, 1,511.1 lb/hr as a 24-hour average, and 6,618.62 TPY. During periods of NCG burning, maximum 24-hour emissions are limited to 1,733.7 lb/hr, but emissions greater than 1,511.1 lb/hr must be offset during the calendar year by purchasing and burning lower sulfur content fuel oil. The sulfur content of the No. 6 fuel oil combusted in No. 5 PB cannot exceed 2.5 percent.

2.2 No. 4 Recovery Boiler (EU 007)

The No. 4 Recovery Boiler (No. 4 RB) at the Fernandina Mill has a permitted capacity of 137,500 lb/hr black liquor solids (BLS), equivalent to a maximum heat input of 852 MMBtu/hr. The boiler, manufactured by Babcock & Wilcox, is permitted to combust BLS and No. 6 fuel oil, and provides the Fernandina Beach Mill with up to 492,000 lb/hr of high-pressure steam. The unit is of low-odor design and incorporates an ESP for control of PM emissions.

This emissions unit is regulated under Rules 62-296.404 and 62-204.800 F.A.C. and 40 CFR 63, Subpart MM.

PM emissions from No. 4 RB are limited to 0.044 grains per dry standard cubic foot (gr/dscf) of exhaust gases and 3 lb/3,000 pounds of BLS fired. Total mass emissions are also limited to 137.5 lb/hr and 602.25 TPY. The maximum sulfur content of the No. 6 fuel oil burned in this unit is 2.5 percent.

2.3 No. 4 Smelt Dissolving Tank (EU 013)

The No. 4 Smelt Dissolving Tank (No. 4 SDT) at the Fernandina Beach Mill has a permitted capacity of 137,500 lb/hr BLS, equal to the No. 4 RB rate. The No. 4 SDT incorporates a venturi scrubber to control PM emissions.

This emissions unit is regulated under Rules 62-296.404 and 62-204.800 F.A.C. and 40 CFR 63, Subpart MM. PM emissions from No. 4 SDT are limited to 0.20 lb/ton BLS fired.

3.0 BART EXEMPTION ANALYSIS AND RESULTS

A BART modeling protocol for the Fernandina Beach Mill was submitted to the FDEP on September 30, 2006 and a revised protocol was submitted in January 2007. Initial visibility modeling was conducted to determine if the BART-eligible source could be exempt from BART based on its impacts at the Class I areas. The baseline emissions and methodology used for the exemption modeling and the exemption modeling results are presented below.

3.1 Emission Rates

The emissions used for visibility modeling for the Fernandina Mill are contained in the BART modeling protocol, which is included as Appendix A.

3.2 Modeling Methodology

The CALPUFF model, Version 5.756, was used to predict the maximum visibility impairment at the PSD Class I areas located within 300 km of the Fernandina Mill. Recent technical enhancements, including changes to the over-water boundary layer formulation and coastal effects modules (sponsored by the Minerals Management Service), are included in this version. The methods and assumptions used in the CALPUFF model are presented in the Protocol. The 4-km spacing Florida domain was used for the BART exemption. The refined CALMET domain, used for the SSCE BART modeling analysis has been provided by the FDEP. The major features used in preparing these CALMET data have also been described in Section 4.0 of the Protocol.

Currently, atmospheric light extinction is estimated by an algorithm developed by the Interagency Monitoring of Protected Visual Environments (IMPROVE) committee, which was adopted by the EPA under the 1999 Regional Haze Rule (RHR) and is referred to as the "1999 IMPROVE" algorithm. This algorithm for estimating light extinction from particle speciation data tends to underestimate light extinction for the highest haze conditions and overestimate it for the lowest haze conditions and does not include light extinction due to sea salt, which is important at sites near coastal areas. As a result of these limitations, the IMPROVE Steering Committee recently developed a new algorithm (the "new IMPROVE algorithm") for estimating light extinction from PM component concentrations, which provides a better correspondence between measured visibility and that calculated from PM component concentrations. A detailed description of the new IMPROVE algorithm and its implementation is presented in Section 3.4 of the Protocol.

Both the 1999 IMPROVE algorithm and the new IMPROVE algorithm were used to calculate the natural background light extinction at the Class I areas for the SSCE BART modeling analysis. Visibility impacts were predicted at each PSD Class I area using receptors provided by the National Park Service, as presented in the BART protocol.

3.3 BART Exemption Modeling Results

Summaries of the maximum visibility impairment values for the Fernandina Beach Mill BART-eligible emission units estimated using the 1999 IMPROVE algorithm are presented in Tables 3-1 and 3-2. In Table 3-1, the 98th percentile 24-hr average visibility impairment values (i.e., 8th highest) for the years 2001, 2002 and 2003; and the 22nd highest 24-hr average visibility impairment value over the three years, are presented. This table also presents the number of days and receptors for which the visibility impairment was predicted to be greater than 0.5 dv. The eight highest visibility impairment values predicted at the PSD Class I areas are presented in Table 3-2.

As shown in Tables 3-1 and 3-2, the 8th highest visibility impairment values predicted for each year, using the 1999 IMPROVE algorithm, are greater than 0.5 dv at the Okefenokee and Wolf Island National Wilderness Areas (NWAs), but are below 0.5 dv at the Chassahowitzka and Saint Marks NWAs. The 22nd highest visibility impairment value predicted over the 3-year period is also greater than 0.5 dv at the Okefenokee and Wolf Island NWAs but less than 0.5 dv at Chassahowitzka and Saint Marks NWAs.

The eight highest visibility impairment values for the Fernandina Beach Mill BART-eligible emission units, estimated using the new IMPROVE algorithm, are presented in Table 3-3 for Okefenokee and Wolf Island NWAs. As shown the 8th highest visibility impairment values predicted for each year, using the new IMPROVE algorithm, are lower than those predicted with the 1999 IMPROVE algorithm, but are still are greater than 0.5 dv.

Based on these results, the Fernandina Beach Mill is subject to the BART requirements and a BART determination analysis is required for each of the BART-eligible emissions units at the facility. Since the visibility impacts due to the facility were found to be more than 0.5 dv only at the Okefenokee and Wolf Island NWAs, the BART determination analysis will include only these two Class I areas.

The 8th highest impacts of each BART-eligible unit and the contributions of the individual visibility impairing pollutants to those impacts for each unit predicted at the Okefenokee and Wolf Island NWAs are presented in Table 3-4 for the 1999 IMPROVE algorithm and Table 3-5 for the new IMPROVE algorithm. The visibility impairing pollutants include sulfate (SO_4), nitrate (NO_3), and PM_{10}.

TABLE 3-1
SUMMARY OF BART EXEMPTION MODELING RESULTS, 1999 IMPROVE ALGORITHM- SMURFIT-STONE CONTAINER ENTERPRISES, INC., FERNANDINA MILL

PSD Class I Area	Distance from Source to Nearest Class I Area Boundary (km)	Number of Days and Receptors with Change in Impacts >0.5 dv									22nd Highest Impact (dv) Over 3-Yr Period
		2001			2002			2003			
		No. of Days	No. of Receptors	8th Highest Impact (dv)	No. of Days	No. of Receptors	8th Highest Impact (dv)	No. of Days	No. of Receptors	8th Highest Impact (dv)	
Okefenokee NWA	66	15	180	0.848	19	180	0.751	32	180	0.915	0.798
Wolf Island NWA	71	23	30	0.697	14	30	0.681	19	30	0.742	0.697
Chassahowitzka NWA	242	1	87	0.230	2	113	0.259	0	0	0.154	0.200
St. Marks NWA	249	0	0	0.190	4	101	0.360	1	101	0.201	0.260

TABLE 3-2
VISIBILITY IMPACT RANKINGS AT PSD CLASS I AREAS
1999 IMPROVE ALGORITHM
SMURFIT-STONE CONTAINER ENTERPRISES, INC., FERNANDINA MILL

PSD Class I Area	Rank	Predicted Impact (dv) 2001	Predicted Impact (dv) 2002	Predicted Impact (dv) 2003
Okefenokee NWA	1	1.540	2.685	1.646
	2	1.469	1.113	1.635
	3	1.068	1.021	1.096
	4	0.902	0.837	1.052
	5	0.891	0.826	1.045
	6	0.875	0.768	1.036
	7	0.867	0.753	0.966
	8	0.848	0.751	0.915
Wolf Island NWA	1	1.081	1.097	1.358
	2	0.995	0.939	1.268
	3	0.983	0.780	1.235
	4	0.894	0.776	0.955
	5	0.888	0.718	0.851
	6	0.833	0.716	0.807
	7	0.768	0.690	0.784
	8	0.697	0.681	0.742
Chassahowitzka NWA	1	0.556	0.671	0.343
	2	0.339	0.545	0.340
	3	0.326	0.370	0.333
	4	0.308	0.301	0.216
	5	0.307	0.290	0.200
	6	0.303	0.273	0.162
	7	0.261	0.267	0.161
	8	0.230	0.259	0.154
St. Marks NWA	1	0.432	0.908	0.672
	2	0.430	0.663	0.399
	3	0.326	0.659	0.393
	4	0.290	0.619	0.302
	5	0.277	0.404	0.250
	6	0.260	0.398	0.213
	7	0.216	0.364	0.201
	8	0.190	0.360	0.201

TABLE 3-3
VISIBILITY IMPACT RANKINGS AT PSD CLASS I AREAS
NEW IMPROVE ALGORITHM
SMURFIT-STONE CONTAINER ENTERPRISES, INC., FERNANDINA MILL

PSD Class I Area	Rank	Predicted Impact (dv)		
		2001	2002	2003
Okefenokee NWA	1	1.231	2.160	1.277
	2	1.188	0.850	1.261
	3	0.818	0.808	0.872
	4	0.711	0.664	0.831
	5	0.708	0.655	0.816
	6	0.691	0.604	0.811
	7	0.672	0.593	0.778
	8	0.676	0.596	0.717
Wolf Island NWA	1	0.794	0.789	0.978
	2	0.732	0.678	0.906
	3	0.705	0.562	0.889
	4	0.639	0.559	0.694
	5	0.638	0.517	0.613
	6	0.595	0.511	0.569
	7	0.550	0.494	0.567
	8	0.511	0.486	0.536

TABLE 3-4
CONTRIBUTION OF VISIBILITY IMPAIRING PARTICLE SPECIES
1999 IMPROVE ALGORITHM
SMURFIT-STONE CONTAINER ENTERPRISES, INC., FERNANDINA MILL

		8th Highest Impact and Contribution by Species											
		2001				2002				2003			
		Impact	Contribution (%) [a]			Impact	Contribution (%) [a]			Impact	Contribution (%) [a]		
Emission Unit	Unit ID	(dv)	SO_4	NO_3	PM_{10}	(dv)	SO_4	NO_3	PM_{10}	(dv)	SO_4	NO_3	PM_{10}
1999 IMPROVE Algorithm													
Okefenokee NWA													
No. 5 Power Boiler	PB5	0.731	90.4	5.4	4.2	0.608	75.8	18.7	5.6	0.806	79.3	17.9	2.7
No. 4 Recovery Boiler	RB4	0.096	51.2	38.7	10.0	0.102	80.9	4.7	14.4	0.124	39.6	47.6	12.8
No. 4 Smelt Dissolving Tank	SDT4	0.021	33.0	10.1	56.9	0.023	28.5	7.6	63.8	0.024	37.0	1.1	61.9
Wolf Island NWA													
No. 5 Power Boiler	PB5	0.620	94.9	2.9	2.2	0.610	89.0	6.0	5.0	0.623	97.3	0.5	2.3
No. 4 Recovery Boiler	RB4	0.084	76.0	8.3	15.7	0.076	80.5	2.6	16.9	0.086	50.8	38.0	11.3
No. 4 Smelt Dissolving Tank	SDT4	0.017	35.0	0.7	64.3	0.013	38.4	1.4	60.2	0.019	30.6	11.1	58.3

[a] Sulfate (SO4) particles are formed due to SO_2 and H_2SO_4 emissions; nitrate (NO3) particles are formed due to NOx emissions, and other non-hygroscopic PM_{10} particles are a result of fine filterable PM_{10}, coarse filterable PM_{10}, elemental carbon, and condensable secondary organic aerosol emissions.

TABLE 3-5
CONTRIBUTION OF VISIBILITY IMPAIRING PARTICLE SPECIES
NEW IMPROVE ALGORITHM
SMURFIT-STONE CONTAINER ENTERPRISES, INC., FERNANDINA MILL

		8th Highest Impact and Contribution by Species											
		2001				2002				2003			
		Impact	Contribution (%) [a]			Impact	Contribution (%) [a]			Impact	Contribution (%) [a]		
Emission Unit	Unit ID	(dv)	SO_4	NO_3	PM_{10}	(dv)	SO_4	NO_3	PM_{10}	(dv)	SO_4	NO_3	PM_{10}
New IMPROVE Algorithm													
Okefenokee NWA													
No. 5 Power Boiler	PB5	0.578	89.5	5.8	4.7	0.478	74.0	19.7	6.2	0.637	87.4	10.7	2.0
No. 4 Recovery Boiler	RB4	0.078	48.7	39.9	11.4	0.079	77.2	4.7	18.0	0.102	37.3	48.5	14.2
No. 4 Smelt Dissolving Tank	SDT4	0.018	31.3	2.1	66.6	0.018	31.3	2.1	66.6	0.022	23.7	3.4	72.9
Wolf Island NWA													
No. 5 Power Boiler	PB5	0.451	94.4	3.2	2.4	0.433	95.4	0.9	3.7	0.440	96.8	0.5	2.7
No. 4 Recovery Boiler	RB4	0.061	73.6	8.7	17.7	0.055	64.5	22.5	13.1	0.064	47.8	39.1	13.1
No. 4 Smelt Dissolving Tank	SDT4	0.014	31.2	0.0	68.8	0.011	26.1	18.9	55.0	0.015	35.6	2.4	62.0

[a] Sulfate (SO4) particles are formed due to SO_2 and H_2SO_4 emissions; nitrate (NO3) particles are formed due to NOx emissions, and other non-hygroscopic PM_{10} particles are a result of fine filterable PM_{10}, coarse filterable PM_{10}, elemental carbon, and condensable secondary organic aerosol emissions.

4.0 REQUIREMENTS FOR ANALYSIS OF BART CONTROL OPTIONS

The visibility regulations define BART as follows:

> *Best Available Retrofit Technology (BART)* means an emission limitation based on the degree of reduction achievable through the application of the best system of continuous emission reduction for each pollutant which is emitted by . . . [a BART-eligible source]. The emission limitation must be established, on a case-by-case basis, taking into consideration the technology available, the costs of compliance, the energy and non-air quality environmental impacts of compliance, any pollution control equipment in use or in existence at the source, the remaining useful life of the source, and the degree of improvement in visibility which may reasonably be anticipated to result from the use of such technology. [FR, Volume 70, pages 39104-9172].

The BART analysis identifies the best system of continuous emission reduction taking into account:

1. The available retrofit control options,
2. Any pollution control equipment in use at the source (which affects the availability of options and their impacts),
3. The costs of compliance with control options,
4. The remaining useful life of the facility,
5. The energy and non-air quality environmental impacts of control options, and
6. The visibility impacts analysis.

Once it is determined that a source is subject to BART for a particular pollutant, then for each affected emission unit, BART must be established for that pollutant. The BART determination must address air pollution control measures for each emissions unit or pollutant emitting activity subject to review.

For volatile organic compounds (VOC) and PM sources subject to maximum achievable control technology (MACT) standards under 40 CFR 63, the analysis may be streamlined (at the discretion of the State) by including a discussion of the MACT controls and whether any major new technologies have been developed subsequent to the MACT standards. There are many VOC and PM sources that are well-controlled because they are regulated by the MACT standards that EPA developed under CAA Section 112. There are also MACT standards that have invoked stringent control measures for SO_2. Any source subject to MACT standards must meet a level that is as stringent as the best-controlled 12 percent of sources in the industry. The EPA believes that, in many cases, it will be unlikely that States will identify emission controls more stringent than the MACT standards without identifying control options that would cost many thousands of dollars per ton. Unless there are new technologies subsequent to the MACT standards that would lead to cost-effective increases in the level of control, EPA believes the State may rely on the MACT standards for purposes of BART [FR, Volume 70, pages 39104-39172].

The EPA believes that the same rationale also holds true for emissions standards developed for municipal waste incinerators under the Clean Air Act (CAA) section 111(d), and for many new source review/prevention of significant deterioration (NSR/PSD) determinations and NSR/PSD settlement agreements. However, EPA does not believe that technology determinations from the 1970s or early 1980s, including new source performance standards (NSPS), should be considered to represent best control for existing sources, as best control levels for recent plant retrofits are more stringent than these older levels.

Where the source is relying on these standards to represent a BART level of control, a discussion of whether any new technologies have subsequently become available should be provided.

The five basic steps of a case-by-case BART analysis are:

STEP 1—Identify All Available Retrofit Control Technologies,

STEP 2— Eliminate Technically Infeasible Options,

STEP 3— Evaluate Control Effectiveness of Remaining Control Technologies,

STEP 4— Evaluate Impacts and Document the Results, and

STEP 5—Evaluate Visibility Impacts.

Each of these steps is described briefly in the following sections.

STEP 1—Identify All Available Retrofit Control Technologies

Available retrofit control options are those air pollution control technologies with a practical potential for application to the emissions unit and the regulated pollutant under evaluation. In identifying "all" options, the most stringent option and a reasonable set of options for analysis that reflects a comprehensive list of available technologies are identified. It is not necessary to list all permutations of available control levels that exist for a given technology—the list is complete if it includes the maximum level of control each technology is capable of achieving.

Air pollution control technologies can include a wide variety of available methods, systems, and techniques for control of the affected pollutant. Technologies required as Best Achievable Control Technology (BACT) or lowest achievable emission rate (LAER) are available for BART purposes and must be included as control alternatives. The control alternatives can include not only existing controls for the source category in question but also take into account technology transfer of controls that have been applied to similar source categories and gas streams. Technologies that have not yet been applied to (or permitted for) full-scale operations need not be considered as available; as it is not expected that the source owner should purchase or construct a process or control device that has not already been demonstrated in practice.

Where a NSPS exists for a source category (as is the case for most of the categories affected by BART), the BART analysis should include a level of control equivalent to the NSPS as one of the control options. The NSPS standards are codified in 40 CFR 60.

Potentially applicable retrofit control alternatives can be categorized in three ways.

- Pollution prevention: use of inherently lower-emitting processes/practices, including the use of control techniques (e.g. low-NO_x burners) and work practices that prevent emissions and result in lower "production-specific" emissions (note that it is not our intent to direct States to switch fuel forms; e.g., from coal to gas),
- Use of (and where already in place, improvement in the performance of) add-on controls, such as scrubbers, fabric filters, thermal oxidizers and other devices that control and reduce emissions after they are produced, and
- Combinations of inherently lower-emitting processes and add-on controls.

In the course of the BART review, one or more of the available control options may be eliminated from consideration if demonstrated to be technically infeasible or to have unacceptable energy, cost, or non-air quality environmental impacts on a case-by-case (or site-specific) basis.

The EPA does not consider BART as a requirement to redesign the source when considering available control alternatives. For example, where the source subject to BART is a coal-fired electric generator, EPA does not require the BART analysis to consider building a natural gas-fired electric turbine although the turbine may be inherently less polluting on a per unit basis.

For emission units subject to a BART review, there will often be control measures or devices already in place. For such emission units, it is important to include control options that involve improvements to existing controls and not to limit the control options only to those measures that involve a complete replacement of control devices.

If a BART source has controls already in place that are the most stringent controls available (note that this means all possible improvements to any control devices have been made), it is not necessary to comprehensively complete each following step of the BART analysis. As long these most stringent controls available are made federally enforceable for the purpose of implementing BART for that source, the remaining analyses may be skipped, including the visibility analysis in Step 5. Likewise, if a source commits to a BART determination that consists of the most stringent controls available, then there is no need to complete the remaining analyses.

STEP 2— Eliminate Technically Infeasible Options

In Step 2, the source evaluates the technical feasibility of the control options identified in Step 1. The source should document a demonstration of technical infeasibility and should explain; based on physical, chemical, or engineering principles; why technical difficulties would preclude the successful use of the control option on the emissions unit under review. The source may then eliminate such technically infeasible control options from further consideration in the BART analysis.

Control technologies are technically feasible if either (1) they have been installed and operated successfully for the type of source under review under similar conditions, or (2) they could be applied to the source under review. Two key concepts are important in determining whether a technology could be applied: "availability" and "applicability." A technology is considered "available" if the source owner may obtain it through commercial channels, or it is otherwise available within the common sense meaning of the term. An available technology is "applicable" if it can reasonably be installed and operated on the source type under consideration. A technology that is available and applicable is technically feasible.

Where it is concluded that a control option identified in Step 1 is technically infeasible, the source should demonstrate that the option is either commercially unavailable, or that specific circumstances preclude its application to a particular emission unit. Generally, such a demonstration involves an evaluation of the characteristics of the pollutant-bearing gas stream and the capabilities of the technology. Alternatively, a demonstration of technical infeasibility may involve a showing that there are irresolvable technical difficulties with applying the control to the source (e.g., size of the unit, location of the proposed site, operating problems related to specific circumstances of the source, space constraints, reliability, and adverse side effects on the rest of the facility). Where the resolution of technical difficulties is merely a matter of increased cost, you should consider the technology to be technically feasible. The cost of a control alternative is considered later in the process.

A possible outcome of the BART procedures discussed in these guidelines is the evaluation of multiple control technology alternatives resulting in essentially equivalent emissions. It is not EPA's intent to encourage evaluation of unnecessarily large numbers of control alternatives for every emissions unit. [FR, Volume 70, pages 39104-39172]. Consequently, one should use judgment in deciding how to conduct an alternative, detailed impacts analysis (Step 4, below). For example, if two or more control techniques result in control levels that are essentially identical, considering the uncertainties of emissions factors and other parameters pertinent to estimating performance, only the less costly of these options need to be evaluated. The scope of the BART analysis should be narrowed in this way only if there is a negligible difference in emissions and energy and non-air quality environmental impacts between control alternatives.

STEP 3— Evaluate Control Effectiveness of Remaining Control Technologies

Step 3 involves evaluating the control effectiveness of all the technically feasible control alternatives identified in Step 2 for the pollutant and emissions unit under review. Two key issues in this process include:

1. Ensure that the degree of control is expressed using a metric that ensures an "apples to apples" comparison of emissions performance levels among options, and
2. Giving appropriate treatment and consideration of control techniques that can operate over a wide range of emission performance levels.

This issue is especially important when comparing inherently lower-polluting processes to one another or to add-on controls. In such cases, it is generally most effective to express emissions performance as an average steady state emissions level per unit of product produced or processed. Examples of common metrics are:

- Pounds of SO_2 emissions per million Btu heat input, and
- Pounds of NO_x emissions per ton of black liquor solids (BLS) burned.

Many control techniques, including both add-on controls and inherently lower polluting processes, can perform at a wide range of levels. Scrubbers and high and low efficiency ESPs are two of the many examples of such control techniques that can perform at a wide range of levels. It is not EPA's intent to require analysis of each possible level of efficiency for a control technique as such an analysis would result in a large number of options [FR, Volume 70, pages 39104-39172]. It is important, however, that in analyzing the technology one take into account the most stringent emission control level that the technology is capable of achieving. Recent regulatory decisions and performance data (e.g., manufacturer's data, engineering estimates and the experience of other sources) should be considered when identifying an emissions performance level or levels to evaluate.

In assessing the capability of the control alternative, latitude exists to consider special circumstances pertinent to the specific source under review, or regarding the prior application of the control alternative. However, the basis for choosing the alternate level (or range) of control in the BART analysis should be explained. Situations may occur where it is preferred or appropriate to evaluate other levels of control in addition to the most stringent level for a given device.

For retrofitting existing sources in addressing BART, the source should consider ways to improve the performance of existing control devices, particularly when a control device is not achieving the level of control that other similar sources are achieving in practice with the same device. For example, improving performance for sources with ESPs that are performing below currently achievable levels should be considered.

STEP 4— Evaluate Impacts and Document the Results

After identifying the available and technically feasible control technology options, the following analyses should be conducted when making the BART determination:

1. Costs of compliance,
2. Energy impacts,
3. Non-air quality, environmental impacts, and
4. Remaining useful life.

The source should discuss and, where possible, quantify both beneficial and adverse impacts. In general, the analysis should focus on the direct impact of the control alternative.

Costs of Compliance

To conduct a cost analysis, the following steps are used:

1. Identify the emissions units being controlled,
2. Identify design parameters for emission controls, and
3. Develop cost estimates based upon those design parameters.

It is important to identify clearly the emission units being controlled, that is, to specify a well-defined area or process segment within the plant. In some cases, multiple emissions units can be controlled jointly. Then, specify the control system design parameters. The value selected for the design parameter should ensure that the control option will achieve the level of emission control being evaluated. The source should include in the analysis documentation of the assumptions regarding design parameters. Examples of supporting references include the EPA *OAQPS Control Cost Manual* and background information documents used for NSPS and hazardous pollutant emission standards.

Once the control technology alternatives and achievable emissions performance levels have been identified, then the source must develop estimates of capital and annual costs. The basis for equipment cost estimates also should be documented, either with data supplied by an equipment vendor (i.e., budget estimates or bids) or by a referenced source (such as the *OAQPS Control Cost Manual,* Fifth Edition, February 1996, EPA 453/B–96–001). To maintain and improve consistency, cost estimates should be based on the *OAQPS Control Cost Manual,* where possible. The *Control Cost Manual* addresses most control technologies in sufficient detail for a BART analysis. The cost analysis should also take into account any site-specific design or other conditions identified above that affect the cost of a particular BART technology option.

Cost effectiveness, in general, is a criterion used to assess the potential for achieving an objective in the most economical way. For purposes of air pollutant analysis, "effectiveness" is measured in terms of tons of pollutant emissions removed, and "cost" is measured in terms of annualized control costs. The EPA recommends two types of cost-effectiveness calculations—average cost effectiveness and incremental cost effectiveness.

Average cost effectiveness means the total annualized costs of control divided by annual emissions reductions (the difference between baseline annual emissions and the estimate of emissions after controls). Because costs are calculated in (annualized) dollars per year ($/yr) and emission rates are calculated in tons per year (TPY), the result is an average cost-effectiveness number in (annualized) dollars per ton ($/ton) of pollutant removed.

The baseline emissions rate should represent a realistic depiction of anticipated annual emissions for the source. In general, for the existing sources subject to BART, the anticipated annual emissions will be estimated based upon actual emissions from a baseline period.

When future operating parameters (e.g., limited hours of operation or capacity utilization, type of fuel, raw materials or product mix or type) are projected to differ from past practice, and if this projection has a deciding effect in the BART determination, then these parameters or assumptions are to be translated into enforceable limitations. In the absence of enforceable limitations, baseline emissions are calculated based upon continuation of past practice.

In addition to the average cost effectiveness of a control option, the incremental cost effectiveness should also be calculated. The incremental cost effectiveness calculation compares the costs and performance level of a control option to those of the next most stringent option, as shown in the following formula (with respect to cost per emissions reduction):

Incremental Cost Effectiveness (dollars per incremental ton removed) =

[(Total annualized costs of control option) − (Total annualized costs of next control option)] ÷ [(Control option annual emissions) − (Next control option annual emissions)]

Energy Impacts

The energy requirements of the control technology should be analyzed to determine whether the use of that technology results in energy penalties or benefits. If such benefits or penalties exist, they should be quantified to the extent practicable. Because energy penalties or benefits can usually be quantified in terms of additional cost or income to the source, the energy impacts analysis can, in most cases, simply be factored into the cost impacts analysis.

The energy impact analysis should consider only direct energy consumption and not indirect energy impacts. The energy requirements of the control options should be shown in terms of total (and in certain cases, also incremental) energy costs per ton of pollutant removed. These units can then be converted into dollar costs and, where appropriate, factored into the control cost analysis. Generally, do not consider indirect energy impacts (such as energy to produce raw materials for construction of control equipment).

The energy impact analysis may also address concerns over the use of locally scarce fuels. The designation of a scarce fuel may vary from region to region. However; in general, a scarce fuel is one that is in short supply locally and can be better used for alternative purposes, or one that may not be reasonably available to the source either at the present time or in the near future.

Non-Air Quality Environmental Impacts

In the non-air quality related environmental impacts portion of the BART analysis, environmental impacts other than air quality due to emissions of the pollutant in question are addressed. Such environmental impacts include solid or hazardous waste generation and discharges of polluted water from a control device.

Any significant or unusual environmental impacts associated with a control alternative that has the potential to affect the selection or elimination of a control alternative should be identified. Some control technologies may have potentially significant secondary environmental impacts. Scrubber effluent, for example, may affect water quality and land use. Alternatively, water availability may affect the feasibility and costs of wet scrubbers. Other examples of secondary environmental impacts could include hazardous waste discharges, such as spent catalysts or contaminated carbon.

In general, the analysis need only address those control alternatives with any significant or unusual environmental impacts that have the potential to affect the selection of a control alternative, or elimination of a more stringent control alternative. Thus, any important relative environmental impacts (both positive and negative) of alternatives can be compared with each other.

Remaining Useful Life

The requirement to consider the source's "remaining useful life" of the source for BART determinations may be treated as one element of the overall cost analysis. The "remaining useful life" of a source, if it represents a relatively short time period, may affect the annualized costs of retrofit controls. For example, the methods for calculating annualized costs in EPA's *OAQPS Control Cost Manual* require the use of a specified time period for amortization that varies based upon the type of control. If the remaining useful life will clearly not exceed this time period, the remaining useful life has an effect on control costs and on the BART determination process. Where the remaining useful life is less than the time period for amortizing costs, you should use this shorter time period in your cost calculations.

The remaining useful life is the difference between:

1. The date that controls will be put in place (capital and other construction costs incurred before controls are put in place can be rolled into the first year, as suggested in EPA's OAQPS Control Cost Manual).
2. The date the facility permanently stops operations. Where this affects the BART determination, this date should be assured by a federally- or State-enforceable restriction preventing further operation.

The EPA recognizes that there may be situations where a source operator intends to shut down a source by a given date, but wishes to retain the flexibility to continue operating beyond that date in the event, for example, that market conditions change. Where this is the case, the BART analysis may account for this, but it must maintain consistency with the statutory requirement to install BART within 5 years. Where the source chooses not to accept a federally enforceable condition requiring the source to shut down by a given date, it is necessary to determine whether a reduced time period for the remaining useful life changes the level of controls that would have been required as BART.

STEP 5—Evaluate Visibility Impacts

The following is an approach EPA suggests to determine visibility impacts (the degree of visibility improvement for each source subject to BART) for the BART determination. Once a source has been determined to be subject to BART, a visibility improvement determination for the source must be conducted as part of the BART determination.

The permitting agency has flexibility in making this determination; i.e., in setting absolute thresholds, target levels of improvement, or *de minimis* levels since the deciview improvement must be weighed among the five factors; and the agency is free to determine the weight and significance to be assigned to each factor. For example, a 0.3-dv improvement may merit a stronger weighting in one case versus another, so one "bright line" may not be appropriate.

CALPUFF or another appropriate dispersion model must be used to determine the visibility improvement expected at a Class I area from the potential BART control technology applied to the source. Modeling should be conducted for SO_2, NO_x, and direct PM emissions ($PM_{2.5}$ and/or PM_{10}). There are several steps for determining the visibility impacts from an individual source using a dispersion model:

- Develop a modeling protocol.
- For each source, run the model, at pre-control and post-control emission rates according to the accepted methodology in the protocol. Use the 24-hour average actual emission rate from the highest emitting day of the

meteorological period modeled (for the pre-control scenario). Calculate the model results for each receptor as the change in dv compared against natural visibility conditions. Post-control emission rates are calculated as a percentage of pre-control emission rates. For example, if the 24-hr pre-control emission rate is 100 lb/hr of SO_2, then the post control rate is 5 lb/hr if the control efficiency being evaluated is 95 percent.

- Make the net visibility improvement determination. Assess the visibility improvement based on the modeled change in visibility impacts for the pre-control and post-control emission scenarios. Flexibility exists to assess visibility improvements due to BART controls by one or more methods. Factors such as the frequency, magnitude, and duration of components of impairment may be considered. Suggestions for making the determination are:
  - Use of a comparison threshold, as is done for determining if BART-eligible sources should be subject to a BART determination. Comparison thresholds can be used in a number of ways in evaluating visibility improvement (e.g. the number of days or hours that the threshold was exceeded, a single threshold for determining whether a change in impacts is significant, or a threshold representing an x percent change in improvement).
  - Compare the 98th percent days for the pre- and post-control runs.

Note that each of the modeling options may be supplemented with source apportionment data or source apportionment modeling.

Selecting the "Best" Alternative

From the alternatives evaluated in Step 3, EPA recommends developing a chart (or charts) displaying for each of the alternatives the following:

1. Expected emission rate (TPY, lb/hr);
2. Emissions performance level (e.g., percent pollutant removed, emissions per unit product, lb/MMBtu, ppm);
3. Expected emissions reductions (TPY);
4. Costs of compliance—total annualized costs ($), cost effectiveness ($/ton), and incremental cost effectiveness ($/ton), and/or any other cost-effectiveness measures (such as $/dv);
5. Energy impacts;
6. Non-air quality environmental impacts; and
7. Modeled visibility impacts.

The source has the discretion to determine the order in which control options are evaluated for BART. The source should provide a justification for adopting the technology selected as the "best" level of control, including an explanation of the CAA factors that led to the choice of one option over other control levels.

In the case where the source is conducting a BART determination for two regulated pollutants on the same source, if the result is two different BART technologies that do not work well together, a different technology or combination of technologies can be substituted.

Even if the control technology is cost effective, there may be cases where the installation of controls would affect the viability of continued plant operations. There may be unusual circumstances that justify taking into consideration the conditions of the plant and the economic effects of requiring the use of a given control technology. These effects would include product prices, the market share, and profitability of the source. Where there are such unusual circumstances that are judged to affect plant operations, the source may take into consideration the conditions of the plant and the economic effects of requiring the use of a control technology. Where these effects are judged to have a severe impact on plant operations, this may be considered in the selection process, but it may be preferred to provide an economic analysis that demonstrates, in sufficient detail for public review, the specific economic effects, parameters, and reasoning. Any analysis may also consider whether other competing plants in the same industry have been required to install BART controls if this information is available.

5.0 BART ANALYSIS

5.1 BART FOR SO_2 EMISSIONS FROM THE NO. 5 POWER BOILER

As shown in Table 3-5, the 8th highest visibility impact due to the No. 5 PB alone is 0.637 dv, which is about 88 percent of the total facility impact. The contributions from individual visibility impairing pollutants are also shown in Table 3-5. Based on these results, 75 to 90 percent of the total visibility impacts from No. 5 PB are due to sulfate (SO_4) particles. Since sulfate particles are formed due to SO_2 and SAM emissions, it can be clearly seen that control of SO_2 emissions from the No. 5 PB provides the most effective strategy for reduction of visibility impacts due to the emissions unit and due to the facility.

5.1.1 Available Retrofit Control Technologies

As part of the BART analysis, a review was performed of previous SO_2 BACT determinations for power boilers at paper mills listed in the RACT/BACT/LAER Clearinghouse (RBLC) on EPA's webpage. A summary of BACT determinations for industrial boilers from this review is presented in Table 5-1. Determinations issued during the last 10 years are included in the table. From the review of previous BACT determinations, it is evident that SO_2 BACT determinations for large industrial boilers and boilers firing fuel oil and biomass have largely been based on use of low-sulfur fuels. Depending upon the boiler configuration, use of a wet scrubber flue gas desulfurization (FGD) system could also be an option for consideration. BACT determinations for fuel oil-fired industrial boilers are as low as 0.05 percent sulfur No. 2 fuel oil.

5.1.2 Control Technology Feasibility

The technically feasible SO_2 controls for the No. 5 PB are shown in Table 5-2. A technology that is available and applicable is technically feasible. Given that approximately 86 percent of the SO_2 emission rate from the No. 5 PB is associated with fuel oil firing with the remaining 14 percent from combustion of bark, the focus for SO_2 reduction for the BART analysis is the firing of liquid fuels with lower sulfur content than the 2.45 percent used in the BART modeling analysis. As shown, there are three feasible approaches for SO_2 abatement: low sulfur No. 6 fuel oil, No. 2 fuel oil, and wet or dry scrubbers. Each abatement method is described below.

Low Sulfur No. 2 Fuel Oil

Emissions of SO_2 are directly proportional to fuel oil sulfur content. BACT determinations involving the use of No. 2 fuel oil define low sulfur fuel as having a sulfur content as low as 0.05 percent. The use of ultra-low sulfur No. 2 fuel oil results in SO_2 emissions between 0.05 and 0.06 lb/MMBtu. Since the No. 5 PB combusts No. 6 fuel oil, modifications to the existing boiler would be required to accommodate No. 2 fuel oil firing. This would require a new fuel oil storage tank, piping (fuel transport) systems and new burners. The existing process control systems would likely require upgrading to support the use of No. 2 fuel oil in the No. 5 PB. However, this is considered a technically feasible means of reducing SO_2 emissions and therefore is being evaluated as a potential BART determination for this boiler.

Reduced Sulfur No. 6 Fuel Oil

Reducing the sulfur content of the No. 6 fuel oil combusted in the boiler will reduce SO_2 emissions proportional to the magnitude of the sulfur reduction. Based on information from the Energy Information Administration (EIA), low sulfur No. 6 fuel oil is defined as having sulfur content of 1 percent or less. Although there is a cost premium for low sulfur No. 6 fuel oil, since the boiler currently combusts No. 6 fuel oil with a maximum sulfur content of 2.5 percent, it is considered a technically feasible control technology.

Post-Combustion Controls

Post-combustion SO_2 controls are comprised primarily of FGD systems or scrubbers. In a wet scrubber, the SO_2-containing flue gas passes through a vessel or tower where it contacts an alkaline slurry, usually in a counter-flow arrangement. The intensive contact between the gas and the liquid droplets ensures rapid and effective reactions that can yield greater than 90 percent SO_2 capture. Conversely, a configuration where the reaction between SO_2 and the sorbent takes place in a dedicated reactor is referred to as a "dry scrubber". Several configurations are possible based on the temperature window desired. This can occur at furnace (~2,200°F), economizer (800-900°F), or duct temperatures (~250°F). Dry processes are more compatible with low to medium sulfur coals due to limitations in reaction rates and sorbent handling (MANE-VU. March 2005).

From review of the BACT/RACT/LAER clearinghouse, post combustion controls are typically applied to coal-fired boilers. The application of scrubbing systems to primarily fuel oil and/or carbonaceous-fueled boilers is considered cost prohibitive. The No. 5 PB primarily combusts carbonaceous fuel. For example, over the last 3 years, the boiler has averaged 86 percent of annual heat input from carbonaceous fuel, versus 14 percent from fuel oil.

The burning of bark and other carbonaceous fuels in the No. 5 PB already results in inherent SO_2 removal from the exhaust gas stream. This is due to the alkaline nature of the ash from carbonaceous fuels, which acts to absorb SO_2 from the flue gas, and has been well documented by NCASI in past studies. This fact further reduces the feasibility of add-on scrubbers as a potential BART technology. Since BART is not intended to be more stringent than BACT, SO_2 scrubbing systems for the No. 5 PB are not given further consideration.

5.1.3 Control Effectiveness of Options

Each of the above available control techniques is listed in Table 5-2 with its associated control efficiency estimate and ranked based on control efficiency.

5.1.4 Impacts of Control Technology Options

Cost of Compliance

To achieve SO_2 emissions below current levels in No. 5 PB would require use of lower sulfur fuel oil. Two options were identified: low sulfur No. 2 fuel oil or reduced sulfur No. 6 fuel oil.

Based on information provided by SSCE, the current fuel (2.5 percent sulfur) cost is $39.39/bbl or $0.94/gal. The cost of compliance to use reduced sulfur No. 6 fuel oil is represented by the additional cost of the fuel: $1.01/gal for 1.0 percent sulfur No. 6 fuel oil versus $0.94/gal for the current 2.5 percent sulfur fuel oil used in the boiler.

Lower sulfur No. 6 fuel oil is quoted to have the following differential cost: 2.0 percent maximum - $1.17/bbl or $.03/gal; 1.5 percent maximum - $2.16/bbl or $0.05/gal; and 1.0 percent maximum - $2.91/bbl or $0.07/gal (see Appendix B, letter from Colonial Oil).

To convert to lower sulfur No. 6 fuel oil, the evaluation must include the addition of a new fuel oil storage tank, pumps, piping, etc. To evaluate the cost-effectiveness of converting to lower sulfur No. 6 fuel oil, capital costs of $1.2 million were estimated for the new fuel oil storage tank (based on SSCE data, which includes foundations and installation). Purchased equipment costs for new piping, pumps, etc., were based on an engineering estimate. The total capital investment is estimated at $1,500,000, as shown in Table 5-3.

Annual operating costs were developed considering the annualized capital recovery cost and other direct and indirect operating costs, which are based on standard cost factors and engineering estimates. Capital recovery costs are based on an interest rate of 7 percent and a 20-year equipment (remaining useful) life. Annual operating costs, including the cost differential for the lower sulfur fuel oil, are estimated to be $217,000 per year. Total annual costs are estimated at $418,600 per year.

The total cost effectiveness is therefore \$1,125 per ton of SO_2 removed. The cost analysis is presented in Table 5-3.

To convert to lower sulfur No. 2 fuel oil, the evaluation must include the addition of a new fuel oil storage tank, pumps, piping, etc, replacement of the fuel oil burners to accommodate the No. 2 fuel oil, as well as accounting for the lower heating value of No. 2 fuel oil. To evaluate the cost-effectiveness of converting to No. 2 fuel oil, capital costs of \$1.5 million were again assumed for the new fuel oil storage tank, pumps, piping, etc. Information is currently being obtained to determine the cost of the new burners (see Appendix B, letter from Babcock & Wilcox dated January 19, 2007). Once this information is obtained, this BART evaluation will be updated to reflect the retrofit cost estimate.

Annual operating costs will then be developed considering the annualized capital recovery cost and other direct and indirect operating costs, which will be based on standard cost factors and engineering estimates. Capital recovery costs will be based on an interest rate of 7 percent and a 20-year equipment life. The cost differential for the lower sulfur fuel oil, based on burning 3.1 million gallons per year of No. 6 fuel oil, which would require 3.4 million gallons per year of No. 2 fuel oil, is estimated to be \$3.026 million per year, based on a cost differential of \$0.87 per gallon. The total annual costs will be estimated upon receipt of the above-referenced information from Babcock & Wilcox.

Energy Impacts

Use of low or reduced sulfur fuel oils cause energy impacts associated with operating the No. 5 PB, based on the lower heating value of incrementally lower sulfur content fuel oils. The heating value of 2.5 percent sulfur No. 6 fuel oil is approximately 150,000 Btu/lb, while that of low sulfur No. 2 fuel oil (0.05 percent sulfur) is approximately 135,000 Btu/gal, a 10 percent differential. This would translate into 10 percent additional gallons of No. 2 fuel oil fuel oil to provide the same energy input as No. 6 fuel oil.

Non-Air Quality Environmental Impacts

Use of low or reduced sulfur fuel oils do not result in any non-air quality environmental impacts.

Remaining Useful Life

SSCE has no plan to shutdown the Fernandina Mill in the near future, or the No. 5 PB. A useful life of 20 years was therefore used to develop the capital recovery cost in estimating the costs of compliance.

5.1.5 Visibility Impacts

As shown in Table 2-3 of the BART modeling protocol, the baseline SO_2 emissions used in the determination of the visibility impact due to the No. 5 PB is 1,026.4 lb/hr based on 2.5 percent sulfur fuel oil. Of this total, 2.3 lb/hr is from bark combustion. Use of reduced sulfur No. 6 fuel oil (1.0 percent sulfur) would result in hourly SO_2 emissions of 420.3 lb/hr (2.3 lb/hr from bark combustion), which represents an approximate reduction of 60 percent over baseline SO_2 emissions. Use of low sulfur No. 2 fuel oil (0.05 percent sulfur) will result in hourly SO_2 emissions from No. 5 PB of approximately 23 lb/hr, which represents an approximate 98 percent reduction from baseline SO_2 emissions.

The maximum visibility impacts due to No. 5 PB for these two SO_2 emission scenarios predicted at the Okefenokee and Wolf Island NWAs are summarized in Table 5-5. Results are presented using the 1999 and new IMPROVE algorithms. As shown in Table 5-5, the highest, 8th highest visibility impact due to the No. 5 PB using the "controlled" level of 420.3 lb/hr of SO_2 (low sulfur No. 6 fuel oil) is predicted to be 0.32 dv with the new IMPROVE algorithm, which is a reduction of about 0.32 dv from the baseline impact of 0.64 dv. Based on this reduction in the visibility impact and the annualized cost for using lower sulfur No. 6 fuel oil of $418,600 determined in Section 5.1.4, the cost effectiveness of converting the fuel burned in the No. 5 PB to low sulfur No. 6 fuel oil can be estimated as $1.3 million for every 1 dv reduction in visibility impact.

Using the "controlled" level of 23.2 lb/hr of SO_2 (low sulfur No. 2 fuel oil), the highest, 8th highest visibility impact due to the No. 5 PB is predicted to be 0.13 dv, which is a reduction of 0.51 dv from the baseline impact. Based on this reduction in the visibility impact and the total annual cost (to be determined), the cost effectiveness of converting the fuel burned in the No. 5 PB to low sulfur No. 2 fuel oil is estimated as $/dv (to be determined).

5.1.6 Selection of BART

Based on the high cost of converting the No. 5 PB to combust low sulfur No. 6 or No. 2 fuel oil, normalized by the reduction in the change in haze index, this control technology is considered to be economically infeasible. Therefore, SSCE is proposing that BART for the No. 5 PB at the Fernandina Mill is use of the current 2.5 percent sulfur (maximum) No. 6 fuel oil.

5.2 BART For NO_x Emissions From the No. 5 Power Boiler

The No. 5 PB emits modest quantities of NO_x emissions from the combustion of fuel oil and bark. As shown in Table 3-5, only about 6 to 20 percent of the maximum visibility impact attributable to the No. 5 PB is due to the nitrate particles, which are formed by NO_x emissions. Therefore, controlling NO_x emissions will not provide a meaningful reduction in the change in light extinction due to the unit.

It should also be noted that the BACT/RACT/LAER Clearinghouse was reviewed for similar boilers. In the majority of evaluations, good combustion controls were determined to represent BACT. In addition, literature suggests that both SNCR and SCR technologies are problematic when applied to industrial boilers with frequent swing loads, as occurs with kraft mill power boilers (NCASI, 2006). The frequent load swings affect the NO_x conversion efficiency, and can also cause downstream issues related to ammonia slip. These problems are compounded on existing boilers where the SNCR or SCR system must be retrofitted, as opposed to a new boiler where the system can be designed into the boiler. As a result, SSCE proposes that BART for NO_x emissions from the No. 5 PB is the existing combustion process and good combustion practice.

5.3 BART for PM_{10} Emissions from the No. 5 Power Boiler

The No. 5 PB employs PM controls consisting of a multiple cyclone system followed by an ESP. This results in low emissions of PM_{10}. For the baseline visibility modeling, a baseline PM_{10} emission rate of 22.5 lb/hr was used. This was the value determined to comply with 40 CFR 63, Subpart DDDDD (Boiler MACT). As a result of this low emission rate, only 2 to 5 percent of the total maximum predicted visibility impact attributable to the No. 5 PB is due to the PM emissions. Therefore, no amount of additional control of the PM_{10} emissions can provide a meaningful reduction in the change in light extinction due to the unit. In addition, in accordance with regulatory guidance associated with the conduct of BART evaluations, a source that is subject to and is in compliance with a MACT standard (Subpart DDDDD for this unit) is assumed to meet BART for the affected pollutant. As such, BART for PM_{10} from the No. 5 PB will be met by the existing controls on the unit.

5.4 BART for SO_2 Emissions From the No. 4 Recovery Boiler

The No. 4 RB has baseline SO_2 emissions of 50.2 lb/hr. This represents only approximately 4.7 percent of the total SO_2 emissions used in the BART visibility modeling. According to NCASI (2006) "there is no experience in the pulp and paper industry with the use of add-on flue gas desulfurization technologies on kraft recovery furnaces." Additionally, RBs control TRS emissions to the extent possible in order to meet stringent emission limits for TRS. The control of TRS emissions leads directly to the control of SO_2 from the furnace, as these emissions are related; hence, the relatively low SO_2 emissions.

As a result of the relatively low SO_2 emission rate, as well as low NO_x emissions, the maximum visibility impact attributable to the No. 4 RB, 0.1 dv, is only about 15 percent of that due to the No. 5 PB. Of the maximum visibility impact due to the No. 4 RB, only about 40 percent is due to the SO_2 emissions from the No. 4 RB. Based on the literature associated with controlling SO_2 emissions from recovery boilers and the fact that No. 5 PB contributes most to the visibility impact relative to SO_2, it is concluded that additional control of SO_2 emissions will not provide a meaningful reduction in the change in light extinction due to the unit. Therefore, the proposed BART for SO_2 for the No. 4 RB is the existing control technology.

5.5 BART for NO_x Emissions from the No. 4 Recovery Boiler

The No. 4 RB has baseline NO_x emissions of 103.2 lb/hr. This represents approximately 41 percent of the total NO_x emissions used in the BART visibility modeling. NCASI (2006) evaluated several NO_x control technologies potentially applicable to recovery boilers, including:

- Low NO_x Burners,
- Staged Combustion,
- Flue Gas Recirculation,
- Oxygen Trim + Water Injection,
- Selective Non-Catalytic Reduction (SNCR), and
- Selective Catalytic Reduction (SCR).

NCASI concluded that liquor nitrogen content is the dominant factor in the resultant NO_x emissions from a recovery boiler. In addition, many of these prospective control technologies are not considered technically feasible for recovery boilers.

The maximum visibility impact attributable to the No. 4 RB, 0.1 dv, is only about 15 percent of that due to the No. 5 PB. Of the maximum visibility impact due to the No. 4 RB, only about 50 percent is due to the NO_x emissions from the No. 4 RB. Based on the literature associated with controlling NO_x emissions from recovery boilers and the fact that No. 5 PB contributes most to the visibility impact relative to the facility, it is concluded that additional control of NO_x emissions will not provide a meaningful reduction in the change in light extinction due to the unit. Therefore, proposed BART for NO_x for the No. 4 RB is the existing control technology.

5.6 BART for PM_{10} Emissions from the No. 4 Recovery Boiler

The No. 4 RB employs an ESP to control emissions of PM. This technology represents the best control technology that can be employed on recovery boilers. The baseline PM_{10} emissions for this unit are 39.5 lb/hr. The unit is subject to and must comply with the PM emissions limit contained in 40 CFR 63, Subpart MM, which is designed to limit emissions of metals HAPs. As a result of this low emission rate, only about 2.7 percent of the total maximum visibility impact is attributable to the PM emissions from the No. 4 RB. Therefore, no amount of additional control of the PM_{10} emissions can provide a meaningful reduction in the change in light extinction due to the unit. Also, the Subpart MM MACT standard for PM is presumptively considered to be BART. As such, BART for PM_{10} from the No. 4 RB is proposed as the existing controls on the unit.

5.7 BART for the No. 4 Smelt Dissolving Tank

The No. 4 SDT is a BART eligible unit at the Fernandina Beach Mill, but emits relatively low emissions of precursor pollutants. The unit employs a venturi scrubber for control of PM emissions. This technology is recognized as the best control technology for controlling PM emissions. Compared to emissions from the other two BART eligible units at the Fernandina Beach Mill, the No. 4 SDT is responsible for:

- 0.09 percent of the SO_2 emissions;
- 0.96 percent of the NO_x emissions; and
- 17.6 percent of total PM_{10} emissions.

In addition, the unit employs a venturi scrubber to control PM emissions in accordance with 40 CFR 63, Subpart MM.

Given the relatively low emissions from the unit, the even lower contribution of the unit to the total predicted visibility impact, and the fact that the NCASI study (2006) concludes that except for the type of scrubber already installed on the unit, there are no technically feasibly PM control measures available, it is concluded that no amount of additional control of the PM_{10} emissions can provide a meaningful reduction in the change in light extinction due to the unit. As such, BART for PM_{10} from the No. 4 SDT is proposed as the existing controls on the unit.

5.8 Application for BART Determination

The FDEP's Application for Air Permit—Long Form is included in Appendix C to support this BART determination.

TABLE 5-1
SUMMARY OF BACT DETERMINATIONS FOR SULFUR DIOXIDE EMISSIONS FROM LARGE INDUSTRIAL BOILERS

Company Name	State	Permit No./RBLC ID	Permit Issue Date	Throughput		Emission Limit		Control Equipment
COLUMBIA ENERGY CENTER	SC	SC-0091	7/3/2003	550	MMBTU/HR	0.06	lb/MMBtu	LOW SULFUR FUEL OIL (No. 2)
INTERNATIONAL PAPER - MANSFIELD MILL	LA	LA-0122	8/14/2001	645	MMBTU/HR	0.7	%S	REDUCED SULFUR FUEL OIL
GRAYS FERRY COGEN PARTNERSHIP	PA	PA-0187	3/21/2001	1,119	MMBTU/HR	0.2	LB/MMBTU	GOOD COMBUSTION PRACTICE, LOW SULFUR FUEL
RAYONIER SPECIALTY PULP PRODUCTS	GA	GA-0084	6/16/1997	338	MMBTU/HR	0.05	%S	LOW SULFUR FUEL OIL
INTERSTATE PAPER, LLC	GA	GA-0097	11/21/2001	300	MMBTU/HR	0.14	LB/MMBTU	CAUSTIC WET SCRUBBER
WEYERHAEUSER CO	FL	PSD-FL-278/FL-0237	2/6/2001	NA	NA	0.15	LB/MMBTU	LOW SULFUR FUEL W/ OR W/OUT EMISSION CONTROL
CHAMPION INTERNATIONAL	AL	AL-0112	12/9/1997	710	MMBTU/HR	0.045	LB/MMBTU	WET SCRUBBER WITH SODA ASH
REGENTS OF THE UNIVERSITY OF MICHIGAN	MI	MI-0248	10/6/1998	376	MMBTU/HR	0.3	LB/MMBTU	LOW SULFUR FUEL OIL

Reference: RACT/BACT/LAER Clearinghouse on EPA's Webpage, 2006.

TABLE 5-2
SO_2 CONTROL TECHNOLOGY FEASIBILITY ANALYSIS FOR THE N0. 5 POWER BOILER
SMURFIT-STONE CONTAINER ENTERPRISES, FERNANDINA MILL

SO_2 Abatement Method	Estimated Efficiency	Technically Feasible and Demonstrated? (Y/N)	Rank Based on Control Efficiency
Low-sulfur (0.05%) No. 2 Fuel Oil	98%	Y	1
Reduced sulfur (1%) No. 6 Fuel Oil	60%	Y	4
Wet Scrubbers	>90%	Y	2
Dry Scrubbers	60-95%	N	3

TABLE 5-3
COST EFFECTIVENESS OF NO. 6 FUEL OIL (1.0 PERCENT SULFUR CONTENT WITH NEW TANK) FOR NO. 5 POWER BOILER, SSCE FERNANDINA MILL

Cost Items	Cost Factors	Cost ($)
DIRECT CAPITAL COSTS (DCC):		
Purchased Equipment Cost- Storage tank[a]	See Footnote "b"	1,200,000
Purchased Equipment Cost- pumps, piping, etc.	See Footnote "b"	300,000
INDIRECT CAPITAL COSTS (ICC):[c]		
Indirect Installation Costs		
(a) Engineering		Included Above
(b) Construction & Field Expenses		Included Above
(c) Construction Contractor Fee		Included Above
(d) Contingencies		Included Above
Other Indirect Costs		
(a) Startup & Testing		Included Above
(b) Working Capital		Included Above
Total ICC:		Included Above
TOTAL CAPITAL INVESTMENT (TCI):	DCC + ICC	1,500,000
DIRECT OPERATING COSTS (DOC):[d]		
(1) Operating Labor		
Operator		0
Supervisor		0
(2) Maintenance		
Labor		0
Materials		0
(3) Utilities		
(4) Fuels		
No. 6 Fuel cost differential (1.0% vs. 2.5% S)	See Footnote "e"	217,000
Total DOC:		217,000
INDIRECT OPERATING COSTS (IOC):[d]		
Overhead	60% of oper. labor & maintenance	0
Property Taxes	1% of total capital investment	15,000
Insurance	1% of total capital investment	15,000
Administration	2% of total capital investment	30,000
Total IOC:		60,000
CAPITAL RECOVERY COSTS (CRC):	CRF of 0.0944 times TCI (20 yrs @ 7%)	141,600
ANNUALIZED COSTS (AC):	DOC + IOC + CRF	418,600
BASELINE SO_2 EMISSIONS (TPY) :	3.1 MMgal/yr No. 6 Fuel Oil with a Sulfur Content of 2.5% by weight	620
MAXIMUM SO_2 EMISSIONS WITH NO. 2 FUEL OIL (TPY):	3.1MMgal/yr No. 6 Fuel Oil with a Sulfur Content of 1.0% by weight	248
REDUCTION IN SO_2 EMISSONS (TPY):		372
COST EFFECTIVENESS:	$ per ton of SO_2 Removed	1,125

Footnotes:

[a] All direct installation costs are included in basic price.

[b] Based on SSCE data on actual installed cost of $1,200,000 for a storage tank, and estiamted cost of piping, pumps, etc.

[c] All indirect capital costs are included in basic price.

[d] Factors and cost estimates reflect OAQPS Cost Manual, Section 3.

[e] Increase in fuel cost associated with buying No. 6 fuel oil with a sulfur content of 1.0% ($1.01/gal) instead of No. 6 fuel oil with a sulfur content 2.5% ($0.94/gal) based on combusting 3.1 million gallons per year of fuel oil.

TABLE 5-4
COST EFFECTIVENESS OF NO. 2 FUEL OIL (0.05% SULFUR CONTENT WITH NEW TANK AND BURNERS) FOR POWER BOILER NO. 5, SSCE FERNANDINA BEACH

Cost Items	Cost Factors	Cost ($)
DIRECT CAPITAL COSTS (DCC):		
Purchased Equipment Cost- Storage tank[a]	See Footnote "b"	1,200,000
Purchased Equipment Cost- pumps, piping, etc.	See Footnote "b"	300,000
Purchased Equipment Cost- pumps, piping, etc.	To Be Determined	To Be Determined
INDIRECT CAPITAL COSTS (ICC):[c]		
Indirect Installation Costs		
(a) Engineering		Included Above
(b) Construction & Field Expenses		Included Above
(c) Construction Contractor Fee		Included Above
(d) Contingencies		Included Above
Other Indirect Costs		
(a) Startup & Testing		Included Above
(b) Working Capital		Included Above
Total ICC:		Included Above
TOTAL CAPITAL INVESTMENT (TCI):	DCC + ICC	1,500,000
DIRECT OPERATING COSTS (DOC):[d]		
(1) Operating Labor		
Operator		0
Supervisor		0
(2) Maintenance		
Labor		0
Materials		0
(3) Utilities		
(4) Fuels		
Differential Fuel Cost (2.5% vs. 0.05% S Content)	See Footnote "e"- 3.4 MMgal/yr	2,697,000
Total DOC:		2,697,000
INDIRECT OPERATING COSTS (IOC):[d]		
Overhead	60% of oper. labor & maintenance	0
Property Taxes	1% of total capital investment	15,000
Insurance	1% of total capital investment	15,000
Administration	2% of total capital investment	30,000
Total IOC:		60,000
CAPITAL RECOVERY COSTS (CRC):	CRF of 0.0944 times TCI (20 yrs @ 7%)	141,600
ANNUALIZED COSTS (AC):	DOC + IOC + CRF	2,898,600
BASELINE SO_2 EMISSIONS (TPY) :	3.1 million gal/yr No. 6 Fuel Oil with a Sulfur Content of 2.5% by weight	620
MAXIMUM SO_2 EMISSIONS WITH NO. 2 FUEL OIL (TPY):	3.4 million gal/yr No. 2 Fuel Oil with a Sulfur Content of 0.05% by weight	12.2
REDUCTION IN SO_2 EMISSONS (TPY):		607.8
COST EFFECTIVENESS:	$ per ton of SO_2 Removed	To Be Determined

Footnotes:

[a] All direct installation costs are included in basic price.

[b] Based on SSCE data on actual installed cost of $1,200,000 for a storage tank, and estiamted cost of piping, pumps, etc.

[c] All indirect capital costs are included in basic price.

[d] Factors and cost estimates reflect OAQPS Cost Manual, Section 3.

[e] Increase in fuel cost associated with buying No. 2 fuel oil with a sulfur content of 0.05% ($1.81/gal) instead of No. 6 fuel oil with a sulfur content 2.5% ($0.94/gal) based on combusting 3.1 MMgal/yr No. 6 oil, equivalent to 3.4 MMgal/yr No. 2 oil.

TABLE 5-5
BART DETERMINATION ANALYSIS FOR NO. 5 POWER BOILER
1999 AND NEW IMPROVE ALGORITHMS
SMURFIT-STONE CONTAINER ENTERPRISES, INC., FERNANDINA MILL

		8th Highest Impact and Contribution by Species											
		2001				2002				2003			
		Impact	Contribution (%)[a]			Impact	Contribution (%)[a]			Impact	Contribution (%)[a]		
Emission Unit	Unit ID	(dv)	SO_4	NO_3	PM_{10}	(dv)	SO_4	NO_3	PM_{10}	(dv)	SO_4	NO_3	PM_{10}
1999 IMPROVE Algorithm													
Okefenokee NWA													
No. 6 Fuel Oil- 1% Sulfur Content Fuel Oil	PB5	0.356	95.5	1.6	2.9	0.309	92.4	1.6	6.0	0.407	76.1	20.4	3.4
No. 2 Fuel Oil- 0.05% Sulfur Content Fuel Oil	PB5	0.115	27.5	53.6	18.9	0.115	36.4	39.6	24.1	0.163	22.0	58.9	19.1
Wolf Island NWA													
No. 6 Fuel Oil- 1% Sulfur Content Fuel Oil	PB5	0.286	88.6	6.5	4.9	0.288	88.8	1.1	10.1	0.324	73.8	16.1	10.2
No. 2 Fuel Oil- 0.05% Sulfur Content Fuel Oil	PB5	0.089	39.4	39.0	21.6	0.089	30.3	46.2	23.5	0.101	33.9	43.2	22.9
New IMPROVE Algorithm													
Okefenokee NWA													
No. 6 Fuel Oil- 1% Sulfur Content Fuel Oil	PB5	0.279	95.1	1.7	3.2	0.242	91.6	1.8	6.6	0.319	74.4	21.6	4.0
No. 2 Fuel Oil- 0.05% Sulfur Content Fuel Oil	PB5	0.096	25.6	54.4	20.0	0.093	32.7	24.6	42.7	0.134	20.3	59.2	20.6
Wolf Island NWA													
No. 6 Fuel Oil- 1% Sulfur Content Fuel Oil	PB5	0.208	87.8	6.9	5.3	0.205	87.3	1.2	11.5	0.233	71.6	17.0	11.4
No. 2 Fuel Oil- 0.05% Sulfur Content Fuel Oil	PB5	0.066	42.6	34.4	23.0	0.067	28.3	46.7	25.0	0.076	31.2	43.0	25.9

[a] Sulfate (SO4) particles are formed due to SO_2 and H_2SO_4 emissions; nitrate (NO3) particles are formed due to NOx emissions, and other non-hygroscopic PM_{10} particles are a result of fine filterable $PM_{10,}$ coarse filterable PM_{10}, elemental carbon, and condensable secondary organic aerosol emissions.

6.0 REFERENCES

Guidelines for Best Available Retrofit Technology. Federal Register, Volume 70, pages 39104-39172. August 1, 2005.

OAQPS Cost Control Manual, Fifth Edition, EPA-4531B-96-001. February 1996.

MANE-VU, March 2005. Assessment of Control Technology Options for BART-Eligible Sources; Northeast States for Coordinated Air Use Management, in partnership with the Mid-Atlantic/Northeast Visibility Union.

NCASI, 2006. Retrofit Control Technology Assessment for NO_x, SO_2, and PM Emissions from Kraft Pulp and Paper Mill Unit Operation. National Council for Air and Stream Improvement.

APPENDIX A

REVISED
AIR MODELING PROTOCOL
TO EVALUATE BART OPTIONS
SMURFIT-STONE CONTAINER ENTERPRISES, INC.
FERNANDINA BEACH MILL

REVISED
AIR MODELING PROTOCOL TO EVALUATE BART OPTIONS
SMURFIT-STONE CONTAINER ENTERPRISES, INC.
FERNANDINA MILL

Prepared For:

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January 2007

063-7613

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1.0 INTRODUCTION

1.1 Objectives

Under the regional haze regulations contained in Title 40, Part 51 of the Code of Federal Regulations (40 CFR 51), Subpart P – Protection of Visibility, the U.S. Environmental Protection Agency (EPA) has issued final rules and guidelines dated July 6, 2005, for Best Available Retrofit Technology (BART) determinations [Federal Register (FR), Volume 70, pages 39104-39172]. BART applies to certain large stationary sources known as BART-eligible sources. Sources are BART-eligible if they meet the following three criteria:

- Contains emissions units that are one of the 26 listed source categories in the guidance;
- Contains emissions units that were put in place between August 7, 1962 and August 7, 1977; and
- Potential emissions from these emissions units of at least 250 tons per year (TPY) of a visibility-impairing pollutant [sulfur dioxide (SO_2), nitrogen oxides (NO_x), and direct particulate matter of equal to or less than 10 microns (PM_{10})].

Smurfit-Stone Container Enterprises, Inc.'s (SSCE) Fernandina Mill facility has been identified as a BART-eligible source with multiple BART-eligible emissions units.

The Florida Department of Environmental Protection (FDEP) has proposed to adopt EPA's visibility protection rules and guidelines contained in 40 CFR 51, Subpart P. Final adoption of these rules is expected by the end of this year.

The basic tenet of the regional haze program is the achievement of natural visibility conditions in Prevention of Significant Deterioration (PSD) Class I areas by the year 2064. Florida has four PSD Class I areas while Georgia has two PSD Class I areas that can be affected by Florida sources [i.e., located in Florida or within 300 kilometers (km) of Florida].

BART is required for any BART-eligible source that FDEP determines emits any air pollutant that may "reasonably be anticipated to cause or contribute to any impairment of visibility in any Class I area." The BART guidelines establish a threshold value of 0.5 deciview (dv) for any single source for determining whether the source contributes to visibility impairment.

Throughout this protocol the terms "source" and "facility" have the same meanings. The term "BART-eligible emissions unit" is defined as any single emissions unit that meets the criteria described above, except for the 250 TPY criterion, which applies to the entire BART-eligible source. A "BART-eligible source" is defined as the collection of all BART-eligible emissions units at a single facility. If a source has several emissions units, only those that meet the BART-eligible criteria are included in the definition of "BART-eligible source."

The FDEP requires that the California Puff (CALPUFF) modeling system be used to determine visibility impacts from BART-eligible sources at the PSD Class I areas. A source-specific modeling protocol is required to be submitted by the affected sources to FDEP for review and approval. Protocols are due to FDEP no later than September 30, 2006. The source-specific modeling must be included in the BART application, due to FDEP no later than January 31, 2007.

This protocol describes the modeling procedures to be followed for performing the air modeling and includes site-specific data for SSCE's Fernandina Mill BART-eligible emissions units. The site-specific data includes emissions unit locations, stack parameters, emission rates, and PM_{10} speciation information.

For guidance in preparing the air modeling protocol, the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) has developed a "common" modeling protocol outline that describes the recommended procedures for performing a visibility impairment analysis under the BART regulations [see *Protocol for the Application of the CALPUFF Model for Analyses of Best Available Retrofit Technology (BART)*, December 22, 2005 (Revision 3.2 – August 31, 2006)]. The proposed modeling protocol for the SSCE Fernandina Mill facility follows the general procedures recommended by VISTAS.

1.2 Location of Source

The Fernandina Mill is located in Fernandina Beach, Nassau County, Florida. An area map showing the facility location and PSD Class I areas located within 300 km of the facility is presented in Figure 1-1. The PSD Class I areas and their distances from the Fernandina Mill are as follows:

- Okefenokee National Wildlife Area (NWA) - 66 km,
- Wolf Island NWA - 71 km,
- Chassahowitzka NWA - 242 km, and

- Saint Marks NWA - 249 km.

Bradwell Bay PSD Class I area is located within 300 km of the facility, but visibility impairment is not required to be addressed for this area.

The Universal Transverse Mercator (UTM) coordinates of the Fernandina Mill are approximately 456.2 km East and 3,394.1 km North in UTM Zone 17.

1.3 Source Impact Evaluation Criteria

The common BART modeling protocol describes the application of the CALPUFF modeling system for two purposes:

- Air quality modeling to determine whether a BART-eligible source is "subject to BART" – to evaluate whether a BART-eligible source is exempt from BART controls because it is not reasonably expected to cause or contribute to impairment of visibility in Class I areas and
- Air quality modeling of emissions from sources that have been found to be subject to BART – to evaluate regional haze benefits of alternative control options and to document the benefits of the preferred option.

The common BART protocol identifies the first activity as the "BART exemption analysis" and the second activity as the "BART control analysis."

The final BART rule (70 FR 39118) states that the proposed threshold at which a source may "contribute" to visibility impairment should not be higher than 0.5 dv. The FDEP is also recommending the criterion of 0.5 dv.

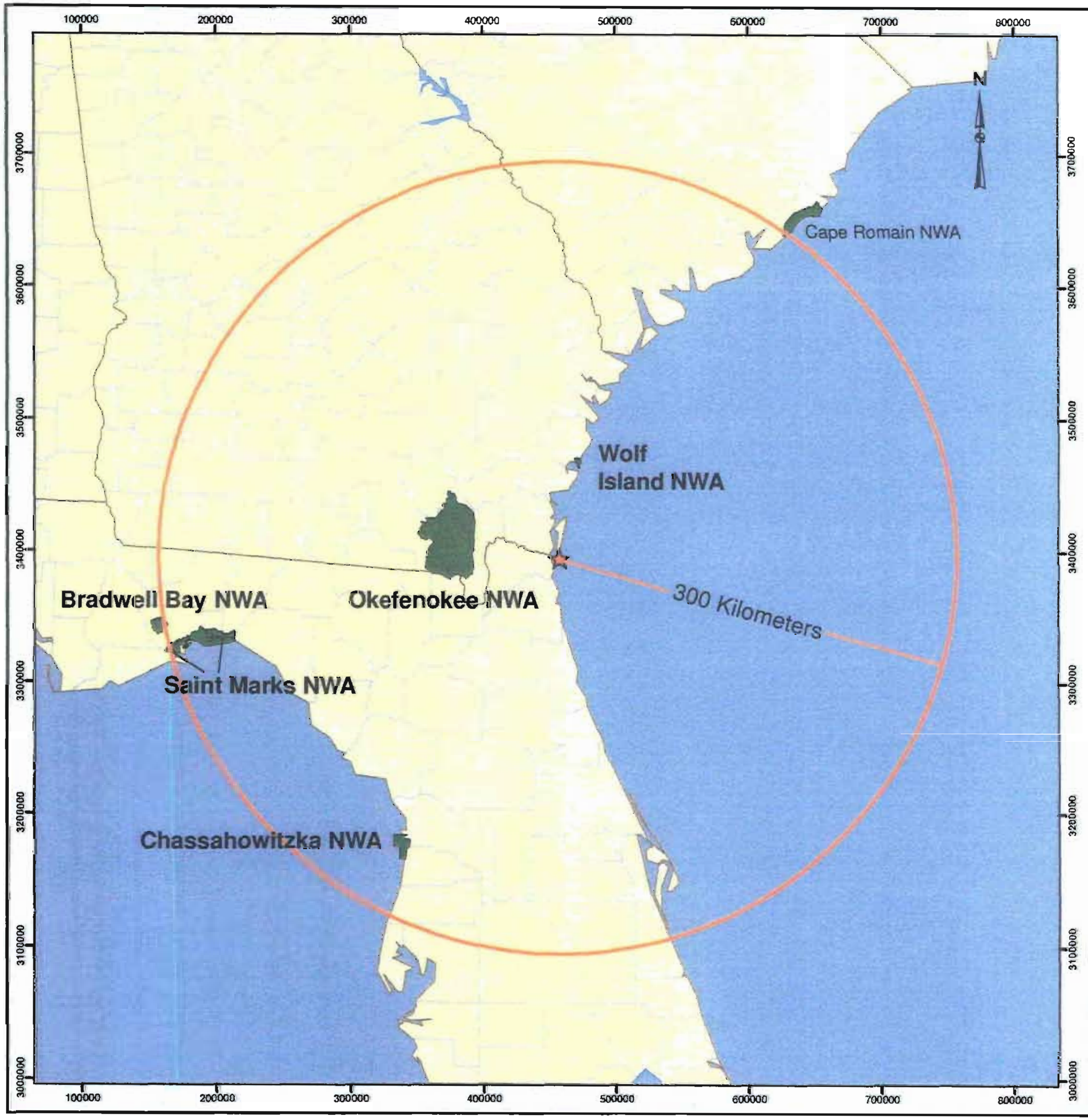
Based on VISTAS recommendations regarding BART exemption analysis, "initial screening" and "refined" analyses can be performed to determine whether a BART-eligible source is subject to or exempt from BART. The initial screening analysis, which is based on a coarse scale 12-km regional VISTAS domain, is optional and answers two questions – whether (a) a particular source may be exempted from further BART analyses and (b) if refined (finer grid) CALPUFF analyses were to be undertaken, which Class I areas should be included.

For the screening analysis, the highest predicted 24-hour impairment value is compared to the 0.5 dv criteria. If the highest predicted impacts are found to be less than 0.5 dv, no further analysis is required. But if the highest impact is predicted to be greater than 0.5 dv, then a refined, finer grid, analysis may be performed.

The refined analysis, which is based on a finer grid subregional California Meteorological Model (CALMET) domain, is the definitive test for whether a source is subject to BART. In the refined analysis, the 98th percentile, i.e., the 8th highest 24-hour average visibility impairment value in 1 year or the 22nd highest 24-hour average visibility impairment value over 3 years combined, whichever is higher, is compared to 0.5 dv.

The screening analysis is optional for large sources that will clearly exceed the initial screening thresholds or sources that are very close to the Class I areas, which will be better analyzed by a finer grid resolution. For the SSCE Fernandina Mill BART analyses, only the refined analysis will be performed to determine whether the source is exempt from BART. All Class I areas within 300 km of the Fernandina Mill will be included in the refined modeling analysis and modeling results will be presented for each evaluated Class I area.

If the BART exemption analysis reveals that the BART-eligible source is subject to the BART control analysis, part of the BART review process involves evaluating the visibility benefits of different BART control measures. These benefits will be determined by the refined analysis, where CALPUFF will be executed with the baseline emission rates and again with emission rates reflective of BART control options.



LEGEND

☆ Facility

🟩 Class I Areas

REFERENCE

Projection: Transverse Mercator Datum: NAD 27 Coordinate System: UTM Zone 17

110,000 0 110,000 Meters

PROJECT

SSCE FERNANDINA MILL
BART MODELING PROTOCOL

TITLE

Facility Location and
PSD Class I Areas Within 300 km

Golder Associates
Gainesville, Florida

PROJECT No.			SCALE AS SHOWN	REV. 0
DESIGN	AB	28 Sep. 2006	**FIGURE 1-1**	
GIS	AB	28 Sep. 2006		
CHECK	SM	28 Sep. 2006		
REVIEW	[illegible]	28 Sep. 2006		

2.0 SOURCE DESCRIPTION

2.1 Source Applicability

SSCE operates two power boilers, two recovery boilers, two smelt dissolving tanks, lime kiln, tall oil plant, brownstock washer system, pulping system, a package boiler, and ancillary equipment at the Fernandina Mill to make kraft linerboard. The FDEP has published a list of potential BART-eligible sources (updated September 12, 2006), which is based on a survey questionnaire sent by FDEP to selected facilities in Florida on November 4, 2002 and April 18, 2003. FDEP's list contains five potential BART-eligible emissions units located at the Fernandina Mill. SSCE's Fernandina Mill is on FDEP list since it is one of the 26 major source categories identified in the BART regulation (kraft pulp mills) and has potential emissions of visibility impairment pollutants (i.e., SO_2, NO_x, and PM_{10}) from its BART-eligible emissions units that are greater than 250 TPY.

From detailed information obtained from SSCE, a BART-eligibility analysis was performed to verify the applicability of the BART rule to the facility as well as the list of BART-eligible units at the facility. This analysis consisted of a three-step procedure.

First, the facility is a BART-eligible source since it is classified under the source category of "Kraft pulp mills".

Second, each emissions unit at the facility was reviewed to determine which units met the date requirements for a BART-eligible unit. For each emissions unit, it was determined which units began operation after August 7, 1962, and also were in existence on August 7, 1977.

Third, if an emissions unit met the date requirements for BART eligibility, the potential emissions of visibility impairing pollutants from each unit were identified. At present, the visibility impairing pollutants include SO_2, NO_x, and PM_{10}. Other potential visibility impairing pollutants, such as volatile organic compounds (VOCs) and ammonia have been determined by FDEP to have no significant effect on regional haze in Florida.

The results of this analysis are summarized in Table 2-1, which shows a total of four BART-eligible emission units at this facility. As shown in Table 2-1, the potential annual SO_2, NO_x, and PM_{10} emissions from the BART-eligible emissions units total more than 250 TPY for each pollutant. Because the emissions of one or more pollutants are greater than the 250 TPY threshold, all of these pollutants will be included in the visibility impairment assessment for the facility. Since PM_{10}

emissions from the non-fugitive emissions units are greater than 250 TPY, it is not necessary to quantity fugitive particulate matter (PM) emissions from the BART-eligible emissions units for source applicability under the BART regulation. Only the visibility impairing pollutants of SO_2, NO_x, and PM_{10} are required to be included in the visibility modeling analysis. Therefore, BART-eligible emission units that do not emit these pollutants will not be included in the modeling analysis. In addition, FDEP is not requiring fugitive emissions to be included in the modeling unless the source is relatively close to a PSD Class I area (i.e.: 50 km). The final list of BART-eligible, non-fugitive emissions units for SSCE are as follows:

- No. 5 Power Boiler (EU006)
- No. 4 Recovery Boiler (EU007)
- No. 4 Smelt Dissolving Tank (EU013)

Based on discussions with FDEP, if a BART-eligible emission unit does not emit SO_2, NO_x, or PM_{10}, the emission unit is not required to undergo a BART control technology determination. Also, if a facility is more than 50 km from the nearest PSD Class I area, fugitive PM emissions from BART-eligible emissions units are not required to undergo BART control evaluation.

2.2 Stack Parameters

The stack height above ground, stack diameter, exit velocity, and exit temperature for the BART-eligible emissions units at the Fernandina Mill are presented in Table 2-2. For the modeling analysis, all the emissions units will be collocated in the VISTAS domain Lambert Conformal Conic (LCC) coordinate system at (X, Y) = (1,486.149, -906.200) km.

2.3 Emission Rates for Visibility Impairment Analyses

The EPA BART guidelines indicate that the emission rate to be used for BART modeling is the highest 24-hour actual emission rate representative of normal operations for the modeling period. Depending on the availability of the source data, the source emissions information should be based on the following in order of priority, based on the BART common protocol:

- 24-hour maximum emissions based on continuous emission monitoring (CEM) data for the period 2001-2003,

- Facility stack test emissions,
- Potential to emit,
- Allowable permit limits, and
- AP-42 emission factors.

The maximum 24-hour average emission rates for the BART-eligible units at the Fernandina Mill that will be used in the modeling are presented in Table 2-3. Detailed calculation of the emission rates are presented in Appendix A. The 24-hour average SO_2 and NO_x emission rates for the No. 5 Power Boiler at the Fernandina Mill are based on the maximum daily No. 6 fuel oil usage for the period 2001-2003 and the annual average sulfur content for the year when the maximum daily usage occurred. SO_2 and NO_x emission rates for the No. 4 Recovery Boiler and the No. 4 Smelt Dissolving Tank are based on maximum daily black liquor solids (BLS) usage from the period 2001-2003 and emission factors from the National Council on Air and Stream Improvement (NCASI).

The 24-hour average PM_{10} emission rates for the No. 5 Power Boiler, No. 4 Recovery Boiler, and the No. 4 Smelt Dissolving Tank are from the stack test data. A summary of the stack test data is also presented in Appendix A.

2.4 PM Speciation

Based on the latest regulatory guidance, PM emissions by size category are required to be considered in the appropriate species for the visibility analysis. The effect that each species has on visibility impairment is related to a parameter called the extinction coefficient. The higher the extinction coefficient, the greater the species' affect on visibility. Filterable PM is speciated into coarse (PMC), fine (PMF), and elemental carbon (EC), with default extinction efficiencies of 0.6, 1.0, and 10.0, respectively. PMC is PM with aerodynamic diameter between 10 microns and 2.5 microns. Both EC and PMF have aerodynamic diameters equal to or less than 2.5 microns. Condensable PM is comprised of inorganic PM such as sulfate (SO_4) and organic PM such as secondary organic aerosols (SOA). The extinction efficiencies for these species are 3*f(RH) and 4, respectively, where f(RH) is the relative humidity factor.

The PM emissions from the BART-eligible units at the Fernandina Mill were speciated into the recommended size and species categories using the latest EPA Publication AP-42 emission factors for wood-fired boilers and NCASI particulate emissions data for pulp and paper industry-specific sources (dated August 25, 2006) (see Appendix B). The PM emissions from the stack test data were considered as total filterable PM. Using the AP-42 or NCASI factors, emission factors for all the species categories were first developed as a fraction of the total filterable PM and then using the fraction, the emission rates of the different species were estimated. Speciation among the different size categories were also developed based on NCASI's data on particle size ranges for Kraft recovery sources. A detailed PM speciation summary is presented in Tables 2-4 and 2-5.

2.5 Building Dimensions

Based on discussions with FDEP, building downwash effects will not be considered in the modeling because these effects are considered to be minimal in assessing impacts at the distance of the nearest PSD Class I area, which is more than 50 km from the Fernandina Mill.

TABLE 2-1
BART ELIGIBILITY ANALYSIS FOR SMURFIT-STONE CONTAINER ENTERPRISES - FERNANDINA MILL
(FACILITY ID 0890003)

EU ID	Emission Unit	BART Category[a]	Dates		In Existence on 8/7/1977 ? (Yes/No)	Began Operation After 8/7/1962 ? (Yes/No)	Meets BART Date Criteria ? (Yes/No)	SO_2, NO_x, or PM Source ? (Yes/No)	BART Eligible ? (Yes/No)	Potential Emissions			Comments
			Start-Up	Initial Construction						SO_2 (TPY)	NO_x (TPY)	PM_{10} (TPY)	
006	No. 5 Power Boiler	3	1968	--	Yes ✓	Yes	Yes	Yes	Yes	6618.6[b]	1015.7[c]	598.9[b]	
007	No. 4 Recovery Boiler	3	1969	--	Yes ✓	Yes	Yes	Yes	Yes	222.8[c]	457.7[c]	236.5[c]	
011	No. 5 Recovery Boiler	3	1978	8/16/1977	No	Yes	No	--	No	--	--	--	Did not exist on 8/7/1977
013	No. 4 Smelt Dissolving Tank	3	1969	--	Yes ✓	Yes	Yes	Yes	Yes	4.52[c]	10.84[c]	60.2[b]	
014	No. 5 Smelt Dissolving Tank	3	1978	8/16/1977	No	Yes	No	--	No	--	--	--	Did not exist on 8/7/1977
015	No. 7 Power Boiler	3	6/16/1983	--	No	Yes	No	--	No	--	--	--	Did not exist on 8/7/1977
020	Tall Oil Plant[e]	3	1966	--	Yes ✓	Yes	Yes	No	Yes	--	--	--	Not a SO_2, NO_x, or PM source
021	No. 4 Lime Kiln	3	7/24/1990	--	No	Yes	No	--	No	--	--	--	Did not exist on 8/7/1977
024	C-Line Brownstock Washer System	3	2/20/91	--	No	Yes	No	--	No	--	--	--	Did not exist on 8/7/1977
033	Pulping System MACT I	3	1937	--	No	Yes	No	--	No	--	--	--	Began operation before 1962
034	Package Boiler	N/A	1966	--	Yes ✓	Yes	Yes	Yes	No	--	--	--	<250 MMBtu/hr and not integral to process[d]
									Total TPY =	6,846.0	1,484.3	895.6	

[a] BART category 3 is Kraft Pulp Mills.

[b] Title V Permit No. 0890003-009-AV.

[c] See Appendix A.

[d] The Package Boiler (EU034) has a heat input of less than 250 MMBtu/hr and only provides steam to the process, and is therefore exempt based on EPA guidelines.

[e] Not a SO_2, NO_x, or PM_{10} source and therefore, will not be included in any modeling and a BART determination will not be required.

TABLE 2-2
SUMMARY OF STACK AND OPERATING PARAMETERS AND LOCATIONS FOR THE BART-ELIGIBLE EMISSIONS UNITS
SMURFIT-STONE CONTAINER ENTERPRISES - FERNANDINA MILL

		Stack Parameters				Operating Parameters				
		Height		Diameter		Flow Rate	Exit Temperature		Velocity	
Emission Unit	Model ID	ft	m	ft	m	acfm	°F	K	ft/s	m/s
No. 5 Power Boiler[a]	SSCEPB5	257	78.33	11.0	3.35	235,000	450	505.4	41.2	12.56
No. 4 Recovery Boiler[b]	SSCERB4	249	75.90	12.3	3.75	342,000	431	494.8	48.0	14.62
No. 4 Smelt Dissolving Tank[b]	SSCESDT4	249	75.90	6.0	1.83	23,000	143	334.8	13.6	4.13

[a] No. 5 Power Boiler operating parameters based on Boiler MACT application, September 2006.

[b] Stack and operating parameters from Title V permit renewal application, December 2002.

Note: All emissions units will be collocated for the purpose of exemption modeling. The facility coordinates are as follows:

UTM Zone 16: 456.2 km East, 3,394.1 km North.

Lambert Conformal Conic (LCC) coordinate, VISTAS Domain: 1,486.149 km, -906.200 km

TABLE 2-3
SUMMARY OF MAXIMUM 24-HOUR AVERAGE EMISSION RATES FOR THE BART-ELIGIBLE EMISSIONS UNITS
SMURFIT-STONE CONTAINER ENTERPRISES - FERNANDINA MILL

			PM		NO_x		SO_2	
Source	EU ID	Model ID	lb/hr	Reference	lb/hr	Reference	lb/hr	Reference
No. 5 Power Boiler	006	SSCEPB5	22.5	Table A-3	145.1	Table A-2	1,026.4	Table A-2
No. 4 Recovery Boiler	007	SSCERB4	39.5	Table A-3	103.2	Table A-2	50.2	Table A-2
No. 4 Smelt Dissolving Tank	013	SSCESD4	13.3	Table A-3	2.4	Table A-2	1.0	Table A-2

TABLE 2-4
PM SPECIATION FOR THE BART-ELIGIBLE EMISSIONS UNITS - SPECIES CATEGORIES
SMURFIT-STONE CONTAINER ENTERPRISES - FERNANDINA MILL

Source	Control Device	EU ID	Model ID	Filterable PM[a] (lb/hr)	Filterable PM_{10}[b]			Condensable PM (CPM)[b]		Total Filterable PM_{10} (lb/hr)	Total Condensable PM (lb/hr)	Model PM (Filterable PM_{10} + SOA) (lb/hr)	Contribution to Model PM (%)				
					Coarse PM_{10} (lb/hr)	Fine PM_{10} (Soil) (lb/hr)	Elemental Carbon (EC) (lb/hr)	Inorganic CPM (SO_4) (lb/hr)	Organic CPM (SOA) (lb/hr)				Coarse PM_{10} (%)	Fine PM_{10} (Soil) (%)	Carbon (EC) (%)	CPM (SO4) (%)	Organic CPM (SOA) (%)
No. 5 Power Boiler	ESP	006	SSCEPB5	22.5	2.1	13.2	1.4	3.5	3.5	16.7	7.1	20.2	10.3%	65.5%	6.7%	[c]	17.5%
No. 4 Recovery Boiler	ESP	007	SSCERB4	39.5	5.1	14.1	0.6	4.6	0.9	19.8	5.5	20.7	24.8%	68.0%	2.8%	[c]	4.4%
No. 4 Smelt Dissolving Tank	Wet Scrubber	013	SSCESDT4	13.3	1.2	9.3	0.4	0.5	0.2	10.9	0.7	11.1	11.2%	83.7%	3.5%	[c]	1.7%

[a] From Table 2-3.

[b] Calculated using the percentages of the total filterable PM provided in the table below:

[c] Inorgaoic CPM (SO4) is modeled in CALPUFF as a separate category other than PM.

Source	Control Device	Emission Factors											Emission Factor Contribution to Filterable PM (%)				
		Emission Factors and Basis (lb/ton BLS for NCASI and lb/MMBtu for EPA)								Estimated Emission Factors							
		Filterable PM	Filterable PM_{10}	Filterable $PM_{2.5}$	Condensable PM (CPM)	CPM Organic	CPM Inorganic Sulfate	CPM Inorganic Non-Sulfate	Reference	Coarse PM_{10}[d]	Fine PM_{10} (Soil)[e]	Elemental Carbon (EC)[f]	Coarse PM_{10}	Fine PM_{10} (Soil)	Elemental Carbon (EC)	Inorganic CPM (SO_4)[g]	Organic CPM (SOA)
No. 5 Power Boiler	ESP	0.054	0.040	0.035	0.017	--	--	--	EPA[h]	0.005	0.032	0.003	9.3%	58.8%	6.0%	15.7%	15.7%
No. 4 Recovery Boiler	ESP	0.65	0.33	0.242	0.09	0.015	0.032	0.043	NCASI[i]	0.085	0.232	0.010	13.0%	35.7%	1.5%	11.6%	2.3%
No. 4 Smelt Dissolving Tank	Wet Scrubber	0.148	0.12	0.107	0.0074	0.002	0.002	0.003	NCASI[j]	0.0138	0.103	0.004	9.3%	69.7%	2.9%	3.6%	1.4%

[d] Coarse PM_{10} = Filterable PM_{10} - Filterable $PM_{2.5}$.

[e] Fine PM_{10} = Filterable $PM_{2.5}$ - Elemental Carbon (EC).

[f] Elemental carbon (EC) fraction is as follows:

Recovery Boiler and Smelt Dissolving Tank - 4.0 % of $PM_{2.5}$ (Particulate Emissions Data for Pulp and Paper Industry-Specific Sources. NCASI. August 2006)
Power Boiler - 9.3 % of $PM_{2.5}$ (EPA's Catalog of Global Emissions Inventories, Table 6, Draft Report, January 2002)

[g] Sum of inorganic sulfate and inorganic non-sulfate CPMs. Inorganic non-sulfate CPMs conservatively assumed as inorganic sulfate CPMs for the purpose of modeling.

[h] Table 1.6-1 Emission Factors for PM From Wood Residue Combustion, AP-42, EPA 2003. Total condenseble PM equally divided between inorganic and organic PM.

[i] Table 2. Particulate Emissions Data for Pulp and Paper Industry-Specific Sources, NCASI, August 2006.

[j] Table 1. Particulate Emissions Data for Pulp and Paper Industry-Specific Sources, NCASI, August 2006.

TABLE 2-5
PM SPECIATION FOR THE BART-ELIGIBLE EMISSIONS UNITS - SIZE CATEGORIES
SMURFIT-STONE CONTAINER ENTERPRISES - FERNANDINA MILL

					Size Distribution of Filterable PM_{10}[b]						Size Distribution of Organic CPM (SOA)[c]		Particle Matter Emissions by Size Category						
Source	EU ID	Model ID	Filterable PM[a] (lb/hr)	Organic CPM (SOA)[a] (lb/hr)	PM0063 (<0.625 µm) (%)	PM0100 (0.625-1 µm) (%)	PM0125 (1-1.25 µm) (%)	PM0250 (1.25-2.5 µm) (%)	PM0600 (2.5-6 µm) (%)	PM1000 (6-10 µm) (%)	PM0063 (<0.625 µm) (%)	PM0100 (0.625-1 µm) (%)	PM0063 (<0.625 µm) (lb/hr)	PM0100 (0.625-1 µm) (lb/hr)	PM0125 (1-1.25 µm) (lb/hr)	PM0250 (1.25-2.5 µm) (lb/hr)	PM0600 (2.5-6 µm) (lb/hr)	PM1000 (6-10 µm) (lb/hr)	Model Total (Filt PM_{10} + (lb/hr)
No. 5 Power Boiler[d]																			25.6
No. 4 Recovery Boiler	006	SSCEPB5	22.5	3.5	47.5%	47.5%	1.0%	2.0%	0.0%	0.0%	50.0%	50.0%	12.5	12.5	0.2	0.5	0.0	0.0	20.7
No. 4 Smelt Dissolving Tank	007	SSCERB4	39.5	0.9	16.4%	7.1%	4.9%	8.8%	8.0%	5.0%	50.0%	50.0%	6.9	3.3	1.9	3.5	3.2	2.0	11.1
	013	SSCESDT4	13.3	0.2	34.6%	14.3%	7.9%	15.9%	8.1%	1.2%	50.0%	50.0%	4.7	2.0	1.1	2.1	1.1	0.2	

[a] From Table 2-4.

[b] Table 4, Particulate Emissions Data for Pulp and Paper Industry-Specific Sources, NCASI, August 2006.

[c] Condensable PM is of less than 1 µm in size, which is equally divided into PM0063 and PM0100.

[d] Particle size distribution for PM emissions from No. 2 Bark Boiler is based on Table 1.6-5, AP-42, EPA 2003.

3.0 GEOPHYSICAL AND METEOROLOGICAL DATA

3.1 Modeling Domain and Terrain

CALMET data sets have been developed by EarthTech, Inc. that are based on the following 3 years of Fifth Generation Mesoscale Model (MM5) meteorological data assembled by VISTAS:

- 2001 MM5 data set at 12 km grid (developed by EPA),
- 2002 MM5 data set at 12 km grid (developed by VISTAS), and
- 2003 MM5 data set at 36 km grid (developed by Midwest Regional Planning Organization).

For the finer grid modeling analysis (refined analysis), the 4-km spacing Florida CALMET domain will be used. VISTAS has prepared a total of five sub-regional 4-km spacing CALMET domains. Domain 2 covers all Florida sources and Class I areas that can be potentially affected by the Florida sources.

Golder Associates Inc. (Golder) obtained these data sets from FDEP. As indicated in Section 1.3, for this protocol, the exemption modeling will be based on the finer grid modeling since the Fernandina Mill is a large source that is likely to exceed the initial screening thresholds.

3.2 Land Use and Meteorological Database

The CALMET meteorological domains to be used in the exemption modeling have been supplied by VISTAS. The CALMET data sets contain meteorological data and land use parameters for the three-dimensional modeling domain.

3.3 Air Quality Database

3.3.1 Ozone Concentrations

For these analyses, observed ozone data for 2001-2003 from CASTNet and Aerometric Information Retrieval System (AIRS) stations will be used. These data sets have been obtained from EarthTech's website as recommended by FDEP.

3.3.2 Ammonia Concentrations

A fixed monthly background ammonia concentration of 0.5 parts per billion (ppb) will be used based on FDEP's recommendation.

3.4 Natural Conditions at Class I Area

Based on VISTAS' recommendation, Visibility Method 6 will be used in all BART-related modeling, which will compute extinction coefficients for hygroscopic species (modeled and background) using a monthly f(RH) in lieu of calculating hourly RH factors. Monthly RH values from Table A-3 of EPA's *Guidance for Estimating Natural Visibility Conditions under the Regional Haze Rule* (Haze Guideline) will be used. Monthly RH factors for the Class I areas within 300 km of the Fernandina Mill are as follows:

Month	Okefenokee NWA	Wolf Island NWA	Chassahowitzka NWA	Saint Marks NWA
January	3.5	3.4	3.8	3.7
February	3.2	3.1	3.5	3.4
March	3.1	3.1	3.4	3.4
April	3.0	3.0	3.2	3.4
May	3.6	3.3	3.3	3.5
June	3.7	3.7	3.9	4.0
July	3.7	3.7	3.9	4.1
August	4.1	4.1	4.2	4.4
September	4.0	4.0	4.1	4.2
October	3.8	3.7	3.9	3.8
November	3.5	3.5	3.7	3.7
December	3.6	3.5	3.9	3.8

Method 6 requires input of natural background (BK) concentrations of ammonium sulfate ($BKSO_4$), ammonium nitrate ($BKNO_3$), coarse particulates (BKPMC), organic carbon (BKOC), soil (BKSOIL), and elemental carbon (BKEC) in micrograms per cubic meter ($\mu g/m^3$). The model then calculates the natural background light extinction and haze index based on these values.

According to FDEP recommendations, the natural background light extinction may be based on haze index (HI) values (in dv) for either the annual average or the 20-percent best visibility days provided by EPA in Appendix B of the Haze Guideline document (using the 10th percentile HI value). For

SSCE's BART analysis, the annual average HI values will be used to determine natural background light extinction of the Class I areas. The light extinction coefficient in inverse megameters (Mm^{-1}) is based on the concentration of the visibility impairing components and the extinction efficiency, in square meters per gram (m^2/g), for each component.

Per VISTAS and FDEP recommendations, the natural background light extinction that is equivalent to EPA-provided background HI values for each Class I area, based on the annual average, will be estimated using the following background values:

- Rayleigh scattering = 10 Mm^{-1};
- Concentrations of $BKSO_4$, $BKNO_3$, BKPMC, BKEC, and BKEC = 0.0; and
- BKSOIL concentration, which is estimated from the extinction coefficient that corresponds to EPA's HI value (corresponding to annual average) and then subtracting the Rayleigh scattering of 10 Mm-1 (assumes that the extinction efficiency of soil is 1 m^2/g).

According to Appendix B of the Haze Guideline document, the annual average background light extinction coefficient for each PSD Class I area and corresponding calculated BKSOIL concentrations are as follows:

- Okefenokee NWA – 21.40 Mm^{-1} (equivalent to 7.61 dv); 11.40 $\mu g/m^3$
- Wolf Island NWA – 21.34 Mm^{-1} (equivalent to 7.58 dv); 11.34 $\mu g/m^3$
- Chassahowitzka NWA – 21.45 Mm^{-1} (equivalent to 7.63 dv); 11.45 $\mu g/m^3$
- Saint Marks NWA – 21.53 Mm^{-1} (equivalent to 7.67 dv); 11.53 $\mu g/m^3$

Currently, the atmospheric light extinction is estimated by an algorithm developed by the Interagency Monitoring of Protected Visual Environments (IMPROVE) committee, which was adopted by the EPA under the 1999 Regional Haze Rule (RHR). This algorithm for estimating light extinction from particle speciation data tends to underestimate light extinction for the highest haze conditions and overestimate it for the lowest haze conditions and does not include light extinction due to sea salt, which is important at sites near the sea coasts. As a result of these limitations, the IMPROVE Steering Committee recently developed a new algorithm (the "new IMPROVE algorithm") for estimating light extinction from particulate matter component concentrations, which provides a better correspondence between measured visibility and that calculated from particulate matter component concentrations.

The new algorithm splits the total sulfate, nitrate, and organic carbon compound concentrations into two fractions, representing small and large size distributions of those compounds. New terms added to the algorithm are light absorption by NO_2 gas and light scattering due to fine sea salt accompanied by its own hygroscopic scattering enhancement factor and Class I area specific Rayleigh scattering values rounded off to the nearest whole number. The U.S. Environmental Protection Agency (EPA) and the Federal Land Managers (FLMs) from the National Park Service and the U.S. Fish and Wildlife Service have determined that adding site-specific data (e.g., sea salt and site-specific Rayleigh scattering) to the old IMPROVE algorithm, for a hybrid approach, is not recommended and is allowing the optional use of the new IMPROVE algorithm.

Because one or more of the Class I areas within 300 km of the SSCE's Fernandina Mill facility are located near the sea coast, the new IMPROVE algorithm may additionally be used to calculate the natural background at these Class I areas. The new IMPROVE algorithm accounts for the background sea salt concentrations and site-specific Rayleigh scattering. Since the new IMPROVE equation cannot be directly implemented using the existing version of the CALPUFF model without additional post-processing or model revision, VISTAS has developed a methodology for implementing the new IMPROVE equation using existing CALPUFF/CALPOST output in a spreadsheet. This spreadsheet, known as the CALPOST-IMPROVE processor will be used to re-calculate visibility impacts due to SSCE's BART-eligible units in addition to the visibility impacts determined using the old IMPROVE equation.

It is assumed that ambient NO_2 concentrations due to SSCE's BART eligible units would be very small as to cause negligible light absorption, so light absorption by NO_2 gas, which is a new term added to the new IMPROVE algorithm, will not be considered for SSCE's BART modeling analysis. The following Class I area specific Rayleigh scattering (in Mm^{-1}) and sea salt concentrations (in $\mu g/m^3$) values will be used to evaluate the visibility impacts using the new CALPOST-IMPROVE processor:

- Okefenokee NWA – 11 Mm^{-1} ; 0.09 $\mu g/m^3$
- Wolf Island NWA – 12 Mm^{-1} ; 0.20 $\mu g/m^3$
- Chassahowitzka NWA – 11 Mm^{-1} ; 0.08 $\mu g/m^3$
- Saint Marks NWA – 11 Mm^{-1} ; 0.03 $\mu g/m^3$

4.0 AIR QUALITY MODELING METHODOLOGY

For predicting maximum visibility impairment at the Class I areas, the CALPUFF modeling system will be used. For BART-related visibility impact assessments, the CALPUFF model, Version 5.756 (060725), is recommended for use by EPA and VISTAS. Recent technical enhancements, including changes to the over-water boundary layer formulation and coastal effects modules (sponsored by the Minerals Management Service), are included in this version. The CALPUFF model is a non-steady-state long-range transport Lagrangian puff dispersion model applicable for estimating visibility impacts. The methods and assumptions used in the CALPUFF model will be based on the latest recommendations for CALPUFF analysis as presented in the VISTAS modeling protocol, Interagency Workgroup on Air Quality Models (IWAQM) Phase 2 Summary Report and the Federal Land Managers' Air Quality Related Values Work Group (FLAG) document. This model is also maintained by EPA on the Support Center for Regulatory Air Models (SCRAM) website.

4.1 Modeling Domain Configuration

The 4-km spacing Florida domain will be used for the BART exemption modeling and if required, modeling to evaluate visibility benefits of different BART control measures. VISTAS has prepared five sub-regional 4-km spacing CALMET domains. Domain 2 covers sources in Florida and Class I areas that are affected by the sources in Florida.

4.2 CALMET Meteorological Domain

The refined CALMET domain, to be used for SSCE's BART modeling, has been provided by FDEP. The major features used in preparing these CALMET data have been described in Section 4.0 of the VISTAS BART modeling protocol.

4.3 CALPUFF Computational Domain and Receptors

The computational domain to be used for the refined modeling will be equal to the full extent of the meteorological domain. Visibility impacts will be predicted at each PSD Class I area using receptor locations provided by the Federal Land Managers. Because the Okeefenokee NWA has such a large number of receptors, a smaller set of receptors consisting of the boundary and some intermediate points in this PSD Class I area will be modeled. The receptors to be used for each of the PSD Class I areas are presented in Figures 4-1 through 4-4.

4.4 CALPUFF Modeling Options

The major CALPUFF modeling options recommended in the IWAQM guidance (EPA, 1988; Pages B-1 through B-8), in addition to the recommendations in Section 4.3.3 of the VISTAS BART modeling protocol, will be used. An example CALPUFF input file showing the default modeling options and modeling options to be used for SSCE's BART analysis is presented in Appendix C.

4.5 Light Extinction and Haze Impact Calculations

The CALPOST program will be used to calculate the light extinction and the haze impact. The Method 6 technique, which is recommended by the BART guideline document, will be used to compute change in light extinction.

4.6 Quality Assurance and Quality Control (QA/QC)

Quality assurance procedures will be established to ensure that the setup and execution of the CALPUFF model and processing of the modeling results satisfy the regulatory objectives of the BART program. The meteorological datasets to be used in the modeling were developed and provided by VISTAS and therefore, no further QA will be required for these.

The CALPUFF modeling options are described in Section 4.4. The site-specific source data will be independently confirmed by an independent modeler not involved in the initial setup of the modeling files. The verification will include:

- Units of measure;
- Verification of the correct source and receptor locations, including datum and projection;
- Confirmation of the switch selections relative to modeling guidance;
- Checks of the program switches and file names of the various processing steps; and
- Confirmation of the use of the proper version and level of each model program.

In addition, all the data and program files needed to reproduce the modeling results will be supplied with the modeling report.

The source and emission data will be independently verified by Golder and SSCE. The source coordinates and related projection/datum parameters will be checked using the CALPUFF GUI's COORDS software and other comparable coordinate translation software such as CORPSCON and National Park Services Conversion Utilities software.

The POSTUTIL and CALPOST post-processor input files will be carefully checked to make sure of the following:

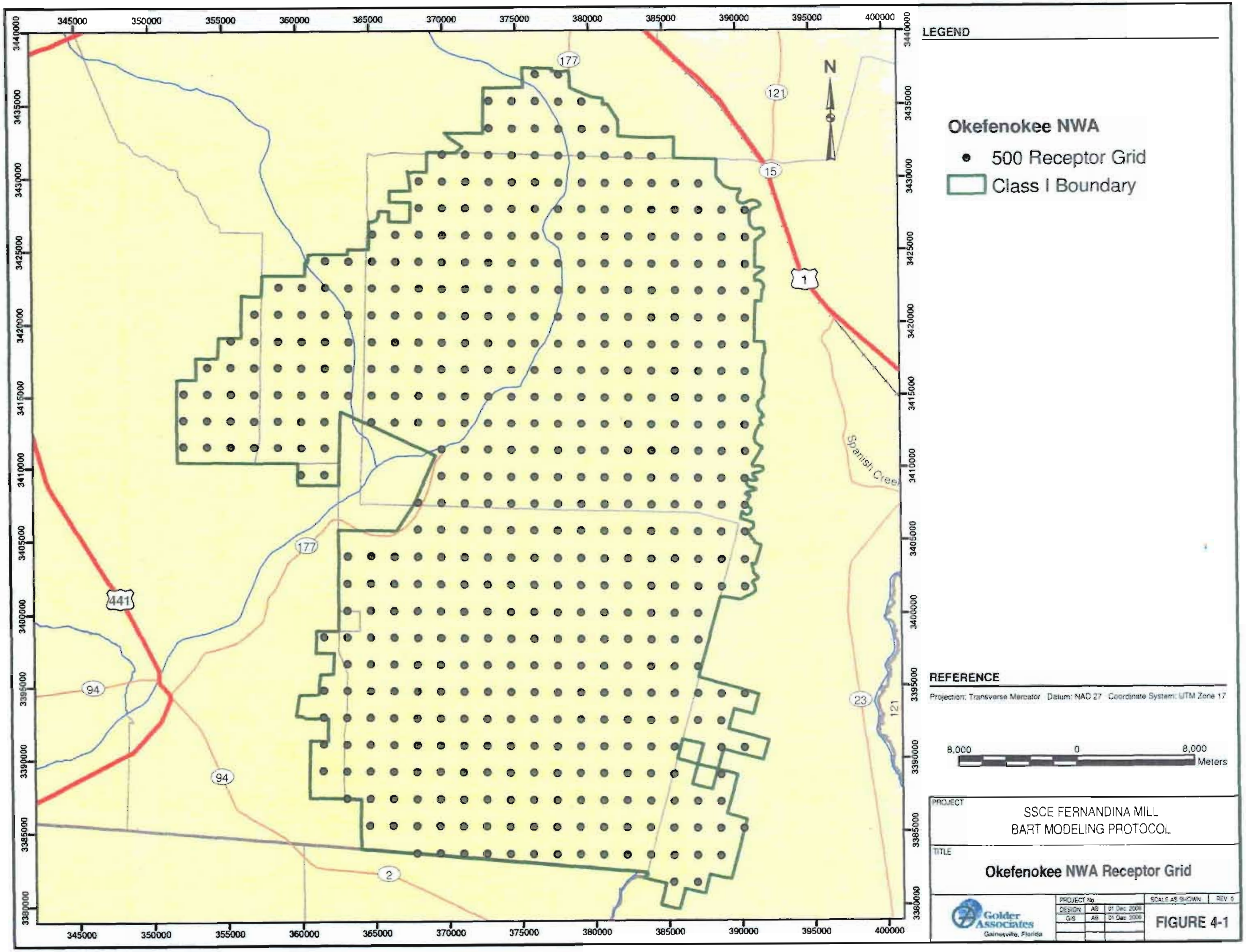
- Appropriate CALPUFF concentrations files are used in the POSTUTIL run;
- The PM species categories are computed using the appropriate fractions;
- Background light extinction computation method selected as Method 6;
- Correct monthly relative humidity adjustment factors used for the appropriate Class I area;
- Background light extinction values as described in Section 3.4 of this protocol;
- Appropriate species names for coarse and fine PM;
- Appropriate Rayleigh scattering term used; and
- Appropriate Class I receptors selected for each Class I area-specific CALPOST run.

4.7 Modeling Report

A modeling report will be submitted containing the following information:

- Map of source location and Class I areas within 300 km of the source;
- Table showing visibility impacts at each Class I area within 300 km of the source; and
- For the refined modeling analysis, a table showing the eight highest visibility impairment values ranked in a descending order for the prime Class I area(s) of interest.

The predicted visibility impairment results for the base emission case and all evaluated BART emission scenarios will be included in the report to show the affect on visibility for each proposed control technology. Final recommendations for BART will also be presented, based on the analysis results of the five evaluation criteria presented in the BART regulation.



REFERENCE

Projection: Transverse Mercator Datum: NAD 27 Coordinate System: UTM Zone 17

PROJECT

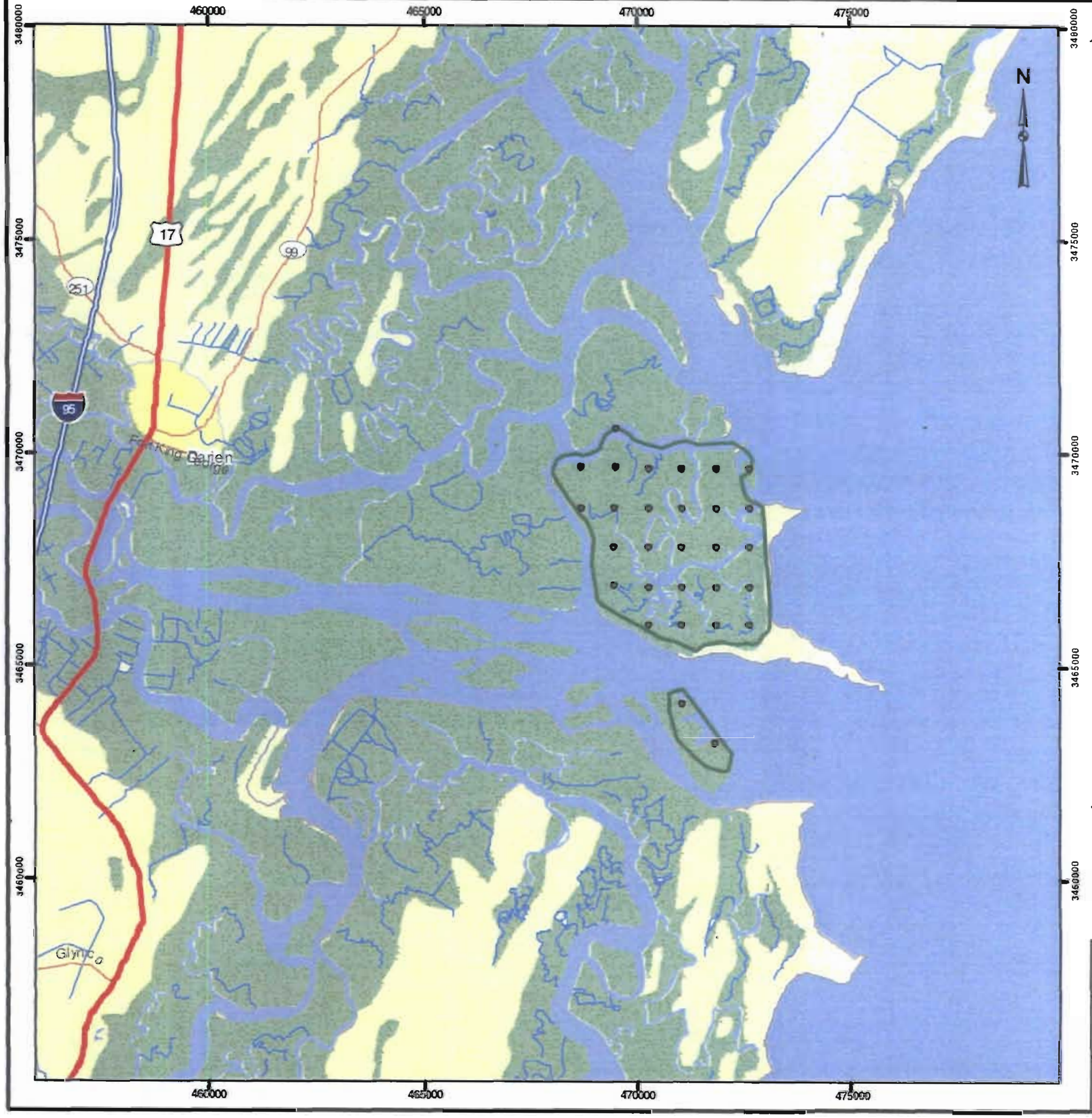
SSCE FERNANDINA MILL
BART MODELING PROTOCOL

TITLE

Okefenokee NWA Receptor Grid

Golder Associates
Gainesville, Florida

PROJECT No.			SCALE AS SHOWN	REV. 0
DESIGN	AB	01 Dec. 2006	**FIGURE 4-1**	
GIS	AB	01 Dec. 2006		



LEGEND

REFERENCE

Projection: Transverse Mercator Datum: NAD 27 Coordinate System UTM Zone 17

PROJECT

SSCE FERNANDINA MILL
BART MODELING PROTOCOL

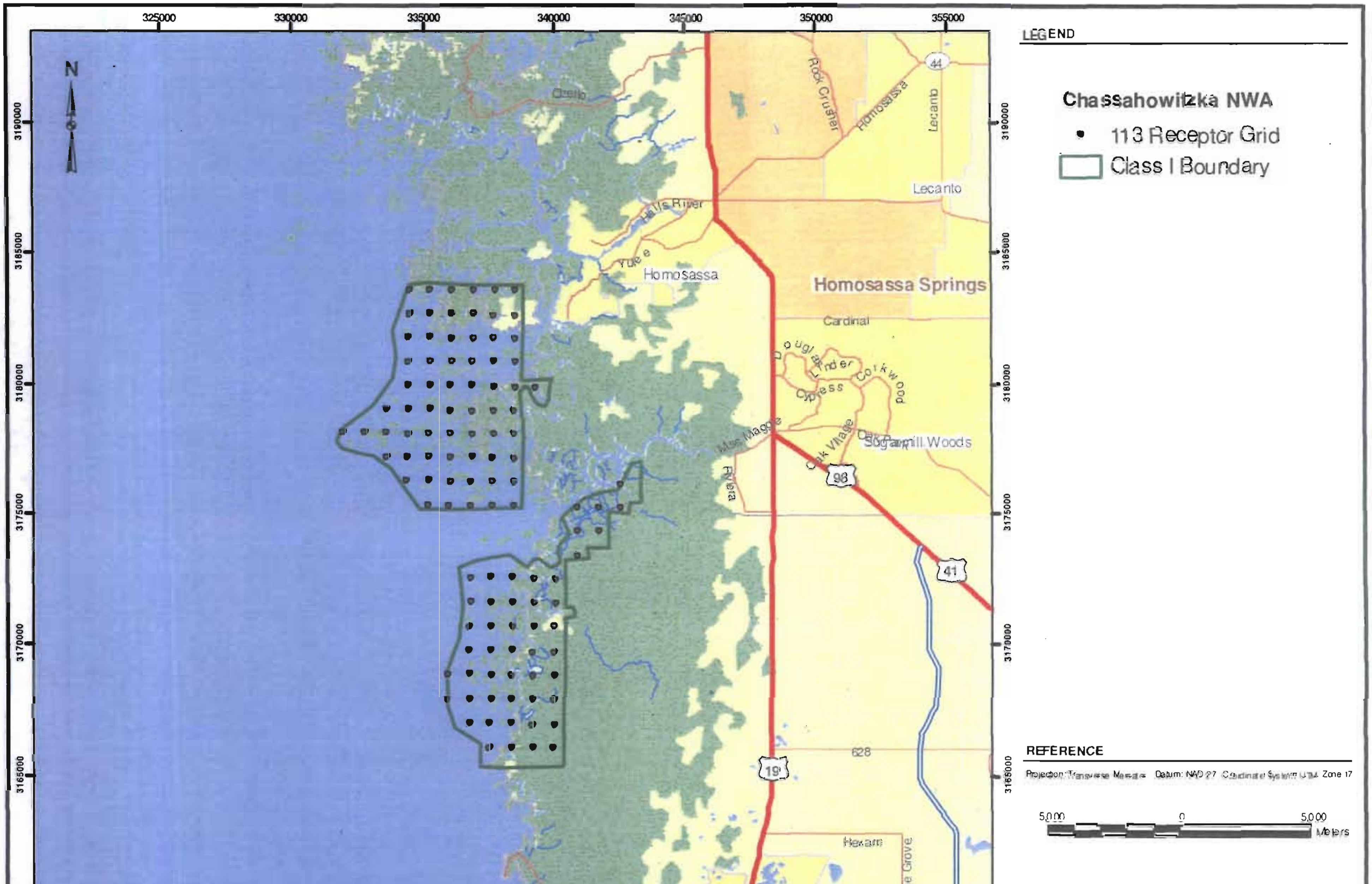
TITLE

Wolf Island NWA Receptor Grid

Golder Associates
Gainesville, Florida

PROJECT No.
SCALE AS SHOWN
REV. 0

FIGURE 4-2



PROJECT

SSCE FERNANDINA MILL

BART MODELING PROTOCOL

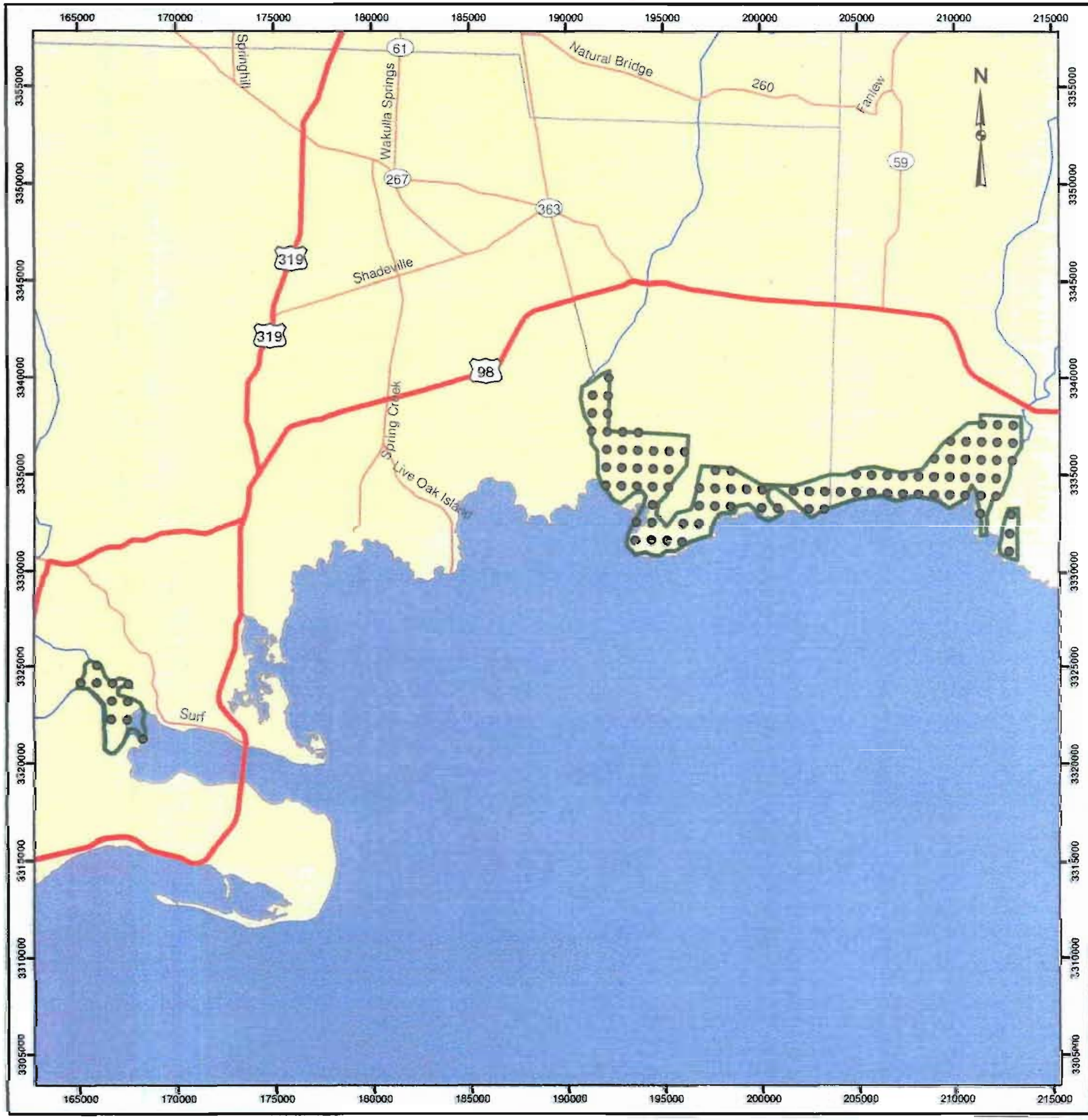
TITLE

Chassahowitzka NWA Receptor Grid

Golder Associates
Gainesville, Florida

PROJECT No.			SCALE AS SHOWN	REV. 0
DESIGN		25 Apr. 2006		
GIS		25 Apr. 2006		

FIGURE 4-3



LEGEND

Saint Marks NWA

● 100 Receptor Grid

▭ Class I Boundary

REFERENCE

Projection: Transverse Mercator Datum: NAD 27 Coordinate System: UTM Zone 17

6,000 0 6,000 Meters

PROJECT

SSCE FERNANDINA MILL
BART MODELING PROTOCOL

TITLE

Saint Marks NWA Receptor Grid

Golder Associates
Gainesville, Florida

PRODUCT No.			SCALE AS SHOWN	REV. 0
DESIGN	AB	25 Apr. 2006	FIGURE 4-4	
GIS	AB	25 Apr. 2006		

APPENDIX A

DETAILED EMISSIONS CALCULATIONS AND STACK TEST DATA SUMMARY

TABLE A-1
POTENTIAL EMISSION RATE CALCULATION FOR THE BART-ELIGIBLE EMISSIONS UNITS
SMURFIT-STONE CONTAINER ENTERPRISES - FERNANDINA MILL

EU ID	Source	Fuel	Emission Factor	Emission Factor Reference	24-Hour Heat Input (MMBtu/hr)	Fuel Usage	Emission Rate	
							lb/hr	TPY
NOx								
006	No. 5 Power Boiler[a]	No. 6 Oil[b]	47.0 lb/10^3 gal	Table 1.3-1, AP-42	573.4	3,850 gal/hr	181.0	792.6
		Bark	0.22 lb/MMBtu	Table 1.6-2, AP-42	231.6	54 ton/hr	51.0	223.2
						Total =	231.9	1,015.7
007	No. 4 Recovery Boiler	BLS	1.52 lb/ton	NCASI T.B. 884, Aug 2004	852	137,500 lb/hr	104.5	457.7
013	No. 4 Smelt Dissolving Tank	BLS	0.036 lb/ton	Stack test on No. 5 SDT	852	137,500 lb/hr	2.5	10.8
SO_2								
006	No. 5 Power Boiler	No. 6 Oil[b]	157.0 *S lb/10^3 gal	Table 1.3-1, AP-42	573.4	3,850 gal/hr	1,511.1	6,618.7
006	No. 5 Power Boiler	Bark	0.025 lb/MMBtu	Table 1.6-2, AP-42	231.6	54 ton/hr	5.8	25.4
						Total =	1,516.9	6,644.1
007	No. 4 Recovery Boiler	BLS	0.74 lb/ton	NCASI T.B. 884, Aug 2004	852	137,500 lb/hr	50.9	222.8
013	No. 4 Smelt Dissolving Tank	BLS	0.015 lb/ton	NCASI T.B. 884, Aug 2004	852	137,500 lb/hr	1.0	4.5
PM_{10}								
006	No. 5 Power Boiler	--	-- --	Permit 0890003-009-AV	852	-- --	137.1	598.9
007	No. 4 Recovery Boiler	BLS	0.044 gr/dscf	Permit 0890003-009-AV	852	137,500 lb/hr	54.0	236.5
013	No. 4 Smelt Dissolving Tank	BLS	0.20 lb/ton	Permit 0890003-009-AV	852	137,500 lb/hr	13.8	60.2

BLS = Black Liquor Solids.

[a] Worst-case combination of fuels.

[b] No. 6 fuel oil heat content of 148,935 Btu/gal and sulfur content (S) of 2.5 % by weight used in calculation.

TABLE A-2
24-HOUR AVERAGE ACTUAL EMISSION RATE CALCULATION FOR THE BART-ELIGIBLE EMISSIONS UNITS
SMURFIT-STONE CONTAINER ENTERPRISES - FERNANDINA MILL

EU ID	Source	Fuel	Emission Factor	Emission Factor Reference	Fuel Usage	Hourly Average Emission Rate (lb/hr)
NO_x						
006	No. 5 Power Boiler[a]	No. 6 Oil[b]	47.0 $lb/10^3$ gal	Table 1.3-1, AP-42	63,900 gal/day	125.1
		Bark[c]	0.22 lb/MMBtu	Table 1.6-2, AP-42	256 ton/day	19.9
					Total =	145.1
007	No. 4 Recovery Boiler	BLS[d]	1.52 lb/ton	NCASI T.B. 884, Aug 2004	1,629 tons/day	103.2
013	No. 4 Smelt Dissolving Tank	BLS	0.036 lb/ton	Stack test on No. 5 SDT	1,629 tons/day	2.4
SO_2						
006	No. 5 Power Boiler[a]	No. 6 Oil[b]	157.0 *S $lb/10^3$ gal	Table 1.3-1, AP-42	63,900 gal/day	1,024.1
		Bark[c]	0.025 lb/MMBtu	Table 1.6-2, AP-42	256 ton/day	2.3
					Total =	1,026.4
007	No. 4 Recovery Boiler	BLS	0.74 lb/ton	NCASI T.B. 884, Aug 2004	1,629 tons/day	50.2
013	No. 4 Smelt Dissolving Tank	BLS	0.015 lb/ton	NCASI T.B. 884, Aug 2004	1,629 tons/day	1.0

[a] Worst-case combination of fuels.

[b] Emission rate based on maximum daily No. 6 fuel oil usage from 3/5/2001 and 2001 annual average fuel oil sulfur content (S) of 2.45 %.

[c] Bark used on 3/5/2001 was 256 TPD. Bark heating value of 8.494 MMBtu/ton used in calculation.

[d] Emission rate based on maximum daily black liquor solids (BLS) usage from 6/5/2003.

TABLE A-3
SSCE FERNANDINA MILL PM STACK TEST DATA SUMMARY

		Title V Limit	MACT II Limit	Boiler MACT			
Unit	**Year**	**Allowable Emission Rate**		**Particulate Matter Emissions**			
PB 5		**lbs/hr**	**lb/MMBTU**	**(lbs/hr)**	**gr/dscf**	**lb/MMBTU**	**lb/ton Bark**
	2002			4.3	0.004	0.007	
	2003			3.7	0.003	0.006	
	2004			3.9	0.003	0.010	0.079
	2005			3.0	0.003	0.008	0.061
	2006	71.47	0.07*	22.5	0.025	0.061	0.4775
Unit	**Year**	**Allowable Emission Rate**		**Particulate Matter Emissions**			
RB 4		**lbs/hr**	**gr/dscf @ 8%**	**(lbs/hr)**	**gr/dscf @ 8%**	**lb/TBLS**	
	2003	(MACT II Oct)	0.044	6.3	0.006	0.099	
	2004			5.2	0.006	0.078	
	2005			39.5	0.019	0.627	
	2006			11.0	0.009	0.166	
Unit	**Year**	**Allowable Emission Rate**		**Particulate Matter Emissions**			
SDT 4		**lbs/hr**	**lb/ton BLS**	**(lbs/hr)**	**gr/dscf**	**lb/ton BLS**	
	2004	(MACT II Jan)	0.2	11.4	0.089	0.180	
	2004			13.3	0.114	0.185	
	2005			26.2[a]	0.148	0.415	
	2005	Retest		7.9	0.068	0.117	
	2006			16.9[a]	0.114	0.255	
	2006	Retest		6.5	0.049	0.099	
	2006	Adjust scrubber*		11.0	0.043	0.168	

* Modified scrubber to 11.5", WW 45 GPM, Recir 303 GPM.

[a] Test failed, therefore these data were not used.

APPENDIX B

NCASI PARTICULATE EMISSIONS DATA FOR PULP AND PAPER INDUSTRY SPECIFIC SOURCES

NATIONAL COUNCIL FOR AIR AND STREAM IMPROVEMENT, INC.
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Phone (919) 941-6400 Fax (919) 941-6401

Ronald A. Yeske, Ph.D.
President
(919) 941-6404

August 25, 2006

TO: Corporate Correspondents -- CC 06-021
Regional Managers

FROM: Ronald A. Yeske

SUBJECT: Information on Kraft Pulp Mill Particulate Emissions for Visibility Modeling

<u>This memorandum will be of interest to kraft pulp mills conducting modeling of visibility impacts in response to regional haze regulatory programs.</u>

Numerous kraft pulp mills have “BART-eligible” power boilers, recovery furnaces, smelt dissolving tanks, and lime kilns. Generally speaking, “BART-eligible” sources were built between 1962 and 1977, as discussed in NCASI Corporate Correspondent Memorandum No. 05-17, and emit SO_2, NO_x, and particulate matter. As required by EPA’s regional haze program, states are now in the process of evaluating whether or not emission reductions should be imposed on these “BART-eligible” sources. The key factor in these evaluations is the impact that the source emissions have on visibility in Class I areas. If the impact is minimal, it is unlikely that emission reductions would be imposed as a result of a BART (Best Available Retrofit Technology) analysis.

As recommended by EPA, visibility impacts are being assessed with the CALPUFF model. CALPUFF is a long-range transport and dispersion model that also simulates the formation of fine particulate matter from gaseous emissions. In visibility assessments, CALPUFF is used to predict concentrations of ammonium sulfate, ammonium nitrate, organic aerosols, fine particulates, coarse particulates, and elemental carbon. These concentrations are then used to calculate a total light extinction coefficient based on the light scattering and absorption properties of each of the components. The amount of light extinction can then related to the deciview change in a Class I area attributable to emissions from a point source. EPA suggests BART-eligible sources with less than a 0.5 deciview impact in any Class I area could reasonably be exempted from further BART analysis.

To run the CALPUFF model for “BART-eligible” sources, emission rates of SO_2, NO_x, and particulate matter are required. However, CALPUFF inputs needed for particulate matter are rather detailed. A breakdown of PM_{10} emissions into the following components and aerodynamic diameters is necessary:

Filterable PM_{10}:
- <0.625 µm
- 0.625 – 1.0 µm
- 1.0 – 1.25 µm
- 1.25 – 2.5 µm
- 2.5 - 6 µm
- 6 – 10 µm
- Elemental carbon percentage

Condensible PM_{10}:
- organic portion
- inorganic sulfate, nitrate and soils portions

Most mills have total particulate emission test results from EPA Method 5, but very few have PM_{10} or $PM_{2.5}$ results and virtually none have detailed particle size distribution information. In response to company requests for this information, NCASI has compiled available data for kraft recovery furnaces, smelt dissolving tanks, and lime kilns that may used to estimate the required inputs for CALPUFF. The data are described and summarized in the attachment. For power boilers, similar information can be found in Chapter 1 of EPA's AP-42 publication for coal, oil, gas, and wood fuels.

The attached summary was prepared by Arun Someshwar (asomeshwar@ncasi.org; ext. 226) and Ashok Jain (ajain@ncasi.org; ext. 0) at the Southern Regional Center (352-331-1745). Please contact either one if you need further details or assistance.

Attachment

Particulate Emissions Data for Pulp and Paper Industry-Specific Sources

August 25, 2006

This material has been prepared to assist mills which are using the CALPUFF model to assess the visibility impacts of their kraft pulp mill sources. It contains data on particulate emissions from the major sources at kraft pulp mills, including smelt dissolving tanks, lime kilns, and recovery furnaces. Boilers are not addressed since EPA AP-42 emission factors are considered the best source for these sources. The EPA AP-42 particulate emission factors for coal-fired, oil-fired, gas-fired and wood-fired boilers are also presented in NCASI Technical Bulletin No. 884 (NCASI 2004).

The CALPUFF model requires as input emission rates of filterable and condensable particles in different size distribution ranges. Over the years, NCASI has conducted studies at a number of kraft mill sources to characterize their PM and CPM (condensible particulate matter) emissions. These and other industry generated data have been compiled in NCASI Technical Bulletin No. 884 (NCASI 2004). The CALPUFF model, however, requires input of emission rates of particles in size ranges which are more detailed than what is generally measured. Consequently, in this document, the industry and NCASI data have been combined with the detailed size distribution data in AP-42 to provide data suitable for CALPUFF modeling for kraft recovery furnaces, lime kilns, and smelt dissolving tanks. The elemental carbon content data from EPA's CMAQ (Community Multi-Scale Air Quality) data base have also been included in this document.

In reviewing and using these data it should be noted that CPM emissions comprise an organic and an inorganic fraction. The inorganic fraction of CPM may consist of sulfates, nitrates, and soil (inert material presumably from passing of otherwise filterable PM material through the filter). It has been suggested that as a worst case visibility impact analysis, the non-sulfate fraction of inorganic CPM may be treated as nitrate, which has the same extinction coefficient of 3 as sulfate. However, there is little evidence that nitric acid or hygroscopic ammonium nitrate is present in CPM. Thus, caution should be exercised in assuming that all the non-sulfate inorganic CPM is nitrate.

To assist mills in using their own data for input into CALPUFF, NCASI has developed a companion spreadsheet, which has been posted on the NCASI website at http://www.ncasi.org/support/downloads/Detail.aspx?id=37. (A user name and password are required for access.) The spreadsheet allows facilities to input their site-specific PM and, if available, PM_{10}, $PM_{2.5}$ and CPM data to the different size fractions for input into CALPUFF.

Smelt Dissolving Tanks

The emission data for smelt dissolving tanks were obtained from NCASI Technical Bulletin Nos. 884 (NCASI 2004) and 898 (NCASI 2005). These data are summarized in Table 1. All smelt dissolving tanks (SDTs) in this data set had wet particulate control devices, and thus "wet" stacks. Wet stacks are not amenable to be tested for PM_{10}, $PM_{2.5}$ and condensible PM (CPM) by the traditional EPA Methods 201A (PM_{10}), modified 201A ($PM_{2.5}$), CTM 039 ($PM_{10,}$ $PM_{2.5}$) and CTM 040 ($PM_{10,}$ $PM_{2.5}$), which are designed for stacks following dry PM control devices. Thus far, the only PM_{10}, $PM_{2.5}$ and CPM emission data for SDTs with wet stacks have been obtained by O'Connor and Geneste (2003) using a modified dilution tunnel method. O'Connor and Geneste quantified total PM_{10} and $PM_{2.5}$ emissions from seven Canadian smelt dissolving tanks with wet stacks. They determined the filterable and condensible fractions of total PM_{10} and $PM_{2.5}$ emissions by heating the filters to 120°C and determining weight loss. The portion remaining after heating was assumed to be the filterable material and the portion lost was assumed to equal the condensible portion of the samples

Table 1 is a summary of the PM data for smelt dissolving tanks. The detailed data are presented in Table A1 of Appendix A. The filterable PM data in Table 1 were obtained from combining the data set of 36 sources listed in NCASI Technical Bulletin No. 884 (NCASI 2004), Table A15c, and the data set of 6 sources listed in NCASI Technical Bulletin No. 898 (NCASI 2005). The data for PM_{10} and $PM_{2.5}$ emissions, which are presented as a percentage of the filterable PM, correspond to the eight Canadian SDTs reported by O'Connor and Geneste (2003) after subtracting 19% attributed to CPM (see NCASI Technical Bulletin No. 884, Table A15d).

The total CPM data in Table 1 were obtained from NCASI tests (3 units) and mill tests (3 units), both of which are summarized in NCASI Technical Bulletin No. 898 (NCASI 2005). Organic and inorganic (water soluble) CPM fractions were also determined in emissions from these six units. Sulfate CPM fractions were determined in three of the six units. Total CPM data for two other units were available in NCASI files. CPM emissions for eight Canadian mill SDTs were also estimated by O'Connor and Geneste (2003) using the modified dilution tunnel method. However, these emissions were found to be consistently much higher than the corresponding emissions from U.S. SDT vents by as much as one to two orders of magnitude. Use of foul or dirty condensates to make weak wash used as scrubbing solution on the SDTs which in turn may have contained elevated levels of organics and ammonia is suspected to be the cause of this large difference. Consequently, the Canadian data were not used for estimating averages of total SDT CPM emissions in Table 1.

Table 1. Smelt Tank Data Summary

Parameter	Measurement Method	No. of Sources	Range (lb/ton BLS)	Mean (lb/ton BLS)	Mean Percent of PM or CPM
PM	EPA Method 5	42	0.03 - 0.64	0.148	
PM_{10}	Dilution Tunnel	7			81.9[1]
$PM_{2.5}$	Dilution Tunnel	7			72.6[1]
CPM – Total	EPA Method 202	8	0.002 - 0.015	0.0074	
CPM – Organic		6			27.8[2]
CPM Inorganic - Sulfate (as H_2SO_4)		3			27.3[2]
CPM Inorganic – non-sulfate[3]		6			44.9[2]

---

[1] filterable PM_{10} and $PM_{2.5}$ values expressed as percent of filterable PM values; [2] organic and inorganic (sulfate and non-sulfate) CPM values expressed as percent of total CPM values; [3] Nitrate may comprise some or all of the non-sulfate inorganic CPM fractions. As a conservative measure, the non-sulfate portion of inorganic CPM may be assumed to be sulfate. Sulfate and nitrate have the same extinction efficiency (3.0) and the same dependence on relative humidity, and thus in terms of modeling for visibility using the CALPUFF model, they will behave the same way. This assumption is conservative since in reality some of the nitrate may become nitric acid in the atmosphere, depending on temperature, relative humidity and availability of ammonia. However, as a first step, the assumption of all inorganic condensable PM as sulfate should be sufficient. Primary NO_3 should not be categorized as soil, because soil is non-hygroscopic with lower extinction efficiency (1.0). If the assumption of all inorganic CPM as sulfate proves to be too conservative, it may be possible to conduct tests with the model to explore whether the NO_3 can be properly entered as a primary (emitted) pollutant.

Recovery Furnaces

The recovery furnace data were obtained from NCASI Technical Bulletins Nos. 852 (NCASI 2002) and 884 (NCASI 2004). These are summarized in Table 2. All of the recovery furnaces in this data set use electrostatic precipitators (ESP) for particulate matter emissions control. In NCASI Technical Bulletins No. 852 and 884, the total PM data for the data sets where PM_{10} and $PM_{2.5}$ were also measured were obtained by using an in-stack filter. The total PM values in these tests, thus, are similar to what would be obtained if an EPA Method 17 train was used. However, in Subpart BB, kraft mills subject to NSPS are required to add 0.004 gr/dscf to the results of in-stack Method 17 when the latter is used as an alternative to EPA Method 5. Thus, in order to estimate PM_{10} and $PM_{2.5}$ fractions of Method 5-derived PM values, 0.004 gr/dscf was added to the total PM values obtained with the EPA CTM-40 train. For example, if a run gave 0.020, 0.025 and 0.036 gr/dscf for $PM_{2.5}$, PM_{10} and total PM, respectively, the total PM value was adjusted upwards to 0.036 + 0.004 or 0.040 gr/dscf. The $PM_{2.5}$ would then be 0.020/0.040 x 100 = 50 percent of PM Method 5 and PM_{10} would be 0.0250/0.040 x 100 = 62 percent of PM Method 5. If such adjustments to total PM values were not made, the values of $PM_{2.5}$ and PM_{10} as percent of total PM would have been higher and these are shown in the table footnote.

The PM data for DCE recovery furnaces shown in Table 2 are from the 23 sources listed in NCASI Technical Bulletin No. 884 (NCASI 2004), Table A11c. Detailed data are presented in Table A2 of Appendix A. The PM_{10} and $PM_{2.5}$ data for the DCE recovery furnaces are from the 4 DCE sources listed in Technical Bulletin No. 884 (NCASI 2004), Table A11d. Total CPM, organic CPM, inorganic CPM (water soluble) and sulfate CPM data were available from two sources listed in Technical Bulletin No. 852 (NCASI 2002). Data for total CPM, organic CPM, and inorganic CPM emissions from two DCE recovery furnaces and sulfate emissions from one DCE furnace generated in an ongoing unpublished NCASI study are also included in Table 2.

The PM data for the NDCE recovery furnaces shown in Table 2 are from the 20 sources listed in NCASI Technical Bulletin No. 884 (NCASI 2004), Table A12b. Detailed data are presented in Table A3 of Appendix A. The PM_{10} and $PM_{2.5}$ data are from the 10 NDCE sources listed in Technical Bulletin No. 884 (NCASI 2004), Table A12c for which both PM_{10} and $PM_{2.5}$ data were available. The NDCE furnace CPM data are from 6 sources listed in Technical Bulletin No.884 (NCASI 2004). The organic CPM, inorganic CPM (water soluble) and sulfate CPM data are from two sources listed in Technical Bulletin No. 852 (NCASI 2002). Data for total CPM, organic CPM, and inorganic CPM emissions from one NDCE recovery furnace generated in an ongoing unpublished NCASI study are also included in Table 2.

Table 2. Recovery Furnace Data Summary

Kraft DCE Recovery Furnace

Parameter	Measurement Method	No. of Sources	Range (lb/ton BLS)	Mean (lb/ton BLS)	Mean Percent of PM or CPM
PM	EPA Method 5	23	0.07 - 2.58	0.74	
PM_{10}	EPA CTM-040	4			56.7[1]
$PM_{2.5}$	EPA CTM-040	4			40.2[1]
CPM – Total	EPA Method 202	4	0.208 – 0.678	0.38	
CPM - Organic		4			7.4[2]
CPM Inorganic - Sulfate (as H_2SO_4)		3			36.0[2]
CPM Inorganic – non-sulfate[3]		3			56.6[2]

Kraft NDCE Recovery Furnace

Parameter	Measurement Method	No. of Sources	Range (lb/ton BLS)	Mean (lb/ton BLS)	Mean Percent of PM or CPM
PM	EPA Method 5	20	0.02 - 3.50	0.65	
PM_{10}	EPA CTM-040	10			50.2[1]
$PM_{2.5}$	EPA CTM-040	10			37.2[1]
CPM – Total	EPA Method 202	7	0.05 - 0.15	0.09	
CPM – Organic		3			16.5[2]
CPM Inorganic - Sulfate (as H_2SO_4)		3			35.2[2]
CPM Inorganic – non-sulfate[3]		1			48.3[2]

[1] filterable PM_{10} and $PM_{2.5}$ values expressed as percent of filterable PM values – note that PM_{10} and $PM_{2.5}$ were calculated as percent of total PM by adding 0.004 gr/dscf to total PM values; average PM_{10} and $PM_{2.5}$ values without such adjustment would be higher (75.0% and 52.9%, respectively, for DCE furnaces and 67.8% and 51.0%, respectively, for NDCE furnaces); [2] organic and inorganic (sulfate and non-sulfate) CPM values expressed as percent of total CPM values; [3] see footnote 3 in Table 1

Lime Kilns

The lime kiln data were obtained from NCASI Technical Bulletins Nos. 852 (NCASI 2002), 884 (NCASI 2004), and 898 (NCASI 2005) and are summarized in Table 3. Detailed data are presented in Table A4 of Appendix A. The emissions data are separated by control device type. The majority of lime kilns in this data set used wet control devices for particulate control. Two of the lime kilns used an ESP for particulate control, followed by a wet scrubber for SO_2 control. The remainder used an ESP for particulate control. Once again, as for SDTs, wet stacks are not amenable to be tested for PM_{10}, $PM_{2.5}$ and CPM by the traditional EPA Methods 201A (PM_{10}), modified 201A ($PM_{2.5}$), CTM 039 ($PM_{10,}PM_{2.5}$) and CTM 040 ($PM_{10,}PM_{2.5}$), which are designed for stacks following dry PM control devices. O'Connor and Geneste (2003) used a modified dilution tunnel method to quantify total PM_{10} and $PM_{2.5}$ emissions from six Canadian kraft lime kilns with wet scrubbers.

The filterable PM data for lime kilns using wet control devices are from 31 sources listed in NCASI Technical Bulletin No. 884 (NCASI 2004), Table A13c. The data for PM_{10} and $PM_{2.5}$ emissions for lime kilns using wet control devices are presented as a percentage fraction of the total PM corresponding to the six Canadian lime kilns tested by O'Connor and Geneste (2003) (see NCASI Technical Bulletin No. 884, Table A13d) for which both PM_{10} and $PM_{2.5}$ data were obtained . In the O'Connor and Geneste (2003) study, lime kiln total PM_{10} and $PM_{2.5}$ emissions were measured using a dilution tunnel followed by size-specific cyclones and quartz filters. To determine the filterable and condensible fractions of total PM_{10} and $PM_{2.5}$ emissions, the filters were heated at 120°C to determine weight loss. The portion remaining after heating was assumed to be the filterable fraction and the portion lost was assumed to equal the condensible fraction of the samples.

The CPM data for lime kilns with wet scrubbers in Table 3 were obtained from NCASI tests (4 units) reported in NCASI Technical Bulletin No. 898 (NCASI 2005) and from the Canadian study (seven kilns) summarized in Technical Bulletin No. 884 (NCASI 2004). The organic CPM, inorganic CPM and sulfate CPM data are from two to three sources listed in Technical Bulletin No. 898 (NCASI 2005).

All of the PM and CPM data for lime kilns using an ESP followed by a wet control device are from two sources listed in NCASI Technical Bulletin No. 898 (NCASI 2005). Unfortunately, no PM_{10} and $PM_{2.5}$ data are available for such sources. However, if one assumes that the wet scrubber played no role in removing or contributing to PM emissions from such sources, which is not an unreasonable assumption, one could use the results for lime kilns using ESPs to estimate the PM_{10} and $PM_{2.5}$ fractions of PM. Total CPM emissions data for two kilns, and organic CPM, inorganic CPM and sulfate CPM emissions for one kiln are obtained from Technical Bulletin No. 898 (NCASI 2005).

The filterable PM data for lime kilns using an ESP alone are from the 7 sources listed in NCASI Technical Bulletin No. 884 (NCASI 2004), Table A13c. The PM_{10} and $PM_{2.5}$ data are from the 6 sources listed in Technical Bulletin No. 884 (NCASI 2004), Table A13d. These data are also presented as a percentage fraction of the filterable PM corresponding to the six lime kilns tested. As discussed earlier for the recovery furnaces, the in-stack total PM data for kilns with ESPs were adjusted by 0.004 gr/dscf to obtain estimated total Method 5 PM values. These adjusted PM values were used to estimate $PM_{2.5}$ and PM_{10} values at percents of EPA Method 5 values. Table 3 also shows the estimated percentages if the total PM value was not adjusted. The CPM data are from 4 sources that are summarized in NCASI Technical Bulletin No. 852 (NCASI 2002). The organic CPM, organic CPM (water soluble) and sulfate CPM data are from two to three sources listed in Technical Bulletins No. 852 (NCASI 2002).

Table 3. Lime Kiln Data Summary

Lime Kilns with Wet Particulate Control Devices

Parameter	Measurement Method	No. of Sources	Range (lb/ton CaO)	Mean (lb/ton CaO)	Mean Percent of PM or CPM
PM	EPA Method 5	31	0.35 – 5.34	1.59	
PM_{10}	Dilution Tunnel	6			84.7[1]
$PM_{2.5}$	Dilution Tunnel	6			76.8[1]
CPM – Total	EPA Method 202	11	0.020 - 0.453	0.155	
CPM - Organic		3			8.3[2]
CPM Inorganic - Sulfate (as H_2SO_4)		2			58.2[2]
CPM Inorganic – non-sulfate[4]		3			33.5[2]

Lime Kilns with a Dry ESP for Particulate Control Followed by a Wet Scrubber

Parameter	Measurement Method	No. of Sources	Range (lb/ton CaO)	Mean (lb/ton CaO)	Mean Percent of PM or CPM
PM	EPA Method 5	2	0.043 - 0.053	0.048	
PM_{10}					No Data[3]
$PM_{2.5}$					No Data[3]
CPM – Total	EPA Method 202	2	0.070 - 0.161	0.116	
CPM - Organic		1			54.9[2]
CPM Inorganic - Sulfate (as H_2SO_4)		1			45.1[2]
CPM Inorganic – non-sulfate[4]		1			0.0[2]

Lime Kilns with a Dry ESP for Particulate Control

Parameter	Measurement Method	No. of Sources	Range (lb/ton CaO)	Mean (lb/ton CaO)	Mean Percent of PM
PM	EPA Method 5	7	0.024 - 0.525	0.175	
PM_{10}	EPA CTM-040	6			30.2[1]
$PM_{2.5}$	EPA CTM-040	6			11.0[1]
CPM – Total	EPA Method 202	4	0.057 - 0.198	0.152	
CPM - Organic		3			31.5[2]
CPM Inorganic - Sulfate (as H_2SO_4)		2			20.8[2]
CPM Inorganic – non-sulfate[4]		3			47.7[2]

---

[1] filterable PM_{10} and $PM_{2.5}$ values expressed as percent of filterable PM values – note that for lime kilns with ESPs, PM_{10} and $PM_{2.5}$ were calculated as percent of total PM by adding 0.004 gr/dscf to total PM values; average PM_{10} and $PM_{2.5}$ values without such adjustment would be higher (64.2% and 23.6%, respectively); [2] organic and inorganic (sulfate and non-sulfate) CPM values expressed as percent of total CPM values; [3] may be estimated using the fractions for lime kilns with dry ESPs in Table 3; [4] see footnote 3 in Table 1

Estimating PM Emissions in Particle Size Ranges

Table 4 reproduces the representative particle size distributions for PM emissions from various kraft recovery sources (smelt tanks, lime kilns and recovery furnaces) as provided in Chapter 10.2 (Chemical Wood Pulping) of EPA's AP-42 document. Using these distributions and the mean emissions for PM_{10} and $PM_{2.5}$ as percent of total PM shown in Table 1(smelt dissolving tanks), Table 2 (kraft recovery furnaces) and Table 3 (lime kilns), further breakdowns of PM_{10} and $PM_{2.5}$ emissions can be developed for the particle size ranges 0 to 0.625 µm, 0.625 to 1.0 µm, 1.0 to 1.25 µm, 1.25 to 2.5 µm, 2.5 to 6.0 µm, and 6.0 to 10.0 µm and these are also shown in Table 4. Note that if mill-specific measurements for PM_{10} and/or $PM_{2.5}$ were used instead, this would result in slightly different estimates for the breakdowns (as explained later). Finally, in EPA's CMAQ (Community Multi-scale Air Quality) database, filterable $PM_{2.5}$ has been split into elemental carbon and non-elemental carbon portions for kraft mill sources (recovery furnace, smelt dissolving tank, lime kiln). For these sources, the elemental carbon fraction of total $PM_{2.5}$ (filterable $PM_{2.5}$ + CPM) was reported as 0.0153, and the filterable, non-elemental carbon fraction of total $PM_{2.5}$ was reported as 0.3699. Thus, the elemental C fraction of filterable $PM_{2.5}$ for kraft mill sources is 0.0397 (0.0153 / {0.0153 + 0.3699}), or about 4%.

Table 4. Breakdown of PM Emissions from Kraft Recovery Sources – from Chapter 10.2 of AP-42

	Smelt Tank[1a]	Smelt Tank[1b]	Lime Kiln[2]	Lime Kiln[3]	DCE Furnace[4]	NDCE Furnace[4]
PM size, µm	Cumulative Mass % ≤ stated size					
15	89.9	95.3	98.9	91.2	no data	78.8
10	89.5	95.3	98.3	88.5	no data	74.8
6	88.4	94.3	98.2	86.5	68.2	71.9
2.5	81.3	85.2	96.0	83.0	53.8	67.3
1.25	63.5	63.8	85.0	70.2	40.5	51.3
1	54.7	54.2	78.9	62.9	34.2	42.4
0.625	38.7	34.2	54.3	46.9	22.2	29.6
Total	100.0	100.0	100.0	100.0	100.0	100.0
$PM_{6.0-10.0}$, as % of PM[6]	1.2%	0.9%	0.3%	7.0%	2.7%[5]	5.0%
$PM_{2.5-6.0}$, as % of PM[6]	8.1%	8.4%	7.6%	12.2%	13.8%	8.0%
$PM_{1.25-2.5}$, as % of PM[6]	15.9%	18.2%	8.8%	1.7%	9.9%	8.8%
$PM_{1.0-1.25}$, as % of PM[6]	7.9%	8.2%	4.9%	1.0%	4.7%	4.9%
$PM_{0.625-1.0}$, as % of PM[6]	14.3%	17.0%	19.7%	2.1%	9.0%	7.1%
$PM_{0.625}$, as % of PM[6]	34.6%	29.1%	43.4%	6.2%	16.6%	16.4%

[1a] smelt dissolving tank vent with venturi scrubber; [1b] smelt dissolving tank vent with packed tower; [2] lime kiln with venturi scrubber; [3] lime kiln with ESP; [4] kraft recovery furnace with ESP; [5] cumulative mass % for PM_{10} not available; assumed same ratio of PM_{10} to $PM_{6.0}$ as for NDCE furnaces; [6] these PM distributions (expressed as percent of total PM) are estimated based on the mean PM_{10} and $PM_{2.5}$ emissions shown in Tables 1, 2 and 3 (as % of total PM); note that they would be different if mill-specific PM_{10} and $PM_{2.5}$ measurements were used instead – see section on Excel Spreadsheet for further explanation

Sample Calculation – The following calculations show how a mill which has Method 5 PM data may use the information contained in this document to estimate the emission rates needed for BART modeling. Known: The total PM emissions from a DCE kraft recovery furnace are 1.0 lb/ton BLS.

From Table 2, the filterable PM_{10} *emissions from this furnace* $= 0.567 \times 1.0 = 0.567$ *lb/tbls*

and the filterable $PM_{2.5}$ *emissions* $= 0.402 \times 1.0 = 0.402$ *lb/tbls*

Thus, the PM_{coarse} *emissions* $= PM_{10} - PM_{2.5} = 0.567 - 0.402 = 0.165$ *lb/tbls*

From Table 4, PM_{coarse} *emissions that are* $PM_{2.5\text{-}6.0} = 0.138 \times 1.0 = 0.138$ *lb/tbls,*

and PM_{coarse} *emissions that are* $PM_{6.0\text{-}10.0} = 0.027 \times 1.0 = 0.027$ *lb/tbls*

The filterable $PM_{2.5}$ *emissions comprise both elemental carbon and non-elemental carbon emissions. The elemental carbon* $PM_{2.5}$ *emissions = 4% of total filterable* $PM_{2.5}$ *emissions* $= 0.04 \times 0.402$ *or* 0.016 *lb/tbls*

The non-elemental carbon filterable $PM_{2.5}$ *emissions = remaining 96% of filterable* $PM_{2.5}$ *emissions* $= 0.96 \times 0.402 = 0.386$ *lb/tbls*

From Table 4, further fractions of the non-carbon filterable $PM_{2.5}$ *emissions are estimated as follows:*

$PM_{0.625}$ *emissions* $= 0.96 \times 0.166 \times 1.0 = 0.159$ *lb/tbls*

$PM_{0.625\text{-}1.0}$ *emissions* $= 0.96 \times 0.09 \times 1.0 = 0.086$ *lb/tbls*

$PM_{1.0\text{-}1.25}$ *emissions* $= 0.96 \times 0.047 \times 1.0 = 0.045$ *lb/tbls*

$PM_{1.25\text{-}2.5}$ *emissions* $= 0.96 \times 0.099 \times 1.0 = 0.095$ *lb/tbls*

and further fractions of the elemental carbon $PM_{2.5}$ *emissions are estimated as follows (note- the non-carbon and elemental carbon filterable* $PM_{2.5}$ *emissions are assumed to have similar breakdowns):*

$PM_{0.625}$ *emissions* $= 0.04 \times 0.166 \times 1.0 = 0.0066$ *lb/tbls*

$PM_{0.625\text{-}1.0}$ *emissions* $= 0.04 \times 0.09 \times 1.0 = 0.0036$ *lb/tbls*

$PM_{1.0\text{-}1.25}$ *emissions* $= 0.04 \times 0.047 \times 1.0 = 0.0019$ *lb/tbls*

$PM_{1.25\text{-}2.5}$ *emissions* $= 0.04 \times 0.099 \times 1.0 = 0.0040$ *lb/tbls*

From Table 2, the total CPM emissions = 0.38 lb/tbls (note - CPM emissions are independent of PM emissions)

Also from Table 2, the organic CPM emissions $= 0.074 \times 0.38 = 0.028$ *lb/tbls*

the sulfate as H_2SO_4 *component of inorganic CPM emissions* $= 0.36 \times 0.38 = 0.137$ *lb/tbls*

and the rest of the inorganic CPM (non-sulfate)emissions $= 0.38 - 0.028 - 0.137 = 0.215$ *lb/tbls*

The calculated emission rates can be input into the CALPUFF model for determining visibility impacts.

Excel Spreadsheet Example Calculations

NCASI has prepared an excel spreadsheet that carries out the above calculations for all six categories of unit operations shown in Table 4. For a mill that has only PM data for a given unit operation, the spreadsheet estimates all the distributions as shown above using the mean PM_{10}, $PM_{2.5}$, and CPM values shown in Tables 1, 2 and 3 combined with the PM distributions shown in Table 4. The spreadsheet also allows a mill to input its own PM_{10} and $PM_{2.5}$ values, as also its own CPM, organic CPM and inorganic CPM as sulfate (H_2SO_4) values. The spreadsheet can be accessed at the NCASI website at http://www.ncasi.org/support/downloads/Detail.aspx?id=37. (A user name and password are required for access.)

References

National Council for Air and Stream Improvement, Inc. (NCASI). 2002. Performance of EPA stack sampling methods for PM_{10}, $PM_{2.5}$ and condensible particulate matter on sources equipped with electrostatic precipitators. Technical Bulletin No. 852. Research Triangle Park, NC: National Council for Air and Stream Improvement, Inc.

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———. 2006. $PM_{2.5}$ and condensible particulate matter emissions from kraft recovery furnaces and power boilers. Technical Bulletin in preparation. Research Triangle Park, NC: National Council for Air and Stream Improvement, Inc.

O'Connor, B., and Geneste, S. 2003. Development of PM_{10} and $PM_{2.5}$ stack emission factors for kraft mill smelt dissolving tanks and lime kilns with wet scrubbers. In Proceedings of the PAPTAC Pacwest Conference, Harrison Hot Springs, British Columbia, Canada, May 7-10.

Appendix A

The following tables provide detailed data for the PM emissions from smelt dissolving tanks, lime kilns and kraft recovery furnaces.

Table A1. Smelt Dissolving Tank Particulate Matter Emissions

Mill Code	Total In-Stack PM gr/dscf	PM_{10}	$PM_{2.5}$	Total CPM	Organic CPM		Inorganic CPM			
							Total		SO_4 as H_2SO_4	
		As % of PM		lb/t BLS	lb/t BLS	% of total	lb/t BLS	% of total	lb/t BLS	% of total
SDTA	0.0529	99.4%	86.7%	0.0401[2]						
SDTB	0.1632	96.6%	87.3%	0.1224[2]						
SDTC	0.1077	68.3%	64.6%	0.0584[2]						
SDTD	0.0540	62.0%	58.7%	0.0266[2]						
SDTE	0.0760			0.0306[2]						
SDTF	0.0160	91.0%	84.3%	0.0114[2]						
SDTG1	0.4237	70.7%	54.0%	0.2153[2]						
SDTG2	0.0758	85.2%	72.4%	0.0487[2]						
Mill A	0.0500			0.0020	0.0005	25.6%	0.0015	74.4%	0.0015	74.9%
Mill B	0.0400			0.0070	0.0018	26.0%	0.0052	74.0%	*0.0018*	*25.5%*
Mill C	0.0200			0.0080	0.0018	22.4%	0.0062	77.6%	*0.0014*	*17.0%*
Mill F1	0.0200			0.0060	0.0004	6.3%	0.0056	93.7%		
Mill F2	0.0200			0.0060	0.0002	2.9%	0.0058	97.1%		
Mill G	0.0400			0.0150	0.0076	50.4%	0.0074	49.6%		
SDTAD	0.72 lb/hr			0.0140						
SDTAE	0.0387			0.0010						
Mean	0.0799	81.9%	72.6%	0.0074	0.0020	27.8%[1]	0.0053	72.2%[1]	0.0015	27.3%[1]
Number	7	7	7	8[2]	6		6		3	

[1] The mean % for organic CPM is obtained by dividing the mean organic CPM in lb/t BLS by the mean of the corresponding set of total CPM in lb/t BLS - same for inorganic CPM (total and SO_4 as H_2SO_4).

[2] These Canadian mill CPM data were not developed using EPA Method 202; thus only the CPM data generated using M202 for the U.S. mill SDTs (Mills A, B, C, F1, F2, G, AD and AE) were included when estimating the mean. CPM emissions estimated using the modified dilution tunnel method in the Canadian SDT vents appear to be consistently higher than their U.S. counterparts by one to two orders of magnitude. Use of foul or dirty condensates in the Canadian mill SDT scrubbers with high levels of organics and ammonia is suspected.

Note – italicized entries denote non-detects shown at ½ detection limit

Table A2. DCE Kraft Recovery Furnace Particulate Matter Emissions

Mill Code	Total In-Stack PM gr/dscf	PM_{10}[1]	$PM_{2.5}$[1]	Total CPM	Organic CPM		Inorganic CPM			
							Total		SO_4 as H_2SO_4	
		As % of PM		lb/t BLS	lb/t BLS	% of total	lb/t BLS	% of total	lb/t BLS	% of total
B2RF	0.0118	51.3%	34.8%	0.6778	0.0404	6.0%	0.6373	94.0%	0.2428	35.8%
G1RF	0.0034	35.1%	24.3%	0.2080	0.0347	16.7%	0.1733	83.3%	0.0865	41.6%
C1	0.0250	67.2%	46.6%							
C8	0.0800	73.3%	55.1%							
A3RF	0.0061			0.2800	0.0112	4.0%	0.2688	96.0%	0.0860	30.7%
B1RF	0.0254			0.3731	0.0277	7.4%	0.3454	92.6%		
Mean	0.0253	56.7%	40.2%	0.3847	0.0285	7.4%[2]	0.3562	92.6%[2]	0.1384	36.0%[2]
Number	4	4	4	4	4		4		3	

[1] PM_{10} and $PM_{2.5}$ calculated as percent of total PM by adding 0.004 gr/dscf to total PM value; average PM_{10} and $PM_{2.5}$ values without such adjustment would be higher (75.0% and 52.9%, respecitively); [2] The mean % for organic CPM is obtained by dividing the mean organic CPM in lb/t BLS by the mean of the corresponding set of total CPM in lb/t BLS - same for inorganic CPM (total and SO_4 as H_2SO_4).

Table A3. NDCE Kraft Recovery Furnace Particulate Matter Emissions

Mill Code	Total In-Stack PM gr/dscf	PM_{10}[1]	$PM_{2.5}$[1]	Total CPM	Organic CPM		Inorganic CPM			
							Total		SO_4 as H_2SO_4	
		As % of PM		lb/t BLS	lb/t BLS	% of total	lb/t BLS	% of total	lb/t BLS	% of total
B3RF	0.0053	28.0%	19.4%	0.0579	0.0062	10.7%	0.0517	89.3%		
E1RF	0.0076	36.2%	29.3%						0.0970	
F1RF	0.0072	37.5%	30.4%	0.0684	0.0189	27.6%	0.0495	72.4%	0.0241	35.2%
RFAB	0.0074			0.0880						
RFAE	0.0023			0.1340						
RFAF	0.0030									
RFAH	0.0130			0.0470						
C1	0.0160	64.1%	34.7%							
C4	0.0634	69.1%	49.3%							
C6a	0.0468	83.0%	53.0%							
C6b	0.0118	70.3%	52.3%							
C11	0.0106	69.6%	59.1%							
C12	0.0033	27.5%	25.1%	0.0780						
C21	0.0162	17.3%	19.7%							
A4RF	0.0203			0.1538	0.0212	13.8%	0.1326	86.2%		
Mean	0.0156	50.2%	37.2%	0.0896	0.0154	16.5%[2]	0.0779	83.5%[2]	0.0605	35.2%[2]
Number	10	10	10	7	3		3		1	

[1] PM_{10} and $PM_{2.5}$ calculated as percent of total PM by adding 0.004 gr/dscf to total PM value; average PM_{10} and $PM_{2.5}$ values without such adjustment would be higher (67.8% and 51.0%, respectively); [2] The mean % for organic CPM is obtained by dividing the mean organic CPM in lb/t BLS by the mean of the corresponding set of total CPM in lb/t BLS - same for inorganic CPM (total and SO_4 as H_2SO_4).

Note – italicized entries denote non-detects shown at ½ detection limit

Table A4. Kraft Lime Kiln Particulate Matter Emissions

Mill Code	Total In-Stack PM gr/dscf	PM$_{10}$[1]	PM$_{2.5}$[1]	Total CPM lb/t CaO	Organic CPM lb/t CaO	Organic CPM % of total	Inorganic CPM Total lb/t CaO	Inorganic CPM Total % of total	Inorganic CPM SO$_4$ as H$_2$SO$_4$ lb/t CaO	Inorganic CPM SO$_4$ as H$_2$SO$_4$ % of total
		As % of PM								
Lime Kilns with ESPs										
A	0.0044	27.4%	9.5%	0.1748	0.0357	20.4%	0.1391	79.6%	0.0576	32.9%
E	0.0035	36.0%	16.0%	0.1979	0.0940	47.5%	0.1038	52.5%	0.0200	10.1%
G	0.0020	28.3%	23.3%	0.0565	0.0057	10.0%	0.0509	90.0%		
LKC1a	0.0014	8.4%	0.0%							
LKC1b	0.0015	18.7%	0.0%							
LKC6	0.0334	62.4%	17.0%							
LKC12				0.1789						
Mean	0.0077	30.2%	11.0%	0.1520	0.0451	31.5%[2]	0.0979	68.5%[2]	0.0388	20.8%[2]
Number	6	6	6	4	3		3		2	
Lime Kilns with Wet Scrubbers										
LKA1	0.0581	79.9%	78.0%	0.1494						
LKA2	0.0837	93.0%	91.0%	0.2507						
LKAB	0.0588	102.4%	95.9%	0.1897						
LKAC1	0.0476	92.1%	85.5%	0.1378						
LKAC2	0.1127	70.7%	50.1%	0.2217						
LKAE	0.0719			0.0663						
LKAH	0.0531	70.2%	60.5%	0.1130						
Mill C	0.0430			0.0700	0.0024	3.4%	0.0676	96.6%	0.0429	61.3%
Mill E	0.1640			0.0300	0.0044	14.6%	0.0256	85.4%	*0.0153*	*51.0%*
Mill F	0.0678			0.0200	0.0033	16.3%	0.0167	83.7%		
Mill H	0.0413			0.4532						
Mean	0.0729	84.7%	76.8%	0.1547	0.0033	8.3%[2]	0.0367	91.7%[2]	0.0291	58.2%[2]
Number	11	6	6	11		3		3		2
Lime Kilns with Wet Scrubber and ESP										
Mill D	0.0030			0.0700					0.0370	51.0%
Mill G	0.0033			0.1614	0.0887	54.9%	0.0728	45.1%		
Mean	0.0032			0.1157	0.0887	54.9%[2]	0.0728	45.1%[2]	0.0370	51.0%[2]
Number	2			2	1		1		1	

[1] For lime kilns with ESPs, PM$_{10}$ and PM$_{2.5}$ is calculated as percent of total PM by adding 0.004 gr/dscf to total PM value; average PM$_{10}$ and PM$_{2.5}$ values without such adjustment would be higher (64.2% for mean and 23.6% for median); [2] The mean % for organic CPM is obtained by dividing the mean organic CPM in lb/t CaO by the mean of the corresponding set of total CPM in lb/t CaO - same for inorganic CPM (total and SO$_4$ as H$_2$SO$_4$).

Note – italicized entries denote non-detects shown at ½ detection limit

APPENDIX C

EXAMPLE CALPUFF INPUT FILE

```
EXAMPLE FACILITY XYZ - CALPUFF
IMPACTS AT SOURCE-SPECIFIC CLASS I AREAS
4-km FLORIDA DOMAIN (VISTAS REFINED DOMAIN 2), 2001
---------------- Run title (3 lines) ------------------------------------------

                    CALPUFF MODEL CONTROL FILE
                    --------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names

--------------
Default Name  Type          File Name
------------  ----          ---------
CALMET.DAT    input    * METDAT =             *
    or
ISCMET.DAT    input    * ISCDAT =             *
    or
PLMMET.DAT    input    * PLMDAT =             *
    or
PROFILE.DAT   input    * PRFDAT =             *
SURFACE.DAT   input    * SFCDAT =             *
RESTARTB.DAT  input    * RSTARTB=             *
--------------------------------------------------------------------------------
CALPUFF.LST   output   ! PUFLST = PUFFEXP.LST !
CONC.DAT      output   ! CONDAT = PUFFEXP.CON !
DFLX.DAT      output   * DFDAT  =             *
WFLX.DAT      output   * WFDAT  =             *

VISB.DAT      output   * VISDAT =             *
TK2D.DAT      output   * T2DDAT =             *
RHO2D.DAT     output   * RHODAT =             *
RESTARTE.DAT  output   * RSTARTE=             *
--------------------------------------------------------------------------------
Emission Files
--------------
PTEMARB.DAT   input    * PTDAT  =             *
VOLEMARB.DAT  input    * VOLDAT =             *
BAEMARB.DAT   input    * ARDAT  =             *
LNEMARB.DAT   input    * LNDAT  =             *
--------------------------------------------------------------------------------
Other Files
-----------
OZONE.DAT     input    ! OZDAT  =C:\BARTHRO3\2001FLOz.DAT !
VD.DAT        input    * VDDAT  =             *
CHEM.DAT      input    * CHEMDAT=             *
H2O2.DAT      input    * H2O2DAT=             *
HILL.DAT      input    * HILDAT=             *
HILLRCT.DAT   input    * RCTDAT=             *
COASTLN.DAT   input    * CSTDAT=             *
FLUXBDY.DAT   input    * BDYDAT=             *
BCON.DAT      input    * BCNDAT=             *
DEBUG.DAT     output   * DEBUG =             *
MASSFLX.DAT   output   * FLXDAT=             *
MASSBAL.DAT   output   * BALDAT=             *
FOG.DAT       output   * FOGDAT=             *
--------------------------------------------------------------------------------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
         T = lower case      ! LCFILES = T !
         F = UPPER CASE
NOTE: (1) file/path names can be up to 70 characters in length


Provision for multiple input files
----------------------------------

     Number of CALMET.DAT files for run (NMETDAT)
                                Default: 1       ! NMETDAT =  36  !

     Number of PTEMARB.DAT files for run (NPTDAT)
                                Default: 0       ! NPTDAT =  0  !

     Number of BAEMARB.DAT files for run (NARDAT)
```

```
                                 Default: 0       ! NARDAT =  0  !

     Number of VOLEMARB.DAT files for run (NVOLDAT)
                                 Default: 0       ! NVOLDAT =  0  !

!END!

-------------
Subgroup (0a)
-------------

  The following CALMET.DAT filenames are processed in sequence if NMETDAT>1

Default Name  Type          File Name
------------  ----          ---------
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-01A.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-01B.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-01C.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-02A.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-02B.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-02C.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-03A.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-03B.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-03C.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-04A.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-04B.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-04C.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-05A.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-05B.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-05C.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-06A.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-06B.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-06C.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-07A.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-07B.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-07C.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-08A.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-08B.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-08C.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-09A.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-09B.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-09C.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-10A.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-10B.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-10C.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-11A.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-11B.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-11C.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-12A.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-12B.DAT ! !END!
CALMET.DAT    input    ! METDAT =E:\FLA4KM\2001\MET2001-DOM2-12C.DAT ! !END!
-------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

    Option to run all periods found
    in the met. file      (METRUN)   Default: 0       ! METRUN =   0  !

         METRUN = 0 - Run period explicitly defined below
         METRUN = 1 - Run all periods in met. file

     Starting date:   Year (IBYR) -- No default       ! IBYR =  2001  !
     (used only if   Month (IBMO) -- No default       ! IBMO =  1   !
      METRUN = 0)      Day (IBDY) -- No default       ! IBDY =  1   !
                      Hour (IBHR) -- No default       ! IBHR =  1   !

     Base time zone         (XBTZ) -- No default       ! XBTZ = 5.0  !
        PST = 8., MST = 7.
        CST = 6., EST = 5.

     Length of run (hours) (IRLG) -- No default       ! IRLG = 8760 !

     Number of chemical species (NSPEC)
                                 Default: 5       ! NSPEC = 11   !
```

```
     Number of chemical species
     to be emitted  (NSE)           Default: 3        ! NSE = 9   !

     Flag to stop run after
     SETUP phase (ITEST)            Default: 2        ! ITEST =  2   !
     (Used to allow checking
     of the model inputs, files, etc.)
           ITEST = 1 - STOPS program after SETUP phase
           ITEST = 2 - Continues with execution of program
                       after SETUP

     Restart Configuration:

        Control flag (MRESTART)     Default: 0        ! MRESTART =  0   !

           0 = Do not read or write a restart file
           1 = Read a restart file at the beginning of
               the run
           2 = Write a restart file during run
           3 = Read a restart file at beginning of run
               and write a restart file during run

        Number of periods in Restart
        output cycle (NRESPD)       Default: 0        ! NRESPD =  0   !

           0 = File written only at last period
          >0 = File updated every NRESPD periods

     Meteorological Data Format (METFM)
                                    Default: 1        ! METFM =  1   !

           METFM = 1 - CALMET binary file (CALMET.MET)
           METFM = 2 - ISC ASCII file (ISCMET.MET)
           METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
           METFM = 4 - CTDM plus tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)

     PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2
     Averaging Time (minutes) (AVET)
                                    Default: 60.0     ! AVET = 60. !
     PG Averaging Time (minutes) (PGTIME)
                                    Default: 60.0     ! PGTIME = 60. !


!END!


-------------------------------------------------------------------------------

INPUT GROUP: 2 -- Technical options
--------------


     Vertical distribution used in the
     near field (MGAUSS)                  Default: 1     ! MGAUSS =  1   !
        0 = uniform
        1 = Gaussian

     Terrain adjustment method
     (MCTADJ)                             Default: 3     ! MCTADJ =  3   !
        0 = no adjustment
        1 = ISC-type of terrain adjustment
        2 = simple, CALPUFF-type of terrain
            adjustment
        3 = partial plume path adjustment

     Subgrid-scale complex terrain
     flag (MCTSG)                         Default: 0     ! MCTSG =  0   !
        0 = not modeled
        1 = modeled

     Near-field puffs modeled as
     elongated 0 (MSLUG)                  Default: 0     ! MSLUG =  0   !
        0 = no
```

```
   1 = yes (slug model used)

Transitional plume rise modeled ?
(MTRANS)                              Default: 1      ! MTRANS =  1   !
   0 = no  (i.e., final rise only)
   1 = yes (i.e., transitional rise computed)

Stack tip downwash? (MTIP)            Default: 1      ! MTIP =  1  !
   0 = no  (i.e., no stack tip downwash)
   1 = yes (i.e., use stack tip downwash)

Vertical wind shear modeled above
stack top? (MSHEAR)                   Default: 0      ! MSHEAR =  0  !
   0 = no  (i.e., vertical wind shear not modeled)
   1 = yes (i.e., vertical wind shear modeled)

Puff splitting allowed? (MSPLIT)      Default: 0      ! MSPLIT =  0  !
   0 = no (i.e., puffs not split)
   1 = yes (i.e., puffs are split)

Chemical mechanism flag (MCHEM)       Default: 1      ! MCHEM =  1   !
   0 = chemical transformation not
       modeled
   1 = transformation rates computed
       internally (MESOPUFF II scheme)
   2 = user-specified transformation
       rates used
   3 = transformation rates computed
       internally (RIVAD/ARM3 scheme)
   4 = secondary organic aerosol formation
       computed (MESOPUFF II scheme for OH)

Aqueous phase transformation flag (MAQCHEM)
(Used only if MCHEM = 1, or 3)        Default: 0      ! MAQCHEM =  0   !
   0 = aqueous phase transformation
       not modeled
   1 = transformation rates adjusted
       for aqueous phase reactions

Wet removal modeled ? (MWET)          Default: 1      ! MWET =  1   !
   0 = no
   1 = yes

Dry deposition modeled ? (MDRY)       Default: 1      ! MDRY =  1   !
   0 = no
   1 = yes
   (dry deposition method specified
    for each species in Input Group 3)

Method used to compute dispersion
coefficients (MDISP)                  Default: 3      ! MDISP =  3   !

   1 = dispersion coefficients computed from measured values
       of turbulence, sigma v, sigma w
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.
   5 = CTDM sigmas used for stable and neutral conditions.
       For unstable conditions, sigmas are computed as in
       MDISP = 3, described above.  MDISP = 5 assumes that
       measured values are read

Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
(Used only if MDISP = 1 or 5)         Default: 3      ! MTURBVW =  3  !
   1 = use sigma-v or sigma-theta measurements
       from PROFILE.DAT to compute sigma-y
       (valid for METFM = 1, 2, 3, 4)
   2 = use sigma-w measurements
       from PROFILE.DAT to compute sigma-z
       (valid for METFM = 1, 2, 3, 4)
```

```
   3 = use both sigma-(v/theta) and sigma-w
       from PROFILE.DAT to compute sigma-y and sigma-z
       (valid for METFM = 1, 2, 3, 4)
   4 = use sigma-theta measurements
       from PLMMET.DAT to compute sigma-y
       (valid only if METFM = 3)

Back-up method used to compute dispersion
when measured turbulence data are
missing (MDISP2)                      Default: 3     ! MDISP2 =  3  !
(used only if MDISP = 1 or 5)
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.

PG sigma-y,z adj. for roughness?      Default: 0     ! MROUGH =  0  !
(MROUGH)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTL =  1  !
elevated inversion?
(MPARTL)
   0 = no
   1 = yes

Strength of temperature inversion     Default: 0     ! MTINV =  0  !
provided in PROFILE.DAT extended records?
(MTINV)
   0 = no (computed from measured/default gradients)
   1 = yes

PDF used for dispersion under convective conditions?
                                      Default: 0     ! MPDF =  0  !
(MPDF)
   0 = no
   1 = yes

Sub-Grid TIBL module used for shore line?
                                      Default: 0     ! MSGTIBL = 0  !
(MSGTIBL)
   0 = no
   1 = yes

Boundary conditions (concentration) modeled?
                                      Default: 0     ! MBCON = 0  !
(MBCON)
   0 = no
   1 = yes


Analyses of fogging and icing impacts due to emissions from
arrays of mechanically-forced cooling towers can be performed
using CALPUFF in conjunction with a cooling tower emissions
processor (CTEMISS) and its associated postprocessors.  Hourly
emissions of water vapor and temperature from each cooling tower
cell are computed for the current cell configuration and ambient
conditions by CTEMISS. CALPUFF models the dispersion of these
emissions and provides cloud information in a specialized format
for further analysis. Output to FOG.DAT is provided in either
'plume mode' or 'receptor mode' format.

Configure for FOG Model output?
                                      Default: 0     ! MFOG =  0   !
(MFOG)
   0 = no
   1 = yes  - report results in PLUME Mode format
   2 = yes  - report results in RECEPTOR Mode format
```

```
     Test options specified to see if
     they conform to regulatory
     values? (MREG)                         Default: 1      ! MREG =  1   !

        0 = NO checks are made
        1 = Technical options must conform to USEPA
            Long Range Transport (LRT) guidance
                       METFM     1 or 2
                       AVET      60. (min)
                       PGTIME    60. (min)
                       MGAUSS    1
                       MCTADJ    3
                       MTRANS    1
                       MTIP      1
                       MCHEM     1 or 3 (if modeling SOx, NOx)
                       MWET      1
                       MDRY      1
                       MDISP     2 or 3
                       MPDF      0 if MDISP=3
                                 1 if MDISP=2
                       MROUGH    0
                       MPARTL    1
                       SYTDEP    550. (m)
                       MHFTSZ    0


!END!


-------------------------------------------------------------------------------

INPUT GROUP: 3a, 3b -- Species list
-------------------

------------
Subgroup (3a)
------------

  The following species are modeled:

! CSPEC =          SO2 !         !END!
! CSPEC =          SO4 !         !END!
! CSPEC =          NOX !         !END!
! CSPEC =         HNO3 !         !END!
! CSPEC =          NO3 !         !END!
! CSPEC =       PM0063 !         !END!
! CSPEC =       PM0100 !         !END!
! CSPEC =       PM0125 !         !END!
! CSPEC =       PM0250 !         !END!
! CSPEC =       PM0600 !         !END!
! CSPEC =       PM1000 !         !END!

                                                              Dry                 OUTPUT GROUP
    SPECIES          MODELED          EMITTED          DEPOSITED              NUMBER
     NAME         (0=NO, 1=YES)    (0=NO, 1=YES)    (0=NO,                 (0=NONE,
   (Limit: 12                                        1=COMPUTED-GAS        1=1st CGRUP,
    Characters                                       2=COMPUTED-PARTICLE   2=2nd CGRUP,
    in length)                                       3=USER-SPECIFIED)     3= etc.)

!        SO2  =         1,               1,            1,                  0    !
!        SO4  =         1,               1,            2,                  0    !
!        NOX  =         1,               1,            1,                  0    !
!       HNO3  =         1,               0,            1,                  0    !
!        NO3  =         1,               0,            2,                  0    !
!     PM0063  =         1,               1,            2,                  1    !
!     PM0100  =         1,               1,            2,                  1    !
!     PM0125  =         1,               1,            2,                  1    !
!     PM0250  =         1,               1,            2,                  1    !
!     PM0600  =         1,               1,            2,                  1    !
!     PM1000  =         1,               1,            2,                  1    !

!END!

-------------
Subgroup (3b)
```

```
-------------
  The following names are used for Species-Groups in which results
  for certain species are combined (added) prior to output.  The
  CGRUP name will be used as the species name in output files.
  Use this feature to model specific particle-size distributions
  by treating each size-range as a separate species.
  Order must be consistent with 3(a) above.

! CGRUP =          PM10 !     !END!

INPUT GROUP: 4 -- Map Projection and Grid control parameters
--------------

     Projection for all (X,Y):
     -------------------------

     Map projection
     (PMAP)                     Default: UTM     ! PMAP = LCC  !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
          PS :  Polar Stereographic
          EM :  Equatorial Mercator
        LAZA :  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
     (FEAST)                    Default=0.0      ! FEAST  = 0.000  !
     (FNORTH)                   Default=0.0      ! FNORTH = 0.000  !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                   No Default       ! IUTMZN =  0 !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                   Default: N       ! UTMHEM = N  !
         N   :  Northern hemisphere projection
         S   :  Southern hemisphere projection

     Latitude and Longitude (decimal degrees) of projection origin
     (Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
     (RLAT0)                    No Default       ! RLAT0 =  40N !
     (RLON0)                    No Default       ! RLON0 =  97W !

         TTM :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         LCC :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         PS  :  RLON0 identifies central (grid N/S) meridian of projection
                RLAT0 selected for convenience
         EM  :  RLON0 identifies central meridian of projection
                RLAT0 is REPLACED by 0.0N (Equator)
         LAZA:  RLON0 identifies longitude of tangent-point of mapping plane
                RLAT0 identifies latitude of tangent-point of mapping plane

     Matching parallel(s) of latitude (decimal degrees) for projection
     (Used only if PMAP= LCC or PS)
     (XLAT1)                    No Default       ! XLAT1 = 33N  !
     (XLAT2)                    No Default       ! XLAT2 = 45N  !

         LCC :  Projection cone slices through Earth's surface at XLAT1 and XLAT2
         PS  :  Projection plane slices through Earth at XLAT1
                (XLAT2 is not used)

     ----------
     Note:  Latitudes and longitudes should be positive, and include a
            letter N,S,E, or W indicating north or south latitude, and
            east or west longitude.  For example,
            35.9  N Latitude  =  35.9N
            118.7 E Longitude = 118.7E


     Datum-region
```

```
     ------------

     The Datum-Region for the coordinates is identified by a character
     string.  Many mapping products currently available use the model of the
     Earth known as the World Geodetic System 1984 (WGS-84).  Other local
     models may be in use, and their selection in CALMET will make its output
     consistent with local mapping products.  The list of Datum-Regions with
     official transformation parameters is provided by the National Imagery and
     Mapping Agency (NIMA).

     NIMA Datum - Regions(Examples)
     ------------------------------------------------------------------------------
     WGS-84    WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
     NAS-C     NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
     NAR-C     NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
     NWS-84    NWS 6370KM Radius, Sphere
     ESR-S     ESRI REFERENCE 6371KM Radius, Sphere

     Datum-region for output coordinates
     (DATUM)                    Default: WGS-G     ! DATUM = NWS-84 !


METEOROLOGICAL Grid:

     Rectangular grid defined for projection PMAP,
     with X the Easting and Y the Northing coordinate

            No. X grid cells (NX)      No default     ! NX = 263   !
            No. Y grid cells (NY)      No default     ! NY = 206    !
         No. vertical layers (NZ)      No default     ! NZ =  10   !

           Grid spacing (DGRIDKM)      No default     ! DGRIDKM = 4. !
                                       Units: km

                Cell face heights
                    (ZFACE(nz+1))      No defaults
                                       Units: m
        ! ZFACE = 0.,20.,40.,80.,160.,320.,640.,1200.,2000.,3000.,4000. !

            Reference Coordinates
           of SOUTHWEST corner of
                 grid cell(1, 1):

            X coordinate (XORIGKM)     No default     ! XORIGKM =  721.995 !
            Y coordinate (YORIGKM)     No default     ! YORIGKM = -1598.000 !
                                      Units: km


COMPUTATIONAL Grid:

     The computational grid is identical to or a subset of the MET. grid.
     The lower left (LL) corner of the computational grid is at grid point
     (IBCOMP, JBCOMP) of the MET. grid.  The upper right (UR) corner of the
     computational grid is at grid point (IECOMP, JECOMP) of the MET. grid.
     The grid spacing of the computational grid is the same as the MET. grid.

        X index of LL corner (IBCOMP)      No default     ! IBCOMP =  1  !
                  (1 <= IBCOMP <= NX)

        Y index of LL corner (JBCOMP)      No default     ! JBCOMP =  1  !
                  (1 <= JBCOMP <= NY)


        X index of UR corner (IECOMP)      No default     ! IECOMP = 263 !
                  (1 <= IECOMP <= NX)

        Y index of UR corner (JECOMP)      No default     ! JECOMP = 206 !
                  (1 <= JECOMP <= NY)


SAMPLING Grid (GRIDDED RECEPTORS):

     The lower left (LL) corner of the sampling grid is at grid point
     (IBSAMP, JBSAMP) of the MET. grid.  The upper right (UR) corner of the
```

```
     sampling grid is at grid point (IESAMP, JESAMP) of the MET. grid.
     The sampling grid must be identical to or a subset of the computational
     grid.  It may be a nested grid inside the computational grid.
     The grid spacing of the sampling grid is DGRIDKM/MESHDN.

        Logical flag indicating if gridded
        receptors are used (LSAMP)          Default: T     ! LSAMP = F !
        (T=yes, F=no)

        X index of LL corner (IBSAMP)       No default     ! IBSAMP =  1   !
         (IBCOMP <= IBSAMP <= IECOMP)

        Y index of LL corner (JBSAMP)       No default     ! JBSAMP =  1   !
         (JBCOMP <= JBSAMP <= JECOMP)


        X index of UR corner (IESAMP)       No default     ! IESAMP =  263 !
         (IBCOMP <= IESAMP <= IECOMP)

        Y index of UR corner (JESAMP)       No default     ! JESAMP =  206 !
         (JBCOMP <= JESAMP <= JECOMP)


       Nesting factor of the sampling
        grid (MESHDN)                       Default: 1     ! MESHDN =  1  !
        (MESHDN is an integer >= 1)

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 5 -- Output Options
--------------
                                             *                            *
     FILE                        DEFAULT VALUE             VALUE THIS RUN
     ----                        -------------             --------------

   Concentrations (ICON)              1                    !  ICON =  1   !
   Dry Fluxes (IDRY)                  1                    !  IDRY =  0   !
   Wet Fluxes (IWET)                  1                    !  IWET =  0   !
   Relative Humidity (IVIS)           1                    !  IVIS =  0   !
    (relative humidity file is
     required for visibility
     analysis)
   Use data compression option in output file?
   (LCOMPRS)                            Default: T         ! LCOMPRS = T !

   *
    0 = Do not create file, 1 = create file


    DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:

       Mass flux across specified boundaries
       for selected species reported hourly?
       (IMFLX)                          Default: 0         ! IMFLX =  0  !
         0 = no
         1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames
                  are specified in Input Group 0)

       Mass balance for each species
       reported hourly?
       (IMBAL)                          Default: 0         ! IMBAL =  0  !
         0 = no
         1 = yes (MASSBAL.DAT filename is
              specified in Input Group 0)


    LINE PRINTER OUTPUT OPTIONS:

       Print concentrations (ICPRT)     Default: 0         ! ICPRT =  0   !
       Print dry fluxes (IDPRT)         Default: 0         ! IDPRT =  0   !
       Print wet fluxes (IWPRT)         Default: 0         ! IWPRT =  0   !
```

```
           (0 = Do not print, 1 = Print)

           Concentration print interval
           (ICFRQ) in hours                Default: 1         ! ICFRQ =  24  !
           Dry flux print interval
           (IDFRQ) in hours                Default: 1         ! IDFRQ =  1   !
           Wet flux print interval
           (IWFRQ) in hours                Default: 1         ! IWFRQ =  1   !

           Units for Line Printer Output
           (IPRTU)                         Default: 1         ! IPRTU =  3   !
                          for            for
                     Concentration    Deposition
               1 =      g/m**3         g/m**2/s
               2 =     mg/m**3        mg/m**2/s
               3 =     ug/m**3        ug/m**2/s
               4 =     ng/m**3        ng/m**2/s
               5 =    Odour Units

           Messages tracking progress of run
           written to the screen ?
           (IMESG)                         Default: 2         ! IMESG =  2   !
             0 = no
             1 = yes (advection step, puff ID)
             2 = yes (YYYYJJJHH, # old puffs, # emitted puffs)


         SPECIES (or GROUP for combined species) LIST FOR OUTPUT OPTIONS

                   ---- CONCENTRATIONS ----   ------ DRY FLUXES ------   ------ WET FLUXES ------   --
MASS FLUX --
   SPECIES
   /GROUP          PRINTED?  SAVED ON DISK?   PRINTED?  SAVED ON DISK?   PRINTED?  SAVED ON DISK?   SAVED
ON DISK?
   -------         ------------------------   ------------------------   ------------------------   ------
---------
!         SO2 =       0,           1,            0,           1,            0,           1,            0   !
!         SO4 =       0,           1,            0,           1,            0,           1,            0   !
!         NOX =       0,           1,            0,           1,            0,           1,            0   !
!        HNO3 =       0,           1,            0,           1,            0,           1,            0   !
!         NO3 =       0,           1,            0,           1,            0,           1,            0   !
!        PM10 =       0,           1,            0,           1,            0,           1,            0   !

         OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

           Logical for debug output
           (LDEBUG)                                 Default: F     ! LDEBUG = F !

           First puff to track
           (IPFDEB)                                 Default: 1     ! IPFDEB =  1  !

           Number of puffs to track
           (NPFDEB)                                 Default: 1     ! NPFDEB =  1  !

           Met. period to start output
           (NN1)                                    Default: 1     ! NN1 =  1   !

           Met. period to end output
           (NN2)                                    Default: 10    ! NN2 =  10  !

!END!


-------------------------------------------------------------------------------


INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs
-------------------------


---------------
Subgroup (6a)
---------------
           Number of terrain features (NHILL)       Default: 0     ! NHILL =  0   !

           Number of special complex terrain
```

```
        receptors  (NCTREC)                       Default: 0      ! NCTREC =  0   !

        Terrain and CTSG Receptor data for
        CTSG hills input in CTDM format ?
        (MHILL)                                   No Default      ! MHILL =  2   !
        1 = Hill and Receptor data created
            by CTDM processors & read from
            HILL.DAT and HILLRCT.DAT files
        2 = Hill data created by OPTHILL &
            input below in Subgroup (6b);
            Receptor data in Subgroup (6c)

        Factor to convert horizontal dimensions   Default: 1.0    ! XHILL2M = 1. !
        to meters (MHILL=1)

        Factor to convert vertical dimensions     Default: 1.0    ! ZHILL2M = 1. !
        to meters (MHILL=1)

        X-origin of CTDM system relative to       No Default      ! XCTDMKM = 0.0E00 !
        CALPUFF coordinate system, in Kilometers  (MHILL=1)

        Y-origin of CTDM system relative to       No Default      ! YCTDMKM = 0.0E00 !
        CALPUFF coordinate system, in Kilometers  (MHILL=1)

! END !

---------------
Subgroup (6b)
---------------

                          1 **
     HILL information


HILL          XC         YC        THETAH  ZGRID  RELIEF    EXPO 1    EXPO 2   SCALE 1    SCALE 2
AMAX1     AMAX2
 NO.          (km)       (km)      (deg.)   (m)     (m)       (m)       (m)       (m)        (m)        (m)
(m)
----          ----       ----      ------  -----  ------    ------    ------   -------    -------    ----
-     -----

---------------
Subgroup (6c)
---------------

    COMPLEX TERRAIN RECEPTOR INFORMATION

                        XRCT         YRCT        ZRCT          XHH
                        (km)         (km)         (m)
                       ------        -----       ------        ----


-------------------
1
     Description of Complex Terrain Variables:
          XC, YC  = Coordinates of center of hill
          THETAH  = Orientation of major axis of hill (clockwise from
                    North)
          ZGRID   = Height of the  0  of the grid above mean sea
                    level
          RELIEF  = Height of the crest of the hill above the grid elevation
          EXPO 1  = Hill-shape exponent for the major axis
          EXPO 2  = Hill-shape exponent for the major axis
          SCALE 1 = Horizontal length scale along the major axis
          SCALE 2 = Horizontal length scale along the minor axis
          AMAX    = Maximum allowed axis length for the major axis
          BMAX    = Maximum allowed axis length for the major axis

          XRCT, YRCT = Coordinates of the complex terrain receptors
          ZRCT    = Height of the ground (MSL) at the complex terrain
                    Receptor
          XHH     = Hill number associated with each complex terrain receptor
                     (NOTE: MUST BE ENTERED AS A REAL NUMBER)

    **
```

```
     NOTE: DATA for each hill and CTSG receptor are treated as a separate
           input subgroup and therefore must end with an input group terminator.

-------------------------------------------------------------------------------


INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases
--------------

      SPECIES     DIFFUSIVITY     ALPHA STAR     REACTIVITY    MESOPHYLL RESISTANCE     HENRY'S LAW
COEFFICIENT
       NAME        (cm**2/s)                                          (s/cm)
(dimensionless)
      -------     -----------     ----------     ----------    --------------------     -------------
---------

!          SO2 =     0.1509,          1000,             8,                  0,               0.04 !
!          NOX =     0.1656,             1,             8,                  5,                3.5 !
!         HNO3 =     0.1628,             1,            18,                  0,         0.00000008 !

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 8 -- Size parameters for dry deposition of particles
--------------

     For SINGLE SPECIES, the mean and standard deviation are used to
     compute a deposition velocity for NINT (see group 9) size-ranges,
     and these are then averaged to obtain a mean deposition velocity.

     For GROUPED SPECIES, the size distribution should be explicitly
     specified (by the 'species' in the group), and the standard deviation
     for each should be entered as 0.  The model will then use the
     deposition velocity for the stated mean diameter.

      SPECIES      GEOMETRIC MASS MEAN        GEOMETRIC STANDARD
       NAME              DIAMETER                 DEVIATION
                         (microns)                (microns)
      -------      -------------------        -----------------
!          SO4 =          0.48,                    2.   !
!          NO3 =          0.48,                    2.   !
!       PM0063 =          0.63,                    0.   !
!       PM0100 =          1.00,                    0.   !
!       PM0125 =          1.25,                    0.   !
!       PM0250 =          2.50,                    0.   !
!       PM0600 =          6.00,                    0.   !
!       PM1000 =         10.00,                    0.   !

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 9 -- Miscellaneous dry deposition parameters
--------------

     Reference cuticle resistance (s/cm)
     (RCUTR)                           Default: 30     !  RCUTR = 30.0 !
     Reference ground resistance  (s/cm)
     (RGR)                             Default: 10     !    RGR = 10.0 !
     Reference pollutant reactivity
     (REACTR)                          Default: 8      ! REACTR = 8.0 !

     Number of particle-size intervals used to
     evaluate effective particle deposition velocity
     (NINT)                            Default: 9      !   NINT =  9   !

     Vegetation state in unirrigated areas
     (IVEG)                            Default: 1      !   IVEG =  1    !
        IVEG=1 for active and unstressed vegetation
        IVEG=2 for active and stressed vegetation
```

```
        IVEG=3 for inactive vegetation

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 10 -- Wet Deposition Parameters
---------------

                      Scavenging Coefficient -- Units: (sec)**(-1)

       Pollutant      Liquid Precip.       Frozen Precip.
       ---------      --------------       --------------
!          SO2 =         3.0E-05,              0.0E00 !
!          SO4 =         1.0E-04,             3.0E-05 !
!         HNO3 =         6.0E-05,              0.0E00 !
!          NO3 =         1.0E-04,             3.0E-05 !
!       PM0063 =         1.0E-04,             3.0E-05 !
!       PM0100 =         1.0E-04,             3.0E-05 !
!       PM0125 =         1.0E-04,             3.0E-05 !
!       PM0250 =         1.0E-04,             3.0E-05 !
!       PM0600 =         1.0E-04,             3.0E-05 !
!       PM1000 =         1.0E-04,             3.0E-05 !

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 11 -- Chemistry Parameters
---------------

     Ozone data input option (MOZ)     Default: 1            ! MOZ =   1   !
     (Used only if MCHEM = 1, 3, or 4)
        0 = use a monthly background ozone value
        1 = read hourly ozone concentrations from
            the OZONE.DAT data file

     Monthly ozone concentrations
     (Used only if MCHEM = 1, 3, or 4 and
      MOZ = 0 or MOZ = 1 and all hourly O3 data missing)
     (BCKO3) in ppb                    Default: 12*80.
     !  BCKO3 = 12*50. !

     Monthly ammonia concentrations
     (Used only if MCHEM = 1, or 3)
     (BCKNH3) in ppb                   Default: 12*10.
     !  BCKNH3 = 12*0.5 !

     Nighttime SO2 loss rate (RNITE1)
     in percent/hour                   Default: 0.2          ! RNITE1 = .2 !

     Nighttime NOx loss rate (RNITE2)
     in percent/hour                   Default: 2.0          ! RNITE2 = 2.0 !

     Nighttime HNO3 formation rate (RNITE3)
     in percent/hour                   Default: 2.0          ! RNITE3 = 2.0 !

     H2O2 data input option (MH2O2)    Default: 1            ! MH2O2 =   1   !
     (Used only if MAQCHEM = 1)
        0 = use a monthly background H2O2 value
        1 = read hourly H2O2 concentrations from
            the H2O2.DAT data file

     Monthly H2O2 concentrations
     (Used only if MQACHEM = 1 and
      MH2O2 = 0 or MH2O2 = 1 and all hourly H2O2 data missing)
     (BCKH2O2) in ppb                  Default: 12*1.
     !  BCKH2O2 = 12*1 !
```

```
 --- Data for SECONDARY ORGANIC AEROSOL (SOA) Option
     (used only if MCHEM = 4)

     The SOA module uses monthly values of:
          Fine particulate concentration in ug/m^3 (BCKPMF)
          Organic fraction of fine particulate     (OFRAC)
          VOC / NOX ratio (after reaction)         (VCNX)
     to characterize the air mass when computing
     the formation of SOA from VOC emissions.
     Typical values for several distinct air mass types are:

        Month    1    2    3    4    5    6    7    8    9   10   11   12
                Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

     Clean Continental
        BCKPMF   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
        OFRAC  .15  .15  .20  .20  .20  .20  .20  .20  .20  .20  .20  .15
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Clean Marine (surface)
        BCKPMF  .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5
        OFRAC  .25  .25  .30  .30  .30  .30  .30  .30  .30  .30  .30  .25
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Urban - low biogenic (controls present)
        BCKPMF  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.
        OFRAC  .20  .20  .25  .25  .25  .25  .25  .25  .20  .20  .20  .20
        VCNX     4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.

     Urban - high biogenic (controls present)
        BCKPMF  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.
        OFRAC  .25  .25  .30  .30  .30  .55  .55  .55  .35  .35  .35  .25
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

     Regional Plume
        BCKPMF  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.
        OFRAC  .20  .20  .25  .35  .25  .40  .40  .40  .30  .30  .30  .20
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

     Urban - no controls present
        BCKPMF 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.
        OFRAC  .30  .30  .35  .35  .35  .55  .55  .55  .35  .35  .35  .30
        VCNX     2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.

     Default: Clean Continental
     !  BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00 !
     !  OFRAC  = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.15 !
     !  VCNX   = 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00 !

!END!

-----------------------------------------------------------------------------

INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters
---------------

     Horizontal size of puff (m) beyond which
     time-dependent dispersion equations (Heffter)
     are used to determine sigma-y and
     sigma-z (SYTDEP)                           Default: 550.   ! SYTDEP = 5.5E02 !

     Switch for using Heffter equation for sigma z
     as above (0 = Not use Heffter; 1 = use Heffter
     (MHFTSZ)                                   Default: 0      ! MHFTSZ =  0   !

     Stability class used to determine plume
     growth rates for puffs above the boundary
     layer (JSUP)                               Default: 5      ! JSUP =  5   !

     Vertical dispersion constant for stable
     conditions (k1 in Eqn. 2.7-3)  (CONK1)     Default: 0.01   ! CONK1 = .01 !
```

```
Vertical dispersion constant for neutral/
unstable conditions (k2 in Eqn. 2.7-4)
(CONK2)                                  Default: 0.1     ! CONK2 = .1 !

Factor for determining Transition-point from
Schulman-Scire to Huber-Snyder Building Downwash
scheme (SS used for Hs < Hb + TBD * HL)
(TBD)                                    Default: 0.5     ! TBD = .5 !
   TBD < 0   ==> always use Huber-Snyder
   TBD = 1.5 ==> always use Schulman-Scire
   TBD = 0.5 ==> ISC Transition-point

Range of land use categories for which
urban dispersion is assumed
(IURB1, IURB2)                           Default: 10      ! IURB1 =  10  !
                                                  19      ! IURB2 =  19  !

Site characterization parameters for single-point Met data files ---------
(needed for METFM = 2,3,4)

   Land use category for modeling domain
   (ILANDUIN)                            Default: 20      ! ILANDUIN =  20  !

   Roughness length (m) for modeling domain
   (Z0IN)                                Default: 0.25    ! Z0IN = .25 !

   Leaf area index for modeling domain
   (XLAIIN)                              Default: 3.0     ! XLAIIN = 3.0 !

   Elevation above sea level (m)
   (ELEVIN)                              Default: 0.0     ! ELEVIN = .0 !

   Latitude (degrees) for met location
   (XLATIN)                              Default: -999.   ! XLATIN = -999.0 !

   Longitude (degrees) for met location
   (XLONIN)                              Default: -999.   ! XLONIN = -999.0 !

Specialized information for interpreting single-point Met data files -----

   Anemometer height (m) (Used only if METFM = 2,3)
   (ANEMHT)                              Default: 10.     ! ANEMHT = 10.0 !

   Form of lateral turbulance data in PROFILE.DAT file
   (Used only if METFM = 4 or MTURBVW = 1 or 3)
   (ISIGMAV)                             Default: 1       ! ISIGMAV =  1  !
       0 = read sigma-theta
       1 = read sigma-v

   Choice of mixing heights (Used only if METFM = 4)
   (IMIXCTDM)                            Default: 0       ! IMIXCTDM =  0  !
       0 = read PREDICTED mixing heights
       1 = read OBSERVED mixing heights

Maximum length of a slug (met. grid units)
(XMXLEN)                                 Default: 1.0     ! XMXLEN = 1.0 !

Maximum travel distance of a puff/slug (in
grid units) during one sampling step
(XSAMLEN)                                Default: 1.0     ! XSAMLEN = 1.0 !

Maximum Number of slugs/puffs release from
one source during one time step
(MXNEW)                                  Default: 99      ! MXNEW =  99  !

Maximum Number of sampling steps for
one puff/slug during one time step
(MXSAM)                                  Default: 99      ! MXSAM =  99  !

Number of iterations used when computing
the transport wind for a sampling step
that includes gradual rise (for CALMET
and PROFILE winds)
(NCOUNT)                                 Default: 2       ! NCOUNT =  2  !
```

```
Minimum sigma y for a new puff/slug (m)
(SYMIN)                                    Default: 1.0     ! SYMIN = 1.0   !

Minimum sigma z for a new puff/slug (m)
(SZMIN)                                    Default: 1.0     ! SZMIN = 1.0   !

Default minimum turbulence velocities sigma-v and sigma-w
for each stability class over land and over water (m/s)
(SVMIN(12) and SWMIN(12))

                ----------  LAND  ----------         ---------  WATER  ----------
   Stab Class :  A    B    C    D    E    F          A    B    C    D    E    F
                ---  ---  ---  ---  ---  ---        ---  ---  ---  ---  ---  ---
Default SVMIN : .50, .50, .50, .50, .50, .50,       .37, .37, .37, .37, .37, .37
Default SWMIN : .20, .12, .08, .06, .03, .016,      .20, .12, .08, .06, .03, .016

      ! SVMIN = 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.370, 0.370, 0.370, 0.370, 0.370, 0.370!
      ! SWMIN = 0.200, 0.120, 0.080, 0.060, 0.030, 0.016, 0.200, 0.120, 0.080, 0.060, 0.030, 0.016!

Divergence criterion for dw/dz across puff
used to initiate adjustment for horizontal
convergence (1/s)
Partial adjustment starts at CDIV(1), and
full adjustment is reached at CDIV(2)
(CDIV(2))                                  Default: 0.0,0.0  ! CDIV = .0, .0 !

Minimum wind speed (m/s) allowed for
non-calm conditions. Also used as minimum
speed returned when using power-law
extrapolation toward surface
(WSCALM)                                   Default: 0.5     ! WSCALM = .5 !

Maximum mixing height (m)
(XMAXZI)                                   Default: 3000.   ! XMAXZI = 3000.0 !

Minimum mixing height (m)
(XMINZI)                                   Default: 50.     ! XMINZI = 50.0 !

Default wind speed classes --
5 upper bounds (m/s) are entered;
the 6th class has no upper limit
(WSCAT(5))                          Default    :
                                    ISC RURAL : 1.54, 3.09, 5.14, 8.23, 10.8 (10.8+)

                         Wind Speed Class :  1    2    3    4    5
                                            ---  ---  ---  ---  ---
                                 ! WSCAT = 1.54, 3.09, 5.14, 8.23, 10.80 !

Default wind speed profile power-law
exponents for stabilities 1-6
(PLX0(6))                           Default    : ISC RURAL values
                                    ISC RURAL : .07, .07, .10, .15, .35, .55
                                    ISC URBAN : .15, .15, .20, .25, .30, .30

                          Stability Class :  A     B     C     D     E     F
                                            ---   ---   ---   ---   ---   ---
                                  ! PLX0 = 0.07, 0.07, 0.10, 0.15, 0.35, 0.55 !

Default potential temperature gradient
for stable classes E, F (degK/m)
(PTG0(2))                           Default: 0.020, 0.035
                                  ! PTG0 = 0.020,   0.035 !

Default plume path coefficients for
each stability class (used when option
for partial plume height terrain adjustment
is selected -- MCTADJ=3)
(PPC(6))                  Stability Class :  A     B     C     D     E     F
                            Default  PPC : .50,  .50,  .50,  .50,  .35,  .35
                                            ---   ---   ---   ---   ---   ---
                                  !  PPC = 0.50, 0.50, 0.50, 0.50, 0.35, 0.35 !

Slug-to-puff transition criterion factor
equal to sigma-y/length of slug
(SL2PF)                                Default: 10.       ! SL2PF = 10.0 !
```

```
     Puff-splitting control variables ------------------------

       VERTICAL SPLIT
       --------------

       Number of puffs that result every time a puff
       is split - nsplit=2 means that 1 puff splits
       into 2
       (NSPLIT)                            Default:   3        ! NSPLIT =  3  !

       Time(s) of a day when split puffs are eligible to
       be split once again; this is typically set once
       per day, around sunset before nocturnal shear develops.
       24 values: 0 is midnight (00:00) and 23 is 11 PM (23:00)
       0=do not re-split    1=eligible for re-split
       (IRESPLIT(24))                      Default:  Hour 17 = 1
       !  IRESPLIT = 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0 !

       Split is allowed only if last hour's mixing
       height (m) exceeds a minimum value
       (ZISPLIT)                           Default: 100.       ! ZISPLIT = 100.0 !

       Split is allowed only if ratio of last hour's
       mixing ht to the maximum mixing ht experienced
       by the puff is less than a maximum value (this
       postpones a split until a nocturnal layer develops)
       (ROLDMAX)                           Default: 0.25       ! ROLDMAX = 0.25 !


       HORIZONTAL SPLIT
       ----------------

       Number of puffs that result every time a puff
       is split - nsplith=5 means that 1 puff splits
       into 5
       (NSPLITH)                           Default:   5        ! NSPLITH =  5  !

       Minimum sigma-y (Grid Cells Units) of puff
       before it may be split
       (SYSPLITH)                          Default:  1.0       ! SYSPLITH = 1.0 !

       Minimum puff elongation rate (SYSPLITH/hr) due to
       wind shear, before it may be split
       (SHSPLITH)                          Default:  2.        ! SHSPLITH = 2.0 !

       Minimum concentration (g/m^3) of each
       species in puff before it may be split
       Enter array of NSPEC values; if a single value is
       entered, it will be used for ALL species
       (CNSPLITH)                          Default:  1.0E-07   ! CNSPLITH = 1.0E-07 !

     Integration control variables ------------------------

       Fractional convergence criterion for numerical SLUG
       sampling integration
       (EPSSLUG)                           Default:   1.0e-04  ! EPSSLUG = 1.0E-04 !

       Fractional convergence criterion for numerical AREA
       source integration
       (EPSAREA)                           Default:   1.0e-06  ! EPSAREA = 1.0E-06 !

       Trajectory step-length (m) used for numerical rise
       integration
       (DSRISE)                            Default:   1.0      ! DSRISE = 1.0 !

!END!


-------------------------------------------------------------------------------


INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters
--------------------------------
```

```
---------------
Subgroup (13a)
---------------

     Number of point sources with
     parameters provided below      (NPT1)  No default  !  NPT1 =   1 !

     Units used for point source
     emissions below                (IPTU)  Default: 1  !  IPTU =    3  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (13d)        (NSPT1) Default: 0  !  NSPT1 = 0  !

     Number of point sources with
     variable emission parameters
     provided in external file      (NPT2)  No default  !  NPT2 =  0  !

     (If NPT2 > 0, these point
     source emissions are read from
     the file: PTEMARB.DAT)

!END!

---------------
Subgroup (13b)
---------------
                                            a
          POINT SOURCE: CONSTANT DATA
          -----------------------------
                                                                                   b          c
  Source       X           Y        Stack     Base      Stack    Exit  Exit    Bldg.  Emission
   No.     Coordinate Coordinate   Height  Elevation Diameter   Vel.  Temp.   Dwash   Rates
              (km)       (km)        (m)      (m)        (m)   (m/s) (deg. K)
  ------   ---------- ----------  ------   ------   -------- ----- -------- ----- --------
****************   EMISSION RATES ARE IN LB/HR    *****************SO2****SO4***NOX****HNO3**NO3**PM10

Project-Specific Source Input
--------

    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

     SRCNAM  is a 12-character name for a source
             (No default)
     X       is an array holding the source data listed by the column headings
             (No default)
     SIGYZI  is an array holding the initial sigma-y and sigma-z (m)
             (Default: 0.,0.)
     FMFAC   is a vertical momentum flux factor (0. or 1.0) used to represent
             the effect of rain-caps or other physical configurations that
             reduce momentum rise associated with the actual exit velocity.
             (Default: 1.0  -- full momentum used)

    b
     0. = No building downwash modeled, 1. = downwash modeled
     NOTE: must be entered as a REAL number (i.e., with decimal point)

    c
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IPTU
     (e.g. 1 for g/s).

---------------
Subgroup (13c)
```

```
---------------

          BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH
          -----------------------------------------------------
Source                                                                    a
 No.      Effective building width and height (in meters) every 10 degrees
------    ----------------------------------------------------------------


--------

   a
    Each pair of width and height values is treated as a separate input
    subgroup and therefore must end with an input group terminator.

---------------
Subgroup (13d)
---------------
                                               a
         POINT SOURCE: VARIABLE EMISSIONS DATA
         ---------------------------------------

    Use this subgroup to describe temporal variations in the emission
    rates given in 13b.  Factors entered multiply the rates in 13b.
    Skip sources here that have constant emissions.  For more elaborate
    variation in source parameters, use PTEMARB.DAT and NPT2 > 0.

    IVARY determines the type of variation, and is source-specific:
    (IVARY)                                 Default: 0
          0 =       Constant
          1 =       Diurnal cycle (24 scaling factors: hours 1-24)
          2 =       Monthly cycle (12 scaling factors: months 1-12)
          3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                   where first group is DEC-JAN-FEB)
          4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                   first group is Stability Class A,
                                   and the speed classes have upper
                                   bounds (m/s) defined in Group 12
          5 =       Temperature   (12 scaling factors, where temperature
                                   classes have upper bounds (C) of:
                                   0, 5, 10, 15, 20, 25, 30, 35, 40,
                                   45, 50, 50+)



--------
   a
    Data for each species are treated as a separate input subgroup
    and therefore must end with an input group terminator.


-------------------------------------------------------------------------------


INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters
--------------------------------

---------------
Subgroup (14a)
---------------

    Number of polygon area sources with
    parameters specified below (NAR1)       No default  !  NAR1 =  0   !

    Units used for area source
    emissions below           (IARU)        Default: 1  !  IARU =   1  !
          1 =        g/m**2/s
          2 =       kg/m**2/hr
          3 =       lb/m**2/hr
          4 =     tons/m**2/yr
          5 =     Odour Unit * m/s  (vol. flux/m**2 of odour compound)
          6 =     Odour Unit * m/min
          7 =     metric tons/m**2/yr

    Number of source-species
```

```
     combinations with variable
     emissions scaling factors
     provided below in (14d)         (NSAR1) Default: 0  !  NSAR1 =  0  !

     Number of buoyant polygon area sources
     with variable location and emission
     parameters (NAR2)                       No default  !  NAR2 =  0   !
     (If NAR2 > 0, ALL parameter data for
     these sources are read from the file: BAEMARB.DAT).

!END!

---------------
Subgroup (14b)
---------------
                                           a
          AREA SOURCE: CONSTANT DATA
          ----------------------------
                                                                   b
Source            Effect.    Base      Initial     Emission
 No.              Height   Elevation   Sigma z      Rates
                   (m)       (m)        (m)
-------           ------    ------    --------    ---------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IARU
     (e.g. 1 for g/m**2/s).

---------------
Subgroup (14c)
---------------

           COORDINATES (UTM-km) FOR EACH VERTEX(4) OF EACH POLYGON
           --------------------------------------------------------
Source                                                                a
 No.       Ordered list of X followed by list of Y, grouped by source
------     ------------------------------------------------------------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.


---------------
Subgroup (14d)
---------------
                                                     a
          AREA SOURCE: VARIABLE EMISSIONS DATA
          --------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 14b.  Factors entered multiply the rates in 14b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use BAEMARB.DAT and NAR2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                 Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
```

```
          5 =       Temperature   (12 scaling factors, where temperature
                                   classes have upper bounds (C) of:
                                   0, 5, 10, 15, 20, 25, 30, 35, 40,
                                   45, 50, 50+)


--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------

INPUT GROUPS: 15a, 15b, 15c -- Line source parameters
---------------------------------------------------

---------------
Subgroup (15a)
---------------

     Number of buoyant line sources
     with variable location and emission
     parameters (NLN2)                              No default  !  NLN2 =  0   !

     (If NLN2 > 0, ALL parameter data for
      these sources are read from the file: LNEMARB.DAT)

     Number of buoyant line sources (NLINES)        No default   ! NLINES =  0  !

     Units used for line source
     emissions below              (ILNU)            Default: 1  !  ILNU =   1  !
          1 =        g/s
          2 =       kg/hr
          3 =       lb/hr
          4 =     tons/yr
          5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
          6 =     Odour Unit * m**3/min
          7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (15c)      (NSLN1) Default: 0  !  NSLN1 =  0  !

     Maximum number of segments used to model
     each line (MXNSEG)                             Default: 7   ! MXNSEG =  7  !

     The following variables are required only if NLINES > 0.  They are
     used in the buoyant line source plume rise calculations.

        Number of distances at which                Default: 6   ! NLRISE =  6  !
        transitional rise is computed

        Average building length (XL)                No default   ! XL = .0 !
                                                    (in meters)

        Average building height (HBL)               No default   ! HBL = .0 !
                                                    (in meters)

        Average building width (WBL)                No default   ! WBL = .0 !
                                                    (in meters)

        Average line source width (WML)             No default   ! WML = .0 !
                                                    (in meters)

        Average separation between buildings (DXL)  No default   ! DXL = .0 !
                                                    (in meters)

        Average buoyancy parameter (FPRIMEL)        No default   ! FPRIMEL = .0 !
                                                    (in m**4/s**3)

!END!
```

```
---------------
Subgroup (15b)
---------------

          BUOYANT LINE SOURCE: CONSTANT DATA
          ----------------------------------
                                                                                   a
Source    Beg. X      Beg. Y      End. X     End. Y      Release    Base       Emission
 No.    Coordinate  Coordinate  Coordinate Coordinate   Height   Elevation      Rates
           (km)        (km)        (km)       (km)        (m)       (m)
------  ----------  ----------  ---------- ----------   -------  ---------    ---------

--------

    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by ILNTU
     (e.g. 1 for g/s).

---------------
Subgroup (15c)
---------------
                                                         a
          BUOYANT LINE SOURCE: VARIABLE EMISSIONS DATA
          ----------------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 15b.  Factors entered multiply the rates in 15b.
     Skip sources here that have constant emissions.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                               Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)


--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------


INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters
--------------------------

---------------
Subgroup (16a)
---------------

     Number of volume sources with
     parameters provided in 16b,c (NVL1)     No default  !  NVL1 =  0   !

     Units used for volume source
     emissions below in 16b       (IVLU)     Default: 1  !  IVLU =   1  !
           1 =        g/s
```

```
          2 =       kg/hr
          3 =       lb/hr
          4 =     tons/yr
          5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
          6 =     Odour Unit * m**3/min
          7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (16c)      (NSVL1)    Default: 0  !  NSVL1 =  0  !

     Number of volume sources with
     variable location and emission
     parameters                   (NVL2)     No default  !  NVL2 =   0   !

     (If NVL2 > 0, ALL parameter data for
      these sources are read from the VOLEMARB.DAT file(s) )

!END!

---------------
Subgroup (16b)
---------------
                                                  a
           VOLUME SOURCE: CONSTANT DATA
           ------------------------------
                                                                             b
        X UTM        Y UTM      Effect.    Base      Initial    Initial    Emission
     Coordinate   Coordinate    Height   Elevation   Sigma y    Sigma z     Rates
        (km)         (km)        (m)        (m)        (m)        (m)
     ----------   ----------    ------    ------    --------   --------   --------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IVLU
     (e.g. 1 for g/s).

---------------
Subgroup (16c)
---------------
                                                          a
          VOLUME SOURCE: VARIABLE EMISSIONS DATA
          ---------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 16b.  Factors entered multiply the rates in 16b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                  Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)
```

```
--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------

INPUT GROUPS: 17a & 17b -- Non-gridded (discrete) receptor information
----------------------


---------------
Subgroup (17a)
---------------

     Number of non-gridded receptors (NREC)  No default   !  NREC = 744  !

!END!

---------------
Subgroup (17b)
---------------
                                               a
           NON-GRIDDED (DISCRETE) RECEPTOR DATA
           ------------------------------------

                    X            Y          Ground        Height   b
Receptor       Coordinate   Coordinate   Elevation   Above Ground
  No.             (km)         (km)          (m)           (m)
--------       ----------   ----------   ---------   ------------
RECEPTORS OBTAINED FROM THE NPS/FWS EXTRACTION PROGRAM
ALL RECEPTORS ARE LCC (KM)

PROJECT-SPECIFIC CLASS I AREA RECEPTORS

    a
     Data for each receptor are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     Receptor height above ground is optional.  If no value is entered,
     the receptor is placed on the ground.
```

APPENDIX C

APPLICATION FOR AIR PERMIT – LONG FORM

Department of
Environmental Protection

Division of Air Resource Management

APPLICATION FOR AIR PERMIT - LONG FORM

I. APPLICATION INFORMATION

Air Construction Permit – Use this form to apply for an air construction permit at a facility operating under a federally enforceable state air operation permit (FESOP) or Title V air permit. Also use this form to apply for an air construction permit:

- For a proposed project subject to prevention of significant deterioration (PSD) review, nonattainment area (NAA) new source review, or maximum achievable control technology (MACT) review; or
- Where the applicant proposes to assume a restriction on the potential emissions of one or more pollutants to escape a federal program requirement such as PSD review, NAA new source review, Title V, or MACT; or
- Where the applicant proposes to establish, revise, or renew a plantwide applicability limit (PAL).

Air Operation Permit – Use this form to apply for:

- an initial federally enforceable state air operation permit (FESOP); or
- an initial/revised/renewal Title V air operation permit.

Air Construction Permit & Title V Air Operation Permit (Concurrent Processing Option) – Use this form to apply for both an air construction permit and a revised or renewal Title V air operation permit incorporating the proposed project.

To ensure accuracy, please see form instructions.

Identification of Facility

1. Facility Owner/Company Name: **Smurfit-Stone Container Enterprises, Inc.**
2. Site Name: **Fernandina Beach Mill**
3. Facility Identification Number: **0890003**
4. Facility Location...:
   Street Address or Other Locator: **North 8th Street**
   City: **Fernandina Beach** County: **Nassau** Zip Code: **32034**
5. Relocatable Facility? ☐ Yes ☒ No
6. Existing Title V Permitted Facility? ☒ Yes ☐ No

Application Contact

1. Application Contact Name: **Bill Crews, Environmental Manager**
2. Application Contact Mailing Address...
   Organization/Firm: **Smurfit-Stone Container Enterprises, Inc.**
   Street Address: **North 8th Street**
   City: **Fernandina Beach** State: **FL** Zip Code: **32034**
3. Application Contact Telephone Numbers...
   Telephone: **(904) 277-7746** ext. Fax: **(904) 277-5888**
4. Application Contact Email Address: **bcrews@smurfit.com**

Application Processing Information (DEP Use)

1. Date of Receipt of Application:	3. PSD Number (if applicable):
2. Project Number(s):	4. Siting Number (if applicable):

FACILITY INFORMATION

Purpose of Application

This application for air permit is submitted to obtain: (Check one)

Air Construction Permit

☒ Air construction permit.

☐ Air construction permit to establish, revise, or renew a plantwide applicability limit (PAL).

☐ Air construction permit to establish, revise, or renew a plantwide applicability limit (PAL), and separate air construction permit to authorize construction or modification of one or more emissions units covered by the PAL.

Air Operation Permit

☐ Initial Title V air operation permit.

☐ Title V air operation permit revision.

☐ Title V air operation permit renewal.

☐ Initial federally enforceable state air operation permit (FESOP) where professional engineer (PE) certification is required.

☐ Initial federally enforceable state air operation permit (FESOP) where professional engineer (PE) certification is not required.

Air Construction Permit and Revised/Renewal Title V Air Operation Permit (Concurrent Processing)

☐ Air construction permit and Title V permit revision, incorporating the proposed project.

☐ Air construction permit and Title V permit renewal, incorporating the proposed project.

Note: By checking one of the above two boxes, you, the applicant, are requesting concurrent processing pursuant to Rule 62-213.405, F.A.C. In such case, you must also check the following box:

☐ I hereby request that the department waive the processing time requirements of the air construction permit to accommodate the processing time frames of the Title V air operation permit.

Application Comment

This application is for the purpose of obtaining a BART determination for the BART-eligible emissions units at the SSCE Fernandina Beach Mill.

FACILITY INFORMATION

Scope of Application

Emissions Unit ID Number	Description of Emissions Unit	Air Permit Type	Air Permit Proc. Fee
006	No. 5 Power Boiler	AC1F	
007	No. 4 Recovery Boiler	AC1F	
013	No. 4 Smelt Dissolving Tank	AC1F	

Application Processing Fee

Check one: ☐ Attached - Amount: $__________________ ☒ Not Applicable

FACILITY INFORMATION

Owner/Authorized Representative Statement

Complete if applying for an air construction permit or an initial FESOP.

1. Owner/Authorized Representative Name :

   George Q. Langstaff, Vice-President, Regional Mill Operations

2. Application Responsible Official Mailing Address...

   Organization/Firm: **Smurfit-Stone Container Enterprises, Inc.**

   Street Address: **North 8th Street**

   City: **Fernandina Beach** State: **FL** Zip Code: **32034**

3. Application Responsible Official Telephone Numbers...

   Telephone: **(904) 261-5551** ext. Fax: **(904) 277-5888**

4. Application Responsible Official Email Address: **glangsta@smurfit.com**

5. Owner/Authorized Representative Statement:

   I, the undersigned, am the owner or authorized representative of the facility addressed in this air permit application. I hereby certify, based on information and belief formed after reasonable inquiry, that the statements made in this application are true, accurate and complete and that, to the best of my knowledge, any estimates of emissions reported in this application are based upon reasonable techniques for calculating emissions. The air pollutant emissions units and air pollution control equipment described in this application will be operated and maintained so as to comply with all applicable standards for control of air pollutant emissions found in the statutes of the State of Florida and rules of the Department of Environmental Protection and revisions thereof and all other requirements identified in this application to which the facility is subject. I understand that a permit, if granted by the department, cannot be transferred without authorization from the department, and I will promptly notify the department upon sale or legal transfer of the facility or any permitted emissions unit.

   Signature ____________________ Date ____________________

NOTE: Due to FDEP's very recent request (1/31/07) to include the Air Permit Application—Long Form, the owner/authorized representative signature could not be obtained. It will be submitted at a later date.

FACILITY INFORMATION

Application Responsible Official Certification

Complete if applying for an initial/revised/renewal Title V permit or concurrent processing of an air construction permit and a revised/renewal Title V permit. If there are multiple responsible officials, the "application responsible official" need not be the "primary responsible official."

1. Application Responsible Official Name:

2. Application Responsible Official Qualification (Check one or more of the following options, as applicable):
   - ☐ For a corporation, the president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation, or a duly authorized representative of such person if the representative is responsible for the overall operation of one or more manufacturing, production, or operating facilities applying for or subject to a permit under Chapter 62-213, F.A.C.
   - ☐ For a partnership or sole proprietorship, a general partner or the proprietor, respectively.
   - ☐ For a municipality, county, state, federal, or other public agency, either a principal executive officer or ranking elected official.
   - ☐ The designated representative at an Acid Rain source.

3. Application Responsible Official Mailing Address...
   Organization/Firm:
   Street Address:
   City: State: Zip Code:

4. Application Responsible Official Telephone Numbers...
   Telephone: ( ) - ext. Fax: ( ) -

5. Application Responsible Official Email Address:

6. Application Responsible Official Certification:

   I, the undersigned, am a responsible official of the Title V source addressed in this air permit application. I hereby certify, based on information and belief formed after reasonable inquiry, that the statements made in this application are true, accurate and complete and that, to the best of my knowledge, any estimates of emissions reported in this application are based upon reasonable techniques for calculating emissions. The air pollutant emissions units and air pollution control equipment described in this application will be operated and maintained so as to comply with all applicable standards for control of air pollutant emissions found in the statutes of the State of Florida and rules of the Department of Environmental Protection and revisions thereof and all other applicable requirements identified in this application to which the Title V source is subject. I understand that a permit, if granted by the department, cannot be transferred without authorization from the department, and I will promptly notify the department upon sale or legal transfer of the facility or any permitted emissions unit. Finally, I certify that the facility and each emissions unit are in compliance with all applicable requirements to which they are subject, except as identified in compliance plan(s) submitted with this application.

   Signature Date

FACILITY INFORMATION

Professional Engineer Certification

1. Professional Engineer Name: **David A. Buff**
   Registration Number: **19011**

2. Professional Engineer Mailing Address...
   Organization/Firm: **Golder Associates Inc.****
   Street Address: **6241 NW 23rd Street, Suite 500**
   City: **Gainesville** State: **FL** Zip Code: **32653**

3. Professional Engineer Telephone Numbers...
   Telephone: **(352) 336-5600** ext.**545** Fax: **(352) 336-6603**

4. Professional Engineer Email Address: **dbuff@golder.com**

5. Professional Engineer Statement:

I, the undersigned, hereby certify, except as particularly noted herein, that:*

(1) To the best of my knowledge, there is reasonable assurance that the air pollutant emissions unit(s) and the air pollution control equipment described in this application for air permit, when properly operated and maintained, will comply with all applicable standards for control of air pollutant emissions found in the Florida Statutes and rules of the Department of Environmental Protection; and

(2) To the best of my knowledge, any emission estimates reported or relied on in this application are true, accurate, and complete and are either based upon reasonable techniques available for calculating emissions or, for emission estimates of hazardous air pollutants not regulated for an emissions unit addressed in this application, based solely upon the materials, information and calculations submitted with this application.

(3) If the purpose of this application is to obtain a Title V air operation permit (check here ☐, if so), I further certify that each emissions unit described in this application for air permit, when properly operated and maintained, will comply with the applicable requirements identified in this application to which the unit is subject, except those emissions units for which a compliance plan and schedule is submitted with this application.

(4) If the purpose of this application is to obtain an air construction permit (check here ☒, if so) or concurrently process and obtain an air construction permit and a Title V air operation permit revision or renewal for one or more proposed new or modified emissions units (check here ☐, if so), I further certify that the engineering features of each such emissions unit described in this application have been designed or examined by me or individuals under my direct supervision and found to be in conformity with sound engineering principles applicable to the control of emissions of the air pollutants characterized in this application.

(5) If the purpose of this application is to obtain an initial air operation permit or operation permit revision or renewal for one or more newly constructed or modified emissions units (check here ☐, if so), I further certify that, with the exception of any changes detailed as part of this application, each such emissions unit has been constructed or modified in substantial accordance with the information given in the corresponding application for air construction permit and with all provisions contained in such permit.

Signature Date

(seal)

* Attach any exception to certification statement.

** Board of Professional Engineers Certificate of Authorization #00001670