

November 5, 2007

Laurel Dygowski
Air Quality Planning and Management Unit
US EPA - Region 8
1595 Wynkoop Street
Denver, CO 80202-1129

Dear Ms. Dygowski:

On behalf of Columbia Falls Aluminum Company (CFAC), Bison Engineering, Inc., is pleased to provide EPA with the BART analysis for the CFAC Columbia Falls, Montana, facility. The submittal deadline for this BART analysis was extended to November 5, 2007, by your office.

If you have questions, or would like to discuss this analysis, please call me at 406-442-5768 or Steve Wright at CFAC at 406-892-8211.

Sincerely,
BISON ENGINEERING, INC.



Hal Robbins
President

cc: Steve Wright, CFAC

Enclosure

**BEST AVAILABLE
RETROFIT TECHNOLOGY
(BART) ANALYSIS**

**Columbia Falls Aluminum
Company, LLC**

Prepared for:

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1.0 INTRODUCTION

1.1. Summary

Columbia Falls Aluminum Company, LLC (CFAC) is submitting a Best Available Retrofit Technology (BART) analysis to the U.S. Environmental Protection Agency Region VIII office (EPA). EPA submitted a letter dated June 22, 2007, to CFAC requiring the preparation of a BART analysis for their aluminum ore reduction plant located near Columbia Falls, Montana. The letter was received by CFAC on June 27, 2007. The letter notified CFAC that EPA had [through Western Regional Air Partnership (WRAP)] completed visibility modeling and determined that CFAC was a BART-eligible source due to the possibility that CFAC could cause visibility degradation in a nearby Class I area (Glacier National Park). The notification requested CFAC to submit a BART analysis within 90 days of the June letter.¹ The letter also noted that if CFAC chooses not to perform an engineering analysis, then EPA will develop the analysis instead. CFAC chose to analyze the EPA modeling results and prepare a BART engineering analysis to submit to EPA. A copy of the EPA letter is included here as Appendix A.

CFAC analyzed the existing emission units for specific BART eligibility², and determined that there are nine sulfur dioxide (SO₂) emission sources, three particulate matter (PM₁₀) sources and zero nitrogen oxides (NO_x) emission sources that must be addressed by a BART analysis. Table 1-1 lists those sources.

¹ An extension to November 5, 2007, was granted by Laurel Dygowski of EPA in response to CFAC's August 15, 2007 request for extension.

² The BART program is only applicable to facilities that (in general) were constructed or reconstructed between 1962 and 1977. For CFAC this would only include those units generally associated with Potlines 3, 4 and 5. The remainder of the facility is not subject to BART since it fails to meet the definition of an "existing stationary facility" per 40 CFR 51.301. The identification of Potlines 3, 4 and 5 was generally determined through correspondence with the Montana Department of Environmental Quality (DEQ) prior to the June 19, 2006, letter to EPA from DEQ on the Regional Haze program (see EPA June 22, 2007, letter included here as Appendix A). The selection of these units is also confirmed via EPA's choice of emitting units for modeling purposes pursuant to their June 22, 2007 letter.

Table 1-1: Sources Addressed by CFAC BART Analysis

Emission Unit	PTE (Ton/year)			BART Analysis Performed (Yes or No)
	SO ₂	PM ₁₀	NO _x	
028 – Dry Alumina Scrubber #5	255	Nil ¹	Nil ¹	Yes
029 – Dry Alumina Scrubber #6	255	Nil ¹	Nil ¹	Yes
030 – Dry Alumina Scrubber #7	255	Nil ¹	Nil ¹	Yes
031 – Dry Alumina Scrubber #8	255	Nil ¹	Nil ¹	Yes
032 – Dry Alumina Scrubber #9	255	Nil ¹	Nil ¹	Yes
033 – Dry Alumina Scrubber #10	255	Nil ¹	Nil ¹	Yes
036 – Potline 3 Roof Vents	38.4	72.7	Nil ¹	Yes
037 – Potline 4 Roof Vents	38.4	72.7	Nil ¹	Yes
038 – Potline 5 Roof Vents	38.4	72.7	Nil ¹	Yes
043 – Casting Furnaces #8 and #9	Nil ¹	Nil ¹	6.7	No
047 – Casting Pits #8 and #9	Nil ¹	14.9	Nil ¹	Yes

¹ Nil means that emissions of this pollutant from this emitting unit are un-quantifiably small and were not considered further.

CFAC performed an SO₂ BART analysis on Potlines 3, 4 and 5 with their associated dry alumina scrubbers (numbers 5-10) and roof vents. CFAC determined that there are no SO₂ controls or process alterations that meet the definition of best available retrofit technology. See Section 4.3 of this report for the SO₂ BART analysis.

CFAC performed a PM₁₀ BART analysis on the roof vents for Potlines 3, 4 and 5. CFAC determined that there are no PM₁₀ controls or process alterations that meet the definition of best available retrofit technology. See Section 4.4 for the potline PM₁₀ BART analysis.

CFAC determined that there are no BART-eligible sources of NO_x at their plant. See Section 3.3 of this report for the detailed discussion of NO_x BART eligibility.

The remainder of this report details all of the BART steps and analyses performed for the CFAC facility.

1.2. Background and Purpose

Congress amended the Federal Clean Air Act in 1977 to include a new Section 169A and 169B for the purpose of protecting visibility in certain scenic areas. The areas afforded this visibility protection are identified as “Mandatory Class I Federal Areas.”³

³ These areas are identified in 40 CFR 81.401 *et seq.* Those areas within Montana and Wyoming are found in §417 and §436, respectively.

The rules EPA promulgated to implement these sections of the Act are generally found in 40 CFR 51, Subpart P.

Specific to this document, EPA promulgated [40 CFR 51.308\(e\)](#) which requires certain types of existing stationary sources to install best available retrofit technology (BART). The term BART is defined in §301 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 an existing stationary plant. 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.

As noted in Section 1.1 above, EPA has identified the CFAC aluminum ore reduction plant as an ‘existing stationary facility’⁴ that is subject to the BART requirements. EPA has further identified guidelines for identifying BART-eligible sources and suggested methodologies to be employed for conducting a BART analysis. These guidelines are codified in 40 CFR 51, Appendix Y.

It is the purpose of this document to fulfill the requirements for conducting a BART analysis for the CFAC plant. The remainder of this document conducts a BART analysis for each unit and pollutant subject to the regulation [40 CFR 51.308(3)]. The methodologies and guidelines found in 40 CFR 51, Appendix Y were used to develop this BART document.

1.3. Site Location and Description

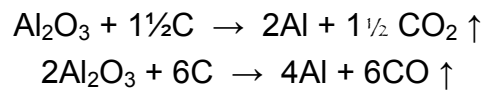
The CFAC plant is located in Columbia Falls in Section 3, Township 30 North, Range 20 West, Flathead County, Montana, with approximate UTM coordinates of Zone 11, Easting 712.2 km, and Northing 5,363.8 km. The elevation is approximately 3,108 feet above sea level. Maps of the CFAC plant are on file with the Montana Department of Environmental Quality (MDEQ). Site description information is also on file with MDEQ. Copies of the maps and descriptions are available upon request.

⁴ As defined in 40 CFR 51.301.

2.0 PROCESS DESCRIPTION

CFAC operates five Vertical Stud Soderberg potlines at the Columbia Falls plant. Each potline has 120 individual cells that produce aluminum by the Hall-Heroult process.

The Hall-Heroult process consists of passing an electric current through aluminum oxide ore, or alumina (Al_2O_3), dissolved in molten cryolite. The reduction process is accomplished in a Vertical Stud Soderberg style pot. Soderberg technology describes the type of consumable carbon anode used in the process. CFAC Soderberg pots (cells) have 60-ton anodes (positive electrode) and 100-ton cathodes (negative electrode). The electrolytic reduction of aluminum oxide is represented by the following reactions:



The cells or “pots” are housed in buildings called potrooms. Two potrooms are connected electrically in series to form one potline. At CFAC there are ten potrooms that comprise the five potlines. Alumina is fed into a molten bath of cryolite and heated to about 1740°F (949°C). Through the electrochemical process, electricity passes from the anode to the cathode, causing the aluminum to be reduced. The aluminum metal is siphoned from the pot every 48 hours and transported to the casting department, where it is cast into ingots of various sizes, shapes and alloys. Each pot is tapped every other day, which results in a pot operational cycle of 48 hours.

3.0 BART ANALYSIS: MODEL AND SOURCE SELECTION

3.1 Initial BART Emission Data

In a series of letters, MDEQ requested that CFAC submit a list of the BART-eligible sources at the plant and supply sulfur dioxide (SO₂), nitrogen oxides (NO_x), and particulate matter less than 10 microns (PM₁₀) emission data for the BART-eligible sources. CFAC concluded 18 emitting units (as provided in the Title V permit) from the plant qualify as BART-eligible. The emission data requested was for annual potential to emit (PTE) and the highest 24-hour emission rates occurring during the three year period of 2001, 2002, and 2003. The plant was not operating at 100% capacity during this time period, therefore; the highest 24-hour emission rates occurring during 1999, when the plant was in operating at 100% were supplied to DEQ, EPA, and WRAP for this analysis.

3.2 Initial EPA/WRAP CFAC BART Emissions Summary

For purposes of BART applicability determination only, EPA had WRAP perform the modeling (via the University of California Riverside) for the initial BART applicability determination. The WRAP model included 14 of the 18 identified BART eligible emitting units in the initial BART applicability determination. Table 3-1 summarizes the 14 sources of SO₂ and NO_x and PM₁₀ emissions that were included in the EPA/WRAP BART applicability determination.

Table 3-1: Initial EPA/WRAP BART Modeled Sources and Emissions

Modeled Emitting Units	Modeled Emissions (lbs/hr)		
	SO ₂	PM ₁₀	NO _x
004 - East Alumina Elevator	0.00	0.08	0.00
005 - East Alumina Unloader	0.00	0.08	0.00
006 - East Alumina Conveyor Storage	0.00	0.08	0.00
019 - Therminol Oil Heating System	0.00	0.00	0.00
020 - East Plant Alumina Transfer	0.00	0.05	0.00
021 - East Plant Alumina Transfer	0.00	0.05	0.00
028 - Dry Alumina Scrubber #5	58.22	0.09	0.00
029 - Dry Alumina Scrubber #6	58.22	0.09	0.00
030 - Dry Alumina Scrubber #7	58.22	0.09	0.00
031 - Dry Alumina Scrubber #8	58.22	0.09	0.00
032 - Dry Alumina Scrubber #9	58.22	0.09	0.00
033 - Dry Alumina Scrubber #10	58.22	0.09	0.00
043 - Casting Furnace #8 & 9	0.01	1.08	1.52
047 - Casting Pits #8 & 9	0.00	3.39	0.00

Note: To convert lbs/hr to tons/yr, multiply by 4.38. Example: 58.22 lbs/hr x 8760 hrs/yr / 2000 lbs/ton = 255 tons/yr

3.3 CFAC BART Emissions Summary

CFAC, with the assistance of Bison Engineering, reviewed the initial EPA/WRAP BART applicability determination. The WRAP model included six potline point sources (dry alumina scrubber stacks) as six volume sources, and did not include the potline roof vents at all. As a result of this review, 17 of the 18 initial BART eligible sources were included in all subsequent modeling analyses. Emitting Unit EU049 (Sheet ingot saw) was not included in any modeling analysis because there are no emissions associated with it. The additional three sources included in the CFAC models are the potline roof vents. The 17 sources SO₂, NO_x, and PM₁₀ emissions that were included in the regional scale and near field modeling analyses performed by CFAC are listed in Table 3-2.

Table 3-2: CFAC BART Modeled Sources and Emissions

Modeled Emitting Units	Modeled Emissions (lbs/hr)		
	SO ₂	PM ₁₀	NO _x
004 - East Alumina Elevator	0.00	0.08	0.00
005 - East Alumina Unloader	0.00	0.08	0.00
006 - East Alumina Conveyor Storage	0.00	0.08	0.00
019 - Therminol Oil Heating System	0.00	0.00	0.00
020 - East Plant Alumina Transfer	0.00	0.05	0.00
021 - East Plant Alumina Transfer	0.00	0.05	0.00
028 - Dry Alumina Scrubber #5	58.22	0.09	0.00
029 - Dry Alumina Scrubber #6	58.22	0.09	0.00
030 - Dry Alumina Scrubber #7	58.22	0.09	0.00
031 - Dry Alumina Scrubber #8	58.22	0.09	0.00
032 - Dry Alumina Scrubber #9	58.22	0.09	0.00
033 - Dry Alumina Scrubber #10	58.22	0.09	0.00
036 - Potline #3 Roof Vents	8.76	16.60	0.00
037 - Potline #4 Roof Vents	8.76	16.60	0.00
038 - Potline #5 Roof Vents	8.76	16.60	0.00
043 - Casting Furnace #8 & 9	0.01	1.08	1.52
047 - Casting Pits #8 & 9	0.00	3.39	0.00
049 - Sheet Ingot Saw (Not Modeled)	0.00	0.00	0.00

Note: To convert lbs/hr to tons/yr, multiply by 4.38. Example: 58.22 lbs/hr x 8760 hrs/yr / 2000 lbs/ton = 255 tons/yr

3.4 CFAC BART Near Field Model Addition

A near field model was developed to address the potential CFAC visibility impacts on the nearby receptors located in Glacier National Park (GNP). The WRAP BART applicability determination recognized the difference of modeled impacts for the long range receptors (>50km) and the near field receptors (<50km) by listing CFAC's potential visibility impacts in GNP for both receptors at greater than 50 km and less than

50 km from the plant. The complex terrain in the area surrounding CFAC is better represented by a refined model analysis. The near field modeling domain reduces the CALMET grid spacing from 6 km to 1 km and significantly improves the terrain resolution over the regional scale modeling domain. Given the short distance (<10 km) between CFAC and the nearest National Park Service generated receptors for Glacier National Park, the development of this refined CALPUFF modeling analysis is appropriate for this BART analysis.

3.5 CFAC BART Model Results Comparison

The two different source emission summaries detailed in Tables 3-1 and 3-2 above were used in the modeling analysis for the CFAC BART applicability determination. The EPA applicability determination used an incomplete emission inventory to perform the regional scale CALPUFF modeling analysis to conclude BART is applicable to CFAC. The complete emission inventory in Table 3-2 was used in both the regional scale CALPUFF model analysis to compare to the EPA/WRAP applicability determination; and the near field modeling analysis for Glacier National Park and the subsequent cost/benefit analysis. Please see Appendix B for a complete modeling discussion.

A comparison of the 98th percentile visibility impacts for the three different CALPUFF models is presented in Table 3-3 below.

Table 3-3: CFAC BART Model Results Comparison

Modeled Emitting Units	Modeled Visibility Impacts (98 th percentile)			
	2001 (Deciview change)	2002 (Deciview change)	2003 (Deciview change)	3 year Average (Deciview change)
EPA/WRAP Regional Scale Visibility	3.13	4.54	3.40	3.69
CFAC/Bison Regional Scale Visibility	4.56	6.29	4.89	5.25
CFAC/Bison Near Field Visibility	4.43	2.94	4.28	3.88

This table shows that the visibility impacts were greater in the CFAC regional model when the additional 3 potline roof vent emission units were added to the sources from the EPA/WRAP model. The table also shows that the CFAC near field model, with the same emission sources as the CFAC regional model, shows substantially lower visibility impacts than the CFAC regional model. CFAC believes the near field model is a more refined and representative model for predicting close (<10 km) visibility impacts than either the EPA/WRAP or CFAC regional model.

3.6 SO₂ Applicable Units Emissions

Potlines 3, 4, and 5 each consist of two potrooms. Each potroom is equipped with an emission collection system to route pot emissions to a bank of six dry alumina

scrubbers intended to capture fluoride, hydrocarbon and particulate emissions. The emissions from these scrubbers are considered primary emissions by CFAC. These scrubbers are assumed to be ineffective for controlling SO₂ emissions. The emission unit numbers for each alumina scrubber are EU028 through EU033. By calculation, the scrubbers each emit 255 tons of SO₂ per year and are analyzed in this BART analysis. Furthermore, Potlines 3 through 5 each also have dual roof vents, EU036, EU037, and EU038, respectively, that by calculation, each emit 38.4 tons of SO₂ per year. The emissions from the potline roof vents are considered secondary emissions by CFAC. The roof vents will also be analyzed in this BART analysis.

Table 3-4 provides a summary of the nine SO₂-emitting units subject to further BART analysis. The table also shows the current emissions control associated with those units.

Table 3-4: SO₂ Sources Analyzed for BART

Source	Current SO ₂ Source Control	Current SO ₂ Emissions (tpy)
028 - Dry Alumina Scrubber #5	None	255.0
029 - Dry Alumina Scrubber #6	None	255.0
030 - Dry Alumina Scrubber #7	None	255.0
031 - Dry Alumina Scrubber #8	None	255.0
032 - Dry Alumina Scrubber #9	None	255.0
033 - Dry Alumina Scrubber #10	None	255.0
036 – Potline 3 Roof Vents (Secondary)	None	38.4
037 – Potline 4 Roof Vents (Secondary)	None	38.4
038 – Potline 5 Roof Vents (Secondary)	None	38.4

3.7 NO_x Applicable Units Emissions

The CFAC plant emits a total of 6.7 tons of NO_x per year from natural gas combustion that primarily occurs in casting furnaces. Under 40 CFR 51, Appendix Y, EPA established a *de minimis* level for emission units and pollutants that constitute BART eligibility. Appendix Y explains *de minimis* levels of emission for pollutants at BART-eligible sources:

“.....De Minimis values should be identified with the purpose of excluding only those emissions so minimal that they are unlikely to contribute to regional haze. Any de minimis values that you adopt must not be higher than the PSD applicability levels: 40 tons/yr for SO₂ and NO_x and 15 tons/yr for PM₁₀. These de minimis levels may only be applied on a plant-wide basis.”

CFAC’s plant-wide NO_x emissions of 6.7 tons per year are well below the PSD applicability level of 40 tons per year; therefore, they are categorized as *de minimis* and are not analyzed further.

3.8 PM₁₀ Applicable Units Emissions

Potlines 3, 4, and 5 each consist of two potrooms. Each potroom is equipped with an emission collection system to route pot emissions to a bank of six dry alumina scrubbers intended to capture fluoride, hydrocarbon and particulate emissions. These scrubbers incorporate high efficiency baghouses as part of the design and are considered 99%+ effective at capturing PM₁₀ emissions. The emission unit numbers for each alumina scrubber are EU028 through EU033. These are considered primary sources by CFAC.

Although the six dry alumina scrubbers are eligible for BART analysis, CFAC believes that the current PM₁₀ control is already the best possible at 99+% control and further improvement could not be practically accomplished. The current PM₁₀ emission rates are so low that visibility impacts from these sources are negligible, and further reductions could not improve upon that. Therefore, the primary PM₁₀ emission sources from the potlines have not been analyzed for BART.

Potlines 3, 4, and 5 each have dual roof vents. The emission unit numbers for the roof vents are EU036, EU037, and EU038. As shown in Table 3-2, each roof vent emits 72.7 tons/year of PM₁₀; therefore, the roof vents warrant further analysis for BART.

EU47, Casting Pits #8 and #9, have an estimated PM₁₀ emission rate of 14.9 tons per year. This is a relatively small source, and through the modeling performed, it was determined that this source, even with 100% PM₁₀ control efficiency, had a negligible impact on visibility. Therefore any control implemented on the source could not produce a significant visibility improvement. Therefore, EU47 was not analyzed further in this BART analysis.

Table 3-5 provides a summary of the three emitting units eligible for further BART analysis. The table also shows the current emissions control associated with those units.

Table 3-5: PM₁₀ Sources Analyzed for BART

Source	Current Source Control	Current PM₁₀ Emissions (tpy)
036 – Potline 3 Roof Vents (Secondary)	None	72.7
037 – Potline 4 Roof Vents (Secondary)	None	72.7
038 – Potline 5 Roof Vents (Secondary)	None	72.7

4.0 BEST AVAILABLE RETROFIT TECHNOLOGY REVIEW

The Clean Air Act (CAA), in section 169(a)(2), requires that State Implementation Plans (SIPs) for visibility protection must apply BART to certain large emitting sources. BART is required for sources that meet **all** of the following criteria:

1. The source is in one of 26 specific listed source categories;⁵
2. The source was in existence as of August 1977, but was not in operation in August of 1962;⁶
3. The facility has the potential to emit 250 tons per year of any visibility-impairing pollutant; and
4. The BART-eligible source emits an air pollutant that “may reasonably be anticipated to cause or contribute to any impairment of visibility in any mandatory Class I federal area, . . .”⁷

Appendix Y further explains how to identify sources subject to BART:

“Once you have determined that your source or sources are subject to BART, you must conduct a visibility improvement determination for the source(s) as part of the BART determination. When making this determination, we believe you have flexibility in setting absolute thresholds, target levels of improvement, or de minimis levels since the deciview improvement must be weighed among the five factors, and you are free to determine the weight and significance to be assigned to each factor.”

4.1 Summary

The CAA, section 169(a)(2) requires that SIPs for visibility protection must apply BART to certain large emitting sources. EPA identified CFAC as a possible BART-eligible source because it is a Primary Aluminum Ore Reduction Plant, which is one of the 26 BART source categories under 40 CFR Part 51.301 under the definition of “Existing stationary source.” The CFAC plant has emitting units that meet the time frames specified in item 2 above. In addition, the entire complex has a potential to emit greater than 250 tons per year.

EPA has completed initial visibility modeling through the WRAP program. As a result of those investigations, EPA has determined that CFAC is subject to a BART analysis in

⁵ The 26 source categories are found in the definition of “Existing stationary facility” found in 40 CFR 51.301.

⁶ The terms “in existence” and “in operation” are defined in 40 CFR 51.301.

⁷ 40 CFR 51.308(e).

accordance with the BART provisions of 40 CFR 51.308. The EPA documentation of this requirement and conclusion is found in a letter from EPA Region VIII dated June 22, 2007, addressed to Mr. Steve Wright of CFAC. A copy of that letter and conclusion is found in Appendix A of this document.

In accordance with the June 22, 2007, letter, CFAC has conducted a BART analysis using EPA-recommended methodologies and dispersion modeling recommendations found in 40 CFR 51, Appendix Y, more specifically the CALPUFF dispersion model, to assist with the proposed BART determination. The purpose of the modeling analysis is to determine the visibility improvement expected at Class I areas from the potential BART control technology applied to the source. The modeling analysis is found in Appendix B of this document.

4.1.1 Affected Units

There are a total of 18 emitting units at the CFAC plant that have been identified as potentially “BART-eligible.” These units have received that designation since they meet the definition of BART-eligible since they were “in existence”⁸ as of August 1977, but not “in operation”⁹ in August of 1962 and having (collectively) the potential to emit 250 tons per year of an air pollutant that could cause visibility degradation in a Class I area (applicable pollutants are listed in Section 4.1.2 below). See Table 3-1 for a list of the 18 potential BART-eligible emitting units.

Nine of the potential BART-eligible sources have the potential to cause visibility impairment, and a detailed BART engineering analysis has been performed on these sources. These sources are potlines 3, 4 and 5 with their associated dry alumina scrubbers and roof vents. The other nine units have very low emission rates and were not analyzed for BART by CFAC. Table 4-1 lists the emissions units analyzed for BART by CFAC.

⁸ As defined by 40 CFR 51.301

⁹ Ibid.

Table 4-1: Sources Analyzed for BART

Modeled Emitting Units	Emission Rates (lbs/hr)			Detailed BART Analysis Performed?		
	SO ₂	PM ₁₀	NO _x	SO ₂	PM ₁₀	NO _x
028 - Dry Alumina Scrubber #5	58.22	0.09	0.00	Yes	No	No
029 - Dry Alumina Scrubber #6	58.22	0.09	0.00	Yes	No	No
030 - Dry Alumina Scrubber #7	58.22	0.09	0.00	Yes	No	No
031 - Dry Alumina Scrubber #8	58.22	0.09	0.00	Yes	No	No
032 - Dry Alumina Scrubber #9	58.22	0.09	0.00	Yes	No	No
033 - Dry Alumina Scrubber #10	58.22	0.09	0.00	Yes	No	No
036 - Potline 3 Roof Vents	8.76	16.60	0.00	Yes	Yes	No
037 - Potline 4 Roof Vents	8.76	16.60	0.00	Yes	Yes	No
038 - Potline 5 Roof Vents	8.76	16.60	0.00	Yes	Yes	No

4.1.2 Applicable Pollutants

The visibility-impairing pollutants analyzed in this BART analysis are:

- Sulfur dioxide (SO₂), and
- Particulate matter less than 10 microns (PM₁₀).

PM₁₀ is used as an indicator for particulate matter. As emissions of PM₁₀ include the components of PM_{2.5} as a subset, there is no need to have separate 250-ton thresholds for PM₁₀ and PM_{2.5}.

4.2 BART Analysis Methodology

In general terms, EPA has identified a methodology for conducting a BART analysis that is similar to the Best Available Control Technology analyses conducted under the PSD permitting program (40 CFR 51.166 and elsewhere). For BART, the methodology is more refined to include pollutants related to visibility impairment and to include an analysis of the impacts the proposed technology has on the visibility directly.

The BART methodology is a case-by-case procedure. The BART methodology chosen for this analysis follows the guidelines established by EPA in 40 CFR 51, Appendix Y. Hereafter these guidelines will be referred to as either the "Appendix Y Guideline" or simply "Appendix Y." Appendix Y suggests that the case-by-case BART analysis should follow the five steps below (Section IV.D of Appendix Y).

Case-by-Case Five Step BART Analysis:

- Step 1 - Identify all¹⁰ 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.

The following paragraphs will evaluate BART for each source or source group emitting any of the pollutants noted above as being released in significant quantities. BART for SO₂ and PM₁₀ emissions from the potlines, essentially the only source of these compounds, will be addressed first. As stated in Section 3.3, no BART analysis will be performed for the plant-wide NO_x emissions because they are below the *de minimis* threshold and are unlikely to contribute to regional haze.

As suggested by Appendix Y, CFAC reviewed the New Source Performance Standards (NSPS) Subpart S for primary aluminum reduction plants to determine if any control technologies or emission restrictions were applicable to new facilities. This review showed that NSPS for primary aluminum reduction plants applies only to fluoride emissions and opacity.

To facilitate the following BART determinations, CFAC queried the EPA RACT-BACT-LAER Clearinghouse (RBLC) database for listings of pollutant emission limits and required control technologies at other aluminum production facilities across the country. The information generated by these queries serves as a helpful guideline to indicate expected emission rate ranges and control technologies that may have been successfully applied at facilities similar to the CFAC plant.

4.3 SO₂ and PM₁₀ BART Analysis for the Potlines (Primary and Secondary Sources)

For the purposes of this BART analysis, CFAC has chosen to analyze SO₂ and PM₁₀ simultaneously. Although the primary and secondary sources can have independent controls, they are all part of the same source (the potlines), and most of the control options intertwine SO₂ and PM₁₀ control. Therefore, any visibility improvements have been modeled using both the SO₂ and PM₁₀ reductions achieved by the same control system.

SO₂ emissions in the CFAC electrolytic reduction plant are generated by oxidation of sulfur-bearing coke and pitch used in the manufacture of aluminum. The contract specifications for sulfur content (% by wt) of the anode raw materials are shown below:

¹⁰ Appendix Y notes that the term “all” refers to identifying the most stringent option and a reasonable set of options for analysis that reflect a comprehensive list of options. It is not necessary (according to Appendix Y) to list all permutations of available control levels for a given technology.

Material Analysis (1999)	% by Wt
Coke	1.5%
Pitch	0.7%

Sacrificial anode carbon is consumed at an overall rate of about 0.54 – 0.58 pounds of carbon per pound of aluminum. This consumption of sulfur-bearing carbon anodes accounts almost all of the SO₂ released in the process.

It is assumed that 100% of the sulfur present in the raw anode materials is converted to SO₂. CFAC estimates that 93% of the primary pot exhaust gas, which contains the SO₂, is collected by exhaust hoods and ducted to the dry alumina scrubbers. Secondary pot gases, the 7% of pot exhaust gases not collected by the exhaust hoods, are mixed with ambient potroom air and discharged through the roof vents. This secondary emission source has a very large volume with a very low concentration of SO₂.

4.3.1 Identify All Available SO₂ Retrofit Control Technologies – Step 1

In accordance with Step 1 described in Section 4.2 above, CFAC has sought to identify all “available” retrofit technologies. To that end, EPA’s RBLC describes several permitted aluminum plants and lists their pollutant emission limits and the control technologies approved to achieve those limits. Another source of information regarding potentially applicable SO₂ control technology for aluminum manufacturing is EPA’s AP-42 for Primary Aluminum Production (Chapter 12, Section 1). Finally, CFAC has used an independent engineering company with considerable aluminum plant experience to identify and judge applicability of potential control strategies. The following were identified as potentially applicable for controlling SO₂ from the potlines at CFAC:

- (i) Proper design and operation (baseline);
- (ii) Process alterations;
- (iii) Dry sorption/spray dry processes;
- (iv) Single alkali process wet SO₂ scrubber;
- (v) Dual alkali Na/Ca process wet SO₂ scrubber;
- (vi) Roof vent spray chamber SO₂ controls.

Process note pertaining to all candidate primary SO₂ removal processes:

The most prevalent FGD processes involve removing SO₂ from combustion exhaust streams such as those typically found in large coal-fired generation stations burning high sulfur (1-3%) coal. SO₂ removal processes in these installations have two characteristics quite different from those in the primary and secondary gases from electrolytic aluminum reduction plants:

- Higher concentrations of SO₂ (3000 ppm vs 300 ppm)
- Higher temperature reaction environments (up to 2500°F vs 250°F max)

Based on sulfur mass balance and volume/mass discharge rates for primary and secondary emission sources, CFAC estimates the following emission source gas conditions:

Typical SO₂ Emissions from Dry Alumina Scrubbers and Roof Monitors

Emission Source	Volume (ACFM)	SO₂ Concentration (ppmv)	Temperature (deg. F)
Primary Gas Emission Sources			
Potline 3	66,000	260	230
Potline 4	66,000	260	230
Potline 5	66,000	260	230
Secondary Gas Emission Sources			
Potline 3	6,080,000	<1.0	70
Potline 4	6,080,000	<1.0	70
Potline 5	6,080,000	<1.0	70

As shown, expected SO₂ concentrations in aluminum process flue gases (especially in the secondary gases) are much lower than those for standard fossil fuel flue gas.

Control Technology Description:

(i) Proper Design and Operation

The CFAC facility has been in operation since the 1950s and has followed the advancements in aluminum reduction technology. CFAC believes the current operation has efficiencies and operational procedures that are similar to other plants in the US. CFAC believes the facility has proper design and operation procedures.

(ii) Process Alterations – Reducing Primary and Secondary Emissions

1. **Improved Reduction Process (Anode) Efficiencies**
 The aluminum oxide reduction process consumes anode carbon to form CO₂ along with some CO. Any CO produced represents sub-optimal oxidation of carbon which corresponds to increased carbon consumption; therefore, SO₂ emissions. A process modification which increased the CO₂/CO ratio would have the effect of reducing SO₂ emissions.

2. **Improved Pot Line Fume Collection Efficiency**
 CFAC estimates overall fume collection efficiency at 93%. Therefore, 93% of the SO₂ emissions are currently ducted to the dry alumina scrubber. This serves as a collection method of SO₂, which could be routed to an effective SO₂ scrubber. Since 7% of the SO₂ escapes collection and is vented through the roof vents, the total potential for SO₂ emission reduction to be achieved by 100% collection is 7% of the 1645 tpy of SO₂

generated, or approximately 115 tons. This assumes 100% SO₂ scrubbing efficiency.

3. Coke and Pitch Sulfur Content Reduction

One method to reduce sulfur dioxide emissions is to use an anode petroleum coke and pitch with lower percent sulfur than is currently used. By reducing the amount of sulfur in the coke and pitch used in the process, the generation of SO₂ is reduced proportionally.

(iii) Dry Sorption/Spray Dry Process Applied to the Primary Sources

The term Spray Dryer Absorber (SDA) here refers to those technologies that inject a dry, semi-dry or semi-wet alkaline solution/suspension either directly into the boiler furnace combustion stream or into hot flue gas streams prior to baghouse filters and/or electrostatic precipitators (ESP) to control SO₂ emissions. An SDA could be applied to the gas stream currently ducted to the dry alumina scrubbers.

The resulting reactants (along with process particulates and spent reagent) are removed as dry solids. The simplicity of this process makes it attractive in boiler/furnace retrofit applications because, in most applications, baghouse/ESP collection/disposal mechanisms are already in place. SO₂ removal efficiencies are generally limited to ~70%. Optimum SO₂ reductions using limestone require significant excess reactants (75%) and very finely ground reagents. The flue stream is cooled by evaporation of the injected slurry and the SO₂ removal reaction takes place on the surface of the finely divided solid alkali at temperatures between 350°F and 1000°F.

(iv) Single Alkali Wet SO₂ Scrubber Applied to the Primary Sources

A wet SO₂ scrubber is one that uses an aqueous chemical system. These systems have been successfully employed in various industries to remove SO₂ from concentrated exhaust streams. These systems use aqueous solutions or slurries as the contact and reaction media. A typical installation uses spray tower scrubbers to introduce a reagent slurry as atomized droplets through the spray nozzles at the top of, or in stages within, the scrubber. The SO₂-laden gas enters at the bottom of the column and travels upward through the tower in a countercurrent flow, although horizontal spray towers which use a crosscurrent design also exist. In most cases the sorbent is an alkaline slurry, commonly limestone, slaked lime, caustic soda/soda ash or a mixture of slaked lime and alkaline fly ash, although many other sorbent processes exist. Absorption of SO₂ is accomplished by the contact between the gas and the reagent slurry. The sulfur oxides react with the sorbent, forming a wet mixture of alkali (sodium or calcium) sulfite and sulfate.

The slurry combines with the SO₂-laden waste gas to form a waste slurry in the bottom of the scrubber. The sludge is removed from the scrubber and, depending upon the reagent or sorbent used to react with the SO₂, the waste reacted sludge is disposed of, recycled or regenerated, or, in some cases, sold as a salable product.

The highest efficiencies are obtained with sodium-based processes; however, in a single pass sodium-based process, feed stock reagents are not regenerated or recovered and reaction by-products (sodium sulfates) are typically of little commercial value and must ultimately be treated as controlled landfill material. This process achieves good efficiencies at temperatures between 200-1000°F, particularly with caustic soda.

(v) Dual Alkali Wet SO₂ Scrubber Applied to the Primary Sources

The Dual Alkali process has not been as widely accepted in boiler/furnace applications as the limestone/lime slurry processes, but has the process advantage of separating the SO₂ absorption and sulfite/sulfate precipitation operations. Dual Alkali systems utilize higher efficiency (albeit higher cost) sodium reactants in the first (absorber) stage and lower cost (calcium) reactants in the second (precipitation) stage. The relatively more expensive sodium reactants are regenerated during the precipitation stage and are re-circulated to the primary scrubbers. More process steps are required, but removal efficiencies over 90% can be obtained with sodium based reagents even at lower flue gas temperatures (200-300°F).

(vi) Roof Vent SO₂ Controls Applied to the Secondary Sources

CFAC has investigated the use of spray chamber type roof vent controls. This system consists of roof-mounted water spray chambers (no other reactants used) to capture and remove SO₂ and PM₁₀ from the roof vent exhaust stream. Parallel systems of multiple modules can be employed. The high volume secondary exhaust streams are captured by dormer outlets in the roof, and inducted by low pressure, high volume fans through large chambers fitted with multiple spray bars. SO₂ is readily absorbed in the airborne liquid droplets and particulate is captured by impingement. Efficiencies of 50% for both SO₂ and particulate have been reported.

4.3.2 Eliminate Technically Infeasible SO₂ Control Options – Step 2

This section discusses the feasibility or infeasibility of each technology identified in Section 4.3.1 above. The decision regarding whether a particular technology was deemed “technically feasible” was based on discussions found in 40 CFR 51, Appendix Y. Appendix Y describes guidelines for BART determinations under the regional haze rule.

The issue of feasibility is found in Section IV.2.STEP 2 of the Appendix Y Guideline. The Guideline states that 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) the technology could be applied to the source under review.”*

The Appendix Y Guideline goes on to describe these circumstances further and discuss the meaning of “available” and “applicability” within the meaning of BART. As a general rule, “available” means that the owner of the facility may obtain the technology through

commercial channels. In the alternative, the technology is “available” within the common sense meaning of that term.

Commercially available is further discussed in the Appendix Y Guideline as having attained either stage (5) or (6) of the following stages of bringing a control technology to reality as a commercial product:

- (1) Concept stage;
- (2) Research and patenting;
- (3) Bench scale or laboratory testing;
- (4) Pilot scale testing;
- (5) Licensing and commercial demonstration; and
- (6) Commercial sales.

Also of note in the Appendix Y Guideline is the following statement:

Similarly, we do not expect a source owner to conduct extended trials to learn how to apply a technology on a totally new and dissimilar source type. Consequently, you would not consider technologies in the pilot scale testing stages of development as “available” for purposes of BART review.

The reader is referred to further discussion in the Appendix Y Guideline on this matter.

Using the Appendix Y Guideline, infeasible technologies are rejected where appropriate. Those technologies deemed infeasible are no longer discussed in further sections of this BART analysis.

(i) Proper Design and Operation

Proper design and operation is clearly feasible and serves as the baseline case.

Conclusion: Proper design and operation is considered feasible for purposes of Step 2 in this BART analysis.

(ii) Process Alterations

1. Improved Reduction Process (Anode) Efficiencies

Engineering refinements over the last 50 years have reduced the carbon consumption from approximately 0.7 lb of carbon per pound of Al in the 1950s to present levels of approximately 0.54 to 0.58 lb of carbon per pound of Al. The stoichiometric lower limit to the carbon consumption is approximately 0.33 lb of carbon per pound of Al, which implies that, at best, a 40% reduction is possible. Significant process improvements over the current efficiency, while highly desirable, are very difficult to achieve and must be categorized as technically experimental at this point.

Conclusion: This process alteration is considered technically infeasible for purposes of Step 2 in this BART analysis. No further discussion of this technology will be presented.

2. Improved Pot Line Fume Collection Efficiency

The current overall efficiency of the fume collection system at CFAC is estimated at 93%. CFAC believes that the design of the current exhaust hoods is typical of the industry in the US. CFAC is not aware of exhaust hoods with newer design or better capture efficiencies for vertical stud soderberg aluminum reduction facilities. CFAC believes that added exhaust hood capture efficiency would be experimental in nature and could only come at the expense of access to the pots for normal operations and interference with the existing process.

Conclusion: This technology is considered technically infeasible for purposes of Step 2 in this BART analysis. No further discussion of this technology will be presented.

3. Coke Sulfur Content Reduction

In the aluminum smelting industry, most smelters use a petroleum coke with approximately 2.5% sulfur content. CFAC believes this is the norm worldwide. CFAC has used 1.5% sulfur coke for many years to keep sulfur dioxide emissions as low as possible. CFAC has a contractual coke percent sulfur limit of 1.5% with its supplier. To CFAC's knowledge, the 1.5% sulfur coke used by CFAC is the lowest sulfur content coke available from United States sources. There may be petroleum cokes offered from overseas sources that have lower sulfur content.

CFAC's 1.5% sulfur petroleum coke, although low in sulfur, is not the best petroleum coke for aluminum production. To improve anode operation, which would reduce anode carbon use and the resulting carbon monoxide and carbon dioxide emissions, CFAC would need to switch to a higher sulfur coke.

CFAC uses a pitch with a sulfur content of 0.7%. CFAC is not aware of any pitch available with a lower sulfur content.

Conclusion: Using a coke with a lower sulfur content is considered feasible for purposes of Step 2 in this BART analysis. Using a pitch with a lower sulfur content is not considered feasible for purposes of Step 2 in this BART analysis. All further discussion of this technology will refer to reduced coke sulfur content only.

(iii) Dry Sorption/Spray Dry Process Applied to the Primary Sources

The "Dry Sorbent" and "Spray Dry" processes are primarily designed for treatment of high-temperature, high-sulfur content combustion flue gases such as those found in

large power generation stations. In these applications, the most efficient alkali sulfate formation takes place at temperatures between 1000 - 2000°F and in spray dry systems the flue gas must be cooled to a temperature of 10°C to 15°C (20°F to 35°F) below saturation temperature to avoid wet solids deposition and plugging on the downstream particulate device. The reaction conditions at the pot-line scrubber exit (260°F and 100-300 ppm of SO₂) are too cool and too dilute for these “dry” processes to be considered effective. To apply the Spray Dry process to the CFAC primary emissions, the exhaust stream would have to be significantly pre-heated to at least 350°F. This option would also require retrofitting the existing process with a particulate control device such as a baghouse or electrostatic precipitator.

Conclusion: This process alteration is considered technically infeasible for purposes of Step 2 in this BART analysis. No further discussion of this technology will be presented.

(iv) Single Alkali Wet SO₂ Scrubber Applied to the Primary Sources

The single alkali “throw-away” processes involve non-recoverable use of the calcium/sodium reagents. In the case of caustic soda and/or soda ash, the higher inherent reaction efficiency of the sodium compounds is more than offset by their higher materials cost coupled with their one-pass consumption. In the case of the sodium-based processes, disposal of the soluble sulfate waste products may pose groundwater leaching issues. The calcium-based systems require tight process control to prevent scaling problems in flues and scrubbers. Sodium-based systems operate with less scaling and freeze at a lower temperature than simple slurries such as lime or limestone. All of the wet scrubber designs suffer from freezing issues when operated in a northerly climate with the cold temperatures normally found at the CFAC facility in wintertime. In fact, EPA considered this when developing the NESHAP for Primary Aluminum Reduction Plants (40 CFR 63 Subpart LL), Basis and Purpose document.

Conclusion: This technology is considered feasible for purposes of Step 2 in this BART analysis.

(v) Dual Alkali Wet SO₂ Scrubber Applied to the Primary Sources

The Dual Alkali process also facilitates the precipitation and settling or filtration of the calcium sulfates and recycles the caustic solution to the scrubber. This can significantly reduce makeup water and discharge requirements. All of the wet scrubber designs suffer from freezing issues when operated in a northerly climate with the cold temperatures normally found at the CFAC facility in wintertime.

Conclusion: This technology is considered feasible for purposes of Step 2 in this BART analysis.

(vi) Roof Vent SO₂ Controls Applied to the Secondary Sources

Aluminum industry installations have successfully used spray chambers to capture fugitive pot line gases. One process reviewed used a water spray (no reagents) to

achieve ~50% removal of SO₂ and ~50% removal of total particulates. An advantage of this process over cloth filter baghouses is that this process not only removes particulate fluorides, but gaseous fluoride as well. Operation of this wet scrubber may be limited to non-winter months. It is anticipated that the wet roof scrubber would not be operable in winter conditions due to freezing issues. For purposes of this analysis, year-round operation has been assumed.

Conclusion: This technology is considered feasible for purposes of Step 2 in this BART analysis.

4.3.3 Evaluate Control Effectiveness of Remaining Control Technologies – Step 3

Of the alternative SO₂ control technologies identified above, proper potline design and operation, a process alteration (coke sulfur content reduction), single alkali wet SO₂ scrubbers, dual alkali wet SO₂ scrubbers, and roof vent SO₂ controls remain as technically feasible options. Proper design and operation is the baseline case for this analysis. The other listed control methods will be evaluated for their potential to improve upon this basis. Table 4-2 summarizes the control effectiveness of the remaining control technologies.

Table 4-2: Summary of SO₂ Control Technology Efficiency

Control Option	Efficiency (%)
Dual Alkali Wet SO ₂ Scrubber	90% on primary sources
Single Alkali Wet SO ₂ Scrubber	90% on primary sources
Roof Vent Controls	50% on secondary sources
Coke Sulfur Reduction	42% on both primary and secondary sources
Baseline	0%

4.3.4 Evaluate Impacts and Document Results – Step 4

(a) Coke Sulfur Content Reduction Impacts

Coke Sulfur Content Reduction Environmental Impacts

CFAC is not aware of any indirect or direct environmental impacts associated with using low sulfur coke other than those associated with shipping this coke from outside the US to CFAC.

Coke Sulfur Content Reduction Economic Impacts

CFAC believes there may be petroleum cokes offered from overseas sources that have sulfur contents as low as 0.5 to 0.75%. For the purposes of this study, and based on CFAC's experience, a 0.75% sulfur coke was used as the basis for this analysis. The cost for this extremely low sulfur coke delivered from offshore sources would be approximately \$160/short ton greater than the cost of the currently used 1.5% sulfur

coke. CFAC consumed approximately 44,248 short tons of anode coke in 1999, the highest year of production to occur recently. The increased cost for a 0.75% sulfur coke would be approximately 44,248 short ton/year x \$160/short ton = \$7,079,680/year.

Coke Sulfur Content Reduction Energy Impacts

CFAC is not aware of any indirect or direct energy impacts associated with using low sulfur coke.

(b) Single Alkali Wet SO₂ Scrubber Impacts

Single Alkali Wet SO₂ Scrubber Environmental Impacts

In the case of the sodium-based processes, disposal of the soluble sulfate waste products may pose groundwater leaching issues. The calcium-based systems require tight process control to prevent scaling problems in flues and scrubbers. The highest SO₂ recovery rates are obtained with sodium-based processes; however, in a single pass process, feed stock reagents are not regenerated or recovered and reaction by-products (sodium sulfates) are typically of little commercial value and must be treated as a leaching landfill material. This control option also puts greater demand on CFAC's water supply and wastewater treatment facilities. The impacts of these effects have not been studied.

Single Alkali Wet SO₂ Scrubber Economic Impacts

CFAC has calculated the cost-effectiveness for employing a single alkali wet SO₂ scrubber for SO₂ control, with the results presented in Table 4-3 below. CFAC has utilized the EPA's Air Pollution Cost Control Manual to estimate costs of SO₂ scrubber control. The manual provides the EPA's recommended methodology for estimating the costs for add-on control technology. To calculate the cost-effectiveness of a control technology in dollars per ton (\$/ton), the following factors are used:

Cost-effectiveness (\$/ton) = [(total capital investment x capital recovery factor {CRF}) + Direct Annual Cost + Indirect Annual Cost]/(tons SO₂ controlled)

Capital Recovery Cost = (total capital investment x CRF)

- Total capital investment = direct and indirect costs for purchasing and installing control equipment.
 - Capital recovery factor (CRF) = multiplier to determine the uniform end-of-year payment necessary to repay an investment in n years with an interest rate of i .
 - Control system life, $n = 10$ to 20 years, typically
 - Interest rate, $i = 7\%$ recommended interest rate
- For this BART analysis, CRF = 10 years @ 7% = 0.142*

Direct Annual Cost (utilities, labor, taxes)

Indirect Annual Cost (overhead, insurance, taxes)

Table 4-3 summarizes the cost-effectiveness for each of the technically feasible control options, compared against a baseline of proper design and operation. Details of the single alkali wet SO₂ scrubber cost analysis can be found in Appendix C.

Single Alkali Wet SO₂ Scrubber Energy Impacts

EPA Publication EPA-542/F-03-034 states that modern wet scrubber designs result in an energy penalty of less than 1% of the total plant energy consumption. This is a minor energy impact which is only further considered in the economic analysis.

(c) Dual Alkali Wet SO₂ Scrubber Impacts

Dual Alkali Wet SO₂ Scrubber Environmental Impacts

The dual alkali process facilitates the precipitation and settling or filtration of the calcium sulfates and recycles the caustic solution to the scrubber. This can significantly reduce makeup water and discharge requirements over that of the single alkali system. This control option also puts greater demand on CFAC's water supply and wastewater treatment facilities. The impacts of these effects have not been studied.

Dual Alkali Wet SO₂ Scrubber Economic Impacts

CFAC has calculated the cost-effectiveness for employing a dual pass alkali wet SO₂ scrubber for SO₂ control, with the results presented in Table 4-3 below. CFAC has utilized the EPA's Air Pollution Cost Control Manual to estimate costs of the dual pass system.

Dual Alkali Wet SO₂ Scrubber Energy Impacts

EPA Publication EPA-542/F-03-034 states that modern wet scrubber designs result in an energy penalty of less than 1% of the total plant energy consumption. This is a minor energy impact which is only further considered in the economic analysis.

(d) Roof Vent SO₂ Control Impacts

Roof Vent Control: Water Spray Chamber Environmental Impacts

This system acts as a simplified wet scrubber, only without a reaction tower, and using only water (no reagent). Nevertheless, the environmental impacts of this system are similar to those of a single pass wet scrubber. As SO₂ is collected by the system, it is converted through chemical process to sodium sulfate. Both the sodium sulfate and collected particulate matter are discharged to a settling pond through the blowdown water. Sodium hydroxide used to treat the settling pond is not regenerated or recovered. Reaction by-products (sodium sulfates) are typically of little commercial value and must be landfilled. In the case of this sodium-based process, disposal of the soluble sulfate waste products, either on-site or in a landfill may pose groundwater leaching issues.

CFAC estimates the total water consumption of this system at 700 gallons per minute (200 gpm blowdown plus 500 gpm evaporation rate during the summer). This control option puts a great demand on CFAC's water supply. The impact of this water consumption rate has not been studied.

Roof Vent Control: Water Spray Chamber Economic Impacts

CFAC has calculated the cost-effectiveness of employing a water spray chamber for SO₂ control, with the results presented in Table 4-4 below. CFAC has utilized EPA's Air Pollution Cost Control methodology to estimate costs of the water spray chamber. Details of the water spray chamber cost analysis can be found in Appendix C.

Roof Vent Control: Water Spray Chamber Energy Impacts

EPA Publication EPA-542/F-03-034 states that modern wet scrubber designs result in an energy penalty of less than 1% of the total plant energy consumption. This is a minor energy impact which is only further considered in the economic analysis.

Alternatives Analysis Summary

For the purposes of this cost analysis, it has been assumed that the remaining life of all of the equipment is at least the 10 years used to calculate the annualized costs.

Primary Sources

There are two separate sources of SO₂ emissions: primary and secondary. The primary sources include the six dry alumina scrubbers (EU28 through EU33) and the secondary sources are the potline roof vents (EU34 through EU38). Table 4-3 summarizes the cost analysis for the remaining feasible controls for the primary SO₂-emitting sources.

Table 4-3: Summary of Primary SO₂ Emissions Cost and Visibility Impacts

Control Option	Capital Cost	Annualized Cost ^a	Efficiency (%)	SO ₂ Emitted (tpy)	SO ₂ Removed (tpy)	Cost ^b (\$/ton)	Glacier Nat'l Park		
							SO ₂ Impact (deciview)	Deciviews Removed (24 hr - Δ)	Cost (\$/dc)
Dual Alkali Wet SO ₂ Scrubber	\$50,581,438	\$12,142,136	90%	153	1,377	\$8,817	2.605	1.279	\$9,490,987
Single Alkali Wet SO ₂ Scrubber	\$34,883,750	\$9,422,298	90%	153	1,377	\$6,842	2.605	1.279	\$7,365,006
Coke Sulfur Content Reduction	\$0	\$7,079,680	42%	887	643	\$10,245	3.267	0.617	\$11,480,562
Baseline	\$0	\$0	0%	1,530	0	--	3.884	0.00	--

^aNote: The annualized cost for coke sulfur content reduction is calculated using the increased cost per anode coke \$160/short ton x 44,248 tpy (1999 production) = \$7,079,680/yr.

^bNote: The cost per ton of SO₂ removed from coke sulfur content reduction is calculated from using the facility-wide SO₂ emissions of 1645 tpy (1530 tpy primary + 115 tpy secondary emissions).

Secondary Sources

Table 4-4 summarizes the cost analysis for the remaining feasible controls for the secondary SO₂-emitting sources.

Table 4-4: Summary of Secondary SO₂ Emissions Cost and Visibility Impacts

Control Option	Capital Cost	Annualized Cost	Efficiency (%)	SO ₂ Emitted (tpy)	SO ₂ Removed (tpy)	Cost (\$/ton)	Glacier Nat'l Park		
							SO ₂ Impact (deciview)	Deciviews Removed (24 hr - Δ)	Cost (\$/dc)
Roof Vent Spray Room SO ₂ Control	\$33,476,076	\$12,096,206	50%	58	58	\$210,057	3.020	0.864	\$13,994,839
Coke Sulfur Content Reduction	\$0	\$7,079,680	42%	67	48	\$10,245	3.267	0.617	\$11,480,562
Baseline	\$0	\$0	0%	115	0	--	3.884	0.00	--

^aNote: The annualized cost for coke sulfur content reduction is calculated using the increased cost per anode coke \$160/short ton x 44,248 tpy (1999 production) = \$7,079,680/yr.

^bNote: The cost per ton of SO₂ removed from coke sulfur content reduction is calculated from using the facility-wide SO₂ emissions of 1645 tpy (1530 tpy primary + 115 tpy secondary emissions).

4.3.5 Evaluate Primary Controls Visibility Impacts – Step 5

CFAC has performed modeling using the CALPUFF model to predict visibility impacts of the identified potentially applicable SO₂ control technologies, using the 98th percentile visibility result as recommended by EPA. The results of the modeling are shown in Table 4-3 above. The results are only presented for Glacier National Park receptors, as it is the closest and most impacted Class I Area. Details of the modeling are found in Appendix B of this document.

4.3.6 Evaluate Secondary Controls Visibility Impacts – Step 5

CFAC has performed modeling using the CALPUFF model to predict visibility impacts of the identified potentially applicable SO₂ control technologies, using the 98th percentile visibility result as recommended by EPA. The results of the modeling are shown in Table 4-4 above. The results are only presented for Glacier National Park receptors, as it is the closest and most impacted Class I Area. Details of the modeling are found in Appendix B of this document.

4.3.7 Select SO₂ BART

The purpose of BART is to apply a control technology that would improve the visibility to a degree that would be beneficial to the area analyzed in a cost-effective manner. In the case of the CFAC facility, the cost, efficiency and visibility improvement from any SO₂ and PM₁₀ controls is inter-related. Section 4.4 analyzes the control options for the secondary PM₁₀ emissions. An analysis was performed using the combination of SO₂

primary and secondary controls in conjunction with PM₁₀ secondary controls to determine an overall BART selection. The combination of SO₂ and PM₁₀ controls showed possible scenarios for visibility improvements. See Section 4.5 for the overall BART selection.

4.4 BART Analysis for PM₁₀ from the Potline Roof Vents

4.4.1 Identify Available Particulate Control Technologies – Step 1

EPA's RBLC describes several permitted aluminum plants and lists their pollutant emission limits and the control technologies approved to achieve those limits. Another source of information regarding potentially applicable PM₁₀ control technology for aluminum manufacturing is EPA's AP-42 for Primary Aluminum Production (Chapter 12, Section 1). The PM₁₀ emissions from the primary emitting sources are very small and had a negligible modeled impact on visibility; however, the PM₁₀ emissions from the secondary emitting sources were predicted by the model to cause the most significant degradation to the visibility in Glacier National Park and are further analyzed below.

The secondary particulate emissions are fugitive emissions released from the roof vents on the top of the potline buildings. There are several components to these fugitive particulate emissions. CFAC estimates a fraction (7%) of potline gases are not collected by the exhaust hoods and then routed to the dry alumina scrubbers. Emissions from reduction cells include alumina and carbon from anode dusting, cryolite, aluminum fluoride, calcium fluoride, chiolite (Na₅Al₃F₁₄), and ferric oxide. Fugitive dust is also generated by normal potline operations within the buildings, including particulate from materials handling and vehicle traffic.

The following were identified as potentially applicable for controlling PM₁₀ from the secondary emitting sources at the facility:

- (i) Proper potline design and operation (baseline),
- (ii) Roof Vent Controls (Baghouses + Water Spray Chamber)

Control Technology Description:

(i) Proper Potline Design and Operation

The CFAC facility has been in operation since the 1950s and has followed the advancements in aluminum reduction technology. CFAC believes the current operation has similar efficiencies and operational procedures to other plants in the US. Therefore, CFAC believes the facility has proper design and operation procedures.

(ii) Roof Vent Controls

1. Fabric Filter Baghouse

It would be possible to collect the air flow currently vented through the roof vents and direct the flow to a series of baghouses. The air flow passes

through tightly woven or felted fabric, causing particulates in the flow to be collected on the fabric by sieving and other mechanisms. As particulate collects on the filter, collection efficiency increases while pressure drop through the system increases. Bags are intermittently cleaned by shaking the bag, pulsing air through the bag, or temporarily reversing the airflow direction.

2. Water Spray Chamber

CFAC has investigated the use of spray chamber type roof vent controls. This system consists of roof-mounted water spray chambers (no other reactants used) to capture and remove SO₂ and PM₁₀ from the roof vent exhaust stream. Parallel systems of multiple modules can be employed. The high volume secondary exhaust streams are captured by dormer outlets in the roof, and inducted by low pressure, high volume fans through large chambers fitted with multiple spray bars. SO₂ is readily absorbed in the airborne liquid droplets and particulate is captured by impingement. Efficiencies of 50% for both SO₂ and particulate have been reported.

4.4.2 Eliminate Technically Infeasible PM₁₀ Control Options – Step 2

(i) Proper Potline Design and Operation

Proper potline design and operation is considered baseline and is technically feasible.

Conclusion: This technology is considered technically feasible for purposes of Step 2 in this BART analysis.

(ii) Roof Vent Controls

1. Although CFAC is not aware of an aluminum production facility which incorporates roof vent baghouse control, the technology is mature and there are no known technical challenges with this type of installation.

Conclusion: This technology is considered technically feasible for purposes of Step 2 in this BART analysis.

2. Aluminum industry installations have successfully used spray chambers to capture fugitive potline gases. One process reviewed used a water spray (no reagents) to achieve approximately 50% removal of SO₂ and approximately 50% removal of total particulates. An advantage of this process over a cloth filter baghouse is that the process not only removes particulate fluorides, but gaseous fluoride as well. A disadvantage to the operation of this wet scrubber is that the wet roof scrubber would probably not be operable in winter conditions due to freezing issues. For purposes of this analysis, year-round operation has been assumed.

Conclusion: This technology is considered technically feasible for purposes of Step 2 in this BART analysis.

4.4.3 Evaluate Control Effectiveness of Remaining PM₁₀ Control Technologies – Step 3

Of the alternative PM₁₀ control technologies identified above, proper potline design and operation, roof vent baghouse control and roof vent water spray chamber control remain as technically feasible options. Proper design and operation is the baseline case for this analysis. The other listed control methods will be evaluated for their potential to improve upon this basis. Table 4-5 summarizes the control effectiveness of the remaining control technologies.

Table 4-5: Secondary Emissions (Potline Roof Vent) PM₁₀ Control Technology Effectiveness

Control Option	Efficiency (%)
Roof Vent Baghouse Control	99%
Roof Vent Water Spray Chamber Control	50%
Baseline	0%

4.4.4 Evaluate Impacts and Document Results – Step 4

(a) Roof Vent Control: Baghouse

Roof Vent Control: Baghouse Environmental Impacts

CFAC is not aware of any severe adverse environmental impacts of operation of a baghouse system. A baghouse system of this magnitude would greatly increase facility auxiliary electrical power requirements; so environmental impacts would result from the generation of this additional electrical power. Also captured particulate would be disposed in a landfill and this may have some local environmental impacts.

Roof Vent Control: Baghouse Economic Impacts

CFAC has calculated the cost-effectiveness for employing a series of very large baghouses for PM₁₀ control, with the results presented in Table 4-6 below. CFAC has utilized the EPA's Air Pollution Cost Control Manual to estimate the costs of PM₁₀ baghouse control. The manual provides the EPA's recommended methodology for estimating the costs for add-on control technology. To calculate the cost-effectiveness of a control technology in dollars per ton (\$/ton), the following factors are used:

$$\text{Cost-effectiveness (\$/ton)} = [(\text{total capital investment} \times \text{capital recovery factor \{CRF\}}) + \text{Direct Annual Cost} + \text{Indirect Annual Cost}] / (\text{tons PM}_{10} \text{ controlled})$$

$$\text{Capital Recovery Cost} = (\text{total capital investment} \times \text{CRF})$$

- Total capital investment = direct and indirect costs for purchasing and installing control equipment.
- Capital recovery factor (CRF) = multiplier to determine the uniform end-of-year payment necessary to repay an investment in n years with an interest rate of i .
 - Control system life, $n = 10$ to 20 years, typically
 - Interest rate, $I = 7\%$ recommended interest rate

For this BART analysis, CRF = 10 years @ 7% = 0.142

Direct Annual Cost (utilities, labor, taxes)

Indirect Annual Cost (overhead, insurance, taxes)

Table 4-6 summarizes the cost-effectiveness for baghouse control, compared against a baseline of proper design and operation. Details and the technical basis of the baghouse cost analysis can be found in Appendix C.

Roof Vent Control: Baghouse Energy Impacts

CFAC estimates that operation of the fans required to power the baghouses would consume approximately 7,500,000 kwh per year of electricity. This energy impact is only further considered in the economic analysis.

(b) Roof Vent Control: Water Spray Chamber

Roof Vent Control: Water Spray Chamber Environmental Impacts

This system acts as a simplified wet scrubber, only without a reaction tower, and using only water (no reagent). Nevertheless, the environmental impacts of this system are similar to those of a single pass wet scrubber, as SO_2 is collected by the system, it is converted through chemical process to sodium sulfate. Both the sodium sulfate and collected particulate matter are discharged to a settling pond through the blowdown water. Sodium hydroxide used to treat the settling pond is not regenerated or recovered. Reaction by-products (sodium sulfates) are typically of little commercial value and must be landfilled. In the case of this sodium-based process, disposal of the soluble sulfate waste products, either on-site or in a landfill may pose groundwater leaching issues.

CFAC estimates the total water consumption of this system at 700 gallons per minute (200 gpm blowdown plus 500 gpm evaporation rate during the summer). This control option puts a great demand on CFAC's water supply. The impacts of this water consumption rate have not been studied.

Roof Vent Control: Water Spray Chamber Economic Impacts

CFAC has calculated the cost-effectiveness of employing a water spray chamber for PM_{10} control, with the results presented in Table 4-6 below. CFAC has utilized EPA's Air Pollution Cost Control methodology to estimate costs of the water spray chamber. Details of the water spray chamber cost analysis can be found in Appendix C.

Roof Vent Control: Water Spray Chamber Energy Impacts

EPA Publication EPA-542/F-03-034 states that modern wet scrubber designs result in an energy penalty of less than 1% of the total plant energy consumption. This is a minor energy impact which is only further considered in the economic analysis.

Alternatives Analysis Summary

For the purposes of this cost analysis, it has been assumed that the remaining life of all of the equipment is at least the 10 years used to calculate the annualized costs.

Table 4-6 summarizes the cost analysis and visibility impacts for the remaining feasible controls for the **secondary** PM/PM₁₀ emitting sources.

Table 4-6: Summary of Secondary PM₁₀ Emissions Cost and Visibility Impacts

Control Option	Capital Cost	Annualized Cost	Efficiency (%)	PM ₁₀ Emitted ^a (tpy)	PM ₁₀ Removed (tpy)	Cost (\$/ton)	Glacier Nat'l Park		
							PM ₁₀ Impact (deciview)	Deciviews Removed (24 hr - Δ)	Cost (\$/dc)
Roof Vent PM ₁₀ Control: Baghouse	\$556,716,625	\$104,151,834	99%	2.18	216	\$482,587	2.359	1.525	\$68,281,360
Roof Vent PM ₁₀ Control: Water Spray Chamber	\$33,476,076	\$12,096,206	50%	109	109	\$110,974	3.020	0.864	\$13,994,839
Baseline		\$0	0%	218	0	--	3.88	0.00	--

^aNote: The spray chamber reduces both SO₂ and PM₁₀ emissions; therefore, visibility impacts, improvements, and cost per deciview for the spray room include SO₂ emissions.

4.4.5 Evaluate PM₁₀ Visibility Impacts – Step 5

CFAC has performed modeling using the CALPUFF model to predict visibility impacts of the identified potentially applicable PM₁₀ control technologies, using the 98th percentile visibility result as recommended by EPA. The results of the modeling are shown in Table 4-6 above. The results are only presented for Glacier National Park receptors, as it is the closest and most impacted Class I Area. Details of the modeling are found in Appendix B of this document.

4.4.6 Select Secondary Source PM₁₀ BART

The purpose of BART is to apply a control technology that would improve the visibility to a degree that would be beneficial to the area analyzed in a cost-effective manner. In the case of the CFAC facility, the cost, efficiency and visibility improvement from any SO₂ and PM₁₀ controls is inter-related. The previous section, Section 4.3, analyzes the control options for the primary and secondary SO₂ emissions. An analysis was performed using the combination of SO₂ primary and secondary controls in conjunction

with PM₁₀ secondary controls to determine an overall BART selection. The combination of SO₂ and PM₁₀ controls showed possible scenarios for visibility improvements. See Section 4.5 for the overall BART selection.

4.5 Select Overall BART

Sections 4.3 and 4.4 have provided a framework for analyzing various control technologies, eliminating infeasible options, and evaluating control effectiveness, control impacts and visibility impacts. The analyses have been related to PM₁₀ and SO₂. Given that these previous sections have identified those available options and their relative impacts, it is the purpose of this section to consider all of the options in their entirety and select BART for this facility.

Similar to prior discussions, the methodology for selecting an appropriate BART will generally follow the discussions found in the Appendix Y Guideline¹¹. Much of that discussion is found in Section IV.E of the Guideline (also found on pages 39170 and 39171 of the July 6, 2005 *Federal Register*). That discussion is labelled as: “How do I select the ‘best’ alternative using the results of Steps 1 through 5.” For our case, steps 1 through 5 in the title refer to steps 1 through 5 found in the discussions in Sections 4.3 and 4.4 above.

There are a total of five discussion points found in Section E. For CFAC, only the first three are relative since the fourth and fifth points relate solely to utility boilers. The three remaining points for discussion regarding the selection of BART are:¹²

1. Summary of the impacts,
2. Selecting a “best” alternative,
3. Consideration of affordability (paraphrased).

These three steps will be considered in concert with the SO₂ and PM₁₀ analysis in prior sections to select BART for this facility. As noted in earlier discussions, it was decided to include analyses of PM₁₀ and SO₂ together in this final section since both pollutants play a potential role in visibility analysis as well as in control technology considerations.

4.5.1 Summary of Impacts – Section E, Item 1

The Appendix Y Guideline suggests that a chart or charts be developed that displays, for comparison purposes, parameters such as emission rate, emission reductions (by control alternative), control costs and air and non-air impacts. However, for this to be useful, it is necessary to consider both the PM₁₀ and SO₂ emission strategies previously discussed in Sections 4.3 and 4.4 and to review impacts and costs associated with not only each pollutant separately, but as a combined analysis. To that end, Table 4-7 below has been created that compares a number of reasonable scenarios that would be considered “feasible” prior to analysis of costs and benefits.

¹¹ 40 CFR 51, Appendix Y.

¹² 40 CFR 51, Appendix Y, Section E, Subsections 1 through 3.

The combined primary SO₂ and PM₁₀, and secondary PM₁₀ BART analysis offered many possible combinations of technologies for analysis. In order to simplify the BART selection process, the single pass wet SO₂ scrubber has been removed from the following analysis. CFAC views the single pass and dual pass wet scrubbers as similar technologies. The single pass wet SO₂ scrubber has the same control efficiency as a dual pass wet SO₂ scrubber, has similar annualized costs, and poses greater potential environmental hazards. CFAC viewed the single pass system as redundant, and has only analyzed the dual pass wet SO₂ scrubber in the following sections.

Table 4-7: Summary of Potential BART Scenarios

Scenario	Description	Primary Sources		Secondary Sources		Explanation
		SO ₂ Emissions % Reduction	PM ₁₀ Emissions % Reduction	SO ₂ Emissions % Reduction	PM ₁₀ Emissions % Reduction	
Baseline	Existing Controls	-	-	-	-	As the facility is currently configured.
1	Coke Sulfur Content Reduction	42%	0%	42%	0%	Purchase and use low-sulfur anode-grade petroleum coke.
2	Roof Vent Spray Chamber SO ₂ & PM Controls	0%	0%	50%	50%	Collect gases vented from roof vents and add a water spray scrubber that removes modest amounts of PM ₁₀ and SO ₂ .
2a	Roof Vent Spray Chamber SO ₂ & PM Controls and Sulfur Reduction in Coke	42%	0%	71%	50%	Scenarios 1 and 2 combined.
3	Wet Scrubber SO ₂ Controls	90%	0%	0%	0%	Add a wet scrubber (single or dual alkali) to the flue gas following (or preceding) the current alumina scrubbers.
3a	Wet Scrubber SO ₂ Controls and Sulfur Reduction in Coke	94%	0%	42%	0%	Combination of Scenarios 1 and 3.
4	Roof Vent Baghouse	0%	0%	0%	99%	Collect gases vented from roof vents and baghouse control.
4a	Roof Vent Baghouse and Sulfur Reduction in Coke	42%	0%	42%	99%	Combination of Scenarios 1 and 4.
5	Wet Scrubber SO ₂ Controls and Roof Vent Spray Chamber SO ₂ and PM Control	90%	0%	50%	50%	Combination of Scenarios 2 and 3.
5a	Wet Scrubber SO ₂ Controls, Roof Vent Spray Chamber SO ₂ and PM Control and Sulfur Reduction in Coke	94%	0%	71%	50%	Combination of Scenarios 1 and 5.
6	Wet Scrubber SO ₂ Control and Roof Vent Baghouse	90%	0%	0%	99%	Combination of Scenarios 3 and 4.
6a	Wet Scrubber SO ₂ Control, Roof Vent Baghouse and Sulfur Reduction in Coke	94%	0%	42%	99%	Combination of Scenarios 1 and 6.

Note: Primary sources are the emissions from the alumina scrubbers while the secondary sources represent the roof vent potline emissions.

Given that a generous set of scenarios has now been developed, it is appropriate to compare the various scenarios against visibility impacts, costs, cost-effectiveness, etc. Using the information already presented in Sections 4.3 and 4.4 along with the dispersion modeling results summarized in Appendix B, the following table provides the substantive comparative values.

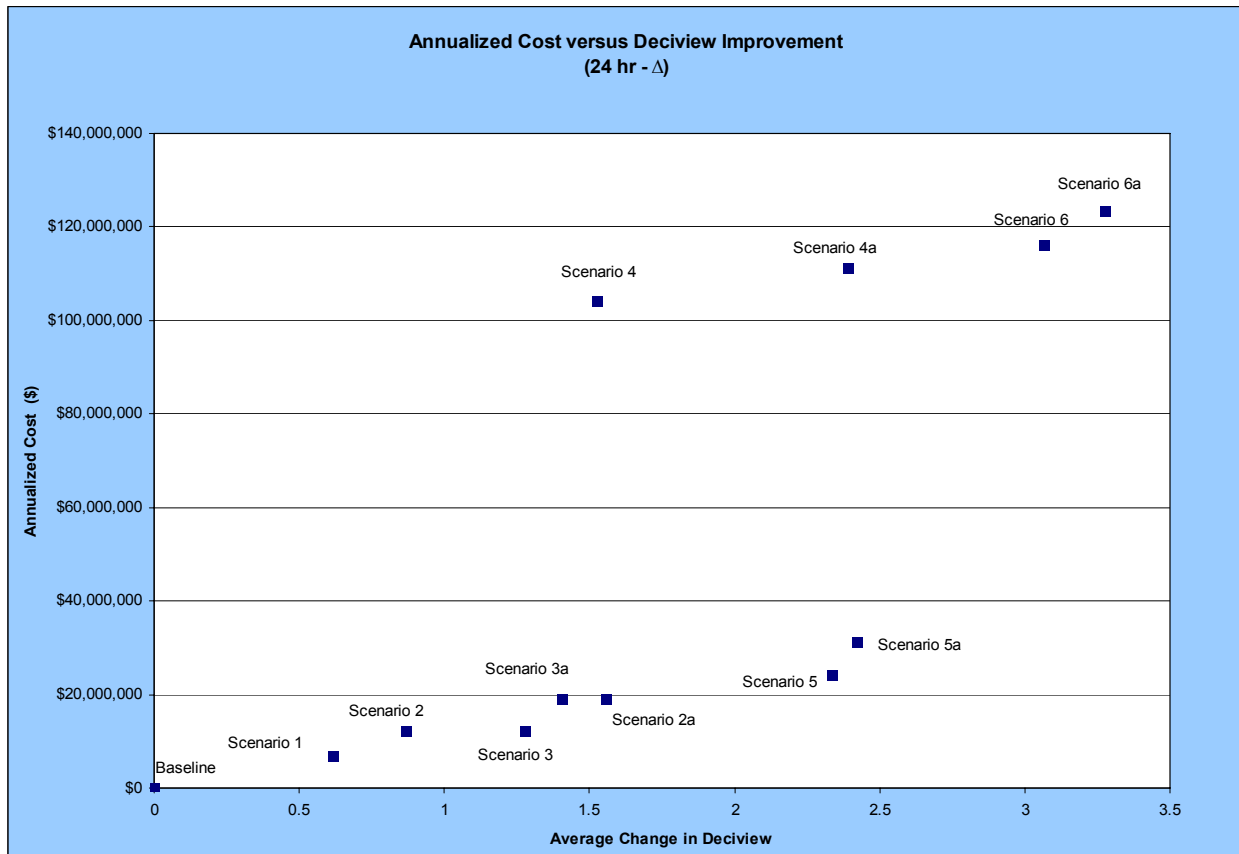
Table 4-8: Summary of SO₂/PM₁₀ Emissions Cost Analysis and Visibility Impacts

Scenario	Description	Primary Sources		Secondary Sources		Average (3 Years) of 98 th Percentile Deciview Impact	Average (3 Years) of 98 th Percentile Improvement in Deciviews (24 hr - Δ)	Total SO ₂ Removed (Ton/yr)	Total PM ₁₀ Removed (Ton/yr)	Capital Cost (\$)	Annualized Cost (\$/year)	SO ₂ Cost-Effectiveness (\$/ton)	PM ₁₀ Cost-Effectiveness (\$/ton)	Visibility Cost Effectiveness (\$/deciview)
		SO ₂ % Removal	PM ₁₀ % Removal	SO ₂ % Removal	PM ₁₀ % Removal									
Baseline	Existing Controls	-	-	-	-	3.884	0	-	-	-	-	-	-	-
1	Coke Sulfur Content Reduction	42%	0%	42%	0%	3.267	0.617	691	0	N/A	\$7,079,680	\$10,245	NA	\$11,480,562
2	Roof Vent Spray Chamber SO ₂ & PM Controls	0%	0%	50%	50%	3.020	0.864	58	109	\$33,476,076	\$12,096,206	\$210,057	\$110,921	\$13,994,839
2a	Roof Vent Spray Chamber SO ₂ & PM Controls and Sulfur Reduction in Coke	42%	0%	71%	50%	2.326	1.558	724	109	\$33,476,076	\$19,175,886	\$26,470	\$175,840	\$12,305,381
3	Wet Scrubber SO ₂ Controls	90%	0%	0%	0%	2.605	1.279	1377	0	\$50,581,438	\$12,142,136	\$8,817	NA	\$9,490,987
3a	Wet Scrubber SO ₂ Controls and Sulfur Reduction in Coke	94%	0%	42%	0%	2.477	1.407	1487	0	\$50,581,438	\$19,221,816	\$12,929	NA	\$13,664,798
4	Roof Vent Baghouse	0%	0%	0%	99%	2.359	1.525	0	216	\$556,716,625	\$104,151,834	NA	\$482,184	\$68,281,360
4a	Roof Vent Baghouse and Sulfur Reduction in Coke	42%	0%	42%	99%	1.497	2.387	691	216	\$556,716,625	\$111,231,514	\$160,963	\$515,140	\$46,592,368
5	Wet Scrubber SO ₂ Controls and Roof Vent Spray Chamber SO ₂ and PM Control	90%	0%	50%	50%	1.549	2.335	1435	109	\$84,057,514	\$24,238,341	\$16,894	\$222,262	\$10,381,928
5a	Wet Scrubber SO ₂ Controls, Roof Vent Spray Chamber SO ₂ and PM Control and Sulfur Reduction in Coke	94%	0%	71%	50%	1.461	2.423	1520	109	\$84,057,514	\$31,318,021	\$20,602	\$287,182	\$12,925,308
6	Wet Scrubber SO ₂ Control and Roof Vent Baghouse	90%	0%	0%	99%	0.817	3.067	1377	216	\$607,298,063	\$116,293,969	\$84,446	\$538,398	\$37,917,825
6a	Wet Scrubber SO ₂ Control, Roof Vent Baghouse and Sulfur Reduction in Coke	94%	0%	42%	99%	0.607	3.277	1487	216	\$607,298,063	\$123,373,649	\$82,984	\$571,374	\$37,652,182

Given that there are numerous scenarios to consider along with numerous criteria (control effectiveness, deciview improvement, etc), it will be necessary to narrow the choices of potential BART technologies. One such method to begin the process of selecting a single BART choice will be to eliminate those scenarios that cost significantly more than competing alternative scenarios and provide no significant improvement in visibility. In other words, it would be appropriate to drop from further consideration any technology that provides similar visibility improvement at substantially higher costs that competing technologies.

To make such a comparison, Figure 4-1 has been created. The figure shows relative annualized costs of the various scenarios compared against the relative improvement in visibility (expressed on a peak 24-hour basis) for each scenario. Mathematically this is the equivalent of dividing the last column in Table 4-8 by the 8th column in the table.

Figure 4-1: Annualized Cost vs. Deciview Improvement by Scenario



A review of Figure 4-1 reveals some startling differences between several scenarios. To begin, Scenarios 4, 4a, 6 and 6a are vastly more costly than all other options. Of particular interest, of course, is that those four scenarios provide either no additional improvement or very little improvement over most of the other scenarios. In particular, Scenarios 4 and 4a provide no visibility improvement over scenarios 2a and 5a, while costing substantially more than these equally effective scenarios.

The same general observation appears appropriate for Scenarios 6 and 6a. Both of these scenarios provide a modest improvement in modeled visibility, but appear to do so at an extraordinary cost. These scenarios are about six times more expensive than other scenarios (disregarding 4 and 4a) with only modest improvements in visibility.

For purposes of the continuing analysis, Scenarios 4, 4a, 6 and 6a are eliminated as BART.

The next step is to compare the cost-effectiveness of the remaining control options in relation to emission reductions on an annualized cost basis. This comparison will help narrow the field of possibilities by eliminating those scenarios that are, by themselves or in comparison to each other, excessively expensive. Table 4-9 provides such a comparison.

Table 4-9: Potential BART Cost-Effectiveness Scenarios

Scenario	Description	SO ₂ Cost-Effectiveness (\$/ton)	PM ₁₀ Cost-Effectiveness (\$/ton)
Baseline	As configured	-	-
1	Coke Sulfur Content Reduction	\$10,245	NA
2	Roof Vent SO ₂ & PM Controls	\$210,057	\$110,921
2a	Roof Vent SO ₂ & PM Controls and Sulfur Reduction in Coke	\$26,470	\$183,546
3	Wet Scrubber SO ₂ Controls	\$8,817	NA
3a	Wet Scrubber SO ₂ Controls and Sulfur Reduction in Coke	\$12,929	NA
5	Wet Scrubber SO ₂ Controls and Roof Vent PM (and SO ₂) Control	\$16,894	\$222,262
5a	Wet Scrubber SO ₂ Controls, Roof Vent PM (and SO ₂) Control and Sulfur Reduction in Coke	\$20,602	\$294,888

This table yields some interesting results. An obvious observation is that the \$/ton costs are clearly excessive in all but perhaps two scenarios. This observation is based on what may be typically considered during a BACT analysis. BACT is, by definition, an analysis that is applicable to a “new” or “modified” facility. When a new facility installs air pollution control equipment, it must do so based on the ‘best’ controls at the time considering economic and other impacts. For BACT purposes, there is no “bright-line”

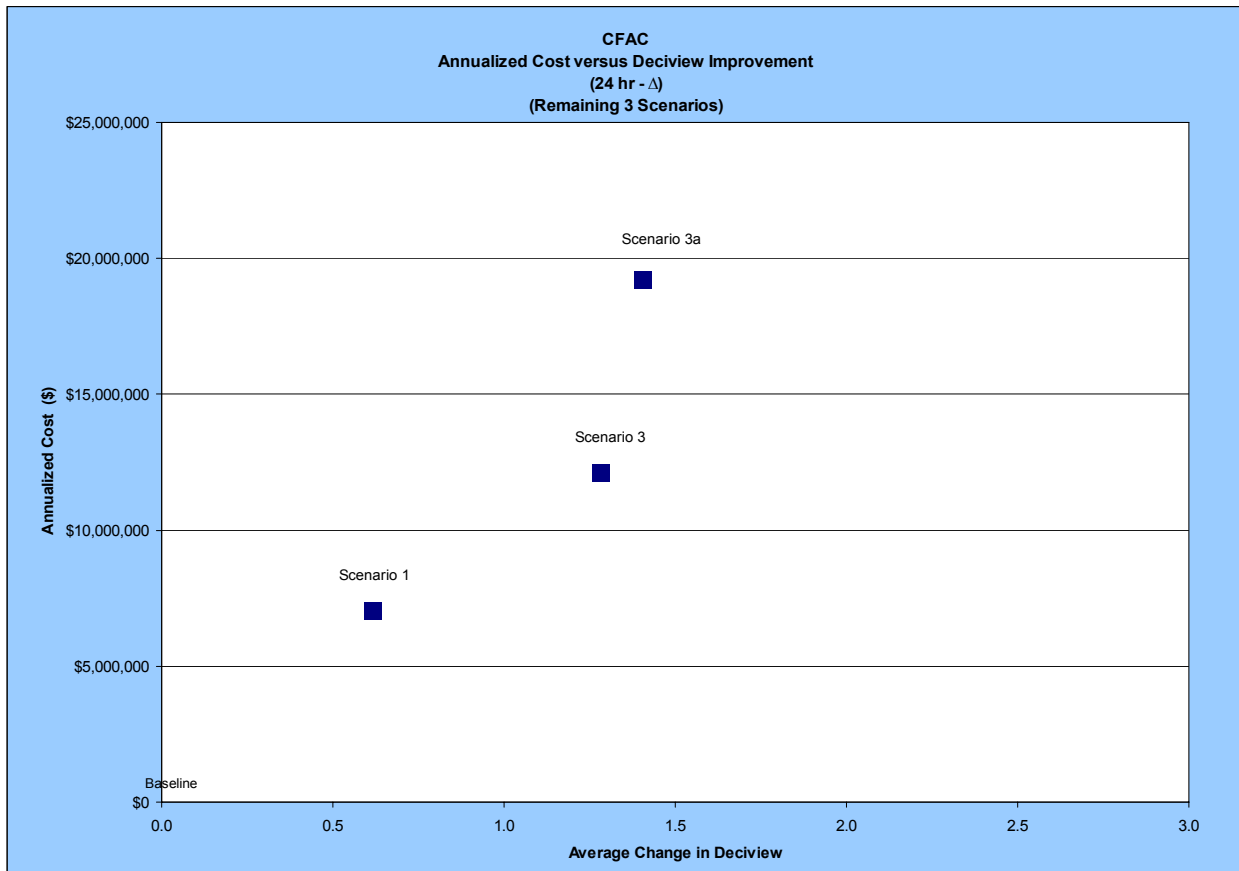
that distinguishes cost-effective costs from “non-cost-effective” costs. Nonetheless, there is considerable history regarding the costs of equipment designed to control sulfur dioxide and particulates (the primary subject of this investigation).

Again, although there are no bright-line values, it is generally understood that maximum acceptable control cost-effectiveness for these pollutants typically ranges from about \$5,000 to \$10,000 per ton. Table 4-9 demonstrates costs far in excess of this general range. For example, all of the options that involve the control of particulate emissions exceed \$100,000 per ton. Further consideration of any of those options would clearly be outside of the intended scope of BART. If one were analyzing the appropriate BACT for a new facility, it is highly likely that control costs in the \$10,000+ range would be rejected. It is clear that one would also reject BART controls in the same or lower range. To that end, four of the above scenarios (2, 2a, 5 and 5a) exceed this guideline by factors ranging from 1.6 to 21. As a result, those scenarios are no longer in consideration for BART.

The only remaining scenarios deserving any further consideration are 1, 3 and 3a. It would be perfectly reasonable to reject these scenarios as well since they have BART cost-effectiveness values of about \$9,000 to \$13,000 per ton. For sulfur dioxide, this cost is well above typical BACT costs. As a result, they should be rejected on this basis alone. Nonetheless, it has been decided to review these scenarios further. The next item of interest is to compare the annualized cost of these alternatives against the air quality benefit (improvement in visibility) on its own merit. Figure 4-1 provided such a comparison, but the information was used to compare scenarios among themselves, as opposed to modeled visibility impacts.

Figure 4-2 has been created to compare the modeled improvement in visibility against the cost of accomplishing that modeled result.

Figure 4-2: Annualized Cost vs. Deciview Improvement - 3 Scenarios



This figure provides a better resolution of the cost of anticipated (modeled) visibility impacts from the three remaining scenarios. In all three cases, the anticipated visibility impact is minor. Scenario 1 improvement is less than 1 deciview. One deciview is a value that is only barely detectible by humans. Scenarios 3 and 3a are only slightly better. In addition, the modeling improvements are only for one small area of Glacier National Park. The vast majority of the park shows impacts from CFAC to be less than 0.5.

Of particular interest is the cost associated with the small modeled improvements. The costs range from about \$7,000,000 per year to about \$19,000,000 per year. Although there is no previously established regulatory cost presumed to be excessive, it would only seem logical that the BART program did not contemplate these types of costs.

4.5.2 Selecting a “Best” Alternative – Section E, Item 2

The Appendix Y Guideline (Section E.2) suggests that the next step is to evaluate the various control options. It further notes that regardless of the order of the evaluation, the agency should always:¹³

1. Display the options,
2. Identify the average and incremental costs,
3. Consider the energy and non-air quality impacts,
4. Consider the remaining useful life, and
5. Consider the modeled visibility impacts.

For purposes of fulfilling those obligations, this document has analyzed the five steps above. Item 1 (display the options) is summarized as Table 4-7. Those options are based on the detailed control technology reviews and discussions found primarily in Sections 4.3 and 4.4.

Item 2 has also been discussed throughout the document but is summarized in Table 4-8. Those costs were developed using general EPA guidelines as well as actual retrofit costs associated with this facility.

Item 3 has been discussed in a more general manner where necessary. Those impacts, while discussed, were not analyzed in any significant manner since the results of other investigations (primarily Items 2, 4 and 5) have supplanted the need for detailed analyses. More detailed analyses can be provided if necessary.

Item 4 relates to the useful life of this facility. While the plant has been in existence since the 1950s, its future health and long-term outlook will depend on many local, state, national and international parameters. Among the more pressing matters is the subject of future electrical supply at a reasonable cost. It is commonly understood that aluminum reduction plants use large amounts of electricity as the underlying mechanism for creating the final product. The cost of electricity is the largest single expense in making aluminum. As it currently stands, the current power contract for one potline of electricity is set to expire in 2011, the timeframe in which installation of BART controls would need to at least be initiated. Power for the other two currently operating potlines is purchased on the open market. CFAC has every intention to continue operating the facility, but it can not guarantee this will be the case unless costs remain reasonable.

Item 5 has been analyzed in considerable detail. The details of the modeling itself are found in Appendix B. A summary of the modeling impacts are presented in Table 4-8. Modeled visibility changes were noted for each control technology scenario, along with various associated costs.

¹³ From: 70 FR 39170 and 39171.

The selection of BART is a culmination of a review of the summarized data primarily found in Section 4.5.1 above. That analysis makes several clear points:

- ◆ Modeling indicates that the pollutant providing the most modeled visibility benefit is particulate matter.
- ◆ Particulate matter reductions are extremely expensive in this case due to extremely large quantities of gas being handled and the need, in most cases, to first collect those gases for processing.
- ◆ The cost of both particulate and sulfur dioxide controls is in the multi-million dollar range.
- ◆ The cost-effectiveness (\$ per ton of pollutant reduced) is very expensive on its face and in comparison to typical BACT costs of the same pollutants.
- ◆ The cost-effectiveness for visibility improvement is in the multi-million dollar range. The estimates for even the most efficient scenarios start at about \$10,000,000 per deciview.

Given the entire discussion above and throughout this document, it becomes quite clear that the only logical conclusion for BART at this facility is the current plant configuration. The addition of more controls on this facility for the purposes of improving visibility is far in excess of any reasonable retrofit cost. This facility is unique in that the cost of control is inordinately high due to the physical design characteristics of the plant. To control emissions from those pollutants for which the model predicts visibility impacts would be especially costly due to the large volumes and collection needs.

As a result, CFAC proposes that BART for this facility is its current configuration and operation.

4.5.3 Consideration of Affordability – Section E, Item 3

On a final note, the Appendix Y Guideline also notes that the Agency is entitled to consider the affordability of controls. This may be considered regardless of the cost-effectiveness of the alternatives (scenarios) that have been identified. Specifically, the Guideline notes the following:

- 1. 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.***
- 2. 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 **effects on product prices, the market share, and profitability of the source.** Where there are such*

unusual circumstances that are judged to affect plant operations, you 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 you may consider them in the selection process, but you may wish to provide an economic analysis that demonstrates, in sufficient detail for public review, the specific economic effects, parameters, and reasoning. . . .”

CFAC believes that this deserves consideration for this facility. CFAC is a producer of commodity grade aluminum ingot. The revenue CFAC receives is determined by the daily trading prices of aluminum on the London Metal Exchange. CFAC has no control over the revenue received for its product. CFAC's competition is global and any increase in CFAC's operating costs will further weaken its competitiveness in the world market.

The aluminum industry in the Pacific Northwest has been in decline for the past eight years due to the poor economic position of the region's aluminum reduction facilities. In 1999, there were ten aluminum reduction facilities operating in Washington, Oregon and Montana. Currently, there are only three of these facilities still operating, most at reduced capacity. Of the shutdown facilities, most have been torn down and will never resume operation. The profitability of aluminum smelting in the Pacific Northwest is marginal due to the region's lack of available power at a reasonable cost for aluminum reduction.

Any requirement to implement any of the pollution control strategies described in this document will greatly increase CFAC's operating costs and probably result in the shutdown of the facility.

APPENDIX A: EPA LETTER TO CFAC



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8

1595 Wynkoop Street
DENVER, CO 80202-1129
Phone 800-227-8917
<http://www.epa.gov/region08>

JUN 22 2007

Ref: 8P-AR

Mr. Steve Wright 406-892-8211
Columbia Falls Aluminum Company
2000 Aluminum Drive
Columbia Falls, MT 59912

Rec'd 6/27/07

Re: Results of "Subject to" Visibility Modeling for Best Available Retrofit Technology (BART) and Request to Conduct a BART Analysis for BART-Eligible Units at Columbia Falls Aluminum Company

Dear Mr. Wright:

On June 19, 2006, EPA received a letter from the Montana Department of Environmental Quality that stated it was withdrawing its efforts to meet the requirements of the Regional Haze Rule (RHR) specified at 40 CFR 51.308. On September 27, 2006, EPA Region 8 sent a letter notifying you that we would be conducting modeling to determine which sources in Montana are "subject to" the Best Available Retrofit Technology (BART) requirements in the RHR as part of our effort to address the requirements of that rule. Since it was determined that Columbia Falls Aluminum Company (CFAC) was BART eligible, we informed you that CFAC would be included in the modeling and asked you to certify the data that would be used for this modeling.

EPA Region 8, with the assistance of the Western Regional Air Partnership (WRAP), has now completed the visibility modeling for determining those Montana sources subject to BART. Based on the modeling, EPA Region 8 has determined that your facility is subject to BART. Accordingly, we are requesting that you submit a BART Analysis for CFAC within 90 days of this letter, as explained below.

In modeling CFAC's visibility impacts, EPA Region 8 followed the approach for determining if a source is subject to BART, including the specifics on how the modeling should be performed, set out in the final RHR and EPA's "Guidelines for Best Available Retrofit Technology Determinations" (BART Guidelines). See 70 FR 39104, July 6, 2005. The BART Guidelines can be found at Appendix Y to 40 CFR Part 51. EPA Region 8's visibility modeling also generally followed the protocol outlined in the document "Draft Calpuff BART Modeling Protocol for Federal Mandatory Class 1 Areas" (Montana Department of Environmental Quality, September 2006). An electronic copy of this protocol is located on EPA Region 8's website at <http://www.epa.gov/region8/air/mtregionalhaze.html>. Where necessary, we made slight variations to the protocol, such as instances where meteorological data was not available for a certain site.

States (or EPA) have several options for determining whether a source is subject to BART, including the use of dispersion modeling to determine whether an individual source may be reasonably anticipated to cause or contribute to any visibility impairment in any Class I area. When dispersion modeling is used, part of the process of determining whether a source is subject to BART is the selection of a deciview threshold against which to measure the visibility impact of a source. For its analysis of Montana sources, EPA Region 8 has established a threshold of 0.5 deciviews as the appropriate threshold based on the number and distribution of sources impacting Class I areas in and around Montana. If dispersion modeling predicts that a source will have visibility impacts of 0.5 deciviews or more at a Class I area on the 98th percentile of values, EPA Region 8 considers that source to be subject to BART. Further information regarding this approach to determining whether a source is subject to BART can be found in section III.A of the BART Guidelines.

For CFAC, the modeling results show a maximum 98th percentile impact within a Class I area of 4.54 deciviews, which exceeds the threshold of 0.5 deciviews. Since CFAC exceeds the 0.5 deciview threshold, and thus may reasonably be anticipated to cause or contribute to visibility impairment in one or more Class I areas, EPA Region 8 has concluded that CFAC is subject to BART.

A summary of the BART modeling results is enclosed. The enclosure provides a summary of the 98th percentile predictions for the three years modeled for CFAC at all federal Class I areas in the vicinity of the plant. More detailed modeling results, including the electronic CALPUFF/CALMET files, are available on the WRAP website at <http://pah.cert.ucr.edu/aqm/308/bart.shtml>.

Because CFAC is subject to BART, EPA Region 8 is requesting that CFAC conduct a BART engineering analysis on the emission units specified on the enclosed spreadsheet and submit the analysis to our office. One of the requirements of the RHR is that each regional haze implementation plan contain enforceable emission limits for eligible stationary sources based on BART. The BART analysis will be used to identify the best system of continuous emissions reduction and corresponding emission limits for each visibility impairing pollutant that is emitted by the CFAC facility. The Clean Air Act and the RHR require that BART be established on a case-by-case basis taking into account the available retrofit control options, the costs of compliance, the energy and non-air quality impacts of compliance, any pollution control equipment in use 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 the technology.

For purposes of the Regional Haze FIP for Montana, EPA Region 8 is intending to follow its BART Guidelines from 40 CFR Part 51, Appendix Y. The BART Guidelines are a statement of EPA's thinking on how best to meet the requirements of BART in the CAA and RHR. Thus, in conducting the CFAC BART engineering analysis, you will need to follow the five-

step BART analysis process identified in Appendix Y, section IV.D, in order to identify an appropriate BART emission limit. The five steps are:

- Identify all available retrofit control technologies
- Eliminate technically-infeasible options
- Evaluate the control effectiveness of remaining control technologies
- Evaluate impacts and document the results
- Evaluate visibility impacts

For each of these five steps, the BART Guidelines provide detailed guidance for producing an acceptable BART analysis. In addition, your BART analysis should follow other EPA guidance and policies related to BART.

Based on the above analysis, you will then identify what you believe is BART for your facility. You will need to provide a justification for adopting the technology and the emission limits that you select as the best level of control, including an explanation of how the BART factors (costs of compliance, energy impacts, non-air quality environmental impacts, remaining useful life of the facility, and visibility improvements) were considered (or weighted) in selecting one technically feasible control option over the others.

Your BART analysis should include proposed emission limits for each BART-eligible unit at your facility and for each pollutant subject to BART. For CFAC we have identified sulfur dioxide, nitrogen oxides, and particulate matter as the pollutants that need to be analyzed.

Once you submit the BART analysis and related documentation to EPA Region 8, we will review the BART analysis and will notify you of our preliminary BART determination. We will provide an opportunity for you to respond to our preliminary BART determination before making a final determination. Our final determination will be included as part of our Regional Haze FIP for Montana, which will be adopted through notice and comment rulemaking.

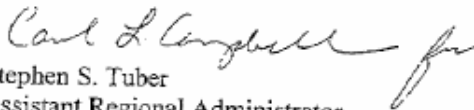
In order to meet regulatory schedules and coordinate with other states, EPA Region 8 is requesting that you submit your BART analysis to our offices within 90 days from the date of this letter. We understand this is a complicated endeavor, and we are available to answer any questions that you may have on the RHR, the BART Guidelines, or the BART analysis. We will assist you in any way we can and look forward to working with you.

If you choose not to perform or are unable to perform an engineering analysis for CFAC, EPA will perform the BART engineering analysis. If you will not be performing and submitting the BART analysis, we ask that you contact us within 30 days from the date of this letter so that we may begin the process of developing the analysis.

CFAC may assert a business confidentiality claim covering part or all of the information requested by this letter, in the manner described at 40 CFR 2.203(b). If no such claim accompanies the information when it is received by EPA, EPA may make the information available to the public without further notice to CFAC. Information subject to a business confidentiality claim will be disclosed by EPA only to the extent, and by means of the procedures, set forth at 40 CFR Part 2, Subpart B.

Once again, we look forward to working with you. If you have any questions regarding the modeling results, please contact Kevin Golden of my staff at (303) 312-6442. For questions related to development of the BART analysis, please contact Laurel Dygowski at (303) 312-6144.

Sincerely,


Stephen S. Tuber
Assistant Regional Administrator
Office of Partnerships and Regulatory Assistance

Enclosure



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Source = Columbia Falls AI: SOx = 816 TPY; NOx = 11 TPY

Class / Area	Minimum Distance (km)	Max Delta-dv (dv)	99 th Delta-dv (dv)		# Days > 0.5 dv	98 th Percentile by Year			98 th 3-Year Average
			Delta-dv	98 th Delta-dv		2001	2002	2003	
glac	10-50	5.72	4.40	3.79	434	3.13	4.54	3.40	3.69
glac	> 50	0.13	0.03	0.00	0	0.00	0.00	0.02	0.01
boma	76	0.21	0.13	0.11	0	0.10	0.11	0.09	0.10
mimo	80	0.21	0.10	0.07	0	0.06	0.08	0.08	0.07
camo	111	0.24	0.15	0.11	0	0.11	0.12	0.10	0.11
scap	130	0.11	0.07	0.05	0	0.04	0.05	0.05	0.05
selw	191	0.12	0.04	0.03	0	0.02	0.03	0.03	0.03
gamo	237	0.07	0.04	0.03	0	0.03	0.03	0.03	0.03
anac	263	0.08	0.02	0.02	0	0.01	0.02	0.02	0.02

APPENDIX B: VISIBILITY IMPACTS MODELING

1.0 VISIBILITY IMPACTS

1.1 Introduction and Summary

CFAC has concurred with the initial EPA BART analysis that the Columbia Falls facility is a BART-eligible source. The following sections detail the modeling analysis that Bison performed on behalf of CFAC to comply with the intent of 40 CFR 51, Appendix Y. This document describes the methodologies and results of the regional scale and near field model analyses.

In conducting the initial regional scale and the near field BART modeling analyses, Bison closely followed the Montana Department of Environmental Quality's (MDEQ) modeling protocol for regional modeling in support of the BART program, entitled *State of Montana Draft CALPUFF BART Modeling Protocol For Federal Mandatory Class I Areas*, September 2006 Draft ("Montana BART protocol"). The analysis also relied on guidance in the *Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report for Modeling Long Range Transport Impacts* (EPA, 1998), and the *Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report*, December 2000 ("FLAG document").

The BART modeling analysis specifically requires demonstrations of impacts to visibility at surrounding mandatory federal Class I areas. The mandatory federal Class I areas evaluated on a regional scale are:

- Glacier National Park,
- Bob Marshall Wilderness Area,
- Mission Mountain Wilderness Area, and
- Cabinet Wilderness Area.

The additional near field BART modeling analysis focused on Glacier National Park and provides the basis for this BART analysis. This near field model was developed to address the potential visibility impacts from CFAC emissions on the nearby receptors located in Glacier National Park. Given the short distance (<10 km) between CFAC and the nearest National Park Service (NPS)-generated receptors for Glacier National Park, the development of this refined CALMET grid was deemed appropriate.

Visibility Impacts: The visibility impacts analysis began with the predicted emissions from the BART-eligible sources located at the Columbia Falls facility. Regional scale modeling was completed to confirm that CFAC had potential modeled visibility impacts greater than 0.5 deciview at the surrounding Class I areas. The near field modeling analysis of Glacier National Park focused on the Class I area where CFAC could have the most visibility impacts. These near field impacts were developed to establish a visibility baseline to analyze what effects, if any, different control technologies or operating practices had on visibility at Glacier National Park.

The visibility impacts analyses included the appropriate potential NO_x, SO₂, and PM₁₀ emissions from the sources modeled since all three pollutants contribute to visibility impairment.

1.2 Model Selection

Selection of the appropriate dispersion model for assessing visibility impacts in Class I areas is typically based on the distance from the emitting source to the Class I area. Appendix W in 40 CFR Part 51 recommends different models for different applications and identifies appropriate models for short- and long-range impacts.

Since EPA has already established CALPUFF for the visibility analysis, the CALPUFF model was used in the present analyses of Class I visibility impacts for both the regional and near field modeling analyses.

CALPUFF is a non-steady-state Lagrangian dispersion model that simulates pollutant releases as a continuous series of “puffs.” It includes algorithms for building downwash, pollutant removal due to wet scavenging and dry deposition, chemical transformation, and plume fumigation. It is supported by two primary sub-programs, CALMET and CALPOST. CALMET is used in refined analyses to create three-dimensional wind fields based on multiple sources of geophysical and meteorological data. The output of the CALPUFF model consists of binary data files with information on pollutant concentrations, wet and dry flux rates, and visibility parameters. CALPOST processes these data based on specified input parameters, and reports calculated impact values.

The present CALPUFF analysis utilized the most current version of the following primary programs and pre- and post-processors obtained from the CALPUFF developer, Atmospheric Studies Group (ASG) at:

<http://www.src.com/calpuff/calpuff1.htm>.

Geophysical Data Processors

- TERREL (Version 3.311, Level 030709)
- CTGCOMP
- CTGPROC (Version 2.42, Level 030709)
- MAKEGEO (Version 2.22, Level 030709)

Meteorological Preprocessors

- SMERGE (Version 5.31a, Level 040706)
- PTRACT
- PMERGE (Version 5.31, Level 030528)
- READ62 (Version 5.52, Level 040716)

Main Models

- CALMET (Version 6.211, Level 060414)
- CALPUFF (Version 6.112, Level 060412)

Postprocessors

- CALPOST (Version 6.131, Level 060410)
- PRTMET
- CALSUM
- POSTUTIL

The version and level identifiers for the major modules used for this project are identified above. Electronic executable files for the primary modules and the primary electronic input and output files associated with this analysis are available upon request.

1.3 Modeling Domain

The regional modeling domain was defined to follow the Montana BART Protocol and is based on 6 kilometer (km) grid spacing with 180 grids in the easting direction and 95 grids in the northing direction. The regional modeling domain is defined in a Lambert Conformal Conic (LCC) system. The LCC coordinate system for this project has a projection origin at 44.25° N and 109.5° W and matching parallels of latitude of 44.0° and 49.0° N. The coordinates of the southwest corner of the domain are 0.000 km easting and 0.000 km northing. This varies from the WRAP modeling domain which defined matching parallels of latitude of 45.0° and 49.0° N.

The near field modeling domain follows the Montana BART Protocol and was developed with a 1 km grid spacing with 190 grids in the easting direction and 100 grids in the northing direction. The near field modeling domain uses the same LCC system, projection origin, and matching parallels as used in the regional modeling domain. The coordinates of the southwest corner of the domain are 187.278 km easting and 438.090 km northing.

1.4 CALMET

CALMET, the meteorological preprocessor for CALPUFF, was used to compile and process land use data, terrain data, and meteorological data for use in the CALPUFF model program. The CALMET output files defined gridded fields of wind speed, wind direction, mixing heights, stabilities, micrometeorological parameters, and precipitation – all parameters required for input to the CALPUFF dispersion model. The following sections provide a brief description of each of these data sets.

1.4.1 Land Use Data

CALMET uses specific land use data developed by the U.S. Geological Survey (USGS)¹. The data files used for both the regional and near field modeling analyses for this project were 1:250,000-scale files. Each land use cell, typically 200 meters square, is assigned a land use code. Using several data processing programs provided by ASG, the land use data were processed and combined with other geophysical data into a single data set for input to the CALMET model.

¹ Available for download from the USGS Earth Resources Observation and Science (EROS) web site.

1.4.2 Terrain Data

CALMET uses USGS Digital Elevation Models (DEMs) to determine the terrain elevation in the model domain. The regional scale model used USGS 1:250k DEMs and the near field model used USGS 1:24K DEMs. The terrain data is preprocessed into a data set recognized by CALMET and used to help create the CALMET output file. Terrain data obtained from www.webmet.com were used to create the appropriate files for CALMET.

1.4.3 Meteorological Data

CALMET output files representing meteorological data for the 2001, 2002, and 2003 calendar years were prepared for the analysis in accordance with the Montana BART Protocol. Input meteorological data consisted of Mesoscale Model (MM5) meteorological data (processed by the CALMM5 utility program), observed hourly surface data, upper air rawinsonde data, and hourly precipitation data.

Mesoscale Model Data

The MM5 meteorological data for the 2001, 2002, and 2003 calendar years obtained from the Western Regional Air Partnership (WRAP) are available at the following website: <http://pah.cert.ucr.edu/aqm/308/bart.shtml>. These data are generated by Pennsylvania State University/National Center for Atmospheric Research mesoscale models. The mesoscale models are limited-area, nonhydrostatic or hydrostatic, terrain-following sigma-coordinate models designed to simulate or predict mesoscale and regional-scale atmospheric circulation. The data are used as a basis for generating an “initial guess field” of multilayer wind vectors in CALMET. The meteorological data for all three years are in the CALMM5 utility program MM5 format. They reflect a spatial resolution of 36 km used in both modeling domains.

Surface Data

Hourly observed surface data for 2001, 2002, and 2003 were also obtained from the WRAP internet site. In accordance with the Montana BART protocol, National Weather Service (NWS) hourly surface data for 39 stations for 2001 and 36 stations for 2002 and 2003 were processed in CALMET for the regional modeling domain. The data files were provided in the SMERGE format and were ready for input into CALMET.

Surface data from the following locations were used for the CALMET regional modeling analysis:

- Badger Peak, MT (2001 only)
- Billings, MT
- Bismarck, ND
- Boise, ID
- Bozeman, MT
- Butte, MT

- Casper, WY
- Coeur d'Alene, ID
- Cut Bank, MT
- Dickinson, ND
- Dillon, MT
- Estevan, SK
- Havre, MT
- Kalispell, MT
- Garfield Peak, MT (2001 only)
- Glacier National Park, MT
- Glasgow, MT
- Great Falls, MT
- Helena, MT
- Havre, MT
- Lander, WY
- Lewistown, MT
- Livingston, MT
- Medicine Hat, AB
- Miles City, MT
- Minot, ND
- Missoula, MT
- Morningstar, MT (2001 only)
- Peabody Coal, MT
- Pocatello, ID
- Rapid City, SD
- Rexburg, ID
- Riverton, WY
- Salmon, ID
- Sheridan, WY
- Spokane, WA
- Spring Creek Coal, MT
- Theodore Roosevelt National Park, ND
- Williston, ND
- Yellowstone National Park, WY

The CALMET near field modeling domain used only the Kalispell, MT and Cut Bank, MT surface data and included surface data from the CFAC onsite meteorological station.

Upper Air Data

The Montana BART Protocol included the use of upper air data; however, the EPA BART Protocol specified that upper air data would not be used, and consequently the WRAP modeling omitted this data. Bison followed the Montana modeling protocol and included the upper air station data in the BART modeling analysis.

Upper air rawinsonde data collected by seven NWS stations were obtained from the rawinsonde data repository maintained by NOAA at <http://raob.fsl.noaa.gov/>. The data were obtained in the standard FSL data format for use in the CALMET system. The seven NWS upper air rawinsonde locations used for this project's regional modeling domain are:

- Bismarck, ND
- Boise, ID
- Glasgow, MT
- Great Falls, MT
- Rapid City, SD
- Riverton, WY
- Spokane, WA

Great Falls, MT and Spokane, WA upper air rawinsonde data are the two upper air locations used in developing the near field model for Glacier National Park.

Upper air data substitution and extrapolation were accomplished as needed according to ASG's FAQ 2.3.4, which recommends temporal substitution (for example, substituting an afternoon sounding with the previous or succeeding afternoon sounding) or spatial substitution from a nearby location if soundings are missing. For in-sounding values flagged by READ62, the data values were corrected using an in-house computer program (Fix6201.exe) developed for this purpose. Nearly all of these flagged values were due to either (1) the pressure remaining constant or rising with height, or (2) the elevation remaining constant or decreasing with height. These were corrected by the in-house program by changing the flagged values by a small amount so that the pressure decreased with height or the elevation increased with height as appropriate. For spatial substitutions, another in-house program (AdjUa.exe) was used to adjust for the difference in elevation between the two locations. Temporal substitutions were accomplished manually using a text editor. All raw and processed data and data processing algorithms are available upon request.

Precipitation Data

The use of precipitation data was referenced in the Montana and EPA BART Modeling Protocols. The WRAP modeling omitted this precipitation data. Bison followed the modeling protocols and included the precipitation station data in the BART modeling analysis.

Hourly precipitation data in NCDC's TD-3240 format were obtained from the data set developed by MDEQ for their BART modeling analysis effort. All precipitation stations located within the CALMET regional scale and near field modeling domains were extracted from the data set and were used in the CALMET analysis. A total of 286 stations were selected for each of the three modeled years in the regional scale analysis and 14 stations were selected for the near field model analysis. A complete list of precipitation stations used is available upon request.

No precipitation data interpolation or substitution was required for this project.

1.5 Ozone

The ozone data provided on the WRAP website contained all the ozone sites in the United States and for the year 2002 the number of ozone sites exceeded the number of stations allowed in the CALPUFF model. Bison obtained ozone data for the following three ozone stations in the modeling domain:

- Yellowstone National Park
- Glacier National Park
- Theodore Roosevelt National Park

1.6 CALPUFF

CALPUFF applies mathematical algorithms to calculate pollutant concentrations at Class I receptors. CALPUFF requires CALMET output files, source emissions, and receptor grids to model Class I impacts.

1.6.1 CALPUFF Parameters

CALPUFF was run in the refined mode using the MESOPUFF III chemical transformation scheme and dry and wet deposition calculations. Model settings were based on recommendations found in the Montana BART protocol. The table below summarizes the model control file settings used for this analysis. Complete CALPUFF input files will be provided upon request.

CALPUFF Model Control File Settings

Model Parameter/Option	Value
Number of chemical species	9
Number of chemical species emitted	7
Vertical distribution near field	Gaussian
Terrain adjustment method	Partial plume path adjustment
Subgrid-scale complex terrain	Not modeled
Slug model	Not used
Transitional plume rise	Yes
Stack tip downwash	Yes
Vertical wind shear	Yes
Puff splitting	Yes
Chemical mechanism	MESOPUFF II scheme
Wet removal	Yes
Dry deposition	Yes
Dispersion coefficient method	PG dispersion coefficients for rural areas
Partial plume penetration – elevated inversion	Yes
PDF used under convective conditions	No
CSPEC	SO ₂ , SO ₄ , NO _x , HNO ₃ , NO ₃ , SOA, EC, PMC, PMF
Chemical parameters – dry gas deposition	Default
Size parameters – dry particle deposition	Default
Reference cuticle resistance (RCUTR)	30 s/cm
Reference ground resistance (RGR)	10 s/cm
Reference pollutant reactivity (REACTR)	8
Number of particle-size intervals (NINT)	9
Vegetation state in un-irrigated areas (IVEG)	1
Wet deposition parameters	Default
Ozone data input option	0
Background ozone concentration	Ozone data: Yellowstone NP, Glacier NP, Theodore Roosevelt NP
Background ammonia concentration (values specific to each Class I area analyzed)	1.22, 1.23, 1.6, 1.94, 2.29, 1.63, 1.65, 1.69, 0.98, 1.04, 1.37, 1.06 ppb
SYTDEP	550 m
MHFTSZ	0
JSUP	5
XSAMLEN	1.0 grid units
MXNEW	99
MXSAM	99
Maximum mixing height	3,000 m
Minimum mixing height	50 m
NSPLIT	2
IRESPLIT	Hour 17-22 = 1
ZISPLIT	100 m
ROLDMAX	0.25

Notes:

ppb = parts per billion

s/cm = seconds per centimeter

1.6.2 Receptors

The Air Resources Division (ARD) of the National Park Service (NPS) has developed a database of modeling receptors for all federal Class I areas in the United States. ARD has also developed a file conversion program to convert the data from latitude/longitude to either LCC or UTM coordinates. Receptor grids for each federally mandated Class I area of concern were developed using the ARD data files converted to the appropriate LCC coordinate system.

1.6.3 Modeled Sources - General

The visibility analyses included potential emissions for the CFAC BART-eligible sources and the projected emission reductions for the applicable pollutant controls. The BART-eligible sources that were included in the analysis are:

- EU004 East Alumina Elevator,
- EU005 East Alumina Unloader,
- EU006 East Alumina Conveyor Storage,
- EU019 Therminol Oil Heating System,
- EU020 East Plant Alumina Transfer,
- EU021 East Plant Alumina Transfer,
- EU028 Dry Alumina Scrubber #5,
- EU029, Dry Alumina Scrubber #6,
- EU030, Dry Alumina Scrubber #7,
- EU031, Dry Alumina Scrubber #8,
- EU032, Dry Alumina Scrubber #9,
- EU033 Dry Alumina Scrubber #10,
- EU036 Potline #3 Roof Vents,
- EU037 Potline #4 Roof Vents,
- EU038 Potline #5 Roof Vents,
- EU043 Casting Furnaces #8 and 9, and
- EU047 Casting Pits #8 and #9.

1.6.4 Modeled Sources - Physical Parameters

The physical parameter for each of the sources included in the models is based on CFAC's emission inventory. This differs from the WRAP model inputs which included the six potline point sources incorrectly input as volume emission sources and did not include the potline roof vents. A complete source list and source parameters are included in Table 1 – attached at the end of this document.

1.6.5 Modeled Sources – Baseline Emission Rates

Class I visibility impacts demonstrations were performed using the maximum actual emission rates for each modeled eligible source for 1999. These emission rates were obtained from CFAC's current air permits and emission inventory analysis. The following table provides the emission rates used to demonstrate the BART impacts for regional haze:

Baseline Modeled Emission Rates

Emitting Unit	Unit Description	NOx (lb/hr)	SO₂ (lb/hr)	PM₁₀ (lb/hr)
EU004	East Alumina Elevator	0.00	0.00	0.08
EU005	East Alumina Unloader	0.00	0.00	0.08
EU006	East Alumina Conveyor Storage	0.00	0.00	0.08
EU019	Therminol Oil Heating System	0.00	0.00	0.00
EU020	East Plant Alumina Transfer	0.00	0.00	0.05
EU021	East Plant Alumina Transfer	0.00	0.00	0.05
EU028	Dry Alumina Scrubber #5	0.00	58.22	0.09
EU029	Dry Alumina Scrubber #6	0.00	58.22	0.09
EU030	Dry Alumina Scrubber #7	0.00	58.22	0.09
EU031	Dry Alumina Scrubber #8	0.00	58.22	0.09
EU032	Dry Alumina Scrubber #9	0.00	58.22	0.09
EU033	Dry Alumina Scrubber #10	0.00	58.22	0.09
EU036	Potline #3 Roof Vents	0.00	8.76	16.60
EU037	Potline #4 Roof Vents	0.00	8.76	16.60
EU038	Potline #5 Roof Vents	0.00	8.76	16.60
EU043	Casting Furnaces #8 and #9 - aluminum handling and natural gas combustion	1.52	0.01	1.08
EU047	Casting Pits #8 and #9	0.00	0.00	3.39

To most accurately demonstrate the changes in visibility impacts at surrounding mandatory Class I areas, NO_x, SO₂, and PM₁₀ emission rates were calculated using 1999 production rates and entered into the CALPUFF models to establish a baseline case for comparison. CFAC's current permit does not contain emission limits specific to these BART-eligible sources.

Particulate matter can be present in different forms, or species, and each species can affect visibility to a different degree. The speciation of PM₁₀ used in the BART modeling analysis assumed all the primary source PM₁₀ emissions as PMF while the secondary source PM₁₀ emissions were split between PMF and PMC based on the particle distributions in AP-42, Table 12.1-2.

1.6.6 Modeled Sources – BART Control Options

The BART modeling analysis required that the baseline emissions be adjusted to reflect the predicted emission reductions for each pollutant. The following table shows the proposed scenarios used in this second step in the BART modeling analysis.

Summary of Potential BART Options

Scenario	Description	Primary Sources		Secondary Sources	
		SO ₂ Emissions % Reduction	PM ₁₀ Emissions % Reduction	SO ₂ Emissions % Reduction	Scenario
Baseline	Existing Controls	-	-	-	Baseline
1	Coke Sulfur Content Reduction	42%	0%	42%	1
2	Roof Vent Spray Chamber SO ₂ & PM Controls	0%	0%	50%	2
2a	Roof Vent Spray Chamber SO ₂ & PM Controls and Sulfur Reduction in Coke	42%	0%	71%	2a
3	Wet Scrubber SO ₂ Controls	90%	0%	0%	3
3a	Wet Scrubber SO ₂ Controls and Sulfur Reduction in Coke	94%	0%	42%	3a
4	Roof Vent Baghouse	0%	0%	0%	4
4a	Roof Vent Baghouse and Sulfur Reduction in Coke	42%	0%	42%	4a
5	Wet Scrubber SO ₂ Controls and Roof Vent Spray Chamber SO ₂ and PM Control	90%	0%	50%	5
5a	Wet Scrubber SO ₂ Controls, Roof Vent Spray Chamber SO ₂ and PM Control and Sulfur Reduction in Coke	94%	0%	71%	5a
6	Wet Scrubber SO ₂ Control and Roof Vent Baghouse	90%	0%	0%	6
6a	Wet Scrubber SO ₂ Control, Roof Vent Baghouse and Sulfur Reduction in Coke	94%	0%	42%	6a

Note: Primary sources are the emissions from the alumina scrubbers while the secondary sources represent the roof vent potline emissions.

1.7 CALPOST

Data generated by CALPUFF was entered into the CALPOST program to summarize peak Class I visibility impacts as required. For the visibility analysis, CALPOST used modeled sulfate, nitrate, and PM₁₀ concentration data to determine the light-absorbing and light-scattering effects resulting from the project's emissions. The method recommended and used for calculating light extinction was "Method 6: Compute extinction from speciated particulate matter measurements." The background extinction coefficients were calculated based on the annual relative humidity factors and data presented in Section 6.1 and Appendices C and D of the Montana BART Protocol. Inputs to CALPOST for visibility processing are summarized in the following table. The attached CD-ROM contains the CALPOST input files.

CALPOST Visibility Control File Settings

CALPOST Parameter/Option	Value
Maximum relative humidity (RHMAX)	95%
Included species	Sulfate, nitrate, coarse particulate (as PM ₁₀), and fine particulate (as PM _{2.5})
Coarse particulate extinction efficiency	0.6 (l/Mm per µg/m ³)
Fine particulate extinction efficiency	1.0 (l/Mm per µg/m ³)
Ammonium sulfate extinction efficiency	3.0 (l/Mm per µg/m ³)
Ammonium nitrate extinction efficiency	3.0 (l/Mm per µg/m ³)
Organic carbon extinction efficiency	4.0 (l/Mm per µg/m ³)
Soil extinction efficiency	1.0 (l/Mm per µg/m ³)
Elemental carbon extinction efficiency	10.0 (l/Mm per µg/m ³)
Method used for background light extinction	MVISBK = 6
Relative humidity	From *.VIS Files
Background extinction coefficients, SO ₄	0.120
Background extinction coefficients, NO ₃	0.100
Background extinction coefficients, PMC	3.006
Background extinction coefficients, OC	0.471
Background extinction coefficients, soil	0.501
Background extinction coefficients, EC	0.2
Extinction due to Rayleigh scattering	10.0

Notes:

NO₃ = Nitrate

1.8 Modeling Results

1.8.1 Regional Haze (Visibility)

Impacts to natural background visibility, expressed in terms of percentage change in 24-hour average background extinction (ΔB_{ex}) were calculated by CALPOST. The guidelines also reference 40 CFR §51.301(a) in asserting that determinations must be made on a "...case-by-case basis taking into account the geographic extent, intensity, duration, frequency and time of visibility impairments...." The average 98th percentile impact results are summarized in the following table.

Summary of BART Options and Visibility Impacts

Scenario	Description	Primary Sources		Secondary Sources		Average (3 Years) of 98 th Percentile Deciview Impact	Average (3 Years) of 98 th Percentile Improvement in Deciviews (24 hr - Δ)	Total SO ₂ Removed (Ton/yr)	Total PM ₁₀ Removed (Ton/yr)
		SO ₂ % Removal	PM ₁₀ % Removal	SO ₂ % Removal	PM ₁₀ % Removal				
Baseline	Existing Controls	-	-	-	-	3.884	0	-	-
1	Coke Sulfur Content Reduction	42%	0%	42%	0%	3.267	0.617	\$11,461	NA
2	Roof Vent Spray Chamber SO ₂ & PM Controls	0%	0%	50%	50%	3.020	0.864	\$210,057	\$110,921
2a	Roof Vent Spray Chamber SO ₂ & PM Controls and Sulfur Reduction in Coke	42%	0%	71%	50%	2.326	1.558	\$27,630	\$183,546
3	Wet Scrubber SO ₂ Controls	90%	0%	0%	0%	2.605	1.279	\$8,817	NA
3a	Wet Scrubber SO ₂ Controls and Sulfur Reduction in Coke	94%	0%	42%	0%	2.477	1.407	\$13,494	NA
4	Roof Vent Baghouse	0%	0%	0%	99%	2.359	1.525	NA	\$482,184
4a	Roof Vent Baghouse and Sulfur Reduction in Coke	42%	0%	42%	99%	1.497	2.387	\$162,179	\$519,032
5	Wet Scrubber SO ₂ Controls and Roof Vent Spray Chamber SO ₂ and PM Control	90%	0%	50%	50%	1.549	2.335	\$16,894	\$222,262
5a	Wet Scrubber SO ₂ Controls, Roof Vent Spray Chamber SO ₂ and PM Control and Sulfur Reduction in Coke	94%	0%	71%	50%	1.461	2.423	\$21,155	\$294,888
6	Wet Scrubber SO ₂ Control and Roof Vent Baghouse	90%	0%	0%	99%	0.817	3.067	\$84,446	\$538,398
6a	Wet Scrubber SO ₂ Control, Roof Vent Baghouse and Sulfur Reduction in Coke	94%	0%	42%	99%	0.607	3.277	\$83,549	\$575,265

APPENDIX C: BART COST ANALYSES

Appendix C
Dual Alkali Wet SO₂ Scrubber Cost Analysis

Columbia Falls Aluminum Company

BART Analysis

Dual Alkali Wet SO₂ Scrubber

Referenced: Estimating Costs of Air Pollution Control, Table 2.2, Venturi Scrubber - William M. Vataavuk
1998 \$

Cost Item		Factor	
DIRECT COSTS			
Purchased equipment costs			
Control device (Assumed)			\$14,500,000
Auxiliary equipment (Assumed)			\$3,625,000
	(A)		\$18,125,000
Instrumentation	0.10(A)		\$1,812,500
Sales taxes	0.03(A)		\$543,750
Freight	0.05(A)		\$906,250
	(B) =		\$21,387,500
DIRECT INSTALLATION COSTS			
Foundations & supports	0.06(B)		\$1,283,250
Handling & erection	0.40(B)		\$8,555,000
Electrical	0.01(B)		\$213,875
Piping	0.05(B)		\$1,069,375
Insulation for ductwork	0.03(B)		\$641,625
Painting	0.01(B)		\$213,875
			\$11,977,000
		Retrofit Installation = DI x 1.5 =	\$17,965,500
Site preparation	As required, SP		
Buildings	As required, Bldg.		
	Total Direct Costs, DC		\$39,353,000
INDIRECT INSTALLATION COSTS, IIC			
Engineering	0.10(B)		\$2,138,750
Construction and Field Expenses	0.10(B)		\$2,138,750
Contractor fees	0.10(B)		\$2,138,750
Start-up	0.01(B)		\$213,875
Performance test	0.01(B)		\$213,875
Contingencies	0.03(B)		\$641,625
			\$7,485,625
		Retrofit Installation = IIC x 1.5 =	\$11,228,438
Total Capital Investment = DC + IIC			\$50,581,438

Cost Item		Wet SO ₂ Scrubber Cost
DIRECT ANNUAL COSTS		
Operating Labor		
Operator	26280 man hrs per year ^a	\$20.00 /hr = \$525,600
Supervisor	*Note: 3x8hrs/shift x 3 shifts/day x 360 days/yr 15% of operator	\$78,840
Operating Materials		
NaOH	Annual Caustic costs from RX Sheet Detail	\$98,631
Ca(OH) ₂	Annual Lime costs from RX Sheet Detail	\$303,898
CaCl ₂ /floculant	2% of Total Caustic cost	\$1,973
Waste Disposal	3,358 ton/yr	\$40 /ton = \$134,320
Makeup Water	100 gal/min	\$0.30 /1000 gal = \$15,768
Maintenance		
Labor	2,190 man hrs per year	\$25.00 /hr = \$54,750
Material	100% of maint. labor	\$54,750
Dredging Pond	\$350,000 every 3 yrs	\$116,667
Utilities (Assumed)		
Electricity	7,500,000 kWh/yr	\$0.06 /kWh = \$450,000
	Total Direct Annual Costs, DAC	\$1,835,196
INDIRECT ANNUAL COSTS (IC)		
	Overhead (60% of total operating & maintenance costs)	\$1,101,118
	Administrative Charges	2% of TCI = \$1,011,629
	Property Taxes	1% of TCI = \$505,814
	Insurance	1% of TCI = \$505,814
	Capital Recovery Factor (10 yrs at 7%)	0.142 = \$7,182,564
	Total Capital Cost*	\$50,581,438
TOTAL ANNUAL COST		\$12,142,136

Appendix C
Single Alkali Wet SO₂ Scrubber Cost Analysis

Columbia Falls Aluminum Company

BART Analysis

Single Alkali Wet SO₂ Scrubber

Referenced: Estimating Costs of Air Pollution Control, Table 2.2, Venturi Scrubber - William M. Vataavuk
1998 \$

Cost Item		Factor
DIRECT COSTS		
Purchased equipment costs		
Control device (Assumed)		\$10,000,000
Auxiliary equipment (Assumed)		\$2,500,000
	(A)	\$12,500,000
Instrumentation	0.10(A)	\$1,250,000
Sales taxes	0.03(A)	\$375,000
Freight	0.05(A)	\$625,000
	(B) =	\$14,750,000
DIRECT INSTALLATION COSTS		
Foundations & supports	0.06(B)	\$885,000
Handling & erection	0.40(B)	\$5,900,000
Electrical	0.01(B)	\$147,500
Piping	0.05(B)	\$737,500
Insulation for ductwork	0.03(B)	\$442,500
Painting	0.01(B)	\$147,500
		\$8,260,000
	Direct installation costs, DI	
	Retrofit Installation = DI x 1.5 =	\$12,390,000
Site preparation	As required, SP	
Buildings	As required, Bldg.	
	Total Direct Costs, DC	\$27,140,000
INDIRECT INSTALLATION COSTS, IIC		
Engineering	0.10(B)	\$1,475,000
Construction and Field Expenses	0.10(B)	\$1,475,000
Contractor fees	0.10(B)	\$1,475,000
Start-up	0.01(B)	\$147,500
Performance test	0.01(B)	\$147,500
Contingencies	0.03(B)	\$442,500
	Total Indirect Costs, IIC	\$5,162,500
	Retrofit Installation = IIC x 1.5 =	\$7,743,750
Total Capital Investment = DC + IIC		\$34,883,750

Cost Item		Wet SO ₂ Scrubber Cost
DIRECT ANNUAL COSTS		
Operating Labor		
Operator	17520 man hrs per year ^a	\$20.00 /hr
	*Note: 3x8hrs/shift x 3 shifts/day x 360 days/yr	
Supervisor	15% of operator	\$52,560
Operating Materials		
NaOH	Annual Caustic costs from RX Sheet Detail	\$723,293
CaCl ₂ /floculant	2% of Total Caustic cost	\$14,466
Waste Disposal	2,918 ton/yr	\$40 /ton
		\$116,720
Makeup Water	300 gal/min	\$0.30 /1000 gal
		\$47,304
Maintenance		
Labor	2,190 man hrs per year	\$25.00 /hr
Material	100% of maint. labor	\$54,750
Dredging Pond	\$350,000 every 3 yrs	\$116,667
Utilities (Assumed)		
Electricity	6,500,000 kWh/yr	\$0.06 /kWh
		\$390,000
	Total Direct Annual Costs, DAC	\$1,920,910
INDIRECT ANNUAL COSTS (IC)		
Overhead (60% of total operating & maintenance costs)		\$1,152,546
Administrative Charges	2% of TCI	\$697,675
Property Taxes	1% of TCI	\$348,838
Insurance	1% of TCI	\$348,838
Capital Recovery Factor (10 yrs at 7%)	0.142	\$4,953,493
	Total Capital Cost*	\$34,883,750
TOTAL ANNUAL COST		\$9,422,298

Appendix C
Spray Room PM₁₀ / SO₂ Control Cost Analysis

Columbia Falls Aluminum Company
BART Analysis
Spray Room Secondary Process PM₁₀ & SO₂ Control
Referenced: OAQPS Control Cost Manual Fifth Edition, Chapter 5 (December 1998)

Cost Item		Factor
DIRECT COSTS		
Purchased equipment costs		
Control Device (assumed)		\$9,996,320
Auxiliary Equipment (assumed 20% of control device)		\$1,999,264
	(A) =	\$11,995,584
Instrumentation	0.10(A)	\$1,199,558
Sales taxes	0.03(A)	\$359,868
Freight	0.05(A)	\$599,779
	(B) =	\$14,154,789
Purchased equipment cost, PEC		
DIRECT INSTALLATION COSTS		
Foundations & supports	0.06(B)	\$849,287
Handling & erection	0.40(B)	\$5,661,916
Electrical	0.01(B)	\$141,548
Piping	0.05(B)	\$707,739
Insulation for ductwork	0.03(B)	\$424,644
Painting	0.01(B)	\$141,548
		\$7,926,682
Direct installation costs		
	Retrofit Installation factor (DI x 1.5)	\$11,890,023
Site preparation	As required, SP	
Buildings	As required, Bldg.	
	Total Direct Costs, DC	\$26,044,812
INDIRECT INSTALLATION COSTS, IIC		
Engineering	0.10(B)	\$1,415,479
Construction and Field Expenses	0.10(B)	\$1,415,479
Contractor fees	0.10(B)	\$1,415,479
Start-up	0.01(B)	\$141,548
Performance test	0.01(B)	\$141,548
Contingencies	0.03(B)	\$424,644
		\$4,954,176
Total indirect Costs, IIC		
	Retrofit Installation factor (IIC x 1.5)	\$7,431,264
Total Capital Investment = DC + IIC		\$33,476,076

Cost Item		Spray Room Secondary Process PM ₁₀ & SO ₂ Control	
DIRECT ANNUAL COSTS			
Operating Labor			
Operator	35040 man hrs per year ^a	\$20.00 /hr	\$700,800
Supervisor	15% of operator		\$105,120
Operating Materials			
NaOH	76 ton/yr	\$400.00 /ton	\$30,400
(maintain pond water pH)			
CaCl ₂ & Flocculant	5% of Total Caustic cost		\$1,520
Solid Waste Disposal			
Makeup Water	3,358 ton/yr	\$40 /ton	\$134,320
	700 gal/min	\$0.30 /1000gal	\$110,376
Maintenance			
Labor	2190 hrs per year	\$25.00 /hr	\$54,750
Material	100% of maint. labor		\$54,750
Dredging Pond	\$350,000 every 9 yrs		\$38,889
Fan House Maint.	\$5,000,000 every 5 years		\$1,000,000
Utilities (Assumed)			
Electricity	25,355,000 kWh/yr ^b	\$0.06 /kWh	\$1,521,300
	^b Note: 48 x 60 hp air fans + 2 x 500 reciprical pumps		
Total Direct Annual Costs, DAC			\$3,752,225
INDIRECT ANNUAL COSTS (IC)			
Overhead (60% of total operating & maintenance costs)			\$2,251,335
Administrative Charges	2% of TCI		\$669,522
Property Taxes	1% of TCI		\$334,761
Insurance	1% of TCI		\$334,761
Capital Recovery Factor (10 yrs at 7%)	0.142		\$4,753,603
	Total Capital Cost*	\$33,476,076	
TOTAL ANNUAL COST			\$12,096,206

Appendix C Baghouse Cost Analysis

Columbia Falls Aluminum Company

BART Analysis

Fabric Filter Baghouse

Referenced: OAQPS Control Cost Manual Fifth Edition, Chapter 5 (December 1998)

	Cost Item	Factor
<u>DIRECT COSTS</u>		
Purchased equipment costs		
Control Device (see Baghouse Purchase Cost Calculations Attachment)		\$137,000,000
Auxiliary equipment (assumed 25% of Control Device)		\$34,250,000
	(A)	\$171,250,000
Instrumentation	0.10(A)	\$17,125,000
Sales taxes	0.03(A)	\$5,137,500
Freight	0.05(A)	\$8,562,500
	(B) =	\$202,075,000
<u>DIRECT INSTALLATION COSTS</u>		
Foundations & supports	0.04(B)	\$8,083,000
Handling & erection	0.50(B)	\$101,037,500
Electrical	0.08(B)	\$16,166,000
Piping	0.01(B)	\$2,020,750
Insulation for ductwork	0.07(B)	\$14,145,250
Painting	0.02(B)	\$4,041,500
	Direct installation costs, DI	\$145,494,000
	Retrofit Installation = DI x 1.5 =	\$218,241,000
Site preparation	As required, SP	
Buildings	As required, Bldg.	
	Total Direct Costs, DC	\$420,316,000
<u>INDIRECT INSTALLATION COSTS, IIC</u>		
Engineering	0.10(B)	\$20,207,500
Construction and Field Expenses	0.20(B)	\$40,415,000
Contractor fees	0.10(B)	\$20,207,500
Start-up	0.01(B)	\$2,020,750
Performance test	0.01(B)	\$2,020,750
Contingencies	0.03(B)	\$6,062,250
	Total Indirect Costs, IIC	\$90,933,750
	Retrofit Installation = IIC x 1.5 =	\$136,400,625
Total Capital Investment = DC + IIC		\$556,716,625

	Cost Item	Fabric Filter Baghouse Cost
<u>DIRECT ANNUAL COSTS</u>		
Operating Labor		
Operator	52,560 man hrs per year ^a	\$20.00 /hr
	*Note: 6x8 hrs/shift x 3 shifts/day x 360 days/yr	
Supervisor	15% of operator	\$157,680
Maintenance		
Labor	2,190 man hrs per year	\$25.00 /hr
Material	100% of maint. labor	\$54,750
Replacement bags	0 square feet	\$0 /ft ²
Utilities (Assumed)		
Electricity	7,500,000 kW-hrs/yr	\$0.0600 /kWh
	Total Direct Annual Costs, DAC	\$1,768,380
<u>INDIRECT ANNUAL COSTS (IC)</u>		
Overhead (60% of total operating & maintenance costs)		\$1,061,028
Administrative Charges	2% of TCI	\$11,134,333
Property Taxes	1% of TCI	\$5,567,166
Insurance	1% of TCI	\$5,567,166
Capital Recovery Factor (10 yrs at 7%)	0.142	\$79,053,761
	Total Capital Cost*	\$556,716,625
TOTAL ANNUAL COST		\$104,151,834

Baghouse Purchase Cost Calculations

Columbia Falls Aluminum Company
 BART Analysis
 Baghouse Purchase Cost Calculations

Secondary Baghouse Sizing: (use a Single Pot Room as basis)

Methodology Reference: Estimating Cost of Air Pollution Control - William M Vataavuk

- Baghouses are sized by the ft2 of filter bag cloth required
- Gas/Cloth Ratio (R) (acfm/ft2 cloth) determines the ft3 of flow per ft2 cloth

3,000,000
 2.5
 1,200,000
 1.04
 1,248,000

Q = Gas Flow rate (acfm) <-- Roof Vent gases per Pot Room

R = gas/cloth ratio (acfm/ft2)

Area(net) = Q/R <-- the **effective** ft2 required to filter each Pot Room

f = factor accounting for fact that some bags will always be shut off for maintenance

Area(Gross) = Area(net)f = (Q/R)f = (the total ft2 of filter media required per pot room for sustained production)

CFAC Secondary Emissions require High Volume (100-400K ft2) (modular) baghouse design (Table 5.5 page 109 Vataavuk)
The limits of the cost correlation table is 400,000 ft2 of bag area therefore we will create 3 modules of 400K ft2 each

400,000

Area(Gross/module) = total ft2 of filter cloth per bag house module (1/3 of the Pot Room Total)

(this is actually a little less than 1,248,000/3)

	factor (a)	factor (b)	
Basic	249,000	Basic	6.11
Stainless steel	104,000	Stainless steel	2.56
Insulation	66,600	Insulation	0.705
	419,600	<Sum	9.375

(Required to resist HF and Sulfurous Acid corrosion)
 (Required to keep the fumes above the dew point at all times)

\$4,169,600 = Price/module(\$) = a + (b x A(Gross/module)) **Shell only, not including bags**
 where a,b are regression parameters from 1988 Contruction actuals (Vavatu table 5.5 -- p. 109)

\$ 0.49 Bag Cost (assume Dacron Polyester) \$/ft2
 \$ 196,000 Bag Cost for one module @ 400,000 ft2/ module

\$ 4,365,600	One Module: Housing and Bags (1988 Dollars)
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1.74 Inflation factor 1988 to 2007 (CPI)

\$ 7,596,144	One Module: Housing and Bags (2007 Dollars)
---------------------	--

\$ 22,788,432	Single Pot Room: 3 modules including bags
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\$ 136,730,592	Facility Total: 6 Pot Rooms (3 lines) 2007 Dollars
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