KBN

June 10, 1994

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JUN 13 1994

Bureau of
Air Regulation

Mr. John C. Brown, Jr., P.E.
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Re: Cargill Fertilizer, Inc.
No. 9 Sulfuric Acid Plant Expansion
AC29-241660; PSD-FL-209

Dear Mr. Brown:

Cargill has received the Department's letter dated December 20, 1993, regarding the above-referenced application. KBN Engineering and Applied Sciences, Inc. (KBN) has assisted Cargill in developing the responses to these questions. On behalf of Cargill, responses to each of the Department's comments are provided below, in the same order as they appear in the December 20 letter.

1. Cargill recently received Construction Permit AC29-239262 for the increase in sulfur throughput at the facility up to a maximum of 1,340,000 tonnes per year. This throughput is intended to allow Cargill to either utilize the sulfur onsite or terminal the sulfur for delivery to its Bartow facility. This application will result in a greater portion of the sulfur being consumed onsite at the Riverview facility.

   The facility currently has three molten sulfur storage tanks with a total capacity of approximately 46,000 tonnes. In addition, the facility has five sulfuric acid storage tanks with a combined capacity of approximately 3,350,000 gallons. There will be no increase in these storage capacities as a result of this application.

2. The additional sulfuric acid production will enable the facility to minimize acid purchases while continuing to operate the facility phosphoric acid plants within permitted rates. Excess sulfuric acid will be either delivered to Cargill's Bartow facility to offset production decreases due to maintenance activities at that facility or sold to brokers.

3. The modifications required to achieve increased production rates will be implemented in a gradual manner, most likely coinciding with scheduled major maintenance overhauls of the plants. The following is a list of the items presently being contemplated by Cargill for the No. 9 H_2SO_4 plant. Cargill may implement any one of these, or a combination of these may be implemented. The actual modifications selected will depend on cost, benefits, efficiency of recovery, energy, etc.

   a. New blower wheel and drive;
   b. New lower pressure drop #1 boiler, same drum;
   c. Install cold air bypass (5 to 10 percent) around burner and boiler;

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d. Replace superheater and economizers with low pressure drop, larger units;
e. Parallel gas flow to #1 and #2 boilers. New superheater in the exit of first mass;
f. Replace all or part of the third mass catalyst with new ring type catalyst;
g. New parallel converter masses;
h. Run inlet acid to dry tower at cooler temperatures;
i. Reverse plant flow to forced draft type; and
j. Reduce IPAT M.E. pressure drop.

4. The No. 9 H_2SO_4 plant was originally permitted in 1974 as a 2,600 TPD plant. The initial operating permit specified a capacity of 2,800 TPD, based on the actual production capability of the plant and the initial performance tests. However, in 1979, the operating permit was renewed to allow only 2,600 TPD production, based on the production rates achieved during compliance testing of that year.

   In 1989, the operating permit for the plant was amended to allow up to 2,800 TPD production without any increase in allowable emissions. This request was based on stack testing which demonstrated compliance with the emission limits at the higher production rate.

5. The current operating permit limits SO_2 emissions to 4.0 lb/ton or 433.2 lb/hr, whichever is less. Likewise, H_2SO_4 mist emissions are limited to 0.15 lb/ton or 16.2 lb/hr, whichever is less. Therefore, the Department's assessment is correct only for a production rate of 2,800 TPD. At lower production rates, the effective lb/ton limits would increase linearly until reaching 4.0 for SO_2 and 0.15 for H_2SO_4 mist at a production rate of 2,600 TPD. At production rates below 2,600 TPD, the 4.0 and 0.15 lb/ton limits would continue to apply.

6. As presented in the application, the alternative SO_2 control technologies identified by EPA for sulfuric acid plants are the following:
   - Flue gas desulfurization (FGD),
   - Molecular sieves, and
   - Replacing first three stages of catalyst bed at a frequency rate three times greater than normal.

   An evaluation of these SO_2 control technologies is presented in Attachment A. The proposed BACT for both the No. 8 and No. 9 H_2SO_4 plants, based on the top-down evaluation presented in Attachment A, is the double adsorption sulfuric acid plant which can achieve an SO_2 emission limit of 4.0 lb/ton of H_2SO_4 produced.

7. The No. 9 H_2SO_4 Plant's converter was originally permitted to produce 2,600 TPD; however, the plant has achieved a production rate as high as 2,820 TPD with emissions of less than 4.0 lb SO_2/ton and 0.15 lb acid mist/ton.

   The plant's converter is the same as originally designed; however, a large portion of the catalyst in the plant has been replaced with "ring" type catalyst (lower pressure drop, same efficiency). The Nos. 1 and 2 masses and portions of Nos. 3 and 4 masses are currently loaded with this catalyst. The lower pressure drop through the catalyst, along with some or all of the modifications described in Item 3 above, will allow a higher production rate to be achieved (up to 3,200 TPD).

However, it is expected that the converter efficiency will degrade slightly at the higher production rates. This is the justification for requesting BACT limits of 4.0 lb/ton for SO_2 and 0.15 lb/ton for H_2SO_4 mist.

8/9. Both the interpass absorber and the final absorbing towers (including mist eliminators) for the No. 9 H_2SO_4 Plant were designed for 2,400 TPD production rate. However, the plant has achieved 2,820 TPD with SO_2 emissions of less than 4.0 lb/ton and acid mist emissions of less than 0.15 lb/ton. However, at the higher production rate of 3,200 TPD, it is expected that the absorber and mist eliminator efficiencies will degrade slightly. This is the reason for requesting emission rates of 4.0 lb/ton for SO_2 and 0.15 lb/ton for acid mist.

10. Cargill received an additional letter from the Department dated January 6, 1994, which requested that an air quality related values (AQRV) analysis be performed on the Class I area for PSD significant pollutants. This analysis for the PSD pollutants, SO_2 and sulfuric acid mist, is provided in Attachment B. Complete model printouts are provided in Attachment D.

Regarding the U.S. Fish and Wildlife Service (FWS) request to support this agency in obtaining and analyzing soil samples from the Class I area, Cargill has contacted Ellen Porter of the National Park Service and has agreed to cooperate with FWS in this effort.

In addition to these responses, Cargill is amending the application to include a change in the No. 8 Sulfuric Acid Plant. Cargill proposes to increase the maximum sulfuric acid production rate of the plant to 2,900 tons per day (TPD) of 100 percent H_2SO_4. However, the combined H_2SO_4 production rate of the No. 8 and No. 9 Sulfuric Acid Plants will be limited to the combined production rate of 5,700 TPD of 100 percent H_2SO_4 (equal to the current permitted No. 8 H_2SO_4 Plant production rate plus the requested production rate for the No. 9 H_2SO_4 Plant). Under this combined limit, the No. 8 H_2SO_4 Plant could operate at rates up to 2,900 TPD, and the No. 9 H_2SO_4 Plant could operate at rates up to 3,200 TPD, but the combined production rate would not exceed 5,700 TPD. Cargill monitors sulfuric acid production hourly at the plant and can ensure through this monitoring that the 5,700 TPD combined production rate is not exceeded (on a 3-hour average basis).

Regarding the No. 8 H_2SO_4 Plant, the following modifications are currently being considered:

a. Replace blower drive with larger horsepower driver;
b. Replace all or a portion of the 3a and 3b catalyst with ring type catalyst;
c. Install star, daisy, or other newer type catalyst in the fourth mass, and relocate existing catalyst to 3a, 3b masses;
d. Modify plant to induced draft blower configuration;
e. Run colder acid over dry tower; and
f. Modify or replace some of the heat transfer equipment in the plant.

As with the No. 9 H_2SO_4 Plant, these modifications would be implemented gradually, most likely coinciding with the scheduled major maintenance outages of the plant.

The No. 8 H_2SO_4 Plant was modified most recently in 1987/88 and had a design capacity at that time of 2,400 TPD. Actual performance test maximum production rate of 2,506 TPD was achieved on January 8, 1990, with emissions of less than 4.0 lb SO_2/ton H_2SO_4 and 0.15 lb H_2SO_4 mist/ton H_2SO_4.

An application form for the No. 8 Sulfuric Acid Plant is provided in Attachment C. Also provided are revised tables from the No. 9 Sulfuric Acid Plant permit application. The air quality analysis presented in the application remains unchanged, since the emissions increase from the No. 8 and No. 9 Sulfuric Acid Plants combined is the same as the emissions increase modeled for the No. 9 Sulfuric Acid Plant application.

Since the No. 8 Sulfuric Acid Plant is being physically modified, it is also subject to BACT analysis. The BACT analysis is presented in Attachment A, along with the evaluation of control technologies for the No. 9 Sulfuric Acid Plant.

In regard to permitting fees for the No. 8 Sulfuric Acid Plant, we believe no additional fee is required because the No. 8 and No. 9 Sulfuric Acid Plants are identically regulated sources and would fall under the similar source fee rule. Cargill has already paid the maximum fee ($7,500 for a PSD construction permit) for the No. 9 Sulfuric Acid Plant application.

If you have any questions concerning this information, please call.

Sincerely,

David A. Buff

David A. Buff, P.E.
Florida P.E. # 19011

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J. Harper, EPA
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ATTACHMENT A

ADDITIONAL BACT INFORMATION

1.0 INTRODUCTION

This document presents additional information regarding the available control technologies for sulfuric acid plants. The air construction permit application has identified three potentially applicable alternative control technologies. These consist of the following:

1. Catalyst replacement more frequently than normal,
2. Molecular sieves, and
3. Flue gas desulfurization (FGD) systems.

Each of these alternative technologies are discussed further in the following sections. In addition, SO_2 and sulfuric acid mist test data from both the No. 8 and No. 9 H_2SO_4 plants at Cargill are presented in order to update the information presented in the permit application for the No. 9 H_2SO_4 plant.

2.0 DESCRIPTION OF ALTERNATIVE CONTROL TECHNOLOGIES

2.1 CATALYST REPLACEMENT

The EPA (1978), in their review of the new source performance standards (NSPS), identified more frequent catalyst replacement as a potential SO_2 control technology for sulfuric acid plants. They analyzed replacing the catalyst on a frequency three times the normal, i.e., once a year for the first catalyst bed, once every 2 years on the second, and once every 3 years on the third bed. Although no estimate of improved conversion efficiency was presented, EPA concluded from this analysis that the economic impact would be adverse to the industry. The price of sulfuric acid was stated to be $55/Mg. The more frequent catalyst replacement was estimated to result in a cost impact of approximately $0.50/Mg. Although this represented only about a 1 percent impact on the price of sulfuric acid, it also represented a 20 percent decrease in pre-tax profits. This impact was concluded to be adverse to the industry.

In addition to the adverse cost impacts of more frequent catalyst replacement, it must be considered that Cargill does not routinely replace the catalyst in its sulfuric acid plants.
Given the type of gas stream to which the catalyst in Cargill's H_2SO_4 plants is normally exposed, essentially no deterioration of the conversion efficiency of the catalyst takes place. Some of the catalyst in the middle and lower masses in the converters has been in service 30 years and longer.

In Cargill's type of operation, where normally no catalyst poisons are encountered in the gas streams, catalyst screening is performed purely as a maintenance function. Catalyst screening is determined by dirt build-up, which results in a higher resistance to air flow and reduced production capacity. Typically, screening of the first mass and occasionally the tops of the second and fourth masses is performed when plant maintenance shutdown takes place. Catalyst replacement is limited to that required to make up for the mechanical attrition taking place during the removal and screening operation. The replacement cost of a full charge of catalyst at Cargill would be in excess of $1 million, depending on the size of unit and catalyst market prices. However, due to Cargill's maintenance procedures, such replacement would not be expected to reduce SO_2 emissions.

In summary, for Cargill's type of gas stream, no gain in efficiency would be obtained from more frequent catalyst replacement, and its costs would be substantial. Therefore, this control technology was not considered further for Cargill's sulfuric acid plants.

2.2 MOLECULAR SIEVES

The EPA, in their review of the new source performance standards (NSPS), also identified molecular sieves as a potential SO_2 control technology for sulfuric acid plants. Molecular sieves consist of a system in which SO_2 is absorbed on synthetic zeolites. The adsorbed material is desorbed by purified hot tail gas from the operating system and sent back to the acid plant.

According to EPA (1979), molecular sieve systems have only been tried on one sulfuric acid plant. However, extensive operational difficulties with this system have caused this plant to be retrofitted with a dual absorption system (same as Cargill's present system). Therefore, based on the lack of commercial demonstration for this technology, it is not considered further for Cargill's sulfuric acid plants.

2.3 FGD SYSTEMS

There are several types of SO_2 FGD systems which could theoretically be employed on sulfuric acid plants. The EPA (1979) identified sodium sulfite-bisulfite scrubbing and ammonia scrubbing as two potential technologies. Other common technologies such as wet limestone FGD, wet sodium hydroxide scrubbing, and lime spray drying FGD could also theoretically be applied. Each of these FGD systems are discussed further in the following sections.

2.3.1 Description of FGD Systems

Sodium Sulfite-Bisulfite Scrubbing

This process, developed by Wellman-Power gas, is based upon absorption of SO_2 in a sodium sulfite solution in a three-stage absorber. The resulting solution is sodium bisulfate. The solution is heated to form sodium sulfite crystals, and SO_2 gas and water vapor is released. The crystals are then separated from the mother liquid and dissolved in the recovered condensate for recycle to the absorber. The recovered SO_2 is sent back to the sulfuric acid plant.

Although this technology has potential for sulfuric acid plants, it is not known to have been applied to any sulfuric acid plant in practice. Therefore, based on the lack of commercial demonstration for this technology, it is not considered further for Cargill's sulfuric acid plants.

Ammonia Scrubbing

Ammonia scrubbing involves the use of aqueous ammonia and water in a two-stage scrubbing system. A mist eliminator follows in order to remove fine ammonium salts generated in the scrubbing process. These fine ammonium salts can result in a highly visible plume if not controlled. Expected SO_2 removal efficiency of an ammonia scrubbing system based upon vendor estimates, is approximately 85 percent.

The resulting ammonium sulfate-bisulfate solution is converted by reaction with sulfuric acid in a stripper to evolve SO_2 gas and produce an ammonium sulfate byproduct solution. The SO_2 is returned to the acid plant while the solution is treated for the production of fertilizer grade ammonium sulfate. The process is dependent upon a suitable market for ammonium sulfate.

There are many different types of plants employing ammonia scrubbing, two of which are sulfuric acid plants in the phosphate industry: one in Texas and one in Idaho. Both of these employ a single absorption sulfuric acid plant, as opposed to the standard dual absorption plant. The single absorption plant would result in much higher uncontrolled SO_2 emissions, making add-on SO_2 control more cost effective, particularly if the byproduct market existed.

Wet Limestone Scrubbing

Wet scrubbing is a gaseous and liquid phase reaction process in which the SO_2 gas is transferred to the scrubbing liquid under saturated conditions. The wet scrubbing process creates a liquid waste stream. Therefore, a wastewater treatment and disposal system is generally required for a wet scrubbing system.

The most frequently utilized wet FGD technology is the wet limestone system. The preferred version of the technology is the spray tower. In this system, a slurry of atomized limestone is sprayed into a tall vertical absorber tower through a series of nozzles. The flue gas enters usually at the bottom of the tower, passes vertically up through the spray droplets, and exits the vessel at the top.

The slurry is recirculated through the absorber system. This recirculation increases the scrubbing utilization of the carbonate reagent. A bleedstream is taken off from the recycled slurry stream to avoid build-up inside the spray tower. The scrubbing reaction produces calcium sulfite as the byproduct. Many systems further oxidize the sulfite into calcium sulfate, which is easier to dewater. Byproducts and unreacted reagent in the bleedstream is dewatered using a variety of equipment including thickeners, centrifuges, and vacuum filters. Dewatering systems reduce the water content in the filtered waste solid to between 10 to 50 percent by weight, depending on the system.

Technically, wet limestone scrubbing processes are capable of reducing SO_2 emissions with a removal efficiency between 70 to 93 percent. Based on vendor estimates, the estimated SO_2 removal efficiency for the wet limestone scrubbing process is 90 percent.

Lime Spray Drying

In the dry scrubbing process, the flue gas entering the scrubber contacts an atomized slurry of either wet lime or wet sodium carbonate (Na_2CO_3) sorbent. The SO_2 gas reacts with lime or sodium sorbent to form initially either calcium sulfite ($CaSO_3 \bullet \frac{1}{2}H_2O$) or sodium sulfite ($Na_2SO_3$). Further oxidation or SO_2 absorption is enhanced by the drying process, and the sulfite salts transform into calcium sulfate ($CaSO_4 \bullet 2H_2O$) or sodium sulfate solids.

A typical spray dryer will use lime as the reagent because it is more readily available than sodium carbonate. Lime slurry is injected into the spray dryer chamber through either a rotary atomizer or pressurized fluid nozzles. The moisture in the lime slurry evaporates and cools the flue gas, and the wet lime absorbs SO_2 in the flue gas and reacts to form pseudo liquid-solid phase salts that are then dried into insoluble crystals by the heat content of the flue gases.

The particulate exiting the spray dryer scrubber contains dried calcium salts and dried unreacted lime. Moisture content of the dried calcium salt leaving the absorber is about 2 to 3 percent, eventually decreasing to about 1 percent downstream. The simultaneous evaporation and reaction in the spray drying process increases the moisture and particulate content of the flue gas and reduces the flue gas temperature.

In the spray dryer scrubber, the amount of water used is optimized to produce an exit stream with "dry" particulates and gases with no liquid discharge from the scrubber. The "dry" reaction products must be removed from the flue gas by a particulate collection device downstream. This differs from the wet scrubber system, wherein the slurry leaving that system must be dewatered at great cost and the gas is cooled to adiabatic saturation temperature.

The dry scrubber usually is located upstream of the particulate control device, which is either an electrostatic precipitator (ESP) or a fabric filter (baghouse) system. A baghouse can provide slightly greater SO_2 removal compared to an ESP system. When a baghouse is used, a layer of porous filter cake forms on the filter bag surfaces. This filter cake contains unspent reagent which provides a site for additional SO_2 removal since the flue gases pass through the filter cake.

Spray dryer scrubbers can reduce SO_2 emissions by up to 92 percent. This is similar to other wet scrubbers such as wet limestone and sodium hydroxide. However, since the dry scrubbing option would require an additional particulate control device, such as a baghouse, this option would be much more expensive than the wet scrubbing options. As a result, this option was not considered further for the Cargill sulfuric acid plants.

3.0 BACT ANALYSIS FOR SO_2

This section discusses the overall technical, environmental, energy, and economic impacts of the alternative control technologies, including the proposed technology of the double absorption sulfuric acid plant. The wet scrubbing techniques of wet limestone, ammonia, and sodium hydroxide can reduce SO_2 emissions by 85 to 90 percent, and are considered technically feasible for the Cargill sulfuric acid plants.

3.1 ENVIRONMENTAL EFFECTS

The primary environmental concern of using the wet scrubbing systems is the process wastewater or waste sludge which is generated. These waste streams require proper treatment and disposal.

Wet Limestone Scrubbing

Typically, waste sludge is landfilled onsite, potentially impacting local groundwater. The wet limestone system applied to both the No. 8 and No. 9 Sulfuric Acid plants at Cargill would generate approximately 9,000 tons of solid sludge each year, which would require approximately 4 acre-ft of landfill space each year. The calcium sulfate sludge could be disposed of by further processing to make gypsum that may be used by a wallboard manufacturing facility. However, this option is not viable for the proposed project since there is no known market for the gypsum in the area. The additional capital cost for the gypsum processing equipment would also be a concern.

A wet limestone scrubber also has the disadvantage of high water consumption. Wet limestone scrubbers for the project will require approximately 146 million gallons of water per year. Such large water demand will have an undesirable environmental effect in the Tampa area, which is already experiencing declining water supply levels due to increasing demands on water consumption and lower than average rainfall.

Ammonia Scrubbing

The major environmental issues concerning the use of the ammonia scrubbing process is wastewater treatment and water consumption. An ammonium sulfate-bisulfate aqueous waste stream is created by the process that requires further treatment or disposal. For every ton of SO_2 removed, there will be approximately 600 gallons of aqueous waste generated. Conversion of this waste stream to ammonium sulfate is not practical since there is no known market in the area for ammonium sulfate.

The estimated maximum water requirement for the ammonia scrubbing system at Cargill is approximately 1.8 million gallons per year. As discussed above, this is a negative environmental impact in an area of declining water levels and declining water availability.

Sodium Hydroxide Scrubbing

As with the ammonia scrubbing process, the major environmental issues concerning the use of the sodium hydroxide scrubbing process is wastewater treatment and water consumption. An aqueous waste stream is created by the process that requires further treatment or disposal. For every ton of SO_2 removed, there will be approximately 400 gallons of aqueous waste generated.

The estimated maximum water requirement for the sodium scrubbing system at Cargill is approximately 1.3 million gallons per year. As discussed above, this is a negative environmental impact in an area of declining water levels and declining water availability.

3.2 ENERGY IMPACTS

All three scrubber alternatives require electricity to drive various mechanical equipment, including fans and pumps. The estimated energy requirement is approximately 6,356 megawatt-hours per year (MW-hr/yr) for the wet limestone scrubber, approximately 7,080 MW-hr/yr for the ammonia scrubbing system, and approximately 2,180 MW-hr/yr for the sodium hydroxide scrubber.

3.3 ECONOMIC ANALYSIS

This section presents the total capital investment (TCI) and the annualized cost (AC) of the three wet scrubber options for the Cargill No. 8 and No. 9 Sulfuric Acid plants. Capital costs were developed from basic equipment costs provided by vendor quotes for each process, and with standard cost factors for estimating the direct and indirect costs of the emission control systems (EPA, 1990b). Annual operating costs were developed considering the annualized capital recovery cost and other direct and indirect operating costs. These costs are presented in Table 3-1.

Uncontrolled SO_2 emissions for the purpose of determining cost effectiveness of the various control alternatives are based on the allowable SO_2 emissions of 4,161 TPY from the No. 8 and No. 9 Sulfuric Acid plants combined, and an operating factor of 80 percent. This operating factor is based on historical data from the plants over the last 7 years (see Table 3-2). These data indicate that SO_2 emissions from the plants over the last 7 years have averaged approximately 60 percent of the allowable SO_2 emissions. However, in 1993 the operating factor was 81 percent, and therefore an operating factor of 80% was used to represent future maximum conditions. The uncontrolled SO_2 emissions used as the basis of the BACT analysis was therefore 3,329 TPY.

Table 3-1. Economic Analysis for Alternative SO2 Control Systems for SAP No. 8 and SAP No. 9 combined at Cargill Fertilizer, Riverview

Cost Items	Cost Factors	Caustic NaOH Scrubber ($)	Limestone Wet Scrubber ($)	Ammonia Scrubber ($)
DIRECT CAPITAL COSTS (DCC):				
1. Purchased Equipment				
a. Basic Equipment (a)	Vendor Quote	2,200,000	3,000,000	5,300,000
b. Auxiliary Equipment	25% / 50% / 50%	550,000	1,500,000	2,650,000
c. Structure Support	10% x (1a)	220,000	300,000	530,000
d. Instrumentation & Controls	included	included	included	included
e. Freight (b)	5% x (1a .. 1d)	148,500	240,000	424,000
f. Sales Tax (Florida)	6% x (1a .. 1d)	178,200	288,000	508,800
g. Subtotal	(1a .. 1f)	3,296,700	5,328,000	9,412,800
2. Direct Installation (b)	80% x (1a .. 1f)	2,637,360	4,262,400	7,530,240
Total DCC:	(1) + (2)	5,934,060	9,590,400	16,943,040
INDIRECT CAPITAL COSTS (ICC):				
3. Indirect Installation				
a. Engineering & Supervision (b)	10% x (DCC)	593,406	959,040	1,694,304
b. Construction & Field Expenses (b)	10% x (DCC)	593,406	959,040	1,694,304
c. Contruction Contractor Fee (b)	10% x (DCC)	593,406	959,040	1,694,304
d. Contigencies (b)	20% x (DCC)	1,186,812	1,918,080	3,388,608
4. Other Indirect Costs				
a. Startup & Testing (b)	3% x (DCC)	178,022	287,712	508,291
b. Working Capital (c)	30-day DOC	287,777	187,180	439,613
Total ICC:	(3) + (4)	3,432,829	5,270,092	9,419,424
TOTAL CAPITAL INVESTMENT (TCI):	DCC + ICC	9,366,889	14,860,492	26,362,464
DIRECT OPERATING COSTS (DOC):				
1. Labor				
a. Operator (d)	22 $/hr, 8,760 hr/yr	192,720	192,720	192,720
b. Supervisor (b)	15% of operator cost	28,908	28,908	28,908
2. Maintenance (d)	5% of direct capital cost	296,703	479,520	847,152
3. Replacement Parts	3% of direct capital cost	178,022	287,712	508,291
4. Utilities				
a. Electricity	85 $per MW-hr; 2180 / 6356 / 7080	185,300	540,260	601,800
b. Water	0.27 $/1,000 gal 16,000 gal/ton limestone	N/A	39,640	N/A
5. Raw Chemicals				
a. Caustic NaOH (50% purity)	207 $ / ton delivered for 10,580 TPY	2,190,060	--	--
b. Limestone (97% purity)	32 $ / ton delivered for 9,176 TPY	--	293,632	--
c. Ammonia (29.4% purity)	260 $ / ton delivered for 10,800 TPY	--	--	2,808,000
6. Solids Waste Disposal (e)	27 $/ton for 14129/13670/10678 TPY	381,483	369,090	288,306
7. Liquid Waste Treatment	0.10 $ / 1000 gal for tmt	126	14,682	181
Total DOC		3,453,322	2,246,164	5,275,358
INDIRECT OPERATING COSTS (IOC):(b)				
8. Overhead	80% of operating labor & maintenance	414,665	560,918	855,024
9. Property Taxes	1% of total capital investment	93,669	148,605	263,625
10. Insurance	1% of total capital investment	93,669	148,605	263,625
11. Administration	2% of total capital investment	187,338	297,210	527,249
Total IOC		789,340	1,155,338	1,909,523
CAPITAL RECOVERY COSTS (CRC)	CRF of 0.1628	1,524,929	2,419,288	4,291,809
ANNUALIZED COSTS (AC):	DOC + IOC + CRC	5,767,592	5,820,790	11,476,690
Uncontrolled SO2 Emissions (TPY) (80% capacity)		3,329	3,329	3,329
SO2 Control Efficiency (%)		95	90	90
TOTAL SO2 REMOVED		3,162	2,996	2,996
COST $$/TON SO2 REMOVED		1,824	1,943	3,831

(a) The basic equipment costs for each scrubber system are based on pricing from Monsanto Enviro-Chem.
(b) Based on catalytic incinerators, from OAQPS Control Cost Manual, Fourth Edition.
(c) 30 days of direct operating costs, calculated from the annualized cost Table 2 (i.e., total DOC/12 months).
(d) Based on Capital Cost Factors for ESP, from OAQPS Control Cost Manual, Fourth Edition (1990).
(e) Scrubber effluent for disposal based on amount of sulfur dioxide removed and ratio of molecular weights for reagent / SO2

Table 3–2. Actual SO2 Emissions and Operating Schedule for Cargill Riverview 1987–1993

Year	SAP No. 8		SAP No. 9		Total SO2 Emissions (TPY)	Percent of Allowable Emissions (b)
	hr/yr	SO2 (TPY) (a)	hr/yr	SO2 (TPY) (a)		
1993	8,384	1,274	8,032	1,737	3,011	80.9
1992	8,459	1,229	8,416	1,521	2,749	73.9
1991	8,607	560	8,232	1,367	1,927	51.8
1990	8,526	1,331	8,528	1,659	2,990	80.3
1989	7,717	868	7,025	1,158	2,026	54.4
1988	6,406	735	7,862	1,176	1,912	51.4
1987	6,807	802	7,280	1,202	2,004	53.8
Average	7,844	971	7,911	1,403	2,374	63.8

Note: (a) Based on Annual Operating Reports.
(b) Based on SO2 allowable of 3,722 TPY for SAP No. 8 and SAP No. 9 combined.

Controlled SO_2 emissions were based on 90 percent removal efficiency for the wet limestone system and the ammonia scrubbing system, and a 95 percent removal efficiency for the sodium hydroxide scrubbing system.

The total cost effectiveness of each scrubber option is obtained by dividing the SO_2 emission reduction (in TPY) by the total annualized cost of the scrubber option (see Table 3-1). The cost effectiveness for the wet limestone scrubber option is \$1,900/ton of SO_2 removed; \$3,800/ton for the ammonia scrubbing system; and \$1,800/ton of SO_2 removed for the sodium hydroxide scrubber system. These cost effectiveness values are near to or higher than the levels that FDEP and EPA have considered as reasonable for controlling SO_2 emissions from new sources (i.e., \$2,000 per ton of SO_2 removed).

In addition to this high cost effectiveness for add-on SO_2 controls, any of these alternatives would have a severe economic impact upon Cargill's business. The Florida phosphate market has been severely depressed for many years. Some large plants have been sold recently due to economic losses. The phosphate plants operate under a very small profit margin. Companies have had to reduce operating costs and improve efficiencies just to remain in business. Cargill is a progressive company which has implemented many process improvements over the years, including air pollution control equipment, in order to increase production rates with existing process equipment.

Market prices for granular phosphate products vary from year to year, but have generally been low. MAP, DAP, and GTSP are the main products produced with the use of sulfuric acid. The current market price for these products is approximately \$140/ton, but was at a much lower price of \$115/ton just last year. In fiscal year 1993/1994, the Cargill plant produced approximately 1.7 million tons of MAP, DAP, and GTSP products. As shown in Table 3-1, any of the three control alternatives would cost at least \$5 million annually. Therefore, in order to maintain an already low profit margin, the impact on the price of MAP, DAP, and GTSP for Cargill would be approximately \$3/ton produced. Although this is only a 2 percent increase in the price of the product, it represents a decrease of about a 66 percent in pretax profits for these products. As noted by EPA in 1979, an impact of 20 percent or more upon pretax profits was found to be adverse to the industry. Therefore, requiring Cargill to impose add-on SO_2 control equipment at considerable annual cost would be unreasonable.

Moreover, no sulfuric acid plant in Florida is known to have been required to use add-on control equipment to control SO_2 emissions. All plants employ the double adsorption technology for SO_2 control. All previous BACT determinations for SO_2 for sulfuric acid plants in Florida have specified double adsorption as the control technology. BACT determinations issued on sulfuric acid plants through 1990 were presented in the permit application. Three more recent BACT determinations have been made since 1990: one in 1991, one in 1992, and one in 1993.

The 1991 determination was for IMC Fertilizer in Polk County (PSD-FL-170). IMC proposed to increase SO_2 emissions from five sulfuric acid plants, by a total of 3,055 TPY of SO_2. The 1992 determination was for Agrico Chemical Co. (PSD-FL-179). Agrico proposed to increase SO_2 emissions from two sulfuric acid plants, by a total of 1,642 TPY of SO_2. The 1993 determination was for Seminole Fertilizer Corp. (PSD-FL-191). Seminole Fertilizer proposed to increase SO_2 emissions from three sulfuric acid plants, by a total of 1,400 TPY of SO_2. In each of these determinations, BACT was determined to be the double adsorption process with a limit of 4 lb/ton of H_2SO_4 produced. These additional BACT determinations are listed in Table 3-3 (revises Table 5-2 from the application).

Cargill is proposing to increase allowable SO_2 emissions by only 439 TPY. This is a relatively small increase compared to recent increases approved for three other phosphate manufacturers. To require Cargill to implement add-on SO_2 controls when no other plant has been required to do so would not be consistent with other BACT determinations, and would impact Cargill severely, as described above. This would place Cargill at a severe economic disadvantage (a decrease of approximately 66 percent in pre-tax profits for MAP, DAP, and GTSP).

For the reasons described above, the three wet scrubber options are considered as economically infeasible for the proposed Cargill project. The double adsorption technology currently employed by the Cargill No. 8 and No. 9 Sulfuric Acid plants represents BACT for SO_2.

Table 3-3. Previous BACT Determinations for H_2SO_4 Plants

			Sulfur Dioxide		H_2SO_4 Mist	
Date Permit Issued	Company Name	Plant Capacity (TPD)	Allowable Emissions (lb/ton)	Basis	Allowable Emissions (lb/ton)	Basis
01/05/93	Seminole Fertilizer (PSD-FL-191)	6,840	4.0	NSPS, Double Absorption	0.15	NSPS, Mist Eliminator
03/10/92[a]	Agrico Chemical (PSD-FL-179)	2,700	4.0	NSPS, Double Absorption	0.15	NSPS, Mist Eliminator
05/22/91[a]	IMC Fertilizer, Inc. (PSD-FL-170)	14,500	4.0	NSPS, Double Absorption	0.15	NSPS, Mist Eliminator
02/29/88	Coal Gasification, Inc.	700	4.0	NSPS	0.15	NSPS
07/21/87	Gardinier, Inc. (No. 8 H_2SO_4 plant)	2,500	4.0	NSPS	0.15	NSPS
06/13/84	Chevron Co., USA	1,900	4.0	NSPS	0.15	NSPS
10/02/81	Conserv, Inc.	2,000	4.0	NSPS, Double Absorption	0.15	NSPS, Acid Mist Eliminator
06/01/81	New Wales Chemical, Inc.	2,750	4.0	NSPS, Double Absorption	0.15	NSPS
04/01/81	U.S.S. Agri-Chemicals	1,850	4.0	NSPS	-	-
07/11/80	Gardinier, Inc. (No. 7 H_2SO_4 Plant)	1,750	4.0	NSPS, Double Absorption	0.15	NSPS

[a] FDEP Technical Evaluation and Preliminary Determination.

Note:
BACT = best available control technology.
H_2SO_4 = sulfuric acid.
TPD = tons per day.
lb/ton = pounds per ton.
NSPS = New Source Performance Standards.

4.0 SULFUR DIOXIDE AND SULFURIC ACID MIST TEST DATA FROM NO. 8 AND NO. 9 PLANTS

SO_2 and acid mist emission test data for the No. 9 H_2SO_4 plant at Cargill was presented in the construction permit application. Since that time, additional test data has been obtained. In addition, the test data for the No. 8 H_2SO_4 plant is presented in order to support the BACT analysis. These data are presented and discussed in this section.

4.1 NO. 8 SULFURIC ACID PLANT

Emission test data from the No. 8 H_2SO_4 plant is presented in Table 4-1. The highest production rate achieved during these tests has been 2,506 TPD (104.4 TPH).. As shown, SO_2 emissions have ranged up to 3.32 lb/ton of 100 percent H_2SO_4 produced, based on compliance test averages, and up to 3.46 lb/ton for an individual test run. H_2SO_4 mist emissions have ranged up to 0.048 lb/ton of 100 percent H_2SO_4 produced, based on compliance test averages, and up to 0.071 lb/ton for an individual test run. These results reflect the potential variability in emissions which are typical of day-to-day variabilities in the plant operation and performance.

When operating at the proposed higher production rate, some increase in emissions on a lb/ton basis is expected, although compliance with the current allowables of 4.0 lb/ton for SO_2 and 0.15 lb/ton for H_2SO_4 mist is expected. The probability of reaching the allowable limit in the future at the higher operating rates will increase. Therefore, based on the emission levels currently achievable by the plant and the proposed higher future production rate, it is not possible to propose lower allowable emissions for the No. 8 H_2SO_4 plant.

4.2 NO. 9 SULFURIC ACID PLANT

Emission test data from the No. 9 H_2SO_4 plant is presented in Table 4-2. The highest production rate achieved during these tests has been 2,820 TPD (117.5 TPH). As shown, SO_2 emissions have ranged up to 3.80 lb/ton of 100 percent H_2SO_4 produced, based on compliance test averages, and up to 3.99 lb/ton for an individual test run. H_2SO_4 mist emissions have ranged up to 0.099 lb/ton of 100 percent H_2SO_4 produced, based on compliance test averages, and up to 0.134 lb/ton for an individual test run. These results reflect the potential variability in emissions which are typical of day-to-day variabilities in the plant operation and performance. Emissions for SO_2 have ranged up to the allowable limit of 4.0 lb/ton.

Table 4-1. Summary of Recent No. 8 H_2SO_4 Plant Emission Test Results

Date	Average Production Rate[a] (tons/hr)	Sulfur Dioxide				Sulfuric Acid Mist			
		(lb/hr)		(lb/ton)		(lb/hr)		(lb/ton)	
		Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
01/11/89	102.0	229	232	2.25	2.27	1.4	1.6	0.013	0.015
01/08/90	104.4	312	326	2.99	3.12	2.7	2.8	0.026	0.027
02/18/91	83.5	130	135	1.56	1.61	4.1	5.1	0.048	0.061
01/09/92	97.3	291	294	2.99	3.03	3.5	4.9	0.036	0.050
01/14/93	91.6	304	317	3.32	3.46	3.2	6.5	0.035	0.071
04/19/93	100.0	313	325	3.13	3.25	2.9	3.6	0.029	0.036
01/07/94	102.0	275	306	2.69	3.00	2.5	3.4	0.024	0.033

Note:
avg. = average.
H_2SO_4 = sulfuric acid.
lb/hr = pounds per hour.
lb/ton = pounds per ton.
max. = maximum.
SO_2 = sulfur dioxide.
tons/hr = tons per hour.

[a] As 100 percent sulfuric acid.

Source: KBN, 1994.

Table 4-2. Summary of Recent No. 9 H_2SO_4 Plant Emission Test Results

Date	Average Production Rate[a] (tons/hr)	Sulfur Dioxide (lb/hr) Avg.	Sulfur Dioxide (lb/hr) Max.	Sulfur Dioxide (lb/ton) Avg.	Sulfur Dioxide (lb/ton) Max.	Sulfuric Acid Mist (lb/hr) Avg.	Sulfuric Acid Mist (lb/hr) Max.	Sulfuric Acid Mist (lb/ton) Avg.	Sulfuric Acid Mist (lb/ton) Max.
07/22/86	100.7	373	402	3.70	3.99	4.6	8.20	0.047	0.080
10/30/87	107.0	300	334	2.80	3.12	10.6	14.4	0.099	0.134
01/10/89	106.0	298	303	2.81	2.86	3.5	5.7	0.043	0.054
09/29/89	109.4	265	267	2.42	2.44	2.7	3.7	0.024	0.033
10/19/89	117.5	394	400	3.36	3.41	5.1	5.9	0.043	0.050
11/02/90	114.2	389	407	3.41	3.56	3.0	3.5	0.027	0.030
12/07/91	114.9	332	346	2.88	3.01	2.8	5.2	0.025	0.045
12/15/92	110.5	361	373	2.79	3.12	2.8	3.1	0.025	0.028
01/13/94	113.0	433	441	3.80	3.90	1.1	1.3	0.010	0.012

Note:
avg. = average.
H_2SO_4 = sulfuric acid.
lb/hr = pounds per hour.
lb/ton = pounds per ton.
max. = maximum.
SO_2 = sulfur dioxide.
tons/hr = tons per hour.

[a] As 100 percent sulfuric acid.

Source: KBN, 1994.

When operating at the proposed higher production rate, some increase in emissions on a lb/ton basis is expected, although compliance with the current allowables of 4.0 lb/ton for SO_2 and 0.15 lb/ton for H_2SO_4 mist is expected. The probability of reaching the allowable limit in the future at the higher operating rates will increase. Therefore, based on the emission levels currently achievable by the plant and the proposed higher future production rate, it is not possible to propose lower allowable emissions for the No. 9 H_2SO_4 plant.

5.0 SUMMARY

In summary, the current double absorption sulfuric acid plants with allowable emissions of 4.0 lb/ton for SO_2 and 0.15 lb/ton for acid mist is considered to be BACT for the following reasons:

1. The adverse and unreasonable economic impact of alternative SO_2 control technologies;
2. The variability in day-to-day emissions due to process variables and performance; and
3. Emission levels already close to the allowable levels, and the potential for higher emissions at the increased operating rates.

ATTACHMENT B

AIR QUALITY RELATED VALUES ANALYSIS

AIR QUALITY RELATED VALUE ANALYSIS FOR THE PROPOSED MODIFICATION TO CARGILL'S RIVERVIEW, FLORIDA FACILITY

1.0 INTRODUCTION

At the request of Cargill Fertilizer Corporation, an air quality-related values (AQRVs) analysis was conducted to assess the potential risk to AQRVs of the Chassahowitzka National Wilderness Area (NWA) due to the proposed Cargill Tampa Bay facility. The AQRV analysis addresses the potential impacts of the pollutants SO_2 and sulfuric acid mist. These are the pollutants for which PSD review is required.

The U.S. Department of the Interior in 1978 administratively defined AQRVs to be:

> All those values possessed by an area except those that are not affected by changes in air quality and include all those assets of an area whose vitality, significance, or integrity is dependent in some way upon the air environment. These values include visibility and those scenic, cultural, biological, and recreational resources of an area that are affected by air quality.
>
> Important attributes of an area are those values or assets that make an area significant as a national monument, preserve, or primitive area. They are the assets that are to be preserved if the area is to achieve the purposes for which it was set aside (Federal Register 1978).

Except for visibility, AQRVs were not specifically defined. However, odor, soil, flora, fauna, cultural resources, geological features, water, and climate generally have been identified by land managers as AQRVs. Since specific AQRVs have not been identified for the Chassahowitkza NWA, this AQRV analysis evaluated the effects of air quality on general vegetation types and wildlife on the Chassahowitzka NWA.

Vegetation type AQRVs and their representative species types have been defined as:

Marshlands - black needlerush, saw grass, salt grass, and salt marsh cordgrass
Marsh Islands - cabbage palm and eastern red cedar
Estuarine Habitat - black needlerush, salt marsh cordgrass, and wax myrtle
Hardwood Swamp - red maple, red bay, sweet bay, and cabbage palm
Upland Forests - live oak, scrub oak, longleaf pine, slash pine, wax myrtle, and saw palmetto
Mangrove Swamp - red, white, and black mangrove

Wildlife AQRVs have been identified as endangered species, waterfowl, marsh and waterbirds, shorebirds, reptiles, and mammals.

A screening approach was used which compared the maximum predicted ambient concentration of air pollutants of concern in the Chassahowitzka NWA with effect threshold limits for both vegetation and wildlife as reported in the scientific literature. A literature search was conducted which specifically addressed the effects of air contaminants on plant species reported to occur in the NWA. While the literature search focused on such species as cabbage palm, eastern red cedar, lichens, and species of the hardwood swamplands and mangrove forest, no specific citations that addressed these species were found. It is recognized that effect threshold information is not available for all species found in the Chassahowitzka NWA, although studies have been performed on a few of the common species and on other similar species which can be used as models. In conducting the assessment, both direct (fumigation) and indirect (soil accumulation/uptake) exposures were considered for flora, and direct exposure (inhalation) was considered for wildlife. Maximum concentrations were predicted using the ISCST model and 5 years of meteorological data, as described in the PSD permit application.

2.0 SULFUR DIOXIDE

2.1 MAXIMUM IMPACTS UPON CLASS I AREA

In order to assess the total air quality impacts at the Class I area that can be compared to the reported effects levels, the predicted impacts due to all PSD increment affecting sources were added to background concentrations applicable to the 3-hour, 24-hour, and annual averaging periods. The background concentrations, available from existing ambient monitoring data, are assumed to be representative of impacts from sources not modeled.

In this analysis, ambient data collected in 1992 from a monitoring station (Station No. 0580-003-J02) located about 15 kilometers (km) from the Class I area were used to represent background concentrations (refer to Table 1). This is the nearest SO_2 monitoring station to the Class I area. The annual concentration of 4 $\mu g/m^3$ and maximum 3-hour and 24-hour concentrations of 140 and 61 $\mu g/m^3$, respectively, were used to represent background concentrations. Incremental impacts due to the proposed Cargill project, as well as total cumulative impacts, are presented in Table 2.

2.2 AIRBORNE EXPOSURE: VEGETATION

The gaseous concentrations ($\mu g/m^3$) of sulfur dioxide (SO_2) were used in the determination of impacts on vegetation. These compounds are believed to interact predominantly with foliage and this is considered the major route of entry into plants. In this assessment, 100 percent of the compound of interest was assumed to interact with the vegetation. The maximum SO_2 concentrations predicted for the proposed sources for the 1-hour, 3-hour, 8-hour, 24-hour, and annual averaging periods are presented in Table 2.

SO_2 gas at elevated levels has long been known to cause injury to plants. Acute SO_2 injury usually develops within a few hours or days of exposure and symptoms include marginal and/or interveinal necrotic areas which appear water-soaked and faded-green initially. This injury generally occurs to younger leaves. Chronic injury usually is evident by signs of chlorosis, bronzing, premature senescence, reduced growth and possible tissue necrosis.

Many studies have been conducted to determine the effects of high concentration, short-term SO_2 exposure on natural community vegetation (Tables 3 and 4). Sensitive plants include ragweed, legumes, blackberry, southern pine, and red and black oak. For example, these species are injured by exposure to 3-hour SO_2 concentrations from 790 to 1,570 $\mu g/m^3$. Intermediate plants include locust and sweetgum. These species are injured by exposure to 3-hour SO_2 concentrations from 1,570 to 2,100 $\mu g/m^3$. Resistant species (injured at concentrations above 2,100 $\mu g/m^3$ for 3 hours) include white oak and dogwood (Woltz and Howe, 1981).

A study of native Floridian species (Woltz and Howe, 1981) demonstrated that cypress, slash pine, live oak, and mangrove exposed to 1,300 $\mu g/m^3$ SO_2 for 8 hours were not visibly damaged. This supports the levels cited by other researchers on the effects of SO_2 on vegetation. A corroborative study (McLaughlin and Lee, 1974) demonstrated that approximately 20 percent of a cross-section of plants ranging from sensitive to tolerant were visibly injured at 3-hour SO_2 concentrations of 920 $\mu g/m^3$.

Jack pine seedlings exposed to SO_2 concentrations from 470 to 520 $\mu g/m^3$ for 24 hours demonstrated inhibition of foliar lipid synthesis; however, this inhibition was reversible (Malhotra and Kahn, 1978). Black oak exposed to 1,310 $\mu g/m^3$ SO_2 for 24 hours a day for 1 week demonstrated a 48 percent reduction in photosynthesis (Carlson, 1979).

Two lichen species indigenous to Florida exhibited signs of SO_2 damage in the form of decreased biomass gain and photosynthetic rate as well as membrane leakage when exposed to concentrations of 200 to 400 $\mu g/m^3$ for 6 hours/week for 10 weeks (Hart et al., 1988).

As shown in Table 2, a maximum total 3-hour SO_2 concentration of 141 $\mu g/m^3$ would be expected in the Class I area. By comparing this concentration to those causing injury to native species, the SO_2-sensitive species (or more tolerant species) would not be damaged by the maximum predicted concentrations. By comparison with concentrations that cause plant injury, the maximum predicted 3-hour SO_2 concentration of 141 $\mu g/m^3$ is approximately 20 percent of the most conservative 3-hour concentration (i.e., 790 $\mu g/m^3$) that causes injury to SO_2-sensitive species.

When the predicted 8-hour and 1-hour SO_2 concentrations at Chassahowitzka (108 and 156 $\mu g/m^3$, respectively) are compared to the concentrations causing injury to native species, it is evident that SO_2-sensitive species (or more tolerant species) would not be damaged by the predicted concentrations. SO_2 concentrations predicted in the wilderness area are less than 12 percent of the most conservative 1-hour concentration (1,300 $\mu g/m^3$) that caused injury to SO_2-sensitive species.

The maximum total 24-hour and annual SO_2 concentrations of 61 and 4 $\mu g/m^3$, respectively, predicted within the Class I area represent levels which are lower than those known to cause damage to test species. By comparison of these levels, it is apparent that the maximum predicted 24-hour concentrations are well below the 24-hour concentrations that cause damage in SO_2-sensitive plants (i.e., 470 $\mu g/m^3$). The maximum annual concentration of 0.008 $\mu g/m^3$ due to the proposed expansion adds only slightly to the background levels and poses a minimal threat to area vegetation.

2.3 AIRBORNE EXPOSURE: SOILS

The majority of the soil in the Class I area is classified as Weekiwachee-Durbin muck. This is an euic, hyperthermic typic sufihemist that is characterized by high levels of sulfur and organic matter. This soil is flooded daily with the advent of high tide and the pH ranges between 6.1 and 7.8. The upper level of this soil may contain as much as 4 percent sulfur (USDA, 1991).

The greatest threat to soils from increased SO_2 deposition is a decrease in pH or an increase of sulfur to levels considered unnatural or potentially toxic. Although ground deposition was not calculated, it is evident that the amount of SO_2 deposited would be inconsequential in light of the inherent sulfur content. The regular flooding of these soils by the Gulf of Mexico regulates the pH and any rise in acidity in the soil would be buffered by this activity.

2.4 AIRBORNE EXPOSURE: WILDLIFE

The predicted SO_2 concentrations are well below the lowest observed effects levels in animals, e.g., less than 427 μg/m^3 for 1 hour (Newman and Schreiber, 1988). Given these conditions, the proposed source's emissions poses no risk to wildlife. Because predicted levels are below those known to cause effect to vegetation, there is also no risk.

3.0 SULFURIC ACID MIST

The maximum 1-hour sulfuric acid mist concentration due to the proposed expansion only is predicted to be 0.112 μg/m^3, which is approximately 0.00003 parts per million (ppm) in the Class I area. Although literature pertaining to the effects of sulfuric acid on terrestrial vegetation could not be obtained, effects on aquatic macrophytes were acquired.

In a study in which the aquatic plants, hydrilla, naiad, and vallisneria were exposed to concentrations of 27 or 80 ppm of sulfuric acid, mild burning was observed around the base of the plants which came into contact with undiluted acid. In jars in which these same concentrations of acid were added homogeneously (i.e., mixed before plant exposure), no plant damage was observed. Because aquatic plants have a poorly developed (if existing) cuticle, they serve to indicate phytotoxicity to a greater extent than terrestrial plants. The potential phytotoxic assessment in this case is therefore more conservative than using terrestrial plant information. The maximum 1-hour concentration of 156 μg/m^3 (0.040 ppm) in the Class I area is 1.1^{-6} to 3.8^{-7} of the values that caused either mild burning or no effects at all on aquatic vegetation.

4.0 REFERENCES

Carlson, R.W. 1979. Reduction in the Photosynthetic Rate of Acer quercus and Fraxinus Species Caused by Sulphur Dioxide and Ozone. Environ. Pollut. 18:159-170.

Hart, R., P.G. Webb, R.H. Biggs, and K.M. Portier. 1988. The Use of Lichen Fumigation Studies to Evaluate the Effects of New Emission Sources on Class I Areas. J. Air Poll. Cont. Assoc. 38:144-147.

Malhotra, S.S. and A.A. Kahn. 1978. Effect of Sulfur Dioxide Fumigation on Lipid Biosynthesis in Pine Needles. Phytochemistry 17:241-244.

McLaughlin, S.B. and N.T. Lee. 1974. Botanical Studies in the Vicinity of the Widows Creek Steam Plant. Review of Air Pollution Effects Studies, 1952-1972, and Results of 1973 Surveys. Internal Report I-EB-74-1, TVA.

Newman, J.R., and Schreiber, 1988. Air Pollution and Wildlife Toxicology: An Overlooked Problem. Environmental Toxicology and Chemistry 7:381-390.

Trent, L.L., R.S. Hestand, and C.C. Carter. 1978. Toxicity of Sulfuric Acid to Aquatic Plants and Organisms. J. Aquat. Plant Manage. 16:40-43.

United States Department of Agriculture, 1991. Surveys of Hernando and Citrus Counties, Florida. USDA Soil Conservation Service in cooperation with University of Florida, Institute of Food and Agricultural Sciences, Agricultural Experiment Stations, and Soil Science Department.

United States Environmental Protection Agency. 1982. Air Quality Criteria for Particulate Matter and Sulfur Oxides. Vol. 3.

United States Environmental Protection Agency. 1982a. Air Quality Criteria for Particulate Matter and Sulfur Oxides. Vol. 3. Final Report.

United States Environmental Protection Agency, 1988. Workbook for Plume Visual Impact Screening and Analysis. EPA-450/4-88-015, September, 1988.

United States Department of Health, Education, and Welfare. 1971. Air Pollution Injury to Vegetation. National Air Pollution Control Administration Publication No. AP-71.

Woltz, S.S. and T.K. Howe. 1981. Effects of Coal Burning Emissions on Florida Agriculture. In: The Impact of Increased Coal Use in Florida. Interdisciplinary Center for Aeronomy and (other) Atmospheric Sciences. University of Florida, Gainesville, Florida.

Table 1. Summary of Continuous SO_2 Monitoring Data Collected Near the Chassahowitzka NWA

Year	County	Monitoring Station ID	Monitor Location	Number of Observations	Maximum Concentrations Reported ($\mu g/m^3$) 3-Hour	24-Hour	Annual
1991	Citrus	0580-003-J02	Crystal River; Twin Rivers Marina	7,854	137	30	4
1992	Citrus	0580-003-J02	Crystal River; Twin Rivers Marina	8,304	140	61	4
1991	Citrus	0580-005-J02	Crystal River; East of FPC Plant	8,344	296	67	6
1992	Citrus	0580-005-J02	Crystal River; East of FPC Plant	8,228	335	51	7

Table 2. Incremental and Cumulative SO_2 Impacts at the Class I Area

Averaging Time	Background SO_2 Concentration ($\mu g/m^3$)	Increase Due to Proposed Project ($\mu g/m^3$)	Cumulative SO_2 Concentration with Proposed Project ($\mu g/m^3$)	Primary/Secondary Ambient Air Quality Standard ($\mu g/m^3$)
Annual	4	0.008	4	50
24-hour	61	0.27	61	150
8-hour	107[a]	0.59	108	—
3-hour	140	1.31	141	—
1-hour	153[a]	2.93	156	—

[a] Based on 24-hour concentration and recommended EPA averaging time factors:
24-hour / 1-hour = 0.4
8-hour / 1-hour = 0.7

Table 3. SO_2 Effects Levels for Various Plant Species

Plant Species	Observed Effect Level ($\mu g/m^3$)	Exposure (Time)	Reference
Sensitive to tolerant	920 (20 percent displayed visible injury)	3 hours	McLaughlin and Lee, 1974
Lichens	200-400	6 hr/wk for 10 weeks	Hart *et al.*, 1988
Cypress, slash pine, live oak, mangrove	1,300	8 hours	Woltz and Howe, 1981
Jack pine seedlings	470-520	24 hours	Malhotra and Kahn, 1978
Black oak	1,310	Continuously for 1 week	Carlson, 1979

Table 4. Sensitivity Groupings of Vegetation Based on Visible Injury at Different SO_2 Exposures[a]

Sensitivity Grouping	SO_2 Concentration 1-Hour	SO_2 Concentration 3-Hour	Plants
Sensitive	1,310 - 2,620 $\mu g/m^3$ (0.5 - 1.0 ppm)	790 - 1,570 $\mu g/m^3$ (0.3 - 0.6 ppm)	Ragweeds Legumes Blackberry Southern pines Red and black oaks White ash Sumacs
Intermediate	2,620 - 5,240 $\mu g/m^3$ (1.0 - 2.0 ppm)	1,570 - 2,100 $\mu g/m^3$ (0.6 - 0.8 ppm)	Maples Locust Sweetgum Cherry Elms Tuliptree Many crop and garden species
Resistant	>5,240 $\mu g/m^3$ (>2.0 ppm)	>2,100 $\mu g/m^3$ (>0.8 ppm)	White oaks Potato Upland cotton Corn Dogwood Peach

[a] Based on observations over a 20-year period of visible injury occurring on over 120 species growing in the vicinities of coal-fired power plants in the southeastern United States.

Source: EPA, 1982a.

ATTACHMENT C

INFORMATION FOR NO. 8 SULFURIC ACID PLANT