KBN

November 13, 1989

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Mr. C.H. Fancy, P.E.
Bureau of Air Regulation
Florida Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Re: Proposed Modification--Kiln 2 Coal Conversion
PSD-FL-142 - AC13-169901

Dear Mr. Fancy:

This correspondence provides responses to the Department's completeness letter dated October 4, 1989, concerning the above-referenced permit application. Each topic described in the EPA's draft comment letter dated October 3, 1989 is addressed in the attached response. In addition, the Department's comment concerning an air quality analysis for the Biscayne National Monument is addressed. Two sets of supportive computer printouts and computer disks are included.

If you have any questions concerning this submittal, please call Mr. David A. Buff, P.E., at 904-331-9000. I appreciate your cooperation in reviewing this important permit application.

Sincerely,

David A. Buff

David A. Buff, M.E., P.E.
Principal Engineer

DAB:dk

cc: Scott Quass
Al Townsend

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89025C1-RSP
10/27/89

TARMAC
KILN 2 COAL CONVERSION
RESPONSES TO FDER/EPA COMMENTS
NOVEMBER 1989

Prepared for:

Tarmac Florida, Inc.
Hialeah, Florida

Prepared by:

KBN Engineering and Applied Sciences, Inc.
Gainesville, Florida

November 8, 1989
89025B1

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1.0 APPLICABILITY DETERMINATION

The U.S. Environmental Protection Agency (EPA) raises several points in commenting on the determination of PSD source applicability and, in particular, on the determination of baseline emissions for Prevention of Significant Deterioration (PSD) new source review applicability. In response, a few general statements are appropriate before discussing each specific pollutant.

EPA contends in its comments that PSD baseline emissions should be based on actual historical emissions. The applicant is in agreement with this comment, except in regards to hours of operation and production rates. In the case of Tarmac, Kiln 2 is the "source" being modified. According to EPA and Florida Department of Environmental Regulation (FDER) PSD regulations, an increase in the operating hours or in the production rate of a source does not constitute a physical change in the source or change in the method of operation of a source (unless prohibited by a federally enforceable permit condition) [Rule 17-2.100(119)]. Therefore, increases in the hours of operation or in the production rate of a source do not constitute "modification" of that source, unless the permit restrictions are exceeded. Thus, a source's annual production rate and operating hours may fluctuate from year to year, depending on market conditions, without triggering PSD review. The PSD regulations are not intended to penalize a source merely because it did not operate at its full permitted capacity.

Does it matter as long as actual emissions are used and permit conditions are not exceeded

Conversion to coal is the modification (change in method of operation)

Tarmac is not requesting any increase in the permitted hours of operation [8,760 hours per year (hr/yr)] or in the permitted production rate [25 tons per hour (TPH)] for Kiln 2. Based upon the exemption in the regulations, actual hours of operation and production rates were not considered in the PSD applicability determination for Tarmac. PSD baseline and future emissions after conversion to coal were based upon the maximum permitted operating hours (8,760) and the maximum production rate for the kiln of 25 TPH.

But for emissions, can use Allowable only if source was not in operation by baseline date 12/27/77.

Tarmac is not requesting offset credit for shutting down a source. When a source is shutdown, it is acknowledged that emission reduction credit would be based on the actual emissions as determined by source operating records. Tarmac is only requesting that it not be penalized for operating a source at lower than capacity, consistent with the exemption in the PSD regulations.

1.1 PARTICULATE MATTER

It is acknowledged that the PSD baseline for PM/PM10 emissions should be based on the actual emissions from Kiln 2. The burning of natural gas or fuel oil has no effect on PM emissions from the kiln; therefore, fuel usage is not relevant to this determination. Since hours of operation and production rate do not enter into this determination, as discussed previously, only the actual emissions in lb/hr representative of the baseline period are required to determine baseline emissions.

To establish the baseline PM emissions for Kiln 2, historic test data for the kiln from 1978 through 1982 (when the kiln shutdown) were reviewed. The test data are summarized in Appendix A, Table A-1. Although PSD rules generally require the most recent 2-year operating period for determining actual emissions, the Department may allow a different time period if it is considered more representative of normal source operation. For Kiln 2, the year 1980 is considered to be more representative for the following reasons.

1. More PM stack tests were conducted during this year than during any other year. These tests were conducted at different times and, therefore, are considered more representative of yearly emissions.
2. The average of all PM stack tests during 1980 was 16.0 lb/hr. There is another year (1978) in which the measured PM emissions were higher (18.4 lb/hr). There are also five stack tests out of the total of 18 tests which resulted in PM emissions higher than 16.0 lb/hr.

Based on these considerations, the baseline PM emission rate is determined to be 16.0 lb/hr. It is further noted that actual PM emissions over the course of a year are likely to be higher than reflected by the stack tests. This is because the compliance tests are run under the best operating conditions (i.e., kiln and ESP are all operating at optimum). However, there is no way to establish what the actual emission rate for the year was, other than the compliance tests.

Based upon a baseline PM emission rate of 16.0 lb/hr for Kiln 2 and 8,760 hr/yr permitted operation, baseline emissions are 70.08 TPY. Baseline PM10 emissions are then 85 percent of PM emissions (refer to page 2-3 of the permit application), or 13.60 lb/hr and 59.57 TPY.

Tarmac is willing to limit future maximum PM emissions from Kiln 2 to 19.3 lb/hr or 84.53 TPY. Future maximum PM10 emissions, based upon the 85 percent factor, will then be limited to 16.4 lb/hr and 71.85 TPY. The proposed new PM limit is much less than the allowable rate of 31.0 lb/hr for Kiln 2, which was based on the process weight table.

Increased fugitive emissions from the existing coal-handling equipment and new coal mill were addressed in the permit application (refer to pages 2-7 and 3-12, Table 3-3, and Appendix B). It is noted that the new coal mill will produce no new emissions, since the exhaust gases are injected into the kiln. In order to further reduce future PM emissions from the coal-handling operation, Tarmac will use a water truck in the coal pile area. The water truck will be used on an as-needed basis to minimize fugitive dust emissions due to vehicular traffic associated with the handling of coal for Kiln 2. The fugitive dust emission estimates presented in the permit application did not consider any fugitive dust control measures. The watering of the coal pile is estimated to result in a 75 percent control efficiency for vehicular traffic, based upon Reference 1, which shows that up to 90 percent control of unpaved roads can be achieved by watering.

Permit Condition

The revised fugitive dust emissions for Kiln 2 coal handling are shown in the revised Tables B-1 and B-3 (see Appendix B). As shown, the revised total PM emissions are 4.30 TPY, and the revised PM10 emissions are 2.64 TPY. The resulting PSD applicability is presented below:

	PM	PM10
Baseline (TPY)		
Kiln 2	70.08	59.57
Future (TPY)		
Kiln 2	84.53	71.85
Coal Handling	4.30	2.64
Subtotal	88.83	74.49
Net Change (TPY)	18.75	14.92

As shown, the net increase in PM emissions is 18.75 TPY, and the net increase in PM10 emissions is 14.92 TPY. These increases are less than the respective PSD significant emission rates of 25 TPY and 15 TPY, respectively.

1.2 SULFUR DIOXIDE (SO_2)

The applicant has stated that PSD review applies for SO_2. Therefore, the determination of exact PSD baseline emissions is not relevant. However, for documentation purposes, the baseline can be assumed to be 100 percent gas firing, which results in the lowest SO_2 emissions. SO_2 emissions from gas firing in Kiln 2 were measured at 4.5 lb/hr. This equates to 19.7 TPY, based on 8,760 hr/yr operation.

Tested When? The calc's show this was derived by mat'l balance. (See App A - application)

1.3 NITROGEN OXIDES (NO_x)

It is acknowledged that baseline emissions for NO_x should be based on the fuel usage in Kiln 2. Actual fuel usage for the period 1977 through 1982 is presented in Table A-2 (see Appendix A). As shown, both gas and oil were burned in 1977 and 1978, but only gas was burned in 1979 through 1982. The year 1980 would be the most representative year, since the most fuel usage and clinker production occurred in this year. This year was also selected as the baseline year for PM emissions.

According to 17-2, Baseline emissions are not based on most representative year, but on actual emissions on applicable baseline date.

Based on clinker production of Kiln 2 in 1980 of 184,922 tons and the measured NO_x emission rate for gas firing of 4.73 lb/ton clinker, baseline emissions are calculated as 437.3 TPY. The proposed NO_x emissions from Kiln 2 for coal burning, as presented in the application, are 741.3 TPY. Therefore, the net increase in NO_x emissions due to the proposed modification is 304.0 TPY. Since this increase exceeds the PSD significant emission rate of 40 TPY, PSD review applies for NO_x emissions. The PSD analysis for NO_x emissions, including air quality impacts, BACT evaluation, and additional impacts, is contained in Appendix B. Maximum hourly emissions for gas firing is 118.3 lb/hr, and, for coal firing, maximum hourly emissions will be 169.3 lb/hr.

1.4 VOLATILE ORGANIC COMPOUNDS (VOCs)

The baseline VOC emissions were not based upon maximum, worst-case conditions as stated by EPA. The baseline VOC emissions were based upon a stack test for VOC on Kiln 3, which established actual emissions. It was assumed that No. 6 fuel oil was burned in the baseline calculation; however, the fuel oil was determined to contribute only 1.3 lb/hr out of the total VOC of 23.1 lb/hr. Therefore, any difference in actual emissions between natural gas and oil firing are insignificant and within the experimental error of the measurement technique (Method 25). As described previously, baseline emissions were based upon 8,760 hr/yr operation, as were future VOC emissions.

2.0 BACT DETERMINATION FOR SO_2

In regards to the SO_2 removal efficiency for Kiln 2, EPA has misinterpreted the data in Appendix A. Kiln 2 has never been converted to coal, nor stack tested when burning coal. All SO_2 stack tests on the kiln were conducted when burning gas or oil, and the actual SO_2 removal efficiencies of the system are specific to these fuels. The SO_2 emissions and removal efficiency for coal shown in Appendix A are from the 1980 permit application for Kiln 2 coal conversion, and as such were theoretical or expected rates.

The Kiln 3 coal conversion demonstrated that burning coal can result in a very different SO_2 removal efficiency. Tarmac went through many attempts to simultaneously meet the SO_2 and NO_x emission rates. This is exactly the reason for requesting the higher SO_2 emission rate for Kiln 2 when burning coal. Tarmac does not want another noncompliance situation caused by a lack of operating data. The differences between Kilns 2 and 3 are significant, such that the Kiln 3 operating experience is not directly applicable. It is not known for certain what the SO_2/NO_x emissions and interrelationship between these two pollutants will be for Kiln 2 until the kiln is actually converted and operated on coal. As stated in the application, Tarmac is willing to accept a lower SO_2 emission limit if source test data show that such a limit can be met on a continuous basis.

The use of lower sulfur coal in Kiln 2 has been investigated. The current coal contract for Kiln 3 specifies a sulfur content not to exceed 2.0 percent. Actual average coal sulfur content in 1988 was 1.5 percent for Kiln 3. Therefore, Tarmac's coal is already fairly low in sulfur.

Based on information from coal suppliers, the cost of 1.5 percent maximum sulfur coal could be as much as $3.80/ton higher or more than 2.0 percent sulfur coal, depending on the tariff zone from which the coal originated. Coal with 1.0 percent sulfur maximum could be as much as $4.90/ton higher or more. The coal suppliers could not guarantee the tariff zone from which the lower sulfur would come and, therefore, could not guarantee a coal price. In addition, the coal suppliers indicated only 6-month contracts would be given, due to uncertainty in future coal prices and supplies.

In addition to the cost of the coal, Tarmac would need to construct separate coal handling and storage facilities for Kiln 2, since the lower sulfur coal could not be mixed with the higher sulfur coal for Kiln 3. This would include separate rail dump facilities, separate storage pile, additional front-end loader, and additional coal conveying and storage bins. The capital cost of new coal handling and storage facilities for segregated coal is $1.7 million. Additional operating and maintenance (O&M) costs are estimated at $100,000 per year, including labor and materials. Use of shared coal handling facilities for Kilns 2 and 3 will result only in increased O&M costs of $20,000/yr.

Utilizing lower sulfur coal will potentially lower SO_2 emissions, but this will be very dependent on operation of the kiln. Assuming the kiln will be operated to minimize SO_2 emissions, it is assumed that SO_2 emissions due to sulfur in the fuel will be directly proportional to the sulfur content of the fuel. Based upon the information presented in the permit application, maximum SO_2 emissions from the kiln are as follows (includes the 36 percent inherent SO_2 removal efficiency):

	2.0 Percent Sulfur	1.5 Percent Sulfur	1.0 Percent Sulfur	
SO_2 due to fuel (lb/hr)	333	250	167	
SO_2 due to raw feed	66	66	66	(lb/hr)
TOTAL (lb/hr)	400	316	233	

A cost-effectiveness analysis of utilizing lower sulfur coal in Kiln 2 is presented in Table 2-1. The capital cost and O & M costs are shown for each coal sulfur content (2.0, 1.5, and 1.0 percent), as well as total

Table 2-1. Cost Analysis of Using Lower Sulfur Coal In Kiln 2

Cost Element	Maximum Coal Sulfur Content (Percent)		
	2.0 percent*	1.5 percent	1.0 percent
Capital Cost	$0	$1,700,000	$1,700,000
Annual O&M Costs:			
Coal+	$1,423,500	$1,639,872	$1,702,506
Other	20,000	120,000	120,000
Subtotal	$1,443,500	$1,759,872	$1,822,506
Annualized Costs			
Annualized Capital Cost**	$0	$340,000	$340,000
Annual Operating Costs	1,443,500	1,759,872	1,822,506
Total Annual Cost	$1,443,500	$2,099,872	$2,162,506
Differential Annual Cost	-	$656,372	$719,006
Cost Effectiveness			
Increase in Production Cost			
($/ton clinker)	$0.00	> $3.00	> $3.28
(%)	0.0	> 8	> 9
SO2 Emissions (TPY)	1,752	1,384	1,021
SO2 Removed (TPY)	-	368	731
Cost Effectiveness ($/ton removed)	-	$1,784	$983

Note: All values based upon a 100 percent annual operating capacity factor.
- 219,000 tons clinker per year.
- 56,940 tons coal per year.
- Current production cost is $38/ton clinker.

* Assumes shared coal handling facilities with Kiln 3.
\+ Minimum coal costs are as follows:
2.0 percent S - $25.00/ton
1.5 percent S - $28.80/ton
1.0 percent S - $29.90/ton
Coal costs may be higher depending on tariff zone.
** Based upon Capital Charge Factor of 0.20.

annualized costs. The O&M costs include fuel costs. As shown, the differential annual cost between 2.0 and 1.5 percent sulfur coal is $656,000 per year, and between 2.0 and 1.0 percent coal is $719,000 per year.

The most significant cost effectiveness figure is that of projected production cost associated with Kiln 2. The projected production cost (which Tarmac desires to keep confidential) currently is just marginally competitive on the open market. For Kiln 2, reducing coal sulfur content to 1.5 percent would increase production cost by $3.00 per ton clinker or more, or more than an 8 percent increase in production cost. Using a 1.0 percent sulfur coal will increase production cost by $3.28 per ton clinker or more, or more than a 9 percent increase over using 2.0 percent sulfur coal.

The increased production costs for Tarmac associated with lower sulfur coal would be prohibitive. The cement industry is highly competitive. The additional cost of lower sulfur coal would place Tarmac in an unfair economic position compared to local competitors who are not restricted to the use of lower sulfur coal.

Tarmac has provided information to support the "antidumping petition" filed September 26, 1989 with the U.S. International Trade Commission and with the International Trade Administration of the U.S. Department of Commerce. This petition depicts the devastating impact on domestic cement producers in Florida, Texas, New Mexico, and Arizona caused by the dumping of cement by Mexican producers. Any increase in production costs above those projected costs for Kiln 2 would seriously impact Tarmac's competitive position. In essence, Tarmac would be forced to keep Kiln 2 shut down. Operating the kiln on oil or gas results in even higher production costs, which would be prohibitive. As a result, using oil or gas is not an option.

In summary, the cost of using lower sulfur coal in Kiln 2 would be economically prohibitive in terms of production cost and the price of clinker on the open market. Future long-term coal prices and availability are uncertain. Tarmac already uses low sulfur coal, which has generally averaged about 1.5 percent sulfur. Using lower sulfur coal would reduce SO_2 emissions by at most 730 tons per year (TPY). The actual reduction may be much less, because, as stated previously, Tarmac will make all efforts to operate Kiln 2 in order to reduce SO_2 emissions below the requested 400 lb/hr. Tarmac will agree to revising this emission limit downward if source test data demonstrate that a lower limit can be met.

In regards to the use of a baghouse as a means of SO_2 control, review of the EPA publication entitled Portland Cement Plants--Background Information for Proposed Revisions To Standards (EPA-450/3-85-003a), shows that there is inconclusive evidence concerning baghouse versus electrostatic precipitator (ESP) SO_2 removal efficiencies. This is because many unpredictable factors affect SO_2 emissions. It is stated that no significant reduction may occur in the fabric filter, depending upon the chemistry of the filter cake. This same document places the 1983 cost of a fabric filter at a small kiln such as Tarmac's at $1.9 million capital cost and $0.6 million annual operating cost. In addition, at Tarmac, the existing ESP would have to be removed to accommodate a new baghouse, requiring additional capital costs. Such costs are not justified since little or no SO_2 removal may result, and an efficient particulate control device is already in place.

3.0 AIR QUALITY ANALYSIS

3.1 BUILDING DOWNWASH EFFECTS

To fully investigate the potential effects of building downwash, a complete downwash analysis with the ISCST model was performed. This analysis evaluated potential downwash due to all structures at Tarmac. The Kiln 3/4 ESPs were simulated as a solid structure, even though they are open at the bottom. The downwash analysis for SO_2 is presented in Appendix C, and the downwash analysis for NO_x emissions is presented in Appendix D.

3.2 PROPERTY BOUNDARY

A description of the property boundary and the restrictions to public access are presented in the revised SO_2 modeling analysis (Appendix C).

3.3 AIR QUALITY ANALYSIS FOR BISCAYNE NATIONAL MONUMENT

FDER has requested an analysis of air quality impacts for the Biscayne National Park. It is Tarmac's position that such an analysis is not required by an applicant under PSD regulations, since this area is not classified as a PSD Class I area. Of course, FDER and the National Park Service are free to conduct their own analysis of the impacts on this area. However, there is no regulatory authority to request that Tarmac perform such an analysis.

APPENDIX A

HISTORICAL DATA FOR KILN 2

Table A-1. Historic PM Emissions, Kiln 2

Test Date	Run No.	Kiln Feed (TPH)	Fuel Type	Production Rate (TPH)	PM (lb/hr)	Gas Flow Rate acfm	Gas Flow Rate dscfm	Stack Temperature (°F)
02/15/78	1	39.8	gas	NA	16.46	111,745	51,066	367
02/16/78	2	39.8	gas	NA	23.28	118,490	54,982	370
02/16/78	3	39.8	gas	NA	15.40	112,319	53,501	352
1978 Average					18.38			
03/29/79	1	41.13	gas	NA	5.03	103,479	52,159	348
03/29/79	2	41.13	gas	NA	5.98	103,492	53,056	347
03/29/79	3	41.13	gas	NA	5.04	102,183	51,273	350
1979 Average					5.35			
04/24/80	20	37.68	gas	23.33	27.00	130,500	65,666	344
04/25/80	22	39.50	gas	24.46	10.00	128,300	62,500	337
04/26/80	24	36.95	gas	22.88	14.00	132,700	64,833	336
04/27/80	26	39.03	gas	24.17	12.00	132,700	64,666	335
04/28/80	28	40.38	gas	25.00	17.00	131,000	63,167	340
04/29/80	30	39.84	gas	24.67	16.00	133,700	64,500	347
1980 Average					16.00			
03/17/81	1	43.21	gas	NA	15.75	137,897	66,249	342
03/17/81	2	43.21	gas	NA	4.00	136,390	65,061	348
03/17/81	3	43.21	gas	NA	4.75	139,781	66,922	345
1981 Average					8.17			
03/04/82	1	44.38	gas	24.83	10.78	92,187	44,810	318
03/04/82	2	44.38	gas	24.83	26.29	101,278	48,082	322
03/04/82	3	44.38	gas	24.83	10.13	95,619	45,571	324
1982 Average					15.73			

Note: acfm = actual cubic feet per minute.
dscfm = dry standard cubic feet per minute.

Table A-2. Historic Fuel Usage Data, Kiln 2

Year	Production (tons clinker)	Fuel	Fuel Used*	MMBTU/ton Clinker
1977	125,443	gas oil	699 $(10)^6 (1000 \frac{BTU}{scf}) = 7.0(10)^{11}$ BTU 724 $(10)^3 (150,000 \frac{BTU}{gal}) = 1.09(10)^{11}$ BTU $8.09(10)^{11}$ BTU	6.4
1978	157,352	gas oil	950 9	6.0
1979	169,075	gas	1,043	6.2
1980	184,922	gas	1,209	6.5
1981	150,690	gas	944	6.3
1982	57,098	gas	305	5.7

*Units of measure:
gas = 10^6 cubic feet.
oil = 10^3 gallon.

1977 ACTUAL SO_2 EMISSIONS:

GAS: $4.5 \frac{lb}{hr} \times \frac{7}{8.09} = 3.89$

OIL: $45.3 \frac{lb}{hr} \times \frac{1}{8.09} = 5.59$

$9.48 \frac{lb}{hr}$

APPENDIX B

REVISIONS TO KILN 2 EMISSIONS OF PARTICULATE MATTER AND PM10

Table B-1. Tarmac Kiln 2 Annual Particulate Matter (TSP) Emissions Increase (Revised)

SOURCE	TYPE	s SILT CONTENT (%)	M MOISTURE CONTENT (%)	U WIND SPEED (MPH)	H DROP HEIGHT (FT)	Y DEVICE CAPACITY (YD**3)	E EMISSION FACTOR (LB/TON)
1) RAILCAR UNLOADING	BATCH DROP	5	7.2	8.8	20	87.0	0.00040
2) FEL-TO-PILE	BATCH DROP	5	7.2	8.8	10	7.0	0.00046
3) FEL-TO-LOADING HOPPER	BATCH DROP	5	7.2	8.8	10	7.0	0.00046
4) ACTIVE COAL PILE	WIND EROSION	5	-	-	-	-	*
5) ACTIVE COAL PILE	VEHICULAR TRAFFIC	5	-	-	-	-	*
6) BAGHOUSE G-509	BAGHOUSE	-	-	-	-	-	*
7) BAGHOUSE G-521	BAGHOUSE	-	-	-	-	-	*
8) BAGHOUSE G-527	BAGHOUSE	-	-	-	-	-	*

ANNUAL EMISSION ESTIMATES

SOURCE	UNCONTROLLED EMISSION FACTOR (LB/TON)	ANNUAL THRUPUT (TPY)	ANNUAL EMISSIONS (TPY)
1) RAILCAR UNLOADING	0.00040	56,940	0.012
2) FEL-TO-PILE	0.00046	56,940	0.013
3) FEL-TO-LOADING HOPPER	0.00046	56,940	0.013
4) ACTIVE COAL PILE (WIND)	*	*	0.480
5) ACTIVE COAL PILE (TRAFFIC)	*	56,940	2.56+
6) BAGHOUSE G-509	*	56,940	0.35
7) BAGHOUSE G-521	*	56,940	0.52
8) BAGHOUSE G-527	*	56,940	0.35

		TOTAL ANNUAL EMISSIONS =	4.30

*REFER TO TEXT FOR EMISSION FACTORS OR BASIS OF EMISSIONS
+RELECTS 75 PERCENT CONTROL DUE TO WATERING

Table B-3. Tarmac Kiln 2 PM10 Emissions Increase (Revised)

ANNUAL PM10 EMISSION ESTIMATES

SOURCE	TYPE OPERATION	ANNUAL PM(TSP) EMISSIONS (TPY)	PM10 PARTICLE SIZE MULTIPLIER	ANNUAL PM10 EMISSIONS (TPY)
1) RAILCAR UNLOADING	BATCH DROP	0.012	0.36	0.0043
2) FEL-TO-PILE	BATCH DROP	0.013	0.36	0.0047
3) FEL-TO-LOADING HOPPER	BATCH DROP	0.013	0.36	0.0047
4) ACTIVE COAL PILE	WIND EROSION	0.480	1.00	0.4800
5) ACTIVE COAL PILE	VEHICULAR TRAFFIC	2.56	0.36	0.9216
6) BAGHOUSE G-509	BAGHOUSE	0.35	1.00	0.3500
7) BAGHOUSE G-521	BAGHOUSE	0.52	1.00	0.5200
8) BAGHOUSE G-527	BAGHOUSE	0.35	1.00	0.3500
		------		------
	TOTAL ANNUAL EMISSIONS =	4.30		2.64

24-HOUR PM10 EMISSION ESTIMATES

SOURCE	TYPE OPERATION	MAXIMUM 24-HOUR PM EMISSIONS (lb/day)	PM10 PARTICLE SIZE MULTIPLIER	MAXIMUM 24-HOUR PM10 EMISSIONS (lb/day)
1) RAILCAR UNLOADING	BATCH DROP	0.00	0.36	0.00
2) FEL-TO-PILE	BATCH DROP	0.00	0.36	0.00
3) FEL-TO-LOADING HOPPER	BATCH DROP	0.15	0.36	0.05
4) ACTIVE COAL PILE	WIND EROSION	8.80	1.00	8.80
5) ACTIVE COAL PILE	VEHICULAR TRAFFIC	11.63	0.36	4.19
6) BAGHOUSE G-509	BAGHOUSE	2.04	1.00	2.04
7) BAGHOUSE G-521	BAGHOUSE	3.06	1.00	3.06
8) BAGHOUSE G-527	BAGHOUSE	2.04	1.00	2.04
		------		------
	TOTAL 24-HOUR EMISSIONS =	27.72		20.18

APPENDIX C

REVISIONS TO AIR QUALITY ANALYSIS FOR SO_2

REVISIONS TO AIR QUALITY ANALYSIS FOR SO_2

C.1 SO_2 MODELING METHODOLOGY

The following discussion is presented in response to comments received from FDER and EPA regarding the PSD permit application for the proposed conversion to coal of Kiln 2 at the Tarmac facility located in northwest Dade County. This response should be viewed in conjunction with the PSD Permit Application (Kiln 2 Coal Conversion, Tarmac Florida, Inc.) prepared by KBN and submitted to FDER in August 1989. All data and assumptions contained in the PSD application remain unchanged except as discussed in the following paragraphs.

The effects of building downwash from structures at the Tarmac facility on predicted SO_2 impacts were considered. The most significant structures at the Tarmac facility are the finish mill building, the kiln burner building, Kiln 1 and 2 ESPs, and Kiln 3 and 4 ESPs. As stated in the PSD application, the kiln burner building and Kiln 1 and 2 ESPs are not tall enough to influence plume dispersion from any of the kilns. However, potential downwash could occur due to the finish mill building and Kiln 3 and 4 ESPs, since the stacks for Kilns 1, 2, and 3 are less than Good Engineering Practice (GEP) stack height for these structures. Source-building combinations and directions relative to the location of Kiln 2, in which building downwash is possible, are presented in the following table (also refer to Figure C-1.).

Source	Radial Direction (Degrees)	Structure
Kilns 1 and 2	120-150	Kiln 3 and 4 ESP
	100-120	Finish Mill Building
	280-330	Kiln 3 and 4 ESP
	Other directions	None
Kiln 3	All directions	Kiln 3 and 4 ESP

The Kiln 3 stack is downwashed in all directions, but Kiln 1 and Kiln 2 stacks are downwashed only in certain directions. The stacks for Kilns 1

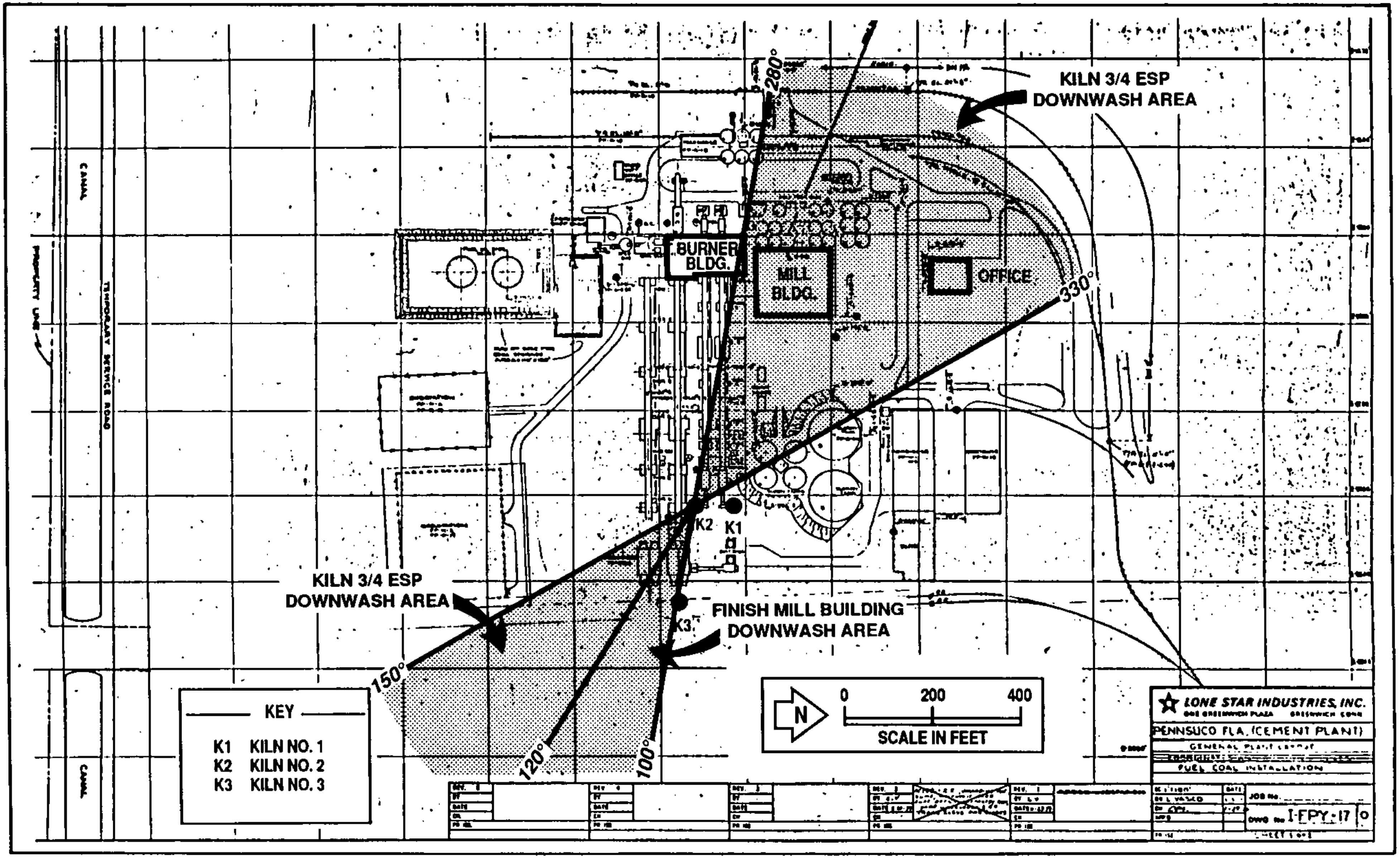

Figure C-1 BUILDING DOWNWASH ANALYSIS FOR KILN NO. 2

and 2 are more than two building heights upwind from the finish mill building and, therefore, are only influenced downwind of this building in the 100° through 120° radial directions.

The building dimensions presented in the PSD application were used in the modeling analysis. None of the structures at the Tarmac facility are tall enough, relative to the stack heights, to require direction-specific building dimensions used in the Schulman-Scire downwash algorithm. Therefore, potential downwash at the Tarmac facility is simulated using the Huber-Snyder downwash algorithms that conservatively assume that any stack within the influence of a building has the potential to downwash in all directions. When a stack is in the influence of several buildings, the building dimensions resulting in highest GEP are used to simulate downwash.

In order to avoid simulating downwash for directions in which the potential for downwash does not exist, the modeling analysis was separated into two cases. For those directions in which downwash potentially can occur for all three kiln stacks (i.e., 110° through 150°; 280° through 300°; and 310° through 330°) receptors were placed accordingly and building dimensions were input into the model for Kilns 1, 2, and 3. In a separate modeling analysis, receptors were located in those directions in which downwash will not occur for the stack for Kilns 1 and 2. Therefore, building dimensions were not input into the model for Kilns 1 and 2 for this case. Building dimensions were included for Kiln 3, which due to its proximity to Kiln 3 and 4 ESP, has the potential to downwash in all directions. The results of each case were reviewed and highest annual and highest, second-highest short-term impacts were identified.

Impacts on plant property, previously reported in the PSD application, were eliminated from consideration. Only those impacts affecting ambient air (not on the limited access Tarmac property) were reported for comparison to PSD increments and AAQS. The extent of Tarmac's plant property is shown in Figure C-2. Distance and direction to plant property relative to Kiln 2 are presented in Table C-1. (Note that in Figure 2-2 of the application,

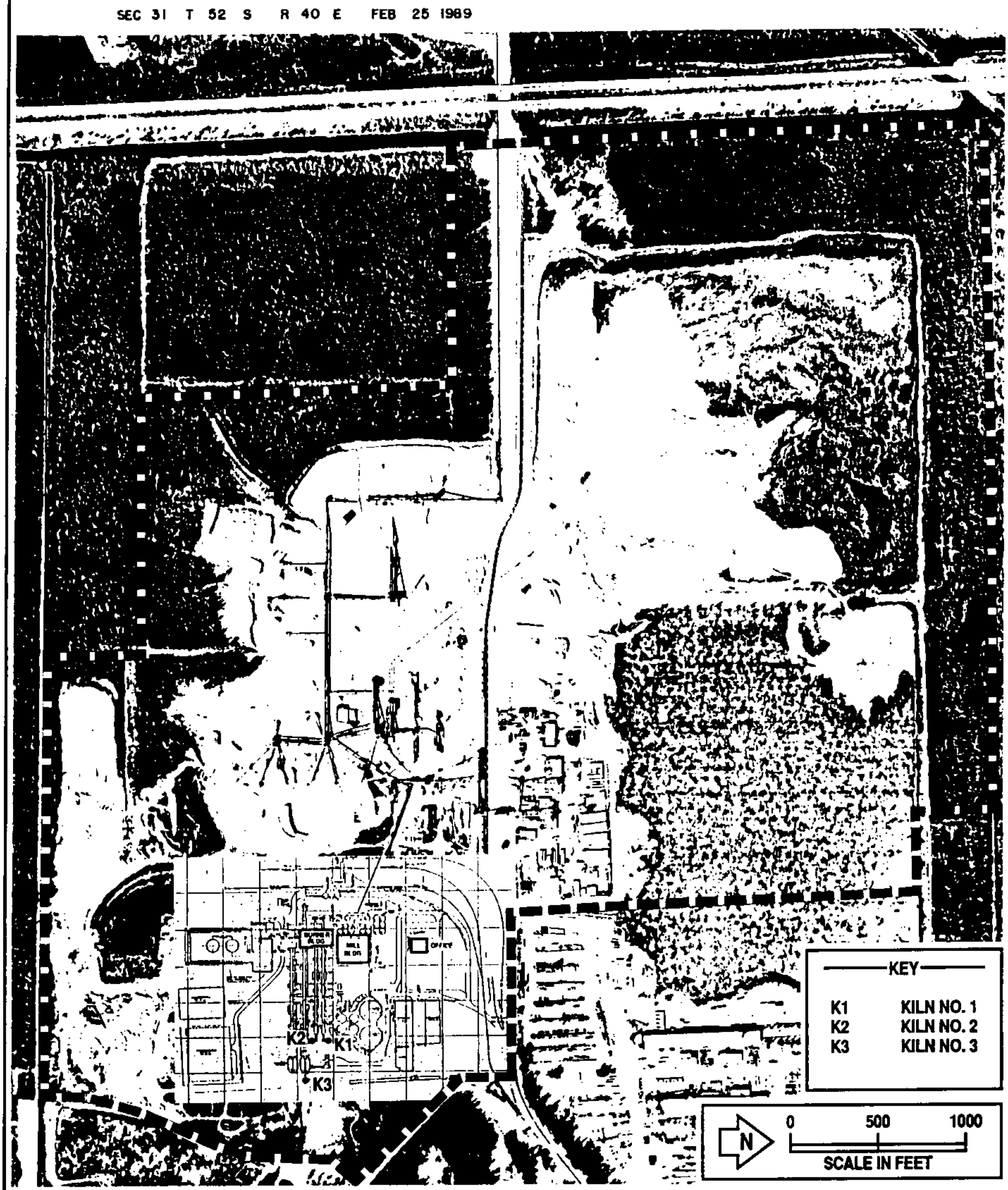

Figure C-2 PLOT PLAN AND PLANT PROPERTY BOUNDARY OF TARMAC FACILITY

KBN

Table C-1. Plant Property Receptors Used in the Modeling Analysis

Direction* (°)	Distance* (m)	Direction* (°)	Distance* (m)
10	336	190	461
20	230	200	470
30	211	210	509
40	211	220	576
50	211	230	701
60	221	240	739
70	230	250	835
80	202	260	1,094
90	192	270	1,085
100	192	280	1,114
110	211	290	1,613
120	211	300	1,766
130	278	310	1,766
140	250	320	1,488
150	221	330	374
160	326	340	346
170	461	350	336
180	451	360	326

*Relative to Kiln 2 stack location.

the north arrow was incorrectly oriented. Figures C-1 and C-2 are correct as shown.

Preliminary modeling showed that maximum impacts would be due to downwash conditions within several hundred meters of Kiln 2. Therefore, a less extensive receptor grid was used in this modeling analysis than in the original PSD application. The ring distances presented in the PSD application were retained, except that 2.5 km was the furthest downwind distance considered.

Tarmac's property boundaries are restricted by physical barriers, inaccessibility, no-trespassing signs, and guard gates. Security patrols the plant area to provide further restriction to the public. The northern, northeastern, and northwestern property boundaries are all protected by canals or lakes. In the southwest portion of the property, Tarmac's property abuts the Florida East Coast (FEC) railway property. Although no fence is located along this property, there is no access to the property by roadway, and the terrain is rugged. The FEC property in this area is bordered by canals on the west and south, further restricting public access.

Tarmac's property to the south of the kiln facilities is bordered by a canal. To the southeast, there is no access to the property by roadway. FEC property also abuts this boundary. Access roads to the southeast and northeast have guard gates. In summary, access to the Tarmac facility is difficult, with restrictions provided by water bodies, spoil piles, guards, restricted signs, and patrols.

C.2 REVISED SO_2 MODELING RESULTS

C.2.1 KILN 2 ONLY

The increase in SO_2 emissions due to Kiln 2 coal conversion, from Table 2-1 of the PSD application, is 354.7 lb/hr. The maximum impacts due to this increase are as follows: 162 $\mu g/m^3$, 3-hour; 54 $\mu g/m^3$, 24-hour; and

3.6 $\mu g/m^3$, annual average. These concentrations were obtained by rationing the maximum predicted impacts due to the proposed SO_2 emission rate for Kiln 2 (400 lb/hr), presented in Table C-2. The impacts due to the increase are above significance levels established by EPA and FDER; therefore, further modeling analysis is required for SO_2 to demonstrate compliance with PSD increments and AAQS.

C.2.2 PSD CLASS II INCREMENT ANALYSIS

Maximum SO_2 concentrations predicted from the screening analysis for comparison to the PSD Class II increments are presented in Table C-3. The results reflect impacts due to all increment consuming sources, which include Kiln 2 and Kiln 3 at Tarmac. The maximum PSD increment consumption values are well below the allowable increments. Based on the receptor spacing utilized in the modeling analysis, no refinements of the PSD Class II increment consumption values were necessary.

A summary of the maximum SO_2 PSD Class II increment consumption concentrations predicted in the analysis are presented in Table C-4. The maximum 3-hour average SO_2 PSD Class II increment consumption due to all increment consuming sources is predicted to be 162 $\mu g/m^3$, which is 32 percent of the maximum allowable PSD Class II increment of 512 $\mu g/m^3$, not to be exceeded more than once per year.

The maximum 24-hour average SO_2 PSD Class II increment consumption due to all sources is predicted to be 55 $\mu g/m^3$, which is 60 percent of the maximum allowable PSD Class II increment of 91 $\mu g/m^3$, not to be exceeded more than once per year. This maximum impact occurs at a receptor very close to the facility (300 m), and is a result of downwash conditions.

The maximum annual average SO_2 PSD Class II increment consumption is predicted to be 5.1 $\mu g/m^3$, which is 26 percent of the maximum allowable PSD Class II increment of 20 $\mu g/m^3$.

Table C-2. Maximum Predicted SO_2 Concentrations from the Screening Analysis Due to Kiln 2 Only at 400 lb/hr

Averaging Period	Maximum Concentration ($\mu g/m^3$)	Receptor Location* Direction (°)	Receptor Location* Distance (km)	Period Julian Day	Period Hour Ending	Period Year
3-Hour+	129	150	0.300	53	15	1982
	183	130	0.300	61	3	1983
	144	150	0.300	310	3	1984
	155	150	0.300	342	24	1985
	155	150	0.300	108	3	1986
24-Hour+	33	150	0.300	351	--	1982
	61	130	0.300	61	--	1983
	41	150	0.300	5	--	1984
	44	150	0.300	77	--	1985
	41	150	0.300	28	--	1986
Annual	4.1	320	1.488	--	--	1982
	2.9	310	1.766	--	--	1983
	2.9	310	1.766	--	--	1984
	3.9	150	0.300	--	--	1985
	3.5	150	0.300	--	--	1986

*Relative to the location of the Kiln 2.
+Highest, second-highest concentrations predicted for this averaging period.

Table C-3. Maximum Predicted SO_2 Concentrations from the Screening Analysis for Comparison to PSD Class II Increments

Averaging Period	Maximum Concentration ($\mu g/m^3$)	Receptor Location* Direction (°)	Receptor Location* Distance (km)	Period Julian Day	Period Hour Ending	Period Year
3-Hour+	123	150	0.300	53	15	1982
	162	130	0.300	61	3	1983
	128	150	0.300	310	3	1984
	137	150	0.300	342	24	1985
	137	150	0.300	108	3	1986
24-Hour+	40	150	0.300	11	--	1982
	55	130	0.300	61	--	1983
	38	130	0.300	328	--	1984
	43	330	0.374	325	--	1985
	44	150	0.374	80	--	1986
Annual	5.1	320	1.488	--	--	1982
	4.5	0.300	1.766	--	--	1983
	4.0	310	1.766	--	--	1984
	4.8	0.150	0.300	--	--	1985
	4.2	0.150	0.300	--	--	1986

*Relative to the location of the Kiln 2.
+Highest, second-highest concentrations predicted for this averaging period.

Note: Concentrations remain unchanged if the impacts of the proposed combined cycle units and Units 4 and 5 at FPL Fort Lauderdale are not considered in the modeling analysis.

Table C-4. Maximum Predicted SO_2 Concentrations for Comparison to PSD Class II Increments

Averaging Period	Maximum Concentration ($\mu g/m^3$)	Receptor Location* Direction (°)	Receptor Location* Distance (km)	Period Julian Day	Period Hour Ending	Period Year	PSD Class II Increment
SO_2 Concentrations							
3-Hour⁺	162	130	0.300	61	12	1983	512
24-Hour⁺	55	130	0.300	61	--	1983	91
Annual	5.1	320	1.488	--	--	1982	20

*Relative to the location of Kiln 2.

⁺Highest, second-highest concentrations predicted for this averaging period.

Based upon these results, operation of Kiln 2 on coal, in conjunction with all other PSD increment consuming sources, will consume less than 60 percent of the allowable Class II increments. Thus, there is PSD increment available for significant future growth in the area. As discussed in Section 6.0 of the application, the PSD Class II analysis was conducted both with and without the planned FPL Lauderdale Repowering Project. Maximum increment consumption values near Tarmac did not change as a result of the planned FPL facility. This indicates that other nearby sources (i.e., Tarmac and Dade County Resource Recovery) are the primary contributors to the Class II increment consumption values.

C.2.3 AAQS ANALYSIS

The maximum 3-hour, 24-hour, and annual average total SO_2 concentrations predicted from the screening analysis are presented in Table C-5. The total concentrations were determined from the impacts of the modeled sources added to the background concentration. These results show that the maximum SO_2 concentrations due to all sources are well below the AAQS for all averaging periods. Based upon the low predicted values, no refinements of these concentrations were performed.

The maximum 3-hour average SO_2 concentration due to all sources is predicted to be 254 $\mu g/m^3$, which is 20 percent of the Florida AAQS of 1300 $\mu g/m^3$, not to be exceeded more than once per year. The maximum 24-hour average SO_2 concentration due to all sources is predicted to be 71 $\mu g/m^3$, which is 27 percent of the Florida AAQS of 260 $\mu g/m^3$, not to be exceeded more than once per year. The maximum annual average SO_2 concentration due to all sources is predicted to be 14 $\mu g/m^3$, which is 23 percent of the Florida AAQS of 60 $\mu g/m^3$.

The Dade County Department of Environmental Resources Management, Environmental Planning Division has developed the following AAQS for SO_2 that must not be exceeded in any part of Dade County:

Table C-5. Maximum Predicted Total SO_2 Concentrations from the Screening Analysis for Comparison to AAQS

Averaging Period	Concentration ($\mu g/m^3$) Total	Total Due To: Modeled Sources	Total Due To: Background	Receptor Location*: Direction (°)	Receptor Location*: Distance (km)	Period: Julian Day	Period: Hour Ending	Period: Year
3-hour⁺	243	228	15	20	2.500	28	24	1982
	220	205	15	10	2.500	277	21	1983
	199	184	15	220	2.500	284	3	1984
	219	204	15	360	2.500	156	24	1985
	254	239	15	350	2.500	130	24	1986
24-hour⁺	64	56	8	240	2.000	325	--	1982
	71	63	8	130	0.300	61	--	1983
	64	56	8	240	2.500	284	--	1984
	66	58	8	350	2.500	337	--	1985
	61	53	8	150	0.300	14	--	1986
Annual	14	10.5	3	320	1.488	--	--	1982
	12	8.9	3	300	1.766	--	--	1983
	12	8.8	3	310	1.766	--	--	1984
	13	10.1	3	150	0.300	--	--	1985
	12	9.4	3	150	0.300	--	--	1986

*Relative to the location of Kiln 2.
⁺Highest, second-highest concentrations predicted for this averaging period.

Note: AAQS are 1,300 ug/m³, 3-hour
260 ug/m³, 24-hour
60 ug/m³, annual

3-Hour Average--350 $\mu g/m^3$
24-Hour Average--110 $\mu g/m^3$
Annual Average--25 $\mu g/m^3$

The 3- and 24-hour average AAQS may be exceeded once per year. As shown in Table C-5, none of the predicted concentrations exceed the Dade County AAQS.

C.2.4 CLASS I AREA ANALYSIS

The results of the PSD Class I area modeling analysis for the Everglades National Park are presented in Table C-6. The modeling analysis evaluated a number of receptors along the boundary of the Class I area.

As shown in Table C-6, total Class I PSD increment consumption concentrations for SO_2 are below the Class I increments for all averaging times. The maximum 3-hour increment consumption is predicted to be 18 $\mu g/m^3$, compared to the Class I increment of 25 $\mu g/m^3$. The maximum predicted 24-hour increment consumption for SO_2 is 4.5 $\mu g/m^3$, which is below the allowable increment of 5 $\mu g/m^3$. These maximum increment consumption values are due to the effects of two increment consuming sources located in Dade County: Tarmac Florida (cement plant) and Dade County Resource Recovery (MSW incinerator). The proposed Lauderdale Repowering Project does not contribute to these maximum increment consumption values. This value was further refined using a refined receptor grid with 100 m spacing along the boundary of the Class I area. The resulting 24-hour increment consumption was 4.7 $\mu g/m^3$ (1983, Day 178).

The maximum predicted annual SO_2 increment consumption concentration in the Class I area is predicted to be 0.56 $\mu g/m^3$. This value is well below the allowable Class I increment of 2 $\mu g/m^3$ for SO_2.

To demonstrate the effects the proposed Kiln 2 Coal Conversion will have on the Class I area, the modeling analysis evaluated the impacts of Kiln 2

Table C-6. Maximum Predicted SO_2 Concentrations for Comparison to PSD Class I Increments

Averaging Period	Maximum Concentration (ug/m^3)	Period Julian Day	Period Hour Ending	Period Year	PSD Class I Increment
3-Hour*	15	317	12	1982	25
	16	266	9	1983	
	16	69	24	1984	
	18	150	9	1985	
	12	251	24	1986	
24-Hour*	3.9	291	--	1982	5
	4.5	303	--	1983	
	3.8	268	--	1984	
	3.7	256	--	1985	
	4.1	349	--	1986	
Annual	0.56	--	--	1982	2
	0.53	--	--	1983	
	0.52	--	--	1984	
	0.49	--	--	1985	
	0.54	--	--	1986	

*Highest, second-highest concentrations predicted for this averaging period.

only. The results of this analysis are presented in Table C-7. As shown, the maximum Class I impacts due to Kiln 2 only are 7.6 $\mu g/m^3$, 3-hour, 1.8 $\mu g/m^3$, 24-hour, and 0.17 $\mu g/m^3$, annual average. These values are less than 40 percent of the Class I increments.

Maximum total SO_2 concentrations predicted in the Class I area due to all sources are presented in Table C-8. These concentrations include the estimated background concentration for the Tarmac area. As shown, the maximum concentrations are predicted to be: 197 $\mu g/m^3$, 3-hour average; 53 $\mu g/m^3$, 24-hour average; and 10.0 $\mu g/m^3$, annual average. These maximum impacts are 20 percent of the AAQS or less.

C.3 ADDITIONAL IMPACT ANALYSIS

The revised SO_2 modeling analysis demonstrates insignificant changes in total SO_2 air quality impacts in the Tarmac area and in the Class I area, compared with the original modeling results. Therefore, the additional impact analysis for SO_2 contained in the application is still applicable.

Table C-7. Maximum Predicted SO_2 Concentrations for Comparison to PSD Class I Increments Due to Kiln 2 Only at 400 lb/hr

Averaging Period	Maximum Concentration (ug/m^3)	Period			PSD Class I Increment
		Julian Day	Hour Ending	Year	
3-Hour*	7.1	281	21	1982	25
	7.6	138	6	1983	
	6.8	260	24	1984	
	6.7	297	3	1985	
	6.2	221	3	1986	
24-Hour*	1.4	292	--	1982	5
	1.8	290	--	1883	
	1.4	227	--	1984	
	1.2	229	--	1985	
	1.3	303	--	1986	
Annual	0.17	--	--	1982	2
	0.14	--	--	1983	
	0.15	--	--	1984	
	0.13	--	--	1985	
	0.15	--	--	1986	

*Highest, second-highest concentrations predicted for this averaging period.

Table C-8. Maximum Total Predicted SO_2 Concentrations for the Everglades NP Class I Area

Averaging Period	Concentration ($\mu g/m^3$) Total	Total due to Modeled Sources	Background	Year	AAQS
3-Hour*	163	148	15	1982	1,300
	197	182	15	1983	
	185	170	15	1984	
	171	156	15	1985	
	169	154	15	1986	
24-Hour*	49	41	8	1982	260
	51	43	8	1983	
	51	43	8	1984	
	53	45	8	1985	
	44	36	8	1986	
Annual	10.0	7.0	3	1982	60
	9.3	6.3	3	1983	
	10.0	7.0	3	1984	
	9.1	6.1	3	1985	
	9.1	6.1	3	1986	

*Highest, second-highest concentrations predicted for this averaging period.

APPENDIX D

PSD ANALYSIS FOR NO_x

PSD ANALYSIS FOR NO_x

D.1 NO_x AIR QUALITY IMPACT ANALYSIS

The results of the SO_2 analysis for the burning of coal in Kiln 2 were scaled to determine maximum annual NO_x impacts. Maximum annual SO_2 impacts due to Kiln 2 only at 400 lb/hr were 4.1 $\mu g/m^3$. The increase in NO_x emissions for Kiln 2, due to conversion from gas to coal, is 51 lb/hr (169.3 lb/hr minus 118.3 lb/hr). The calculated maximum annual NO_x impact due to this increase is therefore 0.52 $\mu g/m^3$. By the same methodology, the maximum annual NO_x impact in the Class I area due to Kiln 2 coal conversion is 0.02 $\mu g/m^3$. The significant impact level established by FDER and EPA is 1.0 $\mu g/m^3$; therefore, no further modeling analysis for NO_x is required.

The maximum predicted NO_x impact due to the increase is also below the NO_x de minimis monitoring concentration of 14 $\mu g/m^3$, annual average. Therefore, Tarmac may be exempted from the preconstruction PSD monitoring requirements for NO_x.

D.2 BACT ANALYSIS FOR NO_x

The State of California, South Coast Air Quality Management District (SCAQMD) was contacted (Mr. Bill Dennison) to inquire as to NO_x control technologies for cement kilns. Mr. Dennison stated that to his knowledge there were no cement kilns operating or permitted in California with add-on NO_x control (i.e., selective catalytic or nonselective catalytic reduction). Review of the BACT/LAER Clearinghouse publications also did not reveal any determinations that required add-on NO_x control. All newly permitted cement kilns were "dry" process kilns, which employed precalciners or calciners ahead of the kiln. NO_x controls utilized were low furnace temperatures and low excess air.

EPA conducted a review of the NSPS for Portland plants in 1985 (Portland Cement Plants--Background Information for Proposed Revisions to Standards). This review revealed only one study that addressed NO_x reduction technologies for Portland cement plants firing coal (KVB, 1982). This report presented the results of a testing program on a subscale cement kiln. Only natural gas was fired in the kiln. It was concluded from the test data that the kiln was not representative of a full-scale production kiln. Therefore, the study is inconclusive. Nevertheless, the following general observations were noted.

1. Fly ash injection (dust insufflation) was the most effective means of reducing NO_x emissions.
2. Lowered excess air was not practical to control NO_x, since the cement industry already maintains the lowest practical oxygen levels in most kilns (1.5 to 2.0 percent O_2).

In another study by KVB, Inc. (1983), a wet process, coal-fired cement kiln was tested for NO_x emissions. This testing showed a 38 percent reduction in NO_x when the oxygen level was lowered from 2.9 percent to 1.5 percent. However, a simultaneous increase of 47 percent in SO_2 emission occurred. Excess air was the only process variable investigated in the full-scale testing. Further testing on a subscale cement kiln was performed, but only generalized conclusions regarding NO_x control measures could be made.

In a third study (KVB, 1984), a subscale cement kiln was evaluated for NO_x emissions. Several control techniques were analyzed, including flue gas recirculation, combustion air preheat, primary air velocity, primary/secondary air ratio, and oxygen level. Because data obtained from the study were limited, only the following general conclusions could be drawn.

1. NO_x emissions are very sensitive to excess O_2 levels.
2. Flue gas recirculation is more effective with gas firing than with coal firing.
3. Primary air dilution with inert gas was the most effective combustion modification for NO_x reduction firing coal.

Unfortunately, SO_2 emissions were not measured and hence, no assessment of NO_x/SO_2 relationships was performed.

In summary, there are few data available on NO_x combustion modification techniques for full-scale wet process cement kilns. In the one study which employed a full-scale kiln, only the oxygen level in the kiln was evaluated, and the data show a significant increase in SO_2 emissions when oxygen is lowered to reduce NO_x emissions. Significantly more research and application to a full-scale cement kiln is needed before combustion modification techniques can be applied successfully to cement kilns. Tarmac will minimize the oxygen level in Kiln 3 to the extent possible, while monitoring clinker quality and minimizing SO_2 emissions.

The most useful information concerning potential NO_x emission reductions through process controls is the experience Tarmac has gained from operation of Kiln 3 on coal. Although Kiln 2 may operate somewhat differently because of its smaller size and different operating parameters, the following general statements are believed to be applicable.

1. NO_x emissions are inversely related to SO_2 emissions (i.e., as NO_x is reduced, SO_x increases).
2. NO_x emissions are reduced by lowering flame temperature and oxygen level (low excess air) in the kiln.

In a wet process kiln, such as Kiln 2, temperature is critical and high enough temperatures must be a maintained to calcine the raw feed. If temperature is not maintained, product quality is reduced.

As a result, NO_x emissions from Kiln 2 can be reduced only by adjusting process parameters, but not so much as to affect clinker quality. Also, SO_2 emissions will increase when reducing NO_x emissions. Tarmac's objective for Kiln 2 will be to minimize SO_2 emissions while simultaneously achieving the proposed NO_x emission limit of 6.77 lb/ton clinker.

REFERENCES

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KVB, Inc. 1983. Evaluation of Combustion Variable Effects on NO_x Emissions From Mineral Kilns. EPA-600/7-83-045.

KVB, Inc. 1982. Application of Advanced Combustion Modifications to Industrial Process Equipment: Subscale Test Results. EPA-600/7-82-021.