SUMTER
COUNTY
CEMENT
CENTER HILL, FLORIDA, USA

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DIVISION OF AIR
RESOURCE MANAGEMENT

January 24, 2012

Mr. Jeffery Koerner, P.E.
Florida Department of Environmental Protection
Division of Air Resource Management
2600 Blair Stone Road, MS#5500
Tallahassee, FL 32399-2400

Subject: ***PSD Re-Application – Phase 1***
Sumter Cement Company, LLC – Center Hill Plant, Sumter County

Dear Mr. Koerner,

Pursuant to our discussions, Sumter Cement Company, LLC which will be operated by Votorantim Cimentos North America (VCNA) is reapplying for its PSD air construction permit for its Sumter Cement Project located in Center Hill, Florida. Sumter Cement Company previously obtained its PSD permit, but due to the overall economic conditions in the United States and in Florida, and specifically in the construction sector, forced VCNA to delay the project. VCNA is now reapplying for the Sumter Cement Project.

Solely at the request of VCNA, VCNA is reapplying in several phases. This will allow VCNA to more efficiently and cost-effectively develop the application over a longer time period, which assists with cash flow during these difficult economic times. In addition, providing the application is phases will allow the project to better align with the recovery of the construction and building material industry in Florida. This phased approach will allow VCNA to speed up or slow down the reapplication process to match the very unpredictable economic recovery.

VCNA did not submit the associated $7500 PSD application fee or the ambient air quality analyses with this initial phase. This fee and the required ambient air quality analyses will be submitted with a subsequent phase. VCNA understands that the Department's permit processing time clock will not start until the $7,500 application fee is received.

Due to VCNA's prolonged re-submittal, VCNA will also waive any claims or rights towards ambient air quality increment consumption for the Sumter Cement Project until such time that VCNA requests these rights to be reinstated. VCNA does not wish to cause the hindrance of any other projects during this process.

Phase 1 represents the first of three planned submittals to the Department associated with the re-permitting of the Sumter Cement Company Portland cement plant. The Phase 2 submittal is planned to be provided to the Department at the end of 2012 and will include the modeling protocol for the air quality analyses. The Phase 3 submittal to the Department is planned for the end of 2013 and will include the Federal Land Manager (FLM) Class I air quality dispersion modeling results, updated NAAQS and PSD Class II increment modeling results, an updated BACT analysis that will address greenhouse gas BACT requirements, updated DEP application forms, and the $7,500 application fee.

The enclosed Phase I Attachments reflect the changes to the plant's proposed engineering design and applicable air quality regulations which have been revised since the issuance of the original PSD Air Permit No. PSD-FL-358 to Sumter Cement Company on February 6, 2006.

The enclosed Attachments are:

- Attachment 1 - PTE Air Emissions Inventory
- Attachment 2 - NSR Applicability Analysis
- Attachment 3 - BACT Analysis
- Attachment 4 - Regulatory Applicability Analysis

If you have any questions on the attachments please contact me at (386) 330-4960.

Sincerely,

Joe Horton
Director – Engineering, Lands and Environment
Votorantim Cimentos North America (VCNA)

CC: Marty Fallon – CEO Sumter Cement Company

TABLE A-1
Potential Plant-Wide Emission Totals

EU No.	EU Description	PM tons/yr	PM_{10} tons/yr	$PM_{2.5}$ tons/yr	SO_2 tons/yr	NO_X tons/yr	CO tons/yr	GHG tons/yr	VOC tons/yr	HCl tons/yr	Lead tons/yr	Mercury tons/yr	Beryllium tons/yr	Dioxin/Furans tons/yr	Fluorides tons/yr
CH-1	Primary Crushing & Associated Conveyors	2.03	0.92	0.16											
CH-2	Raw Material Conveying	1.00	0.47	0.07											
CH-3	Raw Material Processing and Storage	18.08	15.37	5.42											
CH-4	Kiln System with In-Line Raw Mill	90.19	75.76	40.59	147.83	1,067.63	1,971.00	TBD	65.70	76.65	0.041	0.059	0.0001	1.59E-07	0.493
CH-5	Clinker Storage and Conveying	16.62	14.13	4.99											
CH-6	Finish Mills & Cement Processing	72.12	61.30	21.64											
CH-7	Coal Mill System	9.56	8.13	2.87											
CH-8	Coal Conveying	0.15	0.07	0.01											
CH-9	Emergency Generator and Diesel Tank	0.07	0.05	0.05	0.55	2.31	0.43	TBD	0.08						
CH-10	Storage Piles	6.97	3.49	3.49											
CH-11	Paved and Unpaved Roads	6.96	1.57	0.30											
	Pollutant Totals	223.75	181.26	79.58	148.38	1,069.94	1,971.43	>75,000	65.78	76.65	0.041	0.059	0.0001	1.59E-07	0.493

🟨 Point Sources
🟩 Fugitive Sources

NOTE 1 PM, PM10 and PM2.5 emissions are filterable only.

NOTE 2 : Potential-to-emit GHG emissions are expected to be greater than 75,000 tons/year. Detailed GHG calculations for the Sumter Cement Company are anticipated to be available in 2012.

TABLE A-2
Potential Throughput Data for Center Hill Plant

Material	OLD Center Hill Throughputs (tons/yr)	Center Hill Throughputs (tons/yr)	Center Hill Hourly Rates (tons/hr)	Comments
Limestone crushed	3,798,428	2,424,529	1500	
Base Rock	500,000	319,149	1500	
Limestone - raw material	3,298,428	2,105,380	267	
Sand/Clay	385,854	246,290	31	
Steel Slag	87,128	55,614	7	
Bauxite/Wet Flyash	352,662	225,103	29	
Coal Mill	211,160	134,783	17	
Raw Mill Feed (Wet)	3,607,797	2,302,849	292	
Kiln Feed from Raw Mill (Dry) to Blend Silo	2,958,393	1,888,336	240	
Kiln Preheater Feed from Blend Silo	2,553,019	1,629,586	207	
Kiln Baghouse Dust Recirculation	231,351	147,671	19	
Kiln Feed Total	2,784,370	1,777,258	225	Preheater Feed + Baghouse Dust Recirculation
Clinker Produced by Kiln	1,715,500	1,095,000	139	
Total Clinker Needed for Cement	2,354,425	1,095,000	139	
Gypsum/Limestone	177,215	76,650	10	Assume 7% Gypsum/Limestone
Finish Mill #1 (Clinker)	1,177,213	1,095,000	150	
FM #1 (Cement Feed)	1,265,820	1,171,650	150	
Cement Total	2,531,640	1,171,650	150	
Dry Fly Ash	278,437	177,726	23	

Hourly rates are calculated assuming a 90% uptime.

TABLE A-3
Potential Particulate Emissions from Point sources

Stack Parameters >>

EU No.	EP No.	Description	Annual Throughput	Hourly Throughput	Flow ACFM	Temp. deg F	Moisture % (Note 1)	Flow DSCFM	Operating Hours	PM gr/dscf	PM-10 gr/dscf	PM-2.5 gr/dscf	PM		PM-10		PM-2.5		Height ft	Diam. ft	Velocity fpm	Orien-tation
													lb/hr	tons/yr	lb/hr	tons/yr	lb/hr.	tons/yr.				
CH-3		Raw Material Silos Inlet	2,302,849	292	6,000	200	2%	4,704	8,760	0.01	0.0085	0.003	0.40	1.77	0.34	1.50	0.12	0.53	260	1.1	6314	H
		Raw Material Silos Discharge	2,302,849	292	4,000	300	2%	2,723	8,760	0.01	0.0085	0.003	0.23	1.02	0.20	0.87	0.07	0.31	50	1.0	5093	H
		Raw Mill Separators Discharge	1,888,336	240	6,000	200	2%	4,704	8,760	0.01	0.0085	0.003	0.40	1.77	0.34	1.50	0.12	0.53	60	1.1	6314	H
	NDC-03	Raw Material Transport	1,888,336	240	6,000	300	2%	4,085	8,760	0.01	0.0085	0.003	0.35	1.53	0.30	1.30	0.11	0.46	35	1.0	7639	H
	NDC-04	Blend Silo Inlet	1,888,336	240	15,000	200	2%	11,760	8,760	0.01	0.0085	0.003	1.01	4.42	0.86	3.75	0.30	1.32	260	2.0	4775	H
	NDC-06	Blend Silo Outlet	1,777,258	225	3,000	200	2%	2,352	8,760	0.01	0.0085	0.003	0.20	0.88	0.17	0.75	0.06	0.26	84	1.0	3820	H
		Kiln Feed Transport to Kiln Feed Elevator	1,777,258	225	4,000	200	2%	3,136	8,760	0.01	0.0085	0.003	0.27	1.18	0.23	1.00	0.08	0.35	50	1.0	5093	H
		Dust Surge Bin and Lime Bin	147,671	19	6,000	200	2%	4,704	8,760	0.01	0.0085	0.003	0.40	1.77	0.34	1.50	0.12	0.53	260	1.1	6314	H
	NDC-07	Kiln Feed Transport from Kiln Feed Elevator	1,777,258	225	4,000	300	2%	2,723	8,760	0.01	0.0085	0.003	0.23	1.02	0.20	0.87	0.07	0.31	50	1.0	5093	H
	NDC-08	Dry Fly Ash Silo	177,726	23	6,000	110	2%	5,447	8,760	0.01	0.0085	0.003	0.47	2.04	0.40	1.74	0.14	0.61	140	1.1	6314	H
	NDC-09	Dry Fly Ash Bin	177,726	23	2,000	110	2%	1,816	8,760	0.01	0.0085	0.003	0.16	0.68	0.13	0.58	0.05	0.20	30	1.0	2546	H
	DC-01	Preheater/Precalciner Kiln with In-Line Raw Mill	1,095,000	139	464,200	233	15%	300,289	8,760	N/A	N/A		20.6	90.19	17.3	75.76	9.27	40.69	427	16.5	2171	V
CH-5	NDC-10	Clinker Transport From Clinker Cooler	1,095,000	139	3,000	300	2%	2,043	8,760	0.01	0.0085	0.003	0.18	0.77	0.15	0.65	0.05	0.23	40	1	3820	H
	NDC-11	Clinker Silo #1	1,095,000	139	8,000	300	2%	5,447	8,760	0.01	0.0085	0.003	0.47	2.04	0.40	1.74	0.14	0.61	186	2	2546	H
	NDC-12	Clinker Silo #2	1,095,000	139	8,000	300	2%	5,447	8,760	0.01	0.0085	0.003	0.47	2.04	0.40	1.74	0.14	0.61	186	2	2546	H
	NDC-13	Off-Spec Clinker Silo	54,750	139	4,000	300	2%	2,723	8,760	0.01	0.0085	0.003	0.23	1.02	0.20	0.87	0.07	0.31	100	1.5	2264	H
	NDC-14	Clinker Silos Outlet Conveyor	1,095,000	150	8,000	212	2%	6,160	8,760	0.01	0.0085	0.003	0.53	2.31	0.45	1.97	0.16	0.69	20	1.5	4527	H
	NDC-15	Natural Gypsum and Limestone Bins Inlet	76,650	10	8,000	90	2%	7,526	8,760	0.01	0.0085	0.003	0.65	2.83	0.55	2.40	0.19	0.85	70	1.1	8418	H
	NDC-16	Clinker Bin Inlet	1,095,000	138.9	8,000	90	2%	7,526	8,760	0.01	0.0085	0.003	0.65	2.83	0.55	2.40	0.19	0.85	70	1.1	8418	H
	NDC-17	Syn. Gypsum Hopper and Nat. Gypsum, Limestone, and Clinker Bins Discharge	1,171,650.0	159.7	8,000	100	2%	7,392	8,760	0.01	0.0085	0.003	0.63	2.78	0.54	2.36	0.19	0.83	20	3	1132	H
CH-6	DC-02	Finish Mill #1 Separator BH	1,171,650.0	150	150,000	180	3%	120,038	8,760	0.01	0.0085	0.003	10.29	45.07	8.75	38.31	3.09	13.52	131	7.5	3395	V
	DC-03	Finish Mill #1 Sweep BH	1,171,650.0	150	40,000	230	4.6%	29,201	8,760	0.01	0.0085	0.003	2.50	10.96	2.13	9.32	0.75	3.29	131	4	3183	V
	NDC-18	Fringe Cement Bin	11,717	150	4,000	130	2%	3,508	8,760	0.01	0.0085	0.003	0.30	1.32	0.26	1.12	0.09	0.40	75	1	5093	H
	NDC-19	Finish Mill #1 Elevator and Conveying	1,171,650	150	8,000	200	2%	6,272	8,760	0.01	0.0085	0.003	0.54	2.35	0.46	2.00	0.16	0.71	45	1.4	5197	H
		Cement Conveying to Silos	1,171,650	150	5,000	150	2%	4,241	8,760	0.01	0.0085	0.003	0.36	1.59	0.31	1.35	0.11	0.48	45	1.4	3248	H
	NDC-20	Cement Silo #1 NW	1,171,650	150	2,000	150	2%	1,697	8,760	0.01	0.0085	0.003	0.15	0.64	0.12	0.54	0.04	0.19	193	1	2546	H
	NDC-21	Cement Silo #2 NE	1,171,650	150	2,000	150	2%	1,697	8,760	0.01	0.0085	0.003	0.15	0.64	0.12	0.54	0.04	0.19	193	1	2546	H
	NDC-22	Cement Silo #3 Interstice	1,171,650	150	2,000	150	2%	1,697	8,760	0.01	0.0085	0.003	0.15	0.64	0.12	0.54	0.04	0.19	193	1	2546	H
	NDC-23	Cement Silo #5 SE	1,171,650	150	2,000	150	2%	1,697	8,760	0.01	0.0085	0.003	0.15	0.64	0.12	0.54	0.04	0.19	193	1	2546	H
	NDC-24	Cement Silo #4 SW	1,171,650	150	2,000	150	2%	1,697	8,760	0.01	0.0085	0.003	0.15	0.64	0.12	0.54	0.04	0.19	193	1	2546	H
	NDC-25	Truck Loadout #1	1,171,650	150	4,000	150	2%	3,393	8,760	0.01	0.0085	0.003	0.29	1.27	0.25	1.08	0.09	0.38	35	1	5093	H
	NDC-26	Truck Loadout #2	1,171,650	150	4,000	150	2%	3,393	8,760	0.01	0.0085	0.003	0.29	1.27	0.25	1.08	0.09	0.38	35	1	5093	H
	NDC-27	Truck Loadout #3	1,171,650	150	4,000	150	2%	3,393	8,760	0.01	0.0085	0.003	0.29	1.27	0.25	1.08	0.09	0.38	35	1	5093	H
	NDC-28	Packaging Plant	234,330	150	12,000	150	2%	10,179	8,760	0.01	0.0085	0.003	0.87	3.82	0.74	3.25	0.26	1.15	35	2	3620	H
CH-7	DC-06	Coal Mill BH	134,783	17	30,000	162	6.5%	23,811	8,760	0.01	0.0085	0.003	2.04	8.94	1.73	7.60	0.61	2.68	135	5.5	1263	V
	NDC-29	Pulverized Coal Bin	134,783	9	2,000	162	2%	1,664	8,760	0.01	0.0085	0.003	0.14	0.62	0.12	0.53	0.04	0.19	85	1	2546	H
											TOTAL		47.16	206.57	39.88	174.88	17.24	75.50				

Note 1 : The moistura content of the nuisance dust collectors is excepted to be higher than 2%, howevar to conservativaly estimate potential emissions 2% was used.
Note 2 : For all sources except DC-01, PM10 is calculated as 85% of PM and PM2.5 is calculated as 30% of PM per AP-42 Appendix B Category 4.

TABLE A-5
Potential Particulate Emissions from Fugitive Sources

Segment Number	Description	Material	Material Information			PM Emission Factor (lb/ton)	PM10 Emission Factor (lb/ton)	PM2.5 Emission Factor (lb/ton)	Emission Factor Reference	Number of Transfer Points	Building Control Efficiency (%)^1	Enclosed Conveyor Control Efficiency (%)^2	Annual PM Emissions (tons/year)	Annual PM10 Emissions (tons/year)	Annual PM2.5 Emissions (tons/year)	Hourly PM Emissions (lb/hr)	Hourly PM10 Emissions (lb/hr)	Hourly PM2.5 Emissions (lb/hr)
			Annual Qty (ton/yr)	Hourly Rate (ton/hr)	Moisture Content (%)^3													
								CH-1 Primary Crushing and Associated Conveyors										
CH-1-1	**Primary Crushing and Conveying**																	
A	Loader to Primary Crusher	Limestone	2,424,529	308	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1			0.198	0.094	0.014	0.05	0.02	0.00
	Primary Crusher Operation	Limestone	2,424,529	308	17	1.20E-03	5.40E-04	1.00E-04	AP-42 Table 11.19.2-2, 8/04	1			1.455	0.655	0.121	0.37	0.17	0.03
	Conveyors B01 thru B08	Limestone	2,424,529	308	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	8		90%	0.158	0.075	0.011	0.04	0.02	0.00
B	Conveying B08 to B20	Limestone	2,424,529	308	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1		90%	0.020	0.009	0.001	0.01	0.00	0.00
C	Conveying B20 to B21	Limestone	2,424,529	308	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1		90%	0.020	0.009	0.001	0.01	0.00	0.00
D	Conveying B21 to B22	Limestone	2,424,529	308	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1		90%	0.020	0.009	0.001	0.01	0.00	0.00
												Sub Total	**1.870**	**0.851**	**0.151**	**0.474**	**0.218**	**0.038**
CH-1-2	**Base Rock Conveying**																	
A	Belt B22 to B24	Base Rock	319,149	40	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1			0.026	0.012	0.002	0.01	0.00	0.00
B	Belt B24 to B27	Base Rock	319,149	40	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1			0.026	0.012	0.002	0.01	0.00	0.00
C	Belt B27 to Radial Stacker	Base Rock	319,149	40	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1			0.026	0.012	0.002	0.01	0.00	0.00
D	Radial Stacker to Base Rock Pile	Base Rock	319,149	40	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1			0.026	0.012	0.002	0.01	0.00	0.00
												Sub Total	**0.104**	**0.049**	**0.007**	**0.026**	**0.012**	**0.002**
CH-1-3	**Limestone Conveying**																	
A	Belt B22 to B40	Limestone	2,105,380	267	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1		90%	0.017	0.008	0.001	0.00	0.00	0.00
B	Belt B40 to C01	Limestone	2,105,380	267	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1		90%	0.017	0.008	0.001	0.00	0.00	0.00
C	Belt C01 to C02	Limestone	2,105,380	267	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1		90%	0.017	0.008	0.001	0.00	0.00	0.00
												Sub Total	**0.052**	**0.024**	**0.004**	**0.013**	**0.006**	**0.001**
												CH-1 TOTAL EMISSIONS	**2.026**	**0.925**	**0.162**	**0.514**	**0.235**	**0.041**
									CH-2 Raw Material Conveying									
CH-2-1	**Limestone Pile Handling**																	
	C02 Transfer to Limestone Conveyor	Limestone	2,105,380	267	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1	50%	90%	0.009	0.004	0.001	0.00	0.00	0.00
	Transfer to Pile	Limestone	2,105,380	267	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	2	50%		0.172	0.081	0.012	0.04	0.02	0.00
	Piles to reclaim belts	Limestone	2,105,380	267	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	2	50%		0.172	0.081	0.012	0.04	0.02	0.00
												Sub Total	**0.352**	**0.167**	**0.025**	**0.089**	**0.042**	**0.006**
CH-2-2	**Bauxite/Wet Fly Ash Hopper Building**																	
	Truck Dump to Hopper	Wet Fly Ash	225,103	29	27	8.54E-05	4.04E-05	6.11E-06	AP-42 Section 13.2.4, 1/95	1	75%		0.002	0.001	0.000	0.00	0.00	0.00
	Hopper Transfer to Belt	Wet Fly Ash	225,103	28	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1	75%		0.005	0.002	0.000	0.00	0.00	0.00
												Sub Total	**0.007**	**0.003**	**0.001**	**0.002**	**0.001**	**0.000**
CH-2-3	**Bauxite/Wet Fly Ash Pile Handling**																	
	Belt to Belt Transfer	Wet Fly Ash	225,103	29	27	8.54E-05	4.04E-05	6.11E-06	AP-42 Section 13.2.4, 1/95	1	50%		0.005	0.002	0.000	0.00	0.00	0.00
	Transfer to Pile	Wet Fly Ash	225,103	29	27	8.54E-05	4.04E-05	6.11E-06	AP-42 Section 13.2.4, 1/95	1	50%		0.005	0.002	0.000	0.00	0.00	0.00
	Pile Transfer to Reclaim Belt	Wet Fly Ash	225,103	29	27	8.54E-05	4.04E-05	6.11E-06	AP-42 Section 13.2.4, 1/95	1	50%		0.005	0.002	0.000	0.00	0.00	0.00
												Sub Total	**0.014**	**0.007**	**0.001**	**0.004**	**0.002**	**0.000**
CH-2-4	**Clay/Sand Hopper Building**																	
	Truck Dump to Hopper	Clay/Sand	246,290	31	13.01	2.37E-04	1.12E-04	1.70E-05	AP-42 Section 13.2.4, 1/95	1	75%		0.007	0.003	0.001	0.00	0.00	0.00
	Hopper Transfer to Belt	Clay/Sand	246,290	31	27	8.54E-05	4.04E-05	6.11E-06	AP-42 Section 13.2.4, 1/95	1	75%		0.003	0.001	0.000	0.00	0.00	0.00
												Sub Total	**0.010**	**0.005**	**0.001**	**0.003**	**0.001**	**0.000**
CH-2-5	**Clay/Sand Pile Handling**																	
	Belt to Belt Transfer	Clay/Sand	246,290	31	13.01	2.37E-04	1.12E-04	1.70E-05	AP-42 Section 13.2.4, 1/95	1	50%		0.015	0.007	0.001	0.00	0.00	0.00
	Transfer to Pile	Clay/Sand	246,290	31	13.01	2.37E-04	1.12E-04	1.70E-05	AP-42 Section 13.2.4, 1/95	1	50%		0.015	0.007	0.001	0.00	0.00	0.00
	Pile Transfer to Reclaim Belt	Clay/Sand	246,290	31	13.01	2.37E-04	1.12E-04	1.70E-05	AP-42 Section 13.2.4, 1/95	1	50%		0.015	0.007	0.001	0.00	0.00	0.00
												Sub Total	**0.044**	**0.021**	**0.003**	**0.011**	**0.006**	**0.001**
CH-2-6	**Steel Slag Pile Handling**																	
	Truck Dump to Pile	Steel Slag	55,614	7	0.92	9.68E-03	4.58E-03	6.93E-04	AP-42 Section 13.2.4, 1/95	1	50%		0.135	0.064	0.010	0.03	0.02	0.00
	FEL Reclaim	Steel Slag	55,614	7	0.92	9.68E-03	4.58E-03	6.93E-04	AP-42 Section 13.2.4, 1/95	2	50%		0.269	0.127	0.019	0.07	0.03	0.00
	Transfer to Reclaim Belt	Steel Slag	55,614	7	0.92	9.68E-03	4.58E-03	6.93E-04	AP-42 Section 13.2.4, 1/95	1	50%		0.135	0.064	0.010	0.03	0.02	0.00
												Sub Total	**0.538**	**0.255**	**0.039**	**0.137**	**0.065**	**0.010**
CH-2-14	**Raw Mill Feed Conveying**																	
	Belt Transfer to Reject Bin	Raw Mill Feed Rejects	15,000	200	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1		90%	0.000	0.000	0.000	0.00	0.00	0.00
	Elevator Transfer to Reject Bin	Raw Mill Feed Rejects	15,000	200	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1		90%	0.000	0.000	0.000	0.00	0.00	0.00
	Reject Bin Discharge to Truck	Raw Mill Feed Rejects	15,000	200	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1			0.001	0.001	0.000	0.03	0.02	0.00
												Sub Total	**0.001**	**0.001**	**0.000**	**0.039**	**0.019**	**0.003**

TABLE A-5
Potential Particulate Emissions from Fugitive Sources

Segment Number	Description	Material	Material Information			PM	PM10	PM2.5	Emission Factor Reference	Number of Transfer Points	Building Control Efficiency (%)[1]	Enclosed Conveyor Control Efficiency (%)[2]	Annual	Annual	Annual	Hourly	Hourly	Hourly
			Annual Qty (ton/yr)	Hourly Rate (ton/hr)	Moisture Content (%)[3]	Emission Factor (lb/ton)	Emission Factor (lb/ton)	Emission Factor (lb/ton)					PM Emissions (tons/year)	PM10 Emissions (tons/year)	PM2.5 Emissions (tons/year)	PM Emissions (lb/hr)	PM10 Emissions (lb/hr)	PM2.5 Emissions (lb/hr)
CH-2-15	**Gypsum/Limestone Conveying**																	
	Gypsum Unloading	Gypsum	38,325	5	2.1	3.05E-03	1.44E-03	2.18E-04	AP-42 Section 13.2.4, 1/95	1	75%		0.015	0.007	0.001	0.00	0.00	0.00
	Limestone Unloading	Limestone	38,325	5	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1	75%		0.001	0.000	0.000	0.00	0.00	0.00
	FEL Gypsum/Limestone Reclaim	Gypsum/ Limestone	76,650	10	9.55	3.66E-04	1.73E-04	2.62E-05	AP-42 Section 13.2.4, 1/95	1	75%		0.004	0.002	0.000	0.00	0.00	0.00
	FEL Unloading to Belt	Gypsum/ Limestone	76,650	10	9.55	3.66E-04	1.73E-04	2.62E-05	AP-42 Section 13.2.4, 1/95	1			0.014	0.007	0.001	0.00	0.00	0.00
	Synthetic Gypsum Truck Dump to Pile	Syn Gypsum	19,163	2	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1	75%		0.000	0.000	0.000	0.00	0.00	0.00
	Synthetic Gypsum Pile FEL Reclaim	Syn Gypsum	19,163	2	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1	75%		0.000	0.000	0.000	0.00	0.00	0.00
	Synthetic Gypsum FEL Transfer to Belt	Syn Gypsum	19,163	2	17	1.63E-04	7.72E-05	1.17E-05	AP-42 Section 13.2.4, 1/95	1			0.002	0.001	0.000	0.00	0.00	0.00
											Sub Total		**0.035**	**0.017**	**0.003**	**0.009**	**0.004**	**0.001**
												CH-2 TOTAL EMISSIONS	**1.002**	**0.474**	**0.072**	**0.293**	**0.139**	**0.021**
									CH-8 Coal Conveying									
CH-8-1	**Coal/Petcoke Pile Handling**																	
	Coal/Pet Coke Unloading	Coal/Petcoke	134,783	17	5	9.58E-04	4.53E-04	6.86E-05	AP-42 Section 13.2.4, 1/95	1	50%		0.032	0.015	0.002	0.01	0.00	0.00
	FEL Reclaim	Coal/Petcoke	134,783	17	5	9.58E-04	4.53E-04	6.86E-05	AP-42 Section 13.2.4, 1/95	1	50%		0.032	0.015	0.002	0.01	0.00	0.00
	FEL Transfer to Hopper	Coal/Petcoke	134,783	17	5	9.58E-04	4.53E-04	6.86E-05	AP-42 Section 13.2.4, 1/95	1	75%		0.016	0.008	0.001	0.00	0.00	0.00
												Sub Total	**0.081**	**0.038**	**0.006**	**0.020**	**0.010**	**0.001**
CH-8-2	**Coal/Petcoke Conveying**																	
A	Belt Transfer to Elevator	Coal/Petcoke	134,783	17	5	9.58E-04	4.53E-04	6.86E-05	AP-42 Section 13.2.4, 1/95	1	50%	90%	0.003	0.002	0.000	0.00	0.00	0.00
	Transfer to Scrap Metal Box	Coal/Petcoke	674	0	5	9.58E-04	4.53E-04	6.86E-05	AP-42 Section 13.2.4, 1/95	2	50%		0.000	0.000	0.000	0.00	0.00	0.00
	Coal Conveyor transfer to Piles	Coal/Petcoke	134,783	17	5	9.58E-04	4.53E-04	6.86E-05	AP-42 Section 13.2.4, 1/95	1	50%		0.032	0.015	0.002	0.01	0.00	0.00
	Truck Dump to Hopper	Coal/Petcoke	134,783	17	5	9.58E-04	4.53E-04	6.86E-05	AP-42 Section 13.2.4, 1/95	1	75%		0.016	0.008	0.001	0.00	0.00	0.00
	Hopper transfer to Elevator	Coal/Petcoke	134,783	17	5	9.58E-04	4.53E-04	6.86E-05	AP-42 Section 13.2.4, 1/95	1	75%	90%	0.002	0.001	0.000	0.00	0.00	0.00
B	Elevator to Coal Conveyor	Coal/Petcoke	134,783	17	5	9.58E-04	4.53E-04	6.86E-05	AP-42 Section 13.2.4, 1/95	1		90%	0.006	0.003	0.000	0.00	0.00	0.00
	Elevator to Coal Bins	Coal/Petcoke	134,783	17	5	9.58E-04	4.53E-04	6.86E-05	AP-42 Section 13.2.4, 1/95	2		90%	0.013	0.006	0.001	0.00	0.00	0.00
												Sub Total	**0.073**	**0.035**	**0.005**	**0.019**	**0.009**	**0.001**
												CH-8 TOTAL EMISSIONS	**0.154**	**0.073**	**0.011**	**0.039**	**0.018**	**0.003**
											Total		**3.182**	**1.471**	**0.245**	**0.846**	**0.392**	**0.065**

Note 1 A control efficiency of 50% was used to account for reduction of fugitives due to a partial building enclosure of two walls and a roof. A control efficiency of 75% was use to account for reduction of fugitives due to a building enclosure of three connecting walls and a roof.

Note 2 A control efficiency of 90% was used to account for reduction of fugitives due to enclosed conveyor transfer points, enclosed bins, and below ground transfer.

Note 3 Moisture Content for limestone, clay, and sand is based on the Raw Material Analysis provided in Appendix G. All other moisture contents are based on the values provided in AP-42 Table 13.2.4-1.

Material transfer Calculation Method
Material transfer factors from AP-42 Section 13.2.4-3 (Aggregate Handling and Storage Piles, 1/95).

$E = k * 0.0032 * (U/5)^{1.3} / (M/2)^{1.4}$

E = transfer emission factor (lb/ton)
k = particle size multiplier
U = mean wind speed (mph)
M = material moisture content (%)

k (<30 um) = 0.74
k (<10 um) = 0.35
k (<2.5 um) = 0.053

Mercury Calculation Methodology

Mercury Emissions from the Center Hill plant will be estimated based on a calculated emission factor of 1.078E-04 lb of mercury per ton of clinker. This emission factor is based on data on two years worth of data on Raw Material Mercury Input from Suwannee American Cement in Branford, Fl. Provided below is an analysis of how this emission factor was derived:

Based on two plus years of raw material and feed samples from Suwannee American Cement (SAC) in Branford, Fl which use limestone from the same formation as SCC and proposes use of similar other raw materials and fuels, a average mercury concentration was developed for each input. Additionally, an extensive two day mercury mass balance test was conducted at SAC which involved hourly samples of raw materials, intermediate process outputs, final clinker outputs and stack testing. Based on results from these data sources and the proposed dry mass input of materials needed at SCC an emission factor was developed for total mercury input, then divided by the total clinker output. The estimated total mercury input was approximately 185 pounds of mercury per year which divided by a total maximum clinker output of 1,715,500 tons per year equals a mercury factor of 0.00010784 lbs of mercury per ton of clinker. When compared to two separate stack tests conducted at SAC the results matched closely the mercury factors from the stack testing when evaluating mill on and mill off conditions.

To insure that mercury emissions will not exceed the estimated potential emissions, the SCC Center Hill Plant will conduct mercury monitoring through sampling and analysis of raw materials and feeds.

To determine the total mass input of mercury into the kiln system all inputs have to be identified and then sampled. The following figure shows all the mercury input locations into the kiln system.

The inputs shown include the combined raw material feed to the Raw Mill which includes the pre-determined amounts of calcium carbonate, silica, alumina, and iron from the raw materials. The fuel from the fuel storage is also accounted as an input for the system which may contain coal or petcoke blended together. Finally the dry fly ash which is injected into the calciner is identified as an input. Overall these represent the total mass inputs into the kiln system for which mercury may be introduced.

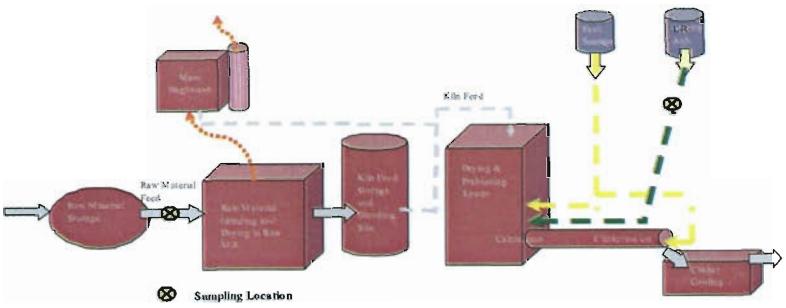

Figure 1

Also identified in Figure 1 are the sampling locations for all the inputs. The raw materials sampling location represents the total of all raw materials into the kiln system prior to being ground and dried in the raw mill. Samples for raw material feed, fuel fed to the kiln system, and dry fly ash injected into the calciner are taken at appropriate intervals through out the day. These samples are combined into daily composites and at the end of the month the daily composites are combined into a monthly composite. As appropriate the monthly composites will be combined to form quarterly composites and semi-annual composites. For purposes of the example the monthly calculation will be shown.

These monthly composites are then sent to an appropriate offsite lab for analysis to determine the mercury concentration using the currently approved EPA Method 7471A Mercury in Solid or Semisolid Waste (Manual Cold Vapor Technique) or other approved or appropriate methods that may be developed in the future.

The analytical results are then used with the total dry feed rates of the component to determine a mass input of mercury into the system for the month, this could just as easily be quarterly or semi-annually. The mass input for the raw material feed is a total mass of all of the material fed into the raw material for the corresponding month on a dry basis. The overall calculation for mercury input for all of the components is shown in below.

Equation 1: Monthly Composite of Material (unit of weight dry) * Concentration of Mercury (ppb) = Mass of Mercury (unit of weight)

This formula is repeated for all three inputs (Raw Material Feed, Fuel Feed, and Dry Fly Ash) and the total sum of these three inputs equals the total monthly input of mercury. This is shown in Equation 2.

Equation 2:

Monthly Mass of Mercury from Raw Material (dry)_
Monthly Mass of Mercury from Fuel (dry)
+ Monthly Mass of Mercury from Dry Fly Ash
Total Monthly Mercury Input into Kiln System

This is repeated for every month, quarter or semi-annual period and then a yearly mass input for mercury can be determined and compared to the yearly emission limit.

This estimate for mercury emissions is overly conservative for demonstration of compliance with the Mercury Emission Limit proposed in the permit because it first assumes that all the mercury entering the kiln systems exits through the main stack. Through the testing conducted at SAC and studies conducted by Portland Cement Association (PCA), small amounts of mercury have been shown to exit through the clinker.

Additionally, analytical results for the samples of raw material are typically below detection limits when utilizing the currently approved EPA Method 7471A Mercury in Solid or Semisolid Waste (Manual Cold Vapor Technique). SCC considers the detection limit as the amount of mercury present in that material despite the fact that the actual mercury concentration maybe well below this. This intern effectively overestimates the entire input of mercury into the system due to limitations of the currently analytical technology which routinely measure down to parts per billion (ppb) of mercury.

TABLE A-4
Potential Emissions from the Kiln System, Clinker Cooler, and Emergency Generator

Hourly Emissions:

EU No.	EU Description	Flow Rate DSCFM	Clinker tons/hr	PM lbs/hr	PM_{10} lbs/hr	$PM_{2.5}$ lbs/hr	SO2 lbs/hr	NO_X lbs/hr	CO lbs/hr	VOC lbs/hr	HCl lbs/hr	Lead lbs/hr	Mercury lbs/hr	Dioxin/Furan lbs/hr	Beryllium lbs/hr	Fluorides lbs/hr
CH-4	New Kiln System	300,289	138.9	20.59	17.30	9.27	37.50	270.83	500.00	16.67	19.44	0.010	0.015	0.00	0.00	0.00

EU No.	EU Description	Size	Fuel Rate gal/hr	Heat Input MMBtu/hr	Output hp-hr	PM lbs/hr	PM_{10} lbs/hr	$PM_{2.5}$ lbs/hr	SO2 lbs/hr	NO_X lbs/hr	CO lbs/hr	VOC lbs/hr
CH-9-1	Emergency Generator	750 kW	54.8	7.51	1,006	0.48	0.37	0.36	3.79	15.90	2.97	0.55

Annual Emissions:

EU No.	EU Description	Flow Rate DSCFM	Clinker tons/yr	PM tons/yr	PM_{10} tons/yr	$PM_{2.5}$ tons/yr	SO2 tons/yr	NO_X tons/yr	CO tons/yr	VOC tons/yr	HCl tons/yr	Lead tons/yr	Mercury tons/yr	Dioxin/Furan (tons/yr)	Beryllium tons/yr	Fluorides tons/yr
CH-4	New Kiln System	300,289	1,095,000	90.19	75.76	40.59	147.83	1,067.63	1,971.00	65.70	76.65	0.041	0.059	0.0000	0.0001	0.493

EU No.	EU Description	Operating Hours	Fuel Rate gal/yr	Heat Input MMBtu/yr	Output hp-hr/yr	PM tons/yr	PM_{10} tons/yr	$PM_{2.5}$ tons/yr	SO2 tons/yr	NO_X tons/yr	CO tons/yr	VOC tons/yr
CH-9-1	Emergency Generator	291	15,947	2,165	292,673	0.07	0.05	0.05	0.55	2.31	0.43	0.08

Notes: The emergency generator operates during testing and power outages only.
In the event of a power outage, fuel to the kiln is cut off and the generator is the only combustion source operating.
Generator is diesel fuel-fired. Assume 137,000 Btu/gal heat value of fuel and sulfur content of 0.5 percent.

Emissions Basis:

Proposed Kiln

Pollutant	Emission Factor	Emission Factor Units	Source of Emission Factor
PM	0.008	gr/dscf	Proposed BACT
PM_{10}	0.0067	gr/dscf	84% of PM per AP-42 Table 11.6-5
$PM_{2.5}$	0.0036	gr/dscf	45% of PM per AP-42 Table 11.6-5
SO_2	0.27	lb/ton clinker	Proposed BACT
NO_X	1.95	lb/ton clinker	Proposed BACT
CO	3.60	lb/ton clinker	Proposed BACT
VOC	0.12	lb/ton clinker	Proposed BACT
HCl (annual)	0.1400	lb/ton clinker	AP-42 Table 11.6-9
Lead	7.50E-05	lb/ton clinker	AP-42 Table 11.6-9
Mercury	1.08E-04	lb/ton clinker	Based on Stack Test Data from similar SAC Plant in Brandford, FL.
Beryllium	2.41E-07	lb/ton clinker	Similar PH/PC Plant Stack Test Dec. 9-12, 2003
Fluorides	9.00E-04	lb/ton clinker	AP-42 Table 11.6-9
Dioxin/ Furans	2.90E-10	lb/ton clinker	AP-42 Table 11.6-9

Emergency Generator

Pollutant	Emission Factor	EF Units	Source of EF
PM	0.215	lb/hp-hr	Generator specifications
PM_{10}	0.0496	lb/MMBtu	AP-42 Table 3.4-2 (filterable only)
$PM_{2.5}$	0.0479	lb/MMBtu	AP-42 Table 3.4-2 (filterable only)
SO_2	0.505	lb/MMBtu	AP-42 Table 3.4-1
NO_X	7.17	lb/hp-hr	Generator specifications
CO	1.34	lb/hp-hr	Generator specifications
VOC	0.25	lb/hp-hr	Generator specifications

TABLE A-6
Potential Particulate Emissions from Storage Piles

ID NO.	Description	Material	Surface Area (Acres)	Active Days (n) (days/yr)	Silt Content (s) percent	Material Moisture (%)	Material Throughput (T/yr)	Average Wind Speed (mph)	Wind Speed > 12 mph (f) percent	Rain Days (p) (days/yr)	Enclosure Control Efficiency (%)	TSP Wind Emissions (T/yr)	PM10 Wind Emissions (T/yr)	PM2.5 Wind Emissions (T/yr)	TSP Hourly Emissions (lb/hr)	PM10 Hourly Emissions (lb/hr)	PM2.5 Hourly Emissions (lb/hr)
CH-10-1	Crushed Limestone Pile	Limestone	3.0	365	3.9	17	2,424,529	6.9	9.74	105	0	1.74	0.87	0.87	0.397	0.198	0.198
CH-10-2	Base Rock Pile	Limestone	1.5	365	3.9	17	319,149	6.9	9.74	105	0	0.87	0.43	0.43	0.198	0.099	0.099
CH-10-3A	Raw Limestone Storage	Limestone	0.4	365	3.9	17	2,105,380	6.9	9.74	0	50	0.16	0.08	0.08	0.037	0.019	0.019
CH-10-3B	Raw Limestone Storage	Limestone	0.4	365	3.9	17	2,105,380	6.9	9.74	0	50	0.16	0.08	0.08	0.037	0.019	0.019
CH-10-4	Sand/Clay Storage	Sand/Clay	0.4	365	4.3	13.0	246,290	6.9	9.74	0	50	0.18	0.09	0.09	0.041	0.020	0.020
CH-10-5	Steel Slag Storage	Steel Slag	0.2	365	5.3	0.9	55,614	6.9	9.74	0	50	0.11	0.06	0.06	0.025	0.013	0.013
CH-10-6	Bauxite/Wet Fly Ash Stor	Bauxite/Fly Ash	0.4	365	80.0	27.0	225,103	6.9	9.74	0	50	3.34	1.67	1.67	0.762	0.381	0.381
CH-10-7	Gypsum Storage	Gypsum	0.1	365	3.9	2.1	38,325	6.9	9.74	0	50	0.04	0.02	0.02	0.009	0.005	0.005
CH-10-8	Syn. Gypsum Storage	Syn. Gypsum	0.1	365	3.9	10.7	19,163	6.9	9.74	0	50	0.04	0.02	0.02	0.009	0.005	0.005
CH-10-9	Limestone Storage	Limestone	0.10	365	3.9	17.0	38,325	6.9	9.74	0	50	0.04	0.02	0.02	0.009	0.005	0.005
CH-10-10	Coal Storage	Coal	0.3	365	4.6	5	134,783	6.9	9.74	0	50	0.14	0.07	0.07	0.033	0.016	0.016
CH-10-11	Pet Coke Storage	Pet Coke	0.30	365	4.6	5		6.9	9.74	0	50	0.14	0.07	0.07	0.033	0.016	0.016
											TOTALS	6.97	3.49	3.49	1.59	0.80	0.80

NOTES:

Above emissions include only wind erosion emissions from the piles, all emissions from material transfer are accounted for in the Material Handling emissions.

Wind Erosion

Reference: Control of Open Fugitive Dust Sources, EPA-450/3-88-008, p. 4-17

Ef = 1.7*(s/1.5)*(f/15)*((365-p)/235)*(1-(C/100))	TSP (lbs/acre/day)	PM10 fraction =	0.5
E = A*n*Ef/2000	TSP (tons/yr)	PM2.5 is assumed to equal PM10	

s = Silt content of the aggregate (%)
f = Percent of time that the unobstructed wind speed exceeds 12 mph at the mean pile height
p = Number of days with >= 0.01 in. of precipitation per year
C = Overall control efficiency (%)
A = Size of the pile (acres)
n = Number of days per year the pile is continuously active

Typical moisture of limestone, sand, and clay are from the raw material analysis provided in Appendix G
All other moisture values are from AP-42 Table 13.2.4-1.
Typical silt contents of materials from AP-42 Table 13.2.4-1.

TABLE A-7
Potential Particulate Emissions from Paved and Unpaved Roads

Paved Road Emission Summary

Segment No.		Segment Length (mi)	Silt Loading (g/m2)	Maximum Annual Emissions								Hourly Emissions		
				Material Trips (#/yr)	Total Mileage (Mi/yr)	TSP E Factor lb/VMT	PM10 E Factor lb/VMT	PM2.5 E Factor lb/VMT	TSP Emissions (Ton/yr)	PM10 Emissions (Ton/yr)	PM2.5 Emissions (Ton/yr)	TSP Emissions (lb/hr)	PM10 Emissions (lb/hr)	PM2.5 Emissions (lb/hr)
CH-11-1	Main Entrance Road	0.60	0.15	145,855	144,688	0.04	0.01	0.002	2.80	0.56	0.14	0.640	0.128	0.031
CH-11-2	Cement Silos to Main Road	0.04	0.15	87,932	4,438	0.02	0.00	0.001	0.05	0.01	0.00	0.012	0.002	0.001
CH-11-3	Main Road to Cement silos	0.12	0.15	145,856	27,875	0.04	0.01	0.002	0.50	0.10	0.02	0.115	0.023	0.006
CH-11-4A	Trucks Entering Cement Silos	0.04	0.15	53,257	1,901	0.05	0.01	0.002	0.05	0.01	0.00	0.011	0.002	0.001
CH-11-4B	Trucks Leaving Cement Silos	0.03	0.15	53,257	1,699	0.05	0.01	0.002	0.04	0.01	0.00	0.010	0.002	0.000
CH-11-5	Admin Building Road	0.15	0.15	34,676	10,479	0.00	0.00	0.000	0.02	0.00	0.00	0.004	0.001	0.000
CH-11-6	Main Road to Gypsum Building	0.04	0.15	57,923	5,028	0.05	0.01	0.002	0.13	0.03	0.01	0.029	0.006	0.001
CH-11-7	Gypsum Building Road	0.03	0.15	3,066	207	0.05	0.01	0.003	0.01	0.00	0.00	0.001	0.000	0.000
CH-11-8	Main Road to Coal Building	0.08	0.15	64,857	8,843	0.05	0.01	0.002	0.22	0.04	0.01	0.050	0.010	0.002
CH-11-9	Coal Truck Loop	0.04	0.15	5,391	402	0.05	0.01	0.003	0.01	0.00	0.00	0.002	0.000	0.000
CH-11-10	FEL - Coal/Petcoke	0.03	0.15	2,696	146	0.06	0.01	0.003	0.00	0.00	0.00	0.001	0.000	0.000
CH-11-11	Base Rock Road	0.75	0.15	21,277	32,094	0.04	0.01	0.002	0.70	0.14	0.03	0.159	0.032	0.008
CH-11-12	Dry Fly Ash Road	0.03	0.15	7,109	357	0.05	0.01	0.003	0.01	0.00	0.00	0.002	0.000	0.000
CH-11-13	Main Road to Raw Material Storage	0.11	0.15	21,080	4,806	0.05	0.01	0.003	0.13	0.03	0.01	0.029	0.006	0.001
CH-11-14	Truck Dump for Steel Slag	0.02	0.15	2,225	68	0.05	0.01	0.003	0.00	0.00	0.00	0.000	0.000	0.000
CH-11-17	Main Road to Sand/Clay Unloading	0.04	0.15	18,856	1,425	0.05	0.01	0.003	0.04	0.01	0.00	0.009	0.002	0.000
CH-11-18	Sand/Clay Unloading Road	0.04	0.15	9,852	822	0.05	0.01	0.003	0.02	0.00	0.00	0.005	0.001	0.000
CH-11-19	Main Road to Bauxite/Wet Fly Ash Unloading	0.07	0.15	9,004	1,189	0.05	0.01	0.003	0.03	0.01	0.00	0.007	0.001	0.000
CH-11-20	Bauxite/Wet Fly Ash Unloading Road	0.04	0.15	9,004	747	0.05	0.01	0.003	0.02	0.00	0.00	0.005	0.001	0.000
CH-11-21	FEL - Gypsum/Limestone	0.04	0.15	10,220	752	0.06	0.01	0.003	0.02	0.00	0.00	0.005	0.001	0.000
CH-11-24	Main Road to Dry Fly Ash	0.05	0.15	28,366	2,873	0.05	0.01	0.002	0.07	0.01	0.00	0.015	0.003	0.001
TOTAL		2.27			250,838				4.87	0.97	0.24	1.11	0.22	0.05

Unpaved Road Emission Summary

Segment No.		Trip Length (mi)	Silt Content (%)	Maximum Annual Emissions								Hourly Emissions		
				Material Trips (#/yr)	Total Mileage (Mi/yr)	TSP E Factor lb/VMT	PM10 E Factor lb/VMT	PM2.5 E Factor lb/VMT	TSP Emissions (Ton/yr)	PM10 Emissions (Ton/yr)	PM2.5 Emissions (Ton/yr)	TSP Emissions (lb/hr)	PM10 Emissions (lb/hr)	PM2.5 Emissions (lb/hr)
CH-11-16	FEL - Steel Slag	0.03	8.3	7,415	252	7.46	2.12	0.21	0.05	0.01	0.00	0.011	0.003	0.000
CH-11-22	FEL - Limestone	0.03	8.3	323,270	10,442	7.46	2.12	0.21	1.95	0.55	0.06	0.444	0.126	0.013
CH-11-23	FEL - Base Rock	0.03	8.3	21,277	600	6.68	1.90	0.19	0.10	0.03	0.00	0.023	0.007	0.001
TOTAL		0.09			11,293.75				2.09	0.60	0.06	0.48	0.14	0.01

	TSP Emissions (Ton/yr)	PM10 Emissions (Ton/yr)	PM2.5 Emissions (Ton/yr)	TSP Emissions (lb/hr)	PM10 Emissions (lb/hr)	PM2.5 Emissions (lb/hr)
TOTAL PAVED AND UNPAVED EMISSIONS	6.96	1.57	0.30	1.59	0.36	0.07

TABLE A-8
Paved Roads Emission Worksheet

Segment No. CH-11-1 **Main Entrance Road**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.50	Cement	0.15	15	22	37	26	X	X	26.0	22	1,171,650	53,257	26,415	26,415	52,831	1,373,600						
0.50	Bauxite/Wet Flyash	0.15	15	25	40	27.5	X	X	27.5	25	225,103	9,004	4,466	4,466	8,932	245,633						
0.50	Sand/Clay	0.15	15	25	40	27.5	X	X	27.5	25	246,290	9,852	4,886	4,886	9,773	268,751						
0.50	Steel Slag	0.15	15	25	40	27.5	X	X	27.5	25	55,614	2,225	1,103	1,103	2,207	60,688						
0.50	Coal/Fuels	0.15	15	25	40	27.5	X	X	27.5	25	134,783	5,391	2,674	2,674	5,348	147,075						
0.50	Gypsum/Limestone Shed	0.15	15	25	40	27.5	X	X	27.5	25	76,650	3,066	1,521	1,521	3,041	83,640						
0.50	Dry Fly Ash	0.15	15	25	40	27.5	X	X	27.5	25	177,726	7,109	3,526	3,526	7,052	193,934						
0.50	Employee Vehicles	0.15	1.75	0	1.75	1.75	X	X	1.8	0	34,675	34,675	17,199	17,199	34,398	60,196						
0.50	Base Rock (Limestone)	0.15	15	15	30	22.5	X	X	22.5	15	319,149	21,277	10,553	10,553	21,106	474,894						
0.50	SUBTOTAL	0.15							20.1			145,855	72,344	72,344	144,688	2,908,410	0.04	0.01	0.00	2.80	0.56	0.14

Segment No. CH-11-2 **Cement Silos to Main Road**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.04	Cement	0.15	15	22	37	26		X	26.0	22	1,171,650	53,257	0	1,928	1,928	50,125						
0.04	Employee Vehicles	0.15	1.75	0	1.75	1.75	X	X	1.8	0	34,675	34,675	1,255	1,255	2,510	4,393						
0.04	SUBTOTAL	0.15							12.3			87,932	1,255	3,183	4,438	54,519	0.02	0.00	0.00	0.05	0.01	0.00

Segment No. CH-11-3 **Main Road to Cement silos**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.12	Cement	0.15	15	22	37	26	X		26.0	22	1,171,650	53,257	6,226	0	6,226	161,869						
0.12	Bauxite/Wet Flyash	0.15	15	25	40	27.5	X	X	27.5	25	225,103	9,004	1,053	1,053	2,105	57,892						
0.12	Sand/Clay	0.15	15	25	40	27.5	X	X	27.5	25	246,290	9,852	1,152	1,152	2,303	63,341						
0.12	Steel Slag	0.15	15	25	40	27.5	X	X	27.5	25	55,614	2,225	260	260	520	14,303						
0.12	Coal/Fuels	0.15	15	25	40	27.5	X	X	27.5	25	134,783	5,391	630	630	1,260	34,664						
0.12	Gypsum/Limestone Shed	0.15	15	25	40	27.5	X	X	27.5	25	76,650	3,066	358	358	717	19,713						
0.12	Dry Fly Ash	0.15	15	25	40	27.5	X	X	27.5	25	177,726	7,109	831	831	1,662	45,708						
0.12	Employee Vehicles	0.15	1.75	0	1.75	1.75	X	X	1.8	0	34,675	34,675	4,054	4,054	8,107	14,187						
0.12	Base Rock (Limestone)	0.15	15	15	30	22.5	X	X	22.5	15	319,149	21,277	2,487	2,487	4,974	111,926						
0.12	SUBTOTAL	0.15							18.8			145,855	17,050	10,825	27,875	523,601	0.04	0.01	0.00	0.50	0.10	0.02

Segment No. CH-11-4A **Trucks Entering Cement Silos**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.04	Cement	0.15	15	22	37	26	X		26.0	22	1,171,650	53,257	1,901	0	1,901	49,433						
0.04	SUBTOTAL	0.15							26.0			53,257	1,901	0	1,901	49,433	0.05	0.01	0.00	0.05	0.01	0.00

Segment No. CH-11-4B **Trucks Leaving Cement Silos**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.03	Cement	0.15	15	22	37	26		X	26.0	22	1,171,650	53,257	0	1,699	1,699	44,171						
0.03	SUBTOTAL	0.15							26.0			53,257	0	1,699	1,699	44,171	0.05	0.01	0.00	0.04	0.01	0.00

Segment No. CH-11-5 **Admin Building Road**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.15	Employee Vehicles	0.15	1.75	0	1.75	1.75	X	X	1.8	0	34,675	34,675	5,239	5,239	10,479	18,338						
0.15	SUBTOTAL	0.15							1.8			34,675	5,239	5,239	10,479	18,338	0.00	0.00	0.00	0.02	0.00	0.00

Segment No. CH-11-6 **Main Road to Gypsum Building**

TABLE A-8
Paved Roads Emission Worksheet

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.04	Bauxite/Wet Flyash	0.15	15	25	40	27.5	X	X	27.5	25	225,103	9,004	391	391	782	21,493						
0.04	Sand/Clay	0.15	15	25	40	27.5	X	X	27.5	25	246,290	9,852	428	428	855	23,516						
0.04	Steel Slag	0.15	15	25	40	27.5	X	X	27.5	25	55,614	2,225	97	97	193	5,310						
0.04	Coal/Fuels	0.15	15	25	40	27.5	X	X	27.5	25	134,783	5,391	234	234	468	12,869						
0.04	Gypsum/Limestone Shed	0.15	15	25	40	27.5	X	X	27.5	25	76,650	3,066	133	133	266	7,319						
0.04	Dry Fly Ash	0.15	15	25	40	27.5	X	X	27.5	25	177,726	7,109	309	309	617	16,969						
0.04	Base Rock (Limestone)	0.15	15	15	30	22.5	X	X	22.5	15	319,149	21,277	923	923	1,847	41,553						
0.04	SUBTOTAL	0.15							25.7			57,923	2,514	2,514	5,028	129,029	0.05	0.01	0.00	0.13	0.03	0.01

Segment No. CH-11-7 **Gypsum Building Road**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.03	Gypsum/Limestone Shed	0.15	15	25	40	27.5	X	X	27.5	25	76,650	3,066	103	103	207	5,683						
0.03	SUBTOTAL	0.15							27.5			3,066	103	103	207	5,683	0.05	0.01	0.00	0.01	0.00	0.00

Segment No. CH-11-8 **Main Road to Coal Building**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.08	Bauxite/Wet Flyash	0.15	15	25	40	27.5	X	X	27.5	25	225,103	9,004	726	726	1,451	39,915						
0.08	Sand/Clay	0.15	15	25	40	27.5	X	X	27.5	25	246,290	9,852	794	794	1,588	43,672						
0.08	Steel Slag	0.15	15	25	40	27.5	X	X	27.5	25	55,614	2,225	179	179	359	9,861						
0.08	Coal/Fuels	0.15	15	25	40	27.5	X	X	27.5	25	134,783	5,391	435	435	869	23,900						
0.08	Dry Fly Ash	0.15	15	25	40	27.5	X	X	27.5	25	177,726	7,109	573	573	1,146	31,514						
0.08	Base Rock (Limestone)	0.15	15	15	30	22.5	X	X	22.5	15	319,149	21,277	1,715	1,715	3,430	77,170						
0.08	SUBTOTAL	0.15							25.6			54,857	4,421	4,421	8,843	226,033	0.05	0.01	0.00	0.22	0.04	0.01

TABLE A-8
Paved Roads Emission Worksheet

Segment No. CH-11-9 **Coal Truck Loop**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.0373	Coal/Fuels	0.15	15	25	40	27.5	X	X	27.5	25	134,783	5,391	201	201	402	11,060						
0.04	SUBTOTAL	0.15							27.5			5,391	201	201	402	11,060	0.05	0.01	0.00	0.01	0.00	0.00

Segment No. CH-11-10 **FEL - Coal/Petcoke**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.03	Front End Loader 3 Coal/Petcoke	0.15	25	7.5	32.5	28.75	X	X	28.8	7.5	20,217	2,696	73	73	146	4,185						
0.03	SUBTOTAL	0.15							28.8			2,696	73	73	146	4,185	0.06	0.01	0.00	0.00	0.00	0.00

Segment No. CH-11-11 **Base Rock Road**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.75	Base Rock (Limestone)	0.15	15	15	30	22.5	X	X	22.5	15	319,149	21,277	16,047	16,047	32,094	722,106						
0.75	SUBTOTAL	0.15							22.5			21,277	16,047	16,047	32,094	722,106	0.04	0.01	0.00	0.70	0.14	0.03

Segment No. CH-11-12 **Dry Fly Ash Road**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.03	Dry Fly Ash	0.15	15	25	40	27.5	X	X	27.5	25	177,726	7,109	178	178	357	9,814						
0.03	SUBTOTAL	0.15							27.5			7,109	178	178	357	9,814	0.05	0.01	0.00	0.01	0.00	0.00

Segment No. CH-11-13 **Main Road to Raw Material Storage**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.11	Bauxite/Wet Flyash	0.15	15	25	40	27.5	X	X	27.5	25	225,103	9,004	1,026	1,026	2,053	56,456						
0.11	Sand/Clay	0.15	15	25	40	27.5	X	X	27.5	25	246,290	9,852	1,123	1,123	2,246	61,769						
0.11	Steel Slag	0.15	15	25	40	27.5	X	X	27.5	25	55,614	2,225	254	254	507	13,948						
0.11	SUBTOTAL	0.15							27.5			21,080	2,403	2,403	4,806	132,173	0.05	0.01	0.00	0.13	0.03	0.01

Segment No. CH-11-14 **Truck Dump for Steel Slag**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.02	Steel Slag	0.15	15	25	40	27.5	X	X	27.5	25	55,614	2,225	34	34	68	1,860						
0.02	SUBTOTAL	0.15							27.5			2,225	34	34	68	1,860	0.05	0.01	0.00	0.00	0.00	0.00

Segment No. CH-11-17 **Main Road to Sand/Clay Unloading**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.04	Bauxite/Wet Flyash	0.15	15	25	40	27.5	X	X	27.5	25	225,103	9,004	340	340	681	18,720						
0.04	Sand/Clay	0.15	15	25	40	27.5	X	X	27.5	25	246,290	9,852	372	372	745	20,481						
0.04	SUBTOTAL	0.15							27.5			18,856	713	713	1,425	39,201	0.05	0.01	0.00	0.04	0.01	0.00

TABLE A-8
Paved Roads Emission Worksheet

Segment No. CH-11-18 **Sand/Clay Unloading Road**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.04	Sand/Clay	0.15	15	25	40	27.5	X	X	27.5	25	246,290	9,852	411	411	822	22,595						
0.04	SUBTOTAL	0.15							27.5			9,852	411	411	822	22,595	0.05	0.01	0.00	0.02	0.00	0.00

Segment No. CH-11-19 **Main Road to Bauxite/Wet Fly Ash Unloading**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.07	Bauxite/Wet Flyash	0.15	15	25	40	27.5	X	X	27.5	25	225,103	9,004	594	594	1,189	32,685						
0.07	SUBTOTAL	0.15							27.5			9,004	594	594	1,189	32,685	0.05	0.01	0.00	0.03	0.01	0.00

Segment No. CH-11-20 **Bauxite/Wet Fly Ash Unloading Road**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.04	Bauxite/Wet Flyash	0.15	15	25	40	27.5	X	X	27.5	25	225,103	9,004	374	374	747	20,552						
0.04	SUBTOTAL	0.15							27.5			9,004	374	374	747	20,552	0.05	0.01	0.00	0.02	0.00	0.00

Segment No. CH-11-21 **FEL - Gypsum/Limestone**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.04	Front End Loader 2 Gypsum/Limestone	0.15	25	7.5	32.5	28.75	X	X	28.8	7.5	76,650	10,220	376	376	752	21,626						
0.04	SUBTOTAL	0.15							28.8			10,220	376	376	752	21,626	0.06	0.01	0.00	0.02	0.00	0.00

Segment No. CH-11-24 **Main Road to Dry Fly Ash**

Segment Length (mi)	Material	Silt Loading (g/m2)	Truck Weights				Truck Trips		Truck Weight (Tons)	Material Net (Tons)	Material (Tons/Yr)	Material Trips (#/Yr)	Empty Mileage (Mi/Yr)	Loaded Mileage (Mi/Yr)	Total Mileage (Mi/Yr)	Weight x Mileage	TSP Emission Factor lb/VMT	PM10 Emission Factor lb/VMT	PM2.5 Emission Factor lb/VMT	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
			Empty (Tons)	Capacity (Tons)	Loaded (Tons)	Average (Tons)	Empty	Loaded														
0.05	Dry Fly Ash	0.15	15	25	40	27.5	X	X	27.5	25	177,726	7,109	360	360	719	19,764						
0.05	Base Rock (Limestone)	0.15	15	15	30	22.5	X	X	22.5	15	319,149	21,277	1,077	1,077	2,153	48,447						
0.05	SUBTOTAL	0.15							23.8			28,386	1,436	1,436	2,873	68,231	0.05	0.01	0.00	0.07	0.01	0.00

	TSP Emissions (Tons/Yr)	PM10 Emissions (Tons/Yr)	PM2.5 Emissions (Tons/Yr)
GRAND TOTAL	4.67	0.97	0.24

Notes:

Emissions based on AP-42 Section 13.2.1 (Jan 2011), Equation (2).

E = [k * (sL)^0.91 * (W)^1.02] * (1 - P/4N)

where E = emission factor, lb/VMT
k = particle size multiplier
sL = road surface silt loading, g/m^2
W = average vehicle weight, tons
P = number of days with >= 0.01 in precipitation
N = number of days in the averaging period (365)

k (PM-30) = 0.011 lb/VMT
k (PM-10) = 0.0022 lb/VMT
k (PM-2.5) = 0.00054 lb/VMT
P = 105 days (Tampa average)

Silt loading of 0.15 g/m2 or less will be maintained by use of vacuum sweeping

TABLE A-9
Unpaved Roads Emission Worksheet

Segment No.	Material Hauled	Annual Material Throughput (tons)	Total Miles (Round Trip)	Average Load per Vehicle (tons)	Unloaded Vehicle Weight (tons)	Mean Vehicle Weight (tons) (W)	Surface Material Silt Content (%) (s)	VMT (miles/ year)	PM Emission Factor (lb/VMT)[1]	PM10 Emission Factor (lb/VMT)[1]	PM2.5 Emission Factor (lb/VMT)[1]	Control Efficiency (%)[2]	PM Emissions (tons/year)	PM10 Emissions (tons/year)	PM2.5 Emissions (tons/year)
16	Front End Loaders-Steel Slag	56,614	0.03	7.5	25	28.75	8.3	252	7.46	2.12	0.21	95%	0.05	0.01	0.00
22	Front End Loaders-Limestone	2,424,529	0.03	7.5	25	28.75	8.3	10,442	7.46	2.12	0.21	95%	1.95	0.55	0.06
23	Front End Loader-Base Rock	319,149	0.03	15	15	22.5	8.3	600	6.68	1.90	0.19	95%	0.10	0.03	0.00
											Total Emissions		2.09	0.60	0.06

Notes:

E = k * (s/12)^a * (W/3)^b * (365 - P)/365 for industrial unpaved roads

where E = emission factor, lb/VMT
k = particle size multiplier
s = surface material silt content, %
W = average vehicle weight, tons
P = number of days with >= 0.01 in precipitation
a, b = constants for specific particle size

Constant	PM-30	PM-10	PM-2.5
k	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

P = 105 days (Tampa average)

[1] Based on AP-42 Section 13.2.2 (11/06), Equations (1a) & (2). Silt content based on default stone quarrying haul road (Table 13.2.2-1).

[2] A control efficiency of 95% was used to account for high natural surface moisture in the quarry and/or watering at an equivalent moisture ratio of 5 (Figure 13.2.2-2). This control efficiency also reflects the slow travel speed of the loaders (<10 mph).

Assumes average round trip distance for limestone loader is 600 ft and for base rock loader is 400 ft.

TABLE A-10
Traffic Inputs for Paved and Unpaved Roads

Material	Amount of Material		Truck/Loader Weight (Empty)		Truck/Loader Capacity		Total Trips	Type of Road
Cement	1,171,650	tons/year	15	tons	22	tons	53,257	Paved
Bauxite/Wet Fly Ash	225,103	tons/year	15	tons	25	tons	9,004	Paved
Sand/Clay	246,290	tons/year	15	tons	25	tons	9,852	Paved
Steel Slag	55,614	tons/year	15	tons	25	tons	2,225	Paved
Coal	134,783	tons/year	15	tons	25	tons	5,391	Paved
Gypsum	76,650	tons/year	15	tons	25	tons	3,066	Paved
Dry Fly Ash	177,726	tons/year	15	tons	25	tons	7,109	Paved
Employee Traffic	95	employees/day	3,500	lbs	1	employee	34,675	Paved

Front End Loader 1 Steel Slag	55,614	tons/year	25	tons	7.5	tons	7,415	Unpaved (Packed Limestone)
Front End Loader 2 Gypsum/Limestone	76,650	tons/year	25	tons	7.5	tons	10,220	Paved
Front End Loader 3 Coal/Petcoke (Note 1)	20,217	tons/year	25	tons	7.5	tons	2,696	Paved

Quarry								
Front End Loaders Limestone	2,424,529	tons/year	25	tons	7.5	tons	323,270	Unpaved
Front End Loaders Base Rock (Limestone)	319,149	tons/year	15	tons	15.0	tons	21,277	Unpaved
Base Rock (Limestone)	319,149	tons/year	15	tons	25.0	tons	12,766	Paved

Note 1 : Only 15% of Coal/Pet Coke is moved by front end loader, the remainder will be handled directly from the truck.

TABLE A-11
Storage Tank

Emission Unit ID	**CH-9-2**
Description	**Diesel Tank**
Shell Length	25
Diameter, ft	8
Volume Capacity, gal	10,000
Tank Throughput, gal	520,000
Monthly Throughput, gal	43,333
Annual Turnovers	52.0
Turnover Factor	1.0
tank heated - Y or N	no
tank underground - Y or N	N - above ground
shell color / shade	white
shell condition	good
Organic, Petroleum, or Crude Liquid	petroleum
Liquid mixture	No. 6 Oil
single or multicomponent liquid	single
tank type	Horizontal
pressure setting	default

VOC Emisisons (Note 1) lb/year	**0.11**
VOC Emisisons (Note 1) ton/year	**0.0001**

The defualt for vacuum setting is -0.03 psig
The default for pressure setting is 0.03 psig

NOTE 1 - The EPA program TANKS 4.0.9d was used to calculate emissions

TABLE 5-1
Facility-Wide New Source Review Applicability

NSR REGULATED POLLUTANT	POTENTIAL-TO-EMIT ANNUAL EMISSIONS (TONS/YEAR)	ACTUAL 2-YEAR AVERAGE ANNUAL EMISSIONS[2,3] (TONS/YEAR)	NET CHANGE IN FACILITY-WIDE ANNUAL EMISSIONS DUE TO PLANT MODIFICATION (TONS/YEAR)	PRE-PROJECT 5-YEAR CONTEMPORANEOUS EMISSION CHANGES (TONS/YEAR)	POST-PROJECT NET EMISSION INCREASES INC. NETTING EMISSIONS (TONS/YEAR)	NSR DE MINIMUS EMISSIONS (TONS/YEAR)	EXCEEDS DE MINIMUS EMISSIONS AND REQUIRES NSR REVIEW? YES OR NO
PM	224	0.0	224	0	224	25	YES
PM$_{10}$	181	0.0	181	0	181	15	YES
PM$_{2.5}$	80	0.0	80	0	80	10	YES
SO$_2$	148	0.0	148	0	148	40	YES
NO$_x$	1070	0.0	1,070	0	1,070	40	YES
CO	1971	0.0	1,971	0	1,971	100	YES
VOCS	66	0.0	66	0	66	40	YES
LEAD	0.04	0.0	0.04	0	0.04	0.6	NO
GHG	>75,000	0.0	>75,000	0	>75,000	75,000	YES
BERYLLIUM[4]	0.0001	0.0	0.00013	0	0.00013	0.0004	NO
MERCURY[5]	0.0590	0.0	0.0590	0	0.0590	0.1	NO
FLUORIDES	0.49	0.0	0.49	0	0.49	3	NO
DIOXINS / FURANS	1.59E-07	0.0	1.59E-07	0	1.59E-07	3.50E-06	NO
SULFURIC ACID MIST	*	*	*	0	*	7	NO
HYDROGEN SULFIDE	*	*	*	0	*	10	NO
TOTAL REDUCED SULFUR	*	*	*	0	*	10	NO
REDUCED SULFUR COMPOUNDS	*	*	*	0	*	10	NO

NOTES:

1. * INDICATES THAT THESE POLLUTANTS ARE NOT EMITTED FROM THE PRODUCTION OF PORTLAND CEMENT.
2. POTENTIAL-TO-EMIT EMISSIONS LISTED ABOVE ARE BASED ON THE SCC PLANT PRODUCING 1,095,000 STONS OF CLINKER PER YEAR.
3. POTENTIAL-TO-EMIT EMISSIONS ARE BASED ON THE NEW KILN SYSTEM USING AN EMISSION FACTOR OF 0.27 LB/TON FOR SO2, 1.95 LB/TON FOR NOX, 0.12 LB/TON FOR VOC, AND 3.60 LB/TON FOR CO.
4. THE BERYLLIUM EMISSION FACTOR IS BASED ON DECEMBER 9-12, 2003 STACK TEST DATA FROM A SIMILAR POLYSIUS PREHEATER/PRECALCINER PLANT CONDUCTED DURING NORMAL OPERATION. THE AP-42 EMISSION FACTOR WAS NOT USED SINCE IT WAS FROM A 1993 STACK TEST FOR AN OLDER PLANT BURNING HAZARDOUS WASTE DERIVED FUEL.
5. THE MERCURY EMISSION FACTOR IS BASED ON DATA AND STACK TESTING FROM THE SIMILAR SAC PLANT IN BRANFORD, FL.

BEST AVAILABLE CONTROL TECHNOLOGY ANALYSES
IN SUPPORT OF A PSD PERMIT APPLICATION
SUMTER CEMENT COMPANY, LLC

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SECTION 1

INTRODUCTION

The Sumter Cement Company, LLC (SCC) plans to construct a new dry process preheater/precalciner (PH/PC) Portland cement kiln system and associated equipment. The SCC Plant is to be located in Center Hill, Florida. The PH/PC kiln system will result in new emissions of particulate matter (PM), PM less than 10 microns in diameter (PM_{10}), PM less than 2.5 microns in diameter ($PM_{2.5}$), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NO_x), and volatile organic compounds (VOC) that will exceed the Federal and Florida Department of Environmental Protection (FL DEP) significant emission rates. Greenhouse gas (GHG's) will also be emitted by the new PH/PC kiln system. A GHG BACT will be performed at a later date and this BACT analysis will be updated. Since the SCC Plant is located in an attainment area for all regulated criteria air pollutants, the SCC Plant will be subject to Best Available Control Technology (BACT) requirements under FL DEP PSD rules for each of the air pollutants listed above.

The PH/PC kiln system will have a design capacity of 207.0 short tons per hour of kiln feed to the PH (dry basis) and 139.0 short tons per hour of clinker production. The finish mill will have an average design capacity of 150.0 short tons per hour of Portland cement production. Maximum annual throughput will be 1,629,586 short tons per year of kiln feed to the PH (dry basis) and 1,095,000 short tons per year of clinker produced. The finish mill will produce a maximum of 1,171,650 short tons per year of Portland cement. The raw materials and additives used in the new PH/PC kiln system include limestone (or other calcium carbonate sources), fly ash, clay (or other alumina sources), sand (or other silica sources), and iron ore and mill scale (or other iron sources). The PH/PC kiln system will be designed to accommodate the introduction of fly ash through the PC burner or directly into the PC.

Traditional fuels to be used in the PH/PC kiln system include, but are not limited to, natural gas, fuel oil, coal, and petroleum coke. Other alternate fuels plan to be used and include a variety of non-hazardous secondary material in both solid and liquid form. None of these alternate fuels are considered by SCC as being classified as a solid waste. As discussed in the following sections of this report, SCC engineering studies have determined that use of any of the above fuels in any possible combination or amount is not expected affect the ability of the SCC Plant to be continually compliant with the proposed BACT emission limits.

The SCC Plant will also include a coal processing operation that will crush approximately 134,783 short tons of coal, petroleum coke, or other alternate fuel annually. Other equipment at the SCC Plant will also include raw material storage bins, clinker storage silos, cement storage silos, and associated conveyor systems.

A case-by-case determination of BACT is required by regulation and this report provides all the information necessary for the FL DEP to determine that the control technologies proposed for the affected SCC emission units represent the correct application of BACT. It is understood that the FL DEP shall give consideration to the following in making this BACT determination:

- Any past U.S. Environmental Protection Agency (EPA) BACT determinations pursuant to Section 160 of the Clean Air Act (CAA), any emission limitation contained in 40 CFR Part 60 (Standards of Performance for New Stationary Sources), and any emission limitation contained in 40 CFR Parts 61 and 63 (National Emission Standards for Hazardous Air Pollutants).

- All applicable scientific, engineering and technical material and other information available to FL DEP.

- The emission limiting standards or BACT determinations from any other state or regulatory authority.

- The social and economic impact of the application of the proposed BACT.

The PSD control technology review requires that all applicable Federal and State of Florida emission limiting standards be met and that BACT be applied to the source. The BACT requirements are applicable to all regulated pollutants subject to a PSD review. BACT is defined as an emission limitation, including a visible emission (VE) limit, based on the maximum degree of reduction of each pollutant emitted. This is determined by the FL DEP on a case-by-case basis, taking into account energy, environmental, and economic impacts, and other costs. Also this determination will determine that the proposed BACT is achievable through application of production processes and available methods, systems, and techniques (including fuel cleaning or treatment or innovative fuel combustion techniques) for the control of such pollutants.

If the FL DEP determines that technological or economic limitations on the application of measurement methodology to a particular part of a source or facility would make the imposition of an emission standard infeasible, a design, equipment, work practice, operational standard or combination thereof, may be prescribed instead to satisfy the requirement for the application of BACT. Such standard shall, to the degree possible, set forth the emissions reductions achievable by implementation of such design, equipment, work practice or operation. Each BACT determination shall include applicable test methods or shall provide for determining compliance with the standard(s) by means that achieve equivalent results.

The BACT review analyzes the control systems used in the design of a proposed facility. The BACT, at a minimum, has to comply with the applicable New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP) for the source. The BACT analysis also requires the evaluation of the available air pollution control methods including a cost-benefit analysis of the alternatives. The cost-benefit analysis includes consideration of materials, energy, and economic penalties associated with the control systems, as well as environmental benefits derived from the alternatives.

The top-down BACT approach requires a technology evaluation to start with the most stringent control alternative, and justify its rejection or acceptance as BACT. Rejection of control alternatives may be based on technical or economical unfeasibility, physical differences, location differences, and environmental or energy impact differences when comparing a proposed project with a project previously subject to that BACT.

SECTION 2

CONTROL TECHNOLOGY ANALYSIS: PARTICULATE MATTER ($PM/PM_{10}/PM_{2.5}$)

The various physical and chemical processes at a Portland cement plant generate particulate matter ($PM/PM_{10}/PM_{2.5}$) which is composed of finely dispersed solids. Control of particulate matter emissions is achieved by the collection of particles from the facility's stack emissions and by the prevention of generation of particles from fugitive emission sources. Commonly used particulate matter control devices for stack emissions are fabric filter baghouses and electrostatic precipitators (ESP). Fabric filter baghouses and ESPs are considered equivalent for particulate matter control, with both types of devices achieving control removal efficiencies of over 99.9 percent. ESP's and fabric filter baghouses are used extensively as control devices at Portland cement plant kilns. Fabric filter baghouses are primarily used to control particulate matter emissions from most material processing operations at a Portland cement plant.

Inertial separators (cyclones) can have efficiencies over 90 percent within narrow particle size ranges, but their overall efficiencies are generally less than 85 percent. Inertial separators have not been demonstrated as an effective control at Portland cement plants, but they are used extensively as process devices to recover product (meal) at Portland cement plants. The use of cyclones as process devices at Portland cement plants serves to enhance the overall control efficiency of the system by reducing large abrasive particles.

ESPs and fabric filter baghouses are considered as BACT for particulate collection controls for Portland cement plants. The proposed SCC Plant will have fabric filter baghouses for the PH/PC kiln system and for all other plant point sources which control various material processing operations. A fabric filter baghouse was selected for the PH/PC kiln system rather than an ESP to avoid ESP trips caused by process carbon monoxide (CO) spikes. In all cases, the collected fines will be returned to the process.

The clinker cooler gas will exit the Clinker Cooler through the Main Kiln Stack and be controlled by a fabric filter baghouse. Ambient air will be used to cool the Clinker Cooler gas.

Table 2-1 presents a summary of the PM, PM_{10}, and $PM_{2.5}$ BACT determinations made for Portland cement plants since 2002. The PH/PC kiln particulate matter emission limits and other SCC Plant point source particulate matter emission limits are based on use of a fabric filter baghouse with emission limits based on outlet grain loading (gr/dscf) basis. A summary of the proposed PM, PM_{10}, and $PM_{2.5}$ BACT emission limits are presented in Section 6, Table 6-1. Also, VE BACT limits for all SCC Plant particulate matter emission sources are presented in Table 6-1.

TABLE 2-1
RBLC SUMMARY FOR PARTICULATE (PM, PM_{10}, AND $PM_{2.5}$)
PORTLAND CEMENT MANUFACTURING

RBLCID	FACILITY NAME	STATE	DATE DETERMINATION ENTERED INTO	PROCESS NAME	UNITS	POLLUTANT	CONTROL METHOD	EMISSION LIMIT 1	EMISSION LIMIT 1 UNITS	EMISSION LIMIT 1 AVG. TIME	EMISSION LIMIT 2	EMISSION LIMIT 2 UNITS	EMISSION LIMIT 2 AVG. TIME	EMISSION LIMIT 3	EMISSION LIMIT 3 UNITS	EMISSION LIMIT 3 AVG. TIME
AZ-0052	ARIZONA PORTLAND CEMENT	AZ	6/23/2009	KILN	T/H	Particulate matter, filterable < 10 µ (FPM10)	BAGHOUSE	0.008	G/DSCF		0			0		
FL-0267	THOMPSON S. BAKER- CEMENT PLANT (FRI)	FL	7/29/2005	IN LINE KILN/RAW MILL WITH ESP AND SNCR		Particulate matter, filterable < 10 µ (FPM10)	ESP	0.2	LB/TON CLINKER	3 HR	25	LB/H	3 HR	0.2	LB/T	CLINKER
FL-0267	THOMPSON S. BAKER- CEMENT PLANT (FRI)	FL	7/29/2005	IN LINE KILN/RAW MILL WITH ESP AND SNCR		Particulate Matter (PM)	ESP	0.23	LB/TON CLINKER	3 HR	28.8	LB/H	3 HR	0.23	LB/T	CLINKER
FL-0268	BROOKSVILLE CEMENT PLANT (FCS)	FL	7/29/2005	125 TPH CLINKER KILN AND ASSOCIATED EQUIPMENT		Particulate Matter (PM)	BAGHOUSE	0.23	LB/TON CLINKER	3-HR	28.8	LB/H	3-HR	0.23	LB/T	CLINKER
FL-0268	BROOKSVILLE CEMENT PLANT (FCS)	FL	7/29/2005	125 TPH CLINKER KILN AND ASSOCIATED EQUIPMENT		Particulate matter, filterable < 10 µ (FPM10)	BAGHOUSE	0.2	LB/TON CLINKER	3-HR	25	LB/H	3-HR	0.2	LB/T	CLINKER
FL-0271	BRANFORD CEMENT PLANT (SUWANNE)	FL	12/23/2005	KILN W/IN LINE RAW MILL W/ SNCR AND BAGHOUSE	T/H clinker	Particulate Matter (PM)	BAGHOUSE	0.1	LB/TON OR PHF	AVERAGE OF 3, 1-HR RUNS	21.5	LB/H	AVERAGE OF 3, 1-HR RUNS	0.1	LB/T	
FL-0281	SUMTER/CENTER HILL CEMENT PLANT	FL	9/28/2006	CEMENT PYROPROCESSING SYSTEM	T/H CLINKER	Particulate matter, filterable < 10 µ (FPM10)	BAGHOUSE	0.153	LB/T CLINKER	ANNUAL TEST	31.87	LB/H	ANNUAL TEST	10	% OPACITY	6-MINUTE BLOCK
FL-0282	AMERICAN CEMENT COMPANY	FL	9/29/2006	CEMENT PYROPROCESSING SYSTEM	ton/h clinker	Particulate matter, filterable < 10 µ (FPM10)	BAGHOUSE	0.153	LB/TON CLINKER	ANNUAL TEST	19.13	LB/H	ANNUAL TEST	10	OPACITY	COMS
FL-0297	NORTH BROOKSVILLE CEMENT PLANT	FL	11/15/2007	KILN NO. 3 WITH PREHEATER, CALCINER, IN-LINE RAW MILL AND AIR HEATER	MMBTU/H	Particulate matter, filterable < 10 µ (FPM10)	FABRIC FILTER	0.1	LB/T CLINKER	THREE 1-H RUN	0			0		
GA-0134	HOUSTON AMERICAN CEMENT PLANT	GA	4/29/2010	MAIN KILN STACK ST35	T/H OF DRY FEED	Particulate matter, filterable (FPM)	FABRIC FILTERS/BAGHOUSE	0.153	LB/T CLINKER	AVG OF 3 1-HR RUNS	0.129	LB/T CLINKER	METHOD 201 S 201A AND 202 CONDITION 3.3.	0.153	LB/T CLINKER	AVG OF 3 1-HR RUNS/METHOD S/CONDITION 3.
GA-0134	HOUSTON AMERICAN CEMENT PLANT	GA	4/29/2010	MAIN KILN STACK ST35	T/H OF DRY FEED	Particulate matter, filterable (FPM)	FABRIC FILTERS/BAGHOUSE	0.01	GR/DSCF	AVG OF THREE 1-HR RUNS/METH 5/COND 3.3.1	0.0085	GR/DSCF	METH 201 OR 201A & 202/COND 3.3.1	0		
GA-0136	CEMEX SOUTHEAST, LLC	GA	5/6/2010	MAIN KILN STACK K218	T/H OF DRY FEED	Particulate matter, filterable (FPM)	FABRIC FILTERS/BAGHOUSE	0.153	LB/T PM CLINKER	AVG. OF THREE 1-HR RUNS/METH. S	0.129	LB/T PM10 CLINKER	METH. 201 OR 201A AND 202	0.153	LB/T PM CLIMKER	AVVG OF THREE 1-HR RUNS/METH 5
IA-0052	LAFARGE CORPORATION	IA	2/5/2001	CEMENT MANUFACTURING, PREHEATER/PRECALCINER KILN	T/D	Particulate matter, filterable < 10 µ (FPM10)	BAGHOUSE (LIMIT INCLUDES CONDENSIBLES)	0.516	LB/TON OF CLINKER		0			0.516	LB/T	
IA-0070	LEHIGH CEMENT COMPANY - MASON CITY PLANT	IA	12/11/2003	KILN/CALCINER/PREHEATER	T/H	Particulate matter, filterable < 10 µ (FPM10)	ESP.	0.516	LB/T	LB/TON OF CLINKER	0			0.516	LB/T	
IA-0070	LEHIGH CEMENT COMPANY - MASON CITY PLANT	IA	12/11/2003	KILN/CALCINER/PREHEATER	T/H	Particulate Matter (PM)	ESP.	0.516	LB/T	LB/T OF CLINKER	0			0.516	LB/T	

TABLE 2-1 (CONTINUED)
RBLC SUMMARY FOR PARTICULATE (PM, PM_{10}, AND $PM_{2.5}$)
PORTLAND CEMENT MANUFACTURING

RBLCID	FACILITY NAME	STATE	DATE DETERMINATION ENTERED INTO	PROCESS NAME	UNITS	POLLUTANT	CONTROL METHOD	EMISSION LIMIT 1	EMISSION LIMIT 1 UNITS	EMISSION LIMIT 1 AVG. TIME	EMISSION LIMIT 2	EMISSION LIMIT 2 UNITS	EMISSION LIMIT 2 AVG. TIME	EMISSION LIMIT 3	EMISSION LIMIT 3 UNITS	EMISSION LIMIT 3 AVG. TIME
MO-0059	CONTINENTAL CEMENT COMPANY, LLC	MO	9/27/2002	ROTARY KILN	T/H	Particulate matter, filterable < 10 µ (FPM10)	FABRIC FILTER	99	% REDUCTION		0			0		
MO-0072	CONTINENTAL CEMENT COMPANY, L.L.C.	MO	5/9/2007	PORTLAND CEMENT KILN		Particulate matter, filterable < 10 µ (FPM10)	BAGHOUSES HAVE BEEN SELECTED AS BACT FOR EACH POINT SOURCE OF PM10 EMISSIONS THAT IS NEW OR MODIFIED	0.516	LB/T	CLINK 3-HOUR AVERAGING TIME	0			0		
SD-0003	GCC DACOTAH	SD	12/23/2002	ROTARY KILN #6	T/D	Particulate matter, filterable < 10 µ (FPM10)	FABRIC FILTER	0.01	GR/DSCF		11.95	LB/H		0.13	LB/T	calculated
TX-0355	PORTLAND CEMENT MANUFACTURING PLANT	TX	9/2/2003	GRINDING/ PREHEATING/ KILN, K-19		Particulate matter, filterable (FPM)	ESP	32.24	LB/H		135.41	T/YR		0		NOT AVAILABLE
TX-0355	PORTLAND CEMENT MANUFACTURING PLANT	TX	9/2/2003	GRINDING/ PREHEATING/ KILN, K-19		Particulate Matter (PM)	ESP	36.33	LB/H		152.59	T/YR		0		NOT AVAILABLE
TX-0355	PORTLAND CEMENT MANUFACTURING PLANT	TX	9/2/2003	GRINDING/ PREHEATING/ KILN, K-19		Particulate matter, filterable < 10 µ (FPM10)	ESP	40	LB/H		168	T/YR		0		NOT AVAILABLE
TX-0466	TEXAS LEHIGH CEMENT	TX	12/29/2005	KILN EXHAUST (4)		Particulate Matter (PM)	BAGHOUSES	95	LB/H		360	T/YR		0		
VA-0272	ROANOKE CEMENT	VA	9/29/2003	LIME KILN	T/YR	Particulate matter, filterable < 10 µ (FPM10)	ELECTROSTATIC PRECIPITATORS AND GOOD COMBUSTION PRACTICES.	71.31	LB/H		252.8	T/YR		0.39	LB/T	calculated
WA-0307	PORTLAND CEMENT CLINKERING PLANT	WA	7/28/2003	KILN EXHAUST STACK		Particulate matter, filterable < 2.5 µ (FPM2.5)	BAGHOUSE STACK	0.005	GR/DSCF	24 H PERIOD	0			0		NOT AVAILABLE
WA-0307	PORTLAND CEMENT CLINKERING PLANT	WA	7/28/2003	KILN EXHAUST STACK		Particulate Matter (PM)	BAGHOUSE	10.6	LB/H		46	7/YR		0		NOT AVAILABLE, SEE NOTES

SECTION 3

BACT ANALYSIS FOR SO_2

3.1 Description of Pyroprocessing System

SCC proposes to construct a modern PH/PC kiln system which will employ a four- stage preheater, staged combustion calciner with or without a separate combustion chamber (depending on vendor selection), in-line raw grinding mill, and fabric filter baghouse for particulate matter control. The nominal fuel split between the calciner and main kiln burner is 55/45, respectively. The general sulfur circulation for this type of system is shown in Figure 1, except that SCC will not employ a bypass.

The rotary kiln section is a long, cylindrical, slightly inclined furnace lined with refractory to protect the steel shell and retain heat within the kiln. The raw material mix enters the kiln at the elevated end, and the combustion fuels generally are introduced into the lower end of the kiln in a countercurrent manner. The materials are continuously and slowly moved to the lower end by the rotation of the kiln. As the raw materials move down the kiln, they are changed to cementations or hydraulic minerals as a result of the increasing temperature and chemical reactions within the kiln.

The preheater section consists of cyclone-type vessels arranged vertically, in series, and are supported by a structure known as the preheater tower. The first or highest stage of the preheater typically consists of dual parallel cyclones. Hot exhaust gases from the calciner and rotary kiln pass counter currently through the downward-moving raw materials in the preheater vessels.

Compared to the simple rotary kiln, the heat transfer rate is significantly increased, the degree of heat utilization is greater, and the process time is markedly reduced by the intimate contact of the solid raw material particles with the hot kiln system exhaust gases. The improved heat transfer allows the length of the rotary kiln to be reduced. The last or lowest vessel in the series is the precalciner, where a significant amount of thermal energy is introduced, as noted above.

The in-line PH/PC kiln system offers ideal conditions for adsorption of SO_2 from the kiln (from both the fuel and sulfur compounds in the mix) due to the high amount of free CaO and a temperature of approximately 1,650°F in the calciner. The majority of the absorbed SO_2 is mostly converted to calcium sulfate through the following reactions:

$$CaO + SO_2 \rightarrow CaSO_3$$

$$CaSO_3 + \tfrac{1}{2} O_2 \rightarrow CaSO_4.^{1}$$

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[1] An Overview of the Formation of SO_x and NO_x in Various Pyroprocessing Systems, Peter Nielson and Ove Lar Jepssen, F. L. Smidth Co.

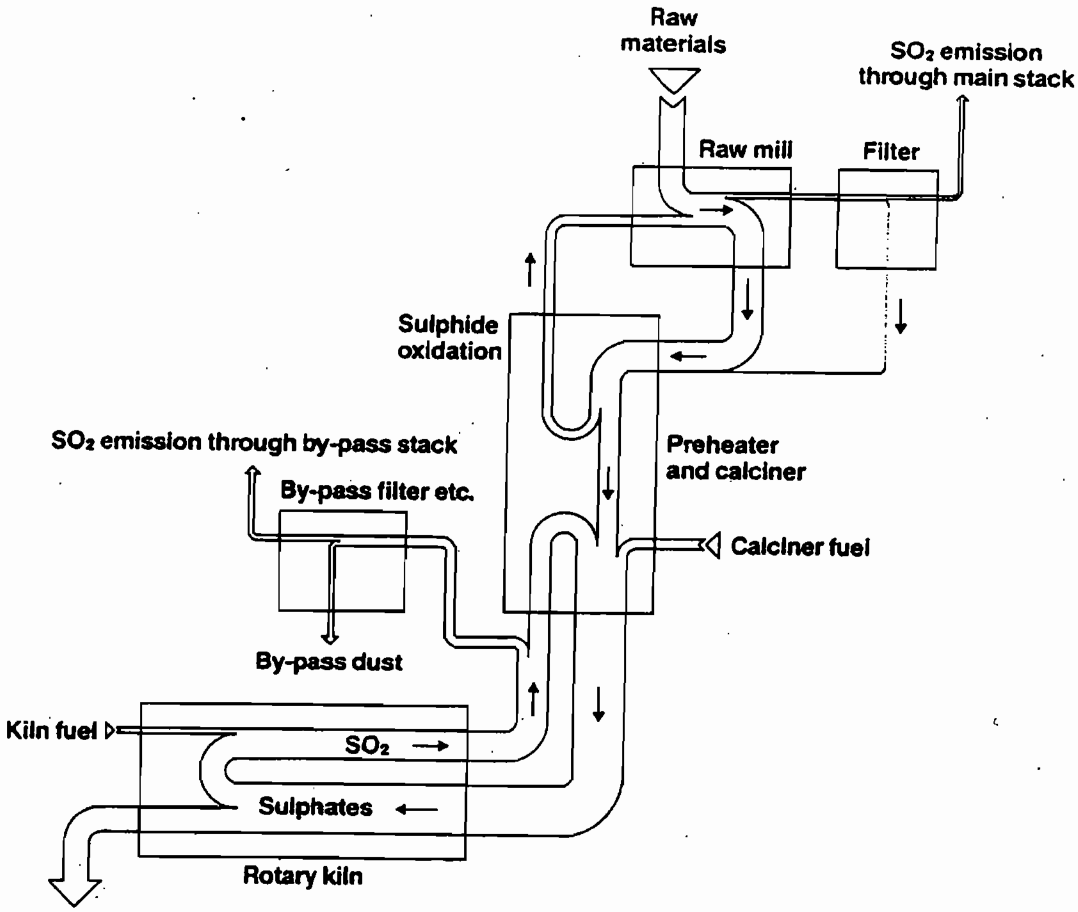

Figure 1. Sulfur Circulation in Preheater/Precalciner Kiln System

Also, SO_2 exiting the PH/PC kiln system is additionally absorbed into the raw meal in the in-line raw mill. Sodium sulfate and potassium sulfate are also produced as a result of fuel burning (to a lesser extent). The sulfate compounds are incorporated into the clinker product produced by the kiln and in the dust collected by the main kiln stack fabric filter baghouse (all of which will be recycled back into the process). Because of the above inherent process controls, and the fact that sulfur input to the kiln system from fuel is less than the sulfur introduced in the feed material, SO_2 emissions from the main kiln stack are quite insensitive to use of higher sulfur fuels such as petroleum coke. Use of higher sulfur fuels will not cause a "break through" in the PH/PC kiln system and do not affect the BACT determination or the ability of the SCC Plant to comply with the requested BACT SO_2 emission limit.

The generic sulfur circulation includes a bypass for sulfur removal as alkali sulfate salts. The SCC Plant PH/PC kiln system will be low in alkali and meal sulfur and a bypass is not included as part of the engineering design of the SCC Plant. This inherently low SO_2 emitting process, in addition to the low sulfur content of the raw materials used by SCC Plant, results in an expectation that the SCC Plant PH/PC kiln system can be expected to achieve an SO_2 emission rate of 0.27 lb/ton of clinker without the use of an SO_2 "add-on" control technology. The three available add-on SO_2 control technologies which would be potentially applicable to the SCC Plant are described below.

3.2 Wet Scrubbing

3.2.1 Description of Technology

Wet scrubbing can be an effective add-on control technology for SO_2 removal using an aqueous alkaline solution. SO_2 is removed from the exhaust gases by scrubbing because it can be readily neutralized by alkaline solution and is highly soluble in aqueous solutions. A wet scrubber has been shown to provide SO_2 control in excess of 90 percent under optimal operating conditions. Cyclonic spray towers generally achieve control efficiencies at the higher end of the range. Wet scrubbing can also remove particulate matter, some volatile organic compounds (VOCs), and acid gases. As applied to Portland cement plants, the scrubber is located after the primary PM control device (i.e., fabric filter baghouse of ESP) and minimal additional particulate is removed. The solids in mist carryover from the scrubber can in some cases be greater than the inlet particulate loading from the fabric filter baghouse. In theory, wet scrubbing produces a calcium sulfate ($CaSO_4$) byproduct, typically referred to as synthetic gypsum. However, in practice, not all Portland cement plants that have utilized wet scrubbing have been successful in obtaining useable synthetic gypsum. If the Portland cement plant can reclaim the scrubber sludge as synthetic gypsum and reincorporate it into the finish grinding process as synthetic gypsum, the overall environmental benefits associated with a wet scrubber can be considerable.

3.2.2 Theory of Abatement

Application of a wet scrubber requires passing the exhaust gases through a particulate control device to reduce the dust load and recover meal. Next, the exhaust gas is cooled by spraying quench water or a slurry reagent (such as slaked lime or finely ground limestone) in an absorption chamber. SO_2 is scrubbed from the exhaust gas by the reaction with the slurry lime [$Ca(OH)_2$] or limestone (calcium carbonate). The $Ca(OH)_2$ or calcium carbonate reacts with the SO_2 to form synthetic gypsum ($CaSO_4 - 2H_2O$). In theory, the synthetic gypsum precipitates into small crystals that are dewatered. The dewatered synthetic gypsum can then be used to supplement purchased gypsum in the production of Portland cement and represents a potential beneficial reuse of byproduct materials. However, if the gypsum cannot be effectively crystallized, as has been experienced by some Portland cement plants utilizing wet scrubbing systems, the scrubber sludge must be disposed of at considerable cost.

3.2.3 Applicability of Wet Scrubbing

At the present time there have been five known cement plants permitted to employ wet scrubbing technology for abatement of SO_2 in North America. Five are currently in operation. The following describes the operations of three of these operational plants.

ESSROC, Nazareth, Pennsylvania – A wet scrubber was installed on a preheater kiln to reduce SO_2 by 20 to 25 percent to comply with a PADEP SO_2 emission limit. The scrubber was an early design with two units in parallel, and only had an availability of 65 percent of kiln operating hours. Chronic fouling of demisters, piping, and nozzles occurred and the scrubbers were discontinued with conversion of the kiln to a precalciner design during an expansion project.

Holcim, Midlothian, Texas – Scrubbers were installed on two kiln lines in an effort to increase production and avoid PSD permitting. The units are a more advanced design and have removal efficiencies of between 70 to 90 percent. Availability of the units is 90 percent or less of the kiln run time.

TXI, Midlothian, Texas – A scrubber was installed as part of an upgrade of the plant from a wet kiln operation (4 units) to a new preheater/precalciner line. No data are available on the performance but it is expected that it is similar to the Holcim experience. This scrubber is located between the kiln fabric filter and a regenerative thermal oxidizer (RTO) used for carbon monoxide (CO)/VOC control.

Environmental Impacts
The use of wet scrubbers can have an adverse environmental impact by generating solid waste requiring landfill disposal (if a usable synthetic gypsum cannot be produced), and require treatment and disposal of liquid blowdown containing dissolved solids (alkali salts).

In addition, saturation of the gas stream results in evaporation of large quantities of fresh water which has an impact on the supply in the area.

Energy Impacts
The static pressure drop through the wet scrubber and demister increases the electrical energy demand for the project and has an adverse impact on energy usage at the site. In addition, the need to reheat stack gases for dispersion and corrosion prevention has a significant energy impact.

Product Impacts
The wet scrubber does not have an adverse process impact if the waste is landfilled, but it can have an impact if synthetic gypsum is returned to the process. Changes in process quality cannot be predicted until after scrubber startup in that the quality of synthetic gypsum is site specific.

3.3 Wet Absorbent Addition

3.3.1 Description of Technology

Wet absorbent addition to the process gas stream can reduce high levels of SO_2 emissions in dry cement kiln systems. Lime or hydrated lime can be used for this purpose. Various types of wet absorbent systems have been used on dry kilns, with lime slurry addition being the most effective.

Wet absorbent addition is limited to kiln systems where the lime slurry droplet can evaporate to dryness before entering the particulate control device. This eliminates use on wet kilns where flue gas temperatures are too low for rapid evaporation and flue gas moisture is near moisture saturation levels.

3.3.2 Theory of Abatement

It should be noted that the limestone in the kiln feed and calcium oxide in kiln dust act as natural absorbents of some of the SO_2 emissions produced from fuel combustion and pyritic sulfur in the feed. Further, good burner design and proper operation of the kiln will chemically absorb sulfur into the clinker. Additional SO_2 reduction can be achieved by absorbent addition into the process gas stream.

With wet absorbent addition, calcium oxide (CaO) or calcium hydroxide [$Ca(OH)_2$] slurry is injected into the process gas stream. Solid particles of calcium sulfite ($CaSO_3$) or calcium sulfate ($CaSO_4$) are produced, which are removed from the gas stream along with excess reagent by a particulate matter control device. The SO_2 removal efficiency varies widely depending on the point of introduction into the process according to the temperature, degree of mixing, properties of the absorbent (i.e., size, surface area, etc.), and retention time.

3.3.3 Applicability of Wet Absorption Addition

In a dry process cement kiln system, the gases contain a low concentration of water vapor at an elevated temperature and must be cooled and humidified prior to entering the baghouse or ESP. Lime or calcium hydrate slurry can be introduced with the spray cooling water. Flue gas temperatures are reduced through the heat absorbed as sensible heat from evaporation of water. These temperatures are defined by the system design, kiln heat balance, amount of air in-leakage, and radiant and convective heat losses. The conditions present are optimal for proper operation of the kiln.

For slurry injection to succeed as an SO_2 absorption control method several conditions must occur. These include:

1. Generation of spray droplets of sufficient surface area to adsorb SO_2 (typically 150 to 250 μm).

2. Droplets exist for sufficient duration to allow absorption and reaction (typically 3 to 5 s).

3. Sufficient reagent present in the droplet to maintain excess absorbent during droplet life.

4. Activity of hydrate particle in the droplet sufficient to replenish dissolved solids in the liquid as SO_2 consumes reagent (i.e., particle size, reactivity, etc.)

5. When used in conjunction with a dry particulate collection device, the droplet must evaporate to dryness prior to entering the device.

An analysis of the heat balance for the dry process kiln determines if there is sufficient sensible heat available in the gas streams to allow evaporation of injected water containing hydrate slurry. Hydrate solids may be introduced in the conditioning water as suspended/dissolved solids. The normal solids content in the water can be as high as 5 percent solids by weight using air atomizing spray nozzles. The generation of small droplets and fine hydrate particle size allows effective absorption of SO_2 and reaction to form sulfates. SO_2 removal effectiveness can vary between 50 and 90 percent depending on residence time and hydrate surface area.

The lower SO_2 removal estimates have been documented in applications where the conditioning towers, duct arrangement, and particulate control devices are not adequate for injection of lime slurry. The constraints of the system result in wet bottoms in the conditioning towers and build up on ducts and baghouse walls. These conditions limit the hydrate slurry injection rates and the removal efficiency.

The higher SO_2 removal estimates have been documented at Greenfield installations in which optimum designs have been implemented. In these designs, larger conditioning towers and longer straight runs of ductwork are used along with control device gas distribution systems.

Environmental Impacts

No adverse environmental impacts are expected from the use of wet absorption at this location.

Energy Impacts

The change in energy required to implement wet slurry injection is minimal and does not result in adverse energy impacts.

Process Impacts

The injection of wet slurry is not expected to have a significant process impact, in that it would only be used during mill-down periods and the addition of $Ca(OH)_2$ will not affect the Ca/S molar ratio significantly.

3.4 Dry Absorbent Addition

3.4.1 Description of Technology

Dry absorbent addition to the process gas stream or in an add-on control device (dry scrubber) can reduce high levels of SO_2 emissions. Lime, calcium hydrate, limestone, or soda ash could be used for this purpose. Various types of dry absorbent systems have been used on wet and dry cement kilns and one end-of-pipe dry scrubber has been installed on a kiln in Switzerland. SCC plans to utilize a dry absorbent injection system utilizing hydrated lime injection for SO_2 control during raw mill down or upset conditions.

3.4.2 Theory of Abatement

It should be noted that the calcium oxide in kiln dust and limestone in the kiln feed acts as a natural absorbent of some of the SO_2 emissions produced from fuel combustion and pyritic decomposition. Further, good burner design and proper operations of the kiln will chemically bond sulfur into the clinker. Additional SO_2 reduction can be achieved by dry absorbent addition into the process gas stream.

With absorbent addition, dry CaO or $Ca(OH)_2$ is injected into the process gas stream. Solid particles of $CaSO_3$ or $CaSO_4$ are produced, which are removed from the gas stream along with excess reagent by a particulate matter control device in the process flow. The SO_2 removal efficiency varies widely depending on the point of introduction into the process according to the temperature, degree of mixing, and retention time.

The single known application of an add-on dry scrubber uses a venturi reactor column to produce a fluidized bed of dry slaked lime and raw meal. As a result of contact between the exhaust gas and the absorbent, as well as the long residence time and low temperature characteristic of the system, SO_2 is efficiently absorbed by this system. An additional application injects $Ca(OH)_2$ in the gas stream after the preheater first stage cyclone.

3.4.3 Applicability of Dry Absorbent Addition

The addition of dry absorbent to flue gas streams has been used at Roanoke Cement in Troutville, Virginia and has been proposed at several other Portland cement plants. Effectiveness and cost are specific to each application and depend on the gas stream conditions and residence time available for reaction.

Typically the molar ratio (Ca/S) for absorption is on the order of 3.0 to 15.0 and requires approximately 2 seconds for completion. Initial surface reactions occur in the first 0.1 s and the coating retards reaction with the bulk of the particle. For increased effectiveness a very fine particle is required or a high Ca/S ratio. Typical removal efficiency is between 20 and 50 percent depending on gas stream conditions.

For the process to be implemented, hydrate would be received by truck, pneumatically conveyed to a storage silo, and then injected through nozzles into the gas stream. Complete and uniform distribution and mixing in the gas stream are necessary. The best location for injection will be determined by SCC to allow for adequate residence time for reaction.

Environmental Impacts
No adverse environmental impacts are expected from the use of dry absorption at this location.

Energy Impacts
The change in energy required to implement dry adsorption is minimal and does not result in adverse energy impacts.

Process Impacts
The injection of dry absorbent is not expected to have a significant process impact because in general it would only be used during mill-down periods and the addition of $Ca(OH)_2$ will not affect the Ca/S molar ratio significantly.

3.5 Review of Recent Permit Limits

Table 3-1 summarizes the SO_2 BACT determinations made for Portland cement kilns since 2002.

3.6 Summary of Impact Analysis

Table 3-2 presents a summary of the cost analysis for each of the above control options. The detailed calculations are presented in Appendix A.

TABLE 3-2. SUMMARY OF IMPACT ANALYSIS FOR SO_2

Method	% removal	SO_2 Removed, tons/yr	Capital Costs, MM $	Annualized Cost, 1000 $	Cost Effectiveness $/ton SO_2	Impacts		
						Environmental	Product	Energy
Wet Scrubbing*	70.0	110.1	27.46	9,278.1	84,248	Yes	No	Yes
Wet Absorbent**	40.0	5.9	3.17	734.6	124,235	No	No	No
Dry Scrubber	32.8	46.0	2.17	680.4	13,372	No	No	No

*Expected control efficiency for wet scrubbing is 70 percent with raw mill on (7,446 hours/year) and 80 percent with the raw mill off (1,314 hours/year).

**Wet absorbent would only be added when the raw mill is off (1,314 hours/year) due to water spray limitations.

3.7 Selection of BACT

Wet scrubbing and wet absorbent addition are rejected on a cost effectiveness basis. SCC proposes as BACT for SO_2 the inherently low-emitting process of using dry absorbent coupled with the use of low-sulfur raw materials. The requested BACT emission limit is 0.27 lb/ton of clinker, 30-day rolling average, as measured by a continuous emission monitor (CEM). This averaging time is appropriate to account for the sulfur variability in the raw materials and the short-term increase in SO_2 emissions when the raw mill is down and during some upset conditions in the kiln. Because the basis for the emission limit is BACT and it is not associated with the attainment of the National Ambient Air Quality Standards (NAAQS) for SO_2, a short term emission limit (e.g., 1-hour or 24 hour) is determined to be not necessary.

TABLE 3-1
RBLC SUMMARY FOR SULFUR DIOXIDE (SO_2)
PORTLAND CEMENT MANUFACTURING

RBLCID	FACILITY NAME	STATE	DATE DETERMINATION ENTERED INTO RBLC	PROCESS NAME	UNITS	CONTROL METHOD	EMISSION LIMIT 1	EMISSION LIMIT 1 UNITS	EMISSION LIMIT 1 AVG. TIME	EMISSION LIMIT 2	EMISSION LIMIT 2 UNITS	EMISSION LIMIT 2 AVG. TIME	EMISSION LIMIT 3	EMISSION LIMIT 3 UNITS	EMISSION LIMIT 3 AVG. TIME
AL-0200	CEMEX, INC.	AL	11/12/2003	KILN, CEMENT	T/H	NONE INDICATED.	160	LB/H		0.821	LB/T	LB/TON KILN FEED	0		
AZ-0052	ARIZONA PORTLAND CEMENT	AZ	6/23/2009	KILN	T/H	NONE INDICATED.	0.16	LB/T CLINKER	30 DAY AVERAGE	0			0		
FL-0267	THOMPSON S. BAKER- CEMENT PLANT (FRI)	FL	7/29/2005	IN LINE KILN/RAW MILL WITH ESP AND SNCR		PROCESS CONTROL AND RAW MATERIALS IN FLORIDA	0.28	LB/TON CLINKER	24 HR	35	LB/H	24 HR	0		
FL-0268	BROOKSVILLE CEMENT PLANT (FCS)	FL	7/28/2005	125 TPH CLINKER KILN AND ASSOCIATED EQUIPMENT		PROCESS CONTROL AND RAW MATERIALS	0.23	LB/TON CLINKER	24-HR	28.8	LB/H	24-HR	0		
FL-0271	BRANFORD CEMENT PLANT (SUWANNE)	FL	12/23/2005	KILN W/IN LINE RAW MILL W/ SNCR AND BAGHOUSE	T/H clinker	RAW MATERIALS AND PROCESS CONTROL	0.2	LB/TON CLINKER	CEMS 24-HR ROLLING AVERAGE	25.4	LB/H	CEMS 24-HR ROLLING AVERAGE	0		
FL-0281	SUMTER/CENTER HILL CEMENT PLANT	FL	9/28/2006	CEMENT PYROPROCESSING SYSTEM	T/H CLINKER	HYDRATED LIME INJECTION	0.2	LB/T CLINKER	24-H ROLLING	41.66	LB/H	24-H ROLLING	0		
FL-0282	AMERICAN CEMENT COMPANY	FL	9/29/2006	CEMENT PYROPROCESSING SYSTEM	ton/h clinker	NONE INDICATED.	0.2	LB/T CLINKER	24-HR ROLLING	15	LB/H	24-HR ROLLING	0		
FL-0287	NORTH BROOKSVILLE CEMENT PLANT	FL	11/15/2007	KILN NO. 3 WITH PREHEATER, CALCINER, IN-LINE RAW MILL AND AIR HEATER	MMBTU/H	NONE INDICATED.	0.2	LB/T	24-HR ROLLING CEMS	0			0		
GA-0134	HOUSTON AMERICAN CEMENT PLANT	GA	4/28/2010	MAIN KILN STACK ST35	T/H OF DRY FEED	JUDICIOUS SELECTION/USE OF RAW MATERIALS AND , AS NECESSARY, USE OF HYDRATED LIME INJECTION.	1	LB/T CLINKER	30 DAY ROLLING BASED ON SO2 CEMS	1.25	LB/H		1	LB/T CLINKER	30 DAY ROLLING AVG BASED ON SO2 CEMS
GA-0136	CEMEX SOUTHEAST, LLC	GA	5/6/2010	MAIN KILN STACK K218	T/H OF DRY FEED	JUDICIOUS SELECTION/USE OF RAW MATERIALS AND , AS NECESSARY, USE OF HYDRATED LIME INJECTION.	1	LB/T CLINKER	30-DAY ROLLING AVG.	160	LB/H		1	LB/T CLINKER	30-DAY ROLLING AVG.
IA-0052	LAFARGE CORPORATION	IA	2/5/2001	CEMENT MANUFACTURING, PREHEATER/PRECALCINER KILN	T/D	DRY SCRUBBER EQUIVALENT-NOT AN ADD ON CONTROL. LIME IS GENERATED FROM LIMESTONE IN FEED AND COMES INTO CONTACT WITH SO2 AND SOME SO2 CAPTURED IN WASTE KILN DUST. ALTERNATE EMISSION LIMIT IS NAAQS, ALSO 68,500 LB/D.	4850	TONS/YR		0			0		
IA-0070	LEHIGH CEMENT COMPANY - MASON CITY PLANT	IA	12/11/2003	KILN/CALCINER/PREHEATER	T/H	WET SCRUBBER.	1.01	LB/T	LB/T OF CLINKER	530.3	T/YR		0		
MO-0059	CONTINENTAL CEMENT COMPANY, LLC	MO	9/27/2002	ROTARY KILN	T/H	WET SCRUBBER	12	LB/T	lb/t clinker, 3-hr rolling avg	10	LB/T	lb/t clinker, 24-hr rolling avg	0		
MO-0072	CONTINENTAL CEMENT COMPANY, L.L.C.	MO	5/9/2007	PORTLAND CEMENT KILN		INHERENT RAW MILL SCRUBBING IS CONSIDERED TO BE BACT	1.93	LB/T	CLINK 30-DAY ROLLING AVERAGE	285.38	LB/T	30-DAY ROLLING AVERAGE	0		
SD-0003	GCC DACOTAH	SD	12/23/2002	MATERIAL TRANSFER, ALKALI	T/D	INHERENT SCRUBBING EFFECT OF PROCESSING LIMESTONE	632	LB/H		885	T/YR		0		
SD-0003	GCC DACOTAH	SD	12/23/2002	ROTARY KILN #6	T/D	INHERENT SCRUBBING EFFECT OF PROCESSING LIMESTONE	632	LB/H		885	T/YR		0		
SD-0003	GCC DACOTAH	SD	12/23/2002	COAL MILL	T/H	INHERENT SCRUBBING EFFECT OF PROCESSING LIMESTONE	632	LB/H		885	T/YR		0		
TX-0355	PORTLAND CEMENT MANUFACTURING PLANT	TX	9/2/2003	GRINDING/ PREHEATING/ KILN, K-19		NONE INDICATED	20	LB/H		84	T/YR		0		
TX-0466	TEXAS LEHIGH CEMENT	TX	12/29/2005	KILN EXHAUST (4)		BAGHOUSES	416	LB/H		1822	T/YR		0		
VA-0272	ROANOKE CEMENT	VA	9/29/2003	LIME KILN	T/YR	LOW SULFUR FUEL, GOOD COMBUSTION PRACTICES, AND CONTINUOUS EMISSION MONITORING SYSTEM.	950	LB/H		3104.4	T/YR		0		
WA-0307	PORTLAND CEMENT CLINKERING PLANT	WA	7/28/2003	KILN EXHAUST STACK		DURING KILN PRE-HEATING PERIOD, SHUTDOWN, AND DURING MAINTENANCE OF THE BAGHOUSE. ONLY NAT GAS WILL BE BURNED. AND SULFUR RINGS SHALL BE REMOVED IF THE RING WAS THE CAUSE OF THE SHUTDOWN.	180	PPM @ 10% O2	1-H AV	0			0		

SECTION 4

BACT ANALYSIS FOR NO_x

4.1 NO_x Formation and Control Mechanisms

This section discusses the mechanisms of NO_x formation and control for the SCC PH/PC cement kiln.

4.1.1 NO_x Formation Theory

NO_x is formed as a result of reactions occurring during combustion of fuels in the main kiln and precalciner vessel of a traditional PH/PC cement kiln. NO_x is produced through three mechanisms during combustion 1) fuel NO_x, 2) thermal NO_x, and 3) "prompt" NO_x.

Fuel NO_x is the NO_x that is formed by the oxidation of nitrogen and nitrogen complexes in fuel. In general, approximately 60 percent of fuel nitrogen is converted to NO_x. The resulting emissions are primarily affected by the nitrogen content of fuel and excess O_2 in the flame. Nitrogen in the kiln feed may also contribute to NO_x formation although to a much smaller extent.

Thermal NO_x is the most significant NO_x mechanism in kiln combustion. The rate of conversion is controlled by both excess O_2 in the flame and the temperature of the flame. In general, NO_x levels increase with the higher flame temperatures that are typical in the kiln burning zone.

"Prompt NO_x" is a term applied to the formation of NO_x in the flame surface during luminous oxidation. The formation is instantaneous and does not depend on flame temperature or excess air. This formation may be considered the baseline NO_x level that is present during combustion and is relatively small compared to the other two mechanisms.

Thermal NO_x formation can be expressed by two important reactions of the extended Zeldovich mechanism:

$$O + N_2 \rightarrow NO + N(slow)$$

$$N + O_2 \rightarrow NO + O(fast)$$

At high temperature and excess O_2, a higher concentration of O radicals (or H radicals) is present and therefore NO_x forms more rapidly. At lower temperatures, an equilibrium reaction of NO with O_2 further results in NO_2 formation. Fuel NO_x is formed by the reaction of nitrogen in the fuel with available oxygen.

In a PH/PC kiln, fuel combustion occurs at two locations and each follows a separate mechanism in the formation of NO_x (i.e., thermal NO_x dominates in the kiln burning zone and fuel NO_x dominates in the precalciner). For this reason, the effects of process operation on final NO_x

levels are complex and do not necessarily conform to conventional understanding of combustion as defined through steam generation technology. Experience with various cement kilns also has shown that actual NO_x emissions are highly site specific.

4.1.2 Fuel Effects

Fuel type has an effect on NO_x emissions. For example, data from combustion simulations and field trials indicate combustion of coal produces significantly lower NO_x than natural gas combustion in a main kiln burner. In general, substituting fuels with higher Btu content will reduce NO_x emissions in part because fuel efficiency is increased and less total fuel is consumed.

4.1.3 Main Kiln Firing

In the rotary kiln section, the purpose of combustion is to increase material temperature to a level that will allow calcined meal to become viscous (liquid) and form calcium silicates. The temperature required for "burning" depends on cement type and meal properties and is in excess of 2,550°F. Some meal types require a higher flame temperature than others to achieve the material temperature required to initiate fusion.

Cement kilns are distinct from conventional combustion sources such as steam generation in that the combustion chamber is a confined space that is refractory lined. This radiates energy back into the flame, thereby increasing the flame temperature. At given excess air levels, a confined flame will usually produce higher NO_x emissions than an open flame such as a boiler fire box.

NO_x levels from kiln firing are also strongly related to fuel type, flame shape, and peak flame temperature. At higher peak flame temperatures, more thermal NO_x is formed. Flame shape is also related to the percentage of primary air used in combustion in the kiln. High levels of primary air increase NO_x formation by providing excess O_2 in the hottest portion of the flame. Experience has indicated that a long flame and low primary air volume can minimize NO_x formation in the main kiln. However, in order to obtain high quality clinker with the best microstructure, a relatively short, strong, and steady flame is necessary. In addition, too long of a flame may also cause kiln rings and lead to incomplete fuel combustion.

4.1.4 Precalciner Firing

A secondary firing zone is the precalciner vessel. Fuel is introduced and burned in situ with the preheated raw meal. The calciner will be designed to accommodate the introduction of fly ash and non-hazardous solid waste through the calciner burner. The burner will contain a specific chamber or nozzle within the burner for the simultaneous introduction of coal, petroleum coke, fly ash, and non-hazardous solid wastes. Under these conditions, heat released by fuel oxidation is extracted by meal decarbonization. The efficient use and transfer of energy reduces the peak temperature in the vessel. Normal temperatures are between 1,650° and 1,800°F. This lower temperature and operation at reduced excess air levels reduces the formation of NO_x. Thermal NO_x is minimized and fuel NO_x predominates.

The introduction of fly ash and/or solid non-hazardous waste theoretically should have little effect on the Low NO_x design of the calciner. Fly ash and solid non-hazardous waste such as filter fluff typically have high volatile content and suitable reactivity for combustion. The reactivity of the material can depend heavily on the size and the introduction method into the calciner. The SCC calciner will employ a burner designed to accommodate the introduction of these fuels as described above. Additionally, the calciner will be designed with adequate retention time to insure the complete combustion of these materials should the reactivity of the material require this additional retention time for combustion. Petroleum coke typically has a lower reactivity and typically requires the longest retention time in the calciner.

As a non-virgin non-hazardous solid fuel, tires may also be used in either a whole or shredded form that can be injected via an air lock/gate system into the material inlet of the kiln. This location is a common location in kiln systems and the tires provide additional heat to the calcination process, as well as, providing a localized reduction zone around the tire fuel which assists in NO_x reduction. A tire gasification system is also proposed that would produce a combustible gas that would be injected into the kiln inlet or calciner region of the kiln system. The portion of the tires that do not gasify will form a coke/residue material. This material will be fed into the kiln inlet in the same manner as shredded or whole tires and provides additional heat input while incorporating the ash into the clinker. Air is supplied to the tire gasification system via the tertiary air from the clinker cooler and/or ambient air.

The primary fuel firing scenario will have a heat input of 55 to 60 percent of the total heat input being provided in the calciner via the calciner burner and 40 to 45 percent of the heat input being provided in the kiln main burner. During periods when tire derived fuels are being used, whole tires may account for up to 15 percent of the calciner heat input which will reduce the heat input of the calciner burner. During use of a tire gasification system, up to 40 percent of the calciner fuel may be supplied by the gasification of the tires, which again directly reduces the heat input provided from the calciner burner while leaving the kiln main burner heat input unaffected.

The primary fuel for the main burner and calciner burner will be ground bituminous coal and pet coke. The burners will be designed such that non-hazardous liquids, such as fuel oil, may be fed through both the calciner burner and main burner. These fuels could replace up to 50% of the total heat input in varying amounts of each burner. Solid non-hazardous waste would only be introduced in the calciner region through the calciner burner as described above and again substitute for the primary fuel in varying amounts from 0 to 50 percent of the total heat input.

Heat inputs of 55 to 60 percent in the calciner region supplied by various fuels (coal, pet coke, natural gas, fuel oil, non-hazardous liquids, non-hazardous solids, and tires) and 40 to 45 percent in the kiln burning zone supplied by various fuels (coal, pet coke, fuel oil, non-hazardous liquids, and natural gas) remain fairly constant. This heat input can fluctuate slightly as more or less heat is need in the calciner region or burning zone for the kiln main burner. If raw materials or quality control characteristics dictate, occasions can arise when more fuel is needed in the main burning zone via the kiln main burner. Regardless of the fuel firing scenario or fuels used, overall heat input to the kiln remains fairly constant in comparison to kiln feed rate. Theoretically, constant heat inputs are needed for the overall process of clinker formation with uniformly predictable variations for raw material deviations, heat exchange rates, and other conditions experienced under normal kiln operating conditions.

Emissions for all above listed fuel firing scenarios or heat input ratios are expected to remain fairly constant for most pollutants in terms of concentration or mass per unit time and within the proposed BACT NO_x limit. However, NO_x emissions can be affected by both fuel firing scenarios and heat input ratios. Fuels higher in volatiles used in the calciner such as fuel oils, coal, and some non-hazardous liquids and solids can increase the free radical pool, allowing for more reduction in NO_x generated by the main burner of the kiln. Additionally, tires injected via the mechanism described above or solid non-hazardous waste utilized in the calciner can create localized reducing zones around the fuel as it combusts. These reducing zones can also enhance the reduction of NO_x by the creation of additional reduction zones in comparison to highly reactive fuels. The heat input ratio can also play an important role in NO_x emissions. The more fuel fired in the high heat burning zone through the main kiln burner, the higher the overall NO_x per unit of heat input. The more fuel that can be utilized in the calciner at lower temperatures while still maintaining the needed temperature profile in the burning zone the less the overall NO_x per unit of heat input. In modern kilns this ratio is typically 60 percent in the calciner and 40 percent in the kiln main burner. As described above, this same ratio for heat input is proposed in the design for the SCC kiln system. Slight variations as described above may occur as more fuel is needed in the main burner to maintain the needed burning zone temperature. However, considering worst case scenarios for both fuel firing scenarios and heat input ratios (which would be low volatile fuels usage in the calciner and 45 percent heat usage ratio on the main kiln burner), NO_x emissions will remain below the proposed limits in the application.

NO_x formed in the main kiln combustion passes through the precalciner and the gases are cooled slowly in the preheater cyclones. NO_x formation is an endothermic process and as gases cool, NO_x tends to revert to N_2 and O_2. This decomposition process is rapid at elevated temperatures but decreases at temperatures below approximately 1,300°F. In effect, if the flue gases can be slowly cooled to 1,300°F over an extended period, a progressive decrease in NO_x concentration occurs. This process occurs in the preheater after other combustion radicals (OH^-, H^+, O^-, etc.) have been eliminated.

The available control technologies for NO_x are discussed below.

4.2 Selective Non-Catalytic Reduction

4.2.1 Description of Technology

Selective non-catalytic reduction (SNCR) involves the injection of an ammonia-containing solution into the preheater tower to reduce NO_x within the optimum temperature range of 800° to 1,090°C. Because the optimum temperature range must be present for a sufficient time period to allow the reaction to occur, SNCR is only a viable technology on some preheater or precalciner kiln designs. The ammonia-containing solution may be supplied in the form of anhydrous ammonia, aqueous ammonia, or urea.

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4.2.2 Theory of Abatement

SNCR involves the following primary reactions:

$$NH_3 + OH^- \rightarrow NH_2 + H_2O$$
$$2NH_3 + O^{2-} \rightarrow 2NH_2 + H_2O$$
$$NH_3 + H^+ \rightarrow NH_2 + H_2$$

Following NH_2 formation by any of the above mechanisms, reduction of NO occurs:

$$NH_2 + NO \rightarrow N_2 + H_2O$$

At temperatures lower than 800°C, reaction rates are slow, and there is potential for significant amounts of ammonia to exit or "slip" through the system. This ammonia slip may result in a detached visible plume at the main stack, as the ammonia will combine with sulfates and chlorides in the exhaust gases to form inorganic condensable salts. The condensable salts can become a significant source of condensable PM emissions that cannot be controlled with a fabric filter baghouse or ESP. Ammonium sulfate aerosols would be a concern under upcoming programs to deal with regional haze. In addition, there may be health and safety issues with on-site ammonia generation.

At temperatures within the optimal temperature range, the above reactions proceed at normal rates. However, as noted in the literature as well as by vendors, a minimum of 5 ppm ammonia slip may still occur as a side effect of the SNCR process.

At temperatures above 1,090°C, the necessary reactions do not occur. In this case, the ammonia or urea reagent will oxidize and result in even greater NO_x emissions. In addition, SNCR secondary reactions can form a precipitate, resulting in preheater fouling and kiln upset. Ammonia reagent may react with sulfur in kiln gases to form ammonium sulfate. Ammonium sulfate in the preheater can create a solids buildup. Ammonium sulfate in the kiln dust recycle stream may adversely affect the kiln operation.

The optimal temperature window for application of the SNCR process occurs somewhere in the preheater system. Fluctuations in the temperature at various points in the preheater are common during normal cement kiln operation. Therefore, selecting one zone for SNCR application in the preheater cannot reliably assure consistent results. Alternatively, selecting multiple zones of injection creates significantly increased complexity to an already complex chemical process.

4.2.3 Applicability of SNCR

SNCR has been employed at a number of European and United States cement plants for NO_x reduction. Suwannee American Cement (SAC) has tested and installed SNCR at its Branford, Florida plant in conjunction with multi-stage combustion (MSC) and without MSC utilized. The results from this installation at the Branford Plant showed promising results in controlling NO_x emissions to approximately 1.95 lb/ton clinker. In Europe, the chemical of choice for ammonia reagent is photowater. Photowater is a waste produced during development of film, which contains approximately 5.0 percent ammonia and is classified as a hazardous waste in the U.S. The availability and classification of the waste make it a low cost alternative to other ammonia or urea reagents for NO_x control in Europe.

In the U.S., either ammonia solution or urea is available for use in a SNCR system. SAC tested SNCR with use of an ammonia solution. A driving force for the use of SNCR in Europe is the alternate fuels usage allowed with lower NO_x limits. Facilities that can meet a limit of 500 mg/Nm^3 @ 10 percent oxygen (approximately 2.5 to 2.8 lb/ton) are allowed to utilize upwards of 50 to 75 percent alternate fuels which results in favorable cost benefits.

The requirements for SNCR include an optimum temperature range (i.e., 800° to 1,090°C) and the presence of an oxidizing atmosphere. At the low flue gas temperature the reaction rate is slow and ineffective. Ammonia introduced will not react and will be lost as gas. Some of the ammonia will react with SO_2 in the conditioning tower forming ammonium sulfate $(NH_4)_2SO_4$ which is a submicron aerosol. This aerosol may form a visible emission at the stack.

Because the raw materials at the plant site can contain naturally occurring carbon (i.e., bitumen and kerogens), pyrolysis of organics occurs in the preheater tower producing CO. This results in a reducing atmosphere. The current control practice is to limit oxygen at the calciner exit to reduce NO_x. SNCR requires an oxidizing atmosphere and the two conditions are opposed in theory. CO emissions are expected to increase as NO_x is reduced. Data from preliminary testing in Europe and at SAC on MSC/SNCR systems indicate an increase in CO emissions of 5 to 20 percent is possible.

In addition, ammonia emitted as gas in the plume will react with SO_2 or HCl in the condensed water vapor plume forming a highly visible plume under certain weather conditions. A similar plume has been noted as result of naturally occurring ammonia in the kiln feed at the following plants:

- Votorantim's St. Mary's plant
- Glens Falls, New York
- Permanente, California
- Redding, California
- Ravena, New York
- Midlothian, Texas
- Mississauga, Ontario
- Edmonton, Alberta
- Exshaw, Alberta

Direct mixing of urea with feed would not be effective in system designs where the feed is injected into the gas stream at the inlet of the first stage preheater for meal preheating. At this location flue gas temperatures are too low for the reaction to affect NO_x, but sufficiently high to decompose the urea to ammonia, CO_2, and water vapor.

SAC has conducted trials on the kiln system in Branford to determine the effectiveness of SNCR and determine the required reagent injection rate. This short-term data has indicated no significant conflict with the reducing atmosphere. Some ammonia slip was noted during the testing but only for small periods while the raw mill was down, even during periods with no ammonia injection. Further long-term operations are needed to completely understand the ammonia cycle and ammonia slip. The testing has initially indicated that SNCR can be successfully applied without the formation of a visible plume. It should be noted that CO emissions showed a moderate increase during the testing

SNCR in combination with a staged combustion principle has been demonstrated as a means of reducing NO_x. Although SNCR and staged combustion can in theory conflict, testing and operations at SAC have shown that the use of staged combustion can help to reduce the initial NO_x that is subsequently reduced by SNCR. Any reduction in initial concentration of NO_x prior to introduction to the SNCR will result in a minimization of reagent used by the SNCR to reduce the NO_x. This results in cost savings and makes the SNCR a more effective means of reducing NO_x emissions. Low NO_x burners and kiln firing rates can also be used in conjunction with SNCR to help reduce the NO_x subsequently reduced by SNCR. In testing conducted at SAC, SNCR in conjunction with low NO_x burners and staged combustion principles, resulted in NO_x emissions at or around 1.95 lb/ton clinker. Another advantage of using the SNCR in conjunction with staged combustion is it allows running in an oxidizing condition that helps to avoid buildup in the riser duct. This allows having a much more stable operation in the kiln and fewer process upsets.

4.3 Selective Catalytic Reduction

4.3.1 Description of Technology

Selective catalytic reduction (SCR) is a process that uses ammonia in the presence of a catalyst to reduce NO_x. The catalyst is typically vanadium pentoxide, zeolite, or titanium dioxide. The SCR process has been proven to reduce NO_x emissions from combustion sources such as incinerators and boilers used in electric power generation plants but not in cement kilns. No full-scale application of SCR on a Portland cement plant exists anywhere in North America.

4.3.2 Theory of Abatement

The NO_x-containing exhaust gas is injected with anhydrous ammonia and passed through a catalyst bed to initiate the catalytic reaction. As the catalytic reaction is completed, NO_x is reduced to nitrogen and water. The critical temperature range required for the completion of this reaction is 300° to 450°C, which is higher than the typical cement kiln ESP or baghouse exit gas temperature. Technical application of SCR requires the catalyst to be placed prior to the gas conditioning tower (dirty side) or after the particulate control device (clean side). Placement at the preheater exit satisfies the temperature requirements, but subjects the catalyst to the re-circulating dust load and potential fouling. Location at the baghouse exit requires reheating of the gases to the required temperature for catalyst activation.

<u>Dirty Side Application</u>
Installation of the catalyst before the pollution control device (i.e., dirty side) increases the potential for fouling from meal/re-circulating dust load, but requires a less significant reheating of the gas stream. The most prohibitive disadvantage of the SCR process in this location is fouling of the SCR catalyst. The high dust loading in cement kiln gases may plug the catalyst and render it ineffective. Minor impurities in the gas stream, such as compounds or salts of

sulfur, arsenic, calcium, and alkalis, may deactivate the catalyst very rapidly, strongly affecting the efficiency and system availability as well as increasing the waste catalyst disposal volume.

Continual fouling of the SCR catalyst would render it inoperative as a NO_x control option. Ammonia injected to an SCR system with a fouled catalyst would pass unreacted through the system (i.e., ammonia slip). The unreacted ammonia would combine with sulfates and chlorides in the exit gases, forming inorganic condensable salts, which result in a detached visible plume and a significant increase in condensable PM_{10} emissions. In addition, SCR on power plants have been shown to convert SO_2 to SO_3 as a secondary reaction. SO_3 will react with CaO between preheater stages forming gypsum ($CaSO_4$), which can plug the tower and cause kiln shutdown.

Clean Side Application

Installation of the catalyst after the pollution control device (i.e., clean side) reduces the potential for fouling from meal/re-circulating dust load, but requires significant reheating of the gas stream. This can be significant if combined with wet scrubbing prior to the NO_x control. SO_2 removal is required to prevent conversion of SO_2 to SO_3 in the catalyst bed which would increase SO_3 emissions if the NO_x control were the last system in the gas train.

Placement of the SCR catalyst between the fabric filter and scrubber would not reduce the SO_3 emissions if the SO_3 hydrates and condenses in the scrubber quench. H_2SO_4 aerosols are submicron and therefore not collected in wet scrubbers designed for SO_2 removal.

4.3.3 Applicability of SCR

SCR systems are currently being installed on electric utility boilers in North America for NO_x control. These systems use up to three catalyst beds with ammonia gas injection before each bed. Temperature is controlled by placing the reactor beds between the boiler outlet and air heater. For most applications the boilers are base load units with little or no load variation. This allows a stable temperature profile for optimum function and injection of ammonia. Ammonia is typically generated by the thermal decomposition of urea in a water solution under pressure.

The optimum temperature for reaction is 300° to 450°C. In the presence of the catalyst, the NO_x is reduced to N_2 by reaction with ammonia. For the reaction to occur the ammonia must be present in excess molar ratio. Typical usage in utility applications is 1.05 - 1.10 to 1.0 (NH_3/NO_x). The excess ammonia required produces "ammonia slip" of between 10 and 15 ppm in the flue gases.

Recent studies of the use of SCRs at major utilities have indicated that some SO_2 present in the flue gases is oxidized to SO_3 during the process. The rate of conversion can increase SO_3 by 15 to 100 ppm depending on catalyst composition, temperature, and SO_2 concentration. It has also been noted that the catalyst life is greatly reduced by the presence of SO_3 in the gas stream. The slippage of ammonia and formation of SO_3 has resulted in an intense visible plume as ammonia reacts with SO_2 in the flue gases and when SO_3 condenses forming acid aerosols ($H_2SO_4 \bullet 2H_2O$).

The application of SCR on cement kilns is fundamentally different than utility boilers due to their differences in gas composition, dust loading, and chemistry. EPA's, "*Alternative Control Techniques (ACT) Document for NO_x Emissions from Cement Manufacturing*" (pages 6-32, 6-36, and 6-37), acknowledges that there are no installations of SCR technology in cement plants in the United States, however EPA concludes that SCR technology is technically feasible based on technology transfer from utility boiler and gas turbine applications. The ACT document indicates a control efficiency of 80 percent for using SCR technology. However, this assumed efficiency is unproven for use in cement kilns.

There is one installed SCR unit in Europe on a preheater cement kiln and several pilot studies. The one installed unit is experimental and has had some operational problems concerning catalyst deactivation and fouling. The application of SCR to "dirty side" kiln gases is still in an experimental stage. Currently the one full scale SCR unit is still testing for long-term catalyst optimization. Extensive data from the experimental test is not available but the facility currently meets the regulatory limit of 500 mg/m^3 at 10 percent oxygen. Similar or better results can be achieved with more proven technologies such as SNCR or staged combustion. The use on "clean side" application may be technically feasible but has a high energy cost to reheat the gases.

The most serious issues yet to be resolved are catalyst life, poisoning of the catalyst, fouling of the bed, system resistance, ability to correctly inject ammonia at proper molar ratio under non-steady state conditions, and creation of detached plume. Additionally, inexperience with SCR limits the availability of such a technology without long-term testing to determine the applicability and long-term reductions of NO_x associated with the production of Portland cement.

4.4 Indirect Firing and Low NO_x Burners

4.4.1 Description of Technology

Indirect firing systems (a low NO_X technology) can be used on the precalciner and rotary kiln burner systems. This technology functions by grinding the fuel and collecting the pulverized fuel with a baghouse and receiving bin. The fuel is then weighed and fired using a dense phase conveying system that limits the volume of air necessary to transport fuel to the burner. This design reduces primary air injected with fuel.

The indirect-firing process allows the flame to be fuel rich, which reduces the oxygen available for NO_x formation. In some cases it can also result in higher flame temperatures because the heat release occurs with less combustion gases (i.e., excess air).

Low NO_x burners in general are not as effective when used on the rotary kiln section of a preheater-precalciner kiln system because gases containing the thermal NO_x formed in the main kiln section are gradually cooled as they move through the system resulting in NO_x reduction (as previously discussed), and subsequently the gases pass through the precalciner burning zone and preheater cyclones where they are further reduced. NO_x contained in the alkali bypass gases, however, would not be subject to this reduction.

4.4.2 Theory of Abatement

The indirect-firing process allows the flame to be fuel rich, which reduces the oxygen available for NO_x formation. In some cases it can also result in higher flame temperatures because the heat release occurs with less combustion gases (i.e., excess air).

Indirect firing with a low NO_x burner attempts to create two combustion zones, primary and secondary, at the end of the main burner pipe. In the high-temperature primary zone, combustion is initiated in a fuel-rich environment in the presence of a less than stoichiometric oxygen level. The submolar level of oxygen at the primary combustion site minimizes NO_x formation. The presence of CO in this portion of the flame also chemically reduces some of the NO_x that is formed.

In the secondary zone, combustion is completed in an oxygen-rich environment. The temperature in the secondary zone is much lower than in the first; therefore, lower NO_x formation is achieved as combustion is completed.

4.4.3 Applicability of Indirect Firing and Low NO_x Burners

Indirect-firing and a low NO_x main kiln burner will be used by the SCC Plant kiln.
SCC will install a burner with multiple channels allowing for the creation of distinct combustion zones in the flame. These distinct zones allow portions of the flame to exist in sub-stoichiometric oxygen conditions, which limits the formation of thermal NO_x due to the lack of sufficient oxygen. Other portions exist at lower temperatures, again limiting the formation of thermal NO_x due to the lowering of the temperature profile.

The emission levels achieved with indirect firing are defined by the burnability of the mix, amount of conveying air required, and design of the burner. In kiln systems where the mix is difficult to burn (crystalline silica, quartz, high lime/silica ratio, etc.) or where high excess air is required, the NO_x levels are generally higher and this technology is more effective in such situations. In general, the expected NO_x reduction ranges from 0 to 40 percent from baseline levels at the same mix design and excess air levels.

4.5 Semi-Direct Firing and Low NO_x Burners

4.5.1 Description of Technology

Semi-direct firing practice involves the separation of pulverized fuel from the mill sweep air using a cyclone separator. The fuel is placed in a small feeder bin from which it is metered to the kiln burner pipe. The exhaust gases of the cyclone are used to transport the fuel from the bin discharge. Advantages in the design are that a portion of the sweep air can be returned to the mill or exhausted to the atmosphere and that minor variations in fuel delivery rate are eliminated. The major advantage for NO_x abatement is that the volume of primary air can be marginally reduced (i.e., 20 to 25% of combustion air). The system is similar to mill recirculation but can include partial sweep air discharge.

4.5.2 Theory of Abatement

The theory of abatement is similar to indirect firing as described in Section 4.4.2; however, primary air volume will be higher than indirect firing.

4.5.3 Applicability of Semi-Direct Firing and Low NO_x Burners

Semi-Direct firing would not reduce NO_x emissions below current levels and is therefore not applicable. Indirect firing will be used on the SCC kiln.

4.6 Mill Air Recirculation

4.6.1 Description of Technology

A method to reduce primary air usage involves returning a portion of the coal mill sweep air (30 to 50%) to the coal mill inlet. By returning sweep air, the volume of air used to convey pulverized fuel to the burner pipe is reduced. The amount of the return air possible depends on the mill grinding rate (i.e., percent of utilization), volatile content of fuel, moisture in the fuel, grindability of the fuel, and the final conveying air temperature achieved. The reduction in primary air allows the use of low NO_x burner technology that further reduces NO_x formation. The use of mill air recirculation can achieve primary combustion air between 15 and 25 percent but is highly variable. Kilns operating with a hard burning mix do not typically achieve high NO_x reductions. Also, recirculation is not possible for fuels containing high free moisture (i.e., fuels stored outdoors exposed to weather).

4.6.2 Theory of Abatement

The theory of abatement is similar to indirect firing as described in Section 4.4.2.

4.6.3 Applicability of Mill Air Recirculation

This technology applies to coal/coke direct-fired kilns not currently using a fuel-rich primary combustion technology. Since the SCC kiln will be indirect-fired, this technology is not applicable.

4.7 Mid-Kiln Firing

4.7.1 Description of Technology

Mid-kiln firing (MKF) is a potential NO_x reduction technology that involves injecting solid fuel into the calcining zone of a rotating long kiln using a specially designed feed injection mechanism. The technology is applicable to conventional wet process and long dry kilns. The fuel used is generally whole tires, although containerized waste fuels have also been used at some plants. Fuel is injected near the mid-point of the kiln, once per kiln revolution, using a system consisting of a "feed fork," pivoting doors, and a drop tube extending through the kiln wall.

Another form of mid-kiln firing has been used for certain preheater and preheater/precalciner kiln systems. Whole tires are introduced into the riser duct using a specially designed feed mechanism (drop chute with air lock or thermal suspension). This creates an additional secondary firing zone in which the solid fuel is burned in contact with the partially calcined meal. Combustion is initiated in the riser duct (located midway between the calciner and rotary kiln sections of the kiln system) and is completed within the rotary kiln section in a reducing atmosphere away from the elevated temperatures of the main kiln burner. NO_x formation is inherently lower in this area, and NO_x formation may be further reduced due to improvements in fuel efficiency and the shifting of fuel burning requirements (e.g., less fuel must be burned at the main kiln burner).

4.7.2 Theory of Abatement

MKF is a staged combustion technology that allows part of the fuel to be burned at a material calcination temperature of 600° to 900°C, which is much lower than the clinker burning temperature of 1,200° to 1,480°C, thus reducing the potential for thermal NO_x formation. By adding fuel in the main flame at mid-kiln, MKF changes both the flame temperature and flame length. These changes may reduce thermal NO_x formation by burning part of the fuel at a lower temperature and by creating reducing conditions at the solid waste injection point that may destroy some of the NO_x formed upstream in the kiln burning zone. MKF may also produce additional fuel NO_x depending upon the nitrogen content of the fuel. The additional fuel NO_x, however, is typically insignificant relative to thermal NO_x formation. The discontinuous fuel feed from MKF can also result in increased CO. To control CO emissions, the kiln may require an increase in combustion air, which can decrease production capacity.

Test data showing NO_x reduction levels for long dry and wet kilns were compiled for the EPA in the report "*NO_x Control Technology for the Cement Industry*" (EC/R Inc., 2000). Tests conducted on three wet process kilns using MKF technology showed an average reduction in NO_x emissions of 40 percent, with a range from 28 to 59 percent.

4.7.3 Applicability of MKF

As discussed above, mid-kiln firing in the form of riser duct firing is potentially applicable at the SCC Plant. The major concerns in applying this combustion practice include:

1. Community acceptance of tire burning.
2. Reduced sulfur retention in the clinker resulting in increased SO_2 emissions.
3. Adverse product quality impacts.

These issues are addressed in detail in the following discussion.

Community Acceptance

The ability to implement tire burning is strongly dependent on the acceptance of the local community. Historically, public acceptance of tires as an alternate or supplemental fuel has been influenced by negative implications of open tire burning and generation of hazardous products of incomplete combustion. This potential inference can be overcome through public education, meetings, and involvement in the regulatory process. The nearby CEMEX Cement Plant is currently successfully using the MKF technology.

Increased SO_2 Emissions

For sulfur to be retained in the clinker, the sulfur must combine with alkali forming an alkali salt (Na_2SO_4, K_2SO_4) or with calcium forming calcium sulfate ($CaSO_4$). In most kiln systems sulfur inputs exceed the capacity of available alkali (i.e., alkali/sulfur ratio less than 1.0). When this occurs excess sulfur can only be retained by forming calcium sulfate. Calcium sulfate can only be formed under oxidizing conditions, and under reducing conditions calcium sulfite ($CaSO_3$) is produced. $CaSO_3$ is unstable at burning zone temperatures and reverts to CaO and SO_2. For sulfur to be retained, excess oxygen at the kiln exit must be maintained above a minimum concentration. The creation of a reducing zone at mid-kiln may potentially reduce sulfination of clinker and potentially increase SO_2 emissions. This, potentially conflicts with the ability to decrease SO_2 emissions concurrently with NO_x reduction.

Product Quality Impacts

The introduction of whole tires to the system changes the chemistry of the system. Tires contain iron, which must be considered in the mix design. When tires are being burned, the mix is adjusted to allow for the addition of iron as part of the fuel. If an interruption in tire usage occurs, the mix cannot be immediately changed to accommodate for the loss of iron in the mix. The kiln feed will require a higher fusion temperature (loss of flux) and the kiln will go raw (upset condition) and most likely will flush. This represents a potentially serious concern for production and safety. A flush in the kiln produces a rapid influx of hot meal into the cooler, pressurizing the system, and producing hot gases in the cooler area.

4.8 Multi-Staged Combustion (MSC)

4.8.1 Description of Technology

MSC is a combustion technology that is currently used with preheater/precalciner kilns to reduce NO_x generation by all major kiln vendors. MSC, which includes the use of two or more staged air, feed, or fuel burning locations to create low NO_x burning zones, is supplied by one or more vendors as NO_x control technology on modern preheater/precalciner cement kilns. MSC is also considered a common technology as it has been used for many years throughout the cement industry. However, based on actual experience in European cement plants, NO_x reduction in MSC can be adversely impacted if the raw feed contains high pyritic sulfur. This is not a problem for the SCC Plant. Another form of MSC combines high temperature combustion and re-burning without staging air or fuel in the calciner. This technology creates one high temperature reducing zone by injection of all of the calciner fuel into one reducing zone at the bottom of the calciner. The reducing zone is followed immediately by an oxidizing zone where all the tertiary air is introduced into the calciner. Splitting of feed or staged feed is used to control the temperatures and help in creating and controlling the high temperature reducing zone. However, this form of staged combustion does not utilize splitting of tertiary air to stage air flow.

4.8.2 Theory of Abatement

MSC takes place in and around the precalciner and is accomplished in several ways depending on the system design. The purpose of staged combustion is to burn fuel in two stages, i.e., primary and secondary. Staged air combustion suppresses the formation of NO_x by operating under fuel-rich, reducing conditions (less than stoichiometric oxygen) in the flame or primary zone where most of the NO_x is potentially formed. This zone is followed by oxygen-rich conditions in a downstream, secondary zone where CO is oxidized at a lower temperature with minimal NO_x formation.

To delineate the NO_x control mechanisms of MSC, the combustion chemistry of NO_x formation by virtue of fuel nitrogen should be examined. Fuels introduced to the primary combustion zone undergo a pyrolysis that liberates nitrogen originally bound in the fuel. Nitrogen-bearing products that are gaseous will again pyrolize to form HCN and NH_i radicals. With NO and oxygen radicals (OX) already present in the gas stream, the NH_i will react as such:

$$NH_i + OX \rightarrow NO + \ldots$$

$$NH_i + NO \rightarrow N_2 + \ldots$$

Because the primary stage of MSC is a high-temperature (1,150° to 1,200°C) reducing environment where CO is prevalent and oxygen radicals are relatively scarce, NH_i radicals can scavenge oxygen from NO as shown in the second equation. This phenomenon is the basis for successful NO_x reduction in MSC kilns.

Research and actual emission monitoring on preheater/precalciner cement kilns have shown that MSC technology applied to the area of the precalciner works to effectively lower NO_x emissions per unit clinker produced. Although potential disadvantages to MSC may exist, experience has shown that when included as part of the kiln system design, it will produce a reduction in NO_x emissions with minimal process problems. The MSC control option is capable of reducing NO_x emissions by 10 to 50 percent, depending on the site-specific kiln operating parameters (i.e., kiln feed burnability).

MSC can have limitations under specific conditions which affect the potential NO_x control effectiveness. In kiln systems that use a mix that is characteristic of high sulfur to alkali molar ratio, the volatility of sulfur is increased due to the strong reducing conditions in MSC and the relatively low O_2 content in the system. Operationally, this causes severe preheater plugging to occur due to significant sulfur deposition associated with MSC operation. As a result, the required conditions needed for optimum MSC operation (low excess oxygen), conflict with the goal of preventing sulfur deposition and minimizing operational problems. These problems have been documented in Europe and at U.S. cement production facilities. A high S/alkali molar feed ratio prevents the achievement of maximum NO_x reduction using MSC.

Another type of MSC technology involves creating a reducing zone by introduction of all of the calciner fuel into an oxygen deficient zone. F. L. Smidth describes the process of NO_x reduction as the following:

> *"The combustion of coal or pet coke in a calciner may be viewed as consisting of five stages: heating; pyrolysis; ignition; reaction between components in the gas phase; and reaction of char and soot. The gaseous reactants, char and soot are formed when the coal is heated whereby it is pyrolysed. The three pyrolysis products contain the nitrogen introduced to the calciner with the fuel. In the gases the nitrogen is present as N_2, HCN, NH_3 and a small fraction of NO; the rest of the nitrogen is still bound in the soot and char. In addition to the nitrogen-containing compounds, H_2S, H_2, CO, CH_4, and CxHy or its radicals are also present in the gases. The pyrolysis takes place at the very bottom of the reduction zone immediately after the introduction of the coal."*
>
> *"NO_x reduction by re-burning in the calciner is caused by a sequence of reactions involving gases, soot and char from the coal pyrolysis, as well as catalytic effects of raw meal and char."*

4.8.3 Applicability of MSC

A form of MSC (i.e., reducing zone) will be used on the SCC kiln in combination with indirect firing, low NO_x burners, and SNCR. The use of multi-staged combustion, low NO_x burners, and indirect firing will assist in reducing NO_x prior to the SNCR system and help to minimize the amount of reagent needed to reduce the NO_x.

4.9 Technically Feasible Options

Based on the preceding discussion, the technically feasible options are considered to be:

- SNCR (currently planned)
- SCR
- Indirect Firing and Low NO_x Burners (currently planned)
- Mid-Kiln (Riser Duct) Firing (optional)
- MSC (currently planned)

4.10 Review of Recent Permit Limits

Table 4-1 summarizes the NO_x BACT determinations made for cement kilns since 2002.

TABLE 4-1
RBLC SUMMARY FOR OXIDES OF NITROGEN (NO$_x$)
PORTLAND CEMENT MANUFACTURING

RBLCID	FACILITY NAME	STATE	DATE DETERMINATION ENTERED INTO	PROCESS NAME	UNITS	CONTROL METHOD	EMISSION LIMIT 1	EMISSION LIMIT 1 UNITS	EMISSION LIMIT 1 AVG. TIME	EMISSION LIMIT 2	EMISSION LIMIT 2 UNITS	EMISSION LIMIT 2 AVG. TIME	EMISSION LIMIT 3	EMISSION LIMIT 3 UNITS	EMISSION LIMIT 3 AVG. TIME
AL-0203	HOLCIM (US), INC.	AL	5/3/2004	KILN SYSTEM (CALCINING KILN, PREHTR W/PRECALCINER)	T/H	NONE INDICATED.	2998	T/YR		0			0		
FL-0267	THOMPSON S. BAKER- CEMENT PLANT (FRI)	FL	7/29/2005	IN LINE KILN/RAW MILL WITH ESP AND SNCR		SNCR	1.95	LB/TON CLINKER	30 DAY	243.75	LB/H	30 DAY	0		
FL-0268	BROOKSVILLE CEMENT PLANT (FCS)	FL	7/29/2005	125 TPH CLINKER KILN AND ASSOCIATED EQUIPMENT		SNCR	1.95	LB/TON CLINKER	30 DAY	243.75	LB/H	30 DAY	0		
FL-0271	BRANFORD CEMENT PLANT (SUWANNE)	FL	12/23/2005	KILN W/IN LINE RAW MILL W/ SNCR AND BAGHOUSE	T/H clinker	SNCR	1.95	LB/TON CLINKER	CEMS 30 DAYS ROLLING AVERAGE	247.7	LB/H	CEMS 30 DAYS ROLLING AVERAGE	0		
FL-0281	SUMTER/CENTER HILL CEMENT PLANT	FL	9/28/2006	CEMENT PYROPROCESSING SYSTEM	T/H CLINKER	SELECTIVE NON CATALYTIC REDUCTION (SNCR), LOW NOX BURNERS, INDIRECT FIRING, STAGED COMBUSTION	1.95	LB/T CLINKER	30-DAYS ROLLING AVERAGE	406.19	LB/H	30-DAYS ROLLING AVERAGE	0		
FL-0282	AMERICAN CEMENT COMPANY	FL	9/28/2006	CEMENT PYROPROCESSING SYSTEM	ton/h clinker	SELECTIVE NON CATALYTIC REDUCTION (SNCR), LOW NOX BURNERS, INDIRECT FIRING, AND STAGED COMBUSTION	1.95	LB/T CLINKER	30-DAY ROLLING AVERAGE	243.8	LB/H	30-DAY ROLLING AVERAGE	0		
FL-0297	NORTH BROOKSVILLE CEMENT PLANT	FL	11/15/2007	KILN NO. 3 WITH PREHEATER, CALCINER, IN-LINE RAW MILL AND AIR HEATER	MMBTU/H	THE SELECTIVE NON-CATALYTIC REDUCTION (SNCR) PROCESS, THE SELECTIVE CATALYTIC REDUCTION (SCR) PROCESS OR ANY COMBINATION THEREOF	1.5	LB/T CLINKER	30-DAYS ROLLING	0			0		
GA-0134	HOUSTON AMERICAN CEMENT PLANT	GA	4/29/2010	MAIN KILN STACK ST35	T/H OF DRY FEED	STAGED AND CONTROLLED COMBUSITON (SCC), SNCR, LOW NOx BURNER AND INDIRECT FIRING.	1.95	LB/T CLINKER	30 DAY ROLLING AVG	243.8	LB/H		1.95	LB/T CLINKER	30 DAY ROLLING AVG
GA-0136	CEMEX SOUTHEAST, LLC	GA	5/6/2010	MAIN KILN STACK K218	T/H OF DRY FEED	STAGED & CONTROLLED COMBUSTION (SCC), SNCR, LOW NOx BURNER AND INDIRECT FIRING.	1.95	LB/T CLINKER	30-DAY ROLLING AVG. BASED ON NOX CEMS	312	LB/H		1.95	LB/T CLINKER	30-DAY ROLLING AVG. BASED ON NOX CEMS
IA-0052	LAFARGE CORPORATION	IA	2/5/2001	CEMENT MANUFACTURING, PREHEATER/PRECALCINER KILN	T/D	GOOD COMBUSTION PRACTICES	2546	T/YR		4	LB/TON OF CLINKER		0		
IA-0070	LEHIGH CEMENT COMPANY - MASON CITY PLANT	IA	12/11/2003	KILN/CALCINER/PREHEATER	T/H	SNCR, LOW NOX BURNERS, COMBUSTION CONTROLS, AND PROPER KILN DESIGN.	2.85	LB/T	LB/T OF CLINKER	1496	T/YR		0		
MO-0059	CONTINENTAL CEMENT COMPANY, LLC	MO	9/27/2002	ROTARY KILN	T/H	SELECTIVE NON-CATALYTIC REDUCTION, LOW NOX BURNERS, TOP AIR DUCT.	8	LB/T	lb/t clinker, 30-day rolling avg	0			0		
MS-0071	HOLCIM (US), INC.	MS	12/8/2004	POPRTLAND CEMENT MANUFACTURING	TON CLINKER/YR	GOOD COMBUSTION PRACTICE	10	LB/T		2625	T/YR		0		
SD-0003	GCC DACOTAH	SD	12/23/2002	MATERIAL TRANSFER, ALKALI	T/D	NONE INDICATED.	2267	T/YR		0			0		
SD-0003	GCC DACOTAH	SD	12/23/2002	ROTARY KILN #5	T/D	PREHEATER/PRECALCINATOR SYSTEM	2267	T/YR		0			0		
SD-0003	GCC DACOTAH	SD	12/23/2002	COAL MILL	T/H	PREHEATER/PRECALCINATOR SYSTEM	2267	T/YR		0			0		
TX-0466	TEXAS LEHIGH CEMENT	TX	12/29/2005	KILN EXHAUST (4)		BAGHOUSES	600	LB/H		2628	T/YR		0		
VA-0272	ROANOKE CEMENT	VA	9/29/2003	LIME KILN	T/YR	GOOD COMBUSTIONS PRACTICES AND A CONTINUOUS EMISSION MONITORING SYSTEM	982	LB/H		2850	T/YR		0		
WA-0307	PORTLAND CEMENT CLINKERING PLANT	WA	7/28/2003	KILN EXHAUST STACK		NONE INDICATED.	650	PPM @ 10% O2	24-H AV	1846	T/YR	BASED ON 8760 H OF OPERATION/YR	0		

4.11 Summary of Impact Analysis

Table 4-2 presents a summary of energy, environmental, and economic analyses of the SNCR and SCR control options.

TABLE 4-2. SUMMARY OF IMPACT ANALYSIS FOR NO_x

Method	% removal[1]	NO_x, removed tons/yr	Capital Costs, MM $	Annualized Cost, MM $	Cost Effectiveness $/ton NO_x	Impacts		
						Environmental	Product	Energy
SCR[2]	46.43	712	4.78	9.67	13,582	Yes	No	Yes
SNCR[3]	30.4	465	1.58	1.15	2,481	Yes	No	No

[1] Assumes NO_x reduction from kiln system employing indirect firing, low NO_x burners, and MSC and achieves a 2.8 lb NO_x/ton clinker emission rate.

[2] Assumes SCR achieves a 1.5 lb NO_x/ton clinker emission rate.

[3] Assumes SNCR achieves a 1.95 lb NO_x/ton clinker emission rate

The detailed cost calculations are presented in Appendix B.

4.12 Selection of BACT

SCC proposes as BACT the use of indirect firing, low-NO_x burners, MSC, and SNCR. The requested BACT emission limit is 1.95 lb/ton of clinker, 30-day rolling average, as measured by CEM. This averaging time is appropriate to account for the variability in NO_x emissions from cement kilns and is consistent with EPA's NO_x State Implementation Plan (SIP) call guidance for cement kilns. Although mid-kiln firing may be used as a fuel burning option, it is not considered BACT because it is not expected to reduce NO_x emissions significantly when combined with the above proposed combination of control technologies.

SECTION 5

BACT ANALYSIS FOR CO AND VOC

CO and VOC emissions from cement kiln pyroprocessing systems generally occur from two separate and distinct processes in the system: 1) products of incomplete combustion of fuel, and 2) decomposition of organic material in the kiln feed. Each CO and VOC formation process occurs under uniquely different conditions and are defined by the process technology and feed materials.

5.1 CO and VOC from Kiln Feed

For the purpose of this discussion, the pyroprocessing technology is confined to the preheater/precalciner design. In this design, raw meal is introduced to the exhaust gas stream from the preheater and preheated through a series of cyclones (stages) in a countercurrent flow design. In the process of heating, organic materials naturally occurring in the feed (kerogen and bitumin) are progressively heated and they begin to thermally degrade. The heating at relatively low temperature and at a low oxygen atmosphere results in complex organic molecules to be cracked, recombined, and re-ordered until the species are reduced to short-chain VOC's, CO, and/or carbon dioxide (CO_2). During the pyrolytic process, a significant fraction of the organic carbon is fully oxidized to CO_2.

Depending on the nature of the organics present in the feed materials, the location of the thermal decomposition in the preheater varies along with the degree of complete oxidation. The presence of light hydrocarbon species in the meal typically results in VOC and condensable hydrocarbons in the kiln preheater gases, but the CO concentrations are low. Conversely, complex hydrocarbons generally produce CO during decomposition, but low concentrations of VOC.

Depending on the geological strata of the feed materials, the composition and concentration of organic materials in the kiln feed (meal) may vary significantly. The spatial distribution within the deposit is both lateral and vertical, and cannot be mitigated by selective mining or material substitution. The level of contaminants in the kiln feed is unique to each site and results in site-specific CO and VOC emission rates.

The rate of conversion of meal carbon to CO_2 is influenced by the temperature profile of the preheater, the organic content of the kiln feed, and the composition of the organics in the kiln feed. Recent studies do not indicate that the oxygen content of the flue gases influences the CO emission rate. Papers published in Zement-Kalk-Gips also support the same conclusion. The temperature of the preheater stages is defined by the kiln and mix designs (C_3S, silica, etc.) and cannot be modified sufficiently to complete oxidation of CO and VOC in the preheater.

SAC is currently testing injection of fly ash at the SAC Branford Plant into the calciner to avoid exposure of organic material present in fly ash to low temperatures and the progressive heating as it travels through the upper regions of the preheater tower. SCC intends to have the ability to inject some portion of fly ash into the calciner region of the new kiln system. Typical fly ash contains organic compounds not combusted in the original combustion process (power generation) which are complex hydrocarbons. By injecting directly into the calciner, these complex hydrocarbons are exposed to conditions which can greatly reduce the VOC and CO emissions by more completely combusting and destroying the hydrocarbons due to exposure to the high temperatures present in the calciner. Operational and quality factors may limit the amount of fly ash that can be introduced in this manner, but SCC intends to optimize the use of fly ash injection into the calciner region and install equipment to allow for this process in the new kiln system.

5.2 CO and VOC from Incomplete Combustion

CO and VOC may also be produced as a product of incomplete combustion of fuel in the precalciner vessel. A modern precalciner burns fuel in suspension with meal. The precalciner vessel is designed to decarbonize (or calcine) the raw feed simultaneously with the combustion of fuel in suspension. This design allows use of liquid, gaseous, and solid fuels over a range of heat values and qualities (ash, moisture, etc.). Because of the continuous generation of thermal energy (combustion) and consumption of thermal energy due to the decarbonization, the temperatures are stabilized and the thermal variation is minimized. This process results in reduced thermal NO_x and promotes de-NO_x of kiln gases entering the precalciner. With this design, however, it is impossible to eliminate all CO that is normally associated with fuel combustion in a conventional combustion device such as a boiler. Typical CO concentrations after the precalciner and lowest preheater cyclone exit are between 250 and 1,500 ppm and VOC is low (i.e., 5 to 10 ppm).

The SCC design for NO_x control generates a reducing atmosphere zone to enhance NO_x reduction. CO generation will also be increased in this zone. The design functions in a similar manner to staged combustion in boilers. Theoretically, CO is not directly involved in the chemical reactions to reduce NO_x. An oxygen deficiency zone is needed to create more NHi radicals to reduce NO_x. CO is the result of this reducing atmosphere.

5.3 Review of Kiln Permit Limits

Review of literature and the BACT/LAER Clearinghouse indicates that proper design and operation (i.e., good combustion practice) represents BACT for CO and VOC in Portland cement kilns. Properly controlled combustion in the kilns minimizes CO and VOC formation by ensuring that temperatures and O_2 availability are adequate for complete combustion. CO and VOC emissions will primarily result from the decomposition of organic matter naturally contained in the raw material. A properly designed and operated cement kiln acts as a thermal oxidizer, converting 95 percent of the CO that is generated to CO_2. For the SCC kiln, the operating conditions of temperatures and a relative high excess O_2 availability are ideally suited for CO control.

The reducing atmosphere zone required for NO_x control will generate relatively high CO at the bottom of the precalciner. However, the extended combustion ducts on top of the precalciner and a final mixing zone increase the gas retention time and strongly enhance the mixing of the gas from the precalciner and the tertiary air with high oxygen content. These can enhance the combustion process and reduce CO to lower levels at the lower preheater stage exit. This is considered good combustion practice for burning fuel in a precalciner.

Table 5-1 summarizes the CO emission limits for precalciner kilns and Table 5-2 summaries the VOC emission limits for precalciner kilns. Where sufficient data were available, emissions were expressed in both annual average lb/h and lb/ton of clinker basis for comparison.

5.4 Available Control Technologies

Post combustion of volatile organics from painting, printing, and organic chemical processes is an accepted and proven technology. This control option is applied to clean gas streams containing minimal amounts of particulate matter. The processes include direct flame incineration and catalytic oxidation. Because of the presence of chlorides, phosphorus compounds, sulfur, and metals in the gas stream, catalytic oxidation is considered technically infeasible for control of CO and VOC in cement operations (due to catalyst fouling).

The arrangement of equipment used for direct incineration varies in the method of heat recovery to reduce fuel cost but not in the destruction processes. In general, the gas stream temperature must be increased above the auto ignition temperature with sufficient mixing and oxygen available for oxidation. Typical temperature for destruction of CO is 1,500°F or greater with an outlet oxygen content of greater than 3.5 percent.

TABLE 5-1
RBLC SUMMARY FOR CARBON MONOXIDE (CO)
PORTLAND CEMENT MANUFACTURING

RBLCID	FACILITY NAME	STATE	DATE DETERMINATION ENTERED INTO RBLC	PROCESS NAME	UNITS	CONTROL METHOD	EMISSION LIMIT 1	EMISSION LIMIT 1 UNITS	EMISSION LIMIT 1 AVG. TIME	EMISSION LIMIT 2	EMISSION LIMIT 2 UNITS	EMISSION LIMIT 2 AVG. TIME	EMISSION LIMIT 3	EMISSION LIMIT 3 UNITS	EMISSION LIMIT 3 AVG. TIME
AL-0200	CEMEX, INC.	AL	11/12/2003	KILN, CEMENT	T/H	NONE INDICATED.	725	LB/H		3.72	LB/T		0		
AR-0092	ASH GROVE CEMENT COMPANY	AR	1/22/2008	PH/PC KILN		GOOD COMBUSTION PRACTICES	2500	LB/H	8-HR AVERAGE	0			0		
FL-0267	THOMPSON S. BAKER- CEMENT PLANT (FRI)	FL	7/29/2005	IN LINE KILN/RAW MILL WITH ESP AND SNCR		PROCESS CONTROL	3.6	LB/T	24 HR	450	LB/H	24 HR	0		
FL-0268	BROOKSVILLE CEMENT PLANT (FCS)	FL	7/29/2005	125 TPH CLINKER KILN AND ASSOCIATED EQUIPMENT		PROCESS CONTROL AND RAW MATERIALS.	3.6	LB/TON CLINKER	24 HR	450	LB/H	24 HR	0		
FL-0270	TITAN FLORIDA PENNSUCO CEMENT PLANT	FL	12/22/2005	KILN WITH IN LINE RAW MILL	T/H	GOOD COMBUSTION	2	LB/T CLINKER	30 OPERATING-DAY	576	LB/H	24- HOUR BLOCK AVERAGE	0		
FL-0271	BRANFORD CEMENT PLANT (SUWANNE)	FL	12/23/2005	KILN W/IN LINE RAW MILL W/ SNCR AND BAGHOUSE	T/H clinker	GOOD COMBUSTION AND PROCESS CONTROL	2.9	LB/TON CLINKER	CEMS 30 DAYS ROLLING AVERAGE	368.3	LB/H	CEMS 30 DAYS ROLLING AVG	0		
FL-0281	SUMTER/CENTER HILL CEMENT PLANT	FL	9/28/2006	CEMENT PYROPROCESSING SYSTEM	T/H CLINKER	GOOD COMBUSTION PRACTICES	2.9	LB/T CLINKER	30-DAYS ROLLING	604.1	LB/H	30-DAYS ROLLING	0		
FL-0282	AMERICAN CEMENT COMPANY	FL	9/29/2006	CEMENT PYROPROCESSING SYSTEM	ton/h clinker	GOOD COMBUSTION PRACTICES	2.8	LB/T CLINKER	30-DAY AVERAGE	382.5	LB/H	30-DAY AVERAGE	0		
FL-0297	NORTH BROOKSVILLE CEMENT PLANT	FL	11/15/2007	KILN NO. 3 WITH PREHEATER, CALCINER, IN-LINE RAW MILL AND AIR HEATER	MMBTU/H	NONE INDICATED.	2	LB/T CLINKER	30-DAYS ROLLING CEMS	0			0		
GA-0134	HOUSTON AMERICAN CEMENT PLANT	GA	4/28/2010	MAIN KILN STACK ST35	T/H OF DRY FEED	PROPER EQUIPMENT OESIGN AND GOOD COMBUSTION OPERATING PRACTICE	2.9	LB/T CLINKER	30-DAY ROLLING AVG ON CO CEMS	382.5	LB/H		2.9	LB/T CLINKER	30-DAY ROLLING AVG BASED ON CO CEMS
GA-0136	CEMEX SOUTHEAST, LLC	GA	5/6/2010	MAIN KILN STACK K218	T/H OF DRY FEED	PROPER EQUIPMENT DESIGN AND GOOD COMBUSTION OPERATING PRACTICE	2.9	LB/T CLINKER	30-DAY ROLLING AVG. BASED ON CO CEMS	484	LB/H		2.9	LB/T CLINKER	30-DAT ROLLING AVG. BASED ON CO CEMS
IA-0052	LAFARGE CORPORATION	IA	2/5/2001	CEMENT MANUFACTURING, PREHEATER/PRECALCINER KILN	T/D	GOOD COMBUSTION PRACTICES	4.5	LB/TON OF CLINKER		0			0		
IA-0070	LEHIGH CEMENT COMPANY - MASON CITY PLANT	IA	12/11/2003	KILN/CALCINER/PREHEATER	T/H	PROPER KILN DESIGN AND OPERATION.	3.7	LB/T	LB/T OF CLINKER	0			0		
IL-0106	LAFARGE - GRAND CHAIN	IL	11/6/2008	KILN 3		GOOD COMBUSTION PRACTICES	2.5	LB/T	12-MONTH ROLLING AVERAGE	5	LB/T	8-HOUR BLOCK AVERAGE	0		
MO-0059	CONTINENTAL CEMENT COMPANY, LLC	MO	9/27/2002	ROTARY KILN	T/H	PYROCLON	12	LB/T	lb/t clinker, 1-hr rolling avg	10	LB/T	lb/t clinker, 8-hr rolling avg	0		
MO-0072	CONTINENTAL CEMENT COMPANY, L.L.C.	MO	5/8/2007	PORTLAND CEMENT KILN		THE NEW PH/PC KILN SYSTEM AND THE COAL MILL PREHEATER WILL UTILIZE GOOD COMBUSTION PRACTICES FOR BACT.	3.6	LB/T	CLINK	0			0		
SD-0003	GCC DACOTAH	SD	12/23/2002	MATERIAL TRANSFER, ALKALI	T/D	GOOD COMBUSTION PRACTICES	3250	LB/H		2002	T/YR		0		
SD-0003	GCC DACOTAH	SD	12/23/2002	ROTARY KILN #6	T/D	GOOD COMBUSTION PRACTICES	3250	LB/H		2002	T/YR		0		
SD-0003	GCC DACOTAH	SD	12/23/2002	COAL MILL	T/H	GOOD COMBUSTION PRACTICES	3250	LB/H		2002	T/YR		0		
TX-0355	PORTLAND CEMENT MANUFACTURING PLANT	TX	9/2/2003	GRINDING/ PREHEATING/ KILN, K-19		GOOD COMBUSTION PRACTICES AND GOOD COMBUSTION UNIT DESIGN.	460	LB/H		1932	T/YR		0		
TX-0488	TEXAS LEHIGH CEMENT	TX	12/29/2005	KILN EXHAUST (4)		BAGHOUSES	5298	LB/H		5528	T/YR		0		
VA-0272	ROANOKE CEMENT	VA	9/29/2003	LIME KILN	T/YR	GOOD COMBUSTION PRACTICES AND A CONTINUOUS EMISSION MONITORING SYSTEM.	600	LB/H		1950	T/YR		0		
VA-0283	ROANOKE CEMENT	VA	3/4/2004	CEMENT KILN SYSTEM, #5	T/YR	PROCESS CONTROL/GOOD COMBUSTION PRACTICES	3	LB/T		0			3	LB/T	
WA-0307	PORTLAND CEMENT CLINKERING PLANT	WA	7/28/2003	KILN EXHAUST STACK		NONE INDICATED.	1045	PPM @ 10% O2		538	LB/H	8-H AV	0		
WV-0022	MARTINSBURG PLANT	WV	8/2/2005	PRE-HEATER/PRE-CALCINER KILN	T/D	GOOD COMBUSTION PRACTICES	3960	LB/H	1-HR AVG.	4425.7998	T/YR	12-MONTH ROLLING	4	LB/TON CLINKER	

TABLE 5-2
RBLC SUMMARY FOR VOLATILE ORGANIC COMPOUNDS (VOC)
PORTLAND CEMENT MANUFACTURING

RBLCID	FACILITY NAME	STATE	DATE DETERMINATION ENTERED INTO RBLC	PROCESS NAME	UNITS	CONTROL METHOD	EMISSION LIMIT 1	EMISSION LIMIT 1 UNITS	EMISSION LIMIT 1 AVG. TIME	EMISSION LIMIT 2	EMISSION LIMIT 2 UNITS	EMISSION LIMIT 2 AVG. TIME	EMISSION LIMIT 3	EMISSION LIMIT 3 UNITS	EMISSION LIMIT 3 AVG. TIME
AL-0200	CEMEX, INC.	AL	11/12/2003	KILN, CEMENT	T/H	NONE INDICATED.	136	LB/H		0.698	LB/T		0		
AL-0203	HOLCIM (US), INC.	AL	5/3/2004	KILN SYSTEM (CALCINING KILN, PREHTR W/PRECALCINER)	T/H	NONE INDICATED.	2116	T/YR		0			0		
AR-0092	ASH GROVE CEMENT COMPANY	AR	1/22/2008	PH/PC KILN		GOOD COMBUSTION PRACTICES	27.5	LB/H	30-DAY ROLLING AVERAGE	0			0		
FL-0231	RINKER/MIAMI CEMENT PLANT	FL	4/25/2002	IN-LINE KILN/RAW MILL/CLINKER COOLER SYSTEM	T/H	PROPER COMBUSTION CONTROL AND RAW MATERIAL SELECTION. REASONABLE	0.12	LB/T	LB/TON CLINKER	16.6	LB/H		0		
FL-0267	THOMPSON S. BAKER- CEMENT PLANT (FRI)	FL	7/29/2005	IN LINE KILN/RAW MILL WITH ESP AND SNCR		PROCESS CONTROL	0.12	LB/T	30 DAY	15	LB/H	30 DAY	0		
FL-0268	BROOKSVILLE CEMENT PLANT (FCS)	FL	7/29/2005	125 TPH CLINKER KILN AND ASSOCIATED EQUIPMENT		PROCESS CONTROLS	0.12	LB/TON CLINKER	30 DAY	15	LB/H	30 DAY	0		
FL-0271	BRANFORD CEMENT PLANT (SUWANNE)	FL	12/23/2005	KILN W/IN LINE RAW MILL W/ SNCR AND BAGHOUSE	T/H clinker	GOOD COMBUSTION	0.12	LB/TON CLINKER	CEMS 30 DAYS BLOCK AVERAGE	15.2	LB/H	CEMS 30 DAYS BLOCK AVERAGE	0		
FL-0281	SUMTER/CENTER HILL CEMENT PLANT	FL	9/28/2006	CEMENT PYROPROCESSING SYSTEM	T/H CLINKER	NONE INDICATED.	0.115	LB/T CLINKER	30-DAY BLOCK	23.95	LB/H	30-DAY BLOCK	0		
FL-0282	AMERICAN CEMENT COMPANY	FL	9/29/2006	CEMENT PYROPROCESSING SYSTEM	ton/h clinker	NONE INDICATED.	0.12	LB/T CLINKER	30-DAY BLOCK	15	LB/H	30-DAY BLOCK	0		
FL-0297	NORTH BROOKSVILLE CEMENT PLANT	FL	11/15/2007	KILN NO. 3 WITH PREHEATER, CALCINER, IN-LINE RAW MILL AND AIR HEATER	MMBTU/H	NONE INDICATED.	0.115	LB/T CLINKER	30-DAY BLOCK	0			0		
GA-0134	HOUSTON AMERICAN CEMENT PLANT	GA	4/29/2010	MAIN KILN STACK ST35	T/H OF DRY FEED	JUDICIOUS SELECTION/USE OF RAW MATERIALS.	0.5	LB/T CLINKER	30 DAY ROLLIN AVG BASED ON THC CEMS	62.5	LB/H		0.5	LB/T CLINKER	30 DAY ROLLING AVG BASED ON THC CEMS
GA-0136	CEMEX SOUTHEAST, LLC	GA	5/6/2010	MAIN KILN STACK K218	T/H OF DRY FEED	JUDICIOUS SELECTION/USE OF RAW MATERIALS	0.5	LB/T CLINKER	30-DAY ROLLING AVG. BASED ON THE CEMS	80	LB/H		0.5	LB/T CLINKER	30-DAY ROLLING AVG. BASED ON THC CEMS
MO-0072	CONTINENTAL CEMENT COMPANY, L.L.C.	MO	5/9/2007	PORTLAND CEMENT KILN		THE NEW PH/PC KILN SYSTEM AND THE COAL MILL PREHEATER WILL UTILIZE GOOD COMBUSTION PRACTICES FOR BACT.	0.12	LB/T	CLINKER	0			0		
TX-0355	PORTLAND CEMENT MANUFACTURING PLANT	TX	9/2/2003	GRINDING/ PREHEATING/ KILN, K-19		NONE INDICATED	15	LB/H		63	T/YR		0		
TX-0466	TEXAS LEHIGH CEMENT	TX	12/29/2005	KILN EXHAUST (4)		BAGHOUSES	118.69	LB/H		258.58	T/YR		0		
VA-0272	ROANOKE CEMENT	VA	9/29/2003	LIME KILN	T/YR	GOOD COMBUSTION PRACTICES	126.4	LB/H		493	T/YR		0		
WV-0022	MARTINSBURG PLANT	WV	6/2/2005	PRE-HEATER/PRE-CALCINER KILN	T/D	GOOD COMBUSTION PRACTICES	38.7	LB/H	3-HOUR AVG.	154	T/YR	12 MONTH ROLLING AVG.	0.14	LB/TON CLINKER	12 MONTH ROLLING AVG.

Gases from the combined mill bypass exhaust contain 12.5 percent oxygen at a temperature of 220°F. These gases must be raised to greater than 1,500°F using combustion of natural gas. A thermal model of the process provides the heat input requirements for three methods of operation:

1. Direct-fired, no heat recovery
2. Direct-fired, recuperative heat recovery
3. Direct-fired, regenerative heat recovery.

There are no cement plants currently operating using a direct-fired afterburner or a recuperative type afterburner. There are, however, two plants which have employed a regenerative type afterburner (RTO). These are at TXI, Midlothian, Texas and Holcim, Inc., Dundee, Michigan. The TXI operation is a precalciner and the Dundee operation is a wet process kiln (2 units).

TXI, Midlothian, Texas

The system was installed during a plant expansion and was used to reduce CO and VOC emissions below a *de minimus* increase and therefore avoid PSD review. No BACT analysis was conducted and the Texas Natural Resource Conservation Commission (TNRCC) does not consider the use of an RTO as BACT under State or Federal requirements. The unit has experienced significant operational difficulties including higher than anticipated heat exchanger fouling and pressure drop. This has increased afterburner fuel costs and decreased kiln capacity. It should be noted that the uncontrolled CO emissions rate for the plant is between 5 and 8 lb/ton of clinker and a significant fraction of the heat input is from self-fueling that reduces fuel cost. It is also important that the plant operates a fabric filter for primary particulate control and a sulfur dioxide (SO_2) scrubber for SO_2 removal prior to the RTO. This unit is in the process of being decommissioned due to the high heat input, heat exchanger foaling, and impact on the process. This system is not longer in use at the TXI Plant but may be required to be operated in only the ozone season.

Holcim, Dundee, Michigan

Holcim operated two RTO systems on the exhaust of two wet process cement kilns. The mix used to produce the slurry for kiln feed contains a high concentration of kerogen. Kerogen and bitumen are organic species found in oil shale and precursors to petroleum deposits. The introduction of these species under progressive heating conditions, such as a wet kiln, result in fractional distillation of heavy hydrocarbons with minimal oxidation. Historically, the Dundee kilns have emitted condensable hydrocarbons, which formed visible plumes and an objectionable odor. In an effort to control these problems, the plant installed an RTO. The design was modified from the TXI configuration to include an open type (checker) heat exchanger that was expected to have less potential for fouling. The unit has been effective in control of visible emissions (VE) and odor but has experienced poor heat recovery, high fuel costs, and unusual maintenance problems. In some cases under high hydrocarbon loads, the unit has experienced high temperatures due to uncontrolled self-fueling. The units were installed to replace existing carbon injection systems for hydrocarbons and did not go through PSD or a BACT analysis. As a result of the failure of the mechanical system, they have been discontinued.

Controlled emissions are 0.12 lb/ton kiln feed, which is approximately twice that of the TXI facility. It would be expected that fouling would occur at a significantly higher rate resulting in high downtime for cleaning and/or high fuel impact due to reduced heat recovery. In most cases optimal heat recovery allows heat to be returned to the inlet of the preheater with incoming flue gases with an outlet gas temperature no greater than 150°F above the inlet. When the recovery surfaces are fouled, the outlet gas temperature increases, which decreases the amount of heat recovered. In order to maintain combustion set points more fuel must be fired. As the flue gas volume increases, as the result of additional fuel, heat exchanger efficiency decreases further and the total system degrades in performance.

As the system decreases in efficiency, manual cleaning of the heat exchanger surfaces is required. The deposits are composed of calcium oxide and calcium sulfate, which are hard to remove. In addition, when an ESP is used there is the potential for periodic deenergization due to CO spikes in the process, wire breaks, or process upsets. These events would overload the heat exchanger and prevent proper operation of the system.

There is also the partial conversion of SO_2 in the gas stream to sulfur trioxide (SO_3) during the oxidation process. Concentration of SO_2 and CO are high at the preheater outlet and flue gas oxygen after the grinding mills is greater than 10 percent (volume basis). These conditions result in a high kinetic energy reaction to further oxidize SO_2 to SO_3. This occurs in oil-fired boilers, which produces sulfate plumes. The exact conversion rate is not predictable, but only a few ppm in the stack gases will result in a visible aerosol when the stack gases cool below the acid dew point (i.e., 285°F). SO_3 aerosols have a monodisperse particle distribution near 0.5 μm and therefore exhibit a high light attenuation (i.e., opacity).

5.5 Summary of Impacts Analysis

Table 5-3 presents a summary of the cost analysis for an RTO to control CO and VOC. Other options such as direct and recuperative designs would have significantly higher fuel costs and therefore a higher cost per ton abated. For this reason a detailed analysis has not been completed for these scenarios. However, two scenarios were analyzed for CO. The first scenario (Line 1 of Table 5.3) assumes a 95 percent removal efficiency reflecting optimum CO removal on a long-term basis and the second scenario (Line 2 of Table 5.3) assumes a 79.1 percent removal efficiency to achieve 100 ppm in the exit gases. The detailed calculations are presented in Appendix C.

TABLE 5-3. SUMMARY OF IMPACT ANALYSIS FOR CO AND VOC

Method	% removal	Pollutant removed tons/yr	Capital Costs, MM $	Annualized Cost, MM $	Cost Effectiveness $/ton pollutant	Impacts		
						Environmental	Product	Energy
RTO/CO	95.0	1,872.5	25.6	10.8	5,784	Yes	No	Yes
RTO/CO	79.1	1,559.3	25.6	15.4	9,876	Yes	No	Yes
RTO/VOC	95.0	62.4	25.6	10.8	173,522	Yes	No	Yes

5.6 Selection of BACT

The addition of an RTO to reduce CO and VOC can be rejected on a cost effectiveness basis and negative environmental impacts. SCC proposes as BACT the use of good combustion practices for these pollutants. The requested BACT emission limits are 3.6 lb/ton clinker for CO based on a 30-day rolling average as measured by CEM and 0.12 lb/ton clinker for VOC as measured by an annual stack test consisting of three 1-hour stack tests.

SECTION 6

SUMMARY OF PROPOSED BACT EMISSION LIMITS

The proposed BACT controls and limits are summarized in Table 6-1. The pollutants PM, PM_{10}, $PM_{2.5}$, SO_2, NO_x, CO, and VOC are subject to BACT. Should the NSPS PM, SO_2, and NO_x emission limits remain unchanged associated with the current re-consideration of the Final Rule published on of September 9, 2010, SCC is committed to meet the most stringent PM, SO_2, and NO_x emission limit depicted in the columns entitled "PC MACT Emission Limits" and "Proposed SCC BACT Emission Limits" of Table 6-1.

TABLE 6-1
PROPOSED BACT LIMITS

POLLUTANT	OPERATION	VE (%)	CONTROL TECHNOLOGY	PC MACT EMISSION LIMITS[4]	PROPOSED SCC BACT EMISSION LIMITS[1]
PARTICULATE MATTER (PM)	KILN/IN-LINE RAW MILL/CLINKER COOLER[6]	10	FABRIC FILTER BAGHOUSE	0.01 LBS/TON CLINKER	0.008 GR/DSCF (PM FILTERABLE ONLY)[7]
	ALL OTHER PLANT POINT SOURCES	5	FABRIC FILTER BAGHOUSE	NONE	0.01 GR/DSCF (PM FILTERABLE ONLY)[7]
	ALL PLANT FUGITIVE SOURCES, EXCEPT THE PRIMARY CRUSHER AND FUGITIVE SOURCES NOT SUBJECT TO NSPS OOO[5]	5	BEST MANAGEMENT PRACTICE	NONE	NONE
	ALL PLANT FUGITIVE SOURCES SUBJECT TO NSPS OOO[5] EXCEPT FOR THE PRIMARY CRUSHER	7	BEST MANAGEMENT PRACTICE	NONE	NONE
	QUARRY CRUSHER FUGITIVE SOURCE SUBJECT TO NSPS OOO[5]	12	BEST MANAGEMENT PRACTICE	NONE	NONE
PARTICULATE MATTER (PM_{10} AND $PM_{2.5}$)	KILN/IN-LINE RAW MILL/CLINKER COOLER[6]	NONE	FABRIC FILTER BAGHOUSE	NONE	NO LIMIT PROPOSED FOR PM_{10} NO LIMIT PROPOSED FOR $PM_{2.5}$
	ALL OTHER PLANT POINT SOURCES	NONE	FABRIC FILTER BAGHOUSE	NONE	0.085 GR/DSCF (PM_{10} FILTERABLE ONLY) 0.030 GR/DSCF ($PM_{2.5}$ FILTERABLE ONLY)
	PROCESS FUGITIVES	NONE	BEST MANAGEMENT PRACTICE	NONE	NONE
SULFUR DIOXIDE (SO_2)	KILN	N/A	INHERENT DRY SCRUBBING AND HYDRATED LIME INJECTION	0.40 LBS/TON CLINKER	0.27 LBS/TON CLINKER[8], 30-DAY ROLLING AVERAGE
NITROGEN DIOXIDE (NO_x)	KILN	N/A	SNCR, MULTI-STAGE COMBUSTION, LOW NO_x BURNER, AND INDIRECT FIRING	1.50 LBS/TON CLINKER	1ST YEAR: 3.0 LB/TON CLINKER[2,3,8] 30-DAY ROLLING AVERAGE
					2ND YEAR AND THEREAFTER: 1.95 LB/TON CLINKER[2,7,8] 30-DAY ROLLING AVERAGE
CARBON MONOXIDE (CO)	KILN	N/A	GOOD COMBUSTION PRACTICE	NONE	3.60 LBS/TON CLINKER[8], 30-DAY ROLLING AVERAGE
ORGANIC COMPOUNDS (VOC)	KILN	N/A	GOOD COMBUSTION PRACTICE	NONE	0.12 LBS/TON CLINKER[8], 30-DAY ROLLING AVERAGE

NOTES:

1. Emission limits apply to all combination of fuels being burned.
2. Excludes start-up, shutdown, and malfunction as approved by the FL DEP.
3. Allows for shakedown and optimization of the SNCR system.
4. Per 40 CFR 63 Subpart LLL, September 9, 2010. These rules are currently being re-considered by the U.S. EPA.
5. New Source Performance Standard, 40 CFR 60, Subpart OOO, April 28, 2009.
6. Kiln, In-Line Raw Mill, and Clinker Cooler exhaust to a common stack.
7. Based on review of RBLC. Please refer to Tables 2-1 through 2-9.
8. Based on SCC engineering studies.

APPENDIX A

COST CALCULATIONS FOR SO_2

KILN PRODUCTION AND SO_2 DATA

PLANT NAME	KILN NO.	PRODUCTION[1]	CAPACITY[1]	CLINKER	CLINKER	OPERATION	SO_2	SO_2	SO_2	SCRUBBER SO_2	STACK GASES - ACFM	
		T/YR	T/YR	MAX T/HR	AVG T/HR	HR/YR	T/YR	LB/TON	AVG LB/HR	AVG PPM	KILN	QUENCHED
SCC	1	1,095,000	1,095,000	125.00	125.00	8,760	147.83	0.27	33.8	27.7	399,545	278,376

NOTE:

1. REPRESENTS ANNUAL CLINKER PRODUCTION

SUMMARY OF SO_2 CONTROL COST DATA

PLANT NAME	KILN NO.	BASELINE SO_2 EMISSIONS		CONTROL TECHNOLOGY	EXPECTED REMOVAL		CAPITAL	ANNUAL	CONTROL COST	UNIT COST
		T/YR	LB/TON		%	T/YR	COST $	COST $/YR	$/TON SO_2	$/TON CLINKER
SCC	1	147.8	0.27	DRY SCRUBBER	32.8	46.0	2,168,825	680,399	13,372	0.62
		147.8	0.27	WET ABSORBENT ADDITION[1]	40.0	5.9	3,170,879	734,600	124,235	0.67
		147.8	0.27	WET SCRUBBER[2]	70.0	110.1	27,462,404	9,278,146	84,248	8.47

NOTES:

1. WET ABSORBENT WOULD ONLY BE ADDED WHEN THE RAW MILL IS DOWN DUE TO WATER SPRAY RATE LIMITATION. THIS WOULD BE EXPECTED TO OCCUR DURING 438 HOURS OUT OF THE TOTAL OF 8,760 ANNUAL KILN OPERATING HOURS PER YEAR.
2. EXPECTED CONTROL EFFICIENCY FOR WET SCRUBBER IS 70% WITH RAW MILL ON AND 80% WITH RAW MILL OFF.

EXPECTED SO_2 CONCENTRATION AT CONTROL POINT

PLANT NAME	KILN NO.	WET SCRUBBER INLET PPM	WET LIME		DRY LIME	
			PPM	LOCATION	PPM	LOCATION
SCC	1	27.7	16	RAW MILL DOWN	16	DOWNCOMER

SUMMARY OF CONTROL OPTIONS
SO_2 EMISSION FACTORS

PLANT NAME	KILN NO.	CURRENT[1] LB/TON	WET SCRUBBER LB/TON	WET LIME[2] LB/TON	DRY LIME[3] LB/TON
SCC	1	0.27	0.07	0.26	0.19

NOTES:

1. REPPRESENTS INHERENT DRY SCRUBBING
2. WET ABORBENT WOULD ONLY BE USED WHEN THE RAW MILL IS OFF DUE TO WATER SPRAY LIMITIATIONS. THIS IS ESTIMATED TO BE 5 PERCENT OF THE TOTAL KILN ANNUAL OPERATING HOURS (416 HOURS/YEAR)
3. DRY ABSORBENT (I.E., DRY SCRUBBING)

BACT DATA NEEDS

POWER COST	0.04239 $/KWH	
PROPERTY TAX RATE	2.4316 $/100 @ 60% 1.4590 %	
CAPITAL RECOVERY RATE	10 %	
LABOR COSTS		
SUPERVISOR	39.54 $/HR	
KILN OPERATOR	33.17 $/HR	
1ST CLASS MAINTENANCE	25.96 $/HR	
1ST CLASS ELECTRICIAN	25.96 $/HR	
1ST CLASS WELDER	25.96 $/HR	
GENERAL LABOR	18.00 $/HR	
NATURAL GAS	6.27 $/GJ	5.945 $/MMBTU
FUEL OIL	0.00 $/GJ	$/MMBTU
COAL	3.71 $/GJ	3.52 $/MMBTU
COKE	0.00 $/GJ	$/MMBTU
CKD DISPOSAL	0.00 $/TONNE	0 $/TON
SOLID WASTE DISPOSAL	58.97 $/TONNE	65 $/TON
MICROFINE LIME	54.43 $/TONNE	60 $/TON
LIMESTONE	22.68 $/TONNE	25 $/TON
WATER COST	0 $/M3	0 $/MM gal
WATER TREATMENT	2.00 $/M3	7571 $/MM gal

SUMTER CEMENT COMPANY
DESIGN DATA

PRODUCTION DATA				
PRODUCTION	2,722	MT/D	3,000.0	ST/D
EQUIVALENT	365.00	Days/yr	365.00	Days/yr
	993,377	MT/YR	1,095,000	ST/YR
PLANT CAPACITY	100.0	%	125.00	ST/HR
SO2 FACTOR	0.14	Kg/Tonne	0.27	LB/TON
SO2 ANNUAL EMISSIONS	134.1	Tonnes/yr	147.8	TON/YR
AVERAGE ANNUAL HOURLY	15.3	Kg/HR	33.8	LB/HR
MAX HOURLY MILL-ON	-	-	33.8	LB/HR
MAX HOURLY MILL-OFF	-	-	67.5	LB/HR
RATIO			2	

KILN OPERATING HOURS	8,760	-	OPERATING HRS PER YEAR
RAW MILL-ON	8,322	95.0	% OF OPERATING HRS
RAW MILL-OFF	438	5.0	% OF OPERATING HRS

STACK FLOW DATA		
UNITS	**MILL-ON**	**MILL-OFF**
NM3/HR	573,820	380,760
SCFM	369,680	245,302
ACFM	464,200	309,550
DSCFM	310,216	244,360
TEMP F	203	400

INLET TO PREHEATER CYCLONE	
UNITS	**MILL-OFF**
NM3/HR	322,123
SCFM	207,525
ACFM	399,320
DSCFM	225,300
TEMP F	472
TEMP C	230

Ca(OH)2 ABSORBENT INJECTION FOR SO_2 ABATEMENT (LIME SLURRY)

MILL OFF SCENARIO

INLET GASES FROM KILN PREHEATER CYCLONE

FLOWRATE	**322,123**	NM3/HR	207,515	SCFM
FLOWRATE	593,622	M3/HR	356,234	ACFM
H2O	36,325	NM3/HR	23,402	WSCFM
DRY GAS	285,798	NM3/HR	184,124	DSCFM
TEMPERATURE	230	C	446	F

SPECIES	%	NM3/HR	SCFM	LB/MIN	KG/MIN	Cp BTU/LB-F	Cp KJ/Kg-K	h BTU/MIN	h KJ/MIN
H2O	11.28	36324.8	22834.8	1066.5	484.8	1258.1	602.7	1,341,820	1273
CO2	21.30	68628.0	43141.4	4930.5	2241.1	0.2195	0.0584	448,548	426
O2	3.49	11251.5	7073.0	587.0	266.8	0.2185	0.0581	53,139	50
N2	66.03	212689.9	133702.7	9709.7	4413.5	0.2509	0.0668	1,009,589	958
SO2	0.00	10.5	3.4	0.6	0.3	0.2195	0.0584	51	0
NO	0.00	0.0	0.0	0.0	0.0	0.2195	0.0584	0	0
CO	0.06	180.6	113.5	8.2	3.7	0.2195	0.0584	750	1
TOTAL	102.161376	**329,085**	207,515	16302	7410			2,853,898	2708

WATER ADDED

SO2 16.33 PPM

FLOW	15.92	TONNE/HR
	265.36	KG/MIN
	70.00	GPM
	583.80	LB/MIN
QUENCHED TEMPERATURE	253	C
	488	F

SPECIES	%	NM3/HR	SCFM	LB/MIN	KG/MIN	Cp BTU/LB-F	Cp KJ/Kg-K	h BTU/MIN	h KJ/MIN
H2O	16.11	56208	35333.9	1650.3	750.2	1277.0	611.8	2,107,486	2000
CO2	23.44	68628	43141.4	4930.5	2241.1	0.2214	0.059	497,656	472
O2	3.84	11252	7073.0	587.0	266.8	0.2189	0.058	58,561	56
N2	72.65	212690	133702.7	9709.7	4413.5	0.2514	0.067	1,112,501	1056
SO2	0.00	3	2.0	0.3	0.2	0.2214	0.059	34	0
NO	0.00	0	0.0	0.0	0.0	0.2214	0.059	0	0
CO	0.06	181	113.5	8.2	3.7	0.1990	0.053	748	1
TOTAL	100	348961	219367	16886	7675			3,776,985	3583

DIFFERENCE 923086

OPERATION	438	HR/YR	MILL-DOWN
PRODUCTION	2,722	TONNES/DAY	
	113.40	TONNES/HR	
SO2 UNCONTROLLED	0.5952	KG/TONNE	
	30.6818	KG/HR	
	67.5000	LB/HR	
	14.7825	T/YR	MILL-OFF

SO2 REMOVED	12.2727 KG/HR	
	27.0000 LB/HR	
	0.1082 KG/KG CLINKER	
	5.913 T/YR	
CONTROLLED SO2	18 KG/HR	
	40.50 LB/HR	
	8.87 T/YR	
LIME INJECTION RATE	2.5 LB Ca/LB S	
	84 LB/HR Ca	
	156 LB/HR Ca(OH)2	
H2O	35028 LB/HR	
	30660 GAL/YR	
TOTAL	35184 LB/HR	
SLURRY SOLIDS	0.44 %	
PARTICLE SIZE	25 um	
SO2 REMOVAL EFFICIENCY	40 %	AVERAGE
	100 %	AVAILABILITY
	40 %	**ANNUAL**
GYPSUM FORMATION	57 LB/HR	
LIME REACTED	32 LB/HR	
UNREACTED LIME	53 LB/HR	
LOADING TO BAGHOUSE	110 LB/HR	
BAGHOUSE REMOVAL	100 %	
COLLECTED DUST	110.2 LB/HR	
WASTE DUST	0 T/YR	RETURNED
LIME USED	34 T/YR	
	1.485 LOADS/YR	

STEAM ENTHALPY AT ATMOSPHERIC PRESSURE

	A0	A1	A2	C
H2O	4.5630E-01	1.6660E-05	2.2320E-07	1.0690E+03

ESTIMATED COST OF EQUIPMENT SLURRY INJECTION

ITEM	BASE	FACTOR	INSTALLATION	SUBTOTAL	TOTAL
SKID/VALVE RACK					
LANCES/NOZZLES					
PIPING					
INSTRUMENTS					
MIX TANK					
SILO/BH					
REAGENT PUMPS					
AGGITATOR					
WEIGHT FEEDER					
UNLOADING PANEL					
PLC					
SOFTWARE					
N2 SYSTEM					
SUBTOTAL	1426501.25	0.75	1069875.941	2496377.2	
FREIGHT	10374.55458				
TOTAL	**$ 1,436,876**		**$ 1,069,876**	**$ 2,506,752**	**$ 2,506,752**
DUCTS	0	4	0	0	
CYCLONE	0	0.5	0	0	
AIRLOCKS	0	0.2	0	0	
BIN	0	0.2	0	0	
F-K PUMP	0	0.2	0	0	
PIPING	0	2	0	0	
DIVERTER VALVES	0	0.1	0	0	
SILO	0	4	0	0	
LOAD OUT	0	0.2	0	0	
SUBTOTAL	0		0	0	
FREIGHT	0				
TOTAL	0		0	0	**0**
INSTALLED COST					**$ 2,506,752**

COST ESTIMATE
SPRAY DRYING IN CT TOWER (LIME SLURRY ABSORBENT)

PLANT SIZE		CURRENT CAPACITY	**1,095,000**	TON/YR
			FACTOR	COST
CAPITAL COSTS				
DIRECT COST				
	REAGENT SYSTEM	LANCES,NOZZLES		
		VALVES,PUMPS		
		DUCTWORK		
		CYCLONE,BINS		
		ELECTRICAL		
		PIPING		
		MISCELLANEOUS EQUIPMENT		
				1,426,501
	EQUIPMENT	TOTAL		1,426,501
	OTHER	INSTRUMENTS		
		TAXES	0.06	85,590
		FREIGHT		10,375
		TOTAL		1,522,466
	INSTALLATION	FOUNDATIONS		
		ERECTION		
		ELECTRICAL		
		DUCTING		
		INSULATION		
		SITE PREPARATION		
		TOTAL		1,069,876
DIRECT COSTS		TOTAL		2,592,342
INDIRECT COSTS		ENGINEERING/DESIGN	0.10	152,247
		CONST/FIELD EXPENSE	0.10	152,247
		CONTR.FEE	0.05	76,123
		START-UP	0.02	30,449
		PERFORMANCE TEST	0.01	15,225
		CONTINGENCIES	0.10	152,247
		TOTAL		578,537
RETROFIT PREMIUM (N/A)				0
TOTAL CAPITAL COST		**SCC**	**$**	**3,170,879**

COST ESTIMATE
SPRAY DRYING IN CT TOWER (LIME SLURRY ABSORBENT)

OPERATING COST(DIRECT)

UTILITIES			
	TRANSFER PUMP	5.00	BHP
	REAGENT PUMP	2.00	BHP
	AGGITATOR MOTOR	10.00	BHP
	BLOWER COMPRESSOR	100.00	BHP
	CONNECTED LOAD	117.00	BHP
	POWER	87.25	KWHr
	HOURS OPERATED	438	HRS
	ELECTRICAL COST	0.0424	$/KWHr
	ANNUAL COST	1,620	$/YR
REAGENT	REAGENT USAGE	34	T/YR
	COST	60.00	$/TON
	ANNUAL COST	2,049	$/YR
WASTE DISPOSAL	CKD	0	TON/YR
		0.00	$/TON
	COST	0	$/YR
WATER USAGE	DISCHARGE	30660	GAL/YR
	COST	0.00	$/MMGAL
	ANNUAL COST	0	$/YR
MAINTENANCE LABOR & MATERIALS			
	5% OF DIRECT CAPITAL COST	129,617	$/YR

MAINTENANCE	LABOR	HR/YR	500
	COST	$/HR	25.96
	COST	$/YR	12,980
LABOR	LABOR	HR/YR	500
	COST	$/HR	18.00
	COST	$/YR	9,000
SUPERVISOR	LABOR	HR/YR	200
	COST	$/HR	39.54
	COST	$/YR	7,908
FUEL SAVINGS		$/YR	$0
TOTAL DIRECT OPERATING COST		$/YR	$163,174

COST ESTIMATE
SPRAY DRYING IN CT TOWER (LIME SLURRY ABSORBENT)

OPERATING COST(INDIRECT)	OVERHEAD	%		44.00
		$/YR		13,151
	PROPERTY TAX	%		1.46
		$/YR		46,262
	INSURANCE	%		1.00
		$/YR		31,709
	ADMINISTRATION	%		2.00
		$/YR		63,418
	CAPITAL RECOVERY	%-INTEREST		10.00
		LIFE-YEARS		15.00
		FACTOR		0.131474
		$/YR		416,887
TOTAL INDIRECT OPERATING COST		$/YR	**$**	**571,426**
TOTAL ANNUAL COST		**$/YR**	**$**	**734,600**
ANNUAL EMISSIONS REDUCTION		TON/YR		**5.91**
COST BENEFIT		**$/TON**	**$**	**124,235**

KILN CONDITIONS RAW MILL OFF

STACK

	SCFM	LB/MIN	% WET
H2O	35899.0	1676.7	14.6
CO2	44209.1	5052.5	18.0
O2	8808.3	731.0	3.59
N2	155402.6	11293.8	63.4
SO2	6.8	1.1	0.003
NO	0.0	0.0	0.0
CO	116.3	8.5	0.047
TOTAL	**245,284**	18,764	99.7

WATER INJECTED	70.00 GPM
	583.8 LB/MIN
AIR LEAKAGE	6725.3 LB/MIN
O2	1560.3 LB/MIN
N2	5165.0 LB/MIN

PREHEATER INLET

	SCFM	LB/MIN	%
H2O	23399.9	1092.9	11.3
CO2	44209.1	5052.5	21.3
O2	7248.1	731.0	3.49
N2	137011.6	11293.8	66.0
SO2	6.8	1.1	0.0
NO	0.0	0.0	0.0
CO	116.3	8.5	0.1
TOTAL	**207,507**	18179.8	102.2
NM3/HR	**322,095**		

3 TARGET

DRY LIME INJECTION SYSTEM
(DRY SCRUBBING WHEN RAW MILL IS OFF)

OPERATION	438	HR/YR	MILL-OFFCONDITION	
PRODUCTION	2,722	TONNES/DAY		
	113.40	TONNES/HR		
SO2 UNCONTROLLED	0.270565	KG/TONNE		
	30.68182	KG/HR		
	67.5	LB/HR		
	14.7825	T/YR	MILL-OFF	
			TEMP	
SO2 REMOVED	32.8	%	AVE	230.2 C
	100	%	AVAILABILITY	
	32.8	%	ANNUAL	
SO2 REMOVED	10.05793	KG/HR		
	22.12744	LB/HR		
	0.088695	KG/KG CLINKER		
	4.85	**T/YR**		
CONTROLLED SO2	21	KG/HR		
	45	LB/HR		
	9.94	T/YR	MILL-DOWN	
LIME INJECTION RATE	15	LB Ca/LB S		
	506	LB/HR Ca		
	935	LB/HR Ca(OH)2		
GYPSUM FORMATION	47	LB/HR		
LIME REACTED	26	LB/HR		
UNREACTED LIME	480	LB/HR		
LOADING TO CYCLONE	527	LB/HR		
CYCLONE REMOVAL	0	%		
COLLECTED DUST	0.0	LB/HR		
WASTE DUST	0	T/YR	RETURNED TO PROCESS	
LIME USED	205	T/YR		

DRY LIME INJECTION SYSTEM
(DRY SCRUBBING - RAW MILL ON)

OPERATION	8322 HR/YR	MILL-ON CONDITION	
PRODUCTION	2,722 TONNES/DAY		
	113.40 TONNES/HR		
SO2 UNCONTROLLED	0.135282 KG/TONNE		
	15.34091 KG/HR		
	33.75 LB/HR		
	140.4338 T/YR	MILL-ON	
			TEMP
SO2 REMOVED	32.8 %	AVE	230.2 C
	100 %	AVAILABILITY	
	32.8 %	**ANNUAL**	
SO2 REMOVED	5.028963 KG/HR		
	11.06372 LB/HR		
	0.044347 KG/KG CLINKER		
	46.04 T/YR		
CONTROLLED SO2	10 KG/HR		
	23 LB/HR		
	94.40 T/YR	MILL-ON	
LIME INJECTION RATE	15 LB Ca/LB S		
	253 LB/HR Ca		
	468 LB/HR Ca(OH)2		
GYPSUM FORMATION	24 LB/HR		
LIME REACTED	13 LB/HR		
UNREACTED LIME	240 LB/HR		
LOADING TO CYCLONE	264 LB/HR		
CYCLONE REMOVAL	0 %		
COLLECTED DUST	0.0 LB/HR		
WASTE DUST	0 T/YR	RETURNED TO PROCESS	
LIME USED	1946 T/YR		

ESTIMATED COST OF EQUIPMENT

ITEM	BASE	FACTOR	INSTALLATION	SUBTOTAL	TOTAL
PIPING					
INSTRUMENTS					
SILO/BH					
FAN/INJECTOR					
WEIGHT FEEDER					
UNLOADING PANEL					
PLC					
SOFTWARE					
SUBTOTAL	778091.5936	0.75	583568.6952	1361660.3	
FREIGHT	10374.55458				
TOTAL	**788466.1482**		**583568.6952**	**1372034.8**	**1372034.843**
DUCTS	213180	0.5	106590	319770	
CYCLONE	0	0.5	0	0	
AIRLOCKS	0	0.2	0	0	
BIN	0	0.2	0	0	
F-K PUMP	0	0.2	0	0	
PIPING	0	2	0	0	
DIVERTER VALVES	0	0.1	0	0	
SILO	0	4	0	0	
LOAD OUT	0	0.2	0	0	
SUBTOTAL	213180		106590	319770	
FREIGHT	10374.55458				
TOTAL	**$ 223,555**		**$ 106,590**	**$ 330,145**	**$ 330,145**
INSTALLED COST					**$ 1,702,179**

COST ESTIMATE
DRY LIME INJECTION (DRY SCRUBBING)

PLANT SIZE			CURRENT CAPACITY	**1,095,000**	TON/YR
				FACTOR	COST
CAPITAL COSTS					
	DIRECT COST				
		DRY SYSTEM	SILO/FILTER		
			BLOWERS		
			DUCTWORK		
			CYCLONE,BINS		
			ELECTRICAL		
			PIPING		
			MISCELANEOUS EQUIPMENT		
		EQUIPMENT	TOTAL		991,272
		OTHER	INSTRUMENTS		
			TAXES	0.06	59,476
			FREIGHT		20,749
			TOTAL		**1,071,497**
		INSTALLATION	FOUNDATIONS		
			ERECTION		
			ELECTRICAL		
			DUCTING		
			INSULATION		
			SITE PREPARATION		
			TOTAL		690,159
	DIRECT COSTS		**TOTAL**		**1,761,656**
	INDIRECT COSTS		ENGINEERING/DESIGN	0.10	107,150
			CONST/FIELD EXPENSE	0.10	107,150
			CONTR.FEE	0.05	53,575
			START-UP	0.02	21,430
			PERFORMANCE TEST	0.01	10,715
			CONTINGENCIES	0.10	107,150
			TOTAL		**407,169**
	RETROFIT PREMIUM (N/A)				0
	TOTAL CAPITAL COST		**HAC**	**$**	**2,168,825**

COST ESTIMATE
DRY LIME INJECTION (DRY SCRUBBING)

OPERATING COST(DIRECT)

UTILITIES	BH FAN STATIC PRESSURE	8.00	IN H2O
	FAN VOLUME	1000	ACFM
	FAN POWER	15.00	BHP
	FK PUMP STATIC PRESSURE	40.00	IN H2O
	BLOWER VOLUME	500	ACFM
	FAN POWER	50.00	BHP
	CONNECTED LOAD	65.00	BHP
	POWER	48.47	KWHr
	HOURS OPERATED	8760	HRS
	ELECTRICAL COST	0.0424	$/KWHr
	ANNUAL COST	17,999	$/YR
REAGENT	REAGENT USAGE	2,151	TON/YR
	COST	60.00	$/TON
	ANNUAL COST	129,069	$/YR
WASTE DISPOSAL	CKD	0	TON/YR
		0.00	$/TON
	COST	0	$/YR
MAINTENANCE LABOR & MATERIALS	5% OF DIRECT CAPITAL COST	108,441	$/YR

MAINTENANCE	LABOR	HR/YR	500
	COST	$/HR	25.96
	COST	$/YR	12,980
LABOR	LABOR	HR/YR	500
	COST	$/HR	18.00
	COST	$/YR	9,000
SUPERVISOR	LABOR	HR/YR	200
	COST	$/HR	39.54
	COST	$/YR	7,908
FUEL SAVINGS		$/YR	$0
TOTAL DIRECT OPERATING COST		$/YR	$285,398

COST ESTIMATE
DRY LIME INJECTION (DRY SCRUBBING)

OPERATING COST(INDIRECT)	OVERHEAD	%	44.00
		$/YR	13,151
	PROPERTY TAX	%	1.46
		$/YR	31,642
	INSURANCE	%	1.00
		$/YR	21,688
	ADMINISTRATION	%	2.00
		$/YR	43,376
	CAPITAL RECOVERY	%-INTEREST	10.00
		LIFE-YEARS	15.00
		FACTOR	0.131474
		$/YR	285,144
TOTAL INDIRECT OPERATING COST		$/YR	395,001
TOTAL ANNUAL COST		**$/YR**	**$ 680,399**
ANNUAL EMISSIONS REDUCTION		TON/YR	50.88
COST BENEFIT		**$/TON**	**$ 13,372**
PERCENT SO2 REMOVAL EFFICIENCY			32.8

DESIGN BASIS FOR WET SCRUBBER SYSTEM

INLET TO KILN STACK (MILL-OFF)

FLOWRATE	380,760 NM3/HR	245,302 SCFM	
FLOWRATE	607,201 M3/HR	399,545 ACFM	
H2O	57,114 NM3/HR	36,795 WSCFM	
DRY GAS	323,646 NM3/HR	208,507 DSCFM	
TEMPERATURE	162.4 C	400 F	**MILL DOWN WORST CASE**

SPECIES	%	NM3/HR	SCFM	LB/MIN	KG/MIN	Cp BTU/LB-F	Cp KJ/Kg-K	h BTU/MIN	h KJ/MIN
H2O	15.00	57107.0	35899.0	1676.7	762.2	1128.5	540.7	1,892,243	1795
CO2	18.47	70326.4	44209.1	5052.5	2296.6	0.2065	0.0550	136,079	129
O2	3.68	14012.0	8808.3	731.0	332.3	0.2156	0.0574	20,560	20
N2	62.81	239061.4	155402.6	11293.8	5133.5	0.2478	0.0660	365,043	346
SO2	0.003	12.4	6.8	1.13	0.5	0.2065	0.0550	30	0
NO	0.00	0.0	0.0	0.0	0.0	0.2065	0.0550	0	0
CO	0.06	213.1	116.3	8.5	3.8	0.2065	0.0550	228	0
TOTAL	100.02	380,726	244,442	18764	8529			2,414,183	2290

SATURATION	0.113 LB/LB-DA	**AVG. SO2 PPM**	**27.7**
TEMPERATURE	125.5 F		
	51.9 C		
	525.1 K		

SO2 REMOVAL	**80 %**	**AVERAGE**
	100 %	AVAILABILITY
	80 %	ANNUAL

SPECIES	%	NM3/HR	SCFM	LB/MIN	KG/MIN	Cp BTU/LB-F	Cp KJ/Kg-K	h BTU/MIN	h KJ/MIN
H2O	16.59	65966	41468.2	1936.9	880.4	1111.7	532.6	2,153,139	2043
CO2	21.20	70326	44209.1	5052.5	2296.6	0.2048	0.055	96,732	92
O2	4.22	14012	8808.3	731.0	332.3	0.2153	0.057	14,711	14
N2	74.52	247209	155402.6	11293.8	5133.5	0.2474	0.066	261,215	248
SO2	0.00	2	1.4	0.2	0.1	0.2048	0.055	4	0
NO	0.00	0	0.0	0.0	0.0	0.2048	0.055	0	0
CO	0.06	185	116.3	8.5	3.8	0.2048	0.055	162	0
TOTAL	100.00	397701	250006	19023	8647			2,525,964	2397

SO2 REMOVED	54.00 LB/HR
HR/YR	438 HR/YR
	11.83 T/YR

INLET GAS VOLUME	7889	AM3/MIN
QUENCHED FLOWRATE	**278,376**	**ACFM**
SCRUBBER DIAMETER	6.7	M
SCRUBBER AREA	35.2	M2
VELOCITY	224.0	M/MIN
HEIGHT/DIAMETER	4.0	
HEIGHT	26.8	M
LIQUID GAS RATIO	7.13	M3/KM3
RECIRCULATION	56.2	M3/MIN
	14786.9	GAL/MIN
HEAD	21.3	M
DENSITY	1.15	
OXIDATION BLOWER	3	M3/M3
	168.74	NM3/MIN
HEAD	6.63	M
	261.0	IN WC
REAGENT FEED	0.5	M3/MIN
	131.4	GAL/MIN
HEAD	29.8	M
DENSITY	1.25	
GYPSUM SLURRY	1.7	M3/MIN
	436.4	GAL/MIN
	29.8	M
	1.25	
SLURRY DISCHARGE	0.75	M3/MIN
	197.0	GAL/MIN
	16.2	M
	1.15	

WATER MAKEUP

GYPSUM PRODUCTION

SO2 REMOVED		24.5	KG/HR	
SULFUR		12.3	KG/HR	
GYPSUM		52.4	KG/HR	ANHYDRATE
		66.2	KG/HR	HYDRATED
WATER		13.8	KG/HR	HYDRATED
PRODUCTION		2,722	TONNE/DAY	
		113.4	TONNE/HR	
GYPSUM		0.58	KG/TONNE	
		290	TONNE/YR	
FREE MOISTURE		10	%	
REAGENT USAGE	CaCO3	38.5	KG/HR	
		0.3	KG/TONNE	
		168.8	TONNE/YR	
WATER LOSS	FREE	6.6	KG/HR	
	HYDRATE	13.8	KG/HR	
STACK WATER LOSS		7094.2	KG/HR	
BLOWDOWN	TOTAL	0.63	%	
(RECIRC)	TOTAL	0.4	M3/MIN	
	WATER	19.9	M3/HR	
		19,881	KG/HR	
SOLIDS (WEIGHT)		6.2	%	
WATER MAKE-UP		26,995	KG/HR	
		0.45	M3/MIN	
		118.68	GPM	
SO2 REMOVAL	BASELINE	0.135	KG/TONNE	
	PRODUCTION	993,377	TONNE/YR	
		134	TONNE/YR	
		148	T/YR	
	CONTROLLED	27	TONNE/YR	
		30	T/YR	
	REDUCTION	107	TONNE/YR	
		118	**T/YR**	

B. STEAM ENTHALPY AT ATMOSPHERIC PRESSURE

	A0	A1	A2	C
H2O	4.5630E-01	1.6660E-05	2.2320E-07	1.0690E+03

DESIGN BASIS FOR WET SCRUBBER SYSTEM

INLET GASES FROM KILN STACK (MILL-ON)

FLOWRATE	573,820	NM3/HR	369,680	SCFM	
FLOWRATE	757,519	M3/HR	464,200	ACFM	
H2O	45,906	NM3/HR	29,574	WSCFM	
DRY GAS	527,914	NM3/HR	340,105	DSCFM	
TEMPERATURE	87.4	C	203.0	F	**MILL ON WORST CASE**

SPECIES	%	NM3/HR	SCFM	LB/MIN	KG/MIN	Cp BTU/LB-F	Cp KJ/Kg-K	h BTU/MIN	h KJ/MIN
H2O	8.00	45905.6	28857.5	1347.9	612.7	1094.3	524.3	1,474,956	1399
CO2	20.00	114764.0	72143.8	8245.0	3747.7	0.2030	0.0540	92,810	88
O2	6.00	34429.2	21643.1	1796.1	816.4	0.2149	0.0572	21,398	20
N2	65.97	378456.8	244663.4	17780.8	8082.2	0.2470	0.0657	243,466	231
SO2	0.001	6.2	3.4	0.56	0.3	0.2030	0.0540	6	0
NO	0.00	0.0	0.0	0.0	0.0	0.2030	0.0540	0	0
CO	0.04	213.1	116.3	8.5	3.8	0.2030	0.0540	95	0
TOTAL	100.01	573,803	367,428	29179	13263			1,832,731	1739

SATURATION	0.050	LB/LB-DA	SO2 PPM		9.2
TEMPERATURE	96.6	F			
	35.9	C		2,252	
	509.1	K			

SO2 REMOVAL	**70 %**	**AVERAGE**
	100 %	AVAILABILITY
	70 %	ANNUAL

SPECIES	%	NM3/HR	SCFM	LB/MIN	KG/MIN	Cp BTU/LB-F	Cp KJ/Kg-K	h BTU/MIN	h KJ/MIN
H2O	8.16	47841	30074.3	1404.7	638.5	1098.5	526.3	1,543,033	1464
CO2	21.31	114764	72143.8	8245.0	3747.7	0.2034	0.054	108,404	103
O2	6.39	34429	21643.1	1796.1	816.4	0.2150	0.057	24,952	24
N2	72.26	389202	244663.4	17780.8	8082.2	0.2471	0.066	283,901	269
SO2	0.00	2	1.0	0.2	0.1	0.2034	0.054	2	0
NO	0.00	0	0.0	0.0	0.0	0.2034	0.054	0	0
CO	0.03	185	116.3	8.5	3.8	0.2034	0.054	111	0
TOTAL	100	586423	368642	29235	13289			1,960,404	1860

SO2 REMOVED	23.63	LB/HR
HR/YR	8322	HR/YR
	98.30	**T/YR**

INLET GAS VOLUME	11058 AM3/MIN	
	390510 ACFM	
SCRUBBER DIAMETER	7.9 M	
SCRUBBER AREA	49.4 M2	
VELOCITY	224.0 M/MIN	
HEIGHT/DIAMETER	4.0	
HEIGHT	31.7 M	
LIQUID GAS RATIO	7.13 M3/KM3	
RECIRCULATION	78.8 M3/MIN	
	20728.1 GAL/MIN	
HEAD	21.3 M	
DENSITY	1.15	
OXIDATION BLOWER	3 M3/M3	
	236.54 NM3/MIN	
HEAD	6.63 M	
	261.0 IN WC	
REAGENT FEED	0.5 M3/MIN	
	131.4 GAL/MIN	
HEAD	29.8 M	
DENSITY	1.25	
GYPSUM SLURRY	1.7 M3/MIN	
	436.4 GAL/MIN	
	29.8 M	
	1.25	
SLURRY DISCHARGE	0.75 M3/MIN	
	197.0 GAL/MIN	
	16.2 M	
	1.15	
WATER MAKEUP		
GYPSUM PRODUCTION		
SO2 REMOVED	10.7 KG/HR	
SULFUR	5.4 KG/HR	
GYPSUM	22.9 KG/HR	ANHYDRATE
	28.9 KG/HR	HYDRATED
WATER	6.0 KG/HR	HYDRATED
PRODUCTION	2,722 TONNE/DAY	
	113.4 TONNE/HR	
GYPSUM	0.26 KG/TONNE	
	127 TONNE/YR	
FREE MOISTURE	10 %	

REAGENT USAGE	CaCO3	16.9	KG/HR
		0.1	KG/TONNE
		73.9	TONNE/YR
WATER LOSS	FREE	2.9	KG/HR
	HYDRATE	6.0	KG/HR
STACK WATER LOSS		1550.0	KG/HR
BLOWDOWN	TOTAL	0.63	%
(RECIRCULATION)	TOTAL	0.5	M3/MIN
	WATER	28.0	M3/HR
		27,868	KG/HR
SOLIDS(WEIGHT)		6.2	%
WATER MAKE-UP		29,427	KG/HR
		0.49	M3/MIN
		129.38	GPM
SO2 REMOVAL	BASELINE	0.135	KG/TONNE
	PRODUCTION	993,377	TONNE/YR
		134	TONNE/YR
		148	T/YR
	CONTROLLED	40	TONNE/YR
		44	T/YR
	REDUCTION	94	TONNE/YR
		103	T/YR

B. STEAM ENTHALPY AT ATMOSPHERIC PRESSURE

	A0	A1	A2	C
H2O	4.5630E-01	1.6660E-05	2.2320E-07	1.0690E+03

HEAT BALANCE FOR REHEAT FLUE GASES (WET SCRUBBER)

INPUTS

KILN STACK - MILL ON

	LB/MIN	KG/MIN	LB/HR	SCFM	NM3/HR	%	PPM(WET)	PPM(DRY)
CO	8.45	3.84	507.20	116.32	185.0	0.03	298.0	314.6
O2	1796.11	816.41	107786.71	21643.15	34429.2	5.54		
N2	17780.77	8082.17	1066846.18	266404.20	423787.0	68.24		
SO2	0.17	0.08	10.13	1.02	1.6	0.00	2.6	
NO	0.00	0.00	0.00	0.00	0.0	0.00	0.0	
H2O	1404.69	638.49	84281.11	30074.31	47841.2	7.70		
CO2	8245.01	3747.73	494700.50	72143.82	114764.0	18.48		
TOTAL(WET)	29235.20	13288.73	1754111.82	390,383	621,008	100.00		
TOTAL(DRY)	27830.51	12650.23	1669830.71	369,678	588,720			

449,880 ACFM
702,635 AM3/HR
96.63 oF
35.90 C

BURNER COMBUSTION AIR

	LB/MIN	KG/MIN
DRY AIR	435.8	198.08
O2	101.10	45.95
N2	334.67	152.12
H2O	9.51	4.32
WET AIR	445.28	202.40

31.69 MMBTU/HR
8.3 LB/1000BTU
435.8 LB/MIN

MOISTURE	0.0218	lb/lb DA
	0.0218	KG/KG DA
T=	70	oF
	21	C
RH	50	%

COMBUSTION AIR

	LB/MIN	KG/MIN	LB/HR	SCFM	NM3/HR
O2	101.10	45.95	6065.86	1218.61	1938.5
N2	334.67	152.12	20080.07	4605.03	7325.5
DRY GAS	435.77	198.08	26145.93	5823.64	9264.1
H2O	9.5098	4.32	570.59	203.60	323.9
TOTAL	445.28	202.40	26716.52	6027.25	9587.9

TOTAL HEATER INPUTS

	LB/MIN	KG/MIN	LB/HR	SCFM	NM3/HR	%WET	%DRY
CO	8.45	3.842	507.20	116.32	185.0	0.03	0.03
O2	1897.21	862.368	113832.56	22861.76	36367.7	5.77	6.24
N2	18115.44	6234.290	1086926.25	271009.23	431112.5	68.37	74.02
SO2	0.17	0.077	10.13	1.02	1.6	0.00	0.00
NO	0.00	0.000	0.00	0.00	0.0	0.00	0.00
CO2	8245.01	3747.731	494700.50	72143.82	114764.0	18.20	19.70
TOTAL	28266.28	12848.308	1695976.64	366132.15	582430.9		
H2O	1414.20	642.816	84851.70	30277.92	48165.1	7.64	
TOTAL	29680.47	13491.124	1760828.34	396410.06	630596.0	100.00	100.00

HHV FUELS

CO	4339	BTU/LB
	0.0101	GJ/KG
N.G.	22077	BTU/LB
	0.0512	GJ/KG

AUXILIARY FUEL RATE

N.G.	23.93	LB/MIN
	10.88	KG/MIN

HEAT INPUTS

CO	18,340	BTU/MIN	3.36 %
	0.019	GJ/MIN	
	2,200,741	BTU/HR	
	2.3196	GJ/HR	
N.G.	528,201	BTU/MIN	96.64 %
	0.557	GJ/HR	
	31,692,035	BTU/HR	
	33.403	GJ/HR	
TOTAL	546,540	BTU/MIN	
	0.576	GJ/HR	
	33,892,775	BTU/HR	
	35.723	GJ/HR	

HEAT BALANCE FOR REHEAT FLUE GASES (WET SCRUBBER)

FUEL ANALYSIS

	CO %	N.G.%
C	42.85	69.12
H	0.00	23.20
O	57.15	1.58
N	0.00	5.76
S	0.00	0.34
TOTAL	100.00	100.00

OXYGEN REQUIRED

	GASES		N.G.		TOTAL	
	LB/MIN	KG/MIN	LB/MIN	KG/MIN	LB/MIN	KG/MIN
C-CO2	0.00	0	43.99	20.00	43.99	19.995
CO-CO2	2.41	1.10	0.00	0	2.41	1.095
H2-H2O	0.00	0	44.07	20.03	44.07	20.033
S-SO2	0.00	0	0.08	0.04	0.08	0.037
N-NO	0.00	0	3.15	1.43	3.15	1.431
NET	2.41	1.10	91.29	41.50	93.70	42.591
O2 BOUND	4.83	2.20	0.38	0.17	5.21	2.368
O2 EXCESS					-88.49	-40.224
COMBUSTION AIR					1897.21	862.368
NET O2 EXCESS					1808.72	822.144

CO REMOVAL 50.00 %

FLUE GAS PRODUCTS

	FLUE GASES LB/MIN	NG LB/MIN	INPUT LB/MIN	TOTAL LB/MIN	TOTAL KG/MIN	FLOW SCFM	NM3/HR	%DRY	%WET	PPM DRY
CO2	6.63	80.53	8245.01	8312.16	3778.26	72827.02	115850.8	21.16	19.40	
CO	0.00	0.00	4.23	4.23	1.92	58.16	92.5	0.02	0.02	169.0
H2O	0.00	49.62	1414.20	1463.82	665.37	31340.35	49855.2		8.35	
N2	0.00	0.00	18115.44	18115.20	8234.18	249468.02	396845.5	72.49	66.44	
O2 EXCESS	0.00	0.00	1808.72	1808.72	822.14	21786.00	34656.4	6.33	5.80	
SO2	0.00	0.16	0.17	0.33	0.15	2.00	3.2	0.00	0.00	5.8
NO	0.00	0.51	0.00	0.51	0.23	4.29	6.8	0.00	0.00	12.5
TOTAL	6.63	110.82	29587.75	29704.97	13502.26	375485.84			100.00	
TOTAL(DRY)						344145.49		100.00		

MASS BALANCE

19,1 PPM NOX

	LB/MIN	KG/MIN
SOURCE GASES	29235.20	13288.72593
COMBUSTION AIR	445.28	202.3978477
N.GAS	23.93	10.87517193
TOTAL	29704.40	13501.99895
COMBUSTION PRODUCTS	29704.97	13502.25802
DIFFERENCE	0.00	0.00 %

INPUT ENTHALPY FLUE GASES

	Cp-BTU/LB-oF	Cp KJ/Kg-K	T-oF	LB/MIN	KG/MIN	h-BTU/MIN	h KJ/MIN
N2	0.2471	0.066	96.63	17780.77	8082.168025	283900.91	269
O2	0.2150	0.057	96.83	1796.11	816.4144406	24952.40	24
CO	0.2034	0.054	96.63	8.45	3.842424242	111.14	0
CO2	0.2034	0.054	96.63	8245.01	3747.731051	108404.28	103
SO2	0.1283	0.034	96.63	0.17	0.076704545	1.40	0
NO	0.2034	0.054	96.63	0.00	0	0.00	0
H2O	1098.5	526.2766	96.63	1404.69	638.4932804	1543032.71	1464
TOTAL				29235.20	13288.72593	1,960,403	1860

INPUT ENTHALPY PRIMARY AIR

	Cp-BTU/LB-oF	Cp KJ/Kg-K	T-oF	LB/MIN	KG/MIN	h-BTU/MIN	h KJ/MIN
N2	0.2468	0.066	70.00	334.67	152.1217657	3138.27	3
O2	0.2147	0.057	70.00	101.10	45.95345007	824.81	1
H2O	1086.3	520.5	70.00	9.51	4.322631939	10330.87	10
TOTAL				445.28	202.3978477	14294	14
TOTAL GASES						1974697	1874

	BTU/LB	GJ/KG	LB/MIN	KG/MIN	h-BTU/MIN	h KJ/MIN
CO	4339.0	0.01	4.23	1.921212121	18340	17
NAT. GAS	22077	0.05	23.93	10.87517193	528201	501
FUEL TOTAL					546540	519

TOTAL		2,521,237
RADIATION LOSSES	2.00	50,425
NET ENTHALPY FLUE GASES		2,470,812

HEAT BALANCE FOR REHEAT FLUE GASES (WET SCRUBBER)

OUTPUT ENTHALPY

	Cp-BTU/LB-oF	Cp KJ/Kg-K	T-oF	LB/MIN	KG/MIN	h-BTU/MIN	h KJ/MIN	% wt	SCFM	NM3/HR	PPM(WET)
N2	0.2486	0.066	233.00	18115.20	8234.2	905056	859	60.98	249446.3	396810.9	
O2	0.2163	0.058	233.00	1808.72	822.1	78647	75	6.09	21795.0	34670.8	
CO2	0.2097	0.056	233.00	8312.16	3778.3	350385	332	27.98	72731.4	115698.7	
CO	0.2097	0.056	233.00	4.23	1.9	178	0	0.01	58.2	92.5	154.93
SO2	0.1396	0.037	233.00	0.33	0.2	9	0	0.00	2.0	3.2	
NO	0.2097	0.056	233.00	0.51	0.2	22	0	0.00	4.3	6.8	
H2O	1160.72	556.1	233.00	1463.82	665.4	1699083	1612	4.93	31340.3	49855.2	
TOTAL				29704.97	13502.3	3033381	2878	100	375377.5	597138.1	
NET DIFFERENCE				562568							

REHEAT TEMPERATURE	233.0 °F	NOX EF=	83.00 LB/MMFT3
	111.7 °C	NOX	11.08 T/YR
N.GAS USAGE	23.93 LB/MIN		
N.GAS USAGE	10.88 KG/MIN	CO EF=	61.00 LB/MMFT3
N.GAS USAGE	31.69 MMBTU/HR	CO	8.14 T/YR
	33.40 GJ/HR		
		SO2 EF=	0.60 LB/MMFT3
FLUE GAS OXYGEN	6.33 %	SO2	0.08 T/YR
INLET FUEL CONCENTRATION	1.38 BTU/SCF		

FLUE GAS VOLUME SUMMARY @ COMBUSTOR

	DSCFM	NM3/HR	WSCFM	NM3/HR	ACFM	AM3/HR
INLET	360309	573167	390383	621008	512377	874713
OUTLET	344145	547455	375486	597310	492825	841334

STEAM ENTHALPY AT ATMOSHERIC PRESSURE

	A0	A1	A2	C
H2O	4.563E-01	1.668E-05	2.232E-07	1.069E+03

COST ESTIMATE
WET SCRUBBER

PLANT SIZE		CURRENT CAPACITY	**1,095,000**	TON/YR
			FACTOR	COST
CAPITAL COSTS				
DIRECT COST				
	SCRUBBER COMPOMENTS	SCRUBBER		4,000,000
		VALVES,PUMPS		80,000
		DUCTWORK		350,000
		CIVIL		700,000
		ELECTRICAL		750,000
		N.GAS SERVICE		750,000
		ID FAN		600,000
		SLUDGE TREATMENT		2,200,000
		MISCELLANEOUS EQUIPMENT		300,000
		STACK/REHEAT		1,500,000
	EQUIPMENT	TOTAL		11,230,000
	OTHER	INSTRUMENTS	0.05	561,500
		TAXES	0.06	673,800
		FREIGHT	0.08	898,400
		TOTAL		13,363,700
	INSTALLATION	FOUNDATIONS	0.05	668,185
		ERECTION	0.15	2,004,555
		ELECTRICAL	0.10	1,336,370
		DUCTING	0.10	1,336,370
		INSULATION	0.10	1,336,370
		SITE PREPARATION	0.10	1,336,370
		TOTAL	0.60	8,018,220
DIRECT COSTS		TOTAL		21,381,920
INDIRECT COSTS		ENGINEERING/DESIGN	0.10	1,336,370
		CONST/FIELD EXPENSE	0.10	1,336,370
		CONTR.FEE	0.08	1,002,278
		START-UP	0.02	267,274
		PERFORMANCE TEST	0.01	133,637
		CONTINGENCIES	0.15	2,004,555
		TOTAL		6,080,484
RETROFIT PREMIUM (N/A)				0
TOTAL CAPITAL COST		**SCC**	**$**	**27,462,404**

COST ESTIMATE
WET SCRUBBER

OPERATING COST(DIRECT)

UTILITIES	ID FAN STATIC PRESSURE	12.00	IN H2O
	FAN VOLUME	512377	ACFM
	FAN POWER	1387.81	BHP
	FAN STATIC PRESSURE	5.00	IN H2O
	COMBUSTION FAN VOLUME	6027	ACFM
	FAN POWER	6.80	BHP
	RECIRCULATION PUMPS(4)	1375	BHP
	REAGENT PUMP	71.50	BHP
	AGGITATOR MOTOR	185.00	BHP
	PULSE PUMP	285.00	BHP
	BLOWER COMPRESSOR	285.00	BHP
	CONNECTED LOAD	3596.11	BHP
	POWER	2681.62	KWHr
	HOURS OPERATED	8760	HRS
	ELECTRICAL COST	0.0424	$/KWHr
	ANNUAL COST	995,784	$/YR
	N.GAS(FLUE GAS REHEAT)	33.40	GJ/HR
	COST	6.266	$/GJ
	ANNUAL COST	1,833,527	$/YR
REAGENT	REAGENT USAGE	168.82	TON/YR
	COST	25.00	$/TON
	ANNUAL COST	4,221	$/YR
WASTE DISPOSAL	GYPSUM	290	TON/YR
		65.00	$/TON
	COST	18835	$/YR
WATER TREATMENT	DISCHARGE	174703	M3/YR
	COST	2.00	$/M3
	ANNUAL COST	349405	$/YR
MAINTENANCE LABOR & MATERIALS			
	5% OF DIRECT CAPITAL COST	1,069,096	$/YR

MAINTENANCE	LABOR	HR/YR		2000
	COST	$/HR		25.96
	COST	$/YR		51,920
LABOR	LABOR	HR/YR		2000
	COST	$/HR		18.00
	COST	$/YR		36,000
SUPERVISOR	LABOR	HR/YR		800
	COST	$/HR		39.54
	COST	$/YR		31,632
FUEL SAVINGS		$/YR		$0
TOTAL DIRECT OPERATING COST		$/YR	**$**	**4,390,419**

COST ESTIMATE
WET SCRUBBER

OPERATING COST(INDIRECT)	OVERHEAD	%	44.00
		$/YR	52,603
	PROPERTY TAX	%	1.46
		$/YR	400,665
	INSURANCE	%	1.00
		$/YR	274,624
	ADMINISTRATION	%	2.00
		$/YR	549,248
	CAPITAL RECOVERY	%-INTEREST	10.00
		LIFE-YEARS	15.00
		FACTOR	0.131474
		$/YR	3,610,586
TOTAL INDIRECT OPERATING COST		$/YR	4,887,726
TOTAL ANNUAL COST		**$/YR**	**9,278,146**
ANNUAL EMISSIONS REDUCTION		TON/YR	110.13
COST BENEFIT		**$/TON**	**$ 84,248**

PLANT COSTS

POWER COST	0.04239 $/KWH	
PROPERTY TAX RATE	2.4316 $/100 @ 60% 1.4590 %	
CAPITAL RECOVERY RATE	10 %	
LABOR COSTS		
SUPERVISOR	39.54 $/HR	
KILN OPERATOR	33.17 $/HR	
1ST CLASS MAINTENANCE	25.96 $/HR	
1ST CLASS ELECTRICIAN	25.96 $/HR	
1ST CLASS WELDER	25.96 $/HR	
GENERAL LABOR	18.00 $/HR	
NATURAL GAS	6.27 $/GJ	5.945 $/MMBTU
FUEL OIL	0.00 $/GJ	$/MMBTU
COAL	3.71 $/GJ	3.52 $/MMBTU
COKE	0.00 $/GJ	$/MMBTU
CKD DISPOSAL	0.00 $/TONNE	0 $/TON
SOLID WASTE DISPOSAL	58.97 $/TONNE	65 $/TON
MICROFINE LIME	54.43 $/TONNE	60 $/TON
LIMESTONE	22.68 $/TONNE	25 $/TON
WATER COST	0 $/M3	0 $/MM gal
WATER TREATMENT	2.00 $/M3	7571 $/MM gal

APPENDIX B

COST CALCULATIONS FOR NO_x

KILN PRODUCTION AND NO_x DATA
SUMTER AMERICAN CEMENT COMPANY PLANT
11/21/2011

		CLINKER					MSC ONLY UNCONTROLLED		
PLANT NAME	KILN NO.	PRODUCTION T/YR	CAPACITY T/YR	CLINKER MAX T/HR	CLINKER AVG T/HR	OPERATION HR/YR	NO_x T/YR	NO_x LB/TON	NO_x AVG LB/HR
SCC	1	1,095,000	1,095,000	131.6	131.6	8,760	1,533	2.80	350.0

SUMMARY OF NO_x CONTROL COST DATA
SUMTER CEMENT COMPANY
11/21/11

		MSC ONLY		ADD-ON CONTROLS								
PLANT NAME	KILN NO.	BASELINE NOx EMISSIONS		CONTROL TECHNOLOGY	AFTER CONTROL TECHNOLOGY NOx EMISSSIONS		EXPECTED REMOVAL		CAPITAL COST $	ANNUAL COST $/YR	CONTROL COST $/TON NO_x	UNIT COST $/TON CLINKER
		T/YR	LB/TON		T/YR	LB/TON	%	T/YR				
SCC	1	1,533	2.80	SCR[1]	821	1.50	46.4	712	4,777,870	9,666,691	13,582	8.83
	1	1,533	2.80	SNCR	1,068	1.95	30.4	465	1,576,645	1,154,433	2,481	1.05

NOTE:

1. SCR ANNUAL OPERATING COST INCLUDES ADDED NATURAL GAS FUEL COMBUSTION FOR REHEATING CLEAN SIDE GASES TO OPTIMUM CATALYST TEMPERATURE (340 DEG C) FOR NOX REDUCTION, AND REPLACEMENT OF CATALYST EVERY 3 YEARS.

SUMTER CEMENT COMPANY
DESIGN DATA

	METRIC		ENGLISH	
PRODUCTION	2,722	MTONS/D	3,000.0	STONS/D
	365.0	DAYS/YR	365.0	DAYS/YR
	993,384	MTONS/YR	1,095,000	STONS/YR
PLANT CAPACITY	100.0	%	125.0	ST/HR
NOx EMISSION FACTOR *(MSC ONLY BASELINE)*	1.40	KG/MTON	2.80	LB/TON
NOx ANNUAL EMISSIONS	1,390.7 158.8	MTONS/YR KG/HR	1,533.00 350.0	TON/YR LB/HR
OPERATING HOURS	8,760			

COST ESTIMATE
SNCR NO_x CONTROL OPTION

			FACTOR	COST
CAPITAL COSTS				
DIRECT COST				
	BASIC	UREA/AMMONIA INJECTION UNIT		622,473
	EQUIPMENT	TOTAL		622,473
	OTHER	INSTRUMENTS		60,000
		TAXES	0.06	37,348
		FREIGHT	0.10	64,579
		TOTAL		784,401
	INSTALLATION	FOUNDATIONS	0.08	62,752
		ERECTION	0.14	109,816
		ELECTRICAL	0.10	78,440
		PIPING	0.15	117,660
		INSULATION	0.01	7,844
		SITE PREPARATION	0.05	39,220
		TOTAL	0.53	415,732
DIRECT COSTS		TOTAL		1,200,133
INDIRECT COSTS		ENGINEERING/DESIGN	0.10	78,440
		CONST/FIELD EXPENSE	0.10	78,440
		CONTR.FEE	0.05	39,220
		START-UP	0.02	15,688
		PERFORMANCE TEST	0.01	7,844
		CONTINGENCIES	0.20	156,880
		TOTAL		376,512
RETROFIT PREMIUM (N/A)				0
TOTAL CAPITAL COST		**HAC**		**1,576,645**

OPERATING COST(DIRECT)

UTILITIES	PUMP PRESSURE	80.00	PSIG
	LIQUOR DENSITY	11.00	LB/GAL
		1.32	SG
		0.0122	FT3/LB
	PUMP VOLUME	20	GPM
		13200	LB/HR
	PUMP HORSEPOWER	124.00	BHP
	CONNECTED LOAD	124.00	BHP
	POWER	92.47	KWHr
	HOURS OPERATED	8760	HRS
	ELECTRICAL COST	0.0424	$/KWHr
	ANNUAL COST	34,337	$/YR
	NATURAL GAS	0.00	MMBTU/HR
	COST	5.945	$/MMBTU
	ANNUAL COST	0	$/YR
REAGENTS	UTILIZATION	0.70	
	MOLAR RATIO	1.00	
	USAGE	867	T/YR
	UNIT COST	0.12	$/LB
	COST	$208,118	

COST ESTIMATE
SNCR NO_X CONTROL OPTION

MAINTENANCE LABOR & MATERIALS			
	5% OF DIRECT CAPITAL COST	78,832 $/YR	
MAINTENANCE	LABOR	HR/YR	1000
	COST	$/HR	25.96
	COST	$/YR	25,960
OPERATOR	LABOR	HR/YR	8760
	COST	$/HR	33.17
	COST	$/YR	290,569
SUPERVISOR	LABOR	HR/YR	1752
	COST	$/HR	39.54
	COST	$/YR	69,274
TOTAL DIRECT OPERATING COST			707,090
OPERATING COST(INDIRECT)	OVERHEAD	%	44.00
		$/YR	169,753
	PROPERTY TAX	%	1.46
		$/YR	23,003
	INSURANCE	%	1.00
		$/YR	15,766
	ADMINISTRATION	%	2.00
		$/YR	31,533
	CAPITAL RECOVERY	%-INTEREST	10.00
		LIFE-YEARS	15.00
		FACTOR	0.131474
		$/YR	207,287
TOTAL INDIRECT OPERATING COST			447,343
TOTAL ANNUAL COST		**$/YR**	**$1,154,433**
EXPECTED NOx		**LB/TON**	**1.95**
		T/YR	**1068**
REDUCTION		**T/YR**	**465**
		%	**30.4**
		$/TON	**$2,481**
		$/TON-CLK	**$1.05**

HEAT BALANCE FOR REHEAT FLUE GASES (SCR)

INPUTS

KILN STACK - MILL ON

	LB/MIN	KG/MIN	LB/HR	SCFM	NM3/HR	%	PPM(WET)	PPM(DRY)
CO	8.45	3.84	507.20	116.32	185.0	0.04	386.9	375.0
O2	1350.29	613.77	81017.40	16270.99	25883.4	5.41		
N2	13488.06	6130.94	809283.60	207293.59	329755.8	68.95		
SO2	0.24	0.11	14.40	1.45	2.3	0.00	4.8	
NO	0.00	0.00	0.00	0.00	0.0	0.00	0.0	
H2O	1062.23	482.83	63733.80	22742.34	36177.8	7.56		
CO2	6198.46	2817.48	371907.60	54236.53	86277.7	18.04		
TOTAL(WET)	22107.73	10048.97	1326464.00	300,661	478281.9	100.00		
TOTAL(DRY)	21045.50	9566.14	1262730.20	310,216	493481.0			

INLET	464,200	ACFM	43435		
	788,685	AM3/HR	1.69902	FT3/M TO M3/HR	86665
	203.00	oF			
	95.00	C			

BURNER COMBUSTION AIR 233

	LB/MIN	KG/MIN
DRY AIR	1901.1	864.16
O2	441.07	200.48
N2	1460.08	663.67
H2O	20.74	9.43
WET AIR	1921.89	873.59

138.27 MMBTU/HR
8.3 LB/1000BTU
1901.1 LB/MIN

MOISTURE	0.0109	lb/lb DA
	0.0109	KG/KG DA
T=	70	oF
	21	C
RH	50	%

COMBUSTION AIR

	LB/MIN	KG/MIN	LB/HR	SCFM	NM3/HR
O2	441.07	200.48	26463.99	5316.54	8457.4
N2	1460.08	663.67	87604.93	20090.73	31959.7
DRY GAS	1901.15	864.16	114068.92	25407.28	40417.1
H2O	20.7446	9.43	1244.67	444.14	706.5
TOTAL	1921.89	873.59	115313.59	25851.42	41123.6

TOTAL HEATER INPUTS

	LB/MIN	KG/MIN	LB/HR	SCFM	NM3/HR	%WET	%DRY
CO	8.45	3.842	507.20	116.32	185.0	0.04	0.04
O2	1791.36	814.253	107481.39	21587.54	34340.7	6.61	7.12
N2	14948.14	6794.610	896888.53	227384.32	361715.4	69.64	74.96
SO2	0.24	0.109	14.40	1.45	2.3	0.00	0.00
NO	0.00	0.000	0.00	0.00	0.0	0.00	0.00
CO2	6198.46	2817.482	371907.60	54236.53	86277.7	16.61	17.88
TOTAL	22946.65	10430.296	1376799.12	303326.14	482521.2		
H2O	1082.97	492.261	64978.47	23186.49	36884.3	7.10	
TOTAL	24029.63	10922.558	1441777.59	326512.63	519405.5	100.00	100.00

HHV FUELS

CO	4339	BTU/LB
	0.0101	GJ/KG
N.G.	22077	BTU/LB
	0.0512	GJ/KG

AUXILIARY FUEL RATE

N.G.	104.38	LB/MIN
	47.45	KG/MIN

HEAT INPUTS

CO	0	BTU/MIN	0.00 %
	0.000	GJ/MIN	
	2,200,741	BTU/HR	
	2.3196	GJ/HR	
N.G.	2,304,423	BTU/MIN	100.00 %
	2.429	GJ/HR	
	138,265,356	BTU/HR	
	145.732	GJ/HR	
TOTAL	2,304,423	BTU/MIN	
	2.429	GJ/HR	
	140,466,097	BTU/HR	
	148.051	GJ/HR	

HEAT BALANCE FOR REHEAT FLUE GASES (SCR)

FUEL ANALYSIS

	CO %	N.G.%
C	42.85	69.12
H	0.00	23.20
O	57.15	1.58
N	0.00	5.76
S	0.00	0.34
TOTAL	100.00	100.00

OXYGEN REQUIRED

	GASES		N.G.		TOTAL	
	LB/MIN	KG/MIN	LB/MIN	KG/MIN	LB/MIN	KG/MIN
C-CO2	0.00	0	191.91	87.23	191.91	87.234
CO-CO2	0.00	0.00	0.00	0	0.00	0.000
H2-H2O	0.00	0	192.28	87.40	192.28	87.399
S-SO2	0.00	0	0.35	0.16	0.35	0.161
N-NO	0.00	0	13.74	6.24	13.74	6.245
NET	0.00	0.00	398.29	181.04	398.29	181.039
O2 BOUND	4.83	2.20	1.65	0.75	6.48	2.948
O2 EXCESS					-391.81	-178.093
COMBUSTION AIR					1791.36	814.253
NET O2 EXCESS					1399.55	636.159

CO REMOVAL 0.00 %

FLUE GAS PRODUCTS

	FLUE GASES LB/MIN	NG LB/MIN	INPUT LB/MIN	TOTAL LB/MIN	TOTAL KG/MIN	FLOW SCFM	NM3/HR	%DRY	%WET	PPM DRY
CO2	0.00	264.06	6198.46	6462.52	2937.51	56621.39	90071.4	20.26	18.43	
CO	0.00	0.00	8.45	8.45	3.84	116.32	185.0	0.04	0.04	416.2
H2O	0.00	216.49	1082.97	1299.47	590.67	27821.64	44257.7		9.05	
N2	0.00	0.00	14948.14	14947.90	6794.50	205850.56	327460.2	73.66	66.99	
O2 EXCESS	0.00	0.00	1399.55	1399.55	636.16	16857.59	26816.5	6.03	5.49	
SO2	0.00	0.71	0.24	0.95	0.43	5.72	9.1	0.00	0.00	20.5
NO	0.00	0.51	0.00	0.51	0.23	4.29	6.8	0.00	0.00	15.4
TOTAL	0.00	481.78	23637.82	24119.36	10963.35	307277.51			100.00	
TOTAL(DRY)						279455.87		100.00		

MASS BALANCE

23.5 PPM NOX

	LB/MIN	KG/MIN
SOURCE GASES	22107.73	10048.9697
COMBUSTION AIR	1921.89	873.5878185
N.GAS	104.38	47.4459762
TOTAL	24134.01	10970.00349
COMBUSTION PRODUCTS	24119.36	10963.34804
DIFFERENCE	0.06	0.06 %

INPUT ENTHALPY FLUE GASES

	Cp-BTU/LB-oF	Cp KJ/Kg-K	T-oF	LB/MIN	KG/MIN	h-BTU/MIN	h KJ/MIN
N2	0.2482	0.068	203.00	13488.06	6130.936364	572539.05	543
O2	0.2160	0.057	203.00	1350.29	613.7681818	49881.24	47
CO	0.2083	0.055	203.00	8.45	3.842424242	301.16	0
CO2	0.2083	0.055	203.00	6198.46	2817.481818	220825.08	210
SO2	0.1371	0.036	203.00	0.24	0.109090909	5.63	0
NO	0.2083	0.055	203.00	0.00	0	0.00	0
H2O	1147.0	549.5317	203.00	1062.23	482.8318182	1218409.88	1156
TOTAL				22107.73	10048.9697	2,061,962	1956

INPUT ENTHALPY PRIMARY AIR

	Cp-BTU/LB-oF	Cp KJ/Kg-K	T-oF	LB/MIN	KG/MIN	h-BTU/MIN	h KJ/MIN
N2	0.2468	0.066	70.00	1460.08	663.6737078	13691.57	13
O2	0.2147	0.057	70.00	441.07	200.4847659	3598.49	3
H2O	1086.3	520.5	70.00	20.74	9.429344817	22535.64	21
TOTAL				1921.89	873.5878185	39826	38
TOTAL GASES						2101788	1994

	BTU/LB	GJ/KG	LB/MIN	KG/MIN	h-BTU/MIN	h KJ/MIN
CO	4339.0	0.01	0.00	0	0	0
NAT. GAS	22077	0.05	104.38	47.4459762	2304423	2186
FUEL TOTAL					2304423	2186

TOTAL		4,406,210
RADIATION LOSSES	2.00	88,124
NET ENTHALPY FLUE GASES		4,318,086

HEAT BALANCE FOR REHEAT FLUE GASES (SCR)

OUTPUT ENTHALPY

	Cp-BTU/LB-oF	Cp KJ/Kg-K	T-oF	LB/MIN	KG/MIN	h-BTU/MIN	h KJ/MIN	% wt	SCFM	NM3/HR	PPM(WET)
N2	0.2531	0.067	644.00	14947.90	6794.5	2315242	2197	61.97	205832.6	327431.7	
O2	0.2204	0.059	644.00	1399.55	636.2	188812	179	5.80	16864.6	26827.6	
CO2	0.2286	0.061	644.00	6462.52	2937.5	904223	858	26.79	56547.1	89953.2	
CO	0.2286	0.061	644.00	8.45	3.8	1183	1	0.04	116.3	185.0	378.65
SO2	0.1736	0.046	644.00	0.95	0.4	101	0	0.00	5.7	9.1	
NO	0.2286	0.061	644.00	0.51	0.2	72	0	0.00	4.3	6.8	
H2O	1348.27	645.9	644.00	1299.47	590.7	1752030	1662	5.39	27821.6	44257.7	
TOTAL				24119.36	10963.3	5161663	4897	100	307192.2	488671.2	

NET DIFFERENCE 843576

REHEAT TEMPERATURE	644.0 **°F**	NOX EF=	83.00 LB/MMFT3
	340.0 **°C**	NOX	45.92 T/YR
N.GAS USAGE	104.38 **LB/MIN**		
N.GAS USAGE	47.45 **KG/MIN**	CO EF=	61.00 LB/MMFT3
N.GAS USAGE	138.27 **MMBTU/HR**	CO	33.74 T/YR
	145.73 **GJ/HR**		
		SO2 EF=	0.60 LB/MMFT3
FLUE GAS OXYGEN	6.03 **%**	SO2	0.33 T/YR
INLET FUEL CONCENTRATION	7.06 **BTU/SCF**		

FLUE GAS VOLUME SUMMARY @ COMBUSTOR

	DSCFM	NM3/HR	WSCFM	NM3/HR	ACFM	AM3/HR
INLET	277919	442104	300661	478282	628655	1073218
OUTLET	279456	444549	307278	488807	642489	1096835

STEAM ENTHALPY AT ATMOSHERIC PRESSURE

	A0	A1	A2	C
H2O	4.563E-01	1.666E-05	2.232E-07	1.069E+03

COST ESTIMATE
SCR NO_X CONTROL OPTION

			FACTOR	COST
CAPITAL COSTS				
	DIRECT COST			
	BASIC	SCR UNIT		2,074,911
	EQUIPMENT	TOTAL		2,074,911
	OTHER	INSTRUMENTS		100,000
		TAXES	0.06	124,495
		FREIGHT	0.10	215,263
		TOTAL		2,514,668
	INSTALLATION	FOUNDATIONS	0.08	201,173
		ERECTION	0.14	352,054
		ELECTRICAL	0.10	251,467
		PIPING	0.15	377,200
		INSULATION	0.01	25,147
		SITE PREPARATION	0.02	50,293
		TOTAL	0.50	1,257,334
	DIRECT COSTS	TOTAL		3,772,003
	INDIRECT COSTS	ENGINEERING/DESIGN	0.10	251,467
		CONST/FIELD EXPENSE	0.05	125,733
		CONTR.FEE	0.03	75,440
		START-UP	0.01	25,147
		PERFORMANCE TEST	0.01	25,147
		CONTINGENCIES	0.20	502,934
		TOTAL		1,005,867
	RETROFIT PREMIUM (N/A)			0
	TOTAL CAPITAL COST		SCC	4,777,870

OPERATING COST(DIRECT)

UTILITIES	PUMP PRESSURE	80.00	PSIG
	LIQUOR DENSITY	11.00	LB/GAL
		1.32	SG
		0.0122	FT3/LB
	PUMP VOLUME	20	GPM
		13200	LB/HR
	PUMP HORSEPOWER	124.00	BHP
	CONNECTED LOAD	124.00	BHP
	POWER	92.47	KWHr
	HOURS OPERATED	8760	HRS
	ELECTRICAL COST	0.0424	$/KWHr
	ANNUAL COST	34,337	$/YR
	NATURAL GAS	138.27	MMBTU/HR
	COST	5.945	$/MMBTU
	ANNUAL COST	7,200,611	$/YR
REAGENTS	UTILIZATION	0.70	
	MOLAR RATIO	1.00	
	USAGE	1326	T/YR
	UNIT COST	0.12	$/LB
	COST	$318,298	

COST ESTIMATE

SCR NO_X CONTROL OPTION

MAINTENANCE LABOR & MATERIALS			
	15% OF DIRECT CAPITAL COST	716,680 $/YR	
	(INCLUDES CATALYST REPLACEMENT EVERY 3 YEARS)		
MAINTENANCE	LABOR	HR/YR	1000
	COST	$/HR	25.96
	COST	$/YR	25,960
OPERATOR	LABOR	HR/YR	8760
	COST	$/HR	33.17
	COST	$/YR	290,569
SUPERVISOR	LABOR	HR/YR	1752
	COST	$/HR	39.54
	COST	$/YR	69,274
TOTAL DIRECT OPERATING COST			8,655,730
OPERATING COST(INDIRECT)	OVERHEAD	%	44.00
		$/YR	169,753
	PROPERTY TAX	%	1.46
		$/YR	69,707
	INSURANCE	%	1.00
		$/YR	47,779
	ADMINISTRATION	%	2.00
		$/YR	95,557
	CAPITAL RECOVERY	%-INTEREST	10.00
		LIFE-YEARS	15.00
		FACTOR	0.131474
		$/YR	628,165
TOTAL INDIRECT OPERATING COST			1,010,961

TOTAL ANNUAL COST	**$/YR**	**$9,666,691**
EXPECTED NOx	**LB/TON**	**1.50**
	T/YR	**821**
REDUCTION	**T/YR**	**712**
	%	**46.4**
	$/TON	**$13,582**
	$/TON-CLK	**$8.83**

SCC PLANT COSTS

POWER COST	0.04239 $/KWH	
PROPERTY TAX RATE	2.4316 $/100 @ 60% 1.4590 %	
CAPITAL RECOVERY RATE	10 %	
LABOR COSTS		
SUPERVISOR	39.54 $/HR	
KILN OPERATOR	33.17 $/HR	
1ST CLASS MAINTENANCE	25.96 $/HR	
1ST CLASS ELECTRICIAN	25.96 $/HR	
1ST CLASS WELDER	25.96 $/HR	
GENERAL LABOR	18.00 $/HR	
NATURAL GAS	6.27 $/GJ	5.945 $/MMBTU
FUEL OIL	0.00 $/GJ	$/MMBTU
COAL	3.71 $/GJ	3.52 $/MMBTU
COKE	0.00 $/GJ	$/MMBTU
CKD DISPOSAL	0.00 $/TONNE	0 $/TON
SOLID WASTE DISPOSAL	58.97 $/TONNE	65 $/TON
MICROFINE LIME	54.43 $/TONNE	60 $/TON
LIMESTONE	22.68 $/TONNE	25 $/TON
WATER COST	0.00 $/M3	0 $/MM gal
WATER TREATMENT	2.00 $/M3	7571 $/MM gal

DATA INPUT

1. OPERATION - RAW MILL ON

INLET GASES FROM KILN (MILL-ON)				
FLOWRATE	573,820	NM3/HR	369,680	SCFM
FLOWRATE	773,391	M3/HR	**464,200**	ACFM
H2O	45,906	NM3/HR	29,574	WSCFM
DRY GAS	527,914	NM3/HR	**310,216**	DSCFM
TEMPERATURE	95.0	C	**203.0**	F
WATER	8	PERCENT		

2. OPERATION - RAW MILL OFF

INLET GASES FROM KILN (MILL-OFF)				
FLOWRATE	380,760	NM3/HR	245,302	SCFM
FLOWRATE	665,755	M3/HR	**399,550**	ACFM
H2O	26,083	NM3/HR	16,804	WSCFM
DRY GAS	354,677	NM3/HR	**244,360**	DSCFM
TEMPERATURE	204.5	C	**400.0**	F
WATER	8	PERCENT		

APPENDIX C

COST CALCULATIONS FOR CO and VOC

SUMMARY OF EMISSIONS FOR RTO CONTROL OPTIONS
SUMTER CEMENT PLANT

POLLUTANT	DESIGN CASE	CONTROL OPTION	REMOVAL EFFIC. %	INLET RATE LB/HR	OUTLET RATE LB/HR	OUTLET CONC. PPM	ACTUAL HOURS HRS/YR	POLLUTANT EMITTED TON/YR	TOTAL REMOVED TON/YR
CO	1	PROCESS	NA	450.0	450.0	320.3	8,760	1,971.0	0
CO	2	RTO	95.0	450.0	22.5	16.1	8,760	98.6	1,872.5
CO	3	RTO	79.1	450.0	94.0	67.1	8,760	411.7	1,559.3
VOC	1	PROCESS	NA	15.0	15.00	NA	8,760	65.7	0
VOC	2	RTO	95.0	15.0	0.75	NA	8,760	3.3	62.4

NOTES:

1. COMBUSTION PROCESS OPTIMIZATION (CURRENT KILN DESIGN)
2. RTO DESIGN AT 95% OPTIMUM CO REMOVAL EFFICIENCY
3. RTO DESIGN ACHIEVING 100 PPM CO IN EXIT GASES

COST ANALYSIS FOR RTO CONTROL OPTIONS

SUMTER CEMENT PLANT

POLLUTANT	DESIGN CASE	REMOVAL EFFIC. %	INT. RATE %	ECON. LIFE YRS	BASE EMISSIONS TON/YR	NET REMOVED TON/YR	TOTAL CAPITAL COST $	DIRECT OPERATING COST $/YR	TOTAL ANNUALIZED COST $	COST/TON REMOVED $/TON
CO	2	95.0	10	10	1,971.0	1,872.5	25,628,320	5,321,569	10,830,344	5,784
CO	3	79.1	10	10	1,971.0	1,559.3	25,628,320	5,321,874	15,399,028	9,876
VOC	2,3	95.0	10	10	65.7	62.4	25,628,320	5,321,569	10,830,344	173,522

NOTES:

1. DESIGN OF RTO IS BASED ON CO REMOVAL
2. THE 95% CO REMOVAL EFFICIENCY REPRESENTS DESIGN CASE "2" AT OPTIMUM CO REMOVAL EFFICIENCY
3. THE 79.1% CO REMOVAL EFFICIENCY REPRESENTS DESIGN CASE "3 ACHIEVING 100 PPM CO IN EXIT GASES
4. THE VOC REMOVAL EFFICIENCY FOR BOTH CASES IS ASSUMED TO BE 95%

RTO EQUIPMENT ESTIMATED COST BASIS

COMPARIBLE UNIT	TXI MIDLOTHIAN, TEXAS RTO[1]
NO. OF MODULES	11
OPERATING MODULES	9
TOTAL FLOW	540,000 WSCFM
FLOW PER MODULE	60,000 WSCFM
COMBUSTION TEMP	1,500 DEG F
THERMAL EFFICIENCY	95 %
HEAT INPUT	43 MMBTU/HR
CLINKER PRODUCTION	6,000 TONS/DAY
CAPITAL COST (RTO ONLY)	18,000,000 $

COMPARIBLE UNIT	SCC
NO. OF MODULES	8
OPERATING MODULES	6
TOTAL FLOW	337,182 WSCFM
FLOW PER MODULE	60,000 WSCFM
CLINKER PRODUCTION	3,000 TONS/DAY

SCC ESTIMATED CAPITAL COST[2]		
RTO ONLY NO WET SCRUBBER	13,000,000	$

NOTES:

1. TXI RTO DESIGN AND COST DATA FROM MARK HILL, PLANT MANAGER (TELEPHONE COMMUNICATION 7/26/00)

2. CAPITAL COST SCALED USING NUMBER OF MODULES REQUIRED FOR FLOW VOLUME

FLUE GAS VOLUME ESTIMATE

PARAMETER	WSCFM	LB/MIN	%DRY	%WET
CO	200	7.5	0.06	0.06
O2	20231	1678.9	6.52	6.00
N2	222341	16146.8	71.67	65.94
SO2	5	0.56	0.00	0.00
NO	0	0.0	0.00	0.00
H2O	26975	1259.9		8.00
CO2	67439	7707.3	21.74	20.00
TOTAL	337,191	26,801	100	100

STACK DATA - MILL ON		
FLOWRATE	464,200	ACFM
	337,191	WSCFM
	310,216	DSCFM
TEMP	203	oF

PRODUCTION			
PTE	CLINKER	3000	T/D
PTE	CLINKER	125.00	T/HR
PTE	CLINKER	1,095,000	T/YR
OPERATING HOURS		8,760	YEAR

BACT DATA				
BACT	SO_2	147.83	T/YR	ANNUAL AVERAGE
		0.27	LB/TON	ANNUAL AVERAGE
		33.8	LB/HR	ANNUAL AVERAGE
BACT	CO	1971.00	T/YR	ANNUAL AVERAGE
		3.60	LB/TON	ANNUAL AVERAGE
		450.0	LB/HR	ANNUAL AVERAGE
BACT	VOC	65.70	T/YR	ANNUAL AVERAGE
		0.12	LB/TON	ANNUAL AVERAGE
		15.00	LB/HR	ANNUAL AVERAGE

STACK FLOW DATA		
UNITS	**MILL-ON**	**MILL-OFF**
NM3/HR	573,820	380,760
WSCFM	337,191	223,743
ACFM	464,200	399,550
DSCFM	310,216	244,360
TEMP F	203	400

INLET TO PREHEATER CYCLONE	
UNITS	**MILL-OFF**
NM3/HR	322,123
WSCFM	189,287
ACFM	399,320
DSCFM	225,300
TEMP F	472
TEMP C	230

HEAT BALANCE FOR RTO - CASE 2
(95 PERCENT REMOVAL OF CO AND VOC)

INPUTS

FLUE GAS STREAM

	LB/MIN	LB/HR	SCFM	% WET	PPM(WET)	PPM(DRY)
CO	7.50	450.00	103.20	0.03	306.1	332.7
O2	1678.92	100735.45	20231.04	4.00		
N2	16146.80	968807.75	222341.38	65.94		
SO2	0.56	33.75	3.39	0.00	10.1	
NO	0.00	0.00	0.00	0.00	0.0	
H2O	1259.91	75594.72	27015.03	8.01		
CO2	7707.26	462435.50	67477.82	20.01		
TOTAL(WET)	26800.95	1608057.16	**337,182**	100.00		
TOTAL(DRY)	25541.04	1532462.45	**310,216**			

STACK 464,200 ACFM
203 oF

BURNER COMBUSTION AIR

	LB/MIN
DRY AIR	898.6
O2	208.5
N2	690.1
H2O	9.8
WET AIR	908.4

65.35 MMBTU/HR
8.3 LB/1000BTU
898.6 LB/MIN

MOISTURE	0.0109	lb/lb DA
T=	70	oF
RH	50	%

COMBUSTION AIR

	LB/MIN	LB/HR	SCFM
O2	208.48	12508.66	2512.96
N2	690.13	41407.97	9496.23
DRY GAS	898.61	53916.63	12009.18
H2O	9.8053	588.32	209.93
TOTAL	908.42	54504.95	12219.11

TOTAL OXIDIZER INPUTS

	LB/MIN	LB/HR	SCFM	%WET	%DRY	PPM(DRY)
CO	7.50	450.00	103.20	0.03	0.03	320.3
O2	1887.40	113244.11	22743.99	6.51	7.06	
N2	16836.93	1010215.72	231837.61	66.35	71.96	
SO2	0.56	33.75	3.39	0.00	0.00	10.52
NO	0.00	0.00	0.00	0.00	0.00	0
CO2	7707.26	462435.50	67477.82	19.31	20.95	
TOTAL	26439.65	1586379.08	322166.00			
H2O	1269.72	76183.03	27224.96	7.79		
TOTAL	27709.37	1662562.11	349390.97	100.00	100.00	

HHV FUELS

CO	4339 BTU/LB
N.G.	22077 BTU/LB

AUXILIARY FUEL RATE

N.G. 49.34 LB/MIN

HEAT INPUTS

CO	30,915 BTU/MIN 1,854,923 BTU/HR	2.76 %
N.G.	1,089,225 BTU/MIN 65,353,490 BTU/HR	97.24 %
TOTAL	1,120,140 BTU/MIN 67,208,413 BTU/HR	

FUEL ANALYSIS

	CO %	N.G.%
C	42.85	69.12
H	0.00	23.20
O	57.15	1.58
N	0.00	5.76
S	0.00	0.34
TOTAL	100.00	100.00

HEAT BALANCE FOR RTO - CASE 2
(95 PERCENT REMOVAL OF CO AND VOC)

OXYGEN REQUIRED

	GASES LB/MIN	N.G. LB/MIN	TOTAL LB/MIN
C-CO2	0.00	90.71	90.71
CO-CO2	4.06	0.00	4.06
H2-H2O	0.00	90.88	90.88
S-SO2	0.00	0.17	0.17
N-NO	0.00	6.49	6.49
NET	4.06	188.26	192.32
O2 BOUND	4.29	0.78	5.07
O2 EXCESS			-187.25
COMBUSTION AIR			1887.40
NET O2 EXCESS			1700.15

CO EMISSIONS ANALYSIS AT 95% CONTROL

DESTRUCTION EFFICIENCY	95.00	%	CLINKER RATE		125.00	TON/HR
OPERATING HOURS	8760	HR/YR	EMISSION FACTOR		0.18	LB/TON
LB/HR ABATED	427.50	LB/HR	LB/HR EMITTED		22.50	LB/HR
TON/YR ABATED	1872.45	TON/YR	TON/YR EMITTED		98.55	TON/YR

FLUE GAS PRODUCTS

	GASES	N.G.	INPUT	TOTAL	SCFM	%DRY	%WET	PPM DRY
CO2	11.17	124.81	7707.26	7843.25	68718.60	21.40	19.61	
CO	0.00	0.00	0.38	0.38	5.16	0.00	0.00	16.1
H2O	0.00	102.33	1269.72	1372.05	29375.53		8.38	
N2	0.00	0.00	16836.93	16836.69	231861.42	72.21	66.16	
O2 EXCESS	0.00	0.00	1700.15	1700.15	20478.30	6.38	5.84	
SO2	0.00	0.34	0.56	0.90	5.41	0.00	0.00	16.8
NO	0.00	0.51	0.00	0.51	4.29	0.00	0.00	13.4
TOTAL	11.17	227.99	27514.99	27753.92	350448.71		100.00	
TOTAL(DRY)					321073.18	100.00		

MASS BALANCE

20.5 PPM NOX

SOURCE GASES	26800.95 LB/MIN
COMBUSTION AIR	908.42 LB/MIN
N.GAS	49.34 LB/MIN
TOTAL	27758.71 LB/MIN
COMBUSTION PRODUCTS	27753.92 LB/MIN
DIFFERENCE	0.02 %

INPUT ENTHALPY FLUE GASES

	Cp-BTU/LB-oF	T-oF	LB/MIN	h-BTU/MIN
N2	0.2482	203.00	16146.80	685,397
O2	0.2160	203.00	1678.92	62,021
CO	0.2083	203.00	7.50	267
CO2	0.2083	203.00	7707.26	274,577
SO2	0.1371	203.00	0.56	13
NO	0.2083	203.00	0.00	0
H2O	1147.0	203.00	1259.91	1,445,157
TOTAL			26800.95	2,467,433

ENTHALPY PREHEATED INPUT STREAM

	Cp-BTU/LB-oF	T-oF	LB/MIN	h-BTU/MIN
N2	0.2614	1400.00	16146.80	5774016.67
O2	0.2280	1400.00	1678.92	523663.16
CO	0.2634	1400.00	7.50	2702.48
CO2	0.2634	1400.00	7707.26	2777165.65
SO2	0.2362	1400.00	0.56	181.77
NO	0.2634	1400.00	0.00	0.00
H2O	1693.2	1400.00	1259.91	2133335.17
TOTAL			26800.95	11,211,065

AVERAGE TEMPERATURE	1400
HEAT GAIN REHEAT	8,743,632

INPUT ENTHALPY PRIMARY AIR

	Cp-BTU/LB-oF	T-oF	LB/MIN	h-BTU/MIN
N2	0.2468	70.00	690.13	6471.56
O2	0.2147	70.00	208.48	1700.89
H2O	1086.3	70.00	9.81	10651.86
TOTAL			908.42	18824

TOTAL GASES	11,229,889

	BTU/LB	LB/MIN	h-BTU/MIN
CO	4339.0	7.13	30915
NAT. GAS	22077	49.34	1089225
FUEL TOTAL			1120140
TOTAL			12,350,029
RADIATION LOSSES		*2.00*	247,001

HEAT BALANCE FOR RTO - CASE 2
(95 PERCENT REMOVAL OF CO AND VOC)

NET ENTHALPY FLUE GASES	12,103,029

HEAT BALANCE FOR RTO - CASE 2
(95 PERCENT REMOVAL OF CO AND VOC)

OUTPUT ENTHALPY

	Cp-BTU/LB-oF	T-oF	LB/MIN	h-BTU/MIN	% wt	SCFM	PPM(WET)
N2	0.2625	1500.00	16836.69	6,488,018	60.66	231841.22	
O2	0.2290	1500.00	1700.15	571,543	6.13	20486.80	
CO2	0.2680	1500.00	7843.25	3,085,721	28.26	68628.40	
CO	0.2680	1500.00	0.38	148	0.00	5.16	14.73
SO2	0.2445	1500.00	0.90	322	0.00	5.41	15.44
NO	0.2680	1500.00	0.51	201	0.00	4.26	12.16
H2O	1738.87	1500.00	1372.05	2,385,816	4.94	29375.53	
TOTAL			27753.92	12,531,770	100	350346.787	

NET DIFFERENCE	428741		
COMBUSTION TEMPERATURE	1500 **oF**	NO	0.51 LB/MIN
N.GAS USAGE	49.34 **LB/MIN**	NO	30.72 LB/HR
N.GAS USAGE	65.35 **MMBTU/HR**	NOX AS NO2	47.11 LB/HR
			0.72 LB/MMBTU
FLUE GAS OXYGEN	6.38 **%**		
INLET FUEL CONCENTRATION	3.21 **BTU/SCF**		

FLUE GAS VOLUME SUMMARY @ COMBUSTOR

	DSCFM	WSCFM	ACFM
INLET	310166.82	337181.85	1187799.71
OUTLET	321073.18	350448.71	1300908.10
STACK	321073.18	350448.71	577253.37

STACK ENTHALPY

	Cp-BTU/LB-oF	T-oF	LB/MIN	h-BTU/MIN	% wt	PPM(WET)
N2	0.2505	409.71	16636.69	1593082.11	60.66	
O2	0.2181	409.71	1700.15	140055.11	6.13	
CO2	0.2178	409.71	7843.25	645370.17	28.26	
CO	0.2178	409.71	0.38	30.86	0.00	13.51
SO2	0.1542	409.71	0.90	52.31	0.00	
NO2	0.2178	409.71	0.51	42.13	0.00	
H2O	1241.36	409.71	1372.05	1676559.12	4.94	
TOTAL			27753.92	4,055,192	100	

FINAL ENTHALPY	3,788,138
STACK TEMPERATURE	410 oF
GAIN	207 oF

B. STEAM ENTHALPY AT ATMOSHERIC PRESSURE

	A0	A1	A2	C
H2O	4.563E-01	1.666E-05	2.232E-07	1.069E+03

COST ESTIMATE
REGENERATIVE THERMAL OXIDIZER - CASE 2
(95 PERCENT REMOVAL OF CO AND VOC)

CAPITAL COSTS			FACTOR	COST
DIRECT COST				
	BASIC	OXIDIZER UNIT		13,000,000
		ID FAN,MOTOR,ETC.		500,000
		DUCTWORK		100,000
	EQUIPMENT	TOTAL		13,600,000
	OTHER	INSTRUMENTS	0.01	136,000
		TAXES	0.06	816,000
		FREIGHT	0.10	1,360,000
		TOTAL		15,912,000
	INSTALLATION	FOUNDATIONS	0.08	1,272,960
		ERECTION	0.12	1,909,440
		ELECTRICAL	0.03	477,360
		PIPING	0.03	477,360
		INSULATION	0.02	318,240
		SITE PREPARATION	0.02	318,240
		TOTAL	0.30	4,773,600
DIRECT COSTS		TOTAL		20,685,600
INDIRECT COSTS		ENGINEERING/DESIGN	0.10	1,591,200
		CONST/FIELD EXPENSE	0.10	1,591,200
		CONTR.FEE	0.05	795,600
		START-UP	0.01	159,120
		PERFORMANCE TEST		10,000
		CONTINGENCIES	0.05	795,600
		TOTAL		4,942,720
RETROFIT PREMIUM (N/A)				0
TOTAL CAPITAL COST				**25,628,320**

OPERATING COST(DIRECT)

UTILITIES	FAN STATIC PRESSURE	12.10	IN H2O
	FAN VOLUME	577253	ACFM
	FAN	1576.38	BHP
	FAN STATIC PRESSURE	5.00	IN H2O
	FAN VOLUME	12219	ACFM
	FAN	13.79	BHP
	CONNECTED LOAD	1590.17	BHP
	POWER	1185.79	KWHr
	HOURS OPERATED	8760	HRS
	ELECTRICAL COST	0.0424	$/KWHr
	ANNUAL COST	**440,326**	$/YR
	NATURAL GAS	65.35	MMBTU/HR
	COST	5.945	$/MMBTU
	ANNUAL COST	**3,403,492**	$/YR
MAINTENANCE LABOR & MATERIALS			
	5% OF DIRECT CAPITAL COST	**1,034,280**	$/YR

MAINTENANCE	LABOR	HR/YR	2000
	COST	$/HR	25.96
	COST	$/YR	**51,920**
OPERATOR	LABOR	HR/YR	7879
	COST	$/HR	33.17
	COST	$/YR	**261,346**
SUPERVISOR	LABOR	HR/YR	3293
	COST	$/HR	39.54
	COST	$/YR	**130,205**
TOTAL DIRECT OPERATING COST			**5,321,569**

COST ESTIMATE
REGENERATIVE THERMAL OXIDIZER - CASE 2

OPERATING COST(INDIRECT)	OVERHEAD	%	44.00
		$/YR	195,128
	PROPERTY TAX	%	1.46
		$/YR	373,907
	INSURANCE	%	1.00
		$/YR	256,283
	ADMINISTRATION	%	2.00
		$/YR	512,566
	CAPITAL RECOVERY	%-INTEREST	10.00
		LIFE-YEARS	10.00
		FACTOR	0.162745
		$/YR	4,170,891
TOTAL INDIRECT OPERATING COST			5,508,775

TOTAL ANNUAL COST	**$/YR**	**10,830,344**
TOTAL POLLUTANT REMOVED (95% DESTRUCTION)	**TON/YR**	**1,872.45**

EMISSIONS REDUCTION	**T/YR**	**1872.45**
COST/TON TOTAL POLLUTANT REMOVED	**$/TON**	**5,784.05**

HEAT BALANCE FOR RTO - CASE 3
(79.1 PERCENT REMOVAL OF CO AND 95.0 PERCENT REMOVAL OF VOC)

INPUTS

FLUE GAS STREAM

	LB/MIN	LB/HR	SCFM	%	PPM(WET)	PPM(DRY)
CO	7.50	450.00	103.20	0.03	306.1	332.7
O2	1678.92	100735.45	20231.04	6.00		
N2	16146.80	968807.75	222341.38	65.94		
SO2	0.56	33.75	3.39	0.00	10.1	
NO	0.00	0.00	0.00	0.00	0.0	
H2O	1259.91	75594.72	27054.72	8.02		
CO2	7707.26	462435.50	67438.51	20.00		
TOTAL(WET)	26800.95	1608057.16	**337,182**	100.00		
TOTAL(DRY)	25541.04	1532462.45	**310,216**			

STACK	464,200	ACFM
	203	oF

BURNER COMBUSTION AIR

	LB/MIN	
DRY AIR	898.6	
O2	208.5	65.35 MMBTU/HR
N2	690.1	8.3 LB/1000BTU
H2O	9.8	898.6 LB/MIN
WET AIR	908.4	

MOISTURE	0.0109	lb/lb DA
T=	70	oF
RH	50	%

COMBUSTION AIR

	LB/MIN	LB/HR	SCFM
O2	208.48	12508.66	2512.96
N2	690.13	41407.97	9496.23
DRY GAS	898.61	53916.63	12009.18
H2O	9.8053	588.32	209.93
TOTAL	908.42	54504.95	12219.11

TOTAL OXIDIZER INPUTS

	LB/MIN	LB/HR	SCFM	%WET	%DRY	PPM(DRY)
CO	7.50	450.00	103.20	0.03	0.03	320.37084
O2	1887.40	113244.11	22743.99	6.51	7.06	
N2	16836.93	1010215.72	231837.61	66.35	71.97	
SO2	0.56	33.75	3.39	0.00	0.00	10.520899
NO	0.00	0.00	0.00	0.00	0.00	0
CO2	7707.26	462435.50	67438.51	19.30	20.94	
TOTAL	26439.65	1586379.08	322126.70			
H2O	1269.72	76183.03	27264.65	7.80		
TOTAL	27709.37	1662562.11	349391.35	100.00	100.00	

HHV FUELS

CO	4339	BTU/LB
N.G.	22077	BTU/LB

AUXILIARY FUEL RATE

N.G. 49.34 LB/MIN

HEAT INPUTS

CO	25,745 BTU/MIN	2.31 %
	1,544,710 BTU/HR	
N.G.	1,089,225 BTU/MIN	97.69 %
	65,353,490 BTU/HR	
TOTAL	1,114,970 BTU/MIN	
	66,898,200 BTU/HR	

FUEL ANALYSIS

	CO %	N.G.%
C	42.85	69.12
H	0.00	23.20
O	57.15	1.58
N	0.00	5.76
S	0.00	0.34
TOTAL	100.00	100.00

HEAT BALANCE FOR RTO - CASE 3
(79.1 PERCENT REMOVAL OF CO AND 95.0 PERCENT REMOVAL OF VOC)

OXYGEN REQUIRED

	GASES LB/MIN	N.G. LB/MIN	TOTAL LB/MIN
C-CO2	0.00	90.71	90.71
CO-CO2	3.38	0.00	3.38
H2-H2O	0.00	90.88	90.88
S-SO2	0.00	0.17	0.17
N-NO	0.00	6.49	6.49
NET	3.38	188.26	191.64
O2 BOUND	4.29	0.78	5.07
O2 EXCESS			-186.57
COMBUSTION AIR			1887.40
NET O2 EXCESS			1700.83

CO EMISSIONS ANALYSIS

DESTRUCTION EFFICIENCY	79.11	%	CLINKER RATE		125.00	TON/HR
OPERATING HOURS	8760	HR/YR	EMISSION FACTOR		0.75	LB/TON
LB/HR ABATED	356.01	LB/HR	LB/HR EMITTED		93.99	LB/HR
TON/YR ABATED	1559.31	TON/YR	TON/YR EMITTED		411.69	TON/YR

FLUE GAS PRODUCTS

	GASES	N.G.	INPUT	TOTAL	SCFM	%DRY	%WET	PPM DRY
CO2	9.31	124.81	7707.26	7841.38	88702.23	21.40	19.60	
CO	0.00	0.00	1.57	1.57	21.56	0.01	0.01	67.1
H2O	0.00	102.33	1269.72	1372.05	29375.53		8.38	
N2	0.00	0.00	16836.93	16836.69	231861.42	72.21	66.16	
O2 EXCES	0.00	0.00	1700.83	1700.83	20486.48	6.38	5.85	
SO2	0.00	0.34	0.56	0.90	5.41	0.00	0.00	16.8
NO	0.00	0.51	0.00	0.51	4.29	0.00	0.00	13.4
TOTAL	9.31	227.99	27516.86	27753.92	350458.92		100.00	
TOTAL(DRY)					321081.39	100.00		

MASS BALANCE

20.5 PPM NOX

SOURCE GASES	26800.95	LB/MIN
COMBUSTION AIR	908.42	LB/MIN
N.GAS	49.34	LB/MIN
TOTAL	27758.71	LB/MIN
COMBUSTION PRODUCTS	27753.92	LB/MIN
DIFFERENCE	0.02	%

INPUT ENTHALPY FLUE GASES

	Cp-BTU/LB-oF	T-oF	LB/MIN	h-BTU/MIN
N2	0.2482	203.00	16146.80	685396.65
O2	0.2160	203.00	1678.92	62021.35
CO	0.2083	203.00	7.50	267.19
CO2	0.2083	203.00	7707.26	274577.23
SO2	0.1371	203.00	0.56	13.19
NO	0.2083	203.00	0.00	0.00
H2O	1147.0	203.00	1259.91	1445157.02
TOTAL			26800.95	2,467,433

ENTHALPY PREHEATED INPUT STREAM

	Cp-BTU/LB-oF	T-oF	LB/MIN	h-BTU/MIN
N2	0.2614	1400.00	16146.80	5774016.67
O2	0.2280	1400.00	1678.92	523663.16
CO	0.2634	1400.00	7.50	2702.48
CO2	0.2634	1400.00	7707.26	2777165.65
SO2	0.2362	1400.00	0.56	181.77
NO	0.2634	1400.00	0.00	0.00
H2O	1693.2	1400.00	1259.91	2133335.17
TOTAL			26800.95	11,211,065

AVERAGE TEMPERATURE	1400
HEAT GAIN REHEAT	8,743,632

INPUT ENTHALPY PRIMARY AIR

	Cp-BTU/LB-oF	T-oF	LB/MIN	h-BTU/MIN
N2	0.2468	70.00	690.13	6471.56
O2	0.2147	70.00	208.48	1700.89
H2O	1066.3	70.00	9.81	10651.86
TOTAL			908.42	18824

TOTAL GASES	11,229,889

	BTU/LB	LB/MIN	h-BTU/MIN
CO	4339.0	5.93	25745
NAT. GAS	22077	49.34	1089225
FUEL TOTAL			1114970

TOTAL		12,344,859
RADIATION LOSSES	2.00	246,897
NET ENTHALPY FLUE GASES		12,097,962

HEAT BALANCE FOR RTO - CASE 3
(79.1 PERCENT REMOVAL OF CO AND 95.0 PERCENT REMOVAL OF VOC)

OUTPUT ENTHALPY

	Cp-BTU/LB-oF	T-oF	LB/MIN	h-BTU/MIN	% wt	SCFM	PPM(WET)
N2	0.2625	1500.00	16836.69	6488018.37	60.88	231841.22	
O2	0.2290	1500.00	1700.83	571771.04	6.13	20494.988	
CO2	0.2680	1500.00	7841.38	3084986.11	28.25	68612.053	
CO	0.2680	1500.00	1.57	616.32	0.01	21.55594	61.53
SO2	0.2445	1500.00	0.90	322.31	0.00	5.4104214	
NO	0.2680	1500.00	0.51	201.46	0.00	4.2603612	
H2O	1738.87	1500.00	1372.05	2385816.10	4.94	29375.531	
TOTAL			27753.92	12,531,732	100	350355.02	

NET DIFFERENCE 433770

COMBUSTION TEMPERATURE	1500 oF	NO	0.51 LB/MIN
N.GAS USAGE	49.34 LB/MIN	NO	30.72 LB/HR
N.GAS USAGE	65.35 MMBTU/HR	NOX AS NO2	47.11 LB/HR
			0.72 LB/MMBTU

FLUE GAS OXYGEN 6.38 %

INLET FUEL CONCENTRATION 3.19 BTU/SCF

FLUE GAS VOLUME SUMMARY @ COMBUSTOR

	DSCFM	WSCFM	ACFM
INLET	310127.51	337182.23	1187801.05
OUTLET	321081.39	350456.92	1300938.56
STACK	321081.39	350456.92	577728.29

STACK ENTHALPY

	Cp-BTU/LB-oF	T-oF	LB/MIN	h-BTU/MIN	% wt	PPM(WET)
N2	0.2505	410.41	16838.69	1596062.79	60.66	
O2	0.2181	410.41	1700.83	140373.40	6.13	
CO2	0.2179	410.41	7841.38	646498.77	28.25	
CO	0.2179	410.41	1.57	129.16	0.01	56.44
SO2	0.1543	410.41	0.90	52.43	0.00	
NO2	0.2179	410.41	0.51	42.22	0.00	
H2O	1241.67	410.41	1372.05	1703635.35	4.94	
TOTAL			27753.92	4,086,794	100	

FINAL ENTHALPY	3,788,099
DIFFERENCE	-298,695
STACK TEMPERATURE	410 oF
GAIN	207 oF

B. STEAM ENTHALPY AT ATMOSHERIC PRESSURE

	A0	A1	A2	C
H2O	4.563E-01	1.666E-05	2.232E-07	1.069E+03

COST ESTIMATE
REGENERATIVE THERMAL OXIDIZER - CASE 2
(95 PERCENT REMOVAL OF CO AND VOC)

			FACTOR	COST
CAPITAL COSTS				
DIRECT COST				
	BASIC	OXIDIZER UNIT		13,000,000
		ID FAN,MOTOR,ETC.		500,000
		DUCTWORK		100,000
	EQUIPMENT	TOTAL		13,600,000
	OTHER	INSTRUMENTS	0.01	136,000
		TAXES	0.06	816,000
		FREIGHT	0.10	1,360,000
		TOTAL		15,912,000
	INSTALLATION	FOUNDATIONS	0.08	1,272,960
		ERECTION	0.12	1,909,440
		ELECTRICAL	0.03	477,360
		PIPING	0.03	477,360
		INSULATION	0.02	318,240
		SITE PREPARATION	0.02	318,240
		TOTAL	0.30	4,773,600
DIRECT COSTS		TOTAL		20,685,600
INDIRECT COSTS		ENGINEERING/DESIGN	0.10	1,591,200
		CONST/FIELD EXPENSE	0.10	1,591,200
		CONTR.FEE	0.05	795,600
		START-UP	0.01	159,120
		PERFORMANCE TEST		*10,000*
		CONTINGENCIES	0.05	795,600
		TOTAL		4,942,720
RETROFIT PREMIUM (N/A)				0
TOTAL CAPITAL COST				**26,626,320**
OPERATING COST(DIRECT)				
UTILITIES		FAN STATIC PRESSURE	12.10 IN H2O	
		FAN VOLUME	577728 ACFM	
		FAN	1577.48 BHP	
		FAN STATIC PRESSURE	5.00 IN H2O	
		FAN VOLUME	12219 ACFM	
		FAN	13.79 BHP	
		CONNECTED LOAD	1591.27 BHP	
		POWER	1186.61 KWHr	
		HOURS OPERATED	8760 HRS	
		ELECTRICAL COST	0.0424 $/KWHr	
		ANNUAL COST	**440,631** $/YR	
		NATURAL GAS	85.35 MMBTU/HR	
		COST	5.945 $/MMBTU	
		ANNUAL COST	**3,403,492** $/YR	
MAINTENANCE LABOR & MATERIALS				
		5% OF DIRECT CAPITAL COST	**1,034,260** $/YR	
MAINTENANCE		LABOR	HR/YR	2000
		COST	$/HR	25.96
		COST	$/YR	**51,920**
OPERATOR		LABOR	HR/YR	7879
		COST	$/HR	33.17
		COST	$/YR	**261,346**
SUPERVISOR		LABOR	HR/YR	3293
		COST	$/HR	39.54
		COST	$/YR	**130,206**
TOTAL DIRECT OPERATING COST				**5,321,874**
OPERATING COST(INDIRECT)		OVERHEAD	%	44.00
			$/YR	195,128
		PROPERTY TAX	%	1.46
			$/YR	373,907
		INSURANCE	%	1.00
			$/YR	256,283
		ADMINISTRATION	%	2.00
			$/YR	512,566
		CAPITAL RECOVERY	%-INTEREST	10.00
			LIFE-YEARS	10.00
			FACTOR	0.162745
			$/YR	4,170,891
TOTAL INDIRECT OPERATING COST				5,508,775
TOTAL ANNUAL COST			**$/YR**	**10,830,649**
ADJUSTED TOTAL ANNUAL COST			**$/YR**	**15,399,028**
EMISSIONS REDUCTION			**T/YR**	**1559.31**
$/TON REMOVED			**$/TON**	**$ 9,875.56**

PLANT COSTS

POWER COST		0.04239 $/KWH
PROPERTY TAX RATE		2.4316 $/100 @ 60%
	=	1.4590 %
CAPITAL RECOVERY RATE		10 %
LABOR COSTS		
SUPERVISOR		39.54 $/HR
OPERATOR		33.17 $/HR
1ST CLASS MAINTENANCE		25.96 $/HR
1ST CLASS ELECTRICIAN		25.96 $/HR
1ST CLASS WELDER		25.96 $/HR
GENERAL LABOR		18.00 $/HR
NATURAL GAS		5.945 $/MMBTU

Regulatory Applicability Analysis
Sumter Cement Company

- **New Source Performance Standards (NSPS) – 40 CFR Part 60**

NSPS Subpart OOO (Nonmetallic Mineral Processing Plants)
The processing of limestone from the Quarry to the Raw Material Silos at the SCC Plant is subject to NSPS Subpart OOO (Nonmetallic Mineral Processing Plants). This NSPS Final Rule was last issued on April 28, 2009. Individual emission sources subject to this NSPS include crushers, grinding mills, screening operations, bucket elevators, belt conveyors, bagging operations, storage bins, enclosed truck or rail car loading stations. Also, the Sumter Cement Company (SCC) Plant will commence construction after April 22, 2008.

Therefore, the following NSPS Subpart OOO limits apply:

- Fugitive emissions from the crusher is limited to 12 percent opacity.
- Fugitive emissions from other affected quarry fugitive emission sources are limited to 7 percent opacity.
- Point source emissions associated with the Raw Material Silos are limited to 7 percent opacity and subject to a PM limit of 0.014 gr/dscf.

NSPS Subpart Y (Coal Preparation Plants)
The coal handling and crushing equipment at the SCC Plant is subject to NSPS Subpart Y (Coal Preparation Plants.) This NSPS Final Rule was last issued on October 8, 2009. Also, the SCC Plant will commence construction after April 28, 2008. The SCC Plant Coal Mill is considered a thermal dryer.

Therefore, the following NSPS Subpart Y limits apply:

- The opacity from Coal Mill air emission sources is limited to 10 percent. However, SCC has elected to impose a more stringent 5 percent opacity limit on Coal Mill air emission sources as BACT.
- The Coal Mill baghouse is subject to a particulate matter (PM) limit of 0.01 grains/dscf.

Per 60.254(c), since the SCC Plant will construct an open storage pile after May 27, 2009 it is required to develop a Fugitive Coal Dust Control Plan which will address fugitive dust control from the storage pile and associated loading, unloading, and conveying operations.
The SCC Plant will not have any storage tanks that would be subject to NSPS Subpart Kb.

NSPS Subpart F (Portland Cement Plants)

The kiln at the SCC Plant is subject to NSPS Subpart F (Portland Cement Plants). This final rule was last issued on September 9, 2010. The SCC Plant will commence construction after June 16, 2008.

Therefore the following limits apply to the kiln:

- PM emission limit of 0.01 lb/ton clinker on a 30-day rolling average.
- Opacity limit of 20 percent.
- Nitrogen oxide (NO_x) limit of 1.5 lb/ton clinker on a 30-day rolling average.
- Sulfur dioxide (SO_2) limit of 0.4 lb/ton clinker on a 30-day rolling average.

- **National Emission Standards for Hazardous Air Pollutants (NESHAP) – 40 CFR Part 63**

The SCC Plant will be a major source of hazardous air pollutants (HAP) and therefore subject to NESHAP Subpart LLL (Portland Cement Manufacturing Plants.) This NESHAP Final Rule was last issued on September 9, 2010. Since the SCC Plant will be a Greenfield plant, the following emission limits are applicable to the kiln, clinker cooler, in-line raw mill, and finish mill. Also, emission limits are differentiated between normal operation and start-up and shutdown. At the time of the preparation of this regulatory analysis, this Final Rule is still being re-considered by the U.S. EPA.

SCC will meet either the proposed BACT emission limits or the NESHAP and NSPS emission limits specified in the Final Rule of September 9, 2010, whichever is the most stringent. At the time of the preparation of this Regulatory Applicability Analysis it is unknown whether the re-consideration of the Final Rule of September 9, 2010 will result in a change to any of the NESHAP and NSPS emission limits.

The following NESHAP Subpart LLL limits apply per the Final Rule of September 9, 2010:

Kiln – Normal Operation

- PM emission limit of 0.01 lb/ton clinker. SCC has elected to impose a PM filterable emission limit of 0.008 gr/dscf as BACT.
- Dioxins and furans (D/F) emission limit of 0.2 ng/dscm (TEQ) corrected to seven percent oxygen if the average temperature at the inlet to the PM control device during the D/F performance test is greater than 400°F. If the average temperature is 400°F or less than the limit is changed to 0.4 ng/dscm (TEQ).
- Mercury (Hg) emission limit of 21.0 lb/million tons clinker.

- Total Hydorcarbon (THC) emission limit of 24.0 ppmvd corrected to seven percent oxygen.

- Hydrogen Chloride (HCl) emission limit of 3.0 ppmvd corrected to seven percent oxygen.

Kiln – Start-Up and Shutdown

- PM emission limit of 0.0008 gr/dscf.

- Dioxins and furans (D/F) emission limit of 0.2 ng/dscm (TEQ) corrected to seven percent oxygen if the average temperature at the inlet to the PM control device during the D/F performance test is greater than 400°F. If the average temperature is 400°F or less than the limit is changed to 0.4 ng/dscm (TEQ).

- Mercury (Hg) emission limit of 4.0 ug/dscm.

- Total Hydorcarbon (THC) emission limit of 24.0 ppmvd corrected to seven percent oxygen.

- Hydrogen Chloride (HCl) emission limit of 3.0 ppmvd corrected to seven percent oxygen.

Clinker Cooler – Normal Operation

- PM emission limit of 0.01 lb/ton clinker. SCC has elected to impose a PM filterable emission limit of 0.008 gr/dscf as BACT.

Clinker Cooler – Start-Up and Shutdown

- PM emission limit of 0.0008 gr/dscf

Finish Mill – All Operating Modes

- Opacity limit of 10 percent.

Other Plant Point Sources and Fugitive Sources - All Operating Modes

- All other SCC Plant point sources and fugitive sources except those associated with the quarry are subject to an opacity limit of 10 percent. However, SCC has elected to impose a more stringent 5 percent opacity limit as BACT for these sources. The SCC Plant must be in compliance with these limits upon start-up of the new equipment.

SSM Plan and O&M Plan

As required by 40 CFR 63.6(e)(3) and 63.1347, SCC is developing a Start-up, Shutdown, and Malfunction (SSM) Plan for the SCC Plant and has included an Operations and Maintenance (O&M) Plan for the SCC Plant. These Plans provide procedures for the proper operation and maintenance of the emission units and their control devices, corrective actions and measures to be taken to minimize emissions in cases of start-up, shutdown, or malfunction, and procedures used in inspecting and monitoring the emission units and control equipment.

- **New Source Review (NSR)**

The SCC Plant is considered a major facility under F.A.C. 62.212, effective date December 4, 2011. For new major sources that result in a significant net emission increase per Rule 212.400, the following is required:

1. A BACT analysis for each pollutant with a significant net emissions increase (PM, PM_{10}, $PM_{2.5}$, GHG, SO_2, CO, NO_x and VOC.)
2. An analysis of impacts on Federal Class I areas, including Class I PSD increments and air quality related values.
3. A demonstration of compliance with the National Ambient Air Quality Standards (NAAQS) and Class II PSD increments, as applicable.
4. An additional impacts analysis (potential impacts on soil, vegetation, visibility and secondary growth).

As set forth in a March 1, 2000 Fl DEP Policy Memorandum, Florida's air toxics program is based on the application of 40 CFR Parts 61 and 63, adopted by reference. The Air Reference Concentrations for air toxics previously used by the FL DEP in evaluating air permit applications do not implement any statutory authority and are no longer used in evaluation of air permits.

- **Florida Emission Limiting Rules**

A number of provisions of Florida's air rules are applicable to the SCC Plant, although in most cases they are less stringent than the NSPS, NESHAP, or BACT requirements. Applicable provisions of F.A.C. Chapter 62 include:

- 296.320(4)(a) – Process Weight Limits
- 296.320(4)(b) – General Visible Emissions Standards
- 296.320(4)(c) - Unconfined Emissions of Particulate Matter
- 296.407 – Portland Cement Plants
- 296.701 (1) and (2) – Portland Cement Plants, Kilns and Clinker Cooler

- **Requested Permit Limits**

The permit limits, including the regulatory basis and the associated testing and monitoring requirements, being required by the SCC Plant are discussed below. Where there are multiple regulatory basis (e.g., BACT, NESHAP, PSD increment compliance, etc.) the most restrictive limit will be applicable to ensure compliance with other applicable regulations. SCC requests elimination of multiple redundant forms of emission limits and throughput limits. The kiln emission limits provided below are applicable for all combinations of traditional and alternate fuels to be utilized.

- **Kiln/Raw Mill/Cooler Emission Limits**

Provided below is a summary of the current most stringent emission limits.

Normal Operation

-	**PM:**	0.01 lb/ton clinker, 30-day rolling average, as determined by a PM CEMS (NSPS).
-	**PM_{10}:**	None.
-	**Opacity:**	10 percent as measured by COM (BACT).
-	**CO:**	3.60 lb/ton of clinker, 30-day rolling average, as determined by a CO CEMS (BACT).
-	**VOC:**	0.12 lb/ton of clinker, 30-day rolling average, as determined by a CEM that meets Performance Specification 4A (BACT), THC limit of 24.0 ppmvd corrected to seven percent oxygen.
-	**SO_2:**	0.27 lb/ton of clinker, 30-day rolling average, as measured by a CEM that meets Performance Specification 2 (BACT). This average time is appropriate to account for the sulfur variability in the raw materials and the short-term increase in SO_2 emissions when the raw mill is down and during upset conditions in the kiln.
-	**NO_x:**	1.50 lb/ton of clinker, 30-day rolling average, as measured by CEM that meets Performance Specification 2 (NSPS.) This averaging time is appropriate to account for the inherent variability in NO_x emissions from cement kilns and is consistent with EPA's State Implementation Plan (SIP) call guidance for cement kilns (which is based on 8-hour ozone concentrations.) Averaging times for NO_x air quality concentrations (NAAQS and PSD increments) are based on annual concentrations.

SCC also requests that for the first year of operation, the NO_x emission limit be set at 3.0 lb/ton of clinker to allow shake-down and optimization of the kiln system (BACT).

- **D/F:** 0.20 ng/dscm (TEQ) corrected to 7 percent oxygen (>400°F) or 0.40 ng/dscm (TEQ) corrected to 7 percent oxygen (< or = 400°F) as measured by Method 23 initially and then measured every 30 months thereafter (NESHAP).
- **Hg:** 21.0 lb/million tons clinker as determined by a CEM (NESHAP).
- **HCl** 3.0 ppmvd corrected to seven percent oxygen as determined by a CEM (NESHAP).

Start-Up and Shutdown

- **PM:** 0.0008 gr/dscf (NESHAP).
- **D/F**: 0.2 ng/dscm (TEQ) corrected to seven percent oxygen (>400°F) or 0.40 ng/dscm (TEQ) corrected to 7 percent oxygen (< or = 400°F) (NESHAP).
- **Hg:** 4.0 ug/dscm (NESHAP).
- **THC:** 24.0 ppmvd corrected to seven percent oxygen (NESHAP).
- **HCl:** 3.0 ppmvd corrected to seven percent oxygen (NESHAP).

- **Miscellaneous Baghouses**

- **PM:** 0.01 gr/dscf as determined by initial Method 5 test on selected baghouses (BACT)
- **PM_{10}:** 0.0085 gr/dscf as determined by initial Method 201 test on selected baghouses (BACT).
- **Opacity:** 5 percent as determined by initial testing and then tested every 5 years using Method 9 testing requirements stipulated in 40 CFR 63.1350 (BACT).

- **Throughput and Production Limits**

Throughput limits are applicable for only those PM emission sources that are subject to a "lb/ton" PM emission limit. These include process PM fugitive emission sources. Throughput limits are not needed for other miscellaneous PM sources that are controlled by a baghouse. Baghouse PM emissions are calculated using an outlet grain loading methodology which is not a function of throughput. Therefore, a throughput limit for a baghouse source is not appropriate.

SCC requests specific production limits for only the following sources:

- Primary Crusher and associated conveyors: 2,424,529 tons/yr, rolling 12-month average.
- Kiln and Clinker Cooler System: 1,095,000 tons/year clinker, rolling 12-month average of 139 tons/hour clinker.
- Finish Mill: grinding capacity of 1,171,650tons/yr cement, 150 tons per hour.
- Dry Fly Ash Injection: 177,726 tons/yr dry fly ash injection into kiln system, rolling 12-month average, 23 tons per hour.