

Appendix Q

Holcim-Clarksville SO₂ Control Cost Evaluation

Direct Costs		Holcim	MDNR	
<u>Purchased Equipment Costs</u>				
New Coal Mill ID Fan and associated equipment	\$2,000,000	\$1,000,000		Holcim Estimate; Historical Fan Cost
Instrumentation (10% of EC)	\$200,000	\$100,000		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012
Sales Tax (5% of EC)	\$100,000	\$50,000		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012
Freight (5% of EC)	\$100,000	\$50,000		0.05 A
Subtotal, Purchased Equipment Cost (PEC)	\$2,400,000	\$1,200,000		B
<u>Direct Installation Costs</u>				
Foundation (6% of PEC)	\$144,000	\$72,000		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012
Supports (6% of PEC)	\$144,000	\$72,000		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012
Handling and Erection (40% of PEC)	\$960,000	\$480,000		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012
Electrical (1% of PEC)	\$24,000	\$12,000		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012
Piping (30% of PEC)	\$720,000	\$360,000	0.30 B	CCM
Insulation for Ductwork (1% of PEC)	\$24,000	\$12,000		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012
Painting (1% of PEC)	\$24,000	\$12,000	0.01 B	CCM
Subtotal, Direct Installation Cost	\$2,040,000	\$1,020,000		
Site Preparation	N/A	N/A		
Buildings	N/A	N/A		
Total Direct Cost	\$4,440,000	\$2,220,000		
<u>Indirect Costs</u>				
Engineering (10% of PEC)	\$240,000	\$120,000		CCM
Construction and Field Expense (10% of PEC)	\$240,000	\$120,000		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012
Contractor Fees (10% of PEC)	\$240,000	\$120,000		CCM
Start-up (1% of PEC)	\$24,000	\$12,000		CCM
Performance Test (1% of PEC)	\$24,000	\$12,000		CCM
Contingencies (3% of PEC)	\$72,000	\$36,000		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012
Total Indirect Cost	\$840,000	\$420,000		
Total Capital Investment (TCI)	\$5,280,000	\$2,640,000		

Direct Annual Costs

Increased Fuel Cost (calculated by scaling 2007 annual average fuel usage by the ratio of 3-year average clinker production (1,169,667 tons) to 2007 actual clinker production (1,035,283 tons)) Scaled up from 2007 annual average clinker production to 3-yr average clinker production 2007 (1,035,283 tons c Scaled to (3 yr average tons clinker)

#####	Reduction in coke usage (metric ton/yr)	181,802		Holcim Engineering Estim	160,915	181,802
	Heat Value (Gj / Mt)	32.510		Holcim Plant Data		
	Heat (Gj / yr)	5,910,397		Holcim Engineering Estimate		
	Cost (\$/Gj)	\$1.74		Holcim Plant Data		
	Subtotal, reduction in coke cost	-\$10,284,091	-\$10,284,091			
#####	Reduction in coal usage (metric ton/yr)	10,656		Holcim Engineering Estim	9,432	10,656
	Heat Value (Gj / Mt)	22.177		Holcim Plant Data		
	Heat (Gj / yr)	236,325		Holcim Engineering Estimate		
	Cost (\$/Gj)	\$2.41		Holcim Plant Data		
	Subtotal, reduction in coal cost	-\$569,543	-\$569,543			
#####	Increase in low sulfur coal usage - Amount Requir	198,736		Holcim Engineering Estim	208,546	235,616
	Heat Value (Gj / Mt)		25.818	Holcim Engineering Estimate		
	Heat (Gj / yr)		5,131,033	Holcim Engineering Estimate		
	Cost (\$/Mt) or Cost (\$/Gj)	\$72.76	\$2.82	Holcim Marketing and Engineering Estimate		
	Subtotal, increase in Low Sulfur Coal cost	\$14,459,211	\$14,460,031			
	Total Direct Annual Cost (increase)	\$3,605,577	\$3,606,397			

Indirect Annual Costs			
Administrative (2% TCI)	\$105,600	\$52,800	0.02 TCI
Property Tax (1% TCI)	\$52,800	\$26,400	0.01 TCI
Insurance (1% TCI)	\$52,800	\$26,400	0.01 TCI
Capital Re (15 year life, 7 percent interest)	\$579,716	\$289,858	
Total Indirect Annual Cost	\$790,916	\$395,458	

Conclusion

Total Annualized Cost	\$4,396,493	\$4,001,855	
Pollutant Emission Rate Prior to Scrubber (tons SO₂/yr)	11,675	11,675	
Pollutant Removed (tons SO₂/yr) - 23%	3,152	3,152	27% Removal
Cost Per Ton of Pollutant Removed	\$1,395	\$1,270	

11675.16667 Average SO2 Emissions of 3 latest full production years

Pollutant Emitted after Control	8,523	8,523	tons/year
Maximum Actual Historical Clinker Production (t)	1,169,667	1,169,667	
Incremental Cost/ton clinker	\$ 4	\$3.42	

2007 baseline - Holcim Provided in BART Writeup
65% Sulfur Input from Fuel
35% Sulfur Input from Raw Materials
30-35% Sulfur Emitted from Stack

From permit

1169667 Average Production of 3 latest full production years

1611840 Maximum Clinker Production @ 184 TPH

13298 TPY SO2 @ 16.5 lb/ton

6,432,296 Gj/yr Heat Input from Fuel at Maximum Clinker Production

	Maximum Annual Clinker Scaled from 2007 Fuel Use							(TPY)	(TPY)	Raw Material				
	Cost per Gj	S%	BTU/lb	GJ/Mton	\$/Mton fuel	\$/ton fuel	Ex/Repl Use (MT)	GJ/yr	Fuel S Input (TPY)	Baseline (TPY)	Fuel SO2 Unc	Fuel SO2 Cont	SO2 (TPY)	Overall SO2 (TPY)
Existing Coal	\$2.41	3.45%	9534.49	22.177	\$53.45	\$48.49	10,656.31	236,325	9,706.55		19,394.93	7,757.97		11,682.67
Pet Coke	\$1.74	5.72%	13976.93	32.51	\$56.57	\$51.32	181,802	5,910,397	10,978.11		21,935.67	8,774.27		12,698.97
3%S Coal	\$2.81815	3.00%	11100	25.81833508	\$72.76	\$66.01	198,736	5,131,033	7,250.06		14,486.55	5,794.62		9,719.32
Tires		1.83%	13432.5	31.24367441			24,705.02	771,875.48	498.35		995.77	597.46		
PRB Coal	\$5.67	0.70%	11300.00	26.28353031	\$149.03	\$135.20	244,727	6,432,296	1,661.74		3,320.37	1,328.15		5,252.85
Other								529,387.51						

0.9478171 MMBTU/Gj
429.927 BTU/lb per Gj/MetricTon
2.2046 lb/kg
1000 kg/Metric Ton

12,475.12 24,926.90 9,970.76 3,327.24
5,660,420.15 [Max Heat Input] - 12% TDF
Baseline is All Fuel as Pet Coke
60% Fuel SO2 Control (Coal/Coke)
40% Fuel SO2 Control (Tires)

Tires

26.865 MMBTU/short ton
13432.5 BTU/lb
1.83 %S TDF

Modeled	4889.375 lb SO2/hour	117345 lb SO2/day	12/2/2004	4069.382956	TPD Clinker	28.83606711 lb/ton clinker
	3049.375 lb NOx/hour	73185 lb NOx/day	11/24/2007	3762.70105	TPD Clinker	19.45012347 lb/ton clinker

30-day Clinker
104587.71 Metric Tons
104338.4 Metric Tons

MAX 30-day average	80529.88431 lb SO2/day	12/10/05	1/8/06	20.95549232 lb/ton clinker
	52858.73258 lb NOx/day	10/29/07-	11/27/07	13.78776969 lb/ton clinker

2007 Ann Avg lb/ton SO2	17.31083175
2007 Ann Avg lb/ton Nox	10.05306488

2006 Ann Avg lb/ton SO2	13.64712331
2006 Ann Avg lb/ton Nox	8.583653198

2005 Ann Avg lb/ton SO2	11.16488906
2005 Ann Avg lb/ton Nox	5.768385811

Percentile	SO2	UNC (lb/day)	CON(lb/day)	lb/30days	Limits
Max	2415897	80529.9	58786.827	1763604.81	27% Control for SO2 from 30-day Maximum
0.95	2239006	74633.53333	54482.47933		
0.9	2043221	68107.36667	49718.37767		
0.8	1824675	60822.5	44400.425		
0.7	1666853	55561.76667	40560.08967		
0.6	1509100	50303.33333	36721.43333		
0.5	1344408	44813.6	32713.928		

Percentile	NOX	UNC (lb/day)	CON(lb/day)	lb/30days	Limits
Max	1585762	52858.73333	42286.98667	1268609.6	20% Control for NOX from 30-day maximum
0.95	1251125	41704.16667	33363.33333		
0.9	1089332	36311.06667	29048.85333		
0.8	921089	30702.96667	24562.37333		
0.7	855838	28527.93333	22822.34667		
0.6	730787	24359.56667	19487.65333		
0.5	629996	20999.86667	16799.89333		

Direct Costs			MDNR Alt						
<u>Purchased Equipment Costs</u>									
Wet Scrubber Unit including Limestone Prep System	\$10,524,352	\$7,670,653		Based on Ash Grove Cement Company - Moapa Plant Cost Estimate from Enviro-chem quote (65% of installed price plus 25% possible increase). Scaled using ratio of airflows to the 0.6 power					
Instrumentation (15% of EC)	\$1,578,653	\$1,150,598		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012					
Sales Tax (5% of EC)	\$526,218	\$383,533		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012					
Freight (5% of EC)	\$526,218	\$383,533		CCM					
Subtotal, Purchased Equipment Cost (PEC)	\$13,155,441	\$9,588,317			Moapa Airflow	311,360	acfm	0.41	Bypass Fraction
					Clarksville Airflow - Permit Limit	828,969	acfm	489,092	acfm (scaled for bypass)
<u>Direct Installation Costs</u>									
Foundation (10% of PEC)	\$1,315,544	\$958,832		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012					
Supports (10% of PEC)	\$1,315,544	\$958,832		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012					
Handling and Erection (50% of PEC)	\$6,577,720	\$4,794,158		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012					
Electrical (10% of PEC)	\$1,315,544	\$958,832		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012					
Piping (30% of PEC)	\$3,946,632	\$2,876,495		CCM					
Extending gas line 1/2 mile to plant	\$500,000	\$500,000		Engineering Estimate					
Insulation for Ductwork (5% of PEC)	\$657,772	\$479,416		Holcim Regional Capital Expense Manager - Engineering Estimate for 2012					
Painting (1% of PEC)	\$131,554	\$95,883		CCM					
Subtotal, Direct Installation Cost	\$15,760,311	\$11,622,447							
Buildings	N/A	N/A							
Total Direct Cost	\$28,915,752	\$21,210,764							

Indirect Costs			
Engineering (10% of PEC)	\$1,315,544	\$958,832	CCM
Construction and Field Expense (15% of PEC)	\$1,973,316	\$1,438,248	Holcim Regional Capital Expense Manager - Engineering Estimate for 2012
Contractor Fees (10% of PEC)	\$1,315,544	\$958,832	CCM
Start-up (1% of PEC)	\$131,554	\$95,883	CCM
Performance Test (1% of PEC)	\$131,554	\$95,883	CCM
Contingencies (5% of PEC)	\$657,772	\$479,416	Holcim Regional Capital Expense Manager - Engineering Estimate for 2012
Total Indirect Cost	\$5,525,285	\$4,027,093	
Total Capital Investment (TCI)	\$34,441,037	\$25,237,857	
Direct Annual Costs			
Hours (365 days per year, 24 hours per day), 90% Uptime	7,884	7,884	
<u>Operating Labor</u>			
Operator (8 men/yr, 2,080 hrs/yr, \$64.50/hr) 4 men/yr	\$1,073,280	\$1,073,280	Estimate - 8 man years, 2,080 hrs/yr *64.50. Holcim Durkee
Supervisor (15% of operator)	\$160,992	\$160,992	CCM
Subtotal, Operating Labor	\$1,234,272	\$1,234,272	
<u>Maintenance</u>			
Labor (6 men/yr, 2,080 hrs/yr, \$64.50/hr) 3 men/yr	\$804,960	\$804,960	Estimate - 6 man years, 2,080 hrs/yr *64.50. Holcim Durkee
Material (5% of Total Direct Cost)	\$ 1,445,788	\$1,060,538	Holcim Lee Island PSD
Subtotal, Maintenance	\$2,250,748	\$1,865,498	
<u>Utilities</u>			
<u>Electricity</u>			
Pump (kW)	2,342	1,707	Scaled using Moapa data and ratio of airflows to the 0.6 power
Cost (\$/kW-hr)	\$0.0410	\$0.041	Clarksville Budget - 2011
Subtotal, Electricity	\$757,054	\$551,617	
<u>Limestone for slurry</u>			

Amount Required (ton/yr)	15,972	9,423	(1.6 tons CaCO ₃ / ton SO ₂ Removed. From NLA evaluation = 1.03/1.0 molar ratio.
Cost (\$/ton)	\$3.00	\$3	
Subtotal, Lime	\$47,915	\$28,270	
Water			
Amount Required (gpm)	122.0	89	Scaled using Moapa data and ratio of airflows to the 0.6 power
Cost (\$/1000 gallons)	\$1.00	\$1	Plant Estimate
Subtotal, Water	\$57,716	\$42,054	
Sludge Disposal			
Amount Generated (tpy)	66,288	39,110	Scale to synthetic gypsum CaSO ₄ -2H ₂ O MW (170) / SO ₂ MW(64) / 80 percent purity lime / 50 percent moisture
Disposal Fee (\$/ton)	\$36.00	\$36	Bid from Area Disposal Services, Inc.
Monthly Rent for Trailer @ \$120/month	\$1,440	\$1,440	Bid from Area Disposal Services, Inc.
Cost for Box Transportation @ \$220/load (assume 17 tons/trailer)	\$857,851	\$506,132	Bid from Area Disposal Services, Inc.
Subtotal, Sludge	\$3,245,677	\$1,915,540	
Subtotal, Utilities	\$4,108,361	\$2,537,480	
Natural Gas Reheat (assuming a 210 deg F temp drop and reheat)			
Gas Required (MMCF/yr)	1,074,722	634,135	See Calculations Below
Cost (\$/MMBTU)	\$10.06	\$10.06	Missouri Energy Bulletin - April 10 2008
Subtotal, Natural Gas	\$10,811,708	\$6,379,395	
Total Direct Annual Costs	\$18,405,089	\$12,016,646	
Indirect Annual Costs			
Overhead (60% of sum of operating, supervisor, maintenance labor & material)	\$2,091,012	\$1,859,862	
Administrative (2% TCI)	\$688,821	\$504,757	0.02 TCI
Property Tax (1% TCI)	\$344,410	\$252,379	0.01 TCI
Insurance (1% TCI)	\$344,410	\$252,379	0.01 TCI
Capita (15 year life, 7 percent interest)	\$3,781,441	\$2,770,981	
Total Indirect Annual Cost	\$7,250,094	\$5,640,357	

Standard temperature	68	68	F
Density of air	0.0026	0.0026	lb-mole/scf
Specific heat of exhaust gas	7.542	7.542	Btu/lb-mole F
Specific heat of steam 14.7 psia 220 - 600 deg F	8.46	8.46	Btu/lb-mole F
Exhaust gas percent water	35%	0.35	Percent
Specific heat of exhaust gas	7.86	7.8633	Btu/lb-mole F
Exhaust gas temperature after WLS	170	256	Deg. F Based on Holcim Durkee Scrubber Design. NW Email
Current ESP outlet gas temp	380	380	Deg F
Heat input	3.60	1.868	Btu/acf
Exhaust gas flow rate - 367	828969	828,969	acfm
Exhaust gas flow rate - reduced temperature	631,404	717751.17	
Unit natural gas cost	\$10.06	\$10.06	Missouri Energy Bulletin - April 10 2008
Natural gas requirement - Based on 90% Plant Uptime, 95% Scrubber			MMBTU/yr
Uptime	1,074,722	634134.703	
Natural Gas Cost	\$10,811,708	\$6,379,395.11	/yr
Additional NOx Generated	140	140	lbs/MMscf. AP-42 Section 1.4-1. *** LNB Control Included
Conversion	1050	1050	MMBTU / MMSCF. Approximate Value
Natural gas requirement in MMscf/yr	1023.5	603.94	MMSCF/yr
NOx generated - tons/yr	72	42.28	tons/year