CUECost

Coal Utility Environmental Cost

Version 1, November 25, 1998 (revised 2-9-00 as CUECost3.xls)

Developed for EPA

by Raytheon Engineers & Constructors and Eastern Research Group

Current Date: *14-Oct-99*

GoTo Buttons **Print Options**

Inputs:

Calculations and Costs:

APC Technology Choices

Description	Units	Suggested Range	Default Values	Input 1	Input 2	Input 3	Input 4	Input 5	Description of Input
FGD Process (1 = LSFO, 2 = LSD)	Integer	1 or 2	1	2	2	2	2	2	
Particulate Control (1 = Fabric Filter, 2 = ESP)	Integer	1 or 2	1	1	1	1	1	1	
NOx Control (1 = SCR, 2 = SNCR, 3 = LNBs, 4 = NOR)	Integer	1 - 4	1	1	1	1	1	1	

INPUTS

Description	Units	Range	Default Values	Input 1	Input 2	Input 3	Input 4	Input 5	Description of Input
General Plant Technical Inputs									
Location - State	Abbrev.	All States	PA	PA	PA	PA	PA	PA	
MW Equivalent of Flue Gas to Control System	MW	100-2000	500	500	500	500	500	500	Gross Plant Generation (MW) minus auxiliary power requirements. Prior to control system retrofit
Net Plant Heat Rate (w/o APC)	Btu/kWhr		10,500	10,500	10,500	10,500	10,500	10,500	
Plant Capacity Factor	%	40-90%	65%	65%	65%	65%	65%	65%	
Percent Excess Air in Boiler	%		120%	120%	120%	120%	120%	120%	Excess O2
Air Heater Inleakage	%		12%	12%	12%	12%	12%	12%	
Air Heater Outlet Gas Temperature	°F		300	300	300	300	300	300	
Inlet Air Temperature	°F		80	80	80	80	80	80	
Ambient Absolute Pressure	In. of Hg		29.4	29.4	29.4	29.4	29.4	29.4	
Pressure After Air Heater	In. of H2O		-12	-12	-12	-12	-12	-12	
Moisture in Air	lb/lb dry air		0.013	0.013	0.013	0.013	0.013	0.013	
Ash Split									
Fly Ash	%		80%	80%	80%	80%	80%	80%	
Bottom Ash	%		20%	20%	20%	20%	20%	20%	
Seismic Zone	Integer	1-5	1	1	1	1	1	1	See Map
Retrofit Factor (1.0 = new, 1.3 = medium, 1.6 = difficult)	Integer	1.0-3.0	1.3	1.3	1.3	1.3	1.3	1.3	
Select Coal	Integer	1-8	1	1	2	3	4	5	
Is Selected Coal a Powder River Basin Coal?	Yes / No	See Column K	Yes	Yes	No	No	No	No	This question is necessary for a correct SO2 calculation
		Coals Available in Library							
		Coal 1, Wyoming PRB: 8,227 Btu, 0.37% S, 5.32% ash							
		Coal 2, Armstrong, PA: 13,100 Btu, 2.6% S, 9.1% ash							
		Coal 3, Jefferson, OH: 11,922 Btu, 3.43% S, 13% ash							
		Coal 4, Logan, WV: 12,058 Btu, 0.89% S, 16.6% ash							
		Coal 5, No. 6 Illinois: 10,100 Btu, 4% S, 16% ash							
		Coal 6, Rosebud, MT: 8,789 Btu, 0.56% S, 8.15% ash							
		Coal 7, Lignite, ND: 7,500 Btu, 0.94% S, 5.9% ash							
		Coal 8, "User Specified" Btu, 0% S, 0% ash							
Economic Inputs									
Cost Basis - Year Dollars	Year		1998	1998	1998	1998	1998	1998	Date of Startup
Sevice Life (levelization period)	Years		30	30	30	30	30	30	
Inflation Rate	%		3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	
After Tax Discount Rate (current $'s)	%		9.20%	9.20%	9.20%	9.20%	9.20%	9.20%	
AFDC Rate (current $'s)	%		10.80%	10.80%	10.80%	10.80%	10.80%	10.80%	
First-year Carrying Charge (current $'s)	%		22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	
Levelized Carrying Charge (current $'s)	%		16.90%	16.90%	16.90%	16.90%	16.90%	16.90%	
First-year Carrying Charge (constant $'s)	%		15.70%	15.70%	15.70%	15.70%	15.70%	15.70%	
Levelized Carrying Charge (constant $'s)	%		11.70%	11.70%	11.70%	11.70%	11.70%	11.70%	
Sales Tax	%		6%	6%	6%	6%	6%	6%	
Escalation Rates:									
Consumables (O&M)	%		3%	3%	3%	3%	3%	3%	
Capital Costs:									
Is Chem. Eng. Cost Index available?	Yes / No		Yes	Yes	Yes	Yes	Yes	Yes	
If "Yes" input cost basis CE Plant Index.	Integer		388	388	388	388	388	388	The default CE Index value is the published January 1998 value
If "No" input escalation rate.	%		3%	3%	3%	3%	3%	3%	
Construction Labor Rate	$/hr		$35	$35	$35	$35	$35	$35	
Prime Contractor's Markup	%		3%	3%	3%	3%	3%	3%	Percent of Total Process Capital - covers construction labor fees
Operating Labor Rate	$/hr		$30	$30	$30	$30	$30	$30	
Power Cost	Mills/kWh		25	25	25	25	25	25	
Steam Cost	$/1000 lbs		3.5	3.5	3.5	3.5	3.5	3.5	

CUECost - Air Pollution Control Systems Economics Spreadsheet

Limestone Forced Oxidation (LSFO) Inputs												
SO2 Removal Required	%	90-98%	95%	95%	95%	95%	95%	95%				
L/G Ratio	gal / 1000 acf	95-160	125	125	125	125	125	125				
Design Scrubber with Dibasic Acid Addition?	Integer	1 or 2	2	2	1	2	2	2				
(1 = yes, 2 = no)												
Adiabatic Saturation Temperature	°F	100-170	127	127	127	127	127	127				
Reagent Feed Ratio	Factor	1.0-2.0	1.05	1.05	1.05	1.05	1.05	1.05				
(Mole CaCO3 / Mole SO2 removed)												
Scrubber Slurry Solids Concentration	Wt. %		15%	15%	15%	15%	15%	15%				
Stacking, Landfill, Wallboard	Integer	1,2,3	1	1	1	1	1	1				
(1 = stacking, 2 = landfill, 3 = wallboard)												
Number of Absorbers	Integer	1-6	1	1	1	1	1	1				
(Max. Capacity = 700 MW per absorber)												
Absorber Material	Integer	1 or 2	1	1	1	1	1	1				
(1 = alloy, 2 = RLCS)												
Absorber Pressure Drop	in. H2O		6	6	6	6	6	6				
Reheat Required ?	Integer	1 or 2	1	1	1	1	1	1				
(1 = yes, 2 = no)												
Amount of Reheat	°F	0-50	25	25	25	25	25	25				
Reagent Bulk Storage	Days		60	60	60	60	60	60				
Reagent Cost (delivered)	$/ton		$15	$15	$15	$15	$15	$15				
Landfill Disposal Cost	$/ton		$30	$30	$30	$30	$30	$30				
Stacking Disposal Cost	$/ton		$6	$6	$6	$6	$6	$6				
Credit for Gypsum Byproduct	$/ton		$2	$2	$2	$2	$2	$2				
Maintenance Factors by Area (% of Installed Cost)												
Reagent Feed	%		5%	5%	5%	5%	5%	5%				
SO2 Removal	%		5%	5%	5%	5%	5%	5%				
Flue Gas Handling	%		5%	5%	5%	5%	5%	5%				
Waste / Byproduct	%		5%	5%	5%	5%	5%	5%				
Support Equipment	%		5%	5%	5%	5%	5%	5%				
Contingency by Area (% of Installed Cost)												
Reagent Feed	%		20%	20%	20%	20%	20%	20%				
SO2 Removal	%		20%	20%	20%	20%	20%	20%				
Flue Gas Handling	%		20%	20%	20%	20%	20%	20%				
Waste / Byproduct	%		20%	20%	20%	20%	20%	20%				
Support Equipment	%		20%	20%	20%	20%	20%	20%				
General Facilities by Area (% of Installed Cost)												
Reagent Feed	%		10%	10%	10%	10%	10%	10%				
SO2 Removal	%		10%	10%	10%	10%	10%	10%				
Flue Gas Handling	%		10%	10%	10%	10%	10%	10%				
Waste / Byproduct	%		10%	10%	10%	10%	10%	10%				
Support Equipment	%		10%	10%	10%	10%	10%	10%				
Engineering Fees by Area (% of Installed Cost)												
Reagent Feed	%		10%	10%	10%	10%	10%	10%				
SO2 Removal	%		10%	10%	10%	10%	10%	10%				
Flue Gas Handling	%		10%	10%	10%	10%	10%	10%				
Waste / Byproduct	%		10%	10%	10%	10%	10%	10%				
Support Equipment	%		10%	10%	10%	10%	10%	10%				
Lime Spray Dryer (LSD) Inputs												
SO2 Removal Required	%	90-95%	90%	90%	90%	90%	90%	90%				
Adiabatic Saturation Temperature	°F	100-170	127	127	127	127	127	127				
Flue Gas Approach to Saturation	°F	10-50	20	20	20	20	20	20				
Spray Dryer Outlet Temperature	°F	110-220	147	147	147	147	147	147				
Reagent Feed Ratio	Factor	Calc. Based on %S	0.90	0.92	1.50	1.75	1.01	1.94				
(Mole CaO / Mole Inlet SO2)												
Recycle Rate	Factor	Calculated	30	30	1.4	0.66	9	0.49				
(lb recycle / lb lime feed)												
Recycle Slurry Solids Concentration	Wt. %	10-50	35%	35%	35%	35%	35%	35%				
Number of Absorbers	Integer	1-7	2	2	2	2	2	2				
(Max. Capacity = 300 MW per spray dryer)												
Absorber Material	Integer	1 or 2	1	1	1	1	1	1				
(1 = alloy, 2 = RLCS)												
Spray Dryer Pressure Drop	in. H2O		5	5	5	5	5	5				
Reagent Bulk Storage	Days		60	60	60	60	60	60				
Reagent Cost (delivered)	$/ton		$65	$65	$65	$65	$65	$65				
Dry Waste Disposal Cost	$/ton		$30	$30	$30	$30	$30	$30				
Maintenance Factors by Area (% of Installed Cost)												
Reagent Feed	%		5%	5%	5%	5%	5%	5%				
SO2 Removal	%		5%	5%	5%	5%	5%	5%				
Flue Gas Handling	%		5%	5%	5%	5%	5%	5%				
Waste / Byproduct	%		5%	5%	5%	5%	5%	5%				
Support Equipment	%		5%	5%	5%	5%	5%	5%				
Contingency by Area (% of Installed Cost)												
Reagent Feed	%		20%	20%	20%	20%	20%	20%				
SO2 Removal	%		20%	20%	20%	20%	20%	20%				
Flue Gas Handling	%		20%	20%	20%	20%	20%	20%				
Waste / Byproduct	%		20%	20%	20%	20%	20%	20%				
Support Equipment	%		20%	20%	20%	20%	20%	20%				
General Facilities by Area (% of Installed Cost)												
Reagent Feed	%		10%	10%	10%	10%	10%	10%				
SO2 Removal	%		10%	10%	10%	10%	10%	10%				
Flue Gas Handling	%		10%	10%	10%	10%	10%	10%				
Waste / Byproduct	%		10%	10%	10%	10%	10%	10%				
Support Equipment	%		10%	10%	10%	10%	10%	10%				
Engineering Fees by Area (% of Installed Cost)												
Reagent Feed	%		10%	10%	10%	10%	10%	10%				
SO2 Removal	%		10%	10%	10%	10%	10%	10%				
Flue Gas Handling	%		10%	10%	10%	10%	10%	10%				
Waste / Byproduct	%		10%	10%	10%	10%	10%	10%				
Support Equipment	%		10%	10%	10%	10%	10%	10%				
Particulate Control Inputs												
Outlet Particulate Emission Limit	lbs/MMBtu		0.03	0.03	0.03	0.03	0.03	0.03				
Fabric Filter:												
Pressure Drop	in. H2O		6	6	6	6	6	6				
Type (1 = Reverse Gas, 2 = Pulse Jet)	Integer		2	2	2	2	2	2				
Gas-to-Cloth Ratio	ACFM/ft²		3.5	3.5	3.5	3.5	3.5	3.5				
Bag Material (ROFF fiberglass only)	Integer		2	2	2	2	2	2				
(1 = Fiberglass, 2 = Nomex, 3 = Ryton)												
Bag Diameter	inches	5 - 14	6	6	6	6	6	6				
Bag Length	feet	15 - 35	20	20	20	20	20	20				
Bag Reach			3	3	3	3	3	3				
Compartments out of Service	%		10%	10%	10%	10%	10%	10%				
Bag Life	Years	1 - 10	5	5	5	5	5	5				
Maintenance (% of installed cost)	%		5%	5%	5%	5%	5%	5%				
Contingency (% of installed cost)	%		20%	20%	20%	20%	20%	20%				
General Facilities (% of installed cost)	%		10%	10%	10%	10%	10%	10%				
Engineering Fees (% of installed cost)	%		10%	10%	10%	10%	10%	10%				
ESP:												
Strength of the electric field in the ESP = *E*	kV/cm		10.0	10.0	10.0	10.0	10.0	10.0				
Plate Spacing	in		12	12	12	12	12	12				
Plate Height	ft		36	36	36	36	36	36				
Pressure Drop	in. H2O		3	3	3	3	3	3				
Maintenance (% of installed cost)	%		5%	5%	5%	5%	5%	5%				
Contingency (% of installed cost)	%		20%	20%	20%	20%	20%	20%				
General Facilities (% of installed cost)	%		10%	10%	10%	10%	10%	10%				
Engineering Fees (% of installed cost)	%		10%	10%	10%	10%	10%	10%				
NOx Control Inputs												
Selective Catalytic Reduction (SCR) Inputs											***See Source Keys @ bottom of Constants CC Sheet***	
										IAPCS name	**Range Source**	**Default Source**
NH3/NOX Stoichiometric Ratio	NH3/NOX	0.7-1.0	0.9	D	D	D	D	D	*IAPCS Names and a list of sources are contained in sheets L, M, and N*	NH3 NOX ratio		
NOX Reduction Efficiency	Fraction	0.60-0.90	0.70	D	D	D	D	D		n	b	c
Inlet NOx	lbs/MMBtu		0.9	D	D	D	D	D		NOx		
Space Velocity (Calculated if zero)	1/hr		0	D	D	D	D	D		SV	i	i

Overall Catalyst Life	years	2-5	3	D	D	D	D	D			N	d	c
Ammonia Cost	$/ton		206	D	D	D	D	D			UCNH3	d	a
Catalyst Cost	$/ft3		356	D	D	D	D	D			UCCAT	d	a
Solid Waste Disposal Cost	$/ton		11.48	D	D	D	D	D			UCWASTE		a
Maintenance (% of installed cost)	%		1.5%	D	D	D	D	D					a
Contingency (% of installed cost)	%		20%	D	D	D	D	D					f
General Facilities (% of installed cost)	%		5%	D	D	D	D	D					f
Engineering Fees (% of installed cost)	%		10%	D	D	D	D	D					f
Number of Reactors	integer		2	D	D	D	D	D			Nr,tot		
Number of Air Preheaters	integer		1	D	D	D	D	D			Nr,aph		
Selective Non Catalytic Reduction (SNCR) Inputs													
Reagent	integer	1:Urea 2:Ammonia	1	D	D	D	D	D				–	–
Number of Injector Levels	integer		3	D	D	D	D	D			NIL		f
Number of Injectors	integer		18	D	D	D	D	D					
Number of Lance Levels	integer		0	D	D	D	D	D			NLL		f
Number of Lances	integer		0	D	D	D	D	D					
Steam or Air Injection for Ammonia	integer	1: Steam, 2: Air	1	D	D	D	D	D					–
NOX Reduction Efficiency	fraction	0.30-0.70	0.50	D	D	D	D	D			n	b	c
Inlet NOx	lbs/MMBtu		0.9	D	D	D	D	D			NOx		
NH3/NOX Stoichiometric Ratio	NH3/NOX	0.8-2.0	1.2	D	D	D	D	D			NH3:NOX ratio		
Urea/NOX Stoichiometric Ratio	Urea/NOX	0.8-2.0	1.2	D	D	D	D	D		*Urea provides 2 moles of Ammonia for every mole of Urea*	UREA:NOX ratio	f	c
Urea Cost	$/ton		225	D	D	D	D	D			UCUREA		g
Ammonia Cost	$/ton		206	D	D	D	D	D			UCNH3		a
Water Cost	$/1,000 gal		0.4	D	D	D	D	D			UCH2O		a
Maintenance (% of installed cost)	%		1.5%	D	D	D	D	D					a
Contingency (% of installed cost)	%		20%	D	D	D	D	D					e
General Facilities (% of installed cost)	%		5%	D	D	D	D	D					a
Engineering Fees (% of installed cost)	%		10%	D	D	D	D	D					e
Low NOX Burner Technology Inputs													
NOX Reduction Efficiency	fraction	0.15-0.60	0.35	D	D	D	D	D			n	i	g
Boiler Type	T:T-fired, W:Wall		T	D	D	D	D	D					
Retrofit Difficulty	L:Low, A:Average, H:High		A	D	D	D	D	D					
Maintenance Labor (% of installed cost)	%		0.8%	D	D	D	D	D					g
Maintenance Materials (% of installed cost)	%		1.2%	D	D	D	D	D					g
Natural Gas Reburning Inputs													
NOX Reduction Efficiency	fraction	0.55-0.65	0.61	D	D	D	D	D			n	i	
Gas Reburn Fraction	fraction	0.08 - 0.20	0.15	D	D	D	D	D					i
Waste Disposal Cost	$/ton		11.48	D	D	D	D	D			UCWASTE		a
Natural Gas Cost	$/MMBtu		2.31	D	D	D	D	D			UCGAS		a
Maintenance (% of installed cost)	%		1.5%	D	D	D	D	D					a
Contingency (% of installed cost)	%		20%	D	D	D	D	D					a
General Facilities (% of installed cost)	%		2%	D	D	D	D	D					c
Engineering Fees (% of installed cost)	%		10%	D	D	D	D	D					c

CUECost - Air Pollution Control Systems Economics Spreadsheet

APC Technology Choices

Description	Units	Input 1	Input 2	Input 3	Input 4	Input 5
FGD Process	Integer	2	2	2	2	2
(1 = LSFO, 2 = LSD)						
Particulate Control	Integer	1	1	1	1	1
(1 = Fabric Filter, 2 = ESP)						
NOx Control	Integer	1	1	1	1	1
(1 = SCR, 2 = SNCR, 3 = LNBs, 4 = NGR)						

INPUTS

Description	Units	Input 1	Input 2	Input 3	Input 4	Input 5
General Plant Technical Inputs						
Location - State	Abbrev.	PA	PA	PA	PA	PA
MW Equivalent of Flue Gas to Control System	MW	500	500	500	500	500
Net Plant Heat Rate	Btu/kWhr	10,500	10,500	10,500	10,500	10,500
Plant Capacity Factor	%	65%	65%	65%	65%	65%
Total Air Downstream of Economizer	%	120%	120%	120%	120%	120%
Air Heater Leakage	%	12%	12%	12%	12%	12%
Air Heater Outlet Gas Temperature	°F	300	300	300	300	300
Inlet Air Temperature	°F	80	80	80	80	80
Ambient Absolute Pressure	In. of Hg	29.4	29.4	29.4	29.4	29.4
Pressure After Air Heater	In. of H2O	-12	-12	-12	-12	-12
Moisture in Air	lb/lb dry air	0.013	0.013	0.013	0.013	0.013
Ash Split:						
Fly Ash	%	80%	80%	80%	80%	80%
Bottom Ash	%	20%	20%	20%	20%	20%
Seismic Zone	Integer	1	1	1	1	1
Retrofit Factor	Integer	1.3	1.3	1.3	1.3	1.3
(1.0 = new, 1.3 = medium, 1.6 = difficult)						
Select Coal	Integer	1	2	3	4	5
Is Selected Coal a Powder River Basin Coal?	Yes / No	Yes	No	No	No	No
Economic Inputs						
Cost Basis -Year Dollars	Year	1998	1998	1998	1998	1998
Sevice Life (levelization period)	Years	30	30	30	30	30
Inflation Rate	%	3%	3%	3%	3%	3%
After Tax Discount Rate (current $'s)	%	9%	9%	9%	9%	9%
AFDC Rate (current $'s)	%	11%	11%	11%	11%	11%
First-year Carrying Charge (current $'s)	%	22%	22%	22%	22%	22%
Levelized Carrying Charge (current $'s)	%	17%	17%	17%	17%	17%
First-year Carrying Charge (constant $'s)	%	16%	16%	16%	16%	16%
Levelized Carrying Charge (constant $'s)	%	12%	12%	12%	12%	12%
Sales Tax	%	6%	6%	6%	6%	6%
Escalation Rates:						
Consumables (O&M)	%	3%	3%	3%	3%	3%
Capital Costs:						
Is Chem. Eng. Cost Index available?	Yes / No	Yes	Yes	Yes	Yes	Yes
If "Yes" input cost basis CE Plant Index.	Integer	388	388	388	388	388
If "No" input escalation rate.	%	3%	3%	3%	3%	3%
Construction Labor Rate	$/hr	$35	$35	$35	$35	$35
Prime Contractor's Markup	%	3%	3%	3%	3%	3%
Operating Labor Rate	$/hr	$30	$30	$30	$30	$30
Power Cost	Mills/kWh	25	25	25	25	25
Steam Cost	$/1000 lbs	3.5	3.5	3.5	3.5	3.5
Limestone Forced Oxidation (LSFO) Inputs						

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SO2 Removal Required	%	95%	95%	95%	95%	95%
L/G Ratio	gal / 1000 acf	125	125	125	125	125
Design Scrubber with Dibasic Acid Addition?	Integer	2	1	2	2	2
(1 = yes, 2 = no)						
Adiabatic Saturation Temperature	°F	127	127	127	127	127
Reagent Feed Ratio	Factor	1.05	1.05	1.05	1.05	1.05
(Mole CaCO3 / Mole SO2 removed)						
Scrubber Slurry Solids Concentration	Wt. %	15%	15%	15%	15%	15%
Stacking, Landfill, Wallboard	Integer	1	1	1	1	1
(1 = stacking, 2 = lanfill, 3 = wallboard)						
Number of Absorbers	Integer	1	1	1	1	1
(Max. Capacity = 700 MW per absorber)						
Absorber Material	Integer	1	1	1	1	1
(1 = alloy, 2 = RLCS)						
Absorber Pressure Drop	in. H2O	6	6	6	6	6
Reheat Required ?	Integer	1	1	1	1	1
(1 = yes, 2 = no)						
Amount of Reheat	°F	25	25	25	25	25
Reagent Bulk Storage	Days	60	60	60	60	60
Reagent Cost (delivered)	$/ton	$15	$15	$15	$15	$15
Landfill Disposal Cost	$/ton	$30	$30	$30	$30	$30
Stacking Disposal Cost	$/ton	$6	$6	$6	$6	$6
Credit for Gypsum Byproduct	$/ton	$2	$2	$2	$2	$2
Maintenance Factors by Area (% of Installed Cost)						
Reagent Feed	%	5%	5%	5%	5%	5%
SO2 Removal	%	5%	5%	5%	5%	5%
Flue Gas Handling	%	5%	5%	5%	5%	5%
Waste / Byproduct	%	5%	5%	5%	5%	5%
Support Equipment	%	5%	5%	5%	5%	5%
Contingency by Area (% of Installed Cost)						
Reagent Feed	%	20%	20%	20%	20%	20%
SO2 Removal	%	20%	20%	20%	20%	20%
Flue Gas Handling	%	20%	20%	20%	20%	20%
Waste / Byproduct	%	20%	20%	20%	20%	20%
Support Equipment	%	20%	20%	20%	20%	20%
General Facilities by Area (% of Installed Cost)						
Reagent Feed	%	10%	10%	10%	10%	10%
SO2 Removal	%	10%	10%	10%	10%	10%
Flue Gas Handling	%	10%	10%	10%	10%	10%
Waste / Byproduct	%	10%	10%	10%	10%	10%
Support Equipment	%	10%	10%	10%	10%	10%
Engineering Fees by Area (% of Installed Cost)						
Reagent Feed	%	10%	10%	10%	10%	10%
SO2 Removal	%	10%	10%	10%	10%	10%
Flue Gas Handling	%	10%	10%	10%	10%	10%
Waste / Byproduct	%	10%	10%	10%	10%	10%
Support Equipment	%	10%	10%	10%	10%	10%
Lime Spray Dryer (LSD) Inputs						
SO2 Removal Required	%	90%	90%	90%	90%	90%
Adiabatic Saturation Temperature	°F	127	127	127	127	127
Flue Gas Approach to Saturation	°F	20	20	20	20	20
Spray Dryer Outlet Temperature	°F	147	147	147	147	147
Reagent Feed Ratio	Factor	0.92	1.50	1.75	1.01	1.94
(Mole CaO / Mole Inlet SO2)						
Recycle Rate	Factor	30	1.4	0.66	9	0.49
(lb recycle / lb lime feed)						
Recycle Slurry Solids Concentration	Wt. %	35%	35%	35%	35%	35%
Number of Absorbers	Integer	2	2	2	2	2
(Max. Capacity = 300 MW per spray dryer)						
Absorber Material	Integer	1	1	1	1	1
(1 = alloy, 2 = RLCS)						
Spray Dryer Pressure Drop	in. H2O	5	5	5	5	5
Reagent Bulk Storage	Days	60	60	60	60	60
Reagent Cost (delivered)	$/ton	$65	$65	$65	$65	$65
Dry Waste Disposal Cost	$/ton	$30	$30	$30	$30	$30

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Maintenance Factors by Area (% of Installed Cost)						
Reagent Feed	%	5%	5%	5%	5%	5%
SO2 Removal	%	5%	5%	5%	5%	5%
Flue Gas Handling	%	5%	5%	5%	5%	5%
Waste / Byproduct	%	5%	5%	5%	5%	5%
Support Equipment	%	5%	5%	5%	5%	5%
Contingency by Area (% of Installed Cost)						
Reagent Feed	%	20%	20%	20%	20%	20%
SO2 Removal	%	20%	20%	20%	20%	20%
Flue Gas Handling	%	20%	20%	20%	20%	20%
Waste / Byproduct	%	20%	20%	20%	20%	20%
Support Equipment	%	20%	20%	20%	20%	20%
General Facilities by Area (% of Installed Cost)						
Reagent Feed	%	10%	10%	10%	10%	10%
SO2 Removal	%	10%	10%	10%	10%	10%
Flue Gas Handling	%	10%	10%	10%	10%	10%
Waste / Byproduct	%	10%	10%	10%	10%	10%
Support Equipment	%	10%	10%	10%	10%	10%
Engineering Fees by Area (% of Installed Cost)						
Reagent Feed	%	10%	10%	10%	10%	10%
SO2 Removal	%	10%	10%	10%	10%	10%
Flue Gas Handling	%	10%	10%	10%	10%	10%
Waste / Byproduct	%	10%	10%	10%	10%	10%
Support Equipment	%	10%	10%	10%	10%	10%
Particulate Control Inputs						
Outlet Particulate Emission Limit	lbs/MMBtu	0.03	0.03	0.03	0.03	0.03
Fabric Filter:						
Pressure Drop	in. H2O	6	6	6	6	6
Type (1 = Reverse Gas, 2 = Pulse Jet)	Integer	2	2	2	2	2
Gas-to-Cloth Ratio	ACFM/ft^2	3.5	3.5	3.5	3.5	3.5
Bag Material (RGFF fiberglass only)	Integer	2	2	2	2	2
(1 = Fiberglass, 2 = Nomex, 3 = Ryton)						
Bag Diameter	inches	6	6	6	6	6
Bag Length	feet	20	20	20	20	20
Bag Reach		3	3	3	3	3
Compartments out of Service	%	10%	10%	10%	10%	10%
Bag Life	Years	5	5	5	5	5
Maintenance (% of installed cost)	%	5%	5%	5%	5%	5%
Contingency (% of installed cost)	%	20%	20%	20%	20%	20%
General Facilities (% of installed cost)	%	10%	10%	10%	10%	10%
Engineering Fees (% of installed cost)	%	10%	10%	10%	10%	10%
ESP:						
Strength of the electric field in the ESP = *E*	kV/cm	10.0	10.0	10.0	10.0	10.0
Plate Spacing	in.	12	12	12	12	12
Plate Height	ft.	36	36	36	36	36
Pressure Drop	in. H2O	3	3	3	3	3
Maintenance (% of installed cost)	%	5%	5%	5%	5%	5%
Contingency (% of installed cost)	%	20%	20%	20%	20%	20%
General Facilities (% of installed cost)	%	10%	10%	10%	10%	10%
Engineering Fees (% of installed cost)	%	10%	10%	10%	10%	10%
NOx Control Inputs						
Selective Catalytic Reduction (SCR) Inputs						
NH3/NOX Stoichiometric Ratio	NH3/NOX	0.9	0.9	0.9	0.9	0.9
NOX Reduction Efficiency	Fraction	0.70	0.70	0.70	0.70	0.70
Inlet NOx	lbs/MMBtu	0.9	0.9	0.9	0.9	0.9
Space Velocity (Calculated if zero)	1/hr	0	0	0	0	0
Overall Catalyst Life	years	3	3	3	3	3
Ammonia Cost	$/ton	205.66	205.66	205.66	205.66	205.66
Catalyst Cost	$/ft3	356.34	356.34	356.34	356.34	356.34
Solid Waste Disposal Cost	$/ton	11.48	11.48	11.48	11.48	11.48
Maintenance (% of installed cost)	%	1.5%	1.5%	1.5%	1.5%	1.5%
Contingency (% of installed cost)	%	20%	20%	20%	20%	20%

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General Facilities (% of installed cost)	%	5%	5%	5%	5%	5%
Engineering Fees (% of installed cost)	%	10%	10%	10%	10%	10%
Number of Reactors	integer	2	2	2	2	2
Number of Air Preheaters	integer	1	1	1	1	1
Selective NonCatalytic Reduction (SNCR) Inputs						
Reagent	1:Urea 2:Ammonia	1	1	1	1	1
Number of Injector Levels	integer	3	3	3	3	3
Number of Injectors	integer	18	18	18	18	18
Number of Lance Levels	integer	0	0	0	0	0
Number of Lances	integer	0	0	0	0	0
Steam or Air Injection for Ammonia	integer	1	1	1	1	1
NOX Reduction Efficiency	Fraction	0.50	0.50	0.50	0.50	0.50
Inlet NOx	lbs/MMBtu	0.9	0.9	0.9	0.9	0.9
NH3/NOX Stoichiometric Ratio	NH3/NOX	1.2	1.2	1.2	1.2	1.2
Urea/NOX Stoichiometric Ratio	Urea/NOX	1.2	1.2	1.2	1.2	1.2
Urea Cost	$/ton	225	224.95	224.95	224.95	224.95
Ammonia Cost	$/ton	205.66	205.66	205.66	205.66	205.66
Water Cost	$/1,000 gal	0.407	0.407	0.407	0.407	0.407
Maintenance (% of installed cost)	%	1.5%	1.5%	1.5%	1.5%	1.5%
Contingency (% of installed cost)	%	20%	20%	20%	20%	20%
General Facilities (% of installed cost)	%	5%	5%	5%	5%	5%
Engineering Fees (% of installed cost)	%	10%	10%	10%	10%	10%
Low NOX Burner Technology Inputs						
NOX Reduction Efficiency	fraction	0.35	0.35	0.35	0.35	0.35
Boiler Type	T:T-fired, W:Wall	T	T	T	T	T
Retrofit Difficulty	L:Low, A:Average, H:High	A	A	A	A	A
Maintenance Labor (% of installed cost)	%	0.8%	0.8%	0.8%	0.8%	0.8%
Maintenance Materials (% of installed cost)	%	1.2%	1.2%	1.2%	1.2%	1.2%
Natural Gas Reburning Inputs						
NOX Reduction Efficiency	fraction	0.61	0.61	0.61	0.61	0.61
Gas Reburn Fraction	fraction	0.15	0.15	0.15	0.15	0.15
Waste Disposal Cost	$/ton	11.48	11.48	11.48	11.48	11.48
Natural Gas Cost	$/MMBtu	2.31	2.31	2.31	2.31	2.31
Maintenance (% of installed cost)	%	1.5%	1.5%	1.5%	1.5%	1.5%
Contingency (% of installed cost)	%	20%	20%	20%	20%	20%
General Facilities (% of installed cost)	%	2%	2%	2%	2%	2%
Engineering Fees (% of installed cost)	%	10%	10%	10%	10%	10%

SUMMARY OF COSTS

Description	Units	Input 1	Input 2	Input 3	Input 4	Input 5
APC Technologies						
NOx Control		SCR	SCR	SCR	SCR	SCR
Particulate Control		PJFF	PJFF	PJFF	PJFF	PJFF
SO2 Control		LSD	LSD	LSD	LSD	LSD

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NOx Control Costs		SCR	SCR	SCR	SCR	SCR
Total Capital Requirement (TCR)	$	$37,778,643	$36,283,822	$36,377,917	$36,218,457	$36,720,710
	$/kW	$75.6	$72.6	$72.8	$72.4	$73.4
First Year Costs						
Fixed O&M	$	$500,635	$488,196	$488,982	$487,649	$491,842
	$/kW-Yr	1.00	0.98	0.98	0.98	0.98
	Mills/kWH	0.18	0.17	0.17	0.17	0.17
	$/ton NOx removed	$176	$108	$110	$131	$122
Variable O&M	$	$4,259,548	$4,055,448	$4,068,208	$4,046,591	$4,114,794
	$/kW-Yr	8.52	8.11	8.14	8.09	8.23
	Mills/kWH	1.50	1.42	1.43	1.42	1.45
	$/ton NOx removed	$1,499	$897	$912	$1,084	$1,017
Fixed Charges	$	$8,424,637	$8,091,292	$8,112,276	$8,076,716	$8,188,718
	$/kW-Yr	16.85	16.18	16.22	16.15	16.38
	Mills/kWH	2.96	2.84	2.85	2.84	2.88
	$/ton NOx removed	$2,966	$1,790	$1,819	$2,163	$2,024
TOTAL	$	$13,184,820	$12,634,935	$12,669,465	$12,610,956	$12,795,354
	$/kW-Yr	26.37	25.27	25.34	25.22	25.59
	Mills/kWH	4.63	4.44	4.45	4.43	4.49
	$/ton NOx removed	$4,641	$2,796	$2,841	$3,378	$3,163
Levelized Current Dollars						
Fixed O&M	$/kW-Yr	1.36	1.33	1.33	1.33	1.34
	Mills/kWH	0.24	0.23	0.23	0.23	0.24
	$/ton NOx removed	$240	$147	$149	$178	$165
Variable O&M	$/kW-Yr	11.59	11.04	11.07	11.01	11.20
	Mills/kWH	2.04	1.94	1.94	1.93	1.97
	$/ton NOx removed	$2,040	$1,221	$1,241	$1,475	$1,384
Fixed Charges	$/kW-Yr	12.77	12.26	12.30	12.24	12.41
	Mills/kWH	2.24	2.15	2.16	2.15	2.18
	$/ton NOx removed	$2,248	$1,357	$1,379	$1,639	$1,534
TOTAL	$/kW-Yr	25.72	24.63	24.70	24.58	24.95
	Mills/kWH	4.52	4.33	4.34	4.32	4.38
	$/ton NOx removed	$4,528	$2,725	$2,769	$3,292	$3,083
Levelized Constant Dollars						
Fixed O&M	$/kW-Yr	1.00	0.98	0.98	0.98	0.98
	Mills/kWH	0.18	0.17	0.17	0.17	0.17
	$/ton NOx removed	$176	$108	$110	$131	$122
Variable O&M	$/kW-Yr	8.52	8.11	8.14	8.09	8.23
	Mills/kWH	1.50	1.42	1.43	1.42	1.45
	$/ton NOx removed	$1,499	$897	$912	$1,084	$1,017
Fixed Charges	$/kW-Yr	8.84	8.49	8.51	8.48	8.59
	Mills/kWH	2.21	2.12	2.12	2.11	2.14
	$/ton NOx removed	$2,210	$1,334	$1,356	$1,612	$1,508
TOTAL	$/kW-Yr	18.36	17.58	17.63	17.54	17.81
	Mills/kWH	3.88	3.71	3.72	3.71	3.76
	$/ton NOx removed	$3,886	$2,340	$2,377	$2,827	$2,647
Particulate Control Costs		PJFF	PJFF	PJFF	PJFF	PJFF
Total Capital Requirement (TCR)	$	$36,999,765	$33,889,308	$35,928,890	$34,333,231	$39,416,879
	$/kW	$74	$68	$72	$69	$79
First Year Costs						
Fixed O&M	$	$1,305,112	$1,195,395	$1,267,338	$1,211,054	$1,390,372
	$/kW-Yr	2.61	2.39	2.53	2.42	2.78
	Mills/kWH	0.46	0.42	0.45	0.43	0.49
	$/ton PM removed	$3.2	$3.7	$2.9	$3.3	$2.3
Variable O&M	$	$1,271,669	$1,172,584	$1,191,454	$1,163,013	$1,235,651
	$/kW-Yr	2.54	2.35	2.38	2.33	2.47
	Mills/kWH	0.45	0.41	0.42	0.41	0.43
	$/ton PM removed	$3.1	$3.6	$2.8	$3.2	$2.0
Fixed Charges	$	$8,250,948	$7,557,316	$8,012,143	$7,656,310	$8,789,964
	$/kW-Yr	16.50	15.11	16.02	15.31	17.58
	Mills/kWH	2.90	2.65	2.81	2.69	3.09
	$/ton PM removed	$20.0	$23.3	$18.5	$21.1	$14.5
TOTAL	$	$10,827,729	$9,925,295	$10,470,935	$10,030,378	$11,415,987
	$/kW-Yr	21.66	19.85	20.94	20.06	22.83
	Mills/kWH	3.80	3.49	3.68	3.52	4.01
	$/ton PM removed	$26.2	$30.7	$24.2	$27.6	$18.8

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Levelized Current Dollars						
Fixed O&M	$/kW-Yr	3.55	3.25	3.45	3.30	3.78
	Mills/kWH	0.62	0.57	0.61	0.58	0.66
	$/ton PM removed	$4.3	$5.0	$4.0	$4.5	$3.1
Variable O&M	$/kW-Yr	3.46	3.19	3.24	3.17	3.36
	Mills/kWH	0.61	0.56	0.57	0.56	0.59
	$/ton PM removed	$4.2	$4.9	$3.7	$4.4	$2.8
Fixed Charges	$/kW-Yr	12.51	11.45	12.14	11.60	13.32
	Mills/kWH	2.20	2.01	2.13	2.04	2.34
	$/ton PM removed	$15.2	$17.7	$14.0	$16.0	$11.0
TOTAL	$/kW-Yr	19.52	17.90	18.84	18.07	20.47
	Mills/kWH	3.43	3.14	3.31	3.17	3.60
	$/ton PM removed	$23.6	$27.6	$21.7	$24.9	$16.9
Levelized Constant Dollars						
Fixed O&M	$/kW-Yr	2.61	2.39	2.53	2.42	2.78
	Mills/kWH	0.46	0.42	0.45	0.43	0.49
	$/ton PM removed	$3.2	$3.7	$2.9	$3.3	$2.3
Variable O&M	$/kW-Yr	2.54	2.35	2.38	2.33	2.47
	Mills/kWH	0.45	0.41	0.42	0.41	0.43
	$/ton PM removed	$3.1	$3.6	$2.8	$3.2	$2.0
Fixed Charges	$/kW-Yr	8.66	7.93	8.41	8.03	9.22
	Mills/kWH	2.16	1.98	2.10	2.00	2.30
	$/ton PM removed	$14.9	$17.4	$13.8	$15.7	$10.8
TOTAL	$/kW-Yr	13.81	12.67	13.32	12.78	14.48
	Mills/kWH	3.06	2.81	2.96	2.84	3.22
	$/ton PM removed	$21.1	$24.7	$19.5	$22.3	$15.1
SO2 Control Costs		LSD	LSD	LSD	LSD	LSD
Total Capital Requirement (TCR)	$	$81,621,644	$94,276,387	$106,271,661	$81,776,527	$120,823,284
	$/kW	$163	$189	$213	$164	$242
First Year Costs						
Fixed O&M	$	$4,808,263	$5,208,226	$5,595,017	$4,788,488	$6,060,796
	$/kW-Yr	9.62	10.42	11.19	9.58	12.12
	Mills/kWH	1.69	1.83	1.97	1.68	2.13
	$/ton SO2 removed	$397.8	$97.6	$72.4	$241.4	$56.9
Variable O&M	$	$4,542,732	$13,724,195	$22,229,418	$8,466,036	$32,837,602
	$/kW-Yr	9.09	27.45	44.46	16.93	65.68
	Mills/kWH	1.60	4.82	7.81	2.97	11.53
	$/ton SO2 removed	$375.8	$257.3	$287.5	$426.8	$308.5
Fixed Charges	$	$18,201,627	$21,023,634	$23,698,580	$18,236,166	$26,943,592
	$/kW-Yr	36.40	42.05	47.40	36.47	53.89
	Mills/kWH	6.39	7.38	8.32	6.41	9.46
	$/ton SO2 removed	$1,505.8	$394.1	$306.5	$919.3	$253.1
TOTAL	$	$27,552,621	$39,956,056	$51,523,016	$31,490,690	$65,841,990
	$/kW-Yr	55.11	79.91	103.05	62.98	131.68
	Mills/kWH	9.68	14.03	18.10	11.06	23.13
	$/ton SO2 removed	$2,279	$749	$666	$1,587	$619
Levelized Current Dollars						
Fixed O&M	$/kW-Yr	13.09	14.17	15.23	13.03	16.50
	Mills/kWH	2.30	2.49	2.67	2.29	2.90
	$/ton SO2 removed	$541.3	$132.9	$98.5	$328.5	$77.5
Variable O&M	$/kW-Yr	12.36	37.35	60.50	23.04	89.37
	Mills/kWH	2.17	6.56	10.63	4.05	15.70
	$/ton SO2 removed	$511.4	$350.1	$391.2	$580.7	$419.8
Fixed Charges	$/kW-Yr	27.59	31.87	35.92	27.64	40.84
	Mills/kWH	4.85	5.60	6.31	4.85	7.17
	$/ton SO2 removed	$1,141.2	$298.7	$232.3	$696.7	$191.8
TOTAL	$/kW-Yr	53.04	83.39	111.65	63.71	146.71
	Mills/kWH	9.31	14.65	19.61	11.19	25.76
	$/ton SO2 removed	$2,193.9	$781.7	$721.9	$1,605.9	$689.1
Levelized Constant Dollars						
Fixed O&M	$/kW-Yr	9.62	10.42	11.19	9.58	12.12
	Mills/kWH	1.69	1.83	1.97	1.68	2.13
	$/ton SO2 removed	$397.8	$97.6	$72.4	$241.4	$56.9
Variable O&M	$/kW-Yr	9.09	27.45	44.46	16.93	65.68
	Mills/kWH	1.60	4.82	7.81	2.97	11.53
	$/ton SO2 removed	$375.8	$257.3	$287.5	$426.8	$308.5

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Fixed Charges	$/kW-Yr	19.10	22.06	24.87	19.14	28.27
	Mills/kWH	4.76	5.50	6.20	4.77	7.05
	$/ton SO2 removed	$1,122.2	$293.7	$228.4	$685.1	$188.6
TOTAL	$/kW-Yr	37.80	59.93	80.52	45.64	106.07
	Mills/kWH	8.05	12.15	15.98	9.43	20.72
	$/ton SO2 removed	$1,895.8	$648.6	$588.2	$1,353.2	$554.1

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SCR (high-dust) - Preliminary		Case1	Case2	Case3	Case4	Case5		Equations (bold indicates existing cuecost model parameter, blue indicates new input value from NOX User Input Sheet, normal text parameters are calculated on this sheet)
Ammonia Injection Rate	lb/hr	1,574	1,574	1,574	1,574	1,574	NH3= 3.702 x 10-4 * NH3:NOX ratio * **BSIZE** * **HTR** * **NOx**	=3.702x10^-4*NH3:NOX ratio * **BSIZE(MW)** * **HTR (Btu/kWh)** * **NOX(lb/10^6 Btu)**
Space Velocity	1/hr	2,840	2,840	2,840	2,840	2,840	If SV is not input then SV =6131.06/3 * (n)^-0.241 * (NH3 NOx ratio)^-2.306	= 6131.06 / 3 * (NOX reduction eff) ^-0.241 * (NH3 NOX ratio) ^-2.306
Gross Catalyst Volume	ft³	24,664	23,107	23,204	23,039	23,559	CV = Q/SV	= *flue gas volume flow rate (acfm)* * 60min/hr / space velocity (1/hr)

SCR Capital Costs		Case1	Case2	Case3	Case4	Case5		
Cost Basis (Year)		*1998*	*1998*	*1998*	*1998*	*1998*		
Reactor Housing and Installation	$	4,055,272	3,927,986	3,936,070	3,922,364	3,965,437	DCr=18.65 * Nr,tot * (CV/Nr,tot)^0.489*1000**Retrofit Factor**	DCr=18.65 * Number of Reactors * (Gross Catalyst Volume/Number of Reactors)^0.489*1000**Retrofit Factor**
Ammonia Handling and Injection	$	1,917,147	1,917,147	1,917,147	1,917,147	1,917,147	DCnh3=58.8(NH3 (lb/hr))^0.482*1000**Retrofit Factor**	DCnh3=50.8(Ammonia Injection Rate (lb/hr))^0.482*1000**Retrofit Factor**
Flue Gas Handling Ductwork and Fans	$	5,112,798	4,586,549	4,900,828	4,876,627	4,952,804	DCfgh=143.66*(Gfg)^0.694***Retrofit Factor *1989 CI/1982 CI (Note: IAPCS Eqution used)***	DCfgh=143.66*(***Flue gas (SCFM)*** * (750+460)/(70+460))^0.694***Retrofit Factor****108.7/91.8, Gfg = flue gas ACFM, assume maximum operating SCR temperature, 750 deg F, atmospheric pressure
Air Preheater Modifications	$	1,271,466	1,206,829	1,210,895	1,204,005	1,225,711	Dcaph,mod=1370*Nt,aph(UAt,aph/4.4/10^6/Nt,aph)^0.8 *1000***Retrofit Factor***	Dcaph,mod = 1370*No. air preheaters * (*SCFM* *60(m/hr)*7.9 *(T - 725)*(ln(125/(T - T)))/0.7302/530/(125-T - T)/4.4/10^6/No. air preheaters)^0.8 *1000***Retrofit Factor.***
Misc. Other Direct Capital Costs	$	416,262	416,262	416,262	416,262	416,262	DCmisc=(100+300 * (*BSIZE*/550)^0.6) * 1,000***Retrofit Factor***	DCmisc=(100+300 * (*BSIZE(MW)*/550)^0.4) * 1,000***Retrofit Factor***
Equipment Capital Cost Subtotal	$	$12,772,945	$12,354,772	$12,381,201	$12,336,405	$12,477,361	=sum(Direct Capital Costs)	capital costs=SUM(direct capital costs)
Instruments & Controls	$	$255,459	$247,095	$247,624	$246,728	$249,547	=0.02*Equipment Capital Cost Subtotal	=0.02*capital costs
Taxes	$	$766,377	$741,286	$742,872	$740,184	$748,642	=Equipment Capital Cost Subtotal * Sales Tax %	=capital costs*(*Sales Tax*)
Freight	$	$638,647	$617,739	$619,060	$616,820	$623,868	=0.05 * Equipment Capital Cost Subtotal	=0.05*capital costs
Total Direct Cost		$14,433,428	$13,960,893	$13,990,757	$13,940,137	$14,099,417		
Total Direct Cost with Retrofit Factor	$	$18,763,456	$18,149,161	$18,187,985	$18,122,179	$18,329,243		Total Direct Cost with Retrofit Factor= Total Direct Cost****Def_RetroFact***
General Facilities	$	$938,173	$907,458	$909,399	$906,109	$916,462	=Total Direct Cost with Retrofit Factor * General Facilities (%)	=Total Direct Cost with Retrofit Factor*(General Facilities)
Engineering Fees	$	$1,876,346	$1,814,916	$1,818,798	$1,812,218	$1,832,924	=Total Direct Cost with Retrofit Factor * Engineering (%)	=Total Direct Cost with Retrofit Factor*(Engineering Fees)
Contingency	$	$3,752,691	$3,628,832	$3,637,597	$3,624,436	$3,665,849	=Total Direct Cost with Retrofit Factor * Contingency (%)	=Total Direct Cost with Retrofit Factor*(Contingency)
Total Plant Cost (TPC)	$	$25,330,666	$24,501,367	$24,553,779	$24,464,941	$24,744,478		Total Plant Cost (TPC)=SUM(four lines above)
Total Plant Cost (TPC) w/ Prime Contractor's Markup	$	$26,090,586	$25,236,408	$25,290,393	$25,198,889	$25,486,812		
Total Cash Expended (TCE)	$	$25,338,043	$24,508,503	$24,560,931	$24,472,067	$24,751,685		Total Cash Expended (TCE)=Total Plant Cost (TPC)*VLOOKUP(2,Constants_CC!AFDC / TCE FACTORS FOR CASE 1,3)
Allow. for Funds During Constr. (AFDC)	$	$2,778,208	$2,687,253	$2,693,001	$2,683,258	$2,713,917		Allow. for Funds During Constr. (AFDC)=Total Plant Cost (TPC)*VLOOKUP(2,Constants_CC!AFDC / TCE FACTORS FOR CASE 1,2)
Total Plant Investment (TPI)	$	$28,116,252	$27,195,756	$27,253,932	$27,155,324	$27,465,601		Total Plant Investment (TPI)=Total Cash Expended (TCE)+Allow. for Funds During Constr. (AFDC)
Preproduction Costs	$	$722,219	$702,772	$704,002	$701,918	$708,473	=0.02*TPI+(Op. Lab,$/yr+Maint.,$/yr)/12+(Ammonia,$/yr)/(12*CF)	=0.02*TPI+(Op. Lab,$/yr+Maint.,$/yr)/12+(Ammonia,$/yr)/(12*CF)
Inventory Capital								
Initial Ammonia(60 days)	$	$151,522	$151,522	$151,522	$151,522	$151,522	=NH3(lb/hr) * 24(hours/day) * UCNH3($/ton) / 2000(lb/ton) * 60days * CF	=60*24/2000*Ammonia Injection rate (lb/hr)*Ammonia Cost ($/ton)*CF
Initial Catalyst	$	$8,788,650	$8,233,771	$8,268,461	$8,209,692	$8,395,113	DCcat=CV (cf)* UC cat($/cf)	DCcat=Gross Catalyst Volume (cf)* UC cat($/cf)
Total Capital Requirement (TCR)	$	**$37,778,643**	**$36,283,822**	**$36,377,917**	**$36,218,457**	**$36,720,716**		Total Capital Requirement (TCR)=SUM(Total Plant Investment (TPI), Preproduction Costs, Inventory Capital)
	$/kW	$76	$73	$73	$72	$73		=Total Capital Requirement (TCR)/(*BSIZE(MW)**1000)

SCR O&M Costs		Case1	Case2	Case3	Case4	Case5		Equations (bold indicates existing cuecost model parameter, blue indicates new input value from NOX User Input Sheet, normal text parameters are calculated on this sheet)
Cost Basis (Year)		*1998*	*1998*	*1998*	*1998*	*1998*		
Ammonia	$/yr	921,760	921,760	921,760	921,760	921,760	=(8,760/2,000) * (NH3 * *CF* * UCNH3)	= (8,760/2,000) * (NH3 Injection rate (lb/hr) * *Capacity Factor* * Cost rate NH3($/ton))
Catalyst Replacement	$/yr	2,929,550	2,744,590	2,756,154	2,736,564	2,798,371	= CV * UCCAT/ N	= catalyst volume (ft³) * Catalyst cost rate ($/ft³) / catalyst life (yr)
Catalyst Disposal	$/yr	2,265	2,122	2,131	2,116	2,164	= 48 / 2,000 * Catalyst Replacement Cost * UCWASTE/UCCAT	=48 / 2,000 * waste disposal rate ($/ton)* Catalyst Replacement Cost($/yr) / Catalyst cost rate ($/ft3)
Electricity	$/yr	286,797	267,800	268,987	266,975	273,324	= [-545,133 + 5.801**Qfg*] * (*CF*/0.628) * *UCELEC*	= [-545,133 + 5.801* flue gas flow rate (acfm)] * (Capacity Factor/0.628) * electricity rate (mills/kWh)*$/1000mills
High-dust SCR Steam	$/yr	119,175	119,175	119,175	119,175	119,175	= [-14.91 + 33.29 * NH3 **CF*] * UCSTEAM	= [-14.91 + 33.29 * Ammonia Injection Rate (lb/hr) * *Capacity Factor*] * Steam Rate ($/MMBtu)
Operating Labor	$/yr	120,675	120,675	120,675	120,675	120,475	= (1,341 + 5.363 * *BSIZE*) * UCOL	= (1,341 + 5.363 * *BSIZE(MW)*) * Operating Labor Wage ($/labor-hr)
Maintenance	$/yr	379,960	367,521	368,307	366,974	371,167	= Maintenance Cost % * TPC	=Maintenance(% capital cost/year) * total plant cost ($)
Total O&M Costs	$/yr	**4,760,183**	**4,543,643**	**4,557,189**	**4,534,240**	**4,606,636**		

SNCR - Preliminary		Case1	Case2	Case3	Case4	Case5		Equations (bold indicates existing cuecost model parameter, blue indicates new input value from NOX User Input Sheet, normal text parameters are calculated on this sheet)
Number of Wall Injectors	integer	18	18	18	18	18	Ni = (8.6 + 0.03* *BSIZE* - 0.913*n)* NIL	= (8.6 + 0.03* *BSIZE (MW)* - 0.013* NOX Reduction Eff.)* No. Injection Levels
Number of Lances	integer	8	0	0	0	0	Nl = (2 + 0.013 *BSIZE*)* NLL	= (2 + 0.013 *BSIZE(MW)*)* No. Lance Levels
Urea Injection Rate	lb/hr	3686	3686	3686	3686	3686	UREA = 6.5*10^-4 * UREA:NOX * **BSIZE** * **HTR** * **NOx**	= 6.5*10-4 * UREA:NOX ratio * ***BSIZE(MW)* HTR (Btu/kWh) * NOX(lb/10^6 Btu)***
Ammonia Injection Rate	lb/hr	2099	2099	2099	2099	2099	NH3 = 3.702 x 10-4 * NH3:NOX ratio * **BSIZE** * **HTR** * **NOx**	=3.702x10^-4*NH3:NOX ratio * ***BSIZE(MW)* * HTR (Btu/kWh) * NOX(lb/10^6 Btu)***

SNCR Capital Costs		Case1	Case2	Case3	Case4	Case5		
Cost Basis (Year)		*1998*	*1998*	*1998*	*1998*	*1998*		
Urea Based SNCR Costs								
Urea Storage & Handling	$	$471,758	$471,758	$471,758	$471,758	$471,758	=If Urea based, then = 38143*(UREA/8.7)^0.417*(0.915), else 0	=(38143*(UREA injection rate (lb/hour)/8.7)^0.417)*(0.915)
Urea Injection	$	$304,184	$304,184	$304,184	$304,184	$304,184	=If Urea based, then = (117809+10477*Ni+53111*Nl)*(0.915), else 0	=(117809+10477*No. Injectors+53111*No. lances)*(0.915)
Controls/Miscellaneous	$	$164,054	$164,054	$164,054	$164,054	$164,054	=If Urea based, then = (96082+106*BSIZE+898*Ni+2433*Nl)*(0.915), else 0	=(96082+106**BSIZE(MW)*+898*No. injectors+2433*No. lances)*(0.915)
Air Heater Modifications	$	$983,912	$949,253	$953,329	$945,676	$960,731	=If Urea based, then = 11.2*(Economizer Outlet (ACFM))^0.772*(0.915), else 0	ACFM AirHeater Inlet = ***Economizer outlet (wet lb/hour)****0.7302(atm-cf/lbmol/d R)*(678+460)d R/29(lb/lbmol)/1atm, 678 d F is average from Acid Rain Study
Ammonia Based SNCR Costs								
Ammonia Storage, Handling, Injection, Controls	$	$0	$0	$0	$0	$0	=If Amonia based then = 63822*(*BSIZE*)^0.6*(0.655), else 0	=(63822*(*BSIZE(MW)*)^0.6)*(0.655)
Air Heater Modifications	$	$0	$0	$0	$0	$0	=If Amonia based then = 11.2*(Economizer Outlet (ACFM))^0.772*(0.655), else 0	ACFM AirHeater Inlet = ***Economizer outlet (wet lb/hour)****0.7302(atm-cf/lbmol/d R)*(678+460)d R/29(lb/lbmol)/1atm, 678 d F is average from Acid Rain Study
Total Direct Cost	$	$1,923,909	$1,889,249	$1,893,326	$1,885,672	$1,900,768		Total Direct Cost=Installation+Purchased Equipment Cost Subtotal
Total Direct Cost with Retrofit Factor	$	$2,501,081	$2,456,024	$2,461,323	$2,451,374	$2,470,998		Total Direct Cost with Retrofit Factor= Total Direct Cost****Def_RetroFact***
General Facilities	$	$125,054	$122,801	$123,066	$122,569	$123,558		=Total Direct Cost with Retrofit Factor*(General Facilities)
Engineering Fees	$	$250,108	$245,602	$246,132	$245,137	$247,100		=Total Direct Cost with Retrofit Factor*(Engineering Fees)
Contingency	$	$500,216	$491,205	$492,265	$490,275	$494,200		=Total Direct Cost with Retrofit Factor*(Contingency)
Total Plant Cost (TPC)	$	$3,376,460	$3,315,633	$3,322,786	$3,309,355	$3,335,847		Total Plant Cost (TPC)=SUM(four lines above)
Total Plant Cost (TPC) w/ Prime Contractor's Markup	$	$3,477,753	$3,415,102	$3,422,470	$3,408,636	$3,435,923		
Total Cash Expended (TCE)	$	$3,377,443	$3,316,598	$3,323,754	$3,310,319	$3,336,819		Total Cash Expended (TCE)=Total Plant Cost (TPC)*VLOOKUP(2,Constants_CC!AFDC / TCE FACTORS FOR CASE 1,3)
Allow. for Funds During Constr. (AFDC)	$	$370,322	$363,651	$364,435	$362,962	$365,868		Allow. for Funds During Constr. (AFDC)=Total Plant Cost (TPC)*VLOOKUP(2,Constants_CC!AFDC / TCE FACTORS FOR CASE 1,2)
Total Plant Investment (TPI)	$	$3,747,765	$3,680,249	$3,688,190	$3,673,281	$3,702,687		Total Plant Investment (TPI)=Total Cash Expended (TCE)+Allow. for Funds During Constr. (AFDC)
Preproduction Costs	$	$387,576	$386,150	$386,318	$386,003	$386,624		=0.02*TPI+(Op. Lab,$/yr+Maint.,$/yr)/12+(Reagent,$/yr+Water,$/yr)/(12*CF)
Inventory Capital	$	$387,997	$387,997	$387,997	$387,997	$387,997		IF UREA =60*24/2000*Urea Injection rate (lb/hr)*Urea Cost ($/ton), IF AMMONIA =60*24/2000*Ammonia Injection rate (lb/hr)*Ammonia Cost ($/ton)*CF
Total Capital Requirement (TCR)	$	**$4,523,338**	**$4,454,396**	**$4,462,504**	**$4,447,288**	**$4,477,308**		Total Capital Requirement (TCR)=SUM(Total Plant Investment (TPI), Preproduction Costs, Inventory Capital)
	$/kW	$9.0	$8.9	$8.9	$8.9	$9.0		=Total Capital Requirement (TCR)/(*BSIZE(MW)**1000)

SNCR O&M Costs		Case1	Case2	Case3	Case4	Case5		
Cost Basis (Year)		*1998*	*1998*	*1998*	*1998*	*1998*		
Operating and Supervisory Labor	$/yr	65,700	65,700	65,700	65,700	65,700	= 0.25*8,760 *UCOL	= 0.25 * 8,760 * supervisory and labor wage rate ($/hr)
Maintenance Labor and Materials	$/yr	50,647	49,734	49,842	49,640	50,038	=Maintenance Cost %* TPC	= Maintenance(% capital cost/year) * total plant cost ($)
Reagent	$/yr	2,360,315	2,360,315	2,360,315	2,360,315	2,360,315	IF UREA =Urea *8760* *CF*/2,000 * UCUREA*(1+ ***Esc. Consumables O&M)^(Cost Basis year-1998)***, IF AMMONIA = NH3 *8760* *CF*/2,000 * UCNH3	(IF UREA =Injection rate of pure Urea(lb/hr) *8760* *CF*/2,000 * Urea cost rate ($/ton)*(1+ ***Esc. Consumables O&M)^(Cost Basis year-1998)***, IF AMMONIA = Injection rate of ammonia (lb/hr) *8760* *CF*/2,000 * Ammonia cost rate ($/ton))
Electricity	$/yr	1,593	1,593	1,593	1,593	1,593	IF UREA (5.97 + 8.29* NI + 0.87* NL) *8760* *CF**UCELEC*(1+ ***Esc. Consumables O&M)^(Cost Basis year-1998)***, IF AMMONIA, Steam ((***BSIZE****0.12 * 8,760 * *CF*)**UCELEC*, if Ammonia Air (***BSIZE*** *4.23 * 8,760 * *CF*))**UCELE*	(IF UREA = (5.97 + 0.29* No. Wall Injectors + 0.87* No. Lances) * 8760* *CF* * ***Electricity cost ($/kWh)***, IF AMMONIA and steam = ((***BSIZE****0.12 * 8,760 * *CF*)* ***Electricity cost ($/kWh)***), IF AMMONIA and air = (***BSIZE*** *4.23 * 8,760 * *CF*))**UCELE*
Water	$/yr	2,503	2,503	2,503	2,503	2,503	IF AMMONIA = (1.0 * NI + 2.5* NL) *60 *8760* *CF*/1,000 * UCH2O	IF AMMONIA = (1.0 * No. Wall Injectors + 2.5* No. Lances) *60 *8760* *CF*/1,000 * Water cost rate ($/1000 gal)
Steam (for steam atomization)	$/yr	-	-	-	-	-	IF UREA and Steam = ***BSIZE*** * 99.2 * 8,760* *CF*/1,000*UCSTEAM	IF UREA and steam =***BSIZE(MW)*** * 99.2 * 8,760* *CF*/1,000 * Steam atomization cost rate ($/1000 lb)
Total O&M Costs	$/yr	**2,480,757**	**2,479,846**	**2,479,952**	**2,479,751**	**2,480,148**		

Low NOX Burner Technology Capital Costs		Case1	Case2	Case3	Case4	Case5		

CUECost - Air Pollution Control Systems Economics Spreadsheet

Cost Basis (Year)			*1998*	*1998*	*1998*	*1998*	*1998*		
Total Capital Requirement with Retrofit (TCR)	$		**$9,618,183**	**$9,619,183**	**$9,618,183**	**$9,618,183**	**$9,618,183**	IF(Boiler Type="T" IF(RD="H",57.04*(300/BSIZE)^0.679, IF(RD="L",11.71,21.2*(300/BSIZE)^0.35)), IF(Boiler Type="W",IF(RD="H",27.72*(300/BSIZE)^0.573, IF(RD="L",6.53*(300/BSIZE)^0.857,15.37*(300/BSIZE)^0.35))),0)*1000 *BSIZE*388/357.6	
	$/kW		$19.2	$19.2	$19.2	$19.2	$19.2		=Total Capital Requirement (TCR)/(*BSIZE(MW)*1000)
Low NOX Burner Technology O&M Costs			Case1	Case2	Case3	Case4	Case5		Equations (bold indicates existing cuecost model parameter, blue indicates new input value from NOX User Input Sheet, normal text parameters are calculated on this sheet)
Cost Basis (Year)			*1998*	*1998*	*1998*	*1998*	*1998*		
Maintenance Labor	$/yr		76,945	76,945	76,945	76,945	76,945	=0.008 * TPC	=0.008/yr * Total Plant Costs ($)
Maintenance Materials	$/yr		115,418	115,418	115,418	115,418	115,418	=0.012 * TPC	=0.012/yr * Total Plant Costs ($)
Control, Administration, Overhead	$/yr		23,084	23,084	23,084	23,084	23,084	=0.3*Maintenance Labor Cost	=0.3*Maintenance Labor Cost($/year)
Total O&M Costs	$/yr		**215,447**	**215,447**	**235,447**	**215,447**	**215,447**		
Natural Gas Reburning - Preliminary			Case1	Case2	Case3	Case4	Case5		
Fraction of heat input as reburn fuel	fraction		0.15	0.15	0.15	0.15	0.15	if(input>0,input, if(NOx=0,0.15,RBFRAC =(n - 0.48) / 0.86	RBFRAC =(Nox Reduction Efficiency - 0.48) / 0.86
Bottom Ash Rate	tons/yr		967	1038	1630	2058	2368	BA = *BAF * ASH* * (500/*HHV*) * *Qin* * 8.760 * *CF*/2,000	BA = ***Bottom ash Factor * percent ash in coal (% wt)*** * (500/*HHV*) * ***boiler heat input (MMBtu/hr)*** * 8.760 * *CF*/2,000
Natural Gas Reburning Capital Costs			Case1	Case2	Case3	Case4	Case5		
Cost Basis (Year)			*1998*	*1998*	*1998*	*1998*	*1998*		
Gas Pipeline from Fenceline to Boiler	$		$1,343,264	$1,343,264	$1,343,264	$1,343,264	$1,343,264	=372.7*EXP(.00364*MW)*1000 replaced by 1923*MW+276519 (pk 1/24	=372.7*EXP(.00624*MW Output)*1000
Fuel Injectors, Overfire Air Ports and Associated Piping, Valves, Windbox and Control Dampers	$		$3,389,036	$3,389,036	$3,389,036	$3,389,036	$3,389,036	=(*BSIZE*/500)^0.214*(*BSIZE**3237.657+1504675)	=(*BSIZE*/500)^0.214*(*BSIZE**m+b), m= 3237.657, b= 1504675
Total Direct Cost	$		$4,902,815	$4,902,815	$4,902,815	$4,902,815	$4,902,815		Total Direct Cost=Installation+Purchased Equipment Cost Subtotal
Total Direct Cost with Retrofit Factor	$		$6,373,659	$6,373,659	$6,373,659	$6,373,659	$6,373,659		Total Direct Cost with Retrofit Factor= Total Direct Cost**Def_RetroFact*
General Facilities	$		$127,473	$127,473	$127,473	$127,473	$127,473		=Total Direct Cost with Retrofit Factor*(General Facilities)
Engineering Fees	$		$637,366	$637,366	$637,366	$637,366	$637,366		=Total Direct Cost with Retrofit Factor*(Engineering Fees)
Contingency	$		$1,274,732	$1,274,732	$1,274,732	$1,274,732	$1,274,732		=Total Direct Cost with Retrofit Factor*(Contingency)
Total Plant Cost (TPC)	$		$8,413,230	$8,413,230	$8,413,230	$8,413,230	$8,413,230		Total Plant Cost (TPC)=SUM((four lines above)
Total Plant Cost (TPC) w/ Prime Contractor's Markup	$		$8,665,627	$8,665,627	$8,665,627	$8,665,627	$8,665,627		
Total Cash Expended (TCE)	$		$8,415,680	$8,415,680	$8,415,680	$8,415,680	$8,415,680		Total Cash Expended (TCE)=Total Plant Cost (TPC)*VLOOKUP(2,Constants_CC!AFDC / TCE FACTORS FOR CASE 1,3)
Allow. for Funds During Constr. (AFDC)	$		$922,743	$922,743	$922,743	$922,743	$922,743		Allow. for Funds During Constr. (AFDC)=Total Plant Cost (TPC)*VLOOKUP(2,Constants_CC!AFDC / TCE FACTORS FOR CASE 1,2)
Total Plant Investment (TPI)	$		$9,338,424	$9,338,424	$9,338,424	$9,338,424	$9,338,434		Total Plant Investment (TPI)=Total Cash Expended (TCE)+Allow. for Funds During Constr. (AFDC)
Preproduction Costs	$		$179,390	$178,171	$167,692	$160,121	$154,630		=0.02*TPI[+(Maint.,$/yr)/12+(Waste Disp.,$/yr)/12*CF]
Inventory Capital	$		$0	$0	$0	$0	$0		$0
Total Capital Requirement (TCR)	$		**$9,517,814**	**$9,516,595**	**$9,506,116**	**$9,498,545**	**$9,493,054**		Total Capital Requirement (TCR)=SUM(Total Plant Investment (TPI), Preproduction Costs, Inventory Capital)
	$/kW		819.0	819.0	$19.0	$19.8	$19.6		=Total Capital Requirement (TCR)/(*BSIZE(MW)*1000)
Natural Gas Reburning O&M Costs			Case1	Case2	Case3	Case4	Case5		
Cost Basis (Year)			*1998*	*1998*	*1998*	*1998*	*1998*		
Electrical Consumption Savings	$/yr		(147,925)	(92,899)	(102,079)	(100,927)	(120,405)	=9.51 * 10^7 * *Qin* * *CF* * RBFRAC/*HHV* * *VCELEC*	=9.51 * 10^7 * ***boiler heat input(MMBtu/hr)*** * *CF** Fraction of heat input as reburn fuel / *HHV(Btu/lb)* * *Electricity Rate($/kW)*
Maintenance	$/yr		125,990	125,990	125,990	125,990	125,990	=Maintenance (% capital cost)*TPC-1387.5*RBFRAC*(*BSIZE*/500)^0.6	=Maintenance(% capital cost) * Total Plant Cost($) - 1387.5 * Fraction of heat input as reburn fuel * (*BSIZE(MW)* / 500)^0.6
Waste Disposal Savings	$/yr.		(139,444)	(148,953)	(230,693)	(289,740)	(332,575)	=[BA * RBFRAC + .4 336 * RBFRAC *PPHPRT * CF] * 0.5*WASTE	= [***Bottom ash rate(tons/year)*** * fraction of heat input as reburn fuel + .4 336 * fraction of heat input as reburn fuel * ***fly ash rate (ton/hr)*** * 2000 * *CF*] * Waste Disposal Rate($/ton)
Natural Gas Consumption	$/yr.		3,632,060	3,632,060	3,632,060	3,632,060	3,632,060	= *Qin* * RBFRAC * 8.760 * *CF* * UNGAS	= ***boiler heat input(MMBtu/hr)*** * fraction of heat input as reburn fuel * 8.760 * *CF* * Unit cost of gas ($/mmBtu)
Total O&M Costs			**3,470,683**	**3,516,198**	**3,425,279**	**3,367,583**	**3,304,983**		

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CUECost - Air Pollution Control Systems Economics Spreadsheet

LSFO Material Balance - Preliminary		Case1	Case 2	Case 3	Case 4	Case 5
Flue Gas, Downstream of ID Fans						
Temperature	°F	[illegible]	295	295	295	295
Pressure	in H2O	10	10	10	10	10
Flow Rate	SCFM	1,307,230	1,224,629	1,229,791	1,221,076	1,248,646
Flow Rate	ACFM	1,884,489	1,765,411	1,772,854	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1,048,927
N2	lb/hr	4,084,072	4,052,345	4,061,258	4,030,485	4,067,354
SO2	lb/hr	4,717	20,819	30,178	7,742	41,542
O2	lb/hr	327,881	318,571	319,515	317,252	321,554
HCl	lb/hr	66	0	[illegible]	448	535
[illegible]	[illegible]	1,425	2,268	2,238	1,873	2,030
H2O	lb/hr	450,880	267,414	269,037	274,852	317,031
Fly Ash	lb/hr	158	158	158	158	[illegible]
Total (gas only)	lb/hr	[illegible]	[illegible]	5,737,788	5,680,148	5,798,973
Flue Gas, to Absorber						
Temperature	°F	295	295	295	295	295
Pressure	in H2O	10	10	10	10	10
Flow Rate	SCFM	1,307,230	1,224,629	1,229,791	1,221,076	1,248,646
Flow Rate	ACFM	1,884,489	[illegible]	1,772,854	1,760,289	1,800,035
CO2	lb/hr	1,120,920	1,045,412	1,055,110	1,047,495	1,048,927
N2	lb/hr	4,084,072	4,052,345	4,061,258	4,030,485	4,067,354
SO2	lb/hr	4,717	20,819	30,178	[illegible]	[illegible]
O2	[illegible]	[illegible]	[illegible]	319,515	317,252	321,554
HCl	lb/hr	66	0	453	448	535
Other Gases	lb/hr	1,425	2,268	2,238	1,873	2,030
H2O	lb/hr	450,880	267,414	269,037	274,852	317,031
Fly Ash	lb/hr	158	[illegible]	[illegible]	158	158
Total (gas only)	lb/hr	5,989,962	5,706,828	5,737,788	5,680,148	5,798,973
Flue Gas, from Absorbers (total)						
Temperature	°F	127	127	127	127	127
Pressure	in H2O	4	4	4	4	4
Flow Rate	SCFM	1,338,259	1,330,939	1,344,225	1,312,604	1,356,202
Flow Rate	[illegible]	1,522,197	1,513,871	[illegible]	[illegible]	1,542,607
CO2	[illegible]	[illegible]	1,058,999	1,075,078	1,052,818	1,076,362
N2	lb/hr	4,098,918	4,117,859	4,156,226	4,054,849	4,198,083
SO2	lb/hr	236	1,041	1,509	387	2,077
O2	lb/hr	331,239	333,389	[illegible]	322,763	351,122
[illegible]	lb/hr	0	0	0	0	0
Other Gases	lb/hr	1,425	2,268	2,238	1,873	2,030
H2O	lb/hr	527,513	519,173	521,357	516,412	522,285
Fly Ash	lb/hr	158	158	[illegible]	[illegible]	158
[illegible]	[illegible]	[illegible]	[illegible]	6,097,402	5,949,102	6,151,960
Heat Capacities						
O2	Btu/lbmol°F	7.213	7.213	7.213	[illegible]	[illegible]
CO2	Btu/lbmol°F	[illegible]	[illegible]	9.354	9.354	9.354
N2	Btu/lbmol°F	6.999	6.999	6.999	6.999	6.999
H2O	Btu/lbmol°F	8.069	8.069	8.069	8.069	8.069
NO	Btu/lbmol°F	7.164	7.164	7.164	[illegible]	[illegible]
SO2	Btu/lbmol°F	[illegible]	[illegible]	9.830	9.830	9.830
HCl	Btu/lbmol°F	6.951	6.951	6.951	6.951	6.951
O2	Btu/lb°F	0.225	0.225	0.225	0.225	0.225
CO2	Btu/lb°F	0.213	0.213	0.213	[illegible]	[illegible]
N2	Btu/lb°F	[illegible]	[illegible]	0.250	0.250	0.250
H2O	Btu/lb°F	0.448	0.448	0.448	0.448	0.448
NO	Btu/lb°F	0.239	0.239	0.239	0.239	0.239
SO2	Btu/lb°F	0.153	0.153	0.153	0.153	[illegible]
HCl	Btu/lb°F	0.191	0.191	0.191	[illegible]	0.191
Reheated Gas Temperature:	°C	[illegible]	66.7	66.7	66.7	66.7
	K	339.7	339.7	339.7	339.7	339.7
FGD Outlet Temperature:	°C	52.8	52.8	52.8	52.8	[illegible]
	K	325.8	325.8	325.8	[illegible]	325.8
Total Btu/hr	[illegible]	[illegible]	[illegible]	[illegible]	38,529,571	39,782,120
Hot Reheat Air						
Temperature	[illegible]	[illegible]	[illegible]	[illegible]	440	440
Pressure	in H2O	1	1	1	1	1
Flow Rate	SCFM	120,817	119,894	121,104	118,292	[illegible]
Flow Rate	ACFM	212,274	210,654	212,779	207,838	214,594
N2	lb/hr	414,522	[illegible]	[illegible]	405,859	419,053
O2	[illegible]	[illegible]	[illegible]	[illegible]	122,397	126,376
H2O	lb/hr	7,106	7,052	7,123	6,958	7,184
Total	lb/hr	546,638	542,464	547,937	535,213	552,613
Heat Capacities of Hot Reheat Air						
O2	Btu/lbmol°F	[illegible]	7.332	7.332	7.332	[illegible]
N2	Btu/lbmol°F	7.113	7.113	7.113	7.113	[illegible]
H2O	Btu/lbmol°F	8.338	8.338	8.338	[illegible]	[illegible]
O2	Btu/lb°F	0.229	0.229	0.229	[illegible]	0.229
N2	Btu/lb°F	0.254	0.254	[illegible]	0.254	0.254
[illegible]	Btu/lb°F	[illegible]	[illegible]	0.463	0.463	0.463
Heated Temperature	°C	226.7	226.7	226.7	226.7	[illegible]
	K	499.7	499.7	499.7	499.7	499.7
FGD Outlet Temperature	°C	66.7	66.7	66.7	66.7	66.7
	K	339.7	339.7	[illegible]	339.7	339.7

CUECost - Air Pollution Control Systems Economics Spreadsheet

Heat Capacities of Inlet Reheat Air						
O2	Btu/lbmol°F	7.304				
N2	Btu/lbmol	7.087	7.087	7.087	7.087	
H2O	Btu/lbmol°F	8.276	8.276	8.276	8.276	8.276
O2	Btu/lb°F	0.228	0.228	0.228	0.228	0.228
N2	Btu/lb°F	0.253	0.253		0.253	0.253
H2O			0.459	0.459	0.459	
Heated Temperature:	°C	226.7	226.7	226.7	226.7	226.7
	K	499.7	499.7	499.7	499.7	499.7
Inlet Air Temperature:	°C	26.7	26.7		26.7	26.7
		299.7	299.7	299.7	299.7	
Required Heat	Btu/hr	49,190,039	48,814,437	49,306,886	48,161,964	49,727,650
Combustion Air (total)						
Temperature	°F	60	60	60	60	60
Pressure		0	0		0	0
				27,672		
Flow Rate	GPM	4,402	19,427	28,162	7,225	38,766
N2	lb/hr	14,845	65,514	94,968	24,364	130,729
O2	lb/hr	4,477	19,757	28,640	7,348	39,425
H2O				1,607	412	
Total (moisture)	lb/hr	19,574	86,380	125,215	32,124	172,366
Limestone to Ball Mill						
Temperature	°F	80	80	80	80	80
Wt.% Solids	wt. %	100%	100%	100%	100%	100%
Inerts				2,319	625	
CaCO3	lb/hr	7,352	32,445	47,031	12,680	64,741
Total	lb/hr	7,715	34,045	49,351	13,306	67,934
Limestone Slurry to Limestone Slurry Tank						
Temperature	°F	90	90	90	90	90
Flow Rate	GPM					
Wt.% Solids	wt. %	40%	40%	40%	40%	40%
Inerts	lb/hr	363	1,600	2,319	625	3,193
CaCO3	lb/hr	7,352	32,445	47,031	12,680	64,741
H2O						
Total	lb/hr	19,786	85,112	123,377	33,265	169,835
Limestone Slurry to Reaction Mix Tank (total)						
Temperature	°F	68	68	68	68	68
Flow Rate	GPM	64.2	283.5	410.9	110.8	565.7
Wt.% Solids	wt. %	20%	20%	20%	20%	20%
Inerts	lb/hr	363	1,600	2,319	625	3,193
CaCO3	lb/hr	7,352	32,445	47,031	12,680	64,741
H2O	lb/hr	30,858	136,180	197,403	53,223	271,737
Total	lb/hr	38,573				339,671
Slurry to Absorber						
Temperature			126	126	126	126
Flow Rate	GPM	187,950	104,676	188,788	184,347	190,470
Wt.% Solids	wt. %	15%	15%	15%	15%	15%
CaSO3*1/2H2O	lb/hr	0	0	0	0	0
		15,305,569	8,530,790	15,372,869	14,529,688	15,511,676
Inerts	lb/hr	460,753	256,808	462,779	459,676	466,958
CaCl2	lb/hr	126,934	0	137,528	500,954	118,995
CaCO3	lb/hr	330,414	247,961	322,816	422,329	343,564
H2O	lb/hr	91,934,133	51,201,501		90,171,667	93,166,760
Total		108,157,803	60,237,060	108,639,956	106,084,314	109,607,953
Slurry from Rxn Tank to Thickener						
Temperature	°F	126	126	126	126	126
Flow Rate	GPM	147.9	652.2	946.2	250.8	1,302.4
Wt.% Solids	wt. %	15%	15%	15%	15%	15%
CaSO3*1/2H2O	lb/hr	0				
CaSO4*2H2O		12,044	53,153	77,050	19,767	106,064
Inerts	lb/hr	363	1,600	2,319	625	3,193
CaCl2	lb/hr	100	0	689	682	814
CaCO3	lb/hr	260	1,545	1,618	575	
H2O			319,024	462,836	122,675	637,044
Total	lb/hr	85,113	375,323	544,513	144,324	749,463

LSFO Equipment Capital Costs			Case1	Case 2	Case 3	Case 4	Case 5
Cost Basis (Year)			1999	1998	1998	1998	1998
Reagent Feed System	$	Rxn h R	$7,615,854	$8,944,722	$9,511,755	$7,942,769	$10,056,798
Ball Mill & Hydroclone System	$	TPH Re	$1,941,841	$2,245,942	$2,427,960	$2,005,463	$2,654,131
DBA Acid Tank (pump, heater, agitator)	$	gm DBA	$0	$249,991	$0	$0	$0
SO2 Removal System	$	tph S	$2,065,415	$2,556,256	$2,808,789	$2,163,922	$3,088,929
Absorber Tower	$	kACFM	$16,158,565	$15,574,725	$15,611,708	$15,549,233	$15,746,210
Slurry Pump	$		$2,412,210	$1,384,548	$2,418,607	$2,384,569	$2,431,415
Flue Gas Handling System	$	*	$6,778,862	$6,636,725	$6,655,349	$6,616,893	$6,695,850
ID Fans	$	ACFM	$2,318,006	$2,216,762	$2,223,151	$2,212,369	$2,246,416
Waste / By-product Handling System	$		$89,045	$116,165	$130,964	$94,300	$147,976
Thickener System	$		$172,133	$368,431	$482,872	$212,183	$621,501
Support Equipment	$	MW	$1,945,399	$1,945,399	$1,945,399	$1,945,399	$1,945,399
Chimney	$	ACFM	$2,952,722	$3,451,1[illegible]	$3,266,653	$3,232,7[illegible]2	$3,523,5[illegible]
TOTAL	$		$46,160,051	$46,893,857	$48,885,706	$45,759,773	$50,318,129
* Based on Inlet Flue Gas Flow							
Capital Costs with Retrofit Factors							
Reagent Feed System	$		$9,900,611	$11,628,139	$12,365,282		$13,073,837
Ball Mill & Hydroclone System	$		$2,524,393	$2,919,725		$2,607,102	$3,450,371
DBA Acid Tank (pump, heater, agitator)	$		$0	$324,989	$0	$0	$0
SO2 Removal System					$3,650,776	$2,813,098	$4,015,607
Absorber Tower	$		$21,[illegible]134	$20,247,143	$20,295,201	$20,214,003	$20,470,073
Slurry Pump	$		$3,135,873	$1,799,912		$3,099,939	$3,160,839
Flue Gas Handling System				$8,627,742	$8,651,953	$8,601,961	$8,704,606
ID Fans				$2,881,790	$2,890,097	$2,876,067	

Calculated Number of Slurry Pumps				
5	3	5	5	5

Calculated No. of ID Fans and Flue Gas Flow per Fan				
995,632	932,720	936,652	930,014	951,012
2	2	2	2	2

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Waste / By-product Handling System	$		$115,758	$151,015	$170,253	$122,590	$192,369
Thickener System							$807,951
Support Equipment	$		$2,529,019	$2,529,019	$2,529,019	$2,529,019	$2,529,019
Chimney	$		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
					$3,551,418		$5,413,567
General Facilities							
Reagent Feed System	$		[illegible]	$1,162,814	$1,236,528	$1,032,560	[illegible]
Ball Mill & Hydroclone System	$		$252,439	$291,972	$315,635	$260,710	$345,037
DBA Acid Tank (pump, heater, agitator)			$0	$32,499	$0	$0	$0
SO2 Removal System			$268,504	$332,313	$365,078	$281,310	$401,561
Absorber Tower	$		$2,100,613	$2,024,714	[illegible]	[illegible]	$2,047,007
Slurry Pumps	$		$313,587	$179,991	$314,419	$309,994	$316,084
Flue Gas Handling System	$		$881,262	$862,774	$865,195	$860,196	$870,461
ID Fans	$		$301,341	$288,179	$289,010	$287,607	$292,034
Waste / By-product Handling System	$		$11,576	$15,101	$17,025	$12,259	$19,237
Thickener System	$		$22,377	$47,896	$62,773	$27,584	$80,795
Support Equipment	$		$252,902	$252,902	$252,902	$252,902	$252,902
Chimney			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL			[illegible]	$6,096,201	$6,355,142	$5,948,770	[illegible]
Engineering Fees							
Reagent Feed System			[illegible]	$1,162,814	$1,236,528	$1,032,560	[illegible]
Ball Mill & Hydroclone System	$		$252,439	$291,972	$315,635	$260,710	$345,037
DBA Acid Tank (pump, heater, agitator)	$		$0	$32,499	$0	$0	$0
SO2 Removal System	$		$268,504	[illegible]	[illegible]	[illegible]	$401,561
Absorber Tower	$		$2,100,613	$2,024,714	$2,029,522	$2,021,400	$2,047,007
Slurry Pumps	$		$313,587	$179,991	$314,419	$309,994	$316,084
Flue Gas Handling System	$		$881,262	$862,774	$865,195	$860,196	$870,461
ID Fans	$		$301,341	$288,179	$289,010	$287,607	$292,034
Waste / By-product Handling System	$		$11,576	$15,101	$17,025	$12,259	$19,237
Thickener System	$		$22,377	$47,896	$62,773	$27,584	$80,795
Support Equipment	$		$252,902	$252,902	$252,902	$252,902	$252,902
Chimney	$		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	$		$6,000,807	$6,096,201	$6,355,142	$5,948,770	$6,541,357
Contingency							
Reagent Feed System	$		$1,980,122	$2,325,628	$2,473,056	$2,065,120	$2,614,767
Ball Mill & Hydroclone System	$		$504,879	$583,945	$631,270	$521,420	$690,074
DBA Acid Tank (pump, heater, agitator)	$		$0	$64,998	$0	$0	$0
SO2 Removal System	$		$537,008	$664,627	$730,155	$562,620	$803,121
Absorber Tower	$		$4,201,227	$4,049,429	$4,059,044	$4,042,801	$4,094,015
Slurry Pumps	$		$627,175	$359,982	$628,838	$619,988	$632,168
Flue Gas Handling System	$		$1,762,504	$1,725,548	$1,730,391	$1,720,392	$1,740,921
ID Fans	$		$602,681	$576,358	$578,019	$575,213	$584,068
Waste / By-product Handling System	$		$23,152	$30,203	$34,051	$24,518	$38,474
Thickener System	$		$44,755	$95,792	$125,547	$55,168	$161,590
Support Equipment	$		$505,804	$505,804	$505,804	$505,804	$505,804
Chimney	$		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	$		$12,001,613	$12,192,403	$12,710,284	$11,897,541	$13,082,713
Total Plant Cost	$		$84,011,293	$85,346,820	$88,971,985	$83,282,786	$91,578,994
			[illegible]	[illegible]	[illegible]	[illegible]	$94,326,364
Total Cash Expended (TCE)	$		$84,035,762	$85,371,679	$88,997,899	$83,307,044	$91,605,668
Allow. for Funds During Constr. (AFDC)	$		$9,214,163	$9,360,640	$9,758,240	$9,134,262	$10,044,171
Total Plant Investment (TPI)	$		$93,249,925	$94,732,319	$98,756,139	$92,441,305	$101,649,838
Preproduction Costs	$		$2,764,994	$3,030,143	$3,272,655	$2,793,123	$3,510,482
Inventory Capital	$		$83,317	$367,685	$532,989	$143,703	$733,689
Total Capital Requirement (TCR)	$		**$96,098,236**	**$98,130,146**	**$102,561,784**	**$95,378,131**	**$105,[illegible]010**
	$/kW		$192	$196	$205	$191	$212
Maintenance Cost by Area			Case 1	Case 2	Case 3	Case 4	Case 5
TAC w/o Retrofit Factor							
Reagent Feed System	$		$10,966,830	$12,880,400	$13,696,927	$11,437,588	$14,481,789
Ball Mill & Hydroclone System	$		$2,796,250	$3,224,157	$3,496,262	$2,887,867	$3,821,949
DBA Acid Tank (pump, heater, agitator)	$		$0	$359,988	$0	$0	$0
SO2 Removal System	$		$2,974,198	$3,681,009	$4,043,936	$3,116,047	$4,448,057
Absorber Tower			[illegible]	[illegible]	[illegible]	$22,390,896	$22,674,542
Slurry Pumps	$		$3,473,583	$1,993,749	$3,482,794	$3,433,779	$3,501,237
Flue Gas Handling System	$		$9,761,562	$9,556,883	$9,583,702	$9,5[illegible]326	$9,642,025
ID Fans			[illegible]	[illegible]	[illegible]	$3,185,798	$3,234,839
Waste / By-product Handling System	$		$128,224	$167,278	$188,588	$135,792	$213,086
Thickener System	$		$247,871	$530,541	$695,335	$305,[illegible]44	$894,961
Support Equipment	$		[illegible]	$2,801,375	$2,801,375	$2,801,375	$2,801,375
Chimney	$		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	$		$66,470,474	$67,527,154	$70,395,417	$65,894,073	[illegible]72,458,105
First Year Maintenance Costs							
Reagent Feed System	$		$548,342	$644,020	$684,846	$571,879	$724,089
Ball Mill & Hydroclone System			[illegible]	$161,708	$174,813	$144,393	$191,097
DBA Acid Tank (pump, heater, agitator)	$		$0	[illegible]	$0	$0	$0
SO2 Removal System	$		$148,710	$174,848	$202,197	$155,802	$222,403
Absorber Tower	$		$1,163,417	$1,065,311	$1,124,043	$1,119,545	$1,133,727
Slurry Pumps	$		[illegible]	[illegible]	[illegible]	$171,689	$175,062
Flue Gas Handling System	$		$488,078	$477,844	$479,185	$476,416	$482,101
ID Fans	$		$166,896	$159,607	$160,067	$159,290	$161,742
Waste / By-product Handling System			[illegible]	[illegible]	$9,429	$6,790	$10,654
Thickener System			[illegible]	[illegible]	$34,767	$15,[illegible]77	[illegible]

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Su[illegible] E[illegible]ment	$		$140,069	$140,069	$140,069	$140,069	$140,069
Chimney	$		$335,71[illegible]	$335,102	$336,715	$333,553	[illegible]
TOTAL	$		$3,323,524	[illegible]	[illegible]	[illegible]	33,[illegible],905
LSFO O&M Data and Costs			Case1	Case 2	Case 3	Case 4	Case 5
Cost Basis (Year)			*1998*	*1998*	*1998*	*1998*	*1998*
Parameter:							
Rea[illegible]t Re[illegible]ired	lbs/hr		[illegible]	[illegible]	[illegible]	[illegible]	67,934
	lbs/MMBtu		1.469	6.485	9.400	2.534	12.940
DBA Re[illegible]ired	lbs/hr		0.0	197.8	0.0	0.0	0.0
Percent SO2 Removal	%		95%	95%	95%	95%	95%
FGD Slud[illegible]e to Dis[illegible]sal	lbs/hr, [illegible]ry		12,767	56,298	81,677	21,649	112,420
Steam to FGD System	lbs/hr		57,523	57,084	57,659	56,321	[illegible]
Total FGD Power C[illegible]ption	kW		10,000	8,231	10,000	10,000	10,000
FGD [illegible]product	lbs/hr		0	0	0	0	0
Fix[illegible]							
Number of O[illegible]tors			28	28	28	28	28
(40 hrs/week)							
[illegible]ratin[illegible] Labor Cost **	$/yr		$1,755,068	[illegible]	[illegible]	[illegible]	$1,755,068
Maint. Labor & Matls. Cost	$/yr		$3,323,524	$3,306,102	$3,519,771	$3,294,704	$3,622,905
Admin. & Su[illegible]rt Labor	$/yr		$925,3[illegible]	$923,252	$946,[illegible]3	$921,[illegible]85	$961,269
TOTAL	$/yr		$6,003,934	$5,984,422	$6,223,731	$5,971,656	$6,339,242
V[illegible]ri[illegible]ble O[illegible]r[illegible]ati[illegible] Costs **							
Rea[illegible]nt Costs	$/yr		$329,449	$1,453,886	$2,107,528	$568,224	$2,901,129
DBA Costs	$/yr		$0	$242,119	$0	$0	$0
D[illegible] Costs	$/yr		$218,086	$961,690	$1,395,205	$369,801	$1,920,350
Credit for [illegible]y[illegible]uct	$/yr		$0	$0	$0	$0	$0
Steam Costs	$/yr		$1,146,372	$1,137,618	$1,149,095	$1,122,412	$1,158,901
Power Costs	$/yr		$1,423,500	$1,171,[illegible]3	$1,[illegible],500	$1,423,500	$1,423,500
TOTAL	$/yr		$3,117,407	$4,966,997	$6,075,328	$3,483,938	$7,403,880
** [illegible] *cluded).*							
Intermediate Material Balance Calcs.			Case1	Case 2	Case 3	Case 4	Case 5
Sulfite Reaction							
SO2	lbmole/hr		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CaCO3	lbmole/hr		69.96	308.72	447.52	114.81	616.03
H2O	lbmole/hr		34.98	154.36	223.76	57.41	308.02
CaSO3*1/2H2O	lbmole/hr		69.96	308.72	447.52	114.81	616.03
CO2	lbmole/hr		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO2	lb/hr		4,482	19,778	28,669	7,355	39,465
CaCO3	lb/hr		7,002	30,900	44,792	11,491	61,658
H2O	lb/hr		630	2,781	4,031	1,034	5,549
CaSO3*1/2H2O	lb/hr		9,035	39,871	57,797	14,828	79,561
CO2	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sulfate Reaction							
CaSO3*1/2H2O	lbmole/hr		69.96	308.72	447.52	114.81	616.03
O2	lbmole/hr		34.98	154.36	223.76	57.41	308.02
H2O	lbmole/hr		104.93	463.08	671.28	172.22	924.05
CaSO4*2H2O	lbmole/hr		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]SO3*1/2H2O	lb/hr		9,035	39,871	57,797	14,828	79,561
O2	lb/hr		1,119	4,939	7,160	1,837	9,856
H2O	lb/hr		1,890	[illegible]343	12,093	3,103	16,647
CaSO4*2H2O	lb/hr		12,044	53,153	77,050	19,767	106,064
Water in Absorber							
Mole Fraction H2O in Absorber	%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Moles H2O in Absorber	lbmole		29,280.42	28,818.36	28,933.38	28,658.96	28,983.81
DBA Feed Calculations							
SO2 Removed	lbs/hr		4,482	19,778	28,669	7,355	39,465
DBA Added	lbs/hr		0.00	197.78	0.00	0.00	0.00
DBA Added	GPM		0.00	0.26	0.00	0.00	0.00

LSD Material Balance - Preliminary		Case1	Case 2	Case 3	Case 4	Case 5
Flue Gas Downstream of Air Heater						
Temperature	°F	300	300	300	300	300
Pressure	in. H2O		-12	-12	-12	-12
Flow Rate	SCFM	1,307,230	1,224,629	1,229,791	1,221,076	1,248,646
Flow Rate	ACFM	2,004,451	[illegible]	1,885,709	[illegible]	1,914,621
CO2	lb/hr	[illegible]	[illegible]	1,055,110	[illegible]	[illegible]
N2	lb/hr	4,084,072	[illegible]	4,061,258	4,030,485	4,067,354
SO2	lb/hr	4.717	20.819	30.178	7.742	41.542
O2	lb/hr	327.881	318.571	319.515	317.252	321.554
HCl	lb/hr	66	0	453	448	535
Other Gases	lb/hr	1.425	2.268	2.238	1.873	2.030
H2O	lb/hr	450.880	267.414	269.037	274.852	317.031
Fly Ash	lb/hr	28.989	30.323	46.955	[illegible]	[illegible]
Total (gas only)	lb/hr	5,989.962	[illegible]	[illegible]	[illegible]	[illegible]
Flue Gas to Spray Dryer						
Temperature	°F	300	300	[illegible]	[illegible]	[illegible]
Pressure	in. H2O	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Flow Rate	SCFM	653,615	[illegible]	614,886	610,593	624,322
Flow Rate	ACFM	1,002,225	938,897	942,855	936,173	957,310
CO2	lb/hr	560,460	522,706	527,555	523,748	524,464
N2	lb/hr	2,042,036	2,026,173	2,030,629	2,015,242	2,033,677
SO2	lb/hr	2,359	10,409	15,089	3,871	20,771
O2	lb/hr	163,941	159,285	159,757	158,626	[illegible]
HCl	lb/hr	33	0	[illegible]	[illegible]	[illegible]
Other Gases	lb/hr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
H2O	lb/hr	[illegible]	133,707	134,519	137,426	158,516
Fly Ash	lb/hr	34,399	15,161	23,478	29,485	33,843
Total (gas only)	lb/hr	2,994.981	2,853.414	2,868.894	2,840.074	2,899.487
Flue Gas from Spray Dryers (total)						
Temperature	°F	[illegible]	[illegible]	147	147	147
Pressure	in. H2O	[illegible]	-17	-17	-17	-17
Flow Rate	SCFM	1,402,194	1,292,636	1,313,499	1,282,055	1,362,367
Flow Rate	ACFM	1,739,624	1,603,701	1,629,584	1,590,574	1,690,212
CO2	lb/hr	[illegible]	1,045,412	1,055,110	1,047,495	1,048,927
N2	lb/hr	4,084,072	4,052,345	4,061,258	4,030,485	4,067,354
SO2	lb/hr	1.321	5.829	8.450	2.168	11.632
O2	lb/hr	327.669	317.635	318.158	316.904	319.686
HCl	lb/hr	0	0	0	0	[illegible]
Other Gases	lb/hr	1.425	[illegible]	[illegible]	[illegible]	[illegible]
H2O	lb/hr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fly Ash	lb/hr	[illegible]	[illegible]	152.302	127.651	213.405
Total (gas only)	lb/hr	6,257.488	[illegible]	5,959.221	5,848.996	6,099.759
Flue Gas Downstream of Particulate Control Device						
Temperature	°F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pressure	in. H2O	[illegible]	[illegible]	-23	-23	-23
Flow Rate	SCFM	[illegible]	1,291,423	1,311,832	1,280,993	1,360,044
Flow Rate	ACFM	1,765,867	1,627,677	1,653,399	1,614,531	1,714,166
CO2	lb/hr	1,120,920	1,045,412	1,055,110	1,047,495	1,048,927
N2	lb/hr	4,084,072	4,052,345	4,061,258	4,030,485	4,067,354
SO2	lb/hr	472	2,082	3,018	774	4,154
O2	lb/hr	327,616	317,401	317,819	316,817	319,219
HCl	lb/hr	0	0	[illegible]	[illegible]	[illegible]
Other Gases	lb/hr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fly Ash	lb/hr	[illegible]	[illegible]	510,979	447,489	645,884
Total	lb/hr	[illegible]	158	158	158	158
Total (gas only)	lb/hr	6,253,639	5,882,558	5,950,421	5,844,934	6,087,569
Flue Gas Downstream of ID Fans						
Temperature	°F	[illegible]	[illegible]	[illegible]	152	152
Pressure	in. H2O	[illegible]	1	[illegible]	1	1
Flow Rate	SCFM	1,401,998	1,291,423	1,311,832	1,280,993	1,360,044
Flow Rate	ACFM	1,673,929	1,542,933	1,567,317	1,530,472	1,624,919
CO2	lb/hr	1,120,920	1,045,412	1,055,110	1,047,495	1,048,927
N2	lb/hr	4,084,072	4,052,345	4,061,258	4,030,485	4,067,354
SO2	lb/hr	472	2,082	3,018	774	[illegible]
O2	lb/hr	327,616	317,401	317,819	316,817	319,219
HCl	lb/hr	0	0	0	0	[illegible]
Other Gases	lb/hr	1.425	2.268	2.238	[illegible]	2.030
H2O	lb/hr	719.134	463.[illegible]50	[illegible]979	447.489	645.884
Fly Ash	lb/hr	158	[illegible]	[illegible]	158	158
Total (gas only)	lb/hr	[illegible]	[illegible]	5,950,421	5,844.934	6,087.569
Lime to Ball Mill						
Temperature	°F	60	60	60	60	60
Wt.% Solids	wt. %	100%	100%	100%	100%	100%
Inerts	lb/hr	421	3.037	5.151	761	7.824
CaO	lb/hr	3.792	27.336	46.359	6.847	70.417
Total	lb/hr	4.214	30.374	51.510	7.608	78.241
Water to Ball Mill						
Temperature	°F	60	60	60	60	60
Flow Rate	GPM	28	200	339	50	516
Wt.% Solids	wt. %	0%	0%	0%	0%	0%
H2O	lb/hr	13.893	100.144	169.832	25.085	257.067

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Total	lb/hr		13,893	100,144	169,832	25,085	257,967							
Lime Slurry to Head Tanks (Total)														
Temperature	°F		110	110	110	110	110							
Flow Rate	GPM		28	201	340	50	517							
Wt.% Solids	wt. %		30%	30%	30%	30%	30%							
Ca(OH)2	lb/hr		5,011	36,118	61,252	9,047	93,038							
Inerts	lb/hr		421	3,037	5,151	761	7,824							
H2O	lb/hr		12,675	91,362	154,939	22,885	235,346							
Total	lb/hr		18,107	130,517	221,342	32,693	336,208							
Lime Slurry from Head Tank														
Temperature	°F		110	110	110	110	110							
Flow Rate	GPM		279	190	240	167	337							
Wt.% Solids	wt. %		36%	33%	32%	35%	32%							
CaSO3*1/2H2O	lb/hr		10,343	6,407	4,472	4,535	4,621							
CaSO4*2H2O	lb/hr		4,596	2,847	1,987	2,015	2,054							
Flyash / Inerts	lb/hr		47,058	9,433	8,560	26,716	10,575							
Ca(OH)2	lb/hr		2,612	21,727	34,495	4,848	51,560							
CaCl2	lb/hr		4,072	2,059	1,403	1,967	1,248							
H2O	lb/hr		121,283	84,377	107,767	73,120	151,805							
Total	lb/hr		189,965	126,850	158,684	113,202	221,864							
Lime Slurry to Atomizer														
Temperature	°F		104	104	104	104	104							
Flow Rate	GPM		306	217	268	194	364							
Wt.% Solids	wt. %		34%	30%	29%	31%	30%							
CaSO3*1/2H2O	lb/hr		10,343	6,407	4,472	4,535	4,621							
CaSO4*2H2O	lb/hr		4,596	2,847	1,987	2,015	2,054							
Flyash / Inerts	lb/hr		47,058	9,433	8,560	26,716	10,575							
Ca(OH)2	lb/hr		2,612	21,727	34,495	4,848	51,560							
CaCl2	lb/hr		4,072	2,059	1,403	1,967	1,248							
H2O	lb/hr		135,853	98,947	122,337	87,690	166,375							
Total	lb/hr		204,535	141,420	173,254	127,772	236,434							
Solids from Spray Dryers (Total)														
Temperature	°F		150	150	150	150	150							
Wt.% Solids	wt. %		98%	98%	98%	98%	98%							
CaSO3*1/2H2O	lb/hr		2,582	3,548	4,183	1,750	5,456							
CaSO4*2H2O	lb/hr		1,147	1,577	1,859	778	2,424							
Flyash / Inerts	lb/hr		12,171	4,919	5,854	10,695	8,226							
Ca(OH)2	lb/hr		123	2,612	4,338	279	6,792							
CaCl2	lb/hr		100	0	689	682	814							
H2O	lb/hr		329	258	345	289	484							
Total	lb/hr		16,452	12,913	17,268	14,473	24,196							
Baghouse/ESP Solids to Recycle														
Particulate Removal Efficiency	%		99.89%	99.86%	99.90%	99.88%	99.93%							
Temperature	°F		150	150	150	150	150							
Wt.% Solids	wt. %		98%	98%	98%	98%	98%							
CaSO3*1/2H2O	lb/hr		18,104	9,265	4,762	7,320	3,787							
CaSO4*2H2O	lb/hr		8,045	4,117	2,116	3,253	1,683							
Flyash / Inerts	lb/hr		81,524	10,910	6,115	41,977	5,100							
Ca(OH)2	lb/hr		91	4,725	3,401	370	3,290							
CaCl2	lb/hr		8,045	4,117	2,116	3,253	1,683							
H2O	lb/hr		2,199	592	335	1,080	283							
Total	lb/hr		109,963	29,610	16,729	54,000	14,143							
Recycle Solids to Slurry Tank														
Temperature	°F		150	150	150	150	150							
Wt.% Solids	wt. %		98%	98%	98%	98%	98%							
CaSO3*1/2H2O	lb/hr		20,686	12,813	8,945	9,070	9,243							
CaSO4*2H2O	lb/hr		9,192	5,694	3,975	4,031	4,107							
Flyash / Inerts	lb/hr		93,695	15,829	11,969	52,672	13,326							
Ca(OH)2	lb/hr		214	7,336	7,739	650	10,081							
CaCl2	lb/hr		8,145	4,117	2,805	3,935	2,496							
H2O	lb/hr		2,528	850	680	1,369	767							
Total	lb/hr		134,460	46,640	36,113	71,726	40,021							
Blowdown Water to Recycle Solids Tank														
Temperature	°F		60	60	60	60	60							
Flow Rate	GPM		454	153	120	244	135							
Wt.% Solids	wt. %		0%	0%	0%	0%	0%							
H2O	lb/hr		227,362	76,541	59,914	121,986	67,498							
Total	lb/hr		227,362	76,541	59,914	121,986	67,498							
Recycle Slurry to Head Tanks (Total)														
Temperature	°F		110	110	110	110	110							
Flow Rate	GPM		536	182	142	287	159							
Wt.% Solids	wt. %		35%	35%	35%	35%	35%							
CaSO3*1/2H2O	lb/hr		20,686	12,813	8,945	9,070	9,243							
CaSO4*2H2O	lb/hr		9,192	5,694	3,975	4,031	4,107							
Flyash / Inerts	lb/hr		93,695	15,829	11,969	52,672	13,326							
Ca(OH)2	lb/hr		214	7,336	7,739	650	10,081							
CaCl2	lb/hr		8,145	4,117	2,805	3,935	2,496							
H2O	lb/hr		229,891	77,392	60,594	123,355	68,264							
Total	lb/hr		361,823	123,182	96,026	193,712	107,519							
Dry Solids														
Temperature	°F		100	100	100	100	100							
Wt.% Solids	wt. %		98%	98%	98%	98%	98%							
CaSO3*1/2H2O	lb/hr		6,394	28,278	41,050	10,513	56,576							
CaSO4*2H2O	lb/hr		2,841	12,566	18,242	4,672	25,141							
Flyash / Inerts	lb/hr		28,691	33,299	52,023	59,604	75,384							
Ca(OH)2	lb/hr		32	14,420	29,321	532	49,148							
CaCl2	lb/hr		200	0	1,379	1,363	1,627							
H2O	lb/hr		777	1,807	2,884	1,551	4,226							
Total	lb/hr		38,934	90,370	144,899	78,235	212,103							
Solids to Landfill														
Temperature	°F		100	100	100	100	100							
Wt.% Solids	wt. %		80%	80%	80%	80%	80%							
CaSO3*1/2H2O	lb/hr		6,394	28,278	41,050	10,513	56,576							
CaSO4*2H2O	lb/hr		2,841	12,566	18,242	4,672	25,141							
Flyash / Inerts	lb/hr		28,691	33,299	52,023	59,604	75,384							
Ca(OH)2	lb/hr		32	14,420	29,321	532	49,148							
CaCl2	lb/hr		200	0	1,379	1,363	1,627							
H2O	lb/hr		9,539	22,141	35,504	19,171	51,969							
Total	lb/hr		47,697	110,704	177,518	95,856	259,846							

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LSD Equipment Capital Costs			Case 1	Case 2	Case 3	Case 4	Case 5
Cost Basis (Year)			1995	1995	1995	1995	1995
Reagent Feed System	$	*	$4,690,432	$9,322,352	$12,988,374	$5,311,035	$17,599,879
SO2 Removal System	$		$1,596,996	$1,443,732	$1,452,641	$1,509,905	$1,471,138
Spray Dryers	$	kACFM	$17,550,564	[illegible]	[illegible]	[illegible]	$17,777,997
Flue Gas Handling System	$	kACFM	$5,219,175	$4,991,444	$5,028,992	$4,971,738	$5,120,125
ID Fans	$	[illegible]	$1,715,355	$1,622,384	$1,639,832	$1,613,358	$1,680,831
Waste / By-product Handling System	$	kTons SO2	$1,049,229	$2,976,002	$3,390,950	$1,176,161	$4,251,699
Support Equipment	$	MW	$2,404,066	$2,404,066	$2,404,066	$2,404,066	$2,404,066
Chimney	$	[illegible]	[illegible]	[illegible]	[illegible]	$2,671,17[illegible]	[illegible]
TOTAL	$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	$54,571,244

Case 1	Case 2	Case 3	Case 4	Case 5
1,765,867	1,627,677	1,653,399	1,614,531	1,714,166

* Based on lbs/hr of lime feed and GPM of lime slurry

Capital Costs with Retrofit Factors							
Reagent Feed System	$		$6,097,562	$12,119,037	$16,884,886	$6,904,346	$22,879,843
SO2 Removal System	$		$2,076,095	[illegible]	[illegible]	[illegible]	[illegible]
Spray Dryers	$		$22,815,733	[illegible]	[illegible]	$22,277,034	$22,461,396
Flue Gas Handling System	$		$6,784,928	$6,488,878	$6,537,689	$6,463,259	$6,656,163
ID Fans	$		$2,229,961	$2,109,034	$2,131,781	$2,097,365	$2,185,081
Waste / By-product Handling System	$		[illegible]	$3,088,802	$4,408,285	$1,529,010	[illegible]
Support Equipment	$		$3,125,286	[illegible]	[illegible]	[illegible]	$3,125,286
Chimney	$		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	$		$50,750,496	$57,198,319	$63,433,790	$50,431,697	$70,942,618
General Facilities							
Reagent Feed System	$		[illegible]	[illegible]	[illegible]	$690,435	$2,287,984
SO2 Removal System	$		$207,610	$187,685	$188,843	$196,288	$191,248
Spray Dryers	$		$2,281,573	$2,230,142	$2,233,653	$2,227,703	$2,246,140
Flue Gas Handling System	$		$678,493	$648,888	$653,769	$646,326	$665,616
ID Fans	$		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Waste / By-product Handling System	$		$136,400	$308,880	$440,823	$152,901	$552,721
Support Equipment	$		$312,529	$312,529	$312,529	$312,529	$312,529
Chimney	$		$325,6[illegible]	$[illegible]08,899	$[illegible]12,095	$607,752	$61[illegible]
TOTAL	$		$5,075,050	$5,719,832	$6,343,379	$5,043,170	$7,094,262
Engineering Fees							
Reagent Feed System	$		$609,756	$1,211,906	$1,688,489	$690,435	$2,287,984
SO2 Removal System	$		$207,610	$187,685	$188,843	$196,288	$191,248
Spray Dryers	$		$2,281,573	$2,230,142	$2,233,653	$2,227,703	$2,246,140
Flue Gas Handling System	$		$678,493	$648,888	$653,769	[illegible]	[illegible]
ID Fans	$		$222,996	$210,903	$213,178	$209,736	$218,508
Waste / By-product Handling System	$		$136,400	$308,880	$440,823	$152,901	$552,721
Support Equipment	$		$312,529	$312,529	$312,529	$312,529	$312,529
Chimney	$		$325,6[illegible]	$[illegible]	$[illegible]12,[illegible]	$607,752	[illegible]
TOTAL	$		$5,075,050	$5,719,832	$6,343,379	$5,043,170	[illegible]
Contingency							
Reagent Feed System	$		$1,219,512	$2,423,811	$3,376,977	$1,380,869	$4,575,969
SO2 Removal System	$		$415,219	$375,370	$377,687	$392,575	$382,496
Spray Dryers	$		$4,563,147	$4,460,285	$4,467,306	$4,455,407	$4,492,279
Flue Gas Handling System	$		[illegible]	[illegible]	[illegible]	[illegible]	$1,331,233
ID Fans	$		[illegible]	[illegible]	$426,356	$419,473	$437,016
Waste / By-product Handling System	$		$272,800	$617,760	$881,647	$305,802	$1,105,442
Support Equipment	$		$625,057	$625,057	$625,057	$625,057	$625,057
Chimney	$		$1,251,3[illegible]7	$1,717,797	$1,2[illegible]	$1,2[illegible]504	$1,239,032
TOTAL	$		$10,150,099	$11,439,664	$12,686,758	$10,086,339	$14,188,524
Total Plant Cost (TPC)	$		$71,050,695	$80,077,646	$88,807,306	$70,604,376	$99,319,665
Total Plant Cost (TPC) w/o Retrofit Factor	$		$73,182,216	$82,479,976	$91,471,525	$72,722,508	$102,299,255
Total Cash Expended (TCE)	$		$71,071,389	$80,100,970	$88,833,172	$70,624,941	$99,348,593
Allowance for Funds During Construction (AFDC)	$		$7,792,675	$8,782,730	$9,740,178	$7,743,723	$10,893,149
Total Plant Investment (TPI)	$		$78,864,064	$88,883,700	$98,573,350	$78,368,664	$110,241,742
Pre-production Costs	$		$2,560,371	$3,971,205	$5,287,644	$3,051,803	[illegible]
Inventory Capital	$		[illegible]	[illegible]	[illegible]	[illegible]	$3,661,691
Total Capital Requirement (TCR)	$		**$81,621,644**	**$94,276,387**	**$106,171,661**	**$81,771,527**	**$120,823,2[illegible]**
	$/kW		$163	$189	$213	[illegible]	[illegible]

Maintenance Cost by Area			Case 1	Case 2	Case 3	Case 4	Case 5
TPC w/o Retrofit Factor							
Reagent Feed System	$		$6,754,222	$13,424,187	$18,703,258	$7,647,891	$25,343,826
SO2 Removal System	$		[illegible]	[illegible]	$2,091,803	$2,174,2[illegible]	$2,118,438
Spray Dryers	$		[illegible]	[illegible]	$24,742,004	$24,676,099	$24,880,[illegible]15
Flue Gas Handling System	$		$7,515,612	$7,187,680	$7,241,748	$7,159,303	[illegible]
ID Fans	$		$2,470,111	$2,336,160	$2,361,368	$2,323,285	$2,420,397
Waste / By-product Handling System	$		$1,510,890	$3,421,443	$4,882,968	$1,693,672	$6,122,447
Support Equipment	$		$3,461,855	$3,461,855	$3,461,855	$3,461,855	$3,461,855
Chimney	$		[illegible]	[illegible]	$[illegible]	$[illegible]	$[illegible]332
TOTAL	$		[illegible]	$63,338,138	$70,265,121	$55,862,803	$78,582,592
First Year Maintenance Costs							
Reagent Feed System	$		$337,711	$671,209	[illegible]	$382,395	$1,267,191
SO2 Removal System	$		[illegible]	$103,949	$104,590	$108,713	$105,922
Spray Dryers	$		[illegible]	[illegible]	$1,237,100	$1,233,805	[illegible]
Flue Gas Handling System	$		$375,781	[illegible]	$362,087	$357,965	$368,649
ID Fans	$		$123,506	$116,808	$118,068	$116,162	$121,020
Waste / By-product Handling System	$		$75,5[illegible]	$171,072	$244,148	$84,684	$306,122

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Support Equipment	$	$173,093	$173,093	$173,093	$173,093	$173,093
Chimney	$	$346,51[illegible]	[illegible]	$339,[illegible]	$335,32[illegible]	$343,117
TOTAL	$	[illegible]	[illegible]	$3,513,256	$2,793,140	$3,929,130

LSD O&M Data and Costs		Case 1	Case 2	Case 3	Case 4	Case 5
Cost Basis (Year)		1998	1998	1998	1998	1998
Parameters						
Reagent Required	lbs/hr	4,214	30,374	51,510	7,608	78,241
	lbmole/hr	0.803	5.785	9.811	1.449	14.903
Percent SO2 Removal	%	90%	90%	90%	90%	90%
FGD Solids - dry	lbs/hr	[illegible]	[illegible]	142,014	76,684	207,877
	[illegible]	[illegible]	[illegible]	177,518	95,856	259,846
Fresh Water to FGD	gpm	28	200	339	[illegible]	[illegible]
Blowdown Water to FGD	gpm	501	223	214	308	259
Total FGD Power Consumption	kW	3,500	3,500	3,500	3,500	3,500
Fixed O&M Costs						
Number of Operators		20	20	20	20	20
(40 hrs/week)						
Operating Labor Cost **	$/yr	$1,277,054	$1,277,054	$1,277,054	[illegible]	[illegible]
Maint. Labor & Matls. Cost	$/yr	$2,810,797	$3,167,907	$3,513,256	$2,793,140	$3,929,130
Admin. & Support Labor	$/yr	$721,411.90	$711,[illegible]5	$[illegible]4,707	$718,[illegible]3	$[illegible]
TOTAL	$/yr	$4,808,163	$5,208,326	$5,595,017	$4,788,488	$6,060,796
Variable Operating Costs **						
Reagent Costs	$/yr	[illegible]	[illegible]	$9,532,177	$1,407,920	[illegible]
Disposal Costs	$/yr	$3,239,022	$7,564,168	$12,129,447	$6,549,616	$17,754,765
Credit for By-product	$/yr	$0	$0	$0	$0	$0
Steam Costs	$/yr	$0	$0	$0	$0	$0
Fresh Water Costs	$/yr	[illegible]	[illegible]	[illegible]	$10,276	[illegible]
Power Costs	$/yr	[illegible]	$198,775	[illegible]	[illegible]	$198,775
		$4,542,732	$13,724,195	$22,229,418	$8,466,036	$32,837,602

Intermediate Material Balance Calcs.		Case 1	Case 2	Case 3	Case 4	Case 5
FGD Reactions in Spray Dryer (80% of SO2 Removal)						
Sulfite Reaction	60%					
SO2	lbmole/hr	19.88	87.74	127.19	32.63	175.08
Ca(OH)2	lbmole/hr	19.88	87.74	127.19	32.63	175.08
H2O	lbmole/hr	9.94	43.87	63.59	16.32	87.54
CaSO3*1/2H2O	lbmole/hr	19.88	87.74	127.19	32.63	175.08
SO2	lb/hr	1,274	5,621	8,148	2,090	11,216
Ca(OH)2	lb/hr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
H2O	lb/hr	[illegible]	[illegible]	1,180	[illegible]	[illegible]
CaSO3*1/2H2O	lb/hr	[illegible]	[illegible]	[illegible]	[illegible]	22,612
Sulfate Reaction	20%					
Ca(OH)2	lbmole/hr	6.63	29.25	42.40	10.88	58.36
SO2	lbmole/hr	6.63	29.25	42.40	10.88	58.36
O2	lbmole/hr	3.31	14.62	21.20	5.44	29.18
H2O	lbmole/hr	6.63	[illegible]	[illegible]	[illegible]	[illegible]
CaSO4*2H2O	lbmole/hr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca(OH)2	lb/hr	[illegible]	3,167	3,161	[illegible]	[illegible]
SO2	lb/hr	[illegible]	1,824	2,716	[illegible]	3,739
O2	lb/hr	106	468	678	174	934
H2O	lb/hr	119	527	764	196	1,051
CaSO4*2H2O	lb/hr	1,141	5,036	7,299	1,873	10,048
FGD Reactions in Baghouse/Scrubber (70% of SO2 Removal)						
Sulfite Reaction	15%					
SO2	lbmole/hr	9.94	43.87	63.59	16.32	87.54
Ca(OH)2	lbmole/hr	9.94	43.87	63.59	16.32	87.54
H2O	lbmole/hr	[illegible]	[illegible]	31.80	[illegible]	[illegible]
CaSO3*1/2H2O	lbmole/hr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO2	lb/hr	[illegible]	[illegible]	[illegible]	1,045	[illegible]
Ca(OH)2	lb/hr	737	3,251	4,712	1,209	6,486
H2O	lb/hr	90	395	573	147	789
CaSO3*1/2H2O	lb/hr	1,284	5,666	8,213	2,107	11,306
Sulfate Reaction	5%					
Ca(OH)2	lbmole/hr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SO2	lbmole/hr	[illegible]	[illegible]	[illegible]	[illegible]	29.18
O2	lbmole/hr	1.66	7.31	10.60	2.72	14.59
H2O	lbmole/hr	3.31	14.62	21.20	5.44	29.18
CaSO4*2H2O	lbmole/hr	3.31	14.62	21.20	5.44	29.18
Ca(OH)2	lb/hr	246	1,084	1,571	403	2,162
SO2	lb/hr	212	937	1,358	348	1,869
O2	lb/hr	53	234	339	87	467
H2O	lb/hr	60	263	382	98	[illegible]
CaSO4*2H2O	lb/hr	571	[illegible]	[illegible]	[illegible]	[illegible]
Solids in Spray Dryer						
CaSO3*1/2H2O	lb/hr	12,[illegible]11	17,739	20,915	8,749	[illegible]
CaSO4*2H2O	lb/hr	5,737	7,883	9,294	3,888	[illegible]
Inerts	lb/hr	61,353	24,594	32,715	[illegible]	[illegible]
Ca(OH)2	lb/hr	614	[illegible]	689	[illegible]	[illegible]
H2O	lb/hr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	[illegible]	[illegible]	69,274	84,612	70,917	118,558
Spray Dryer Solids Removal						
CaSO3*1/2H2O	lb/hr	1,291	1,774	2,091	875	[illegible]
CaSO4*2H2O	lb/hr	574	788	929	[illegible]	1,[illegible]12
Inerts	lb/hr	6,135	2,459	3,[illegible]72	5,688	4,520
Ca(OH)2	lb/hr	61	1,308	2,169	140	3,396
H2O	lb/hr	165	129	173	[illegible]	242
TOTAL	lb/hr	8,062	6,[illegible]27	8,461	[illegible]	11,856
Solids in Baghouse/ESP						
CaSO3*1/2H2O	lb/hr	24,524	37,596	45,860	17,850	60,408
CaSO4*2H2O	lb/hr	10,898	16,707	20,379	[illegible]	26,844
Inerts	lb/hr	110,435	44,270	58,888	[illegible]	81,358

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[illegible]	[illegible]		123	19,171	32,757	903	52,477
H2O	lb/hr						
TOTAL	lb/hr		145,980	117,743	[illegible]	[illegible]	[illegible]
Com[illegible]onents of Ba[illegible]house/ESP Solids							
CaSO3*1/2H2O	lb/hr		24,497	37,544	45,812	17,834	60,363
CaSO4*2H2O	lb/hr		10,886	[illegible],683	20,358	7,925	26,824
Inerts	lb/hr		110,315	[illegible]	58,827	102,262	81,298
C[illegible]OH)2	lb/hr		123	[illegible]	[illegible],723	[illegible]	52,438
H2O	lb/hr		2,976	2,400	[illegible]	[illegible],631	4,509
TOTAL	lb/hr		[illegible]	119,980	[illegible]	131,554	[illegible]
[illegible]otal Waste Solids Out							
CaSO3*1/2H2O	lb/hr		6,419	28,330	41,066	10,535	56,530
CaSO4*2H2O	lb/hr		2,853	[illegible],589	[illegible]	[illegible],682	25,120
Inerts	lb/hr		2[illegible],910	[illegible]	52,795	60,412	76,323
C[illegible]OH)2	lb/hr		34	14,447	29,378	[illegible]	[illegible]53
H2O	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	lb/hr		[illegible]	88,726	141,488	76,162	207,226
CaSO3*1/2H2O	wt. %		16.80%	31.93%	29.02%	13.83%	27.28%
CaSO4*2H2O	wt. %		7.46%	14.19%	12.90%	6.15%	12.12%
Inerts	wt. %		75.65%	37.60%	37.31%	79.32%	36.83%
Ca(OH)2	wt. %		0.09%	16.28%	20.76%	0.70%	23.77%
H2O	wt. %		NA	NA	NA	[illegible]	NA
TOTAL	wt. %		100.00%	100.00%	100.00%	[illegible]	100.00%
[illegible]aste Out Gas Stream							
CaSO3*1/2H2O	lb/hr		26.5	50.3	45.7	21.8	43.0
CaSO4*2H2O	lb/hr		11.8	22.3	20.3	[illegible]	19.1
Inerts	lb/hr		119.1	[illegible]	[illegible]	[illegible]	[illegible]
C[illegible]OH)2	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
H2O	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	lb/hr		[illegible]	158	158	158	158
[illegible]ry Solids							
CaSO3*1/2H2O	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CaSO4*2H2O	lb/hr		[illegible]	[illegible]	18,228	4,672	25,101
			28,791	33,301	52,737	60,287	76,265
C[illegible]OH)2	lb/hr		33	14,421	29,345	532	49,215
H2O	lb/hr		777	1,808	2,884	1,551	4,226
TOTAL	lb/hr		38,835	90,376	144,215	77,556	211,295
[illegible]TERATION 1							
Assumed Composition of Recycle Solids to Slurry T[illegible]nk							
CaSO3*1/2H2O	lb/hr		20,810	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	lb/hr		[illegible]	5,913	4,297	4,125	4,554
[illegible]	lb/hr		93,720	15,668	12,432	53,[illegible]27	13,838
Ca(OH)2	lb/hr		109	6,785	6,918	470	8,930
H2O	lb/hr		2,528	850	680	1,369	767
TOTAL	lb/hr		126,416	42,523	33,997	68,473	38,338
Com[illegible]osition of Recycle Slurry to Head Tanks							
[illegible]	lb/hr		20,810	13,306	9,670	9,282	10,249
CaSO4*2H2O	lb/hr		9,248	5,913	4,297	4,125	4,554
Inerts	lb/hr		93,720	15,668	12,432	53,227	13,838
C[illegible]OH)2	lb/hr		109	6,785	6,918	470	8,930
H2O	lb/hr		230,076	77,392	61,874	124,621	69,776
TOTAL	lb/hr		353,963	119,064	95,190	191,725	107,347
Co[illegible]							
CaSO3*1/2H2O	lb/hr		10,405	6,653	4,835	4,641	5,125
CaSO4*2H2O	lb/hr		4,624	2,956	2,149	2,062	2,277
Inerts	lb/hr		47,071	9,353	8,791	26,994	10,831
C[illegible]OH)2	lb/hr		2,560	21,452	[illegible]	[illegible]	[illegible]
H2O	lb/hr		121,376	84,377	[illegible]	[illegible]	[illegible]
TOTAL	lb/hr		186,035	[illegible]	158,266	112,269	220,774
S[illegible]ids in S[illegible]ray Dryer							
CaSO3*1/2H2O	lb/hr		12,973	17,985	21,261	8,855	27,737
CaSO4*2H2O	lb/hr		5,765	7,992	[illegible]	[illegible]	[illegible]
Inerts	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	33,416
[illegible]	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	NA
[illegible]	lb/hr		80,815	63,274	84,612	70,917	118,558
Co[illegible]							
[illegible]	lb/hr		[illegible]	[illegible]	[illegible]	886	2,774
[illegible]	lb/hr		[illegible]	799	945	394	1,233
Inerts	lb/hr		6,132	2,451	3,261	5,682	4,[illegible]08
C[illegible]OH)2	lb/hr		56	1,278	2,129	131	3,342
H2O	lb/hr		165	129	173	145	242
TOTAL	lb/hr		8,[illegible]6	6,457	8,634	7,236	12,098
S[illegible]ids in Ba[illegible]house/ESP							
[illegible]	lb/hr		[illegible]	38,039	46,484	18,047	61,232
[illegible]	lb/hr		10,947	16,903	20,656	8,020	27,210
[illegible]	lb/hr		110,368	44,126	58,705	102,[illegible]75	81,145
C[illegible]OH)2	lb/hr		30	18,676	32,038	741	[illegible]
H2O	lb/hr						
TOTAL	lb/hr		145,980	117,743	157,883	129,082	[illegible]
CaSO3*1/2H2O	wt %		16.9%	32.3%	29.4%	14.0%	[illegible]
CaSO4*2H2O	wt %		7.5%	14.4%	13.1%	[illegible]	12.3%
Inerts	wt %		75.6%	[illegible]	[illegible]	79.2%	36.7%
C[illegible]OH)2	wt %		0.0%	[illegible]	[illegible]	0.6%	23.3%
H2O	wt %						
[illegible]			[illegible]	[illegible]	0.0%	100.0%	0.0%
[illegible]y Solids							
CaSO3*1/2H2O	lb/hr		6,423	28,613	41,611	10,626	57,350
CaSO4*2H2O	lb/hr		2,854	12,715	[illegible]	4,722	25,485
Inerts	lb/hr		28,774	33,192	[illegible]	60,220	76,000
C[illegible]OH)2	lb/hr		8	14,048	[illegible]	436	48,234
[illegible]	lb/hr		[illegible]	[illegible]	[illegible]	1,551	4,226
[illegible]	lb/hr		[illegible]	[illegible]	144,215	77,556	211,295
S[illegible]ids Out Stack							
CaSO[illegible]	lb/hr		27	51	46	22	44
[illegible]	lb/hr		12	23	[illegible]	10	19
[illegible]	lb/hr		119	59	[illegible]	125	58

Ca(OH)2	[illegible]		0	25	32	1	37						
H2O	[illegible]												
TOTAL	lb/hr		158	158	158	158	158						
Composition of Baghouse/ESP Solids to Recycle													
CaSO3*1/2H2O	lb/hr		18,186	9,375	4,827	7,399	3,839						
CaSO4*2H2O	lb/hr		8,081	4,166	2,145	3,288	1,706						
Inerts	lb/hr		81,475	10,875	6,096	41,930	5,087						
Ca(OH)2	lb/hr		22	4,603	3,327	304	3,228						
H2O	lb/hr		2,199	592	335	1,080	283						
TOTAL	lb/hr		109,963	[illegible]	[illegible]	[illegible]	14,143						
Calculated Composition of Recycle Solids to Slurry Tank													
CaSO3*1/2H2O	lb/hr		20,781	12,971	9,079	9,170	9,386						
CaSO4*2H2O	lb/hr		9,234	5,764	4,034	4,075	4,171						
Inerts	lb/hr		93,738	15,778	12,718	53,294	14,103						
Ca(OH)2	lb/hr		134	7,159	7,585	565	9,912						
H2O	lb/hr		[illegible]	850	[illegible]	[illegible]	767						
TOTAL	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
ITERATION 2													
Assumed Composition of Recycle Solids to Slurry Tank													
[illegible]	lb/hr		[illegible]	[illegible]	[illegible]	9,057	[illegible]						
[illegible]	lb/hr		9,221	5,616	3,772	4,025	3,787						
Inerts	lb/hr		93,759	16,019	13,045	53,375	14,727						
Ca(OH)2	lb/hr		156	7,401	8,011	647	10,535						
H2O	lb/hr		2,528	850	680	1,369	767						
TOTAL	lb/hr		126,416	42,523	33,997	68,473	38,338						
Composition of Recycle Slurry to Head Tanks													
CaSO3*1/2H2O	lb/hr		20,751	12,637	8,488	9,057	8,523						
CaSO4*2H2O	lb/hr		9,221	5,616	3,772	4,025	3,787						
Inerts	lb/hr		93,759	16,019	13,045	53,375	14,727						
Ca(OH)2	lb/hr		156	7,401	8,011	[illegible]	[illegible]						
H2O			230,076	77,392	[illegible]	[illegible]	[illegible]						
TOTAL	[illegible]		[illegible]	[illegible]	[illegible]	191,725	107,347						
Composition of Slurry from Head Tank													
CaSO3*1/2H2O	lb/hr		10,375	6,319	[illegible]	[illegible]	[illegible]						
CaSO4*2H2O	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
[illegible]	[illegible]		[illegible]	[illegible]	9,098	27,068	11,275						
Ca(OH)2	lb/hr		2,583	21,759	34,631	4,847	51,787						
H2O			121,376	84,377	108,407	73,753	152,561						
TOTAL	lb/hr		186,035	124,791	158,266	112,209	221,778						
Solids in Spray Dryer													
CaSO3*1/2H2O	lb/hr		12,943	17,650	20,671	8,743	26,873						
CaSO4*2H2O	lb/hr		5,752	7,843	9,185	3,885	11,942						
Inerts	lb/hr		61,335	24,690	32,920	56,894	45,525						
Ca(OH)2	lb/hr		586	13,091	21,836	1,396	34,218						
H2O	lb/hr		NA	NA	NA	NA	[illegible]						
TOTAL	lb/hr		80,615	63,274	[illegible]	[illegible]	[illegible]						
Composition of Solids from Spray Dryer													
CaSO3*1/2H2O	lb/hr		1,294	1,765	2,067	[illegible]	[illegible]						
CaSO4*2H2O	lb/hr		575	784	919	389	1,194						
Inerts	lb/hr		6,133	2,469	3,292	5,689	4,552						
Ca(OH)2	lb/hr		59	1,309	2,184	[illegible]	[illegible]						
H2O	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
[illegible]	lb/hr		[illegible]	[illegible]	[illegible]	7,236	12,098						
Solids in Baghouse/ESP													
CaSO3*1/2H2O	lb/hr		24,582	37,437	45,420	[illegible]	[illegible]						
CaSO4*2H2O	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
Inerts	lb/hr		[illegible]	[illegible]	[illegible]	102,409	[illegible]						
[illegible]	lb/hr		[illegible]	[illegible]	[illegible]	900	52,944						
[illegible]	lb/hr												
TOTAL	lb/hr		145,980	117,743	157,883	129,082	221,086						
CaSO3*1/2H2O	wt %		16.8%	31.8%	28.8%	13.8%	27.0%						
CaSO4*2H2O	wt %		7.5%	14.1%	12.8%	6.1%	12.0%						
Inerts	wt %		75.6%	37.7%	37.5%	79.3%	37.1%						
Ca(OH)2	wt %		0.0%	16.3%	20.9%	[illegible]	[illegible]						
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
TOTAL	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
Dry Solids													
CaSO3*1/2H2O	lb/hr		6,409	28,160	40,659	[illegible]	[illegible]						
CaSO4*2H2O	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
[illegible]	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	76,749						
Ca(OH)2	lb/hr		[illegible]	[illegible]	29,560	530	49,587						
H2O	lb/hr		[illegible]	[illegible]	2,884	1,551	4,226						
TOTAL	lb/hr		38,835	90,376	144,215	77,556	211,295						
Solids Out Stack													
CaSO3*1/2H2O	[illegible]		[illegible]	[illegible]	[illegible]	22	43						
CaSO4*2H2O	[illegible]		[illegible]	[illegible]	[illegible]	10	19						
[illegible]	lb/hr		[illegible]	59	59	125	58						
Ca(OH)2	lb/hr		0	26	33	1	38						
[illegible]	lb/hr												
TOTAL	lb/hr		158	158	158	158	158						
Composition of Baghouse/ESP Solids to Recycle													
[illegible]	lb/hr		[illegible]	[illegible]	4,716	7,316	3,741						
[illegible]	lb/hr		[illegible]	[illegible]	2,096	3,251	1,662						
Inerts	lb/hr		81,500	10,952	6,153	41,985	5,137						
Ca(OH)2	lb/hr		53	4,739	3,429	369	[illegible]						
H2O	lb/hr		2,199	592	335	1,080	[illegible]						
TOTAL	lb/hr		109,963	29,610	16,729	[illegible]	[illegible]						
Calculated Composition of Recycle Solids to Slurry Tank													
[illegible]	lb/hr		[illegible]	[illegible]	8,850	9,064	9,116						
CaSO4*2H2O	lb/hr		[illegible]	[illegible]	3,933	4,028	4,051						
Inerts	lb/hr		93,767	15,880	12,737	53,363	[illegible]						
Ca(OH)2	lb/hr		[illegible]	[illegible]	7,796	648	[illegible]						
H2O	lb/hr		2,528	850	680	1,369	[illegible]						
TOTAL	lb/hr		126,416	42,523	33,997	[illegible]	38,338						
ITERATION 3													

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Assumed Composition of Recycle Slurry to Head Tank							
CaSO3*1/2H2O	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	
CaSO4*2H2O	lb/hr		9,207	5,722	4,094	[illegible]	
Inerts			93,779	15,804	12,476	53,358	
Ca(OH)2	lb/hr		182	7,271	7,535	643	9,734
H2O	lb/hr		2,528	850	680	1,369	767
TOTAL	lb/hr		126,416	42,523	33,997	68,473	38,338
Composition of Recycle Slurry to Head Tanks							
CaSO3*1/2H2O	lb/hr		20,719	12,875	9,213	9,071	9,709
CaSO4*2H2O	lb/hr		9,207	5,722	4,094	4,031	4,314
Inerts	lb/hr		93,779	15,804	12,476	53,358	13,814
Ca(OH)2	lb/hr		182	7,271	7,535	643	9,734
H2O	lb/hr		230,076	77,392	61,874	124,621	69,776
TOTAL	lb/hr		353,963	119,064	95,190	191,725	107,347
Composition of Slurry from Head Tank							
CaSO3*1/2H2O	[illegible]		[illegible]	6,438	4,606	4,536	4,855
CaSO4*2H2O	lb/hr		4,604	2,861	2,047	2,015	2,157
Inerts	lb/hr		47,100	9,421	8,813	27,060	10,819
Ca(OH)2	lb/hr		2,596	21,695	34,393	4,845	51,386
H2O	lb/hr		121,376	84,377	108,407	[illegible]	152,561
TOTAL	lb/hr		186,035	[illegible]	[illegible]	112,309	[illegible]
Solids in Spray Dryer							
CaSO3*1/2H2O	lb/hr		12,928	17,770	21,033	8,750	27,466
CaSO4*2H2O	lb/hr		5,745	7,896	9,346	3,888	12,205
Inerts	lb/hr		61,345	24,582	32,635	56,885	[illegible]
Ca(OH)2	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	lb/hr		[illegible]	[illegible]	[illegible]	70,917	118,558
[illegible]							
CaSO3*1/2H2O	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	1,221
Inerts	lb/hr		6,134	2,458	3,264	5,689	4,507
Ca(OH)2	lb/hr		60	1,303	2,160	139	3,382
H2O	lb/hr		165	129	173	145	242
TOTAL	lb/hr		8,226	6,457	8,634	7,236	12,098
Solids in Baghouse/ESP							
CaSO3*1/2H2O	lb/hr		24,553	37,651	46,072	17,857	60,746
CaSO4*2H2O	lb/hr		10,911	16,731	20,473	7,935	26,994
Inerts	lb/hr		110,420	44,248	58,744	102,393	81,123
Ca(OH)2	lb/hr		96	19,113	32,593	897	52,224
H2O	lb/hr						
TOTAL	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CaSO3*1/2H2O	wt %		16.8%	32.0%	29.2%	13.8%	27.5%
CaSO4*2H2O	wt %		7.5%	14.2%	13.0%	6.1%	12.2%
Inerts	wt %		75.6%	37.6%	37.2%	79.3%	36.7%
Ca(OH)2	wt %		0.1%	16.2%	20.6%	0.7%	23.6%
H2O	wt %						
TOTAL	wt %		0.0%	100.0%	100.0%	100.0%	100.0%
Dry Solids							
CaSO3*1/2H2O	lb/hr		6,401	28,322	41,242	10,514	56,894
CaSO4*2H2O	lb/hr		2,845	12,585	18,327	4,672	25,282
Inerts	lb/hr		28,788	33,284	52,585	60,290	75,980
Ca(OH)2	lb/hr		25	14,377	29,176	528	48,912
H2O	lb/hr		777	1,808	2,884	1,551	4,226
TOTAL	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Solids Out Stack							
CaSO3*1/2H2O	lb/hr		26	50	46	22	43
CaSO4*2H2O	lb/hr		12	22	20	10	19
Inerts	lb/hr		119	59	59	125	58
Ca(OH)2	lb/hr		[illegible]	[illegible]	[illegible]		
H2O							
[illegible]	lb/hr		[illegible]	[illegible]	[illegible]	158	158
[illegible] *Recycle*							
CaSO3*1/2H2O	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	1,692
Inerts	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	5,086
Ca(OH)2	lb/hr		71	4,710	3,384	368	3,274
H2O	lb/hr		2,199	592	335	1,080	283
TOTAL	lb/hr		109,963	29,610	16,729	54,000	14,143
[illegible] *Tank*							
CaSO3*1/2H2O	lb/hr		20,711	12,833	8,991	9,071	9,301
CaSO4*2H2O	lb/hr		9,203	5,703	3,995	4,031	4,133
Inerts	lb/hr		93,782	15,821	12,627	53,355	14,099
Ca(OH)2	lb/hr		190	7,316	7,704	647	10,037
H2O	lb/hr		2,528	850	680	1,369	767
TOTAL	lb/hr		126,416	42,523	33,997	68,473	[illegible]
ITERATION #							
Assumed Composition of Recycle Solids to Slurry Tank							
CaSO3*1/2H2O	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	8,894
CaSO4*2H2O	lb/hr		[illegible]	[illegible]	[illegible]	4,031	3,952
Inerts	lb/hr		93,788	15,852	12,787	53,355	14,394
Ca(OH)2	lb/hr			7,346	7,864	647	10,332
H2O	lb/hr		[illegible]	[illegible]	[illegible]	1,369	767
TOTAL	lb/hr		126,416	[illegible]	33,997	68,473	38,338
Composition of Recycle Slurry to Head Tanks							
CaSO3*1/2H2O	lb/hr		[illegible]	[illegible]	[illegible]	9,071	8,894
CaSO4*2H2O	lb/hr		[illegible]	[illegible]	[illegible]	4,031	3,952
Inerts	lb/hr		93,788	15,852	12,787	53,355	14,394
Ca(OH)2	lb/hr		196	7,346	7,864	647	10,332
H2O	lb/hr		[illegible]	77,392	61,874	124,621	[illegible]
TOTAL	lb/hr		[illegible]	119,064	95,190	191,725	107,347
Composition of Slurry from Head Tank							
CaSO3*1/2H2O	lb/hr		[illegible]	6,395	[illegible]	4,535	4,447
CaSO4*2H2O	lb/hr		[illegible]	[illegible]	[illegible]	2,015	1,976
Inerts	lb/hr		[illegible]	[illegible]	[illegible]	27,058	11,109
Ca(OH)2	[illegible]		[illegible]	[illegible]	[illegible]	4,847	51,685

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H2O	lb/hr		[illegible]	[illegible]	[illegible]	73,753	152,561
TOTAL	lb/hr		186,035	124,791	[illegible]	112,209	221,778
Solids in Spray Dryer							
CaSO3*1/2H2O	lb/hr		12,919	[illegible]	20,811	8,750	27,059
CaSO4*2H2O	lb/hr		[illegible]	[illegible]	[illegible]	3,888	12,024
Inerts	lb/hr		61,[illegible]	[illegible]	32,791	56,884	45,359
Ca(OH)2	lb/hr		[illegible]	13,064	21,762	1,396	34,117
H2O	lb/hr		NA	NA	NA	[illegible]	NA
TOTAL	lb/hr		80,615	63,274	84,612	[illegible]	118,558
Co[illegible] Solids Out Dryer							
CaSO3*1/2H2O	lb/hr		[illegible]	[illegible]	[illegible]	875	2,706
CaSO4*2H2O	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	1,202
Inerts	lb/hr		6,135	[illegible]	3,279	[illegible]	4,536
Ca(OH)2	lb/hr		[illegible]	1,306	2,176	[illegible]	3,412
H2O	lb/hr		165	129	173	145	242
TOTAL	lb/hr		8,226	6,457	8,634	7,236	[illegible]
Solids in Baghouse/ESP							
CaSO3*1/2H2O	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	60,012
CaSO4*2H2O	[illegible]		[illegible]	[illegible]	[illegible]	7,[illegible]	26,668
Inerts	[illegible]		110,429	44,291	59,025	102,391	[illegible]
Ca(OH)2	lb/hr		109	19,181	32,890	900	52,761
H2O	lb/hr						
TOTAL	lb/hr		145,980	117,743	157,883	129,082	221,086
CaSO3*1/2H2O	wt %		16.8%	31.9%	28.9%	13.8%	27.1%
CaSO4*2H2O	wt %		7.5%	14.2%	[illegible]	[illegible]	12.1%
Inerts	wt %		[illegible]	[illegible]	[illegible]	[illegible]	36.9%
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
H2O	[illegible]						
TOTAL	wt %		[illegible]	[illegible]	[illegible]	100.0%	[illegible]
Dry Solids							
CaSO3*1/2H2O	lb/hr		6,397	[illegible]	[illegible]	[illegible]	[illegible]
CaSO4*2H2O	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	52,837	60,288	76,469
Ca(OH)2	lb/hr		28	14,428	29,442	530	49,416
H2O	lb/hr		777	1,808	2,884	1,551	4,226
TOTAL	lb/hr		38,835	90,376	144,215	77,556	211,295
Solids Out Stack							
CaSO3*1/2H2O	lb/hr		26	50	46	22	43
CaSO4*2H2O	lb/hr		12	22	20	10	19
Inerts	lb/hr		119	59	59	125	58
Ca(OH)2	lb/hr		0	26	33		38
H2O	lb/hr						
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Composition of Baghouse/ESP Solids to	***Recycle***						
CaSO3*1/2H2O	lb/hr		18,115	9,360	4,743	7,321	3,762
CaSO4*2H2O	lb/hr		8,050	4,115	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca(OH)2	lb/hr		[illegible]	[illegible]	3,415	369	[illegible]
H2O	lb/hr		2,199	592	335	1,080	283
TOTAL	lb/hr		109,963	29,610	16,729	54,000	14,143
Calculated Co[illegible] of Recycle Solids to Slurry	***Tank***						
CaSO3*1/2H2O	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		9,198	5,690	2,057	[illegible]	[illegible]
[illegible]	lb/hr		93,790	15,837	12,687	53,354	14,190
Ca(OH)2	lb/hr		201	7,340	7,768	648	10,131
H2O	lb/hr		2,528	850	680	1,369	767
TOTAL	lb/hr		126,416	42,523	33,997	68,473	38,338
ITERATION 5							
Assumed Composition of Recycle Solids to Slurry T[illegible]nk							
CaSO3*1/2H2O	lb/hr		20,694	12,821	9,041	9,070	9,454
CaSO4*2H2O	lb/hr		9,196	5,697	4,018	4,031	4,201
Inerts	lb/hr		93,793	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	lb/hr		126,416	[illegible]	[illegible]	68,473	[illegible]
Com[illegible]osition of Recycle Slurry to Head Tanks							
[illegible]	lb/hr		[illegible]	12,[illegible]	[illegible]	[illegible]	[illegible]
CaSO4*2H2O	lb/hr		[illegible]	5,697	4,018	[illegible]	4,201
Inerts	lb/hr		93,793	15,826	12,589	53,354	13,988
Ca(OH)2	lb/hr		205	7,329	7,669	648	9,929
H2O	lb/hr		230,076	77,392	61,874	124,621	69,776
TOTAL	lb/hr		353,963	119,064	95,190	191,725	107,347
Com[illegible]sition of Slurry from Head Tank							
CaSO3*1/2H2O	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	4,727
CaSO4*2H2O	[illegible]		[illegible]	2,849	2,009	2,015	2,101
Inerts	lb/hr		47,107	9,432	8,870	27,057	10,906
Ca(OH)2	lb/hr		2,608	21,723	34,460	4,848	51,483
H2O	lb/hr		121,376	84,377	108,407	73,753	[illegible]
TOTAL	lb/hr		186,035	124,791	158,266	112,209	[illegible]
Solids in [illegible]ray Dryer							
CaSO3*1/2H2O	[illegible]		[illegible]	17,742	20,947	8,749	27,339
CaSO4*2H2O	lb/hr		5,739	7,884	9,308	3,888	12,149
Inerts	lb/hr		61,352	24,593	32,692	56,883	[illegible]
Ca(OH)2	lb/hr		610	13,055	21,665	1,397	[illegible]
H2O	lb/hr		NA	NA	NA	NA	
TOTAL	lb/hr		80,615	63,274	84,612	[illegible]	118,558
Co[illegible]Solids Out Dryer							
CaSO3*1/2H2O	lb/hr		1,291	1,774	2,095	875	[illegible]
CaSO4*2H2O	lb/hr		574	788	931	389	[illegible]
Inerts	lb/hr		6,135	2,459	3,[illegible]9	5,688	[illegible]
Ca(OH)2	lb/hr		61	1,306	2,167	140	[illegible]
H2O	lb/hr		165	129	173	[illegible]	242
TOTAL	lb/hr		8,[illegible]	6,457	8,634	[illegible]	12,098
Solids in Ba[illegible]house/ESP							
CaSO3*1/2H2O	lb/hr		[illegible]	[illegible]	45,918	17,856	[illegible]

CaSO4*2H2O	lb/hr		10,901	16,709	20,405	7,935	26,892
Inerts	lb/hr		110,433	44,267	58,846	102,390	81,280
Ca(OH)2	lb/hr		116	19,165	32,714	902	[illegible]
H2O	lb/hr						
TOTAL	[illegible]		[illegible]	117,743	[illegible]	[illegible]	[illegible]
CaSO3*1/2H2O	wt %		[illegible]	[illegible]	[illegible]	13.8%	27.4%
CaSO4*2H2O	wt %		[illegible]	[illegible]	[illegible]	6.1%	12.2%
Inerts	wt %		75.6%	37.6%	37.3%	79.3%	36.8%
Ca(OH)2	wt %		0.1%	16.3%	20.7%	0.7%	23.7%
H2O	wt %						
TOTAL	wt %		100.0%	0.0%	100.0%	0.0%	100.0%
Dry Solids							
CaSO3*1/2H2O	lb/hr		6,395	28,285	41,104	10,514	56,679
CaSO4*2H2O	lb/hr		2,842	12,569	18,265	4,672	25,187
Inerts	lb/hr		28,791	33,298	52,677	60,288	76,127
Ca(OH)2	lb/hr		30	14,416	29,285	531	49,076
H2O	lb/hr		777	1,808	2,884	1,551	4,226
TOTAL	lb/hr		[illegible]	90,376	144,215	77,556	211,295
Solids Out Stack							
CaSO3*1/2H2O	lb/hr		26	50	46	22	43
CaSO4*2H2O	lb/hr		[illegible]	22	20	10	19
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca(OH)2	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	lb/hr						
TOTAL	lb/hr		158	158	[illegible]	158	158
Composition of Baghouse/ESP Solids to Recycle							
[illegible]	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	3,794
CaSO4*2H2O	lb/hr		8,047	4,118	2,119	[illegible]	1,686
Inerts	lb/hr		81,523	10,910	6,110	41,977	5,095
Ca(OH)2	lb/hr		86	4,723	3,397	370	3,285
H2O	lb/hr		2,199	592	335	1,080	283
TOTAL	lb/hr		109,963	29,610	16,729	54,000	14,143
Calculated Composition of Recycle Solids to Slurry Tank							
CaSO3*1/2H2O	lb/hr		20,692	12,815	8,957	9,070	9,262
CaSO4*2H2O	lb/hr		9,195	5,695	3,980	4,031	4,116
Inerts	lb/hr		93,793	15,828	12,649	53,354	14,127
Ca(OH)2	lb/hr		208	7,334	7,730	649	10,068
H2O	[illegible]		[illegible]	850	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ITERATION 4							
Assumed Composition of Recycle Solids to Slurry Tank							
CaSO3*1/2H2O	lb/hr		20,689	12,810	8,874	9,070	9,069
CaSO4*2H2O	lb/hr		9,194	5,692	3,943	4,031	4,030
Inerts	lb/hr		93,795	15,832	12,709	53,354	14,266
Ca(OH)2	lb/hr		209	7,338	7,790	649	10,207
[illegible]	[illegible]		[illegible]	850	680	[illegible]	[illegible]
[illegible]	[illegible]		126,436	[illegible]	[illegible]	68,473	[illegible]
Composition of Recycle Solids to Slurry Tanks							
CaSO3*1/2H2O	lb/hr		20,689	12,810	8,874	9,070	[illegible]
CaSO4*2H2O	lb/hr		9,194	5,692	3,943	4,031	4,030
Inerts	lb/hr		93,795	15,832	12,709	53,354	14,266
Ca(OH)2	lb/hr		209	7,338	7,790	649	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	107,347
Composition of Slurry to Spray Dryers							
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	lb/hr		47,106	9,466	8,990	27,067	11,045
Ca(OH)2	lb/hr		2,610	31,728	34,521	4,848	51,623
H2O	lb/hr		121,376	84,377	108,407	73,753	152,561
TOTAL	lb/hr		186,035	124,791	158,166	112,209	221,778
Solids in Spray Dryer							
CaSO3*1/2H2O	[illegible]		[illegible]	[illegible]	[illegible]	8,749	27,146
CaSO4*2H2O	lb/hr		5,738	7,882	9,271	3,888	12,063
Inerts	lb/hr		61,352	24,596	32,752	56,883	45,294
Ca(OH)2	lb/hr		613	13,060	21,725	1,397	34,054
H2O	lb/hr		NA	NA	NA	NA	NA
TOTAL	lb/hr		80,615	63,274	84,612	70,917	118,558
Composition of Solids from Spray Dryers							
CaSO3*1/2H2O	lb/hr		1,791	1,774	2,086	875	2,715
CaSO4*2H2O	lb/hr		574	788	927	389	1,206
Inerts	lb/hr		6,135	2,460	3,275	5,688	[illegible]
Ca(OH)2	lb/hr		61	1,306	2,173	140	[illegible]
H2O	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	[illegible]		[illegible]	6,457	[illegible]	[illegible]	12,098
Solids in Baghouse/ESP							
CaSO3*1/2H2O	lb/hr		24,526	37,592	45,767	17,856	[illegible]
CaSO4*2H2O	lb/hr		10,899	16,705	20,338	7,935	[illegible]
Inerts	lb/hr		110,434	44,273	5[illegible],954	[illegible]	[illegible]
Ca(OH)2	lb/hr		120	19,173	32,823	[illegible]	52,649
H2O	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	lb/hr		[illegible]	[illegible]	[illegible]	129,082	221,086
[illegible]	wt %		[illegible]	[illegible]	[illegible]	13.8%	27.2%
[illegible]	wt %		7.5%	14.2%	[illegible]	6.1%	12.1%
Inerts	wt %		75.7%	37.6%	37.3%	79.3%	36.9%
Ca(OH)2	wt %		0.1%	16.3%	20.8%	0.7%	[illegible]
H2O	wt %						
TOTAL	wt %		0.0%	100.0%	0.0%	100.0%	[illegible]
Dry Solids							
CaSO3*1/2H2O	lb/hr		[illegible]	[illegible]	[illegible]	10,514	56,355
CaSO4*2H2O	lb/hr		[illegible]	[illegible]	[illegible]	4,672	25,043
Inerts	lb/hr		[illegible]	[illegible]	[illegible]	60,287	[illegible]
Ca(OH)2	lb/hr		31	14,422	29,382	531	[illegible]
H2O	lb/hr		777	1,808	2,884	1,551	[illegible]
TOTAL	lb/hr		38,835	90,376	144,215	77,556	211,295
Solids Out Stack							
CaSO3*1/2H2O	lb/hr		[illegible]	[illegible]	[illegible]	22	[illegible]

CaSO4*2H2O	lb/hr		12	[illegible]	[illegible]	[illegible]	19
Inerts	lb/hr		119				
Ca(OH)2	lb/hr		[illegible]	26	33		
H2O	lb/hr						
TOTAL	lb/hr		158	158	158	158	158
Composition of Baghouse/ESP Solids to	***Recycle***						
CaSO3*1/2H2O	lb/hr		18,106	[illegible]	[illegible]	[illegible]	3,772
CaSO4*2H2O	lb/hr		[illegible]	4,117	2,112	[illegible]	[illegible]
Inerts	lb/hr		81,524	10,911	6,122	41,977	[illegible]
Ca(OH)2	lb/hr		89	4,725	3,408	370	3,301
[illegible]	lb/hr		2,199	592	335	1,080	283
[illegible]	lb/hr		109,963	29,610	16,729	54,000	14,143
Ca[illegible]s to Slurry Tank							
CaSO3*1/2H2O	lb/hr		[illegible]	12,812	8,925	[illegible]	[illegible]
[illegible]	lb/hr		9,193	5,693	3,966	4,031	[illegible]
[illegible]	lb/hr		93,794	15,830	12,672	53,353	14,170
Ca(OH)2	lb/hr		211	7,337	7,753	649	10,111
H2O	lb/hr		2,528	850	680	1,369	767
TOTAL	lb/hr		126,416	[illegible]	33,997	68,473	38,338
ITERATION 7							
Assumed Composition of Recycle Solids to Slurry Tank							
CaSO3*1/2H2O	lb/hr		[illegible]	[illegible]	[illegible]	9,070	9,334
CaSO4*2H2O	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	148
Inerts	lb/hr		93,795	[illegible]	12,638	[illegible]	[illegible]
Ca(OH)2	lb/hr			7,336	7,716	649	10,016
[illegible]	lb/hr		2,528	850	680	1,369	767
[illegible]	lb/hr		126,416	42,523	33,997	68,473	38,338
Composition of Recycle Slurry to Head Tanks							
CaSO3*1/2H2O	lb/hr		[illegible]	12,814	8,976	9,070	9,334
[illegible]	lb/hr		9,193	5,694	3,989	4,031	4,148
[illegible]	lb/hr		93,795	15,829	12,635	53,353	14,074
Ca(OH)2	lb/hr		212	7,336	7,716	649	10,016
H2O	lb/hr		230,076	77,392	61,874	124,621	69,776
TOTAL	lb/hr		353,963	119,064	[illegible]	[illegible]	[illegible]
Composition of Slurry from Head Tank							
CaSO3*1/2H2O	lb/hr		10,343	6,407	4,488	4,535	4,667
CaSO4*2H2O	lb/hr		4,506	2,847	1,994	[illegible]	[illegible]
Inerts	lb/hr		[illegible]	[illegible]	[illegible]	27,057	[illegible]
Ca(OH)2	lb/hr		2,612	[illegible]	[illegible]	4,848	51,527
[illegible]	lb/hr		121,376	84,377	108,407	73,753	152,561
[illegible]	lb/hr		186,035	124,791	158,266	112,209	221,778
Solids in Spray Dryer							
CaSO3*1/2H2O	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	27,279
[illegible]	lb/hr		[illegible]	7,883	9,294	3,888	12,122
[illegible]	lb/hr		61,353	24,594	32,715	56,883	45,199
Ca(OH)2	lb/hr		614	13,059	21,689	1,397	33,959
H2O	lb/hr		NA	NA	NA	NA	NA
TOTAL	lb/hr		80,615	63,274	84,612	70,917	118,558
Composition of Solids from Spray Dryers							
[illegible]	[illegible]		1,291	1,774	2,091	875	2,728
[illegible]	lb/hr		574	788	929	389	1,212
Inerts	lb/hr		6,135	2,459	3,272	5,688	4,520
Ca(OH)2	lb/hr		61	1,306	2,169	140	3,396
H2O	lb/hr		165	129	173	145	[illegible]
TOTAL	lb/hr		8,226	6,457	[illegible]	[illegible]	[illegible]
Solids in Baghouse/ESP							
CaSO3*1/2H2O	lb/hr		24,524	37,596	45,860	17,856	60,408
CaSO4*2H2O	lb/hr		10,898	16,707	20,379	7,935	26,844
Inerts	lb/hr		110,435	44,270	58,888	102,389	[illegible]
Ca(OH)2	lb/hr		123	19,171	[illegible]	[illegible]	[illegible]
H2O	lb/hr						
TOTAL	[illegible]		[illegible]	[illegible]	[illegible]	129,082	221,086
[illegible]	wt %		16.8%	31.9%	29.0%	13.8%	27.3%
CaSO4*2H2O	wt %		7.5%	14.2%	12.9%	6.1%	12.1%
Inerts	wt %		75.7%	37.6%	37.3%	79.3%	36.8%
Ca(OH)2	wt %		0.1%	16.3%	20.7%	0.7%	23.7%
H2O	wt %						
TOTAL	wt %		100.0%	100.0%	100.0%	100.0%	
Dry Solids							
CaSO3*1/2H2O	lb/hr		6,394	28,280	41,052	10,514	56,578
CaSO4*2H2O	lb/hr		2,841	12,567	18,242	4,672	[illegible]
Inerts	lb/hr		28,792	33,301	52,714	[illegible]	[illegible]
Ca(OH)2	lb/hr		32	14,421	29,423	[illegible]	[illegible]
H2O	lb/hr		777	[illegible]	[illegible]	1,551	4,226
TOTAL	lb/hr		[illegible]	[illegible]	[illegible]	77,556	211,295
Solids Out Stack							
CaSO3*1/2H2O	lb/hr		26	50	46	22	[illegible]
CaSO4*2H2O	lb/hr		12	22	20	[illegible]	[illegible]
Inerts	lb/hr		119	[illegible]	[illegible]	[illegible]	[illegible]
Ca(OH)2	lb/hr		0	[illegible]	[illegible]	[illegible]	37
H2O	lb/hr						
TOTAL	lb/hr		[illegible]	[illegible]	[illegible]	[illegible]	158
Composition of Recycle Solids to Slurry	***Recycle***						
CaSO3*1/2H2O	lb/hr		18,104	9,265	4,762	[illegible]	3,787
CaSO4*2H2O	lb/hr		8,045	4,117	[illegible]	[illegible]	1,683
Inerts	lb/hr		[illegible]	[illegible]	[illegible]	41,977	5,100
Ca(OH)2	lb/hr		[illegible]	[illegible]	[illegible]	370	3,290
H2O	lb/hr		2,199	[illegible]	[illegible]	1,080	283
[illegible]	lb/hr		109,963	[illegible]	16,729	54,000	14,143
Calculated Composition of Recycle Solids to Slurry	***Tank***						
CaSO3*1/2H2O	lb/hr		20,686	12,813	8,945	[illegible]	9,243
CaSO4*2H2O	lb/hr		9,192	5,694	3,975	[illegible]	4,107
Inerts	lb/hr		93,795	15,829	[illegible]	53,353	14,140
Ca(OH)2	lb/hr		[illegible]	[illegible]	[illegible]	650	10,081
[illegible]	lb/hr		[illegible]	[illegible]	[illegible]	1,369	767
[illegible]	lb/hr		126,416	42,523	33,997	68,473	38,338

CUECost - Air Pollution Control Systems Economics Spreadsheet

Fabric Filter - Preliminary		Case1	Case 2	Case 3	Case 4	Case 5
Flue Gas, Upstream of Fabric Filter						
Temperature	°F	147	147	147	147	147
Pressure	in. H2O	-17	-17	-17	-17	-17
Flow Rate	SCFM	1,402,194	1,292,636	1,313,499	1,282,055	1,362,367
Flow Rate	ACFM	1,739,624	1,603,701	1,629,584	1,590,574	1,690,212
CO2	lb/hr	1,120,920	1,045,412	1,055,110	1,047,495	1,048,927
N2	lb/hr	4,084,072	4,052,345	4,061,258	4,030,485	4,067,354
SO2	lb/hr	1,321	5,829	8,450	2,168	11,632
O2	lb/hr	327,669	317,635	318,158	316,904	319,686
HCl	lb/hr	0	0	0	0	0
Other Gases	lb/hr	1,425	2,268	2,238	1,873	2,030
H2O	lb/hr	722,080	465,318	514,007	450,071	650,130
Fly Ash	lb/hr	145,108	113,894	152,302	127,651	213,405
Total (gas only)	lb/hr	6,257,488	5,888,807	5,959,221	5,848,996	6,099,759
Total Fabric Required	Ft^2	497,035	458,200	465,596	454,450	482,918
Surface Area per Bag	Ft^2	31.4	31.4	31.4	31.4	31.4
Required No. of Bags (no spare compartments)		15,821	14,585	14,820	14,466	15,372
Final No. of Bags		17,403	16,043	16,302	15,912	16,909
No. of Casings		1	1	1	1	1
Fabric Filter Dimensions (per Casing)	Ft^2	17,086	15,751	16,005	15,622	16,600
Length	Ft	185	177	179	177	182
Width	Ft	92	89	89	88	91

Capital Cost		Case1	Case 2	Case 3	Case 4	Case 5
Cost Basis (Year)		***1998***	***1998***	***1998***	***1998***	***1998***
Fabric Filter	$	$6,250,411	$5,900,180	$5,967,520	$5,865,907	$6,124,047
Bags	$	$916,791	$845,159	$858,800	$838,241	$890,751
Ash Handling System	$	$1,942,059	$1,571,194	$2,027,539	$1,734,644	$2,753,523
ID Fans	$	$770,690	$732,840	$740,139	$729,121	$757,065
Equipment Cost Subtotal	$	$9,879,951	$9,049,374	$9,593,998	$9,167,913	$10,525,387
Instruments & Controls	$	$197,599	$180,987	$191,880	$183,358	$210,508
Taxes	$	$592,797	$542,962	$575,640	$550,075	$631,523
Freight	$	$493,998	$452,469	$479,700	$458,396	$526,269
Purchased Equipment Cost Subtotal	$	$11,164,345	$10,225,792	$10,841,218	$10,359,742	$11,893,687
Installation	$	$7,480,111	$6,851,281	$7,263,616	$6,941,027	$7,968,770
Total Direct Cost	$	$18,644,455	$17,077,073	$18,104,834	$17,300,769	$19,862,457
Total Direct Cost with Retrofit Factor	$	$24,237,792	$22,200,195	$23,536,284	$22,491,000	$25,821,194
General Facilities	$	$2,423,779	$2,220,019	$2,353,628	$2,249,100	$2,582,119
Engineering Fees	$	$2,423,779	$2,220,019	$2,353,628	$2,249,100	$2,582,119
Contingency	$	$4,847,558	$4,440,039	$4,707,257	$4,498,200	$5,164,239
Total Plant Cost (TPC)	$	$33,932,909	$31,080,273	$32,950,797	$31,487,400	$36,149,672
Total Plant Cost (TPC) w/ [illegible]	$	$34,950,896	$32,012,681	$33,939,321	$32,432,022	$37,234,162
Total Cash Expended (TCE)	$	$34,441,902	$31,546,477	$33,445,059	$31,959,711	$36,691,917
Allow. for Funds During Constr. (AFDC)	$	$1,832,377	$1,678,335	$1,779,343	$1,700,320	$1,952,082
Total Plant Investment (TPI)	$	$36,274,280	$33,224,811	$35,224,402	$33,660,030	$38,643,999
Preproduction Costs	$	$725,486	$664,496	$704,488	$673,201	$772,880
Inventory Capital	$	$0	$0	$0	$0	$0
Total Capital Requirement (TCR)	$	**$36,999,765**	**$33,889,308**	**$35,928,890**	**$34,333,231**	**$39,416,879**

CUECost - Air Pollution Control Systems Economics Spreadsheet

	$/kW		$74.0	$67.8	$71.9	$68.7	$78.8	
O&M Data and Costs			Case1	Case 2	Case 3	Case 4	Case 5	
Cost Basis (Year)			*1998*	*1998*	*1998*	*1998*	*1998*	
Power Required Excluding ID Fan(s)	kW		736	681	691	675	716	
ID Fan Power for FF Delta P	kW		1,757	1,620	1,646	1,606	1,707	
Total Power	kW		2,493	2,300	2,337	2,282	2,423	
Power Cost **	$/yr		$354,878	$327,425	$332,654	$324,772	$344,900	
Maintenance Costs	$/yr		$1,305,112	$1,195,395	$1,267,338	$1,211,054	$1,390,372	
Periodic Replacement Items	$/yr		$916,791	$845,159	$858,800	$838,241	$890,751	
First Year Cost. Bags Replaced Every			*5 Years*	*5 Years*	*5 Years*	*5 Years*	*5 Years*	
** [illegible] current dollars [illegible] inflation.								
ESP			Case1	Case 2	Case 3	Case 4	Case 5	
Flue Gas, Upstream of ESP								
Temperature	°F		147	147	147	147	147	
Pressure	in. H2O		-17	-17	-17	-17	-17	
Flow Rate	SCFM		1,402,194	1,292,636	1,313,499	1,282,055	1,362,367	
Flow Rate	ACFM		1,739,624	1,603,701	1,629,584	1,590,574	1,690,212	
CO2	lb/hr		1,120,920	1,045,412	1,055,110	1,047,495	1,048,927	
N2	lb/hr		4,084,072	4,052,345	4,061,258	4,030,485	4,067,354	
SO2	lb/hr		1,321	5,829	8,450	2,168	11,632	
O2	lb/hr		327,669	317,635	318,158	316,904	319,686	
HCl	lb/hr		0	0	0	0	0	
Other Gases	lb/hr		1,425	2,268	2,238	1,873	2,030	
H2O	lb/hr		722,080	465,318	514,007	450,071	650,130	
Fly Ash	lb/hr		145,108	113,894	152,302	127,651	213,405	
Total (gas only)	lb/hr		6,257,488	5,888,807	5,959,221	5,848,996	6,099,759	
Inlet Particulate Loading	lb/hr		145,108	113,894	152,302	127,651	213,405	
	gr/ft3		9.73	8.29	10.90	9.36	14.73	
Overall PM Collection Efficiency	%	η	99.9%	99.9%	99.9%	99.9%	99.9%	
ESP Requirements								
k	dimensionless		0.451	0.473	0.473	0.450	0.472	[illegible] r
E	kV/cm		10.0	10.0	10.0	10.0	10.0	*E* = the stre[illegible] o
Ash Composition								
Na2O	wt% in Ash		1.68	0.90	0.40	0.40	0.60	weight percent o
Fe	wt% in Ash		6.07	20.2	9.00	9.00	20.00	weight percent o
MgO	wt% in Ash		31.97	5.90	6.50	6.50	6.50	weight percent o
CaO	wt% in Ash		0.00	0.00	0.00	0.00	0.00	weight percent o
Flue Gas Composition								
H2O	Vol%		18.57	12.93	14.13	12.57	17.38	volume percent o
SO2	ppm		96	456	653	170	875	volume percent o
SO3	ppm		0.7	3.4	4.8	1.3	6.5	volume percent o
Flue Gas Temperature								
TF	°F		147	147	147	147	147	Flue gas temperatu
TC	°C		64	64	64	64	64	Flue gas temperatu
TK	Kelvin		337	337	337	337	337	Flue gas temperatu
Resistivity Calculations								
Volume Resistivity								
rv1	Log10(ohm-cm)		9.13	8.23	9.28	9.28	8.61	*rv1* = 8.9434 - 1.
rv2	Log10(ohm-cm)		8.89	7.99	9.04	9.04	8.37	*rv2* = *rv1* + (*E* - 2
iv	Log10(ohm-cm)		1.95	1.05	2.11	2.11	1.44	*iv* = *rv2* - 433 5
rv	Log10(ohm-cm)		14.81	13.91	14.97	14.97	14.30	*rv* = *iv* + 4334 5 /
rv(TK=1000/2.4)	Log10(ohm-cm)		12.35	11.45	12.51	12.51	11.84	*rv* = *iv* + 4334 5 /
Volume Resistivity	ohm-cm		6.4904E+14	8.1454E+13	9.3232E+14	9.3232E+14	1.9963E+14	volume resistivity
Surface Resistivity								
rs1	Log10(ohm-cm)		10.27	10.88	11.66	11.66	11.27	*rs1* = 10.7737 - 2
rs2	Log10(ohm-cm)		9.05	10.37	11.01	11.21	10.20	*rs2* = *rs1* + (*H2O* - 9
rs3	Log10(ohm-cm)		7.82	5.90	6.50	6.5[illegible]	6.50	*rs3*: if (*M*[illegible] C
rs4	Log10(ohm-cm)		7.58	5.66	6.26	6.26	6.26	*rs4* = *rs3* + (*E* - 2
rs4(with E=12)	Log10(ohm-cm)		7.52	5.60	6.20	6.20	6.20	*rs4*(with E = 1[illegible]
rs0	Log10(ohm-cm)		9.88	7.25	8.[illegible]	7.80	8.41	*rs0* = *rs4*(with *E* =
rs	Log10(ohm-cm)		4.34	3.39	3.79	4.05	3.23	*rs* = *rs0* - Lo[illegible] 0
Surface Resistivity	ohm-cm		2.2022E+04	2.4594E+03	6.1037E+03	1.1284E+04	1.6991E+03	surface resistivity
rvs1	ohm-cm		2.2022E+04	2.4594E+03	6.1037E+03	1.1284E+04	1.6991E+03	*rvs1* = 10^(*rv* + *r*
rs2(with H2O=10)	Log10(ohm-cm)		1.01E+01	1.07E+01	1.15E+01	1.15E+01	1.11E+01	*rs2*(with *H2O* = 1
rs3(with H2O=10)	Log10(ohm-cm)		8.91	5.90	6.50	6.50	6.50	*rs3*(with *H2O* = 1

CUECost - Air Pollution Control Systems **Economics Spreadsheet**

rs4(with H2O = 10)	Log 10(ohm-cm)	8.67	5.66	6.26	6.26	6.26	*rs4(with H2O* = 1
rs4(with H2O = 10, E = 12)	Log 10(ohm-cm)	8.61	5.60	6.20	6.20	6.20	= 1
rs0(with H2O = 10)	Log 10(ohm-cm)	9.88	6.87	7.47	7.47	7.47	*H*
rs(with H2O = 10, TK = 1000/2.4)	Log 10(ohm-cm)	9.08	6.06	6.66	6.66	6.66	1
rvs1(with H2O=10, TK = 1000/2.4)	ohm-cm	1.1934E+09	1.1610E+06	4.6222E+06	4.6222E+06	4.6222E+06	*r*
rvs2	Log 10(ohm-cm)	9.32	6.30	6.[illegible]	6.90	6.90	*rvs2* = Log10(*rv*
Acid Resistivity							
ia1	Log 10(ohm-cm)	0.29	0.29	0.29	0.29	0.29	= *C*
ra1	Log 10(ohm-cm)	7.44	5.13	5.59	5.59	5.59	*ra1* = *ia1* + 0.[illegible]6
sa		-2.05	-2.05	-2.05	-2.05	-2.05	*C*
ia2	Log 10(ohm-cm)	8.67	6.36	6.82	6.82	6.82	*ra1* - *sa*
ra2	Log 10(ohm-cm)	8.98	5.28	5.42	6.62	5.16	*ia2* + *sa* *L
acid_v	index value	1	2	2	1	2	<
atom_v	index value	1	3	3	3	3	2
sa1		-4.74	-28.39	-28.39	-4.85	-28.39	*a*
ia3	Log 10(ohm-cm)	20.36	73.42	73.55	18.26	73.29	*
ra3	Log 10(ohm-cm)	6.29	-10.82	-10.68	3.87	-10.94	*
ra	Log 10(ohm-cm)	6.73	-6.27	-6.17	4.89	-6.36	6
Acid Resistivity	ohm-cm	5.3953E+06	0.0000E-01	0.0000E-01	7.7218E+04	0.0000E-01	*Acid resistivity* =
Total Resistivity							
rvsa	ohm-cm	2.1933E+04	0.0000E-01	0.0000E-01	9.8450E+03	0.0000E-01	*rvsa* = 10^(rv + r
Migration Velocity							
w_k	1000ft/minute	0.090	0.171	0.170	0.093	0.172	w_k = 0.123297 - 0
Specific Collection Area							
SCA	ft²/1000acfm	**786**	**315**	**345**	**737**	**381**	*SCA* = (144 / [illegible] n)
Total Collector Plate Area	ft²	1,366,477	504,852	562,801	1,172,661	644,498	
ESP Footprint Area	ft²	37,958	14,024	15,633	32,574	17,903	

Capital Cost		Case1	Case 2	Case 3	Case 4	Case 5
Cost Basis (Year)		***1998***	***1998***	***1998***	***1998***	***1998***
ESP	$	$7,611,043	$7,075,234	$7,177,615	$7,023,245	$7,416,777
Ash Handling System	$	$1,942,059	$1,571,194	$2,027,539	$1,734,644	$2,753,523
ID Fan(s)	$	$770,690	$732,840	$740,139	$729,121	$757,065
Equipment Cost Subtotal	$	$10,323,792	$9,379,268	$9,945,293	$9,487,011	$10,927,365
Instruments & Controls	$	$206,476	$187,585	$198,906	$189,740	$218,547
Taxes	$	$619,428	$562,756	$596,718	$569,221	$655,642
Freight	$	$516,190	$468,963	$497,265	$474,351	$546,368
Purchased Equipment Cost Subtotal	$	$11,665,885	$10,598,573	$11,238,181	$10,720,322	$12,347,923
Installation	$	$9,449,367	$8,584,844	$9,102,927	$8,683,461	$10,001,818
Total Direct Cost	$	$21,115,252	$19,183,417	$20,341,108	$19,403,783	$22,349,741
Total Direct Cost with Retrofit Factor	$	$27,449,827	$24,938,443	$26,443,440	$25,224,917	$29,054,663
General Facilities	$	$2,744,983	$2,493,844	$2,644,344	$2,522,492	$2,905,466
Engineering Fees	$	$2,744,983	$2,493,844	$2,644,344	$2,522,492	$2,905,466
Contingency	$	$5,489,965	$4,987,689	$5,288,688	$5,044,983	$5,810,933
Total Plant Cost (TPC)	$	$38,429,758	$34,913,820	$37,020,816	$35,314,884	$40,676,528
Total Plant Cost (TPC) w/ [illegible]	$	$39,582,651	$35,961,234	$38,131,441	$36,374,331	$41,896,824
Total Cash Expended (TCE)	$	$39,006,205	$35,437,527	$37,576,128	$35,844,608	$41,286,676
Allow. for Funds During Constr. (AFDC)	$	$2,075,207	$1,885,346	$1,999,124	$1,907,004	$2,196,533
Total Plant Investment (TPI)	$	$41,081,411	$37,322,873	$39,575,252	$37,751,611	$43,483,208
Preproduction Costs	$	$821,628	$746,457	$791,505	$755,032	$869,664
Inventory Capital	$	$0	$0	$0	$0	$0
Total Capital Requirement (TCR)	$	**$41,903,040**	**$38,069,331**	**$40,366,757**	**$38,5[illegible]6,644**	**$44,352,872**
	$/kW	$83.8	$76.1	$80.7	$77.0	$88.7

O&M Data and Costs		Case1	Case 2	Case 3	Case 4	Case 5
Cost Basis (Year)		***1998***	***1998***	***1998***	***1998***	***1998***
Power Required Excluding ID Fan(s)	kW	379	304	327	365	359
ID Fan Power for FF Delta P	kW	878	810	823	801	853
Total Power	kW	1,258	1,114	1,150	1,168	1,212
Power Cost **	$/yr	$179,048	$158,600	$163,741	$166,239	$172,586
Maintenance Costs	$/yr	$1,478,068	$1,342,839	$1,423,878	$1,358,265	$1,564,482

** [illegible]

in modified Deustch-Anderson equation
f the electric field in the ESP

f Na_2O in the flyash -- from coal library
f Fe_2O_3 in the flyash -- from coal library
f MgO in the flyash -- from coal library
f CaO in the flyash -- from coal library

f H_2O in flue gas on a wet basis -- from CUECost combustion calculations
f SO_2 in flue gas on a wet basis -- from CUECost combustion calculations
f SO_3 in flue gas: *SO3* = 0.74%* *SO2*

ture in the ESP (degrees F)
ture in the ESP (degrees C)
ture in the ESP (Kelvin); note: the temperature in Kelvin is used in resistivity calculations

*8916 * Log10(Na2O)* - 0.9696 * Log10(*Fe*) + 1.237 * (Log10(*MgO* + *CaO*) - Log10(2.5))
*.0) * (-0.03); note: 0.03 is a correction factor for the electric field*
/ 625
TK
(1000/2.4)
= 10^*rv*

*.2334 * Log10(Na2O)*
*.0) * (-0.128)*
aO) > 10.0 then *rs3* = *rs2* + 0.56 - 0.056 * (*MgO* + *CaO*) else *rs3* = *rs2*
*.0) * (-0.03)*
0) = *rs3* + (12.0 - 2.0) * (-0.03)
12.0) + *Log10(Exp(1))* * *7.3895E-4* * *Exp(2303.3 / 385)* * *H2O*
(Exp(1)) * *7.3895E-4* * *Exp(2303.3 / TK)* * *H2O*
= 10^*rs*

s) / (10^*rv* + 10^*rs*); note: combined volume and surface resistivity
0) = *rs1* + (10 - 9.0) * (-0.128)
0): if (MgO + *CaO)* > 10.0 then *rs3* = *rs2(*with *H2O*=10*)* + 0.56 - 0.056 * (*MgO* + *CaO*) else *rs3* = *rs2(*with *H2O*=10*)*

0

0) = *rs3(*with *H2O* = 10) + (*E* - 2.0) * (-0.03)
0, with E = 12.0) = *rs3*(with *H2O*=10) + (12.0 - 2.0) * (-0.03)
2O = 10, with *E* = 12.0) + Log10(Exp(1)) * 7.3895E-4 * Exp(2303.3 / 385) * 10
0, T = 1000/2.4) = *rs0* (with *H2O* = 10) - Log10(Exp(1)) * 7.3895E-4 * Exp(2303.3 / (1000/2.4)) * 10
s) / (10^*rv* + 10^*rs*)
s1(with *H2O* = 10 and *TK* = 1000/2.4)) + (-8) * (-0.03)

aO) < 5 and *Fe* < 1) then *ia1* = 2.6354 else *ia1* = 0.2915
*69 * rvs2*
aO) < 5 and *Fe* < 1) then *sa* = -5.0 else *sa* = -2.0502
og10(4)
og10(SO3)

2.75 then acid_v = 1, else if *SO3* > 6.5 then *acid_v* = 3, else *acid_v* = 2
O > 1 and (*MgO* + *CaO*) > 5) then *atom_v* = 1, else if (*Fe* < 1 and (*MgO* + *CaO*) < 3 then *atom_v* = 2, else *atom_v* = 3
cid_v, atom_v); note: the lookup table is located below
2.4
1000 / TK
** ra3*
10ra

*s + ra)/(10^rv * 10^rs + 10^rv * 10ra + 10^rs * 10_ra)*

*.003323934*ln(rvsa)*

)^(1/k) / w$_k$