Addendum to Dave Johnston Unit 3 BART Report

PREPARED FOR: Wyoming Division of Air Quality

PREPARED BY: CH2M HILL

COPIES: Bill Lawson/PacifiCorp

DATE: March 26, 2008

Introduction

In compliance with the Regional Haze Rule (40 Code of Federal Regulations [CFR] 51), the Wyoming Division of Air Quality (WDAQ) required PacifiCorp Energy to conduct a detailed Best Available Retrofit Technology (BART) review to analyze the effects to visibility in nearby Class I areas from plant emissions, both for baseline and for reasonable control technology scenarios. PacifiCorp submitted these evaluations to WDAQ in January 2007. A revised report was submitted in October 2007.

On January 3, 2008, PacifiCorp Energy personnel met with WDAQ staff to discuss the status of the BART reviews. At that time, the state requested that additional modeling scenarios for several of the PacifiCorp facilities be performed to aid in their BART review. This memorandum presents the economics analysis for two scenarios, referred to as Scenario A and Scenario B and described as follows:

- Scenario A: PacifiCorp committed controls at permitted rates—low nitrogen oxide (NO_x) burners (LNBs) with over-fire air (OFA), dry flue gas desulfurization (FGD), new fabric filter
- Scenario B: PacifiCorp committed controls and selective catalytic reduction (SCR) at permitted rates

The CALPUFF modeling system (v. 5.711a) was used for this analysis. All technical options and model triggers used in CALMET, CALPUFF, and CALPOST are consistent with those used for the previous BART analyses and described in the BART report submitted in October 2007.

Stack Parameters, Emissions Information, and Capital Cost

Table 1 summarizes the control equipment for Scenarios A and B as well as the current equipment installed at the plant. The overall capital cost of installing these options is also shown.

TABLE 1
Control Scenario Summary
Dave Johnson Unit 3

	Equipment Type			Capital Cost
	NO_x	**SO_2**	**PM_{10}**	**Million dollars**
Baseline	No control	No control	ESP	—
Scenario A	LNB with OFA	Dry FGD	Fabric Filter	$187.0
Scenario B	LNB with OFA and SCR	Dry FGD	Fabric Filter	$299.2

Emissions were modeled for the following pollutants:

- Sulfur dioxide (SO_2)
- NO_x
- Coarse particulate ($PM_{2.5}$<diameter<PM_{10})
- Fine particulate (diameter<$PM_{2.5}$)
- Sulfates

Table 2 shows stack parameters and emission rates that were used for the Dave Johnston Unit 3 BART modeling and analysis.

TABLE 2
Calpuff Model Inputs
Dave Johnston Unit 3

	BART Comparison[d]		
Model Input Data	**Baseline**	**Scenario A [e]**	**Scenario B [f]**
Hourly Heat Input (mmBtu/hour)	2,500	2,800	2,800
Sulfur Dioxide (SO_2) Stack Emissions (lb/hr)	3,000	420	420
Nitrogen Oxide (NO_x) Stack Emissions (lb/hr)	1,750	784	196
PM_{10} Stack Emissions (lb/hr)	75	42.0	42.0
Coarse Particulate ($PM_{2.5}$ <diameter< PM_{10}) Stack Emissions (lb/hr)[a]	32.3	23.9	23.9
Fine Particulate (diameter<$PM_{2.5}$) Stack Emissions (lb/hr)[b]	42.8	18.1	18.1
Sulfuric Acid (H_2SO_4) Stack Emissions (lb/hr)	46	2.6	3.7
Ammonium Sulfate [$(NH_4)_2SO_4$] Stack Emissions (lb/hr)	—	—	0.7
$(NH_4)HSO_4$ Stack Emissions (lb/hr)	—	—	1.2
H_2SO_4 as Sulfate (SO_4) Stack Emissions (lb/hr)	45.1	2.5	3.6
$(NH_4)_2SO_4$ as SO_4 Stack Emissions (lb/hr)	—	—	0.5
$(NH_4)HSO_4$ as SO_4 Stack Emissions (lb/hr)	—	—	1.0

TABLE 2
Calpuff Model Inputs
Dave Johnston Unit 3

	BART Comparison[d]		
Model Input Data	**Baseline**	**Scenario A [e]**	**Scenario B [f]**
Total Sulfate (SO_4) (lb/hr)[c]	45.1	2.5	5.1
Stack Conditions			
Stack Height (meters)	152	152.4	152.4
Stack Exit Diameter (meters)	4.6	4.57	4.57
Stack Exit Temperature (Kelvin)	445	348	348
Stack Exit Velocity (meters per second)	32	25.5	25.5

NOTES:
[a] Based on AP-42, Table 1.1-6, the coarse particulates are counted as a percentage of PM_{10}. This equates to 43% ESP and 57% Baghouse. PM_{10} and $PM_{2.5}$ refer to particulate matter less than 10 and 2.5 micrometers, respectively, in aerodynamic diameter.
[b] Based on AP-42, Table 1.1-6, the fine particulates are counted as a percentage of PM_{10}. This equates to 57% ESP and 43% Baghouse.
[c] Total Sulfate (SO_4) (lb/hr) = H_2SO_4 as Sulfate (SO_4) Stack Emissions (lb/hr) + $(NH_4)_2SO_4$ as SO_4 Stack Emissions (lb/hr) + $(NH_4)HSO_4$ as SO_4 Stack Emissions (lb/hr)
[d] SO_2, NO_x, and PM rates are expressed in terms of permitted emission rates. Actual emissions will be less than the permitted rates.
[e] PacifiCorp Committed Controls @ permitted rates: LNB with OFA, Dry FGD, New Fabric Filter
[f] PacifiCorp Committed Controls and SCR @ permitted rates

Economic Analysis

In completing this additional analysis to supplement the previous BART study, technology alternatives were investigated and potential reductions in NO_x, SO_2, and PM_{10} emissions rates were identified.

A comparison of Scenarios A and B on the basis of costs, design control efficiencies, and tons of pollutant removed is summarized in Tables 3 through 5. Capital costs were provided by PacifiCorp. The complete economic analyses for these two scenarios are provided as Attachment 1.

TABLE 3
Scenario A Control Cost
Dave Johnston Unit 3

	NO_x Control	SO_2 Control	PM_{10} Control	Scenario A
	LNB with OFA	**Dry FGD**	**Fabric Filter**	**Control Cost**
Total Installed Capital Costs (million dollars)	$17.5	$169.5	—	$187.0
Annualized First-Year Capital Costs	$1.66	$16.12	—	$17.79
First Year Fixed & Variable O&M Costs (million dollars)	$0.10	$5.30	—	$5.40
Total First Year Annualized Costs (million dollars) [a]	$1.76	$21.42	—	$23.19
Power Consumption (MW)	—	3.88	—	3.88
Annual Power Usage (Million kWh/Yr)	—	30.59	—	30.59
Permitted Emission Rate (lb/mmBtu)	0.28	0.15	0.02	—
Additional Tons of Pollutant Removed per Year over Baseline	4,636	11,589	166	16,391
First Year Average Control Cost ($/Ton of Pollutant Removed)	381	1,848	—	1,414

NOTE:
[a] First year annualized costs include power consumption costs.

TABLE 4
Scenario B Control Cost
Dave Johnston Unit 3

	NO_x Control	SO_2 Control	PM_{10} Control	Scenario B
	LNB with OFA & SCR	**Dry FGD**	**Fabric Filter**	**Control Cost**
Total Installed Capital Costs (million dollars)	$129.7	$169.5	—	$299.2
Annualized First-Year Capital Costs	$12.34	$16.12	—	$28.46
First Year Fixed & Variable O&M Costs (million dollars)	$4.01	$5.30	—	$9.30
Total First Year Annualized Costs (million dollars) [a]	$16.35	$21.42	—	$37.77
Power Consumption (MW)	0.23	3.88	—	5.45
Annual Power Usage (Million kWh/Yr)	12.34	30.59	—	42.97
Permitted Emission Rate (lb/mmBtu)	0.07	0.15	0.02	—
Additional Tons of Pollutant Removed per Year over Baseline	6,954	11,589	166	18,709
First Year Average Control Cost ($/Ton of Pollutant Removed)	2,351	1,848	—	2,019

NOTE:
(a) First year annualized costs include power consumption costs.

TABLE 5
Incremental Control Costs, Scenario B compared to Scenario A
Dave Johnston Unit 3

	NO_x Control	SO_2 Control	PM_{10} Control	Total Control Cost
Incremental Installed Capital Costs (million dollars)	$112.2	0	0	$112.2
Incremental Annualized First-Year Capital Costs	$10.67	0	0	$10.67
Incremental First Year Fixed & Variable O&M Costs (million dollars)	$3.91	0	0	$3.91
Incremental First Year Annualized Costs (million dollars) [a]	$14.58	0	0	$14.58
Incremental Power Consumption (MW)	1.57	0	0	1.57
Incremental Annual Power Usage (Million kWh/Yr)	12.38	0	0	12.38
Incremental Improvement in Emission Rate (lb/mmBtu)	0.21	0	0	—
Incremental Tons of Pollutant Removed	2,318	0	0	2,318
Incremental First Year Average Control Cost ($/Ton of Pollutant Removed)	6,291	0	0	6,291

NOTE:
[a]Incremental first year annualized costs include power consumption costs.

Modeling Results and Least-Cost Envelope Analysis

CH2M HILL modeled Dave Johnston Unit 3 for two post-control scenarios. The results determine the change in deciview based on each alternative at the Class I areas specific to the project. The Class I areas potentially affected are Badlands National Park and Windcave National Park for this unit.

Modeled Scenarios

Current operations (baseline) and two alternative control scenarios were modeled to cover the range of effectiveness for the combination of the individual NO_x, SO_2, and PM control technologies being evaluated. The modeled scenarios include the following:

- Baseline: Current operations with ESP
- Scenario A: LNB with OFA, Dry FGD, new fabric filter
- Scenario B: Scenario A with SCR

Summary of Visibility Analysis

Tables 6 and 7 present a summary of the modeling period (2001–2003) results for each scenario and Class I area.

TABLE 6
Costs and Visibility Modeling Results as Applicable to Badlands National Park
Dave Johnston Unit 3

Scenario	Controls	Total First Year Annualized Cost	Highest ΔdV	98th Percentile ΔdV	Maximum Annual Number of Days Above 0.5 dV
Baseline	Current Operations with ESP	—	4.202	1.500	59
Scenario A	Scenario A: PacifiCorp Committed Controls	$23,184,500	1.297	0.432	7
Scenario B	Scenario B: PacifiCorp Committed Controls and SCR	$37,766,998	0.638	0.208	3

TABLE 7
Costs and Visibility Modeling Results as Applicable to Wind Cave National Park
Dave Johnston Unit 3

Scenario	Controls	Total First Year Annualized Cost	Highest ΔdV	98th Percentile ΔdV	Maximum Annual Number of Days Above 0.5 dV
Baseline	Current Operations with ESP	—	5.191	1.971	57
Scenario A	Scenario A: PacifiCorp Committed Controls	$23,184,500	1.805	0.583	11
Scenario B	Scenario B: PacifiCorp Committed Controls and SCR	$37,766,998	0.904	0.262	2

Results

Tables 8 and 9 present a summary of the costs and modeling results for each scenario and Class I area.

TABLE 8
Incremental Costs and Incremental Visibility Improvements Relative to Badlands National Park
Dave Johnston Unit 3

Scenario Comparison	Controls	Incremental Annualized Cost (Million$)	Reduction in 98th Percentile maximum dV	Reduction in Number of Days Above 0.5 dV	Cost per dV Reduction (Million$/dV Reduced)	Cost per Day to Achieve a Reduction in the Days above 0.5 dV (Million$/Day)
Scenario A Compared to Baseline	Scenario A: PacifiCorp Committed Controls	$23.18	1.068	52	$21.71	$0.45
Scenario B Compared to Baseline	Scenario B: PacifiCorp Committed Controls and SCR	$37.77	1.292	56	$29.23	$0.67
Scenario B Compared To Scenario A	Addition of SCR	$14.58	0.224	4	$65.10	$3.65

TABLE 9
Incremental Costs and Incremental Visibility Improvements Relative to Wind Cave National Park
Dave Johnston Unit 3

Scenario Comparison	Controls	Incremental Annualized Cost (Million$)	Reduction in 98th Percentile maximum dV	Reduction in Number of Days Above 0.5 dV	Cost per dV Reduction (Million$/dV Reduced)	Cost per Day to Achieve a Reduction in the Days above 0.5 dV (Million$/Day)
Scenario A Compared to Baseline	Scenario A: PacifiCorp Committed Controls	$23.18	1.388	46	$16.70	$0.50
Scenario B Compared to Baseline	Scenario B: PacifiCorp Committed Controls and SCR	$37.77	1.709	55	$22.10	$0.69
Scenario B Compared To Scenario A	Addition of SCR	$14.58	0.321	9	$45.43	$1.62

Least-Cost Envelope Analysis

The least-cost envelope graphs for Badlands National Park are shown in Figures 1 and 2 and for Wind Cave National Park are shown in Figures 3 and 4.

FIGURE 1

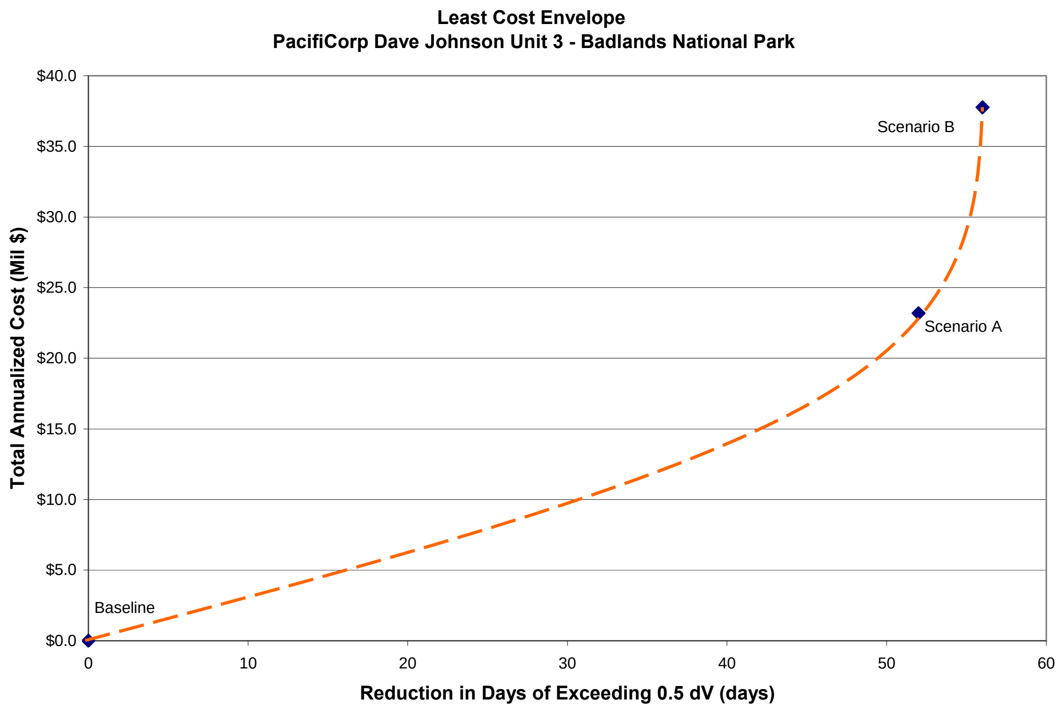


FIGURE 2

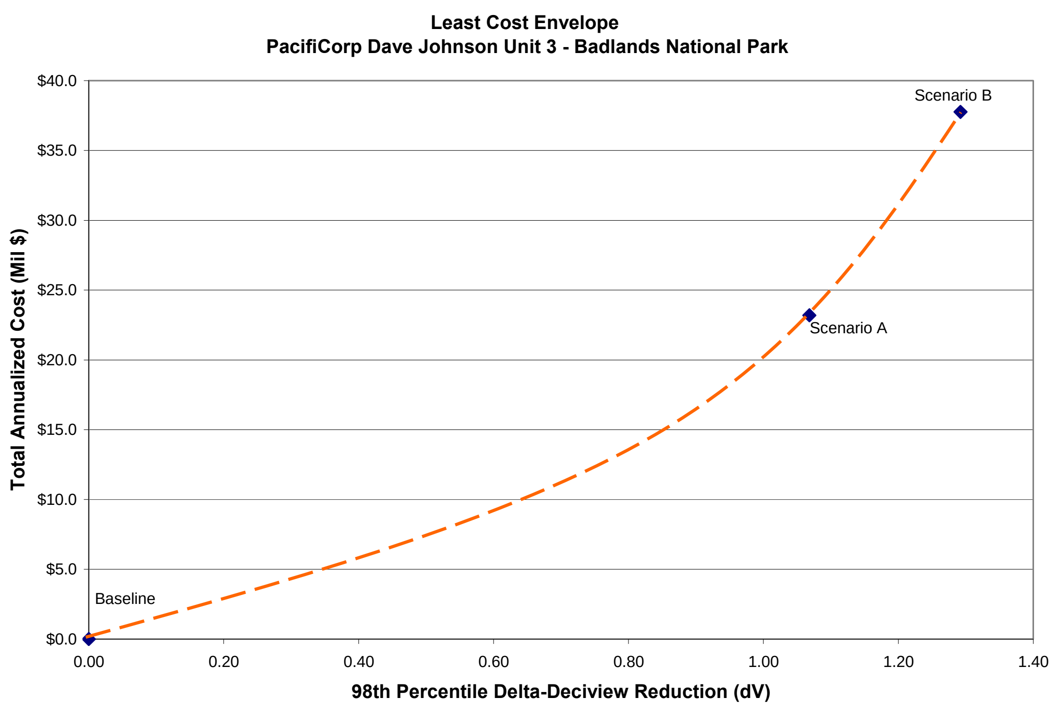


FIGURE 3

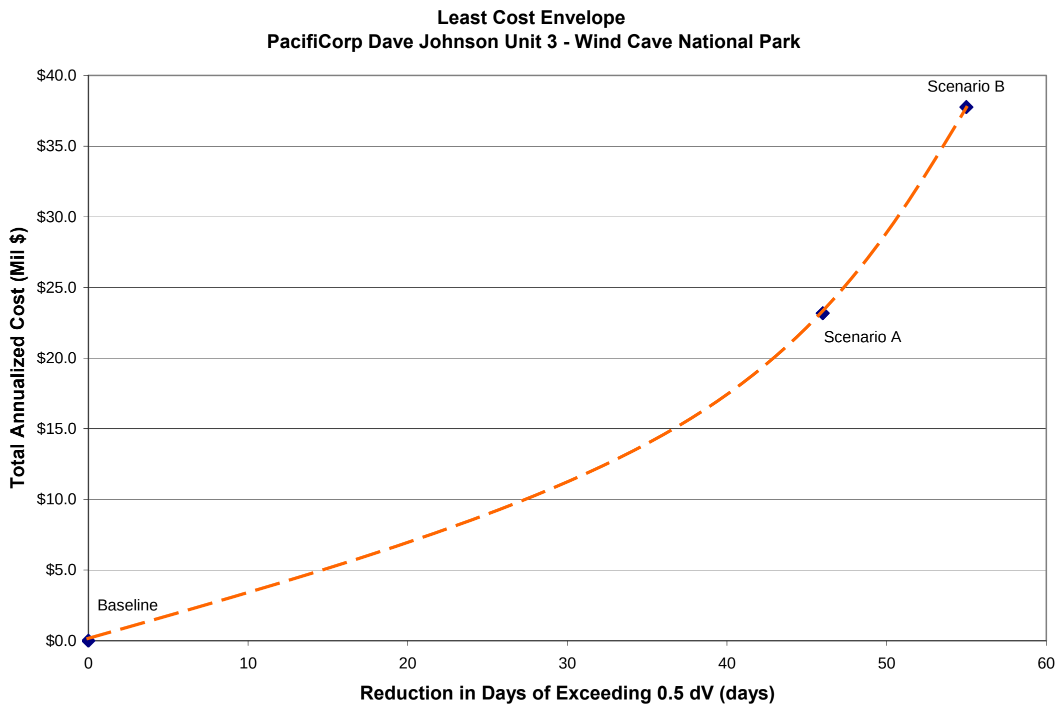
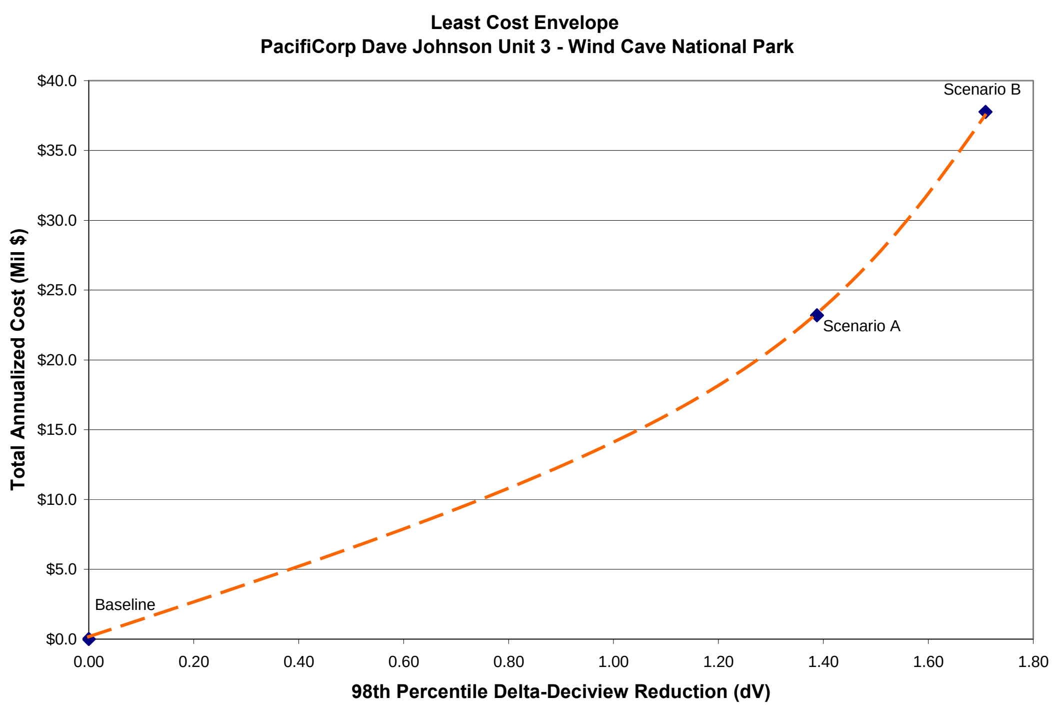


FIGURE 4



ATTACHMENT 1

Complete Economic Analyses for Scenarios A and B

ECONOMIC ANALYSIS SUMMARY - FIRST YEAR COSTS

DJ3 **Boiler Design: 3-Cell BurnerOpposed Wall-Fired PC**

TYPE OF EMISSIONS CONTROLS		NO_x Control				SO_2 and PM Control			Scenario A	Scenario B
Technology Label	**BASE**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**A+F**	**D+F**
	Current Operation	Low NO_x Burners with Overfire Air	Rotating Overfire Air	Low NO_x Burners with Overfire Air and Non-Selective Catalytic Reduction	Low NO_x Burners with Overfire Air and Selective Catalytic Reduction	Dry FGD w/ESP	Upgraded Dry FGD & Fabric Filter	Wet FGD w/ ESP	LNB w/OFA, Dry Flue Gas Desulfurization and Fabric Filter Baghouse	LNB w/OFA, SCR. Dry Flue Gas Desulfurization and Fabric Filter Baghouse
CAPITAL INVESTMENT										
Total Installed Capital Costs ($)	$0	$17,500,000	$12,054,022	$24,035,544	$129,700,000	$91,499,734	$169,500,000	$144,300,464	$187,000,000	$299,200,000
FIRST YEAR DEBT SERVICE ($/Yr)	**$0**	**$1,664,737**	**$1,146,673**	**$2,286,449**	**$12,338,079**	**$8,704,171**	**$16,124,166**	**$13,726,989**	**$17,788,903**	**$28,462,245**
FIRST YEAR FIXED O&M Costs ($/Yr)										
Operating Labor ($/Yr)	$0	$0	$0	$0	$0	$506,128	$506,128	$809,804	$506,128	$506,128
Maintenance Material ($/Yr)	$0	$40,000	$60,000	$98,000	$155,000	$714,175	$714,175	$1,182,587	$754,175	$869,175
Maintenance Labor ($/Yr)	$0	$60,000	$90,000	$147,000	$2,325,000	$476,928	$476,928	$788,391	$536,928	$2,801,928
Administrative Labor ($/Yr)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL FIRST YEAR FIXED O&M COST	**$0**	**$100,000**	**$150,000**	**$245,000**	**$2,480,000**	**$1,697,231**	**$1,697,231**	**$2,780,782**	**$1,797,231**	**$4,177,231**
FIRST YEAR VARIABLE O&M Costs ($/Yr)										
Makeup Water Costs ($/Yr)	$0	$0	$0	$0	$0	$99,566	$99,566	$132,371	$99,566	$99,566
Reagent Costs ($/Yr)	$0	$0	$0	$57,025	$526,265	$1,104,023	$1,182,881	$1,025,183	$1,182,881	$1,709,146
SCR Catalyst / FF Bag Costs ($/Yr)	$0	$0	$0	$0	$384,000	$0	$151,528	$0	$151,528	$535,528
Waste Disposal Costs ($/Yr)	$0	$0	$0	$0	$0	$572,810	$634,896	$746,581	$634,896	$634,896
Electric Power Costs ($/Yr)	$0	$0	$1,087,992	$90,666	$618,894	$981,558	$1,529,496	$1,359,990	$1,529,496	$2,148,390
TOTAL FIRST YEAR VARIABLE O&M Costs ($/Yr)	**$0**	**$0**	**$1,087,992**	**$147,691**	**$1,529,159**	**$2,757,957**	**$3,598,367**	**$3,264,126**	**$3,598,367**	**$5,127,527**
SUMMARY OF FIRST YEAR COSTS ($/Yr)										
First Year Debt Service ($/Yr)	$0	$1,664,737	$1,146,673	$2,286,449	$12,338,079	$8,704,171	$16,124,166	$13,726,989	$17,788,903	$28,462,245
First Year Fixed O&M Costs ($/Yr)	$0	$100,000	$150,000	$245,000	$2,480,000	$1,697,231	$1,697,231	$2,780,782	$1,797,231	$4,177,231
First Year Variable O&M Costs ($/Yr)	$0	$0	$1,087,992	$147,691	$1,529,159	$2,757,957	$3,598,367	$3,264,126	$3,598,367	$5,127,527
Total First Year Costs ($/Yr)	**$0**	**$1,764,737**	**$2,384,665**	**$2,679,140**	**$16,347,238**	**$13,159,358**	**$21,419,765**	**$19,771,897**	**$23,184,501**	**$37,767,002**
CONTROL COST COMPARISONS										
NO_x Technology Comparison										
Additional NO_x Removed From Base Case (Tons/Yr)	0	4,636	5,629	5,298	6,954					
First Year Average Control Cost ($/Ton NO_x Removed)	$0	$381	$424	$506	$2,351					
Technology Case Comparison		A-BASE	B-A	C-A	D-A					
Incremental NO_x Removed (Tons/Yr)	0	4,636	993	662	2,318					
Incremental Control Cost ($/Ton NO_x Removed)	$0	$381	$624	$1,381	$6,291					
SO_2 Technology Comparison	0.5%					81.8%	87.6%	95.0%		
Additional SO_2 Removed From Base Case (Tons/Yr)	0					10,817	11,589	12,583		
First Year Average Control Cost ($/Ton SO_2 Removed)	$0					$1,217	$1,848	$1,571		
Technology Case Comparison						E-BASE	F-E	G-F		
Incremental SO_2 Removed (Tons/Yr)	0					10,817	773	993		
Incremental Control Cost ($/Ton SO_2 Removed)	$0					$1,217	$10,691	-$1,659		
PM Technology Comparison	0.0%									
Additional PM Removed From Base Case (Tons/Yr)	0					0	166	0		
First Year Average Control Cost ($/Ton PM Removed)	$0					#DIV/0!	$129,375	#DIV/0!		
Technology Case Comparison						E-BASE	F-E	G-F		
Incremental PM Removed (Tons/Yr)	0					0	166	-166		
Incremental Control Cost ($/Ton PM Removed)	$0					#DIV/0!	$0	$0		
SCENARIO A AND B COMPARISONS										
Additional NO_x, SO_2, & PM Removed From Base Case (Tons/Yr)	**0**								**16,391**	**18,709**
First Year Average Control Cost Compared to Base Case ($/Ton Removed)	**$0**								**$1,414**	**$2,019**
Incremental Tons Removed - Scenario B vs Scenario A (Tons/Yr)	**0**									**2,318**
Incremental Control Costs - Scenario B vs Scenario A ($/Ton Removed)	**$0**									**$6,291**

INPUT CALCULATIONS

DJ3 Boiler Design: 3-Cell BurnerOpposed Wall-Fired PC

PARAMETER	Current Operation	NO_x Control Technologies				SO_2 and PM Control Technologies			Scenario A	Scenario B
Control Technologies										
NO_x Emission Control System	Good Practices	LNB w/OFA	ROFA	LNB w/OFA & SNCR	LNB w/OFA & SCR				LNB w/OFA	LNB w/OFA & SCR
SO_2 Emission Control System						Dry FGD w/ESP	Upgraded Dry FGD	Wet FGD w/ ESP	Upgraded Dry FGD	Upgraded Dry FGD
PM Emission Control System	ESP						Fabric Filter		Fabric Filter	Fabric Filter
General Plant Design and Operating Data										
Type of Unit	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC
Annual Power Plant Capacity Factor	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Annual Operation (Hours/Year)	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884
Net Power Output (kW)	223,214	223,214	223,214	223,214	223,214	223,214	223,214	223,214	223,214	223,214
Net Plant Heat Rate (Btu/kW-Hr)	12,175	12,175	12,175	12,175	12,175	12,175	12,175	12,175	12,175	12,175
Boiler Heat Input, Measured by Fuel Input (MMBtu/Hr)	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718
Annual Heat Input, Measured by Fuel Input (MMBtu/Year)	21,425,798	21,425,798	21,425,798	21,425,798	21,425,798	21,425,798	21,425,798	21,425,798	21,425,798	21,425,798
Boiler Heat Input, Measured by CEM (MMBtu/Hr)	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800
Annual Heat Input, Measured by CEM (MMBtu/Year)	22,075,200	22,075,200	22,075,200	22,075,200	22,075,200	22,075,200	22,075,200	22,075,200	22,075,200	22,075,200
Plant Fuel Source										
Boiler Fuel Source	Dry Fork PRB	Dry Fork PRB	Dry Fork PRB	Dry Fork PRB	Dry Fork PRB	Dry Fork PRB	Dry Fork PRB	Dry Fork PRB	Dry Fork PRB	Dry Fork PRB
Coal Heating Value (Btu/Lb)	7,784	7,784	7,784	7,784	7,784	7,784	7,784	7,784	7,784	7,784
Coal Sulfur Content (wt.%)	0.47%	0.47%	0.47%	0.47%	0.47%	0.47%	0.47%	0.470%	0.47%	0.47%
Coal Ash Content (wt.%)	5.01%	5.01%	5.01%	5.01%	5.01%	5.01%	5.01%	5.01%	5.01%	5.01%
Coal Flow Rate (Lb/Hr)	349,130	349,130	349,130	349,130	349,130	349,130	349,130	349,130	349,130	349,130
Coal Consumed (Ton/Yr)	1,376,272	1,376,272	1,376,272	1,376,272	1,376,272	1,376,272	1,376,272	1,376,272	1,376,272	1,376,272
Nitrogen Oxide Emissions										
NO_x Emission Rate (Lb/MMBtu)	0.70	0.28	0.19	0.22	0.07				0.28	0.07
NO_x Emission Rate (Lb/Hr)	1,960	784	532	616	196				784	196
NO_x Emission Rate (Lb Moles/Hr)	65.31	26.12	17.73	20.53	6.53				26.12	6.53
NO_x Emission Rate (Ton/Yr)	7,726	3,091	2,097	2,428	773				3,091	773
Add'l NO_x Removed from Current Operations (Lb/Hr)	0	1,176	1,428	1,344	1,764				1,176	1,764
Add'l NO_x Removed from Current Operations (Ton/Yr)	0	4,636	5,629	5,298	6,954				4,636	6,954
Sulfur Dioxide Emissions										
Uncontrolled SO_2 (Lb/MMBtu)	1.21					1.21	1.21	1.21	1.21	1.21
Uncontrolled SO_2 (Lb/Hr)	3,378					3,378	3,378	3,378	3,378	3,378
Uncontrolled SO_2 (Lb Moles/Hr)	52.73					52.73	52.73	52.73	52.73	52.73
Uncontrolled SO_2 (Tons/Yr)	13,316					13,316	13,316	13,316	13,316	13,316
Controlled SO_2 Emission Rate (Lb/MMBtu)	1.20					0.22	0.15	0.06	0.15	0.15
SO_2 Removal Efficiency (%)	0.5%					81.8%	87.6%	95.0%	87.6%	87.6%
Controlled SO_2 Emissions (Lb/Hr)	3,360					616	420	168	420	420
Controlled SO_2 Emissions (Ton/Yr)	13,245					2,428	1,656	662	1,656	1,656
SO_2 Removed (Lb/Hr)	18					2,762	2,958	3,210	2,958	2,958
SO_2 Removed (Ton/Yr)	71					10,887	11,660	12,654	11,660	11,660
Add'l SO_2 Removed from Current Operations (Lb/Hr)	0					2,744	2,940	3,192	2,940	2,940
Add'l SO_2 Removed from Current Operations (Ton/Yr)	0					10,817	11,589	12,583	11,589	11,589
Particulate Matter Emissions										
Uncontrolled Fly Ash (Lb/Hr)	13,993					13,993	13,993	13,993	13,993	13,993
Uncontrolled Fly Ash (Lb/MMBtu)	4.998					4.998	4.998	4.998	4.998	4.998
Uncontrolled Fly Ash (Tons/Yr)	55,161					55,161	55,161	55,161	55,161	55,161
Controlled Fly Ash Emission Rate (Lb/MMBtu)	0.030					0.030	0.015	0.030	0.015	0.015
Controlled Fly Ash Removal Efficiency (%)	99.4%					99.4%	99.7%	99.4%	99.7%	99.7%
Controlled Fly Ash Emissions (Lb/Hr)	84					84	42	84	42	42
Controlled Fly Ash Emissions (Ton/Yr)	331					331	166	331	166	166
Fly Ash Removed (Lb/Hr)	13,909					13,909	13,951	13,909	13,951	13,951
Fly Ash Removed (Ton/Yr)	54,830					54,830	54,995	54,830	54,995	54,995
Add'l Ash Removed from Current Operation (Lb/Hr)	0					0	42	0	42	42
Add'l Ash Removed from Current Operation (Ton/Yr)	0					0	166	0	166	166
Economic Factors										
Interest Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Discount Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Plant Economic Life (Years)	20	20	20	20	20	20	20	20	20	20

INPUT CALCULATIONS

DJ3 Boiler Design: 3-Cell BurnerOpposed Wall-Fired PC

PARAMETER	Current Operation	NO_x Control Technologies				SO_2 and PM Control Technologies			Scenario A	Scenario B
Control Technologies										
NO_x Emission Control System	Good Practices	LNB w/OFA	ROFA	LNB w/OFA & SNCR	LNB w/OFA & SCR				LNB w/OFA	LNB w/OFA & SCR
SO_2 Emission Control System						Dry FGD w/ESP	Upgraded Dry FGD	Wet FGD w/ ESP	Upgraded Dry FGD	Upgraded Dry FGD
PM Emission Control System	ESP						Fabric Filter		Fabric Filter	Fabric Filter
Installed Capital Costs										
NO_x Emission Control System ($2006)		$17,500,000	$12,054,022	$24,035,544	$129,700,000				$17,500,000	$129,700,000
SO_2 Emission Control System ($2006)						$91,499,734	$169,500,000	$144,300,464	$169,500,000	$169,500,000
PM Emission Control System ($2006)						$0	$0	$0	$0	$0
Total Emission Control System Capital Costs ($2006)		$17,500,000	$12,054,022	$24,035,544	$129,700,000	$91,499,734	$169,500,000	$144,300,464	$187,000,000	$299,200,000
NO_x Emission Control System ($/kW)		$78	$54	$108	$581				$78	$581
SO_2 Emission Control System ($/kW)						$410	$759	$646	$759	$759
PM Emission Control System ($/kW)										
Total Emission Control Capital Costs ($/kW)		$78	$54	$108	$581	$410	$759	$646	$838	$1,340
Fixed Operating & Maintenance Costs										
Operating Labor ($)		$0	$0	$0	$0	$506,128	$506,128	$809,804	$506,128	$506,128
Maintenance Material ($)		$40,000	$60,000	$98,000	$155,000	$714,175	$714,175	$1,182,587	$754,175	$869,175
Maintenance Labor ($)		$60,000	$90,000	$147,000	$2,325,000	$476,928	$476,928	$788,391	$536,928	$2,801,928
Administrative Labor ($)		$0	$0	$0	$0	$0	$0	$0	$0	$0
Total 1st Fixed Year O&M Cost ($)		$100,000	$150,000	$245,000	$2,480,000	$1,697,231	$1,697,231	$2,780,782	$1,797,231	$4,177,231
Annual Fixed O&M Cost Escalation Rate (%)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Fixed O&M Cost ($/Yr)		$118,550	$177,825	$290,448	$2,940,047	$2,012,072	$2,012,072	$3,296,625	$2,130,623	$4,952,120
Variable Operating & Maintenance Costs										
Water Cost										
Makeup Water Usage (gpm)		0	0	0	0	173	173	230	173	173
Unit Price ($/1000 gallons)		$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22
First Year Water Cost ($)		$0	$0	$0	$0	$99,566	$99,566	$132,371	$99,566	$99,566
Annual Water Cost Escalation Rate (%)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Water Costs ($/Yr)		$0	$0	$0	$0	$118,036	$118,036	$156,926	$118,036	$118,036
Reagent Cost										
Type of Reagent		None	None	Urea	Anhydrous NH_3	Lime	Lime	Lime	Lime	Lime & Anhydrous NH_3
Unit Cost ($/Ton)		$0.00		$370.00	$400.00	$91.25	$91.25	$91.25		
Unit Cost ($/Lb)		$0.000		$0.185	$0.200	$0.046	$0.046	$0.046		
Molar Stoichiometry		0.00		0.41	1.00	1.15	1.15	1.02		
Reagent Purity (Wt.%)		100%		100%	100%	90%	90%	100%		
Reagent Usage (Lb/Hr)				39	334	3,069	3,288	2,850		
First Year Reagent Cost ($)		$0		$57,025	$526,265	$1,104,023	$1,182,881	$1,025,183	$1,182,881	$1,709,146
Annual Reagent Cost Escalation Rate (%)		2.00%		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Reagent Costs ($/Yr)				$67,603	$623,889	$1,308,822	$1,402,309	$1,215,358	$1,402,309	$2,026,198
SCR Catalyst / Fabric Filter Bag Replacement Cost										
Material Replaced					SCR Catalyst		Bags		Bags	Bags & SCR Catalyst
Annual SCR Catalyst (m3) / No. FF Bags					128		1,457			
SCR Catalyst ($/m3) / Bag Cost ($/ea.)					$3,000		$104			
First Year SCR Catalyst / Bag Replacement Cost ($)					$384,000		$151,528		$151,528	$535,528
Annual SCR Catalyst / Bag Cost Escalation Rate (%)					2.00%		2.00%		2.00%	2.00%
Levelized Catalyst/Fabric Fitler Bag Costs ($/Yr)					$455,233		$179,637		$179,637	$634,870
FGD Waste Disposal Cost										
FGD Solid Waste Disposal Rate, Dry (Lb/Hr)						5,972	6,620	7,784	6,620	6,620
FGD Waste Disposal Unit Cost ($/Dry Ton)						$24.33	$24.33	$24.33	$24.33	$24.33
First Year FGD Waste Disposal Cost ($)						$572,810	$634,896	$746,581	$634,896	$634,896
Annual Waste Disposal Cost Esc. Rate (%)						2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Waste Disposal Costs ($/Yr)						$679,068	$752,671	$885,074	$752,671	$752,671
Auxiliary Power Cost										
Auxiliary Power Requirement (MW)		0.00	2.76	0.23	1.57	2.49	3.88	3.45	3.88	5.45
Auxiliary Power Requirement (% of Plant Output)		0.00%	1.24%	0.10%	0.70%	1.12%	1.74%	1.55%	1.74%	2.44%
Auxilliary Power Useage (MWh)		0	21,760	1,813	12,378	19,631	30,590	27,200	30,590	42,968
Unit Cost ($2006/MW-Hr)		$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00
First Year Auxiliary Power Cost ($)		$0	$1,087,992	$90,666	$618,894	$981,558	$1,529,496	$1,359,990	$1,529,496	$2,148,390
Annual Power Cost Escalation Rate (%)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Auxilliary Power Costs ($/Yr)		$0	$1,289,818	$107,485	$733,701	$1,163,640	$1,813,222	$1,612,272	$1,813,222	$2,546,923