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Techinomics, Inc.
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Techinomics Vista Support
B&V Project 176166
B&V File 40.0000

Attention: Mr. Christopher Martin, President

Subject: Vista Simulation of Expected Changes in As-Fired Coal Quality

In accordance with your request, Black & Veatch used an existing EPRI Vista unit model to evaluate the expected cost and performance impacts of variations in as-fired fuel quality associated with incorporation of Techinomics ' pulverizer throat modifications. The following sections describe the approach, assumptions, and results of this evaluation.

Approach

Black & Veatch utilized an existing Vista unit model representing a 615 MW(net), Babcock & Wilcox, standard two pass, pulverized coal unit equipped with five MPS-89K mills. The unit model includes an SCR for NO_x emission control, wet limestone FGD system for SO_2 control, and a fabric filter for particulate control. The unit was calibrated to reflect firing an eastern high sulfur bituminous coal.

Mr. Scott Smouse, acting as Techinomics' representative worked with Black & Veatch to develop a set of fuel quality and performance overwrite assumptions that reflected reported improvements in fuel quality and reduced primary air requirements seen from incorporation of Techinomics' counter rotating throat modifications at Alabama Power's Greene County Station.

A set of economic criteria reflective of typical values was developed to help quantify fuel related operation and maintenance costs.

Assumptions

The assumptions shown in Table 1 were used for the based fuel in the performance of this evaluation. Gross load was held constant across the two evaluated coal qualities. Vista was allowed to adjust the net rating to account for variations in predicted auxiliary power requirements. For purposes of this evaluation, a single load point representing full load and a 70 percent capacity factor was used to estimate annual mass flows and fuel related costs.

Table 1 - Operating Assumptions	
Gross Rating, MW	677
Net Rating, MW	615
Auxiliary Power, MW	62
Capacity Factor, %	70
Equivalent Availability Factor, %	85
Excess Air, %	20
Unburned Combustible Loss, %	0.30

Table 2 lists the assumed proximate and ultimate fuel quality parameters for the base and overwrite (OW) coal included in the evaluation. Sulfur form and selected trace element data are also provided. It is assumed that the ash mineral analyses, ash fusion temperature, and Hardgrove Grindability index values of the two coals were similar. This data is included in the attached Vista results spreadsheets.

Vista does not currently have the ability to evaluate differences in pulverizer throat modifications such as Techimomics rotating throat option. The manual performance overwrites listed in Table 3 were used to simulate changes reported by Techinomics from tests at Alabama Power's Greene County Generating Station. These include reduction in primary air throughput and unburned combustible losses.

Technomics expressed interest in evaluating reductions in Arsenic poisoning on Selective Catalytic Reduction (SCR) catalyst life. It should be noted that catalyst life varies between catalyst manufacturers based fuel ash constituent levels such as CaO, NaO, K_2O, and P_2O_5. For purposes of this evaluation Vista's default poisoning curve was utilized.

Table 4 lists typical industry cost assumptions used in Vista's fuel related cost calculations. It should be noted that some input and output values such as replacement power and maintenance costs reflect differential values. Costs for systems and equipment which are not impacted by variations in fuel quality are not included in Vista's reported costs.

Emission allowance values and delivered fuel prices are intended to reflect general February 2012 market conditions and not a specific power generating station or utility. Actual values could vary.

Table 2 - Coal Quality Assumptions		
Parameter	**Base Coal**	**OW Coal**
Higher Heating Value, Btu/lb	13100	13112
Proximate Analysis		
Moisture, %	5.71	5.72
Ash, %	7.73	7.74
Volatile Matter, %	35.72	35.72
Fixed Carbon, %	50.84	50.82
Ultimate Analysis		
Carbon, %	73.47	73.56
Hydrogen, %	4.89	4.90
Nitrogen, %	1.47	1.47
Sulfur, %	2.69	2.57
Chlorine, %	0.09	0.09
Oxygen (by difference), %	3.95	3.95
Sulfur Forms		
Pyritic, %	1.39	1.33
Sulfate, %	1.27	1.27
Organic, %	0.02	0.02
Trace Elements		
Arsenic (As), ppm	6.67	5.2
Lead (Pb), ppm	3.28	3.27
Mercury (Hg), ppm	0.090	0.085

Table 3 - Performance Assumptions & Overwrites		
Parameter	**Base Coal**	**OW Coal**
Excess Air, %	20	19.8
Pulverizer Primary Air/Fuel Ratio	2	1.6
Unburned Combustible Loss, %	0.40	0.28

Table 4 - Economic Assumptions	
Parameter	**Price**
Delivered Fuel Price, $/MBtu	3.25
Differential Replacement Power Cost, $/MWh	30
Fly Ash Disposal Cost, $/ton	15
Bottom Ash Disposal Cost, $/ton	15
FGD Waste Disposal, $/ton	20
Salary / Maintenance Rate (loaded), $/man-year	120,000
SCR Reagent Cost, $/ton	350
FGD Additive Cost, $/ton	20
SO2 Emissions, $/ton	3
NOx Emissions, $/ton	15

Results and Observations

Vista input data and performance predictions are stored in a SQL compliant database. Results are displayed via Excel based report templates. A copy of the Vista performance and first year fuel related cost spreadsheets are included as an attachment to this report. Highlights of the analysis are summarized below.

Tables 5 and 6 compare full load performance data and period (annual) values for the base and overwrite coal qualities. The reported reductions in unburned combustible loss and primary air requirements are predicted to result in several performance improvements including:

- Higher boiler efficiency.
- Lower auxiliary (station service) power requirements.
- Lower unit heat rate.
- Reduced mass throughput requirements.
- Reduced annual emissions

These improvements would translate to reduced fuel related operating maintenance costs as shown in Table 7.

Table 5 - Full Load Performance Summary

Parameter	Base Coal	OW Coal
Gross Power, MW	677.00	677.00
Net Power, MW	615.01	615.84
Auxiliary Load, MW	61.99	61.16
Capacity Factor, %	70.0	70.0
Equivalent Availability, %	83.53	83.54
Net Unit Heat Rate. Btu/kWh	9036	8993
Coal Burn Rate, tph	212.1	211.2
Total Heat Input, MBtu/hr	5557.0	5538.5
Excess Air, %	20.0	19.8
Boiler Efficiency, %	87.84	88.14
Unburned Combustible Loss, %	0.40	0.28
Total Ash LOI, %	4.46	3.16
Economizer Gas Outlet Temperature, °F	706	706
SO2 Emission, lb/MBtu	0.10	0.09
NOx Emission, Lb/MBtu	0.23	0.23
Particulate Emission, lb/MBtu	0.01	0.01
Opacity, %	15.0	14.8

Table 6 - Period Values		
Parameter	**Base Coal**	**OW Coal**
Gross Power Generation, GWh	4151.36	4151.36
Net Power Generation, GWh	3771.24	3776.34
Auxiliary Power Required, GWh	380.127	375.026
Coal Burn Rate, kton	1300.6	1295.07
FGD Additive Consumption, ton	111719	106278
Period SCR Reagent Consumption	4762	4728
Fly Ash Production, ton	94717	93168
Bottom Ash Production, ton	10524	10352
FGD Sludge Production (Wet Basis), ton	678486	645439
FGD Sludge Production (Dry Basis), ton	525826	500215
Dry FGD Waste Production (Dry Basis), ton	0	0
Fly Ash Collected & Handled, ton	94788	93227
Bottom Ash Collected & Handled, ton	10524	10352
Period SO2 Emitted, ton	1688	1605
Period Emissions NOx, ton	842	836
Period Emissions CO2, ton	3522000	3516700
Period Emissions CO, ton	1150	804
Period Emissions H2SO4/SO3, ton	73	70
Period Emissions Particulate, ton	230	226
Replacement Power		
Differential Auxiliary Power, GWh	--	-5.10
Lost Generation Due To Derate, GWh	0.00	0.00
Differential Unavailability, GWh	0.00	-0.45

Table 7 - Economic Comparison		
Parameter	**Base Coal $M**	**OW Coal $1M**
Operating and Maintenance		
SCR Ammonia Reagent	1.667	1.655
Scrubber Additive	2.234	2.126
Scrubber Water	0.334	0.323
Scrubber Waste Disposal	13.570	12.909
Fly Ash Disposal	1.422	1.398
Bottom Ash Disposal	0.158	0.155
Differential Maintenance Cost	0.000	-0.019
Emissions		
SO2 Allowance	0.005	0.005
NOx Emission	0.013	0.013
Fuel		
Coal (Delivered Cost)	110.746	110.377
Fuel Transportation	--	--
Replacement Power		
Replacement Power Derate	0.000	0.000
Differential Unavailability	0.000	-0.014
Differential Aux Power	0.000	-0.167
Total Fuel Related Cost, M$	130.149	128.761
Total Differential Cost, M$		-1.388

It should be noted that these predictions are preliminary and actual benefits would vary between units, the coals fired, and actual performance improvements seen by the specific mills.

The potential benefits from reduced Arsenic content and impacts on SCR catalyst poisoning was not demonstrated from this analysis. SCR catalyst life and poisoning/deactiviation impacts vary between manufacturers and are dependent on other parameters as well such as CaO content of the ash. For purposes of this investigation Vista's default poisoning level matrix was utilized. In both coal quality cases, the arsenic specific catalyst poisoning potentials were predicted to be low so no specific difference in catalyst life (SCR maintenance costs or forced outage hours)

could be attributed to arsenic reduction. The minor differences in maintenance cost and outage hours are more likely based on the reduced flue gas flow through the equipment.

More detailed Vista predictions are included in the attached Vista output spreadsheets. These sheets cover the following information. This sheets are provided for backup information and to provide additional information of Vista's technical capabilities for your future reference.

- Fuel Quality
- Full Load Unit Performance
- Period Values
- Equipment Systems Performance
- Emissions Tables
- Slagging, Fouling, and Erosion Potential
- Maintenance/Availability Results
- Derates and Concerns

It is our understanding Technomics is in the process of modifying the pulverizers at the Intermountain Power Station. Black & Veatch suggests establishing a test program with the plant to carefully capture detailed fuel quality and performance data from the mills before and after these modifications are made. Favorable results from such tests could potentially be discussed at technical conferences and/or be used to assist with future marketing efforts.

We appreciate the opportunity to provide Vista related support services. Please feel free to contact me if we can be of further service.

Very truly yours,

BLACK & VEATCH CORPORATION

Walter E. Johnson, P.E.

Enclosure[s]

cc: Scott Smouse
file