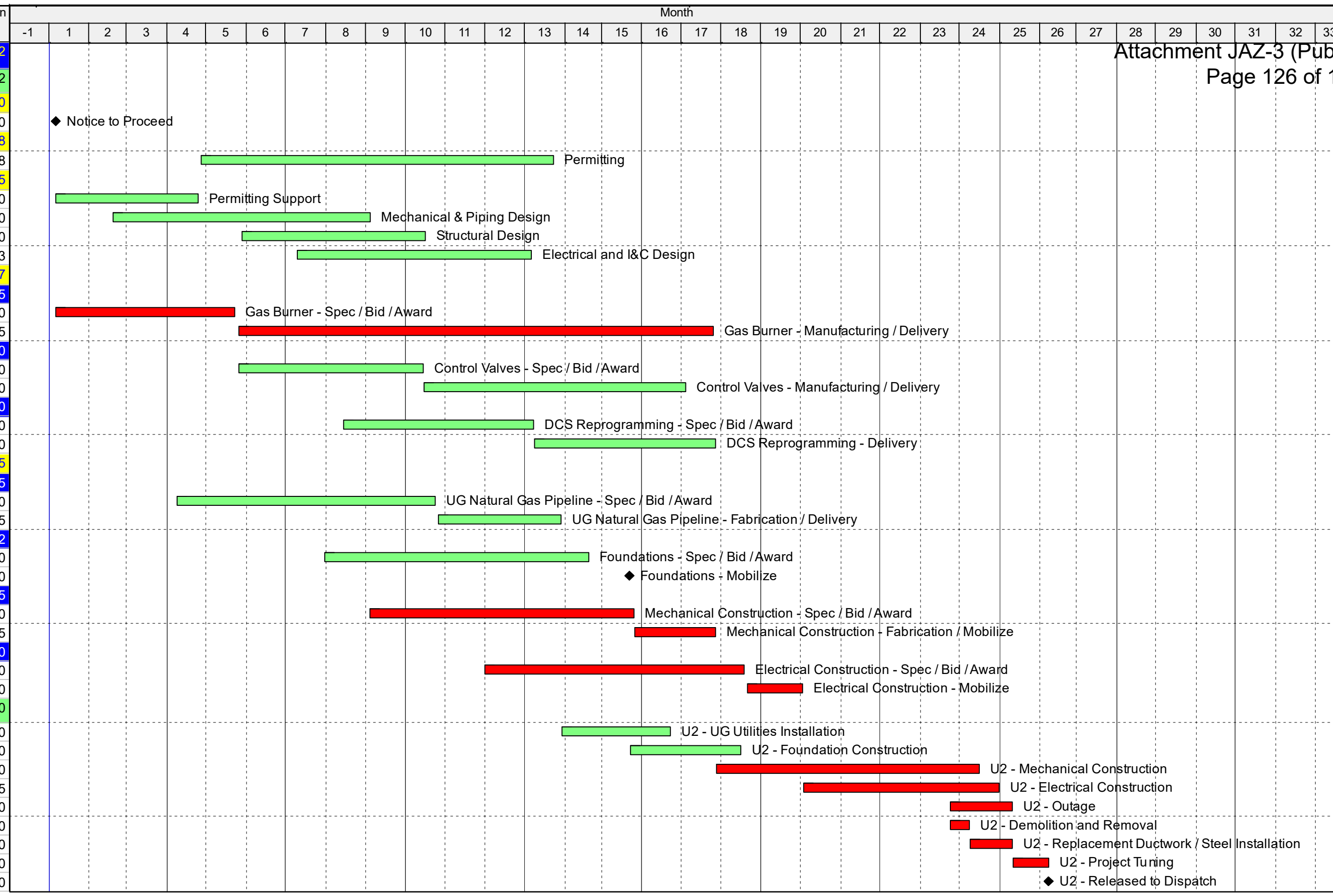
Activity ID	Activity Name	Duration
Vectren A B Brown Coal to Gas Conversion		532
Vectren Gas Conversion Engineering Unit 2		402
Milestones		0
A1000	Notice to Proceed	0
Permitting		188
A1010	Permitting	188
Engineering		255
A1020	Permitting Support	80
A1030	Mechanical & Piping Design	140
A1040	Structural Design	100
A1050	Electrical and I&C Design	123
Procurement		357
Gas Burner		355
A1060	Gas Burner - Spec / Bid / Award	100
A1070	Gas Burner - Manufacturing / Delivery	255
Control Valves		240
A1080	Control Valves - Spec / Bid / Award	100
A1090	Control Valves - Manufacturing / Delivery	140
DCS Reprogramming		200
A1100	DCS Reprogramming - Spec / Bid / Award	100
A1110	DCS Reprogramming - Delivery	100
Construction Contracts		335
UG Natural Gas Pipeline		205
A1120	UG Natural Gas Pipeline - Spec / Bid / Award	140
A1130	UG Natural Gas Pipeline - Fabrication / Delivery	65
Foundations		162
A1140	Foundations - Spec / Bid / Award	140
A1150	Foundations - Mobilize	0
Mechanical Construction		185
A1180	Mechanical Construction - Spec / Bid / Award	140
A1190	Mechanical Construction - Fabrication / Mobilize	45
Electrical Construction		170
A1160	Electrical Construction - Spec / Bid / Award	140
A1170	Electrical Construction - Mobilize	30
Vectren Gas Conversion Construction & Startup Unit 2		260
A1200	U2 - UG Utilities Installation	60
A1210	U2 - Foundation Construction	60
A1220	U2 - Mechanical Construction	140
A1230	U2 - Electrical Construction	105
A1240	U2 - Outage	30
A1250	U2 - Demolition and Removal	10
A1260	U2 - Replacement Ductwork / Steel Installation	20
A1270	U2 - Project Tuning	20
A1280	U2 - Released to Dispatch	0



FILED
June 17, 2021
INDIANA UTILITY
REGULATORY COMMISSION

Remaining Work
Critical Remaining Work
Milestone

BURNS McDONNELL

Vectren - A. B. Brown
Coal to Gas Conversion Project
Page 1 of 1

Date	Revision	Checked	Approved
23-Jan-19	Gas Conversion Proposal	Y Ko	

APPENDIX D – CAPITAL COST ESTIMATE SUMMARY

CAPITAL COST ESTIMATE
VECTREN
AB BROWN
UNIT 2 ONLY NATURAL GAS CONVERSION
MT. VERNON, IN
BMcD #113003

Acct	Area / Discipline	Direct MHRS	Labor Cost	Material Cost	Engr Equip/ Subcontract Cost	Const. Equipment Cost	Total Cost
01	Engineered Equipment	960	$120,000		$7,180,000		$7,300,000
02	Civil	769	$70,000		$50,000	$10,000	$130,000
03	Deep Foundations						
04	Concrete	1,820	$190,000	$40,000	$30,000	$10,000	$270,000
05	Structural Steel	13,028	$1,580,000	$980,000		$280,000	$2,840,000
06	Architectural						
07	Piping	4,191	$550,000	$310,000	$20,000	$30,000	$910,000
08	Electrical	5,407	$680,000	$100,000		$40,000	$820,000
09	Instrument & Control				$270,000		$270,000
10	Insulation				$530,000		$530,000
11	Coatings				$20,000		$20,000
	Total Direct Cost	**26,175**	**$3,190,000**	**$1,430,000**	**$8,100,000**	**$370,000**	**$13,090,000**

Rev.	Revision Date
0	08/27/15
1	02/12/16
2	07/17/18
3	02/01/19

Construction Mgmt & Indirects			$780,000
Engineering			$990,000
Start-Up			$290,000
Commercial			$250,000
Escalation (From 2016-Jan2019)			$160,000
Total Indirect Cost			**$2,470,000**
Total Direct and Indirect Costs			**$15,560,000**
	Cost	Revenue	
Project Contingency	5%	5%	$780,000
Total Project Cost			**$16,340,000**
Owner's Project Development			$250,000
Owner's Operational Personnel Prior to COD			Existing
Owner's Engineer			N/A
Owner's Project Management			$300,000
Owner's Legal Costs			$200,000
Owner's Start-up Engineering			$75,000
Temporary Utilities			$110,000
Operator Training			$50,000
Permitting and Licensing Fees			$100,000
Switchyard			Existing
Political Concessions & Area Development Fees			N/A
Startup/Testing (Fuel & Consumables)			
Startup Fuel (@$4/MMBtu)			$1,570,000
Startup Variable O&M (@$1.30/MWhr			$40,000
Startup Power (@$45/MWhr)			$20,000
Test Power Sales (@$-30/MWhr)			-$1,010,000
Initial Fuel Inventory			N/A
Site Security			Existing
Operating Spare Parts			$70,000
Permanent Plant Equipment and Furnishings			Existing
Builders Risk Insurance (0.45% of Construction Costs)			$60,000
Interest During Construction (10.2% Proj Cost)			$1,670,000
Owner Contingency	10%		$1,980,000
Total Owner Costs			**$5,485,000**
Total Project Cost Incl. Owner Costs			**$21,825,000**

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APPENDIX E – B&W BOILER STUDY

Engineering Study for Natural Gas Firing

for

Vectren Power Supply
AB Brown Station Unit 2
Evansville, Indiana

Contract 591-1048 (317A)
April 1, 2019 - Rev. 4

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TABLE OF CONTENTS

INTRODUCTION

Vectren Power Supply contracted the Babcock and Wilcox Company (B&W), under B&W contract 591-1048 (317A), to evaluate natural gas firing at the AB Brown Station Unit 2, originally supplied by B&W under contract RB-599. The boiler performance model was reviewed at 100% (Maximum Continuous rating) MCR and 60% load when firing 100% natural gas. An analysis of the allowable tube metal stresses was performed for 100% gas firing at 100% MCR and 60% boiler loads in regards to the primary superheater, secondary superheater and reheat superheater.

BACKGROUND

The AB Brown Unit 2 (RB599) is presently balanced draft, subcritical Carolina type radiant boiler, with secondary superheater, primary superheater, reheater and economizer surfaces arranged in series. Superheater steam temperature is controlled by interstage spray attemperation. Reheater steam temperature is controlled by excess air and spray attemperation. The unit was originally designed as a front and rear wall, bituminous coal fired units. The original maximum continuous rating for RB-599 is 1,850,000 lbs/hr of main steam at 1005°F and 1965 psig at the superheater outlet with a feedwater temperature of 467°F. The reheat steam flow is 1,666,500 lbs/hr at 1005 F and 485 psig at the reheater outlet. Spray attemperation is used to control superheat and reheat steam temperatures. The unit was to be operated at 5% overpressure over the load range.

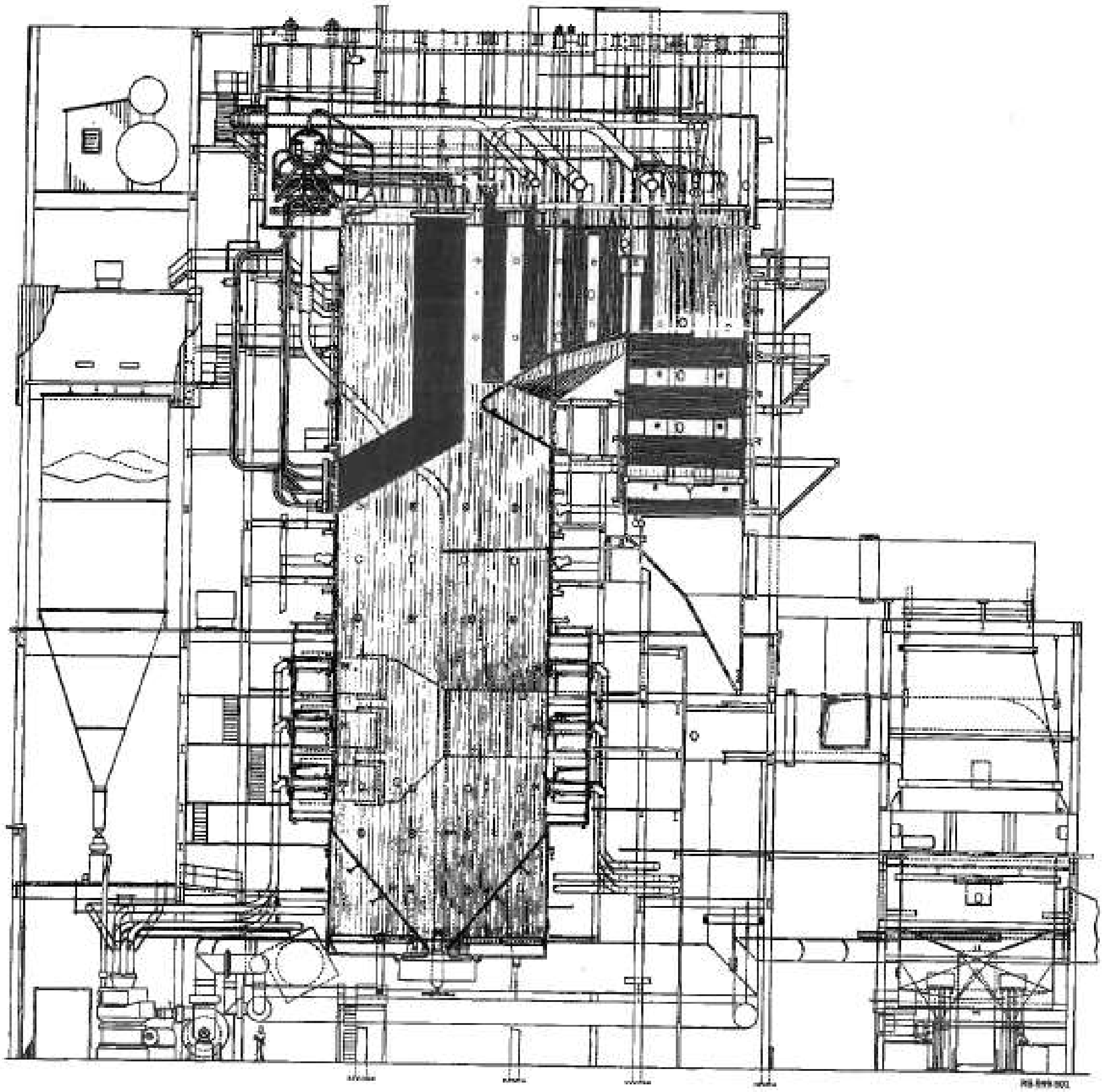
The unit is front and rear wall fired with twenty-four B&W 4Z low NO_x burners, four wide by three high. There are six B&W EL-76 pulverizers supplying coal to the burners.

Combustion air is heated through two Ljungstrom regenerative air heaters.

- Unit 2 has a furnace height of 124’-0’’. The vertical burner spacing is 10’-0” for Unit 2.
- Unit 2 has six water-cooled furnace wing walls.
- Unit 2 was designed without flue gas recirculation.

A sectional side view of the boilers is shown in Figures 1.

FIGURE 1



Brown Station Unit 2

B&W Contract Number RB-599

SCOPE FOR PHASE I

B&W evaluated natural gas firing in the radiant boilers originally supplied by B&W under contract number RB-599. Boiler component drawings and original performance summary data were used to develop comprehensive thermal models and boiler pressure part assessments. The predicted performance of the proposed natural gas firing was analyzed at MCR load and 60% load. The tube metallurgy requirements for the primary superheater, secondary superheater, reheater and headers were also developed. In addition to superheater metals analysis, predicted performance of the air preheaters and the attemperator capacities were also evaluated relative to overall performance.

SCOPE FOR PHASE II

The Phase II engineering scope of supply includes the entire scope of Phase I. In addition, the need surface modifications for firing 100% natural gas were analyzed. The adequacy of the existing forced draft (FD) fans and the induced draft (ID) fans were also assessed.

BASIS

This boiler pressure part metals assessment requires developing overall unit heat and material balances at the indicated steam flow. The 2015 fuel analyses for coal as supplied by Vectren were found to be very close to original design bituminous coal. Since the 2015 fuel analyses were incomplete, the original design fuel analysis was used. The natural gas analysis was also supplied by Vectren. The original design coal and natural gas fuel analyses are provided in Tables 2. These were used as a basis for the heat and material balances shown in Table 3.

Table 1: Original Design As-Fired Fuel Analyses for Bituminous Coal, % by weight

Constituent	
C	64.00
H_2	4.44
N_2	1.38
O_2	6.51
Cl	0.00
S	3.52
H_2O	11.35
Ash	8.76
Total	**100.00**
HHV (Btu/lb)	**11533**

Table 2: Proximate Analysis for Natural Gas, % by volume

Constituent	
Nitrogen	0.28
Methane	96.31
Ethane	1.46
CO_2	1.89
Others	0.06
Total	**100.00**
HHV (Btu/ft^3)	**1,037**

Table 3: Boiler Operating Conditions Used in Metals Evaluation

Boiler Load	MCR	60%
Superheater Steam Flow (lb/hr)	1,850,000	1,110,000
Steam Temperature at SH Outlet (°F)	1005	933
Steam Pressure at SH Outlet (psig)	1965	1917
Reheater Steam Flow (lb/hr) w/o Attemperator Spray	1,666,500	1,000,000
Steam Temperature at RH Outlet (°F)	992	835
Steam Pressure at RH Outlet (psig)	460	261
Feedwater Temperature (°F)	467	417
Excess Air Leaving Econ (%)	10	18

RESULTS

Boiler Performance

The predicted boiler performance summaries are shown in the Appendix, comparing unit performance firing the original bituminous coal at the original design data, recent field data for each of the unit and predicted unit performance firing 100% natural gas.

Attemperator Capacity

Along with the metals analysis, attemperation capacities were studied. The attemperator spray flows for gas firing are lower than the spray flows for firing coal due to lower amounts of excess air required when firing natural gas. Current attemperator capacities for unit should be satisfactory at all boiler loads. The results are shown in Table 6.

Table 6: Predicted Attemperator Flows (lbs/hr)

Boiler Load	MCR	60%
Bituminous Coal:		
SH Spray Flow	77,870	88,000
RH Spray Flow	19,000	0
Natural Gas		
SH Spray Flow	53,700	0
RH Spray Flow	0	0

Air Heater Performance

Air heaters were assessed for natural gas firing. The air and gas side temperature profiles around the air heater were found to be acceptable for the natural gas conversion. Since no field data was provided that would show higher than original air heater leakage or other air heater performance degradation, the predicted air heater performance is based on the original design data with an air heater leakage of 7.4%. Predicted performance is shown on Table 7a and 7b.

Table 7a: Regenerative Air Heater Predicted Performance at

Unit	2	2	2
Boiler load	MCR	94%	MCR
Data Basis	Original Design	7-10-2015 PI Data	Predicted Performance*
Fuel	Bituminous Coal	Bituminous Coal	Natural Gas
Flue Gas Flow Entering Air Heaters, mlb/hr	2,570	2,422	2,234
Flue Gas Temp Entering Air Heaters, F	705	652	697
Flue Gas Temp Leaving Air Heaters w/o Leakage, F	304	346	303
Air Flow Leaving Air Heaters, mlb/hr	2,307	2,174	2,056
Air Temp Entering Air Heaters, F	85	138	85
Air Temp Leaving Air Heaters, F	566	554	567

*Based on original design data

Table 7b: Regenerative Air Heater Predicted Performance

Unit	2	2
Boiler load	60%	60%
Data Basis	Original Design	Predicted Performance*
Fuel	Bituminous Coal	Natural Gas
Flue Gas Flow Entering Air Heaters, mlb/hr	2,060	1,403
Flue Gas Temp Entering Air Heaters, F	675	617
Flue Gas Temp Leaving Air Heaters w/o Leakage, F	283	259
Air Flow Leaving Air Heaters, mlb/hr	1,867	1,273
Air Temp Entering Air Heaters, F	83	83
Air Temp Leaving Air Heaters, F	547	520

*Based on original design data

Tube Metal Temperature Evaluation

B&W uses an ASME Code accepted method to design its tube metallurgies and thicknesses. The method involves applying upsets and unbalances to determine spot and mean tube metal temperatures. The upsets and unbalances include empirical uncertainty in the calculation of furnace exit gas temperature (FEGT), top to bottom gas temperature deviations, side to side gas temperature deviations, steam flow unbalances (a function of tube side pressure drop and component arrangement) and gas flow unbalances. The method applies these upsets and unbalances simultaneously to a single spot in each row of the superheater. Tube row metallurgy and thickness are then determined from the resultant tube spot and mean temperatures, respectively, according to ASME Code material oxidation limits and allowable stresses. B&W policy does not allow the publishing of design tube metal temperatures or unbalanced steam temperatures. However, these values can be reviewed in B&W's offices, if desired.

The remaining life expectancy of the superheaters is dependent on the prior operating history, especially on actual tube operating temperature compared to design temperature. Thus, the assessment of the adequacy of the existing superheaters is not a simple task.

The SSH outlet bank & RSH outlet bank were replaced on unit 2 in the fall of 2015. The evaluation is based on the design of the present SSH outlet banks & RSH outlet banks which were supplied by B&W.

B&W has determined the operating hoop stress level (based on the current minimum tube wall thickness) at operating pressure. The predicted tube operating temperatures based on B&W's standard design criteria and the resulting ASME Code allowable stress level for the existing material has also been determined. Comparison of the operating hoop stress with the Code allowable stresses results in the percent over the allowable stress. A modest overstress level indicates a modest shortening of remaining life expectancy and, unless otherwise indicated by past maintenance experience, does not warrant tube modification at this time.

If the tube analysis shows significant overstress or shows that tubes are predicted to operate at temperatures above those for which ASME Code stresses are published, then serious consideration should be given to tube upgrades and replacement. Significant overstresses are considered those tube rows that are 20% or greater overstressed. An overstress of 20% or more does not necessarily mean that immediate replacement of the tube row is required, but it identifies which tube rows should be examined for potential problems. Potential problems could be signs of creep, internal exfoliation or swelling.

This study showed that all tubes were predicted to operate at temperatures less than the existing material use limit. In addition, all existing convection pass tubes and component headers had no overstress issues. Therefore, the existing convection pass tube metallurgy is acceptable for natural gas firing.

Forced Draft Fans

The existing forced draft fans were analyzed to determine if they meet the requirements of 100% natural gas firing. Unit 2 was originally designed as a balanced draft unit. An adjusted test block static pressure rise and test block capacity for the Unit 2 FD fans was developed from the FD fan curve for 100% natural gas firing. The results show the existing FD fan test block conditions for Unit exceed the requirements in capacity and static pressure rise (including higher natural gas burner pressure drop) for all natural gas firing cases. Predicted fan performance is shown in Table 8A:

Table 8a: Forced Draft Fan Performance at MCR Load (balanced draft operation)

Fuel	FD Fan Test Block Unit 2	FD Fan Original Net Design Conditions Bituminous Coal Unit 2	FD Fan Test Block Adjusted for 100%Natural Gas Unit 2 From Fan Curve	FD Fan Net Conditions 100% Natural Gas Unit 2
Flow per fan (lb/hr)	1,512,000	1,260,000	1,225,440	1,104,100
Static Pressure Rise (in WC)	19.8	15.8	25.1	20.3
Temperature (F)	105	80	105	80

Induced Draft Fans

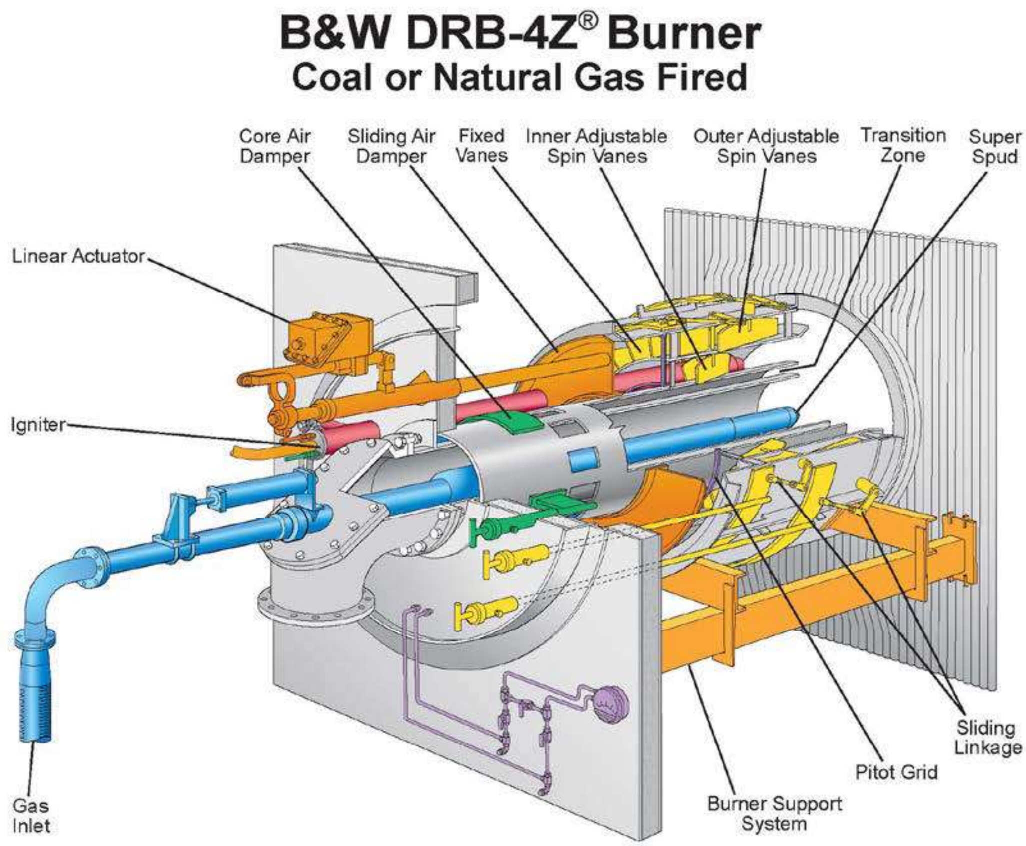
The existing induced draft fans were also analyzed to determine if they meet the requirements of 100% natural gas firing. The results showed the existing ID fans far exceed the requirements in capacity and static pressure rise for all natural gas firing cases. Predicted fan performance is shown in Table 8B:

Table 8b: Induced Draft Fan Performance at MCR Load (balanced draft operation)

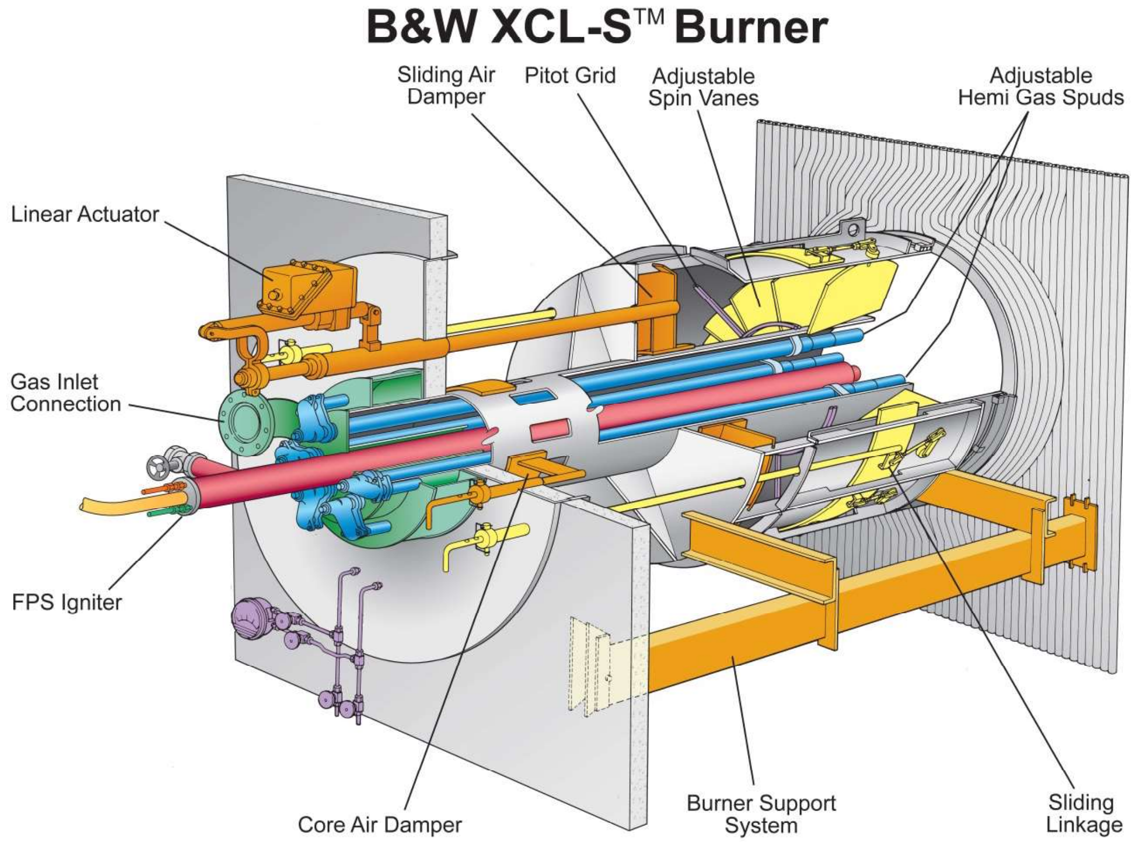
Fuel	ID Fan Test Block Unit 2	Bituminous Coal Unit 2 Original ID Fan Design Net Conditions	100% Natural Gas
Flow per fan (lb/hr)	1,380,100	1,387,610	1,199,390
Static Pressure Rise (in WC)	67.30	47.81	34.22
Temperature (F)	330	305	290

Combustion Equipment

The minimum combustion equipment modifications required to fire natural gas include modifying the twenty-four (24) existing B&W 4Z burners with gas spuds. One option is to add a Super-Spud to each 4Z burner to provide natural gas firing capability to the units. The addition of Super-Spuds will allow the AB Brown unit to still fire coal is desired. The figure below shows a 4Z burner with a Super-Spud.



The second option would be to remove the coal nozzle and replace it with a hemi-spud cartridge. This fundamentally converts the 4Z burners to a B&W XCL-S burner as shown in the figure below. B&W XCL-S burner is an advanced low-NOx burner that was developed to achieve superior NOx performance in burner-only applications.



Since the AB Brown unit already have SCR's, staged combustion (OFA) or flue gas recirculation (FGR) is not recommended.

In addition to the burner modifications, valve racks, gas piping and controls will be needed to supply the natural gas as a main fuel to the modified burners.

Emissions

Emissions predictions are based on converting the unit to fire natural gas as the main fuel. Full load emission predictions for unit are listed in Table 9.

Table 9: Predicted Full Load Emissions on Natural Gas	
	AB Brown Unit 2
NO_x ($lb/10^6$ Btu)	0.19

- CO is predicted to be less than 200ppm. For 200 ppm (dry vol.) CO @ 3% O2 (dry vol.) firing NG with an Fd factor of 8710, B&W calculates 0.148 lb/mmBTU of CO.

CONCLUSIONS

As a result of this study, a review of the existing tube metallurgies on the AB Brown Station Unit 2 revealed that all existing convection pass tubes had no overstress issues. In addition, all tubes were predicted to operate at temperatures below their ASME material code published limit. Header metal temperatures were also checked and showed to meet B&W's standards.

Along with the metallurgical analysis, superheater and reheater spray attemperation capacities were studied. The attemperator spray flows for gas firing are lower than the spray flows for firing coal due to lower amounts of excess air required when firing 100% natural gas. Current attemperator capacities for unit should be satisfactory at all boiler loads.

No surface modifications or surface removal are required when firing 100% natural gas.

Air heaters were assessed for 100% natural gas firing. The air and gas side temperature profiles around the air heater were found to be acceptable for firing natural gas based on the original air heater design parameters.

The existing FD and ID fans were found to exceed the performance requirements when firing 100% natural gas.

The predicted boiler performance summaries are shown in the Appendix, comparing unit performance firing the original bituminous coal and predicted unit performance firing natural gas.

CO-FIRING COAL AND NATURAL GAS

Vectren Power Supply additionally contracted the Babcock and Wilcox Company (B&W), under B&W contract 591-1048 (317A), to evaluate co-firing natural gas and coal in these units.

The predicted boiler performance summaries are shown in the Appendix, comparing unit performance co-firing natural gas and the original bituminous coal at MCR boiler load with the following natural gas inputs:

1. 17% heat input from natural gas through four burners. 83% heat input from coal.
2. 33% heat input from natural gas through eight burners. 67% heat input from coal.
3. 16% heat input (maximum heat input through natural gas ignitors). 84% heat input from coal.

A metallurgical analysis and an analysis of the superheater and reheater spray attemperation capacities were performed for the three conditions above. Current attemperator capacities for unit should be satisfactory at all boiler loads when co-firing natural gas and coal.

This study showed that all tubes were predicted to operate at temperatures less than the existing material use limit. In addition, all existing convection pass tubes and component headers had no overstress issues. Therefore, the existing convection pass tube metallurgy is acceptable for co-firing natural gas and coal.

No surface modifications or surface removal are required when co-firing natural gas and coal.

The air and gas side temperature profiles around the air heater were found to be acceptable for co-firing natural gas and coal based on the original air heater design parameters.

The existing FD and ID fans were found to exceed the performance requirements when co-firing natural gas and coal.

The predicted boiler performance summaries when co-firing natural gas and coal are shown in the Appendix.

Co-firing Operation

When co-firing the two fuels, the preferred arrangement is to fire natural gas through the burners at the higher elevations on a per mill group, or compartment, basis. The compartmented windboxes on the AB Brown unit are advantageous for co-firing the multiple fuels. Airflow control by compartment allows each mill group to obtain its own required amount of air, independent of burner load or fuel. The burners firing natural gas will require more secondary air, since primary airflow is zero, than the coal-firing burners. Managing these separate flow rates can be easily accommodated by the compartment controls. Firing coal at the lower elevations takes advantage of the available residence time in the furnace, maximizing coal burnout and optimizing CO and unburned carbon emissions. If a partial conversion were to become the chosen project path, it would be recommended to convert burners on a per mill group basis following the described firing arrangement, adding gas capability to the top mill groups and continuing downward.

It should be noted that while the AB Brown unit is already equipped to operate under the third scenario listed above (16% input ignitors, 84% input from coal), it could come at the expense of emissions. With the ignitor being located in an upper quadrant of the burner and operating at 16% of the rated burner input, not all of the air going through the burner is nearby and readily available for the ignitor fuel. This can create scenarios of inadequate fuel and air mixing, resulting in higher CO emissions, especially from the upper burner elevations. NOx emissions may also increase. The annular zone arrangement of the 4Z burner stages the mixing of the fuel and air. With the ignitor being located in the air sleeve, it circumvents this delayed mixing arrangement, potentially increasing NOx. Emissions predictions are not available for this scenario.

APPENDIX A – Preliminary Performance Summaries

Table 10a:

A. B. Brown Unit 2 - Preliminary Performance Summary

Contract No.	317A	GBB	Unit 2	Unit 2	Unit 2
Date	7/31/2015	Load ID	PC Firing	PC Firing	Natural Gas
Revision	0	Boiler Arrangement	Existing	Existing	Existing
		Data Basis	Original Contract	7-10-2015 PI Data	Predicted Performance
Load Condition			MCR	94% Load	MCR
Fuel			Bituminous	Bituminous	Natural Gas
Steam Leaving SH, mlb/hr			1,850	1,736	1,850
Superheater Spray Water, mlb/hr			77.86	19.10	53.70
Cold RH Steam Flow, mlb/hr			1,667	1,590	1,667
Reheater Spray Water, mlb/hr			18.90	16.30	0.00
% Excess Air Leaving Economizer			20.0	21.1	10.0
Flue Gas Recirculation, %			None	None	None
Heat Input, mmBtu/hr			2,549.3	2,379.8	2,614.9
Quantity mlb/hr	Fuel (mcf/hr if gas)		221.0	207.0	2604.5
	Flue Gas Entering Air Heaters		2,570	2,422	2,234
	Total Air To Burners		2,307	2,174	2,056
Pressure, psig	Steam at SH Outlet		1965	1926	1965
	Steam at RH Outlet		460	424	460
Temperature, °F	Steam	Leaving Superheater	1005	999	1005
		Leaving Reheater	1005	985	992
	Water	Water Entering Economizer	467	452	467
		Superheater Spray Water	380	370	380
	Gas	Entering Air Heater	705	652	697
		Leaving Air Heater (Excl. Leakage)	304	346	303
	Air	Entering Air Heater	85	138	85
		Leaving Air Heater	566	554	567
Heat Loss Efficiency, %	Dry Gas		4.91	4.75	3.88
	H_2 & H_2O in Fuel		5.06	4.92	10.67
	Moisture in Air		0.12	0.11	0.10
	Unburned Combustible		0.30	0.30	0.00
	Radiation		0.19	0.20	0.19
	Unacc. & Mfgs. Margin		1.50	0.50	1.00
	Total Heat Loss		12.08	10.78	15.84
	Gross Efficiency of Unit, %		87.92	89.22	84.16

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Table 10b:

A. B. Brown Unit 2 - Preliminary Performance Summary

Contract No.	317A	GBB	Unit 2	Unit 2
Date	7/31/2015	Load ID	PC Firing	NG Firing
Revision	0	Boiler Arrangement	Existing	Existing
		Data Basis	Original Contract	Predicted Performance
Load Condition			60%	60%
Fuel			Bituminous	Natural Gas
Steam Leaving SH, mlb/hr			1,110	1,110
Superheater Spray Water, mlb/hr			89	0
Cold RH Steam Flow, mlb/hr			1,000	1,000
Reheater Spray Water, mlb/hr			0	0
% Excess Air Leaving Economizer			52.0	18.0
Flue gas Recirculation, %			None	None
Heat Input, mmBtu/hr			1,638.3	1,540.9
Quantity mlb/hr	Fuel (mcf/hr if gas)		142.0	1486.0
	Flue Gas Entering Air Heaters		2,060	1,403
	Total Air To Burners		1,867	1,273
Pressure, psig	Steam at SH Outlet		1917	1917
	Steam at RH Outlet		261	261
Temperature, °F	Steam	Leaving Superheater	1005	955
		Leaving Reheater	1005	835
	Water	Water Entering Economizer	417	417
		Superheater Spray Water	350	350
	Gas	Entering Air Heater	675	617
		Leaving Air Heater (Excl. Leakage)	283	259
	Air	Entering Air Heater	83	83
		Leaving Air Heater	547	520
Heat Loss Efficiency, %	Dry Gas		5.69	3.35
	H_2 & H_2O in Fuel		5.03	10.38
	Moisture in Air		0.14	0.09
	Unburned Combustible		0.30	0.00
	Radiation		0.30	0.22
	Unacc. & Mfgs. Margin		1.50	1.00
	Total Heat Loss		12.96	15.04
	Gross Efficiency of Unit, %		87.04	84.96

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Table 10c:

A. B. Brown Unit 2 - Predicted Performance Summary Co-Firing Coal & Natural Gas

Contract No.	317A	GBB	Unit 2	Unit 2	Unit 2
Date	8/29/2015	Load ID	PC & NG Firing	PC & NG Firing	PC & NG Firing
Revision	0	Boiler Arrangement	Existing	Existing	Existing
		Data Basis	Predicted Performance	Predicted Performance	Predicted Performance
		Natural Gas Firing Method	Through Burners	Through Burners	Through Ignitors
		Natural Gas Firing % Heat Input	17	33	16
		Coal Firing % Heat Input	83	67	84
Load Condition			MCR	MCR	MCR
Fuel			Bit. Coal & Natural Gas	Bit. Coal & Natural Gas	Bit. Coal & Natural Gas
Steam Leaving SH, mlb/hr			1,850	1,850	1,850
Superheater Spray Water, mlb/hr			27.38	42.94	26.70
Cold RH Steam Flow, mlb/hr			1,667	1,667	1,667
Reheater Spray Water, mlb/hr			23.02	27.14	23.00
% Excess Air Leaving Economizer			21.9	21.9	21.9
Flue Gas Recirculation, %			None	None	None
Heat Input Nat. Gas, mmBtu/hr			434.6	853.1	408.0*
Heat Input Bit. Coal, mmBtu/hr			2121.7	1732.0	2147.3
Total Heat Input, mmBtu/hr			2556.3	2585.1	2555.3
Quantity mlb/hr	Coal Flow		184.0	150.2	186.0
	Natural Gas Flow (mcf/hr)		432.8	849.7	406.3
	Flue Gas Entering Air Heaters		2,568	2,559	2,569
	Total Air To Burners		2,319	2,322	2,320
Pressure, psig	Steam at SH Outlet		1965	1965	1965
	Steam at RH Outlet		460	460	460
Temperature, °F	Steam	Leaving Superheater	1005	1005	1005
		Leaving Reheater	1005	1005	1005
	Water	Water Entering Economizer	467	467	467
		Superheater Spray Water	380	380	380
	Gas	Entering Air Heater	668	670	668
		Leaving Air Heater (Excl. Leakage)	352	353	352
	Air	Entering Air Heater	150	150	150
		Leaving Air Heater	552	554	552
Heat Loss Efficiency, %	Dry Gas		4.51	4.43	4.52
	H_2 & H_2O in Fuel		5.79	6.66	5.74
	Moisture in Air		0.11	0.11	0.11
	Unburned Combustible		0.25	0.20	0.25
	Radiation		0.19	0.19	0.19
	Unacc. & Mfgs. Margin		1.42	1.42	1.42
	Total Heat Loss		12.27	13.01	12.23
	Gross Efficiency of Unit, %		87.73	86.99	87.77

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Predicted performance is based on the original contract boiler performance and PI data as supplied by Vectren

*Maximum heat input from ignitors

APPENDIX B – NG Conversion Equipment Scope & Budgetary Costs

SUPER-SPUD OPTION - Burner Modifications, Scanners, Valve Racks, NG Piping System

Item 1: B&W 4Z Burners converted to Nat Gas Firing (Quantity: 24)

- Qty 24, Super-Spud Assemblies to replace existing coal nozzles
- Qty 12, Burner Valve Racks
- Burner Front Flex Hose and Hardware
- Burner Front Piping
- Gas Header Piping
- Burner Front Valves & Gauges

Item 2: Fossil Power Systems (FPS) Flame Scanners

- Qty 24, FPS main UV flame scanners with rigid fiber optic extension
- Qty 1, main flame scanner electronics cabinet
- 1 Lot – Combustion/Cooling air piping from blower skid to burner fronts

Item 3: Natural Gas Regulating Station and Piping

- Main natural gas regulating station – 50 psig supply pressure
- Natural gas piping from regulating station to the burners
- Natural gas burner front gas piping and valve stations excluding vent piping to above the boiler building roof

HEMI-SPUD OPTION - Burner Modifications, Scanners, Valve Racks, NG Piping System

Item 1: B&W 4Z Burners converted to Nat Gas Firing (Quantity: 24)

- Qty 24, Hemispherical Gas Spud Assemblies to replace existing coal nozzles
- Qty 12, Burner Valve Racks
- Burner Front Flex Hose and Hardware
- Burner Front Piping
- Gas Header Piping
- Burner Front Valves & Gauges

Item 2: Fossil Power Systems (FPS) Flame Scanners

- Qty 24, FPS main UV flame scanners with rigid fiber optic extension
- Qty 1, main flame scanner electronics cabinet
- 1 Lot – Combustion/Cooling air piping from blower skid to burner fronts

Item 3: Natural Gas Regulating Station and Piping

- Main natural gas regulating station – 50 psig supply pressure
- Natural gas piping from regulating station to the burners
- Natural gas burner front gas piping and valve stations
- Vent piping from the regulating stations and the burner valve racks to the boiler roof and above the roof is not included

General Services

- Combustion system tuning services using an economizer outlet sampling grid for measurement of NOx per EPA methods.
- Field Service Engineering outage support for construction, start-up, and post-modification testing.
- Burner System Operator Training consisting of two, one day sessions.
- Training includes project specific training manual for up to 20 participants.
- Brickwork Refractory Insulation & Lagging (BRIL) Specifications and Installation design and materials.
- Contract specific System Requirements Specification, I/O Listing, and Functional Logic Diagrams for all supplied equipment.
- Operating and Maintenance Manuals (10 copies).
- New piping, flue, and duct loading to existing steel
- Delivery F.O.B. Brown Plant, Mt Vernon, IN.

Items not Included

- Hazardous material removal or abatement (i.e., lead paint and asbestos).
- Load analysis of existing structural steel or foundations and any required re-enforcement thereof.
- Hardware or reprograming of existing DCS and/or BMS to support natural gas conversion.
- Gas step down equipment. Equipment scope above assumes incoming gas pressure at B&W's terminal to be 30 to 50psi.

Terminal Points

- Inlet of gas regulating station
- Vent out of any valve rack
- Electrical terminals on provided electrical equipment or instruments
- Electrical terminals in shop provided terminal junction boxes as part of skidded equipment

Budgetary Material & Installation Pricing (USD 2015)

Scope Item	Budgetary	
	Material	Installation
Super-Spud Option: Burner Modifications, Scanners, Valve Racks, NG Piping System	$2,244,000	$3,379,000
Hemi-Spud Option: Burner Modifications, Scanners, Valve Racks, NG Piping System	$2,463,000	$3,685,000

Lead Times

- Material delivery: 52 - 56 weeks
- Installation duration: 8 - 10 weeks

B&W has offered these prices in 2018 US dollars and have not attempted to project escalation for time of performance or delivery.

Please note that these prices are budgetary and is not represent an offer to sell, however, we would welcome the opportunity to provide a formal proposal upon request.

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APPENDIX D

REDACTED

ATTACHMENT JAZ-4 - CONFIDENTIAL