SPRAY DRYER ABSORBER SYSTEM
PERFORMANCE TEST REPORT

JUNE 7 – 11, 1999

<u>HEALY CLEAN COAL PROJECT</u>

PREPARED BY
STONE & WEBSTER ENGINEERING CORPORATION
FOR THE
ALASKA INDUSTRIAL DEVELOPMENT AND EXPORT AUTHORITY
UNDER
U.S. DEPARTMENT OF ENERGY
COOPERATIVE AGREEMENT NO. DE-FC22-91PC90544

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FEBRUARY 14, 2000

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SDA SYSTEM
PERFORMANCE TEST REPORT
HEALY CLEAN COAL PROJECT

ABSTRACT

The Healy Clean Coal Project (HCCP) was selected by the U.S. Department of Energy (DOE) under Round III of the Clean Coal Technology Program. The facility is located at Healy, a town 250 miles north of Anchorage, Alaska (near Denali National Park), on a land adjacent to the existing Golden Valley Electric Association, Inc. (GVEA) Healy Unit No. 1 power plant. The project is owned and financed by the Alaska Industrial Development and Export Authority (AIDEA), and is co-funded by the U.S. DOE. The coal supplier is Usibelli Coal Mine, Inc., located adjacent to the Healy plant.

The technology demonstrated at HCCP combines the TRW Clean Coal Combustion System and the Babcock and Wilcox (B&W)/Joy Spray Dryer Absorber (SDA) System into a single, integrated, combustion/emission control process. These technologies have been designed to achieve reductions in emission of sulfur dioxide (SO_2), oxides of nitrogen (NO_x), and particulate matter, thereby meeting future energy needs from coal-fired generation in an environmentally acceptable manner while burning a variety of coals.

The Flue Gas Desulfurization (FGD) System at the Healy Plant consists of a SDA, followed by a baghouse with attendant lime preparation and other sub-systems. The system was started up in January 1998, has been in operation since then and has performed satisfactorily meeting the emission requirements.

A formal performance test program as required by Contract No. HCCP-007 between AIDEA and Joy Manufacturing Company (now B&W/Joy) was conducted between June 7 and June 11, 1999. A total of nine tests were conducted and eight of which were considered acceptable. The test results are summarized in the following table. For comparison, the contractual guaranteed values are also included.

Performance Test Results and Performance Guarantees

No.	Operating Parameter	Parameter Values								
		Guarantee	Test 1	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9
1	SO_2 Emission	79.6 lb/hr (Max.)	<2.01	<2.07	<2.13	<2.15	<2.10	<2.13	<2.13	<2.15
2	Particulate Loading	0.015 lb/million Btu (Max.)	0.0023	0.0042	0.0052	0.0040	0.0027	0.0030	0.0014	0.0034
3	Opacity	Max. of 20% for a max. of 3 minutes in an hour and during the three minutes a Max. of 27%	<u>Range</u>: 1.3-1.5 <u>Max</u>.: 1.5	 1.3-1.7 1.7	 1.5-1.7 1.7	 1.5-1.7 1.7	 1.1-1.4 1.4	 1.0-2.0 2.0	 1.3-1.5 1.5	 1.3-1.5 1.5
4	System Pressure Drop	13 in. WG	10.0	10.5	9.6	9.7	9.8	9.9	9.8	9.9
6	System Power Consumption	550.5 kW	334	330	324	331	333	333	328	340

From the test results, it is concluded that the SDA System at HCCP has met all performance guarantee requirements of the Contract No. HCCP-007 between the AIDEA and B&W/Joy.

Stone & Webster

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1.0 EXECUTIVE SUMMARY

The HCCP was selected by the U.S. DOE under Round III of the Clean Coal Technology Program. The facility is located at Healy, a town 250 miles north of Anchorage, Alaska (near Denali National Park), on a land adjacent to the existing GVEA Healy Unit No. 1 power plant. Construction was completed in November 1997, with coal-fired operations starting in January 1998.

The project is owned and financed by AIDEA, and is co-funded by the U.S. DOE. GVEA of Fairbanks, Alaska provided the plant operators. The plant engineer was Stone and Webster Engineering Corporation. The coal supplier is Usibelli Coal Mine, Inc., located adjacent to the Healy plant.

The technology demonstrated at HCCP combines the TRW Clean Coal Combustion System and the B&W/Joy SDA System into a single, integrated, combustion / emission control process. These technologies have been designed to achieve reductions in emission of sulfur dioxide (SO_2), oxides of nitrogen (NO_x), and particulate matter, thereby meeting future energy needs from coal-fired generation in an environmentally acceptable manner while burning a variety of coals.

The FGD System at the Healy Plant consists of a SDA, followed by a baghouse with attendant lime preparation and other sub-systems. The system was supplied by Joy Manufacturing Company, which was subsequently acquired by B&W. The system was started up in January 1998, has been in operation since the start-up and has performed satisfactorily meeting the emission requirements.

A formal performance test program as required by Contract No. HCCP-007 between AIDEA and B&W/Joy was conducted between June 7 and June 11, 1999. This report summarizes the results and conclusion of this performance test program.

The following parameters were measured/monitored during the tests.

- SDA Inlet
  - Particulate Loading
  - Temperature
  - Moisture Content
  - Oxygen Content and
  - Static Pressure
- SDA Outlet
  - Temperature and
  - Static Pressure
- Stack
  - Particulate Loading
  - SO_2 Concentration

  - Temperature
  - Moisture Content and
  - Oxygen Content
- Limestone
  - Sample and
  - Feed Rate
- Coal
  - Sample and
  - Feed Rate (from Plant Distributed Control System (DCS))
- Air Preheater Hopper Ash Sample
- Surge Bin Ash Sample
- Electrical Power Consumption
- Stack Opacity (from Plant Continuous Emission Monitoring System)
- Relevant Unit Operating Parameters (from Plant DCS)

A total of nine tests were conducted and eight of which were considered acceptable. The test results are summarized in Table 1. For comparison, the contractual guaranteed values are also included.

Table 1
Performance Test Results and Performance Guarantees

No.	Operating Parameter	Parameter Values								
		Guarantee	**Test 1**	**Test 3**	**Test 4**	**Test 5**	**Test 6**	**Test 7**	**Test 8**	**Test 9**
1	SO_2 Emission	79.6 lb/hr (Max.)	<2.01	<2.07	<2.13	<2.15	<2.10	<2.13	<2.13	<2.15
2	Particulate Loading	0.015 lb/million Btu (Max.)	0.0023	0.0042	0.0052	0.0040	0.0027	0.0030	0.0014	0.0034
3	Opacity	Max. of 20% for a max. of 3 minutes in an hour and during the three minutes a Max. of 27%	Range: 1.3-1.5 Max.: 1.5	1.3-1.7 1.7	1.5-1.7 1.7	1.5-1.7 1.7	1.1-1.4 1.4	1.0-2.0 2.0	1.3-1.5 1.5	1.3-1.5 1.5
4	System Pressure Drop	13 in. WG	10.0	10.5	9.6	9.7	9.8	9.9	9.8	9.9
6	System Power Consumption	550.5 kW	334	330	324	331	333	333	328	340

From the test results, it is concluded that the SDA System at HCCP has met all performance guarantee requirements of the Contract No. HCCP-007 between AIDEA and B&W/Joy.

2.0 INTRODUCTION

2.1 Healy Clean Coal Project (HCCP)

The HCCP was selected by the U.S. DOE under Round III of the Clean Coal Technology Program. After more than five years of planning, design, and permitting activities, the project celebrated its ground-breaking ceremony at Healy, Alaska on May 30, 1995. The facility is located at Healy 250 miles north of Anchorage (near Denali National Park), Alaska on a land adjacent to the existing GVEA Healy Unit No. 1 power plant. Construction was completed in November 1997, with coal-fired operations starting in January 1998.

The project is owned and financed by AIDEA, and is cofunded by the U.S. DOE. GVEA of Fairbanks, Alaska provided the plant operators. The plant engineer was Stone and Webster Engineering Corporation. The coal supplier is Usibelli Coal Mine, Inc., located adjacent to the Healy plant.

The technology currently being demonstrated in the HCCP combines the TRW Clean Coal Combustion System and the B&W/Joy SDA System into a single, integrated, combustion / emission control process. These technologies have been designed to achieve reductions in emission of sulfur dioxide (SO_2), oxides of nitrogen (NO_x), and particulate matter, thereby meeting future energy needs from coal-fired generation in an environmentally acceptable manner while burning a variety of coals.

The TRW Combustion System achieves low NO_x emissions through a combination of well-controlled fuel and air staging. The combustor also removes approximately 80 to 90 percent of the coal ash as a slag by-product. For SO_2 removal, limestone is injected at the exit of the combustor and results in the production of a flash calcined lime material (FCM). Some of the SO_2 in the combustion flue gas is removed in furnace. The FCM is subsequently used downstream in the SDA System, consisting of a spray dryer absorber and a pulse jet baghouse supplied by B&W/Joy, where most of the SO_2 is removed to meet the emission requirement.

2.2 Coal and Ash Characteristics

The coals to be fired in the HCCP Combustion System (shown in Table 2) are low sulfur, high moisture, low heating value fuels from the nearby Usibelli Coal Mine. The three columns of data represent run-of-mine coal (ROM) waste coal and performance coal. ROM coal is run-of-mine coal, where care was taken in the mining operation to minimize the amount of overburden and lenses included with the coal. Waste coal is not subject to this selective separation process and hence has a lower heating value and a higher ash content. Performance coal consists of 50 percent ROM and 50 percent waste coal.

Table 2
Coal and Ash Characteristics
(% by Weight, as received basis)

	ROM Coal	Waste Coal	Performance Coal
Proximate Analysis			
Moisture	26.35	23.87	25.11
Ash	8.20	25.00	16.60
Volatile	34.56	27.00	30.78
Fixed, Carbon	30.89	24.13	27.51
TOTAL	100.00	100.00	100.00
Ultimate Analysis			
Moisture	26.35	23.87	25.11
Ash	8.20	25.00	16.60
Carbon	45.55	35.59	40.57
Hydrogen	3.45	2.70	3.07
Nitrogen	0.59	0.46	0.53
Sulfur	0.17	0.13	0.15
Oxygen	15.66	12.23	13.94
Chlorine	0.03	0.02	0.03
TOTAL	100.00	100.00	100.00
Elemental Ash Analysis	38.61	74.58	65.59
Silicon Dioxide	16.97	9.16	11.09
Aluminum Oxide	0.81	0.43	0.52
Titanium Dioxide	7.12	4.18	4.90
Ferric Oxide	23.75	6.32	10.62
Calcium Oxide	4.54	1.32	1.87
Potassium Oxide	1.02	1.21	1.16
Sodium Oxide	0.66	0.65	0.65
Sulfur Trioxide	5.07	1.36	2.28
Phosphorus Pentoxide	0.48	0.24	0.30
Strontium Oxide	0.23	0.07	0.11
Barium Oxide	0.44	0.15	0.22
Manganese Oxide	0.06	0.05	0.04
Undetermined	1.24	0.29	0.55
TOTAL, %	100.00	100.00	100.00

2.3 HCCP Technology Description

2.3.1 General

The HCCP integrates a slagging, multi-staged coal combustor system with an innovative sorbent injection / spray dryer absorber / baghouse exhaust gas scrubbing system. Twin 350 million Btu/lb combustors designed by TRW are used to supply hot gases to a conventional Foster Wheeler bottom-fired boiler. The flue gas cleaning equipment was supplied by B&W (formerly Joy Environmental Technologies of Houston, Texas) consisting of a single atomizer spray dryer and a pulse jet baghouse.

2.3.2 SDA System

The FGD System at the HCCP consists of a SDA followed by a baghouse with attendant lime preparation and other sub-systems. The System was supplied by Joy Manufacturing Company, which was subsequently acquired by B&W. A schematic diagram of the SDA System is shown in Figure 1. Flue gas from the boiler with the fly ash and flash calcined lime material (FCM) is passed through the SDA, where it is contacted with fine droplets of recycled FCM slurry. The slurry is atomized and sprayed into the gas stream by a rotary atomizer. The gas is cooled and SO_2 in the gas stream is reacted and removed by the alkaline material in the slurry. The amount of slurry sprayed into the gas stream is controlled to maintain the SDA exit gas temperature above the adiabatic saturation temperature. The gas is then passed through a pule-jet baghouse to remove the reaction products, un-reacted FCM and fly ash from the gas before it is discharged through the chimney to the atmosphere. A portion of this collected material is slurried and recycled to SDA and the rest is removed for disposal.

2.4 System Performance Test

The System was installed and started up in the spring of 1998. It has been in operation since startup and has performed well meeting and most of the time exceeding the performance requirements.

Although the System has been in operation for more than a year, no formal performance test has been done. A formal performance test program as required by Contract No. HCCP-007 between AIDEA and B&W/Joy and as generally described in the Demonstration Test Plan was conducted between June 7 and June 11, 1999.

This report describes details of the test program, test plan, test procedures, test methods, plant operational details during the test, test results and a comparison of the actual system performance with performance guarantees as per the Contract.

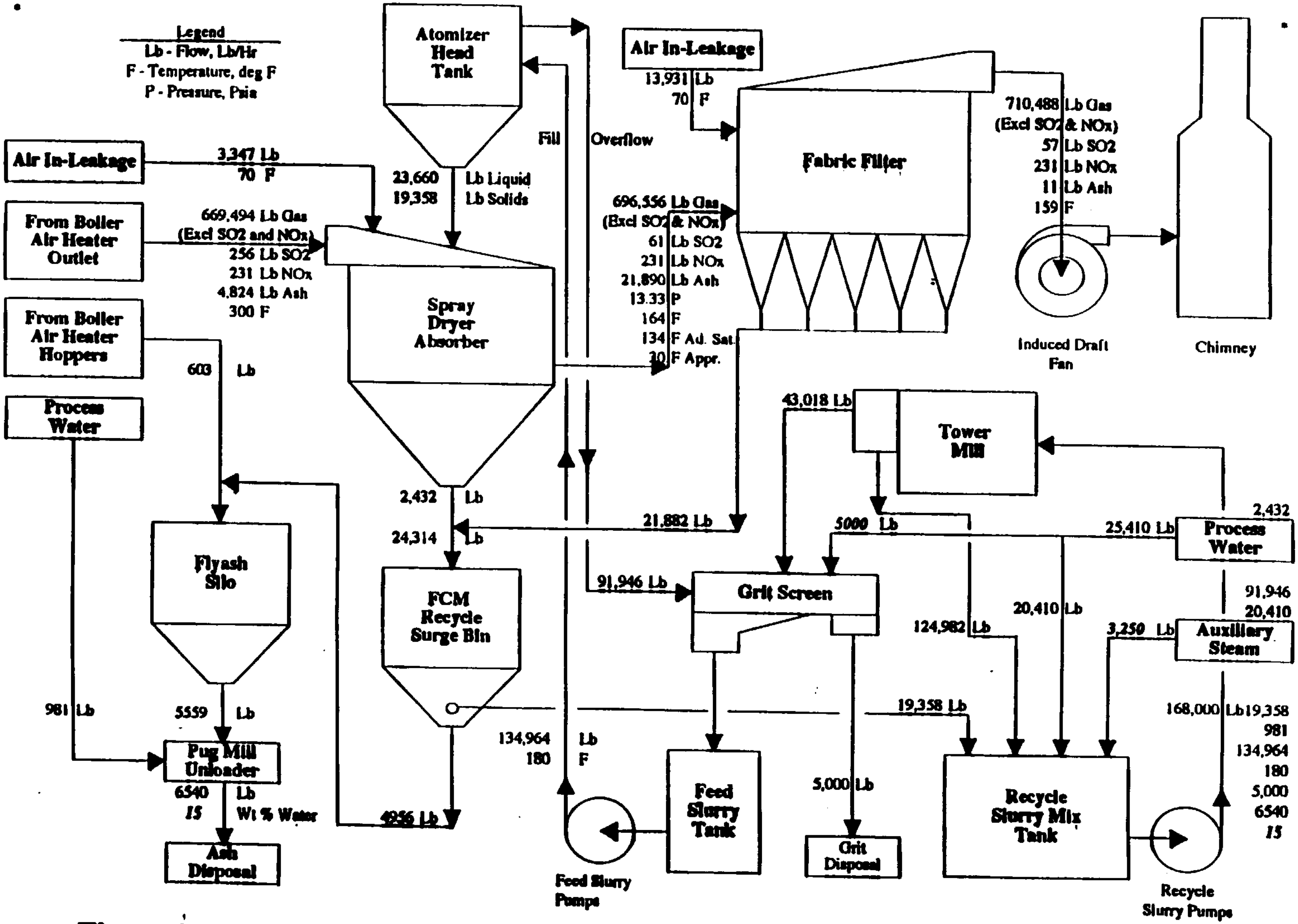

Figure 1 - Flue Gas Desulphurization, Fabric Filter, Flyash and Stack Gas

3.0 GUARANTEES AND TEST CONDITIONS

3.1 Guarantees

The performance parameters guaranteed as per Contract No. HCCP-007 between AIDEA and B&W/Joy are:

- SO_2 Removal/Emission
- Particulate Emission
- Opacity
- FGD System Pressure Drop
- FGD System Power Consumption

The specific guarantee values pertaining to each parameter are summarized in the Table 3. Additional details related to the guarantees are described in Division 1, Section 104, SC-6 of the Contract. There are no performance guarantee requirements for performance tests conducted outside the “Operating Parameter Values” specified in the Contract. The Contract does not make provisions for correction of guarantee performance outside of the “Operating Parameter Values” specified.

Table 3
Summary of FGD System Performance Guarantees

No.	Performance Parameter	Guaranteed Value
1	SO_2 Removal	The sulfur dioxide emission as measured at the baghouse outlet will not exceed 30% of the "Uncontrolled Sulfur Dioxide Emissions" when operated at the Performance Guarantee Test Conditions (see Table 1). A sulfur dioxide loading at the baghouse outlet of less than or equal to 79.6 lb/hr will satisfy this guarantee.
2	Particulate Emission	The particulate emission as measured at the baghouse outlet with one (1) compartment out of service will not exceed 0.015 lb per million Btu heat input to the boiler (exclusive of condensibles) if Teflon coated fiberglass bags are used when operated at the Performance Guarantee Test Conditions, or 0.010 lb per million Btu heat input to the boiler (exclusive of condensibles) if Ryton bags are used when operated at the Performance Guarantee Test Conditions (see Table 1).
3	Opacity	The flue gas opacity as measured at the stack shall not exceed 20% for more than three (3) minutes in any hour and during this three (3) minutes shall not exceed 27% when operated at the Performance Guarantee Test Conditions. Opacity resulting from condensation or chemical formation downstream of the baghouse outlet is excluded. Opacity measurements are based on a light path length of 8-ft (i.e., 8-ft inside diameter stack).
4	Pressure Drop	The FGD System pressure drop with the SDA in service and any one (1) baghouse compartment out of service for maintenance or off-line cleaning will not exceed thirteen (13) inches WG when operated at the Performance Guarantee Test Conditions (see Table 1).
5	Electrical Power Consumption	The FGD System electrical power consumption will not exceed 550.5 kW when operated at the Performance Guarantee Test Conditions (see Table 1).

3.2 Test Conditions

The performance tests are to be conducted with the boiler and FGD System operating within the parameters summarized in Table 4. During the performance tests, the actual obtainable boiler and FGD System operating conditions may vary within the minimum and maximum values specified for each operating parameter. The performance coal analysis, limestone analysis and attendant details are summarized in Division 3, Section 301, Attachments 2 and 2A of the Contract.

Table 4
Boiler and FGD Operating Parameters for Performance Tests

No.	Operating Parameter	Operating Parameter Value		
		Minimum	Target	Maximum
1	Heat Input from Fuel, million Btu/hr	632	643	652
2	Uncontrolled SO_2 Emission, lb/million Btu	0.42 ± 0.05	0.43 ± 0.05	0.52 ± 0.05
3	Total Particulate Flow into SDA, lb/hr	3,600	5,200	7,300
4	Limestone Sorbent Flow, lb/hr	1,100	Note 1	Note1
5	Limestone conversion which results in reactive CaO and calcium sulfur reaction products at the SDA inlet (%)	≥80	≥80	≥80
6	Flue Gas Temperature at SDA Inlet, °F	280	300	320
7	Flue Gas Flow at SDA Inlet, lb/hr	630,000	644,000	648,000
8	Oxygen Content of Flue Gas at SDA Inlet, % Vol. Dry	3.20	3.25	3.60
9	Moisture Content of Flue Gas at SDA Inlet, % Vol.	13.7	13.9	14.1

Note:

During Performance Testing “Limestone Sorbent Flow” shall be 1,100 lb/hr or a flow corresponding to 1.95 moles of reactive CaO per mole of uncontrolled SO_2 emissions, whichever is greater.

4.0 TEST PLAN

4.1 General

A detailed performance guarantee test plan was developed and reviewed by AIDEA and B&W/Joy. Test protocols as required by the Contract between B&W and AIDEA were followed in formulating the test plan. Comments from all the parties were incorporated, where appropriate. The final test plan was agreed by all parties involved and is included as Appendix A.

The tests were coordinated by Stone and Webster, carried out by HMH Technical Environmental Consulting LLC, a testing company based in Anchorage and witnessed by Mr. Bob Myers and Mr. Bob Meredith of B&W from Barberton, Ohio. GVEA's representative from Pacific Energy Research Associates of Spokane, Washington, and GVEA observed the tests. The test plan was reviewed with GVEA staff and the GVEA representative before and during the tests and comments were incorporated as applicable.

4.2 Test Parameters and Test Methods

The methods and codes used to measure/monitor and record (where applicable) the various parameters are summarized in the Table 5. Comments pertaining to each parameter are also included.

Table 5
Test Parameters, Test Codes/Methods and Alternates

No.	Test Parameter/ Variable	Test Codes/ Method	Comments
1	SO_2 Emissions	EPA Method 6C	The SO_2 emission is measured at Continuous Emission Monitoring System (CEMS) location in the stack and the system removal efficiency is determined by using the calculated uncontrolled and the measured controlled SO_2 emission.
2	Particulate Matter Emissions	EPA Method 5B	The flue gas flow rate, particulate matter and moisture content in the exit gas are measured immediately downstream of the baghouse outlet at the CEMS location in the stack. The measured value for particulate matter emissions excludes condensibles and sulfuric acid mist as defined by EPA Test Method 5B.

No.	Test Parameter/ Variable	Test Codes/ Method	Comments
			Particulate samples from each test are saved for analysis.
3	Opacity	Plant Opacity Monitor	The opacity reading of the opacity meter at CEMS location in the stack is recorded and used.
4	System Pressure Drop	U-tube manometer measurement at SDA inlet and baghouse outlet as per Contract.	Flue gas flow rate, oxygen content, temperature and moisture content were determined at CEMS location in the stack. Oxygen content and moisture content of flue gas at SDA inlet are also measured. Flue gas flow at SDA inlet was calculated from the gas flow rate at the CEMS location and the oxygen content at CEMS location and SDA inlet. This was done should there be any need to correct the pressure drop for difference in gas flow rate between the guaranteed condition and the test condition.
5	Average Electric Power Consumption	At FGD System feed circuit breakers using plant or test company-supplied instruments.	Averaged over the time period of particulate emission tests. See Section 6 of this report for additional details.
6	Boiler Heat Input from Fuel (million Btu/hr)	Calculated based on coal feeder totalizer and average analysis of coal samples taken during the tests.	Coal Sampling Frequency: Every hour. Sample Size: Minimum 2 lb (each sample). Sampling Location: Coal belt feeder discharge (from Feeder A and Feeder B). Other: Samples are collected in plastic bags, properly identified and sealed immediately after sampling and stored indoors at room condition for future analysis.
7	Uncontrolled SO_2 Emissions	Calculated based on coal feeder totalizer and average analysis	Same as Item 6 above.

No.	Test Parameter/ Variable	Test Codes/ Method	Comments
		of coal samples taken during the tests.	
8	Total Particulate Flow into SDA (lb/hr)	EPA Method 17, Method 1, and Method 2	The FGD System inlet flue gas, particulate matter flow and moisture content are measured upstream of the SDA inlet. The measured value for particulate matter excludes condensable. Particulate samples are saved for analysis, should it be required.
9	Limestone Sorbent Flow Rate (lb/hr)	Limestone feeder weigh cell (2LH-F27) and flow totalizer or separate measurements during the tests at limestone feeder discharge.	Time averaged over the test period.
10	Limestone Conversion to Reactive CaO (%)	Analysis of samples collected for Item 8 at SDA inlet.	This parameter is very difficult to determine. The parameter was not determined since SO_2 emission and removal efficiency far exceeded the guarantee requirements.
11	Flue Gas Temperature at SDA Inlet (°F)	From Item 8 measurement.	
12	Flue Gas Flow into SDA (lb/hr)	From Item 8 measurement and Flue Gas Analysis	See Item 4.
13	Flue Gas O_2 at SDA Inlet (% vol. dry)	Electronic O_2 analyzer at SDA inlet	
14	Flue Gas Moisture at SDA Inlet (% vol.)	Method 4 at SDA inlet.	
15	Coal Sample	Grab samples	See Item 6

No.	Test Parameter/ Variable	Test Codes/ Method	Comments
16	Coal Analysis	ASTM D3176, D3180, D2015	
17	Limestone	Grab samples	Sampling Frequency: Same as coal sampling frequency (see Item 6). Sample Size: 2 lb minimum (each sample). Sampling Location: Limestone feeder discharge. Other: Samples are collected in plastic bags, properly identified and sealed immediately after sampling and stored indoors at room condition. Analysis Required: As per Contract No. HCCP-007 between AIDEA and Joy Manufacturing Company (now B&W).

All references to the American Society for Testing and Materials (ASTM) Standard Specification, American Society of Mechanical Engineers (ASME), EPA Reference Methods and to other similar standard publications are to the latest issue of each as of the date of Contract No. HCCP-007 between AIDEA and B&W/Joy unless specifically stated otherwise.

5.0 TESTS

5.1 Test Parameters

The following plant operation and SDA System parameters were measured/monitored/ recorded as appropriate during the tests.

- SDA Inlet
  - Particulate Loading
  - Temperature
  - Moisture Content
  - Oxygen Content and
  - Static Pressure
- SDA Outlet
  - Temperature and
  - Static Pressure
- Stack
  - Particulate Loading
  - SO_2 Concentration
  - Temperature
  - Moisture Content and
  - Oxygen Content
- Limestone
  - Sample and
  - Feed Rate
- Coal
  - Sample and
  - Feed Rate (from Plant DCS)
- Air Preheater Hopper Ash Sample
- Surge Bin Ash Sample
- Electrical Power Consumption
- Stack Opacity (CEMS)
  - Relevant Unit Operating Parameters (from Plant DCS)

The above parameters were measured/monitored using the methods and procedures outlined in Table 6. Comments on specific items are as follows:

- **Oxygen Content of Flue Gas**: The oxygen content of the flue gas at SDA inlet and CEMS location in the stack was measured to calculate the gas flow at the SDA inlet. Although test ports were available at SDA inlet, they were not suitable for velocity traverse measurements because of the proximity of elbows and turns both upstream and downstream of the ports and non-uniform velocity distribution. However, gas flow can be measured at the CEMS location with confidence. The flow at the CEMS location will be higher than at SDA inlet due to air leaks through baghouse hoppers, through expansion joints and other joints in the ductwork. This air leakage increases the oxygen content of the flue gas. The air leakage can be calculated from the difference in the oxygen content of flue gas at CEMS location and at SDA inlet. The flow rate at SDA inlet can then be calculated by subtracting the air leakage from the flow rate at the CEMS location.

- **Limestone Feed Rate**: Limestone feed rate was manually measured. Limestone was collected at the limestone feeder discharge on the hour every hour during the test days starting at 4:00 AM until approximately one hour after completion of the last test of the day and recorded. An electronic balance was used for weighing the samples. Sample duration was 30 seconds and approximately 9 to 10 pounds of limestone was collected during this period. Approximately 2 pounds of the collected sample were saved and stored in plastic bags for analysis.
- **Power Consumption**: The power consumption consisted of three separate measurements.
  1. Atomizer: The atomizer is equipped with a 4 kV motor and is fed by a dedicated 4,160 volt feeder. The feeder voltage, current and the power factor are continuously monitored by plant instrumentation. These readings are recorded on the hour every hour during the test days and used to calculate the atomizer power consumption. Even though the voltage, current and power factor remained virtually constant with minor variations, only readings corresponding to actual test period were used in calculating the averages, which were then used in power consumption calculations. (Refer to Table 9 for details.)
  2. Balance of Plant (BOP): A separate 460 volt feeder supplies the balance of the SDA System except for two agitators. A certified dedicated kWh meter was used. The instantaneous power consumption was recorded on a continuous basis. The average power consumption was calculated from the chart. As in the case of atomizer power consumption, only readings corresponding to the actual test period were used in calculating the average value.
  3. Agitators: The 460 volt BOP feeder did not feed two agitators of the SDA System. The agitator feeder lines were isolated and a separate meter was used to measure the line current and voltage. The corresponding power factor was taken from the corresponding plant control panel. As can be seen from Table 4, the agitator power consumption is very small, less than 5 percent of the total system power consumption.
- **Coal Samples**: Approximately 5 pounds of coal samples were taken manually from the two feeders, Feeder A and Feeder B. Samples were taken every 30 minutes throughout the test day starting at 7:30 AM until 30 minutes after completion of the last test of the day. The samples were collected, sealed, labeled and stored in plastic bags for analysis.
- **Surge Bin Ash Samples**: Samples of ash transferred to the surge bin were taken manually at the bin feed inlet, on the hour every hour on all test days starting at 8:00 AM until approximately one hour after the completion of the last test of the day. The samples were stored in plastic bags for analysis.
- **Air Heater Hopper Ash Samples**: Samples of ash from the air heater hoppers were

taken manually, every hour on all test days starting at 8:45 AM until approximately one hour after the completion of the last test of the day. The samples were stored in plastic bags for analysis.

- **Feed Slurry Samples**: Atomizer feed slurry samples were collected manually at the inlet to the atomizer on the hour every hour on all test days staring at 7:00 AM until approximately one hour after the completion of the last test of the day. The samples were collected, sealed, labeled and stored in plastic bottles for analysis.
- **Unit Operating Parameters**: The following unit operating parameters were taken from the plant DCS System: (i) Load, (ii) Steam Flow, (iii) Throttle Press, (iv) Main Steam Temperature, (v) Coal Flow Rate-Feeder A, (vi) Coal Flow Rate-Feeder B, (vii) Total Coal Flow-Feeder A, (viii) Total Coal Flow-Feeder B, (ix) Limestone Flow Rate, (x) Total Limestone Flow, (xi) Feeder Load Cell (% Reading), (xii) Oxygen Content of Flue Gas at CEMS, (xiii) Oxygen Content of Flue Gas at Boiler Outlet, (xiv) Flue Gas Temperature at Stack, (xv) SDA Inlet SO_2, (xvi) SDA Inlet Pressure, (xvii) SDA Inlet Temperature, (xviii) SDA Outlet Temperature, (xix) Baghouse Differential Pressure, (xx) ID Fan Inlet Pressure, (xxi) Baghouse Outlet Temperature, (xxii) ID Fan Discharge Temperature, (xxiii) Stack SO_2, (xxiv) Stack SO_2 One-Hour Average, (xxv) One-Hour Average Stack NOx, (xxvi) Stack CO_2, (xxvii) Stack Opacity, (xxviii) Atomizer Feed Slurry Temperature, (xxix) Atomizer Feed Slurry Density, (xxx) Atomizer Feed Slurry Flow, (xxxi) SDA Differential Pressure, and (xxxii) Atomizer Power.

  The data were extracted at every five-minute interval, from approximately 30 minutes before to 30 minutes after completion of each test.

5.2 Operations and Observations

5.2.1 General

The testing was started on June 8, 1999, and completed on June 11, 1999. Although only three tests separated by 24 hours are required by the Contract, a total of nine tests were conducted over a period of the four days of testing. One test, Test Number 2, was invalid due to equipment malfunction. The remaining eight tests provided a total of two sets of three tests separated by 24 hours as required by the Contract. The test data and results are discussed in detail in Section 5.

5.2.2 Boiler and SDA System Operating Parameters

Pertinent boiler and SDA System operating parameters recorded during the tests are summarized in the Table 6. The expected ranges of the respective parameter values as outlined in the contract are also included for comparison.

Table 6
Boiler and SDA System Operating Parameter Values During Performance Tests

No.	Operating Parameter	Parameter Values								
		Min/Target/Max	**Test 1**	**Test 3**	**Test 4**	**Test 5**	**Test 6**	**Test 7**	**Test 8**	**Test 9**
1	Heat Input from Fuel, million Btu/hr	632/643/652	598	633	619	627	629	604	637	621
2	Uncontrolled SO_2 Emission, lb/million Btu	0.42 /0.43/0.52 (± 0.05)	0.55	0.57	0.53	0.49	0.48	0.47	0.48	0.47
3	Total Particulate Flow into SDA, lb/hr	3,600/5,200/7,300	2737	3385	2446	3684	2949	2539	2910	3586
4	Limestone Sorbent Flow, lb/hr	1,100 (Note 2)	1074	1194	1108	1115	1106	1103	1099	1113
5	Limestone conversion which results in reactive CaO and calcium sulfur reaction products, at the SDA inlet (%)	≥80/≥80/≥80	Not Measured. B&W, the SDA system supplier reserved the right to measure this parameter depending on SO_2 emission. Since SO_2 emissions in all tests were less than 1 ppm, meeting the performance requirement, B&W waived the need to measure this parameter.							
6	Flue Gas Temperature at SDA Inlet, °F	280/300/320	304	301	299	295	298	298	297	297
7	Flue Gas Flow at SDA Inlet, lb/hr	630,000/644,000/ 648,000	851,574	838,996	871,105	929,894	908,718	885,927	912,928	917,563
8	Oxygen Content of Flue Gas at SDA Inlet, % Vol. Dry	3.20/3.25/3.60	4.73	4.44	4.56	4.95	4.97	4.91	4.92	4.82
9	Moisture Content of Flue Gas at SDA Inlet, % Vol.	13.7/13.7/14.1	11.3	12.7	11.5	12.2	12.0	10.9	13.2	13.2

Notes:
1. Test 2 was aborted due to equipment problem.
2. During Performance Testing "Limestone Sorbent Flow" shall be 1,100 lb/hr or a flow corresponding to 1.95 moles of reactive CaO per mole of uncontrolled SO_2 emissions, whichever is greater.

Comments on the actual parameter values during the tests and the respective ranges as per contract are as follows:

- Healy is a mine-mouthed power plant with a very limited coal storage capacity at the plant site. Coal is used as mined and consequently the coal characteristics are difficult to control or modify.

- All pertinent parameters directly related to SO_2 emission, such as, uncontrolled SO_2 emission, limestone feed rate, and flue gas temperature at SDA inlet were within the min/max of the Contract.

- Flue gas flow at SDA inlet (and the oxygen content of flue gas) was higher than the Contract range. This reduces the residence time in SDA and the bag house, both of which tend to have a negative impact on SO_2 removal. Despite this, the system met the SO_2 emission performance requirement.

- The higher flue gas flow rate also has adverse effect on system pressure drop. Despite this, the system met the pressure drop performance guarantee.

- Heat input to the boiler was less than the Contract range. This parameter depends on coal characteristics and boiler operating requirement/condition during the tests and hence is difficult to control/modify. The average heat input to the boiler during the tests was 621 million Btu/hr or approximately 1.7 percent less than the minimum Contract value.

- Total particulate loading at SDA inlet was also less than the Contract range. Similar to heat input to the boiler this parameter also depends on coal characteristics and boiler operating requirement/condition during the tests and hence is difficult to control/modify.

- The average particulate flow at SDA inlet was 3,030 lb/hr or approximately 15.8 percent less than the minimum Contract value. This parameter also depends on coal characteristics - ash content, heating value etc., - and hence is difficult to control. However, one test (Test 5) met the minimum requirement and two other tests (Tests 3 and 9) have values very close (less than 3 percent difference) to the minimum value. In general, the baghouse is a constant emission device, in that, the exit particulate loading is independent of the inlet loading. This is evidenced by the particulate test results, which are summarized elsewhere in the report.

5.2.3 Daily Operation

Some specific comments and pertinent observations on daily operations and tests are as follows:

- **Day 1 – June 8, 1999**: Responsible members from the plant, the test company, HMH Technical Environmental Consulting LLC, GVEA and GVEA's consultant, B&W, and Stone and Webster Engineering Company met in the morning, inspected the sampling locations and test equipment set up, discussed the test program and agreed to proceed with the tests. The test set up, which started the previous night, was completed by noon and the first test was started at 13:40 hour and completed at 15:25 hour. The second test was started at 18:15 hour but had to be terminated due to SDA inlet gas sampler malfunction.
- **Day 2 – June 9, 1999**: The gas sampler was dismantled and the problem was traced to a plugged sampling line. The line was cleaned and the unit reassembled. Testing was started at 09:00 hour and completed at 20:45 hour. Three tests (Tests 3, 4 & 5) were successfully completed.
  A new Gas Sampling System was ordered by airfreight, to ensure uninterrupted testing, should the problem reoccur. (The new unit was delivered the next day. Fortunately, the sampling line of the original unit remained clean for the rest of the program and there was no reoccurrence of the problem.)
- **Day 3 – June 10, 1999**: Testing was started at 09:25 hour and completed at 16:20 hour. Two tests (Tests 6 & 7) were successfully completed.
- **Day 4 – June 11, 1999**: Testing was started at 09:40 hour and completed at 17:30 hour. Two tests (Tests 8 & 9) were successfully completed.
- **Day 5 – June 12, 1999**: Coal, ash and slurry samples collected during the test were assembled, sorted and stored indoors in a secured place at the plant. Samples to be sent for analysis were identified and separated from others for shipment to testing laboratories.
- **General**: Throughout the test program, the Stone and Webster representative inspected all testing activities as the tests were in progress including spot checking the meter readings being recorded by test crew and initialing them as appropriate. Members from B&W and the GVEA consultant also inspected the testing activities to ensure that proper test procedures and protocols were followed.

6.0 RESULTS AND DISCUSSION

6.1 SO_2 Emissions

An FGD System outlet SO_2 emission of less than or equal to 79.6 lb/hr will satisfy the SO_2 removal performance guarantee requirement. This value was measured and used to assess compliance to avoid the need for establishing the level of uncontrolled SO_2 emissions. Operation of the unit without limestone injection would be very difficult to implement due to both boiler operating limitations and environmental permit restrictions. During the tests, the coal feed rate was monitored using existing plant equipment and coal samples were taken during the tests and analyzed for sulfur content. The sulfur content and coal feed rate were used to calculate the uncontrolled SO_2 emission for each test. Based on this calculated uncontrolled emission and the measured emission at CEMS location in the stack, the overall removal efficiency was determined. The results are summarized in Table 7.

Table 7
Summary of SO_2 Emission Test Results

Test No.	Coal Flow Rate (lb/hr)	Lime-stone Feed Rate (lb/hr)	Higher Heating Value (Btu/lb)		Sulfur Content (% by Wt.)		Flue Gas Flow Rate at Stack (acfm)	Heat Input (million Btu/ hr)	Uncontrolled SO_2 Emission*		SO_2 Emission at Stack		
			Data	Avg	Data	Avg			(lb/ million Btu)	(lb/hr)	Concen tration (ppmv)	(lb /million Btu)	(lb/hr)
1	80,400	1,074	7,265	7,443	0.23	0.20	255,178	598	0.55	326.96	<1	<0.0034	<2.01
			7,705		0.19						<1		
			7,359		0.19						<1		
2	Invalid												
3	85,200	1,194	7,275	7,426	0.21	0.21	267,242	633	0.57	362.1	<1	<0.0033	<2.07
			7,630		0.21						<1		
			7,280		0.21						<1		
			7,518		0.22						<1		
4	82,000	1,108	7,630	7,546	0.21	0.20	272,580	619	0.53	328	<1	<0.0034	<2.13
			7,442		0.19						<1		
			7,518		0.22						<1		
			7,593		0.18						<1		
5	83,000	1,115	7,442	7,555	0.19	0.18	274,631	627	0.49	304	<1	<0.0035	<2.15
			7,593		0.18						<1		
			7,630		0.18						<1		
6	84,200	1,106	7,492	7,467	0.18	0.18	267,573	629	0.48	303	<1	<0.0033	<2.10
			7,281		0.18						<1		
			7,611		0.18						<1		
			7,483		0.18						<1		
7	81,000	1,103	7,281	7,461	0.18	0.18	270,619	604	0.47	2845	<1	<0.0035	<2.13
			7,442		0.17						<1		
			7,483		0.18						<1		
			7,639		0.17						<1		
8	84,600	1,099	7,380	7,530	0.18	0.18	269,534	637	0.48	309	<1	<0.0034	<2.13
			7,757		0.19						<1		
			7,443		0.18						<1		
			7,538		0.18						<1		
9	81,500	1,113	7,757	7,615	0.19	0.18	269,534	621	0.47	293	<1	<0.0035	<2.15
			7,710		0.17						<1		
			7,538		0.18						<1		
			7,454		0.18						<1		

* Calculated from the heating value and the sulfur content of coal samples taken during the tests assuming 100 percent conversion of sulfur in coal to SO_2

The heat input to the boiler was calculated based on the time averaged coal feed rate and the average heating value of the coal samples taken during the test. The uncontrolled SO_2 emissions ranged from 0.4 to 0.5 lb/million Btu-heat input and were calculated from the heating value and the sulfur contents of the corresponding coal samples assuming 100 percent conversion of sulfur in coal to SO_2. As can be seen from Table 7, SO_2 concentration in the exit flue gas was consistently less than 1 ppm in all cases. In fact it was below the detection limit of the instruments and therefore was recorded as less than 1 ppm. The results were consistent with CEMS readings recorded during the tests. Because of the very low SO_2 concentration in the stack (exit) flue gas, representatives from Stone and Webster and B&W and the GVEA consultant carefully scrutinized the test protocols and procedures several times during the tests with satisfactory results. This was done to ensure that all appropriate steps were followed.

The SO_2 emission corresponding to an SO_2 concentration of 1 ppm ranged from 2.03 to 2.15 lb/hr. The guarantee is 79.6 lb/hr. Since the SO_2 concentration in the exit gas was consistently less than 1 ppm, it is concluded that the system had met and in fact, exceeded the guarantee requirement.

Relevant comments on SDA performance at conditions other than performance test conditions, specifically with respect to SO_2 inlet concentration i.e., coal sulfur content and removal in the furnace, limestone quality and plant loads are as follows. These comments are based on general industry wide experience with similar systems in addition to the performance of the system at HCCP.

- <u>Inlet Sulfur Dioxide Concentration and Coal Sulfur Content</u>: Although the SDA system at HCCP is unique in that it used FCM in the feed slurry, system based on lime with similar feed slurry has performed well in several commercial installations. The SDA technology used in these installations is very similar i.e., with a spray dryer absorber followed by a bag house, in main features. Removal efficiencies in the range of 70 percent to 90 percent for inlet SO_2 concentration range of 300 to 1000 ppm have been observed. Based on the experience at these installations and the excellent performance at the HCCP with FCM, the technology and the system as installed at HCCP can be expected to perform well meeting the emission requirement for the range of coal specified in Table 2.

- Limestone Quality: The purity and the quality of limestone used in furnace injection primarily have an effect on SO_2 removal in the furnace. The SO_2 removal downstream of the furnace in the SDA system depends primarily chemical characteristics of the feed slurry to the atomizer. At HCCP it is made up of recycled FCM material which is predominantly ash or inert materials with calcined limestone. Although the purity and the quality limestone will have an effect on the alkaline characteristics of the feed slurry, the quality of original limestone will be mitigated by the presence of ash from coal and other inerts from limestone and FCM recycling. In other words, the limestone quality has a lesser impact on system performance in a system such as at HCCP than the quality of lime in a conventional SDA system as commercially used in other plants.

- Plant Load: The performance test was conducted at full load conditions. The gas flow was higher than that corresponds to the guarantee condition. Despite this, parameters related to the plant load and gas flow such as the removal efficiency, pressure drop and power consumption were below the guaranteed values. Therfore, it is expected that the SDA system will perform as good if not better at other load conditions, provided other operating parameters remain the same.

- Approach to Adiabatic Saturation Temperature: One of the important operating parameter that influences SDA system SO_2 removal efficiency is the temperature to which the gas is cooled in the spray dryer. The difference between SDA exit temperature and the adiabatic saturation temperature of the flue gas is referred to as the approach to saturation temperature. Removal efficiency increases with decrease in the approach temperature. During the performance tests, this was maintained at approximately 40°F, which is in the typical operating range for commercial SDA systems. The effect of this important parameter on the SDA system performance was investigated in detail, as a part of the Demonstration Test Program, completed in November 1999. A detailed report on the results of this program in being prepared and will be issued as a separate report in the coming months.

6.2 Particulate Emissions

Teflon coated fiberglass bags are being used and hence the guarantee value for maximum particulate emission is 0.015 lb/million Btu.

Particulate emission at CEMS location in the stack was measured using EPA Method 5B. Although the particulate emission guarantee is at the baghouse outlet, since suitable test ports were not available at this location, sampling ports at a CEMS location in the stack were used. Prior to the tests, all parties including B&W had agreed to this approach and the tests were considered valid.

The particulate sample included the EPA sampling train probe rinse and filter catches. Condensibles were specifically excluded from the particulate measurements. A sampling period of approximately 2 hours was used. The sampling period was found to be sufficient to provide adequate solid sample on the filter paper to measure the emissions. The results are summarized in Table 8.

Table 8
Summary of Particulate Emission Test Results

Test No.	Coal Flow Rate (lb/hr)	Lime-stone Feed Rate (lb/ hr)	Higher Heating Value (Btu/lb)		Heat Input (million Btu per Hour)	Flue Gas Flow Rate (acfm)		Particulate Loading						Guarantee (lb/million Btu)
			Data	Ave.		SDA Inlet	Stack	SDA Inlet	Stk	SDA Inlet	Stk.	SDA Inlet	Stack	
								(lb/hr)		(gr/acf)		(lb/million Btu)		
1	80,400	1,074	7,265	7,443	598	278,891	255,178	2737	1.4	1.15	0.0006	4.5737	0.0023	0.0150
			7,705											
			7,359											
2	Invalid													
3	85,200	1,194	7271	7,460	633	275,414	267,242	3385	2.7	1.43	0.0012	5.3074	0.0042	0.0150
			7196											
			7859											
			7513											
4	82,000	1,108	7859	7562	619	284,236	272,580	2446	3.2	1.00	0.0014	3.9490	0.0052	0.0150
			7513											
			7397											
			7478											
5	83,000	1,115	7397	7332	627	302,846	274,631	3684	2.5	1.42	0.0011	5.8750	0.0040	0.0150
			7478											
			7204											
			7249											
6	84,200	1,106	7513	7481	629	296,746	267,573	2949	1.7	1.16	0.0007	4.6906	0.0027	0.0150
			7565											
			7443											
			7401											
7	81,000	1,103	7443	7527	604	288,397	270,619	2539	1.8	1.03	0.0008	4.2011	0.0030	0.0150
			7401											
			7602											
			7660											
8	84,600	1,099	7344	7401	637	296,794	269,534	2910	0.9	1.14	0.0004	4.5683	0.0014	0.0150
			7273											
			7620											
			7365											
9	81,500	1,113	7620	7465	621	300,414	270,137	3586	2.1	1.39	0.0009	5.7783	0.0034	0.0150
			7365											
			7485											
			7389											

The particulate emission ranged from 0.0014 to 0.0052 lb/million Btu. The guarantee is 0.015 lb/million Btu. The emission is at least 60 percent less than the guarantee value and hence it is concluded that the System has met the particulate emission guarantee.

6.3 Opacity

The flue gas opacity as measured at the stack shall not exceed 20 percent for more than three (3) minutes in any hour and during this three (3) minutes shall not exceed 27 percent when the FGD System is operated within the range of the Performance Guarantee Test Conditions. Opacity resulting from condensation or chemical formation downstream of the baghouse outlet is specifically excluded. The opacity guarantees are based on a stack inside diameter of 8-feet.

The Contract does not specify a test method for the opacity guarantee. The CEMS opacity monitor was used for the guarantee measurement. Since the inside diameter of the stack at the point of opacity measurement is 8 feet, all opacity readings recorded during the test are used without correction.

To ensure that condensation downstream of the baghouse is not a factor in the opacity measurement, the flue gas temperature at the opacity monitor location and the baghouse outlet were measured and compared in order to negate any concern regarding condensation. The temperature at the opacity monitor was in fact 25°F to 30°F higher than the baghouse outlet temperature and hence there can be no condensation in the gas stream from baghouse outlet to opacity monitor location. The opacity readings from the DCS during the tests are summarized in Table 9.

Table 9
Summary of Opacity Measurement Test Results

Test No.	Coal Flow Rate (lb/hr)	Lime-stone Feed Rate (lb/hr)	Higher Heating Value (Btu/lb)		Heat Input (million Btu per Hour)	Flue Gas Flow Rate (acfm)		Particulate Loading				Opacity (%)		Guarantee* (%)
			Data	Ave.		SDA Inlet	Stack	SDA Inlet (lb/hr)	Stk. (lb/hr)	SDA Inlet (gr/acf)	Stk. (gr/acf)	Range	Max.	
1	80,400	1,074	7,265	7,443	598	278,891	255,178	2737	1.4	1.15	0.0006	1.3-1.5	1.5	20
			7,705											
			7,359											
2	Invalid													
3	85,200	1,194	7271	7,460	633	275,414	267,242	3385	2.7	1.43	0.0012	1.3-1.7	1.7	20
			7196											
			7859											
			7513											
4	82,000	1,108	7859	7562	619	284,236	272,580	2446	3.2	1.00	0.0014	1.5-1.7	1.7	20
			7513											
			7397											
			7478											
5	83,000	1,115	7397	7332	627	302,846	274,631	3684	2.5	1.42	0.0011	1.5-1.7	1.7	20
			7478											
			7204											
			7249											

Test No.	Coal Flow Rate (lb/hr)	Lime-stone Feed Rate (lb/hr)	Higher Heating Value (Btu/lb)		Heat Input (million Btu per Hour)	Flue Gas Flow Rate (acfm)		Particulate Loading				Opacity (%)		Guarantee* (%)
			Data	Ave.		SDA Inlet	Stack	SDA Inlet (lb/hr)	Stk. (lb/hr)	SDA Inlet (gr/acf)	Stk. (gr/acf)	Range	Max.	
6	84,200	1,106	7513	7481	629	296,746	267,573	2949	1.7	1.16	0.0007	1.1-1.4	1.4	20
			7565											
			7443											
			7401											
7	81,000	1,103	7443	7527	604	288,397	270,619	2539	1.8	1.03	0.0008	1.0-2.0	2.0	20
			7401											
			7602											
			7660											
8	84,600	1,099	7344	7401	637	296,794	269,534	2910	0.9	1.14	0.0004	1.3-1.5	1.5	20
			7273											
			7620											
			7365											
9	81,500	1,113	7620	7465	621	300,414	270,137	3586	2.1	1.39	0.0009	1.3-1.5	1.5	20
			7365											
			7485											
			7389											
* See Section 5.3. first paragraph for details on guarantees														

As can be seen from the test results, the maximum opacity observed during the entire test period was 2 percent, which is an order of magnitude less than the guaranteed value of 20 percent.

6.4 Pressure Drop

The average total system pressure drop from SDA inlet to baghouse outlet is guaranteed not to exceed 13 in. WG, when the FGD System is operated within the range of the Performance Guarantee Test Conditions summarized in Table 1.

The Contract requires that the pressure drop test consist of verification of the flue gas volumetric flow rate and measurement of static pressure loss across the system using a U-tube manometer. The requirements were followed. Although the Contract does not explicitly define the term "average," an averaging period corresponding to the duration of SO_2 emission test was used. The results are summarized in Table 10.

Table 10
Summary of Gas Flow Rate and Pressure Drop Measurement Test Results

Test No.	Flue Gas Flow Rate				Temperature, ° F			O_2 Content		Static Pressure (In. WG)		Pressure Drop (In. WG)	
	At CEMS		At SDA Inlet		SDA Inlet	BH Exit	CEMS	SDA Inlet	CEMS	SDA Inlet	Bag-house Exit	Actual	Guarantee
	(dscfm)	(acfm)	(acfm)	(lb/hr)									
1	163,096	255,178	278,891	851,574	304	173	206	4.73	5.19	-16.3	-26.3	10	13.0
2	Invalid												
3	161,803	267,242	275,414	838,996	301	174	216	4.44	5.13	-16.1	-26.6	10.5	13.0
4	169,575	272,580	284,236	871,105	299	174	209	4.56	5.22	-16.1	-25.7	9.6	13.0
5	175,570	274,631	302,846	929,894	295	174	208	4.95	5.22	-16.1	-25.8	9.7	13.0
6	171,851	267,573	296,746	908,718	298	174	206	4.97	5.26	-15.6	-25.4	9.8	13.0
7	169,773	270,619	288,397	885,927	298	174	206	4.91	5.24	-15.7	-25.6	9.9	13.0
8	170,950	269,534	296,794	912,928	297	174	203	4.92	5.33	-15.7	-25.5	9.8	13.0
9	173,382	270,137	300,414	917,563	297	174	198	4.82	5.2	-15.8	-25.7	9.9	13.0

As can be seen, the pressure drops in all cases were less than the guaranteed value of 13.0 in. WG, and hence it is concluded that the System has met the guarantee requirement. It must be pointed out that the pressure drop guarantee is at a maximum gas flow rate of 648,000 lb/hr. The actual gas flow rate during the tests was between 838,000 lb/hr and as high as 929,894 lb/hr or approximately 30 percent to 44 percent higher. Even at these higher gas flow rates, the System pressure drop was approximately 30 percent less than the guaranteed value.

6.5 Electrical Power Consumption

An average total electrical power consumption for the FGD System of less than or equal to 550.5 kilowatts will satisfy the performance guarantee when the FGD System is operated within the range of the Performance Guarantee Test Conditions as specified in the Contract.

The average FGD System power consumption was measured using plant instrumentation readings for the 4,160 volt feeder, which consists of the atomizer motor, a separate kWh meter for BOP FGD System equipment and another separate meter for the two agitators that were not measured by the BOP kWh meter. As in the case of system pressure drop guarantee, the averaging period was the duration of the SO_2 emission test. The results are summarized in Table 11.

Table 11
Summary of Electrical Power Consumption Test Results

Test No.	Agitators							Atomizer							BOP		Total Power Consumption (kWh)	
	Voltage (V)		Current (Amp.)		Power Factor		Pwr. (kWh)	Voltage (V)		Current (Amp.)		Power Factor		Pwr. (kWh)	Hrly	Avg	Test	Guarantee
	Hrly	Avg	Hrly	Avg	Hrly	Avg		Hrly	Avg	Hrly	Avg	Hrly	Avg					
1	467	467	21.3	21.6	0.83	0.83	14.5	4.01	4.010	27	27	0.83	0.82	154	165	165	334	550.5
	468		22.0		0.83			4.01		27		0.82			165			
	467		21.5		0.83			4.01		27		0.82			165			
	467		21.7		0.83			4.01		27		0.82			165			
2	Invalid																	
3	466	466.3	21.5	20.9	0.82	0.82	13.8	4.01	4.010	25	26.5	0.82	0.82	151	168	165	330	550.5
	466		20.7		0.82			4.01		27		0.82			165			
	466		20.3		0.82			4.01		27		0.82			165			
	467		20.9		0.82			4.01		27		0.83			162			
4	466	466.7	21.6	21.4	0.82	0.82	14.2	4.01	4.010	25	25	0.82	0.82	143	165	167	324	550.5
	467		21.3		0.82			4.01		25		0.82			167			
	467		21.3		0.82			4.01		25		0.83			168			
5	466	466.8	21.1	21.4	0.82	0.82	14.1	4.01	4.010	27	25.5	0.82	0.82	146	168	172	331	550.5
	467		21.4		0.82			4.01		25		0.82			171			
	467		21.6		0.82			4.01		25		0.83			170			
	467		21.3		0.82			4.01		25		0.82			177			
6	466	466.0	21.5	21.3	0.82	0.82	14.1	4.01	4.010	25	25	0.82	0.82	143	180	177	333	550.5
	466		21.7		0.82			4.01		25		0.82			177			
	466		21.3		0.82			4.01		25		0.83			172			
	466		20.5		0.82			4.01		25		0.82			177			
7	467	467.5	20.5	20.7	0.82	0.82	13.7	4.01	4.020	23	24.5	0.82	0.82	140	189	179	333	550.5
	467		21.2		0.82			4.02		25		0.82			174			
	468		20.9		0.82			4.03		25		0.83			177			
	468		20.2		0.82			4.02		25		0.82			175			
8	469	470.0	21.3	20.9	0.82	0.82	14.0	4.04	4.035	25	25	0.82	0.82	144	171	170	328	550.5
	470		20.8		0.82			4.03		25		0.82			160			
	470		20.9		0.82			4.03		25		0.83			180			
	471		20.7		0.82			4.04		25		0.82			170			
9	471	470.3	20.8	21.0	0.82	0.82	14.0	4.04	4.040	25	25	0.82	0.82	144	188	181	340	550.5
	470		21.2		0.82			4.04		25		0.82			186			
	470		21.2		0.82			4.04		25		0.83			180			
	470		20.8		0.82			4.04		25		0.82			170			

The total power consumption varied from a minimum of 324 kWh to a maximum of 340 kWh during the tests. This is approximately 38 percent to 41 percent less than the guaranteed value of 550.5 kWh and hence it is concluded that the System has met the power consumption performance guarantee requirement.

7.0 SUMMARY AND CONCLUSIONS

A total of nine tests were conducted and eight of which were considered acceptable. The test results are summarized in Table 12. For comparison, the contractual guaranteed values are also included.

Table 12
Performance Test Results and Performance Guarantees

No.	Operating Parameter	Parameter Values							
		Guarantee	**Test 1**	**Test 3**	**Test 4**	**Test 5**	**Test 6**	**Test 7**	**Test 8**	**Test 9**
1	SO_2 Emission	79.6 lb/hr (Max.)	<2.01	<2.07	<2.13	<2.15	<2.10	<2.13	<2.13	<2.15
2	Particulate Loading	0.015 lb/million Btu (Max.)	0.0023	0.0042	0.0052	0.0040	0.0027	0.0030	0.0014	0.0034
3	Opacity	Max. of 20% for a max. of 3 minutes in an hour and during the three minutes a Max. of 27%	Range: 1.3-1.5 Max.: 1.5	1.3-1.7 1.7	1.5-1.7 1.7	1.5-1.7 1.7	1.1-1.4 1.4	1.0-2.0 2.0	1.3-1.5 1.5	1.3-1.5 1.5
4	System Pressure Drop	13 in. WG	10.0	10.5	9.6	9.7	9.8	9.9	9.8	9.9
6	System Power Consumption	550.5 kW	334	330	324	331	333	333	328	340

From the test results, it is concluded that the SDA System at HCCP has met all performance guarantee requirements.

List of Acronyms and Abbreviations

acf	-	Actual Cubic Foot
acfm	-	Actual Cubic Feet per Minute
AIDEA	-	Alaska Industrial Development and Export Authorities
BH	-	Baghouse
B&W	-	Babcock and Wilocox
B&W/Joy	-	Babcock and Wilcox/Joy Manufacturing Company
Btu	-	British Thermal Unit
CEMS	-	Continuous Emission Monitoring System
DCS	-	Distributed Control System
DOE	-	Department of Energy
EPA	-	Environmental Protection Agency
FCM	-	Flash Calcined Material
FGD	-	Flue Gas Desulfurization
gr	-	Grain
GVEA	-	Golden Valley Electricity Association, Inc.
HCCP	-	Healy Clean Coal Project
HHV	-	Higher Heating Value
MAF	-	Moisture and Ash Free
MW	-	Mega Watt
S	-	Sulfur
S&W	-	Stone and Webster
SDA	-	Spray Dryer Absorber

APPENDIX A

COAL ANALYSIS

COAL ANALYSIS – FEEDER "A" SAMPLE

Sample No. 1 (June 8, 1999; 12:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	26.09	-----	Moisture, %	26.09	-----
Ash, %	12.17	16.46	Carbon, %	42.20	57.10
Volatile, %	33.50	45.32	Hydrogen, %	3.48	4.71
Fixed Carbon, %	28.24	38.22	Nitrogen, %	0.55	0.75
	100.00	100.00	Sulfur, %	0.23	0.31
			Ash, %	12.17	16.46
High Heating Value, Btu/lb	7,265	9,829	Oxygen (diff.), %	15.28	20.67
Sulfur, %	0.23	0.31		100.00	100.00
Heating Value MAF, Btu/lb		11,766			
Alk. As Sodium Oxide	0.20	0.28			

Sample No. 2 (June 8, 1999; 10:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	25.81	-----	Moisture, %	25.81	-----
Ash, %	9.18	12.38	Carbon, %	44.34	59.77
Volatile, %	34.36	46.32	Hydrogen, %	3.55	4.79
Fixed Carbon, %	30.65	41.30	Nitrogen, %	0.54	0.73
	100.00	100.00	Sulfur, %	0.19	0.25
			Ash, %	9.18	12.38
High Heating Value, Btu/lb	7,705	10,386	Oxygen (diff), %	16.39	22.08
Sulfur, %	0.19	0.25		100.00	100.00
Heating Value MAF, Btu		11,853			
Alk. As Sodium Oxide	0.15	0.20			

Sample No. 3 (June 9, 1999; 08:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	26.09	-----	Moisture, %	26.09	-----
Ash, %	12.00	16.24	Carbon, %	42.20	57.10
Volatile, %	33.66	45.54	Hydrogen, %	3.38	4.57

COAL ANALYSIS – FEEDER "A" SAMPLE (CONT'D)

Sample No. 3 (Cont'd)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Fixed Carbon, %	28.25	38.22	Nitrogen, %	0.56	0.76
	100.00	100.00	Sulfur, %	0.21	0.28
			Ash, %	12.00	16.24
High Heating Value, Btu/lb	7,275	9,843	Oxygen (diff), %	15.56	21.05
Sulfur, %	0.21	0.28		100.00	100.00
Heating Value MAF, Btu/lb		11,751			
Alk. As Sodium Oxide	0.18	0.25			

Sample No. 4 (June 9, 1999; 13:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	25.89	-----	Moisture, %	25.89	-----
Ash, %	9.83	13.27	Carbon, %	44.06	59.45
Volatile, %	34.05	45.94	Hydrogen, %	3.49	4.71
Fixed Carbon, %	30.23	40.79	Nitrogen, %	0.55	0.74
	100.00	100.00	Sulfur, %	0.22	0.30
			Ash, %	9.83	13.27
High Heating Value, Btu/lb	7,630	10,295	Oxygen (diff), %	15.96	21.53
Sulfur, %	0.22	0.30		100.00	100.00
Heating Value MAF, Btu/lb		11,870			
Alk. As Sodium Oxide	0.15	0.20			

Sample No. 5 (June 9, 1999; 18:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	25.98	-----	Moisture, %	25.98	-----
Ash, %	9.60	12.97	Carbon, %	44.06	59.52
Volatile, %	34.35	46.40	Hydrogen, %	3.60	4.86
Fixed Carbon, %	30.07	40.63	Nitrogen, %	0.56	0.76
	100.00	100.00	Sulfur, %	0.22	0.30

COAL ANALYSIS – FEEDER "A" SAMPLE (CONT'D)

Sample No. 5 (Cont'd)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
			Ash, %	9.60	12.97
High Heating Value, Btu/lb	7,663	10,352	Oxygen (diff), %	15.98	21.59
Sulfur, %	0.22	0.30		100.00	100.00
Heating Value MAF, Btu/lb		11,895			
Alk. As Sodium Oxide	0.15	0.20			

Sample No. 6 (June 9, 1999; 21:30 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	25.76	-----	Moisture, %	25.76	-----
Ash, %	11.24	15.14	Carbon, %	43.19	58.17
Volatile, %	33.71	45.41	Hydrogen, %	3.42	4.61
Fixed Carbon, %	29.29	39.45	Nitrogen, %	0.53	0.71
	100.00	100.00	Sulfur, %	0.19	0.25
			Ash, %	11.24	15.14
High Heating Value, Btu/lb	7,442	10,024	Oxygen (diff), %	15.67	21.12
Sulfur, %	0.19	0.25		100.00	100.00
Heating Value MAF, Btu/lb		11,812			
Alk. As Sodium Oxide	0.18	0.24			

Sample No. 7 (June 10, 1999; 08:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	27.00	-----	Moisture, %	27.00	-----
Ash, %	9.49	13.00	Carbon, %	43.41	59.47
Volatile, %	33.81	46.32	Hydrogen, %	3.40	4.66
Fixed Carbon, %	29.70	40.68	Nitrogen, %	0.53	0.73
	100.00	100.00	Sulfur, %	0.18	0.24
			Ash, %	9.49	13.00

COAL ANALYSIS – FEEDER "A" SAMPLE (CONT'D)

Sample No. 7 (Cont'd))					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
High Heating Value, Btu/lb	7,492	10,263	Oxygen (diff), %	15.99	21.90
Sulfur, %	0.18	0.24		100.00	100.00
Heating Value MAF, Btu/lb		11,797			
Alk. As Sodium Oxide	0.16	0.21			

Sample No. 8 (June 10, 1999; 13:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	26.50	-----	Moisture, %	26.50	-----
Ash, %	11.24	15.29	Carbon, %	42.28	57.53
Volatile, %	33.24	45.22	Hydrogen, %	3.25	4.42
Fixed Carbon, %	29.02	39.49	Nitrogen, %	0.52	0.71
	100.00	100.00	Sulfur, %	0.18	0.24
			Ash, %	11.24	15.29
High Heating Value, Btu/lb	7,281	9,906	Oxygen (diff), %	16.03	21.81
Sulfur, %	0.18	0.24		100.00	100.00
Heating Value MAF, Btu/lb		11,694			
Alk. As Sodium Oxide	0.20	0.27			

Sample No. 9 (June 10, 1999; 18:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	26.61	-----	Moisture, %	26.61	-----
Ash, %	10.33	14.07	Carbon, %	43.15	58.80
Volatile, %	33.78	46.03	Hydrogen, %	3.26	4.44
Fixed Carbon, %	29.28	39.90	Nitrogen, %	0.54	0.73
	100.00	100.00	Sulfur, %	0.17	0.23
			Ash, %	10.33	14.07
High Heating Value, Btu/lb	7,442	10,141	Oxygen (diff), %	15.94	21.73
Sulfur, %	0.17	0.23		100.00	100.00

COAL ANALYSIS – FEEDER "A" SAMPLE (CONT'D)

Sample No. 9 (Cont'd)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Heating Value MAF, Btu/lb		11,801			
Alk. As Sodium Oxide	0.18	0.24			

Sample No. 10 (June 11, 1999; 08:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	26.02	-----	Moisture, %	26.02	-----
Ash, %	11.64	15.74	Carbon, %	42.95	58.05
Volatile, %	33.50	45.28	Hydrogen, %	3.32	4.49
Fixed Carbon, %	28.84	38.98	Nitrogen, %	0.53	0.72
	100.00	100.00	Sulfur, %	0.18	0.24
			Ash, %	11.64	15.74
High Heating Value, Btu/lb	7,380	9,975	Oxygen (diff), %	15.36	20.76
Sulfur, %	0.18	0.24		100.00	100.00
Heating Value MAF, Btu/lb		11,838			
Alk. As Sodium Oxide	0.22	0.30			

Sample No. 11 (June 11, 1999; 13:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	25.94	-----	Moisture, %	25.94	-----
Ash, %	9.01	12.16	Carbon, %	45.01	60.77
Volatile, %	34.40	46.45	Hydrogen, %	3.56	4.81
Fixed Carbon, %	30.65	41.39	Nitrogen, %	0.54	0.73
	100.00	100.00	Sulfur, %	0.19	0.26
			Ash, %	9.01	12.16
High Heating Value, Btu/lb	7,757	10,474	Oxygen (diff), %	15.75	21.27
Sulfur, %	0.19	0.26		100.00	100.00
Heating Value MAF, Btu/lb		11,924			

COAL ANALYSIS – FEEDER "A" SAMPLE (CONT'D)

Sample No. 11 (Cont'd)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Alk. As Sodium Oxide	0.15	0.20			

Sample No. 12 (June 11, 1999; 18:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	26.28	-----	Moisture, %	26.28	-----
Ash, %	9.07	12.31	Carbon, %	44.99	61.03
Volatile, %	34.27	46.48	Hydrogen, %	3.42	4.64
Fixed Carbon, %	30.38	41.21	Nitrogen, %	0.55	0.75
	100.00	100.00	Sulfur, %	0.17	0.23
			Ash, %	9.07	12.31
High Heating Value, Btu/lb	7,710	10,459	Oxygen (diff), %	15.52	21.04
Sulfur, %	0.17	0.23		100.00	100.00
Heating Value MAF, Btu/lb		11,927			
Alk. As Sodium Oxide	0.15	0.21			

COAL ANALYSIS – FEEDER "B" SAMPLE

Sample No. 13 (June 8, 1999; 12:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	26.03	-----	Moisture, %	26.03	-----
Ash, %	11.42	15.44	Carbon, %	42.83	57.90
Volatile, %	34.31	46.38	Hydrogen, %	3.28	4.43
Fixed Carbon, %	28.24	38.18	Nitrogen, %	0.55	0.75
	100.00	100.00	Sulfur, %	0.19	0.26
			Ash, %	11.42	15.44
High Heating Value, Btu/lb	7,359	9,949	Oxygen (diff), %	15.70	21.22
Sulfur, %	0.19	0.26		100.00	100.00
Heating Value MAF, Btu/lb		11,766			
Alk. As Sodium Oxide	0.19	0.25			

Sample No. 14 (June 9, 1999; 08:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	25.67	-----	Moisture, %	25.67	-----
Ash, %	12.05	16.21	Carbon, %	42.55	57.24
Volatile, %	33.98	45.72	Hydrogen, %	3.22	4.33
Fixed Carbon, %	28.30	38.07	Nitrogen, %	0.56	0.75
	100.00	100.00	Sulfur, %	0.21	0.28
			Ash, %	12.05	16.21
High Heating Value, Btu/lb	7,280	9,794	Oxygen (diff), %	15.74	21.19
Sulfur, %	0.21	0.28		100.00	100.00
Heating Value MAF, Btu/lb		11,689			
Alk. As Sodium Oxide	0.19	0.25			

Sample No. 15 (June 9, 1999; 13:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	25.54	-----	Moisture, %	25.54	-----
Ash, %	11.19	15.03	Carbon, %	43.80	58.83

COAL ANALYSIS – FEEDER "B" SAMPLE (CONT'D)

Sample No. 15 (Cont'd)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Volatile, %	34.42	46.22	Hydrogen, %	3.31	4.45
Fixed Carbon, %	28.85	38.75	Nitrogen, %	0.57	0.77
	100.00	100.00	Sulfur, %	0.21	0.28
			Ash, %	11.19	15.03
High Heating Value, Btu/lb	7,518	10,097	Oxygen (diff), %	15.38	20.64
Sulfur, %	0.21	0.28		100.00	100.00
Heating Value MAF, Btu/lb		11,883			
Alk. As Sodium Oxide	0.17	0.23			

Sample No. 16 (June 9, 1999; 18:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	26.14	-----	Moisture, %	26.14	-----
Ash, %	9.73	13.17	Carbon, %	43.92	59.46
Volatile, %	34.74	47.04	Hydrogen, %	3.51	4.75
Fixed Carbon, %	29.39	39.79	Nitrogen, %	0.55	0.74
	100.00	100.00	Sulfur, %	0.18	0.25
			Ash, %	9.73	13.17
High Heating Value, Btu/lb	7,593	10,280	Oxygen (diff), %	15.97	21.63
Sulfur, %	0.18	0.25		100.00	100.00
Heating Value MAF, Btu/lb		11,839			
Alk. As Sodium Oxide	0.15	0.20			

Sample No. 17 (June 9, 1999; 21:30 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	26.42	-----	Moisture, %	26.42	-----
Ash, %	10.89	14.80	Carbon, %	42.81	58.18
Volatile, %	33.73	45.84	Hydrogen, %	3.17	4.31
Fixed Carbon, %	28.96	39.36	Nitrogen, %	0.54	0.74

COAL ANALYSIS – FEEDER "B" SAMPLE (CONT'D)

Sample No. 17 (Cont'd)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
	100.00	100.00	Sulfur, %	0.18	0.24
			Ash, %	10.89	14.80
High Heating Value, Btu/lb	7,367	10,012	Oxygen (diff), %	15.99	21.73
Sulfur, %	0.18	0.24		100.00	100.00
Heating Value MAF, Btu/lb		11,751			
Alk. As Sodium Oxide	0.17	0.23			

Sample No. 18 (June 10, 1999; 08:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	26.51	-----	Moisture, %	26.51	-----
Ash, %	9.15	12.45	Carbon, %	44.51	60.56
Volatile, %	34.41	46.82	Hydrogen, %	3.40	4.62
Fixed Carbon, %	29.93	40.73	Nitrogen, %	0.56	0.76
	100.00	100.00	Sulfur, %	0.18	0.25
			Ash, %	9.15	12.45
High Heating Value, Btu/lb	7,611	10,357	Oxygen (diff), %	15.69	21.36
Sulfur, %	0.18	0.25		100.00	100.00
Heating Value MAF, Btu/lb		11,830			
Alk. As Sodium Oxide	0.14	0.19			

Sample No. 19 (June 10, 1999; 13:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	26.28	-----	Moisture, %	26.28	-----
Ash, %	10.36	14.05	Carbon, %	43.43	58.91
Volatile, %	34.29	46.51	Hydrogen, %	3.33	4.52
Fixed Carbon, %	29.07	39.44	Nitrogen, %	0.55	0.74
	100.00	100.00	Sulfur, %	0.18	0.25
			Ash, %	10.36	14.05

COAL ANALYSIS – FEEDER “B” SAMPLE (CONT’D)

Sample No. 19 (June 10, 1999; 13:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Sulfur, %	0.18	0.25		100.00	100.00
High Heating Value MAF, Btu/lb		11,810			
Alk. As Sodium Oxide	0.17	0.23			

Sample No. 20 (June 10, 1999; 18:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	25.89	-----	Moisture, %	25.89	-----
Ash, %	12.28	16.57	Carbon, %	44.39	59.90
Volatile, %	34.47	46.51	Hydrogen, %	3.37	4.55
Fixed Carbon, %	27.36	36.92	Nitrogen, %	0.55	0.74
	100.00	100.00	Sulfur, %	0.17	0.23
			Ash, %	12.28	16.57
Heating Value MAF, Btu/lb	7,639	10,307	Oxygen (diff), %	13.35	18.01
Sulfur, %	0.17	0.23		100.00	100.00
High Heating Value, MAF Btu/lb		12,354			
Alk. As Sodium Oxide	0.21	0.28			

Sample No. 21 (June 11, 1999; 08:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	26.15	-----	Moisture, %	26.15	-----
Ash, %	11.35	15.37	Carbon, %	42.76	57.90
Volatile, %	33.85	45.83	Hydrogen, %	3.33	4.51
Fixed Carbon, %	28.65	38.80	Nitrogen, %	0.53	0.72
	100.00	100.00	Sulfur, %	0.18	0.24
			Ash, %	11.35	15.37
High Heating Value, Btu/lb	7,443	10,078	Oxygen (diff), %	15.70	21.26
Sulfur, %	0.18	0.24		100.00	100.00

COAL ANALYSIS – FEEDER "B" SAMPLE (CONT'D)

Sample No. 21 (Cont'd)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Heating Value MAF, Btu/lb		11,908			
Alk. As Sodium Oxide	0.20	0.27			

Sample No. 22 (June 11, 1999; 13:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	26.19	-----	Moisture, %	26.19	-----
Ash, %	10.08	13.65	Carbon, %	43.73	59.25
Volatile, %	34.44	46.66	Hydrogen, %	3.28	4.44
Fixed Carbon, %	29.29	39.69	Nitrogen, %	0.56	0.76
	100.00	100.00	Sulfur, %	0.18	0.24
			Ash, %	10.08	13.65
High Heating Value, Btu/lb	7,583	10.213	Oxygen (diff), %	15.98	21.66
Sulfur, %	0.18	0.24		100.00	100.00
Heating Value MAF, Btu/lb		11,827			
Alk. As Sodium Oxide	0.16	0.22			

Sample No. 23 (June 11, 1999; 18:00 hr)					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Moisture, %	26.31	-----	Moisture, %	26.31	-----
Ash, %	10.55	14.31	Carbon, %	43.38	58.87
Volatile, %	33.82	45.89	Hydrogen, %	3.32	4.50
Fixed Carbon, %	29.32	39.80	Nitrogen, %	0.55	0.74
	100.00	100.00	Sulfur, %	0.18	0.25
			Ash, %	10.55	14.31
High Heating Value, Btu/lb	7,454	10,116	Oxygen (diff), %	15.71	21.33
Sulfur, %	0.18	0.25		100.00	100.00

COAL ANALYSIS – FEEDER "B" SAMPLE (CONT'D)

Sample No. 23 (Cont'd))					
Proximate Analysis	As Received	Dry Basis	Ultimate Analysis	As Received	Dry Basis
Heating Value MAF, Btu/lb		11,805			
Alk. As Sodium Oxide	0.18	0.24			

APPENDIX B

ASH ANALYSIS

ASH ANALYSIS

Weight Percent – Ignited Basis												
Sample Number	1	2	3	4	5	6	7	8	9	10	11	12
	06/08/99; 12:00 hr	06/08/99; 16:00 hr	06/09/99; 8:00 hr	06/09/99; 13:00 hr	06/09/99; 18:00 hr	06/09/99; 21:30 hr	06/10/99; 08:00 hr	06/10/99; 13:00 hr	06/10/99; 18:00 hr	06/11/99; 08:00 hr	06/11/99; 13:00 hr	06/11/99; 18:00 hr
Constituent												
Silicon dioxide	53.09	47.19	48.45	50.90	46.20	52.04	52.92	54.23	53.89	59.44	48.94	47.93
Aluminum oxide	17.23	16.22	22.49	17.68	18.46	16.41	13.66	15.30	13.83	13.30	13.79	13.20
Titanium dioxide	0.75	0.75	0.68	0.73	0.69	0.65	0.61	0.86	0.61	0.65	0.59	0.64
Iron oxide	5.64	6.22	5.40	5.52	6.14	5.95	6.00	5.06	6.04	5.33	6.25	6.87
Calcium oxide	14.46	20.19	13.49	16.56	19.01	16.81	18.31	16.21	16.93	13.68	20.59	21.62
Magnesium oxide	2.32	2.91	1.83	2.46	2.79	2.56	2.91	2.58	2.60	2.25	3.19	3.36
Potassium oxide	1.50	1.23	1.33	1.36	1.19	1.38	1.38	1.86	1.39	1.61	1.32	1.34
Sodium oxide	0.69	0.84	0.65	0.59	0.74	0.65	0.74	0.56	0.81	0.86	0.78	0.81
Sulfur trioxide	3.47	3.52	3.55	3.36	3.98	2.70	2.65	2.55	3.01	2.13	3.66	3.26
Phosphorus pentoxide	0.25	0.26	0.23	0.24	0.19	0.21	0.19	0.17	0.25	0.17	0.20	0.22
Strontium oxide	0.14	0.15	0.10	0.13	0.13	0.14	0.14	0.14	0.15	0.13	0.17	0.17
Barium oxide	0.43	0.48	0.40	0.43	0.44	0.46	0.45	0.45	0.45	0.42	0.48	0.54
Manganese oxide	0.03	0.04	0.03	0.04	0.04	0.04	0.04	0.03	0.04	0.03	0.04	0.04
Undetermined	0.00	0.00	1.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Silica Value	70.31	61.68	70.04	67.47	62.31	67.27	66.03	69.45	67.82	73.66	61.97	60.08
Base: Acid Ratio	0.35	0.49	0.32	0.38	0.46	0.40	0.44	0.37	0.41	0.32	0.51	0.55
T_{250} Temperature	2483°F	2320°F	2521°F	2433°F	2349°F	2416°F	2369°F	2445°F	2403°F	2508°F	2305°F	2275°F
Type of Ash	Lignitic	Lignitic	Lignitic	Lignitic	Lignitic	Lignitic	Lignitic	Lignitic	Lignitic	Lignitic	Lignitic	Lignitic
Fouling Index	0.69	0.84	0.65	0.59	0.74	0.65	0.74	0.56	0.81	0.86	0.78	0.81
Slagging Index	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx

APPENDIX C

LIMESTONE - CHEMICAL ANALYSIS

LIMESTONE - CHEMICAL ANALYSIS

Percent Dry Basis					
Sample No.	1	2	3	4	5
	06/08/99; 08:00 hr	06/09/99; 04:00 hr	06/09/99; 18:00 hr	06/10/99; 04:00 hr	06/10/99; 14:00 hr
Parameter					
Calcium, Ca	38.93	39.59	39.80	39.70	39.58
Carbonate, CO_3	59.22	59.13	58.70	58.85	59.15
Magnesium, Mg	0.42	0.30	0.34	0.35	0.33
Inerts	1.19	0.60	0.55	0.54	0.53

Note: Results are reported in weight percent on a dry basis.

APPENDIX D

LIMESTONE – PARTICLE SIZE DISTRIBUTION

LIMESTONE – PARTICLE SIZE DISTRIBUTION

Percent Weight								
Sample No.	1	2	3	4	5	6	7	8
	06/08/99; 08:00 hr	06/08/99; 12:00 hr	06/09/99; 04:00 hr	06/09/99; 18:00 hr	06/10/99; 04:00 hr	06/10/99; 14:00 hr	06/11/99; 04:00 hr	06/11/99; 14:00 hr
Retained On								
+ 80 Mesh	0.08	0.11	0.20	0.17	0.11	0.16	0.02	0.14
+ 100 Mesh	1.05	0.99	1.06	1.07	1.08	1.00	0.79	0.98
+ 140 Mesh	3.06	3.12	3.31	3.13	3.52	3.19	2.98	3.44
+ 200 Mesh	8.10	8.40	8.76	8.09	10.86	8.41	8.36	9.29
+ 270 Mesh	60.94	63.12	60.91	59.64	63.02	56.53	53.60	59.63
+ 325 Mesh	0.13	0.09	0.11	0.09	0.11	13.54	3.12	3.99
- 325 Mesh	26.64	24.17	25.65	27.81	21.30	17.17	31.13	22.53
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

APPENDIX E

FLY ASH ANALYSIS

FLY ASH ANALYSIS

Percent Dry Basis			
Sample No.	1	2	3
	06/09/99; 15:00 hr	06/10/99; 13:00 hr	06/11/99; 13:00 hr
Parameter			
Calcium, Ca	18.71	18.92	18.93
Carbonate, CO_3	2.53	2.49	2.54
Sulfite, SO_3	7.09	6.64	6.74
Sulfate, SO_4	8.51	7.97	8.09
Calcium Oxide, CaO	26.21	26.49	26.51
Magnesium, Mg	1.46	1.53	1.50
Sodium, Na	0.38	0.4	0.40
Potassium, K	1.65	1.64	1.64

Note: Results are reported in weight percent on a dry basis.

APPENDIX F

AIR HEATER HOPPER ASH ANALYSIS

AIR HEATER HOPPER ASH ANALYSIS

Percent Dry Basis		
Sample No.	1	2
	06/10/99; 13:00 hr	06/11/99; 13:00 hr
Parameter		
Calcium, Ca	29.52	26.00
Carbonate, CO_3	2.73	2.65
Sulfite, SO_3	1.17	0.46
Sulfate, SO_4	1.4	0.55
Calcium Oxide, CaO	41.34	36.42
Magnesium, Mg	1.3	1.15

Note: Results are reported in weight percent on a dry basis.

APPENDIX G

SDA FEED SLURRY SOLIDS CONTENT

SDA FEED SLURRY SOLIDS CONTENT

Sample No.	Sample Size	Solids Content (percent)
1 (June 8, 1999; 12:00 hr)	1.7 oz	49.82
2 (June 8, 1999; 13:00 hr)	1.8 oz	49.78
3 (June 8,1999; 14:00 hr)	1.8 oz	49.86
4 (June 9, 1999; 08:00 hr)	1.8 oz	50.03
5 (June 9, 1999; 13:00 hr)	1.8 oz	50.14
6 (June 9, 1999; 18:00 hr)	1.8 oz	50.09
7 (June 9, 1999; 21:00 hr)	1.7 oz	49.89
8 (June 10, 1999; 08:00 hr)	1.8 oz	50.11
9 (June 10, 1999; 13:00 hr)	1.7 oz	50.27
10 (June 10, 1999; 18:00 hr)	1.9 oz	50.44
11 (June 11, 1999; 08:00 hr)	1.8 oz	50.22
12 (June 11, 1999; 13:00 hr)	1.7 oz	50.55
13 (June 11, 1999; 18:00 hr)	1.6 oz	50.90