HEALY CLEAN COAL PROJECT (HCCP) DEMONSTRATION TEST PROGRAM

TOPICAL REPORT BOILER PERFORMANCE TESTING

March 31, 2000
Final Report

Patents cleared by Chicago on March 6, 2000

A report of a project conducted jointly under cooperative agreement DE-FC22-91PC90544 between: The U.S. Department of Energy and the Alaska Industrial Development and Export Authority.

Table of Contents

Abstract

The Foster Wheeler Boiler Performance Guarantee tests for the Healy Clean Coal Project were executed on March 29 and 30, 1999, in accordance with Contract No. HCP-009 (between Foster Wheeler Energy Corporation and the Alaska Industrial Development and Export Authority), the U.S. Department of Energy Demonstration Test Program December 1997, and the "Boiler Performance Guarantee Test Program and Procedures" dated November 23, 1998. The test was conducted by Foster Wheeler Energy Corporation and witnessed by Stone & Webster Engineering Corporation.

Stone & Webster Engineering Corporation's engineering judgement regarding the test was that the Foster Wheeler Boiler Guarantees were satisfactorily met. Critical boiler performance guarantees were maximum steam flow 490,000 lb/hr, pulverizer and forced draft fan power consumption of 330 kW and 3150 kW, respectively and steam pressure and temperature of 1300 psig and 955° F, respectively. Boiler efficiency was predicted to be 79.15%. These performance levels were achieved.

1.0 Executive Summary

The Foster Wheeler Boiler Performance Guarantee test for the Healy Clean Coal Project (HCCP) was executed on March 29 and 30, 1999, in accordance with Contract No. HCP-009 between the Foster Wheeler Energy Corporation (Foster Wheeler) and the Alaska Industrial Development and Export Authority (AIDEA), the U.S. Department of Energy Demonstration Test Program December 1997, and the Foster Wheeler "Boiler Performance Guarantee Test Program and Procedures" provided in Appendix A.

The boiler test was conducted by Foster Wheeler and witnessed by Stone & Webster Engineering Corporation (Stone & Webster). Stone & Webster's judgement regarding the test was "...that the boiler guarantees as presented in Table 1 were satisfactorily met..."Table 1 is from the Stone & Webster test report and reproduced as follows. More detailed Boiler Performance test results are presented in Appendix A - Stone & Webster Review of HCCP Boiler Performance Guarantee Test Report – July 1, 1999, which includes Table 1.

Critical results from Table 1 are:

Parameter	Guarantee or Predicted	Actual
Maximum steam flow	490,000 lb/hr	493,865 lb/hr
Pulverizer power	330 kW	213.6 kW shaft input power A
		204.4 kW shaft input power B
Forced draft fan power	3150 kW	1492 kW
Steam pressure	1300 psig	1308 psig
Steam temperature	955° F	957° F
Boiler efficiency	79.15%	82.2%

Stone & Webster, the witnessing engineer, and Foster Wheeler, the test engineer, believe that the analysis employed, results obtained, and the conclusions drawn are valid.

2.0 Introduction

The Healy Clean Coal Project, selected by the US Department of Energy (DOE) under Round III of the Clean Coal Technology Program. The project is owned and financed by the AIDEA, and is co-funded by the DOE. Golden Valley Electric Association (GVEA), Inc. of Fairbanks, Alaska provided the plant operators. The plant engineer was Stone and Webster. The coal supplier is Usibelli Coal Mine, Inc., located adjacent to the Healy plant.

After more than five years of planning, design engineering, and permitting activities, the project celebrated its ground-breaking ceremony at Healy, Alaska on May 30, 1995. Most of the major plant equipment was delivered to the Healy site 250 miles north of Anchorage, Alaska (near Denali National Park) in 1996. This equipment included the boiler, two 350 million Btu/hr coal combustors and the associated coal and limestone feed systems that were fabricated by TRW and their subcontractors, as well as a the Spray Dryer Absorber System (SDA), which consisted of a single spray dryer vessel, a multi-compartment fabric filter, and an extensive slurry preparation system. Construction of the plant was completed in November 1997, with coal-fired operations starting in January 1998.

The objectives of the project are to demonstrate a novel power plant design which features the combined removal of nitrogen oxides (NO_x), sulfur dioxide (SO_2), and Particulate Matter (PM) using a combination of two advanced technologies, to further demonstrate reduced emission levels well below the requirements of EPA New Source Performance Standards (NSPS) for new utility coal fired units, and to meet future energy needs in an environmentally acceptable manner.

The technologies to be demonstrated in the HCCP combines the TRW Clean Coal Combustion System and the Babcock & Wilcox's (B&W)/Joy Activated Recycle Spray Dryer Absorber (SDA) System into a single, integrated, combustion/control process. The HCCP is the first utility-scale demonstration of the TRW Clean Coal Combustion System. The TRW Combustion System is designed to minimize emissions of NO_x, achieve very high carbon burnout, and remove the majority of flyash from the flue gas prior to the boiler. The TRW system also provides the first step of a three-step process for controlling SO_2 by converting limestone to flash calcined lime that subsequently absorbs SO_2 within the boiler. The majority of SO_2 is removed downstream of the boiler, using B&W's activated SDA system, which utilizes the flash calcined material (flash calcined lime + flyash) produced by the TRW system. Since most of the coal ash is removed by the combustors, the flash calcined material is rich enough in calcium content such that the SDA can be operated solely on recycled lime, eliminating the need to purchase or manufacture lime for the backend scrubbing system.

The boiler furnace configuration is an integral part of the technology as well. The second stage of NO_x control occurs in the furnace and is a function of the boiler tube configuration. Hot gas flow distribution in the boiler is an important part of the NO_x control process.

This report describes results from the Boiler Performance Guarantee test for the HCCP. It is one of a series of topical reports that can be used to determine if the overall goals of the Demonstration Test Program (DTP) have been met. This report addresses the results from the Foster Wheeler Boiler Performance Guarantee test alone, rather than overall DTP goals.

The boiler characterization tests specified in the DTP include:

1. 10% load testing
2. Ramp testing
3. Boiler inspection outage
4. Boiler performance testing

The results of the 100% load testing and the boiler performance testing are included in this report. The tests were conducted in March 1999 by Foster Wheeler and witnessed by Stone & Webster. The ramp testing and boiler inspection occurred December, 1999 during the 90-Day Commercial Operations Test, as required by the Power Sales Agreement between GVEA and AIDEA. The Engineer required to conduct the Date of Commercial Operations Test specified the boiler inspection and material samples to be taken. These results are reported in the Topical Report titled "90-day Commercial Operation Test and Sustained Operations Report: A Participant's Perspective," which as of the writing of this report has not been finalized.

3.0 Description

General

The technologies to be demonstrated in the HCCP combine the TRW Clean Coal Combustion System and the B&W/Joy Activated Recycle SDA System into a single, integrated, combustion/control process. These technologies have been designed to achieve reductions in emission of sulfur dioxide (SO_2), oxides of nitrogen (NO_X), and particulates, while meeting future energy needs from coal-fired generation in an environmentally acceptable manner. The integrated air pollution control process that results from the HCCP configuration of components has been designed to minimize emissions of SO_2, NO_x, and particulates from the facility while firing a broad range of coals. Figure 1, appendix E, is a functional schematic of the TRW Clean Coal Combustion System.

Clean Coal Combustors and Boiler

NO_x emissions are reduced in the coal combustion process by use of the fuel and air-staged combustor system and a boiler that controls fuel and thermal-related conditions that inhibit NO_x formation. The combustor and boiler functions as a limestone calciner and first stage SO_2 removal device in addition to its heat recovery function. A single spray dryer absorber vessel accomplishes secondary and tertiary SO_2 capture.

The TRW Clean Coal Combustion System (also referred to as the slagging combustors) has been designed for installation on the boiler furnace to provide efficient combustion, maintain effective limestone calcination, and minimize the formation of NO_x emissions. Its main components include a precombustor, main combustor, slag recovery section, tertiary air windbox, pulverized coal and limestone feed system, and combustion air system. Ash collection in the process is first achieved by the removal of molten slag in the coal combustors followed by fly ash particulate removal in the bag filter system downstream of the spray dryer absorber vessel. In HCCP, the slagging combustors are bottom mounted on the boiler hopper because of spatial constraints. The combustors may be side mounted on the furnace walls depending upon the specific application.

The coal-fired precombustor is used to increase the air inlet temperature to the main combustor for optimum slagging performance. It burns approximately 25-40 percent of the total coal input to the combustor. Combustion is staged to minimize NO_x formation. The main slagging combustor consists of a water-cooled cylinder, which is sloped toward a slag opening. The remaining coal is injected axially into the combustor, rapidly entrained by the swirling precombustor gases and additional airflow, and burned under substoichiometric (fuel-rich) conditions for NO_x control. The ash contained in the burning coal forms drops of molten slag and accumulates on the water-cooled walls as a result of the centrifugal force resulting from the swirling gas flow. The molten slag is driven by aerodynamic and gravity forces through a slot into the bottom of the slag recovery section where it falls into a water-filled tank and is removed by the slag removal system. Approximately 80 percent of the ash in the coal is removed as molten slag.

The hot gas, containing carbon monoxide and hydrogen, is then ducted to the furnace from the slag recovery section through the hot gas exhaust duct. To ensure complete combustion in the furnace, additional air is supplied from the tertiary air windbox to NO_x control ports and, if required, to final overfire air ports located in the furnace.

Pulverized limestone is fed into each combustor for SO_2 control. While passing into the boiler most of the limestone is decomposed to flash calcined lime by the following reaction:

$CaCO_3$ + heat => CaO + CO_2

The mixture of this lime and the ash not removed by the combustors is called Flash Calcined Material (FCM). Some sulfur capture by the entrained CaO occurs at this time, but the primary SO_2 removal mechanism is through the multiple step process described below, of spray drying the slurried and activated FCM solids.

Emissions of NO_x have been demonstrated at both utility and industrial scales to levels significantly below EPA New Source Performance Standards (NSPS) in the boiler by using the TRW Clean Coal Combustor technology and known combustion techniques within the furnace. The low NO_x emission levels are achieved simultaneously with low CO emission and high carbon burnout.

The TRW Clean Coal combustors achieve NO_x control as a combination of the following two factors:

1. The combustor functions as a well-stirred reactor under substoichiometric conditions for solid fuel combustion; converting the solid fuel components to a hot, partially oxidized fuel gas in an environment conducive to destroying the complex organic fuel bound nitrogen compounds which could easily be oxidized to NO_x in the presence of excess oxygen.

2. The combustor water-cooled enclosure additionally absorbs approximately 10 to 25 percent of the total available heat input to the combustor.

These two conditions together reduce the potential for encountering combustion temperatures in the furnace sufficient for decomposition of molecular nitrogen compounds in the combustion air into forms which can produce thermal NO_x emissions as excess oxygen is made available.

When the exhaust gases leave the combustor, the coal has already been mixed with approximately 80 to 90 percent of the air theoretically necessary to complete combustion. A portion of the remaining 10 to 20 percent of the air is then allowed to mix slowly with the hot fuel gases exiting the combustor and entering the furnace. The hot gases radiate their heat to the furnace walls at rates faster than combustion is allowed to occur so that gas temperatures slowly decay from those at the furnace entrance. After the furnace gases have cooled sufficiently, a second stage of furnace combustion air injection is performed as necessary to complete the coal combustion process in an oxidizing, controlled manner so that combustion gas temperatures are maintained below the thermal NO_x floor where significant NO_x formation begins. This is in contrast with a traditional coal-fired furnace where the pulverized coal is burned in suspension at high excess air rates. Resulting gas temperatures from pulverized coal furnaces typically rise significantly above the 3100° F temperature (in a reducing atmosphere) maintained in the slagging combustor and 2700^0 F (in an oxidizing atmosphere) maintained in the furnace. In the traditional furnace, the pulverized coal is relatively poorly mixed with conventional low NO_x wall burner/suspension firing techniques, and local areas of combustion in the presence of stoichiometric oxygen create hot zones within the flame. These hot, turbulent stoichiometric zones can produce significant NO_x levels in the area of burner throats. This tendency for high, localized NO_x formation is minimized with the slagging combustor through slow, controlled mixing of furnace combustion air with the partially cooled, well-mixed fuel gases discharging from the combustor into the lower furnace NO_x control zone.

SDA System and Pulse-jet Baghouse

Once FCM is produced in the furnace, it is removed in bag filter system. A portion of the material is transported to disposal. Most of the material however, is conveyed to a mixing tank, where it is mixed with water to form 45% FCM solids slurry. The lime-rich FCM material is slaked by agitation of the suspension. A portion of the slurry from the mixing tank passes directly through a screen to the feed tank, where the slurry is continuously agitated. The remainder of the slurry leaving the mixing tank is pumped to a grinding mill, where the suspension is further mechanically activated by abrasive grinding.

By grinding the slurry in a mill, the FCM is activated by a mechanical process whereby the overall surface area of available lime is increased, and coarse lime particle formation is avoided. Thus, the mill enhances the slaking condition of the FCM, and increases the surface area for optimal SO_2 absorption. FCM slurry leaving the tower mill is transported through the screen to the feed tank.

Feed slurry is pumped from the feed tank to the SDA, where it is atomized via rotary atomization using B&W/Joy dry scrubbing technology. SO_2 in the flue gas reacts with the FCM slurry as water is simultaneously evaporated. The dry reaction product is removed via the SDA hopper or bag filter catch. SO_2 is further removed from the flue gas by reacting with the dry FCM in the baghouse.

Particulate emissions control on the HCCP is obtained via the slagging combustors and by the pulsejet bag filter house. Each of ten bag filter compartments will contain 225 six-inch diameter fiberglass bags. The effective length of each bag is 20-feet and the gross air-to-cloth ratio is 2.8:1. The DTP will demonstrate the effectiveness of the HCCP pulsejet baghouse in removing FCM particulate emissions.

4.0 Methodology

The main purpose of the testing was to demonstrate unit performance in meeting the boiler contract performance guarantees the Foster Wheeler/AIDEA Contract No. HCP-009. The DTP methodology was used as a guideline only.

In March, 1999, tests were performed at 100% and 60% maximum continuous rating (MCR) outputs. The test performed at 100% MCR output use a coal with an average heating value of 7025 Btu/lb. The test performed at 60% MCR output used a coal with an average heating value of 6487 Btu/lb. The coal heating value was determined by analysis of coal samples taken from the coal feeders during the test.

Guaranteed values along with test values are listed in the Stone & Webster Review of HCCP Boiler Performance Guarantee Test Report – July 1, 1999, Appendix A. Unit guarantees are at 100% MCR only except for steam temperature which is guaranteed at 60% MCR. Test procedures were reviewed by GVEA and their comments are provided in Appendix C. Stone & Webster's response to GVEA comments is provided in Appendix B.

The Foster Wheeler steam generator is top supported, two (2) drum, and natural circulation, balanced draft boiler designed specifically for firing pulverized coal. The boiler is rated for 490,000 lb/hr steam flow at 1300 psig and 955° F. The boiler is fired with two (2) slagging combustors supplied by TRW. Pulverized coal is supplied to the combustors from two (2) Foster Wheeler 21.5 pulverizers.

The test procedure was as follows:

1. The 100% MCR test was conducted for four (4) hours at the required 490,000 lb/hr steam flow rating with the guaranteed pressure and temperature. Excess air was targeted at 18%, measured oxygen (O_2) during the test was 2.79%. O_2 was measured at the economizer outlet with plant instrumentation. The O_2 analyzers were calibrated prior to the testing. The 60% MCR test was conducted for approximately two (2) hours with 294,000 lb/hr steam flow and at the guaranteed temperature.

2. Prior to each test, all the original design sootblowers were operated and then isolated during the testing. Blowdown lines were closed prior to the start of testing.

3. Raw coal samples were collected from both feeders every hour from the sampling connection on the feeders. These coal samples, at the end of the tests, were thoroughly mixed together and quartered. Two portions of the sample was given to AIDEA for independent analysis, one portion given to GVEA, and one portion was kept by Foster Wheeler for analysis. Foster Wheeler coal samples were analyzed for proximate/ultimate analysis, higher heating value, Hargrove index for hardness, and ash fusion temperature. Results of the analysis are presented in Appendix A.

4. Fly ash, bottom ash, and pulverized coal samples were not required and thus were not taken during the testing.

During each of the tests, boiler data was recorded on a continuous basis by AIDEA using the plant distributed control system (DCS). Copies of the DCS boiler data; taken at 12 minute intervals and continuous data were given to all parties involved in the testing. The large quantity of raw data taken continuously during the testing is available on compact disc.

5.0 Results

Table 1, shown in Appendix A, Stone & Webster Review of HCCP Boiler Performance Guarantee Test Report – July 1, 1999 shows the Boiler Performance Guarantee Requirements cross referenced with the test values. Instrument calibration data for the tests are documented in Attachment 1 of that report. Critical boiler performance guarantees were maximum steam flow 490,000 lb/hr, pulverizer and forced draft fan power consumption of 330 kW and 3150 kW, respectively and steam pressure and temperature of 1300 psig and 955° F, respectively. Boiler efficiency was predicted to be 79.15%. These performance levels were achieved.

The specific results are as follows:

Steam Capacity, Pressure, and Temperature – 100% MCR Test

Steam flow, feed water flow, and superheat spray values were measured by plant instrumentation and were indicated by the plant DCS. The 100% MCR steam flow was recorded at 493,865 lb/hr average for the test period. The average superheat outlet pressure and temperature were 1308 psig and 957° F respectively for the test period. The guarantee boiler capacity of 490,000 lb/hr and guarantee superheater outlet pressure temperature of 1300 psig and 955° F are therefore met.

Motor Power Consumption

The pulverizer and forced draft motors have power guarantees. Motor amp and bus voltage readings were taken during the test periods. The calculated pulverizer motor power output during the 100% MCR test was 213.6 kW and 204.4 kW for A & B mills, respectively. These values are below the 330 kW guarantee value.

Motor amp and bus voltage readings were taken for the forced draft (FD) fan motor during the 100% MCR test. The calculated power output for this motor is 1492 kW. This value is below the 3150 kW guarantee value.

Pulverizer and FD Fan shaft input power was calculated using the following equation:

kW = (Volts x Amps x 1.732 x PF x EFF) /1000

PF is the power factor and EFF is efficiency and are taken from the manufacturers data sheets for the various motors. These sheets are presented in Appendix A.

Pressure Drops

The following are the guaranteed values that were verified during the test:

Fluid Pressure Loss between the Drum and The Superheater Outlet
The drum pressure during the 100% MCR test was 1336 psig and the superheat outlet pressure was 1251.2 psig, a drop of 84.8 psig. This 84.8 psig pressure loss is less than the 126 psig guarantee.

Fluid Pressure Loss between the Economizer Inlet and The Drum
The drum pressure during the 100% MCR test was 1336 psig and the economizer inlet pressure was 1375.3 psig, a loss of 39.3 psig. This 39.3 psig pressure loss is less than the 50 psig guarantee.

Draft Loss between Furnace to Gas Outlet of Main Tubular Air Preheater
The main tubular air heater gas outlet pressure during the 100% MCR was -16.84 in. of water gauge (WG) and the furnace pressure was -0.93 in. WG. The net pressure drop was + 15.9 in. WG. This pressure drop is less than the 19 in. WG guaranteed pressure drop.

Efficiency and Efficiency Calculation Methods

Test data has been used to calculate boiler efficiency, a key performance indicator. Boiler efficiency results are provided in Appendix B, HCCP Boiler Efficiency Calculation, August 24, 1999. Within the accuracy of available test data. Stone & Webster has calculated a full load boiler efficiency of 82.2% and part load boiler efficiency of 79.6% based on full load and part load test data respectively. Foster Wheeler did not guarantee efficiency due to the innovative nature of the boiler and combustor design. However, the technology performance was based on a Foster Wheeler predicted efficiency of 79.15%.

Although boiler efficiency was not a guaranteed parameter of the AIDEA/Foster Wheeler contract, it is of general interest in the context of boiler performance. Two methods have been used to calculate HCCP boiler efficiency based on data collected during the boiler tests. J. S. Strandberg Consulting Engineers, Inc., GVEA's consultants, calculated 80.2% using the input/output method shown in Appendix B, while Stone & Webster used the heat loss method. Both of these methods are potentially acceptable. The following is a discussion of the use of these calculation approaches in determining boiler efficiency estimates for the HCCP and is also included in Appendix D.

The major difference between the input/output method and the heat loss method are the parameters that are used to calculate efficiency. These differences are summarized below:

* The input/output method used in the Strandberg Status Report uses the fuel flow/heating value, the steam, water and air flows, and temperatures to calculate efficiency. The results are summarized in Appendix C, HCCP Boiler Performance Test, August 24, 1998.

* The heat loss method used in the Stone & Webster calculation uses the gas and air temperatures, ultimate fuel analysis, flue gas oxygen content, unburned carbon in the ash, radiation loss, and slag tap loss.

The input/output method relies on flow measurements that are inherently less accurate than the measurements that are required for the heat loss method. The combination of inaccuracies in the coal and steam flows could impact the efficiency calculation by ± 2% - 4%. When sufficient information is available to calculate the boiler efficiency using the heat loss method, doing so will generally result in a more accurate estimate of boiler efficiency. In the case of the HCCP test, sufficient data was collected to use the heat loss method and Stone & Webster recommended that it be considered the accepted method. Stone & Webster's recommendations are provided in Appendix D, HCCP Boiler Efficiency Calculation, November 2, 1999.

It is noted that the data collected during the Boiler Performance testing program was to verify contract guarantees and not specifically intended to be used for establishing boiler efficiency. Therefore, the accuracy/availability of some of the data required for a firm efficiency calculation was not available.

The following comments are made pertaining to the data that is available for the efficiency calculation:

* Regarding the input/output efficiency calculation performed by Strandberg Consultants, there is a large discrepancy in the results with the Stone & Webster heat loss efficiency results. The difference in fuel analysis between the values reported in the Foster Wheeler report, which was verifiably collected during the boiler performance test, and the Usibelli Coal Mine "grab sample and increment samples" dated 3/29/99 whose origin is unknown may be a contributing factor. The Foster Wheeler report indicates a higher heating value of 7,025 Btu/lb and the Usibelli Coal Mine reports a 7,300 Btu/lb heating value from the plant conveyor coal sampler. Stone & Webster recommends that the Foster Wheeler coal analysis be used for all boiler efficiency calculations as it represents the actual coal fired during the test. A referee sample of the test coal is being held by AIDEA to resolve this issue if it should become necessary.

* The boiler and slagging combustor tap losses predicted by Foster Wheeler were originally provided from a TRW heat balance dated 2/22/93. These were predicted losses, based on pilot combustor data, which has been determined to be conservative for design purposes. These losses impact boiler efficiency. This would account for a substantial portion of the difference between the Foster Wheeler prediction and the actual tested efficiencies.

The UBC and slag tap losses predicted by FWEC were originally provided from a TRW heat balance dated 2/22/93. These were predicted losses, based on analytical model predictions which were anchored to industrial-scale combustor data and included conservative assumptions for a "worst-case" design basis. This would account for a substantial portion of the difference between the Foster Wheeler predicted and actual tested efficiencies.

Given the significant difference in coal analysis used in the respective calculations, and the independent method of calculating the slag tap heat loss, Stone & Webster has determined that the heat loss methodology described herin provides a more accurate measure of boiler efficiency. Based on the heat loss method, the full load boiler efficiency is approximately 82.2% and the part load boiler efficiency is approximately 79.6%.

6.0 Conclusions

The boiler performance test documented that the boiler in conjunction with the combustors operated as anticipated. All guarantees were met as shown in the following critical results from Table 1:

Parameter	Guarantee or Predicted	Actual
Maximum steam flow	490,000 lb/hr	493,865 lb/hr
Pulverizer power	330 kW	213.6 kW shaft input power A
		204.4 kW shaft input power B
Forced draft fan power	3150 kW	1492 kW
Steam pressure	1300 psig	1308 psig
Steam temperature	955° F	957° F
Boiler efficiency	79.15%	82.2%

The tests also provided some useful information including:

1. Efficiency losses due to the 9-foot combustor slag tap opening are far less than anticipated by TRW and FW. HCCP is designed with an insert to reduce the opening size. If further efficiency gains are desired, the insert could be used to reduce the opening to 7 feet. However, this would increase the likelihood of bridging by the slag across the opening and possible subsequent plugging of the slag tap opening.

2. FD fan power was considerably less than anticipated due to reduced requirements for combustion air and pressure losses in the ductwork.

3. All MCR guarantees were met with 46% waste coal.

4. All predicted efficiency levels were satisfied at part load with 78% waste coal.

REFERENCES

90-day Commercial Operation Test and Sustained Operations Report: A Participant's Perspective, not finalized as of writing of this report

Boiler Performance Guarantee Test Program and Procedures, November 23, 1998

Stone & Webster Review of HCCP Boiler Performance Guarantee Test Report, July 1, 1999

Power Sales Agreement between AIDEA and GVEA, November 1991

Stone & Webster HCCP Boiler Efficiency Calculation, August 24, 1999

Golden Valley Electric HCCP Boiler Performance Test, October 13, 1998

Stone & Webster Engineering HCCP Boiler Efficiency Calculations, November 2, 1999

Strandberg Status Report Boiler Performance Guarantee Tests, June 2, 1999

ACRONYMS & ABBREVIATIONS

AIDEA	Alaska Industrial Development and Export Authority
B&W	Babcock & Wilcox
DCS	Distributed Control System
DOE	U.S. Department of Energy
DTP	Demonstration Test Program
EFF	Efficiency
F	Fahrenheit
FCM	Flash Calcined Material
FD	Forced Draft
Foster Wheeler	Foster Wheeler Energy Corporation
GVEA	Golden Valley Electric Association
HCCP	Healy Clean Coal Project
MCR	Maximum Continuous Rating
MW	Megawatts
NSPS	New Source Performance Standards
PF	Power Factor
Stone & Webster	Stone & Webster Engineering Corporation
SDA	Spray Dryer Absorber
WG	Water Guage

Appendix A

Stone & Webster Review of HCCP Boiler Performance Guarantee Test –
July 1, 1999

STONE & WEBSTER REVIEW OF
HCCP BOILER PERFORMANCE
GUARANTEE TEST
July 1, 1999

Stone & Webster

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KUALA LUMPUR, MALAYSIA
KUWAIT CITY, KUWAIT
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JAKARTA, INDONESIA
SEOUL, KOREA
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July 1, 1999
J.O. No. 07440.01

HCCP BOILER PERFORMANCE
GUARANTEE TEST

Dear Mr. McCrohan:

The Foster Wheeler boiler performance guarantee test for the Healy Clean Coal Project was executed on March 29 and 30, 1999. The test was directed by Ed LePage of Foster Wheeler Energy Corporation (FWEC) in accordance with their "Boiler Performance Guarantee Test Program and Procedures" document, dated November 23, 1998. The test was witnessed by Jim Knowlton of Stone & Webster Engineers and Constructors, Inc. and observed by John Zarling of Strandberg Engineers.

It is Stone & Webster's opinion that the boiler guarantees as presented in Table 1 were satisfactorily met since proof of proper operation of the superheat outlet steam temperature element was provided. Post-test calibration of this temperature element to 1,000 degrees F establishes continuity with similar data obtained from the 1997 calibration of the temperature element.

Instrument calibration data for the tests are documented in Attachment 1. The FWEC Performance Testing report, S&W's responses to GVEA questions regarding the tests, and Contract Change No. 7 (with Addenda) are presented in Attachments 2, 3 and 4, respectively.

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If you have questions or comments concerning this matter, please do not hesitate to call me at (617) 589-1888, or Verle Bland at (303) 741-7684.

Very truly yours,

Verle Bland for

Jim Knowlton
Senior Engineer

JK/VVB/KNC

Attachments:
1) Instrument Calibration data sheets
2) FWEC Performance Testing Report No. CR-351
3) S&W responses to GVEA questions and comments regarding the boiler performance guarantee tests
4) Contract Change No. 7/Addendum 1/Addendum 5

Table 1
Boiler Perfromance Guarantee Requirements and Test Values

Parameter	Units	Guarantee Value	Tolerance	Test Value	Comments	Tag No.	Cal Date
Superheater outlet steam flow	lb/hr	490,000	-0	493,865	Steam flow confirmed by sum of the feedwater flow plus attemperator spray flow = 499,986 lb/hr	2FWFT26	9-23-1998
Superheater outlet steam pressure	psig	1300		1308		2BSPT14/2MSPT10	9-23-1998/9-24-1998
Superheater outlet steam temperature	degrees F	955	+/-10	957	Thermocouple accuracy not confirmed	2MSTE05	7-15-1997
Steam side pressure loss	psig	126	+0	84.8		2MSPT82/2MSPT83	9-24-1998
Water side pressure loss	psig	50	+0	39.3		2FWPT39	12-28-98
Flue gas draft loss	in H2O	19	+0	15.9		2BAPT21C/2FGPT09	12-22-98/3-11-1999
Maximum forced draft fan power at its guarantee performance conditions	kw	3150	+0	1492		Read Manually	
Maximum pulverizer gearbox shaft input power A	kw	330	+0	213.6		Read Manually	
Maximum pulverizer gearbox shaft input power B	kw	330	+0	204.4		Read Manually	
Excess Air	%	18		22	Approximately 4 delta percent excess air above contract set point		
Superheater outlet steam flow	lb/hr	294,000	-0	295,124	Steam flow confirmed by sum of the feedwater flow plus attemperator spray flow = 292,418 lb/hr (or 0.5% below target)		
Superheater outlet steam pressure	psig	1300		1295			
Superheater outlet steam temperature	degrees F	955	+/-10	954	Thermocouple accuracy not confirmed		
Testing of the following were either not possible or not required as Indicated							
Superheater outlet steam flow	lb/hr	75,000	-0		Testing was not conducted at this condition since it is not possible to operate the boiler on one combustor firing at a this low level		
Solids carryover					low NOx burner retrofit only		
Gas outlet temperature					low NOx burner retrofit only		
Total air to gas air heater leakage					not specified		
Flue gas flow					low NOx burner retrofit only		
Pulverizer fineness					low NOx burner retrofit only		
Boiler efficiency loss					low NOx burner retrofit only		
Emissions guarantee					low NOx burner retrofit only		

ATTACHMENT 1
Instrument Calibration Data Sheets

Branom Instrument Co.
Manufacturers' Representatives & Master Distributors
SINCE 1947
BRANOM INSTRUMENTATION

• For TIME • FLOW
• TEMPERATURE • LEVEL
• PRESSURE • CONTROL SYSTEMS

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HOME OFFICE
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5500 Fourth Ave. South
Seattle, WA 98108-0307
1-206-762-6050
FAX 1-206-767-5669

WASHINGTON
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Richland, WA 99352-1302
1-509-943-6664
FAX 1-509-736-5453
1-800-422-5796

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North 626 Helena
Spokane, WA 99202
1-509-534-9395 or 9396
FAX 1-509-534-9397
1-800-257-3047

OREGON
PORTLAND OFFICE
8435 N. Interstate Place
Portland, OR 97217-3196
1-503-283-2555
FAX 1-503-283-2652
EUGENE 1-503-683-2707
1-800-452-4454

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BOISE
1-208-336-5444
1-800-257-3047

ALASKA & BRITISH COLUMBIA
Call 1-800-654-8205

UTAH
Call 1-800-257-3347

INSTRUMENT CERTIFICATION REPORT

Certification of Accuracy

This instrument has been calibrated to manufacturer's specifications and is traceable to NIST and in accordance with MIL STD 45622A, ISO9000, and ANSI/ASQC Q9002 procedures.

Date: June 21, 1999

Purchase Order #: 980033-0643

Customer Name: JP Dokoozian & Associates
92057

Address: 406 W. Fireweed Ln. #101
Anchorage, AK 99503-2649

Instrument Make: T/C Assembly   Model: Type K, Dual Element   Serial Number: TMS-TE05

Calibration Standard: Techne Calibrator, Fluke 701   Serial Number: 30524/18, 6920103

Standard	Instrument	Standard	Instrument	Standard	Instrument
Standard	Element A	Standard	Element A	Standard	Element A
0 Deg. F	-.3 Deg. F	450 Deg. F	450.4 Deg. F	900 Deg. F	898.00 Deg. F
50 Deg. F	49.7 Deg. F	500 Deg. F	500.6 Deg. F	910 Deg. F	908.00 Deg. F
100 Deg. F	99.7 Deg. F	550 Deg. F	550.5 Deg. F	920 Deg. F	918.40 Deg. F
150 Deg. F	150.2 Deg. F	600 Deg. F	600.65 Deg. F	930 Deg. F	928.00 Deg. F
200 Deg. F	200.5 Deg. F	650 Deg. F	651.25 Deg. F	940 Deg. F	938.2 Deg. F
250 Deg. F	250.5 Deg. F	700 Deg. F	701.75 Deg. F	950 Deg. F	948.2 Deg. F
300 Deg. F	300.95 Deg. F	750 Deg. F	752.00 Deg. F	960 Deg. F	957.7 Deg. F
350 Deg. F	350.6 Deg. F	800 Deg. F	802.65 Deg. F	970 Deg. F	968.00 Deg. F
400 Deg. F	400.3 Deg. F	850 Deg. F	848.45 Deg. F	980 Deg. F	977.8 Deg. F

Remarks: All tests have been performed in accordance with all applicable requirements of MIL-Q-9858A, MIL-Q-45208A and MIL-STD-45662A with test equipment certified to standards traceable to the National Institute of Standards and Technology. The tested instrument is certified to be accurate to manufacturers specifications.

Applicable NIST. No's:

Comments: Tested at customer provided points

LAB Temperature: 70 F

LAB Humidity: 47%

Recertification Due: 6/21/00

Tech.: Frank W. Kerns

Q.A. Manager: Troy Perkins

Branom Instrument Co.

Manufacturers' Representatives & Master Distributors
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EUGENE 1-503-683-2707
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1-800-287-3047

ALASKA & BRITISH COLUMBIA
Call 1-800-454-8205

UTAH
Call 1-800-257-3047

INSTRUMENT CERTIFICATION REPORT

Certification of Accuracy

This instrument has been calibrated to manufacturer's specifications and is traceable to NIST and in accordance with MIL STD 45622A, ISO9000, and ANSI/ASQC Q9002 procedures.

Date: June 21, 1999
Purchase Order #: 980033-0643

Customer Name: JP Dokoozian & Associates
Address: 406 W. Fireweed Ln. #101, Anchorage, AK 99503-2649

92057

Instrument Make: T/C Assembly Model: Type K, Dual Element Serial Number: TMS-TE05

Calibration Standard: Techne Calibrator, Fluke 701 Serial Number: 30524/18, 6920103

Standard	Instrument	Standard	Instrument	Standard	Instrument
Standard	Element A				
990 Deg. F	988.15 Deg. F				
1000 Deg. F	998.00 Deg. F				

Remarks: All tests have been performed in accordance with all applicable requirements of MIL-Q-9858A, MIL-Q-45208A and MIL-STD-45662A with test equipment certified to standards traceable to the National Institute of Standards and Technology. The tested instrument is certified to be accurate to manufacturers specifications.

Applicable NIST. No's:

Comments: Tested at customer provided points

LAB Temperature: 70 F
LAB Humidity: 47%
Recertification Due: 6/21/00

Tech.: Frank W. Kerns
Q.A. Manager: Troy Perkins

INSTRUMENT CONDITION FOUND REPORT

BRANOM INSTRUMENT COMPANY
1-800-767-6051

Date 6/21/99
Purchase Order # 980033-0643

Customer Name JP Dokoozian & Associates Address 406 W. Fireweed Ln. #101
Anchorage, AK 99503-2469

Instrument Make T/C Assembly Model Type K, Dual Element Serial Number TMS-TE05 Element A

Calibration Standard Techne Calibrator, Fluke 701 Serial Number 30524/18, 6920103

STANDARD	INSTRUMENT READING	STANDARD	INSTRUMENT READING
0 F	-.3 F	550 F	550.5 F
50 F	49.7 F	600 F	600.65 F
100 F	99.7 F	650 F	651.25 F
150 F	150.2 F	700 F	701.75 F
200 F	200.5 F	750 F	752 F
250 F	250.5 F	800 F	802.65 F
300 F	300.95 F	850 F	848.45 F
400 F	400.3 F	900 F	898.00 F
450 F	450.4 F	910 F	908.00 F
500 F	500.6 F	920 F	918.40 F

CONDITION FOUND: within specs. for accuracy

RECOMMENDATION: certify as needed.

TEST TECHNICIAN

INSTRUMENT CONDITION FOUND REPORT

BRANOM INSTRUMENT COMPANY
1-800-767-6051

Date 6/21/99

Purchase Order # 980033-0643

Customer Name JP Dokoozian & Associates Address 406 W. Fireweed Ln. #101
Anchorage, AK 99503-2469

Instrument Make T/C Assembly Model Type K, Dual Element Serial Number TMS-TE05 Element A

Calibration Standard Techne Calibrator, Fluke 701 Serial Number 30524/18, 6920103

STANDARD	INSTRUMENT READING	STANDARD	INSTRUMENT READING
930 F	928 F		
940 F	938.2 F		
950 F	948.2 F		
960 F	957.7 F		
970 F	968 F		
980 F	977.8 F		
990 F	988.15 F		
1000 F	998 F		

CONDITION FOUND: within specs. for accuracy

RECOMMENDATION: certify as needed

TEST TECHNICIAN

Branom Instrument Co.

Manufacturers' Representatives & Master Distributors
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INSTRUMENT CERTIFICATION REPORT

Certification of Accuracy

This instrument has been calibrated to manufacturer's specifications and is traceable to NIST and in accordance with MIL STD 45622A, ISO9000, and ANSI/ASQC Q9002 procedures.

Date: June 21, 1999
Purchase Order #: 980033-0643

Customer Name: JP Dokoozian & Associates 92057
Address: 406 W. Fireweed Ln. #101, Anchorage, AK 99503-2649

Instrument Make: T/C Assembly
Model: Type K, Dual Element
Serial Number: TMS-TE05

Calibration Standard: Techne Calibrator, Fluke 701
Serial Number: 30524/18, 6920103

Standard	Instrument	Standard	Instrument	Standard	Instrument
Standard	Element B	Standard	Element B	Standard	Element B
0 Deg. F	-.3 Deg. F	450 Deg. F	450.55 Deg. F	900 Deg. F	901.75 Deg. F
50 Deg. F	49.7 Deg. F	500 Deg. F	500.65 Deg. F	910 Deg. F	911.35 Deg. F
100 Deg. F	99.7 Deg. F	550 Deg. F	550.7 Deg. F	920 Deg. F	918.4 Deg. F
150 Deg. F	150.2 Deg. F	600 Deg. F	600.7 Deg. F	930 Deg. F	928.2 Deg. F
200 Deg. F	200.5 Deg. F	650 Deg. F	651.3 Deg. F	940 Deg. F	938.2 Deg. F
250 Deg. F	250.5 Deg. F	700 Deg. F	701.8 Deg. F	950 Deg. F	948.2 Deg. F
300 Deg. F	300.95 Deg. F	750 Deg. F	752.10 Deg. F	960 Deg. F	957.7 Deg. F
350 Deg. F	350.6 Deg. F	800 Deg. F	802.75 Deg. F	970 Deg. F	968 Deg. F
400 Deg. F	400.3 Deg. F	850 Deg. F	852 Deg. F	980 Deg. F	977.8 Deg. F

Remarks: All tests have been performed in accordance with all applicable requirements of MIL-Q-9858A, MIL-Q-45208A and MIL-STD-45662A with test equipment certified to standards traceable to the National Institute of Standards and Technology. The tested instrument is certified to be accurate to manufacturers specifications.

Applicable NIST. No's:
Comments: Tested at customer provided points

LAB Temperature: 70 F
LAB Humidity: 47%
Recertification Due: 6/21/00

Tech.: Frank W. Kerns
Q.A. Manager: Troy Perkins

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Call 1-800-654-6203

UTAH
Call 1-800-257-3047

INSTRUMENT CERTIFICATION REPORT

Certification of Accuracy

This instrument has been calibrated to manufacturer's specifications and is traceable to NIST and in accordance with MIL STD 45622A, ISO9000, and ANSI/ASQC Q9002 procedures.

Date: June 21, 1999

Purchase Order # 980033-0643

Customer Name: JP Dokoozian & Associates 92057

Address: 406 W. Fireweed Ln. #101, Anchorage, AK 99503-2649

Instrument Make: T/C Assembly Model: Type K, Dual Element Serial Number: TMS-TE05

Calibration Standard: Techne Calibrator, Fluke 701 Serial Number: 30524/18, 6920103

Standard	Instrument	Standard	Instrument	Standard	Instrument
Standard	Element B				
990 Deg. F	988.15 Deg. F				
1000 Deg. F	998.00 Deg. F				

Remarks: All tests have been performed in accordance with all applicable requirements of MIL-Q-9858A, MIL-Q-45208A and MIL-STD-45662A with test equipment certified to standards traceable to the National Institute of Standards and Technology. The tested instrument is certified to be accurate to manufacturers specifications.

Applicable NIST. No's:

Comments: Tested at customer provided points

LAB Temperature: 70 F

LAB Humidity: 47%

Recertification Due: 6/21/00

Tech. [signature] Frank W. Kerns

Q.A. Manager [signature] Troy Perkins

INSTRUMENT CONDITION FOUND REPORT

BRANOM INSTRUMENT COMPANY
1-800-767-6051

RECEIVED

Alaska Industrial Development and Export Authority
Healy Clean Coal Project

Date 6/21/99

Purchase Order # 980033-0643

Customer Name JP Dokoozian & Associates Address 406 W. Fireweed Ln. #101
Anchorage, AK 99503-2469

Instrument Make T/C Assembly Model Type K, Dual Element Serial Number TMS-TE05 Element B

Calibration Standard Techne Calibrator, Fluke 701 Serial Number 30524/18, 6920103

STANDARD	INSTRUMENT READING	STANDARD	INSTRUMENT READING
0 F	-.3 F	500 F	500.65 F
50 F	49.7 F	550 F	550.7 F
100 F	99.7 F	600 F	600.7 F
150 F	150.2 F	650 F	651.3 F
200 F	200.5 F	700 F	701.8 F
250 F	250.5 F	750 F	752.10 F
300 F	300.95 F	800 F	802.75 F
350 F	350.6 F	850 F	852 F
400 F	400.3 F	900 F	901.75 F
450 F	450.55 F	910 F	911.35 F

CONDITION FOUND: within specs. for accuracy

RECOMMENDATION: certify as needed

TEST TECHNICIAN

CH ☒ DVM ☐ SWEC ☐ FA/C G/A ☐
DH ☐ JBO ☐ DM/HCP ☐ DE/GVEA ☐
CG ☐ WRS ☐ R File ☐ Orig. REM ☐
REM ☐ Other Jim Knowlton File 4000

INSTRUMENT CONDITION FOUND REPORT

BRANOM INSTRUMENT COMPANY
1-800-767-6051

Date 6/21/99
Purchase Order # 980033-0643

Customer Name JP Dokoozian & Associates Address 406 W. Fireweed Ln. #101
Anchorage, AK 99503-2469

Instrument Make T/C Assembly Model Type K, Dual Element Serial Number TMS-TE05 Element B

Calibration Standard Techne Calibrator, Fluke 701 Serial Number 30524/18, 6920103

STANDARD	INSTRUMENT READING	STANDARD	INSTRUMENT READING
920 F	918.4 F		
930 F	928.2 F		
940 F	938.2 F		
950 F	948.2 F		
960 F	957.7 F		
970 F	968 F		
980 F	977.8 F		
990 F	988.18 F		
1000 F	998.00 F		

CONDITION FOUND: within specs. for accuracy

RECOMMENDATION: certify as needed

TEST TECHNICIAN

H.C. PRICE CO.

MISCELLANEOUS DEVIC

DATE	SYSTEM	LOCATION	
5.5.97		BENCH CHECK	
EQUIPMENT TYPE / MANUFACTURER			TAG NO.
EWEC TYPE K DUAL ELEMENT			2HS-TE05

DATA

INPUT TEMP	EXPECTED	ACTUAL
1ST		
32°F	32°F	32°F
975°F	975°F	977°F
2ND		
32°F	32°F	32°F
975°F	975°F	977°F

REMARKS:

CALIBRATION EQUIPMENT USED:

TEMP CALIBRATOR HCP D30-804300

ICE BATH/THERMOMETER HCP D30-T129

THERMOCOUPLE CALIBRATOR HCP D30-TC33

PERFORMED BY: [signature] DATE: 5.5.97

WITNESSED BY: DATE:

WITNESSED BY: DATE:

FILE:123R4W \ hccp \ miscdev

H.C. PRICE CO.

MISC

DATE: 7-15-97
SYSTEM: MS
LOCATION: 1398 el H.8-
EQUIPMENT TYPE / MANUFACTURER: TEMPERATURE ELEMENT
TAG: 2

RANGE 0-1000°F

DATA

TYPE K

AMBIENT
~~[illegible]~~ TEMP
58

LOCAL T.E. TEMP	PCS TE
61	61

FORCED TEMP	PCS TE
0	-0
500	498
1000	999

REMARKS:

TRANSCAT HCP 030 T
DIGITAL THERMOMETER HCP 030 T

PERFORMED BY: Fred Pascoe DAT
WITNESSED BY: DAT
WITNESSED BY: J R Marta DAT

FILE:123R4W \ hccp \ misccalv

AIDEA/HCCP SITE CONSTRUCTION MANAGEMENT

ALASKA INDUSTRIAL DEVELOPMENT AND EXPORT AUTHORITY

ALASKA ENERGY AUTHORITY

HEALY CLEAN COAL PROJECT
TEMPERATURE INDICATOR CALIBRATION SHEET

Date 12/29/98 System 2M.S Location 1391' W Boiler

Equipment Type/Manufacturer T.C/OMEGA Tag No. 2MS-TE05

Snubber used: Yes ☐ No ☑ Cleaned ☐

Percent Input	Actual (Std)		TI Indication	
0	92°		92°	
25	212°		212°	
50	332°		331.9	
75	452°		452.5	
100	572°		573.6	
75	452°		452.3	
50	332°		332.1	
25	212°		212.3	
0	92°		91.9	

Remarks: Hart Drywell calibrator 5853T
Fluke 741B Process Calibrator

Performed by: Date:

Witnessed by: [signature] Date: 12/29/98

Witnessed by: [signature] Date: 12/29/98

AIDEA/HCCP SITE CONSTRUCTION MANAGEMENT

ALASKA INDUSTRIAL DEVELOPMENT AND EXPORT AUTHORITY

ALASKA ENERGY AUTHORITY

HEALY CLEAN COAL PROJECT

TEMPERATURE INDICATOR CALIBRATION SHEET

Date 12/29/98 System 2MS Location 1391' W Boi

Equipment Type/Manufacturer T.C/OMEGA Tag No. 2MS-TE05

Snubber used: Yes ☐ No ☑ Cleaned ☐

Percent Input	Actual (Std)	TI Indication
0	92°	92°
25	212°	212°
50	332°	331.9
75	452°	452.5
100	572°	573.6
75	452°	452.3
50	332°	332.1
25	212°	212.3
0	92°	91.9

Remarks: Hart Drywell calibrator 9853T
Fluke 741B Process Calibrator

Performed by: Date:

Witnessed by: Carl D Card Date: 12/29/98

Witnessed by: Howard E Stot Date: 12/29/98

AIDEA/HCCP SITE CONSTRUCTION MANAGEMENT

ALASKA INDUSTRIAL DEVELOPMENT AND EXPORT AUTHORITY

ALASKA ENERGY AUTHORITY

HEALY CLEAN COAL PROJECT
TRANSMITTER CALIBRATION & CONFIGURATION SHEET

Date 9-23-98 System BS Location 1391' West side of Boiler

Equipment Type/Manufacturer GAGE PTS / Bailey Tag No. 2BS-PT14

Mode:	☒ Analog	☐ Digital	____ Channel Number
Output Type:	☒ Linear	☐ Square Root	☐ Other
Output Action:	☒ Normal	☐ Reverse	
Damping:	4.0 sec. (0.00 to 32.00 seconds, default = 0.5 sec.)		
Engineering Units:	☐ H_2O (inch)	☐ HG (inch) ☒ PSI	☐ Other
Lower Range Value:	0 Specified LRV	Upper Range Value: 2000 Specified URV	
Initialize Mode:	X Low	____ High	
Fail Mode:	X Low	____ High	____ Last
Secondary Units:	4mA Secondary LRV	20mA Secondary URV	
Temperature Alarm:	-40°C Lower Temp Alarm	85°C Upper Temp Alarm	

% Input	Unit Input	Expected Output	Actual Output	DCS Reading
0	0	4mA	0 P.S.I	0 psi
25	500 psi	8 mA	8 mA	498.47 psi
50	1000 psi	12 mA	12mA	998 psi
75	1500psi	16 mA	16mA	1497 psi
100	2000psi	20 mA	20mA	1992 psi
75	1500 psi	16 mA	16mA	1496.7 psi
50	1000 psi	12 mA	12mA	999 psi
25	500 psi	8 mA	8mA	498 psi
0	0	4 mA	4mA	-1 psi

Test Equipment Used: ASHCROFT PORTABLE DEAD-WEIGHT-TESTER Type # 1305 B BAILEY STT02E, Fluke 87 III

Remarks:

Performed by: [signature] Date: 9-23-98

Witnessed by: [signature] Date: 9-23-98

Approved by: Howard E. [signature] Date: 9-23-98

AIDEA/HCCP SITE CONSTRUCTION MANAGEMENT

ALASKA INDUSTRIAL DEVELOPMENT AND EXPORT AUTHORITY

ALASKA ENERGY AUTHORITY

HEALY CLEAN COAL PROJECT
TRANSMITTER CALIBRATION & CONFIGURATION SHEET

Date 9-23-98 System FW Location S. W. Turbine Deck

Equipment Type/Manufacturer Smart Transmitter/Bailey Tag No. 2FW-FT26

Mode: ☑ Analog ☐ Digital _____ Channel Number

Output Type: ☐ Linear ☑ Square Root ☐ Other

Output Action: ☑ Normal ☐ Reverse

Damping: 4.0 sec. (0.00 to 32.00 seconds, default = 0.5 sec.)

Engineering Units: ☑ H_2O (inch) ☐ HG (inch) ☐ PSI ☐ Other

Lower Range Value: 0 Specified LRV Upper Range Value: 720 Specified URV

Initialize Mode: ✓ Low _____ High

Fail Mode: ✓ Low _____ High _____ Last

Secondary Units: mA 4 Secondary LRV 20 Secondary URV

Temperature Alarm: -50°C Lower Temp Alarm 120°C Upper Temp Alarm

% Input	Unit Input	Expected Output	Actual Output	DCS Reading
0	0 p.s.i	4 mA	4 mA	-11.86 PPH
25	6.5 "	12 "	12.06 "	396712 "
50	13 "	15.32 "	15.37 "	559392 "
75	19.5 "	17.76 "	17.87 "	683234 "
100	26 "	20 "	19.99 "	787529 "
75	19.5 "	17.76 "	17.85 "	682161 "
50	13 "	15.32 "	15.36 "	559399 "
25	6.5 "	12 "	12.03 "	395133 "
0	0 "	4 "	4 "	-1206 "

Test Equipment Used: Bailey STT02E communicator, Fluke 87 III DMM Omega Test Gauge 0-30 p.s.i, Transcat Test pump 6215P

Remarks: Didn't have large enough iH2O gauge, so had to convert to P.S.I. for calibration
DCS WAS INCREASED BY 1200 PPH TO COVER LOSS IN CONVERSION

Performed by: [signature] Date: 9-23-98

Witnessed by: [signature] Date: 9-23-98

Approved by: Howard E. [signature] Date: 9-23-98

AIDEA/HCCP SITE CONSTRUCTION MANAGEMENT

ALASKA INDUSTRIAL DEVELOPMENT AND EXPORT AUTHORITY

ALASKA ENERGY AUTHORITY

HEALY CLEAN COAL PROJECT
TRANSMITTER CALIBRATION & CONFIGURATION SHEET

Date 9-24-98 System MS Location 1289' North side of turbine pad

Equipment Type/Manufacturer FHG PTS / Fuji Foxboro Tag No. ZMS-PT83

Mode: ☑ Analog ☐ Digital ____ Channel Numbe

Output Type: ☑ Linear ☐ Square Root ☐ Other

Output Action: ☒ Normal ☐ Reverse

Damping: .3 sec. (0.00 to 32.00 seconds, default = 0.5 sec.)

Engineering Units: ☐ H_2O (inch) ☐ HG (inch) ☒ PSI ☐ Other

Lower Range Value: 0 Specified LRV Upper Range Value: 2000 Specified UR

Initialize Mode: N/A ____ Low ____ High

Fail Mode: N/A ____ Low ____ High ____ Last

Secondary Units: 4 mA Secondary LRV 20 mA Secondary URV

Temperature Alarm: / Lower Temp Alarm / Upper Temp Alarm

% Input	Unit Input	Expected Output	Actual Output	DCS Reading
0	0	4 mA	4.03 mA	1 psi
25	500 psi	8 mA	8.03 mA	501 psi
50	1000 psi	12 mA	12.04 mA	1002 psi
75	1500 psi	16 mA	16.03 mA	1501 psi
100	2000 psi	20 mA	20.06 mA	2005 psi
75	1500 psi	16 mA	16.04 mA	1502 psi
50	1000 psi	12 mA	12.03 mA	1001 psi
25	500 psi	8 mA	8.03 mA	501 psi
0	0	4 mA	4.02 mA	0 psi

Test Equipment Used: Ashcroft dead weight tester # 1305 B
Fluke 87 III

Remarks:

Performed by: [signature] Date: 9-24-98

Witnessed by: [signature] Date: 9-24-98

Approved by: Howard E Stark Date: 9/24/98

H:M.W.S.F.trans cal + config

6/24

AIDEA/HCCP SITE CONSTRUCTION MANAGEMENT

ALASKA INDUSTRIAL DEVELOPMENT AND EXPORT AUTHORITY

ALASKA ENERGY AUTHORITY

HEALY CLEAN COAL PROJECT
TRANSMITTER CALIBRATION & CONFIGURATION SHEET

Date 9-24-98 System MS Location S.W corner Turbine 1289'

Equipment Type/Manufacturer Gauge PTS/ Bailey Tag No. 2MS-PT10

Mode: ☑ Analog ☐ Digital ____ Channel Number

Output Type: ☑ Linear ☐ Square Root ☐ Other

Output Action: ☑ Normal ☐ Reverse

Damping: .50 sec. (0.00 to 32.00 seconds, default = 0.5 sec.)

Engineering Units: ☐ H_2O (inch) ☐ HG (inch) ☑ PSI ☐ Other

Lower Range Value: 0 Specified LRV Upper Range Value: 1500 Specified URV

Initialize Mode: ✓ Low ____ High

Fail Mode: ✓ Low ____ High ____ Last

Secondary Units: mA 4 Secondary LRV 20 Secondary URV

Temperature Alarm: -40°C Lower Temp Alarm 85°C Upper Temp Alarm

% Input	Unit Input	Expected Output	Actual Output	DCS Reading
0	0	4 mA	~~4 mA~~	-2 P.S.I
25	375 P.SI	8 mA	8 mA	370 P.S.I
50	750 P.S.I	12 mA	12 mA	745 P.S.I
75	1125 P.S.I	16 mA	16 mA	1121 P.S.I
100	1500 P.S.I	20 mA	20 mA	1495 P.S.I
75	1125 P.S.I	16 mA	16 mA	1127 P.S.I
50	750 P.S.I	12 mA	12 mA	747 P.S.I
25	375 P.S.I	8 mA	8 mA	372 P.S.I
0	0	4 mA	4 mA	-2 P.S.I

Test Equipment Used: Bailey STT02E, Fluke 87 III DMM Ashcroft dead weight tester 1305 B

Remarks:

Performed by: [signature] Date: 9-24-98

Witnessed by: [signature] Date: 9-24-98

Approved by: Howard E. [signature] Date: 9/24/98

H:M.W.S.F.trans cal + config 6/24/98

AIDEA/HCCP SITE CONSTRUCTION MANAGEMENT

ALASKA INDUSTRIAL DEVELOPMENT AND EXPORT AUTHORITY

ALASKA ENERGY AUTHORITY

HEALY CLEAN COAL PROJECT
TRANSMITTER CALIBRATION & CONFIGURATION SHEET

Date 9-24-98 System MS Location 1289' North side turbine pad

Equipment Type/Manufacturer FHG PTS/Fuji FCX Series Tag No. 2MS-PT82

Mode:	[x] Analog	[ ] Digital	____ Channel Number
Output Type:	[x] Linear	[ ] Square Root	[ ] Other
Output Action:	[x] Normal	[ ] Reverse	
Damping:	3 sec. (0.00 to 32.00 seconds, default = 0.5 sec.)		
Engineering Units:	[ ] H_2O (inch)	[ ] HG (inch)	[x] PSI [ ] Other
Lower Range Value:	0 Specified LRV	Upper Range Value: 2000 Specified URV	
Initialize Mode:	____ Low	____ High	
Fail Mode:	____ Low	____ High	____ Last
Secondary Units:	4mA Secondary LRV	20mA Secondary URV	
Temperature Alarm:	____ Lower Temp Alarm	____ Upper Temp Alarm	

% Input	Unit Input	Expected Output	Actual Output	DCS Reading
0	0 psi	4mA	4.02mA	0 psi
25	500 psi	8mA	8.02mA	500 psi
50	1000 psi	12 mA	12.02mA	1000 psi
75	1500 psi	16 mA	16.02mA	1500 psi
100	2000 psi	20 mA	20.06mA	2003 psi
75	1500 psi	16 mA	16.02mA	1500 psi
50	1000 psi	12 mA	12.02mA	999 psi
25	500 psi	8 mA	8.02mA	499 psi
0	0 psi	4 mA	4.03mA	1 psi

Test Equipment Used: Ashcroft Dead weight tester # 1305B

Fluke 87 III

Remarks:

Performed by: [signature] Date: 9-24-98

Witnessed by: [signature] Date: 9-24-98

Approved by: Howard E. Stich Date: 9/24/98

AIDEA/HCCP SITE CONSTRUCTION MANAGEMENT

ALASKA INDUSTRIAL DEVELOPMENT AND EXPORT AUTHORITY

ALASKA ENERGY AUTHORITY

HEALY CLEAN COAL PROJECT
TRANSMITTER CALIBRATION & CONFIGURATION SHEET

Date 12/22/98 System BA Location 1380' N. of Boiler

Equipment Type/Manufacturer Gauge P.T. / Bailey Tag No. 2BA-PT21C

Mode: ☑ Analog ☐ Digital ____ Channel Number

Output Type: ☑ Linear ☐ Square Root ☐ Other

Output Action: ☑ Normal ☐ Reverse

Damping: 4.0 sec. (0.00 to 32.00 seconds, default = 0.5 sec.)

Engineering Units: ☑ H_2O (inch) ☐ HG (inch) ☐ PSI ☐ Other

Lower Range Value: -20.0 in Specified LRV Upper Range Value: -20.0 in Specified URV

Initialize Mode: ✓ Low ____ High

Fail Mode: ✓ Low ____ High ____ Last

Secondary Units: 4.0 mA Secondary LRV 20.0 mA Secondary URV

Temperature Alarm: -40.0°C Lower Temp Alarm 85.0°C Upper Temp Alarm

% Input	Unit Input	Expected Output	Actual Output	DCS Reading
0	-20.0 in H2O	4.0 mA	3.99 mA	-20.02
25	-10.0	8.0	7.96	-10.04
50	0.0	12.0	11.92	-0.06
75	10.0	16.0	15.90	9.92
100	20.0	20.0	19.90	19.89
75	10.0	16.0	15.91	9.91
50	0.0	12.0	11.93	-0.08
25	10.0	8.0	7.95	-10.05
0	20.0	4.0	3.98	-20.08

Test Equipment Used: Bailey Communicator Mod # STT02E / Fluke 85 multimeter
Meri-Cal Pressure Transmitter Mod # DP2001

Remarks:

Performed by: [signature] Date: 12/22/98

Witnessed by: [signature] Date: 12/27/98

Approved by: [signature] Date: 12/22/98

AIDEA/HCCP SITE CONSTRUCTION MANAGEMENT

ALASKA INDUSTRIAL DEVELOPMENT AND EXPORT AUTHORITY

ALASKA ENERGY AUTHORITY

HEALY CLEAN COAL PROJECT
TRANSMITTER CALIBRATION & CONFIGURATION SHEET

Date 12/28/98 System FW Location 1338' (S. of Boiler)

Equipment Type/Manufacturer GAUGE P.T / BAILEY Tag No. 2FW-PT39

Mode:	☑ Analog	☐ Digital	____ Channel Number
Output Type:	☑ Linear	☐ Square Root	☐ Other
Output Action:	☑ Normal	☐ Reverse	
Damping:	4.0 sec. (0.00 to 32.00 seconds, default = 0.5 sec.)		
Engineering Units:	☐ H_2O (inch) ☐ HG (inch)	☑ PSI	☐ Other
Lower Range Value:	0.0 psi Specified LRV	Upper Range Value:	2000.0 psi Specified URV
Initialize Mode:	✓ Low	____ High	
Fail Mode:	✓ Low	____ High	____ Last
Secondary Units:	4.0 mA Secondary LRV	20.0 mA Secondary URV	
Temperature Alarm:	-40.0°C Lower Temp Alarm	85.0°C Upper Temp Alarm	

% Input	Unit Input	Expected Output	Actual Output	DCS Reading
0	0.0 psi	4.0 mA	3.99 mA	0.02 psi
25	500.00	8.0	8.00	500.4
50	1000.00	12.0	12.01	999.3
75	1500.00	16.0	16.02	1500.0
100	2000.00	20.0	20.03	2000.3
75	1500.00	16.0	16.01	1500.1
50	1000.00	12.0	12.01	1000.1
25	500.00	8.0	8.01	499.8
0	0.0	4.0	4.00	0.01

Test Equipment Used: BAILEY COMMUNICATOR MOD# STT02E / AMETEK PRESSURE TESTER MOD# 620 / FLUKE 28 MULTIMETER

Remarks:

Performed by: Richard B. Wilmele Date: 12/28/98

Witnessed by: [signature] Date: 12/28/98

Approved by: Howard E. Steel Date: 12/28/98

AIDEA/HCCP SITE CONSTRUCTION MANAGEMENT

ALASKA INDUSTRIAL DEVELOPMENT AND EXPORT AUTHORITY

ALASKA ENERGY AUTHORITY

HEALY CLEAN COAL PROJECT
TEMPERATURE INDICATOR CALIBRATION SHEET

Date 12/29/98 System 2FW Location 1314'/G.2-15

Equipment Type/Manufacturer T.C./Temtek Tag No. 2FW-TE2

Snubber used: Yes ☐ No ☑ Cleaned ☐

Percent Input	Actual (Std)		TI Indication	
0	92°F		91.4°F	
25	212°		211.6°	
50	332°		330.3°	
75	452°		449.6°	
100	572°F		570.0°F	
75	452°		450.7°F	
50	332°		330.6°	
25	212°		211.6°	
0	92°F		92° F	

Remarks: Hart Dry Block calibrator 5853T
Fluke 741B Process Calibrator

Performed by: [signature] Date: 12/29/98

Witnessed by: Date:

Witnessed by: Howard E. [signature] Date: 12/29/98

AIDEA/HCCP SITE CONSTRUCTION MANAGEMENT

ALASKA INDUSTRIAL DEVELOPMENT AND EXPORT AUTHORITY

ALASKA ENERGY AUTHORITY

HEALY CLEAN COAL PROJECT
TRANSMITTER CALIBRATION & CONFIGURATION SHEET

Date 3-11-99 System ZFG Location EL 1347' / K.2-13.3

Equipment Type/Manufacturer BAILEY PTS Tag No. ZFG-PT09

Mode:	☑ Analog	☐ Digital	____ Channel Numbe
Output Type:	☑ Linear	☐ Square Root	☐ Other
Output Action:	☑ Normal	☐ Reverse	
Damping:	4.0 sec. (0.00 to 32.00 seconds, default = 0.5 sec.)		
Engineering Units:	☑ H_2O (inch)	☐ HG (inch) ☐ PSI	☐ Other
Lower Range Value:	-12" H_2O Specified LRV	Upper Range Value: 0" H_2O Specified UF	
Initialize Mode:	✓ Low	____ High	
Fail Mode:	✓ Low	____ High	____ Last
Secondary Units:	4mA Secondary LRV	20mA Secondary URV	
Temperature Alarm:	-40°C Lower Temp Alarm	85°C Upper Temp Alarm	

% Input	Unit Input	Expected Output	Actual Output	DCS Reading
0				
25				
50				
75				
100				
75				
50				
25				
0				

Test Equipment Used: BAILEY SSTOZE

Remarks: RERANGED TRANSMITTER FROM -10"H2O TO O TO -12" H2O TO 0" PER NABIL

Performed by: ____________ Date: ____________

Witnessed by: ____________ Date: ____________

Approved by: Howard E. [signature] Date: 3/11/99

ATTACHMENT 2
FWEC Performance Testing
Report No. CR-351

ALASKA INDUSTRIAL DEVELOPMENT & EXPORT AUTHORITY
HEALY UNIT #2

FWEC CONTRACT NO.
200595000

PERFORMANCE TESTING
REPORT NO. CR-351

Approved By:

B. K. Newell
Manager, Performance Testing

Submitted By:

E. R. LePage
Performance Test Engineer

Performance Engineering
Test and Performance Section
Services Group

Foster Wheeler Energy Corporation
Perryville Corporate Park
Clinton, New Jersey 08809

April 26, 1999

TABLE OF CONTENTS

ABSTRACT

Boiler performance guarantee tests were conducted on the Alaska Industrial Development and Export Authority's (AIDEA) Healy Unit #2 on March 29–30,1999. Tests were performed at 100% and 60% MCR outputs.

Guaranteed values along with test values are listed in the table below. Unit guarantees are at 100% MCR only and the 60% values are for the steam temperature guarantee. All contract guarantees have been met.

	Guarantee value	100% MCR Value
Steam Flow	490,000 lbs/hr	494,865 lbs/hr
Press. Loss – Econ. Inlet to Drum	50 psid	39.3 psid
Press. Loss – Drum to Sec. S.H. Outlet	126 psid	84.4 psid
S.H. Outlet Temp.	955±10°F	957°F
Draft Loss Furn. To Air Heater Outlet	19 in. w.g.	15.9 in. w.g.
F.D. Fan Motor Power Output	3150 KW	1492 KW
Pulv. "A" Motor Power Output	330 KW	213.6 KW
Pulv. "B" Motor Power Output	330 KW	204.4 KW

	Guarantee value	60% MCR Value
Steam Flow	N.A.	295,124 lbs/hr
S.H. Outlet Temp.	955±10°F	954°F

1.0 OBJECT

The purpose of this test is to demonstrate unit performance in meeting the boiler contract performance guarantees only.

2.0 INTRODUCTION

2.1 The subject steam generator is a FWL "SF" top supported, two (2) drum, natural circulation, balanced draft boiler designed specifically for firing pulverized coal. The boiler is rated for 490 klb/hr steam flow at 1300 psig and 955°F. The boiler is fired with two (2) slagging combustors supplied by TRW. Pulverized coal is supplied to the combustors from two (2) FWEC MBF-21.5 pulverizers.

3.0 TEST PROCEDURE

3.1 The 100% MCR test was conducted for four (4) hours at the required 490 klb/hr steam flow rating with the guaranteed pressure and temperature. Excess air was targeted at 18% which equated to 2.79% O2 wet. O2 was measured at the economizer outlet with plant instrumentation. The O2 analyzers were calibrated prior to the testing.

The 60% MCR test was conducted for approx. two (2) hours with 294 klb/hr steam flow and at the guaranteed temperature.

3.2 Prior to each test, all sootblowers were operated and then isolated during the testing. Blowdown lines were closed prior to the start of testing.

3.3 Raw coal samples were collected from both feeders every hour from the sampling connection on the feeders. These coal samples, at the end of the tests, were thoroughly mixed together and quartered. Two portions of the sample was given to AIDEA for independent analysis, one portion given to Golden Valley Electric Association (GVEA), and one portion was kept by FWEC for analysis. FWEC coal samples were analyzed for proximate / ultimate, HHV, HGI, sizing, and ash fusion temperature. Results of the analysis are presented in Appendix C.

3.4 Fly ash, bottom ash, and pulverized coal samples were not required and thus were not taken during the testing.

4.0 DATA

4.1 Unit Operating Data

During each of the tests, boiler data was recorded on a continuous basis by AIDEA using the plant DCS. Copies of the DCS boiler data; taken at 12 minute intervals and continuous data was given to all parties involved in the testing. The attached Table No. 1 is a summary of the data during the test periods. The large quantity of raw data taken continuously during the testing is available on compact disc.

5.0 CALCULATIONS AND RESULTS

5.1 Capacity and Pressure

5.1.1 100% MCR Test

Steam flow, feed water flow, and superheat spray values were measured by plant instrumentation and were indicated by the plant DCS. The guaranteed 100% MCR (490 klb/hr) steam flow was recorded at 494,865 lbs/hr average for the test period. The average superheat outlet pressure and temperature were 1308 psig and 957°F respectively for the test period. The boiler capacity and superheater outlet temperatures guarantees are therefore met.

5.1.2 Motor Power Consumption

Motor amp and bus voltage readings were taken by AIDEA during the test periods. The pulverizer and forced draft motors have power guarantees. The calculated pulverizer motor power output during the 100% MCR test was 213.6 KW and 204.4 KW for A & B mills. These values are below the 330 KW guarantee value and therefore meets the guarantee.

Motor amp and bus voltage readings were taken for the F.D. Fan motor during the 100% MCR test. The calculated power output for this motor is 1492 KW. This value is below the 3150 KW guarantee value and therefore meets the guarantee.

Pulverizer and F.D. Fan shaft input power was calculated using the following equation:

KW = (Volts x Amps x 1.732 x PF x EFF) /1000
Where PF is power factor and EFF is efficiency and are taken from the manufacturers data sheets for the various motors. These sheets are located in the Appendices A&B.

5.1.3 Pressure Drops

The Following Are The Guaranteed Values That Were Verified During The Test:

5.1.3.1 Fluid Pressure Loss Between The Drum And The Superheater Outlet.

The drum pressure during the 100% MCR test was 1336 psig and the superheat outlet that was taken at the Turbine Throttle was 1251.2 psig, a drop of 84.8 psid. This 84.8 psid pressure loss did not exceed the 126 psid guarantee and thus met the guarantee.

5.1.3.2 Fluid Pressure Loss Between The Economizer Inlet And The Drum.

The drum pressure during the 100% MCR test was 1336 psig and the econmizer inlet pressure was 1375.3 psig, a loss of 39.3 psid. This 39.3 psid pressure loss did not exceed the 50 psid guarantee and thus met the guarantee.

5.1.3.3 Draft Loss Between Furnace To Gas Outlet Of Main Tubular Air Preheater.

The main tubular air heater gas outlet pressure during the 100% MCR was -16.84 inwg and the furnace pressure was -0.93 inwg for a pressure drop of 15.9 inwg. This pressure drop did not exceed the 19inwg guaranteed pressure drop and thus met the guarantee.

6.0 ACKNOWLEDGEMENTS

These tests were accomplished with the assistance and cooperation of Clive Herrington and Nabil Massarwah of AIDEA, James H. Knowlton of Stone and Webster Engineering Corp., John Zarling of Strandberg Engineers, and the operating personnel from AIDEA's Healy Plant.

Foster Wheeler was represented on-site by the writer.

FOSTER WHEELER CORPORATION
TEST AND PERFORMANCE GROUP

CONTRACT NO. HCP-009
CUSTOMER: AIDEA
LOCATION: HEALY #2

TABLE 1
BOILER DATA
PERFORMANCE SUMMARY
PAGE 1

TEST DATE TIME	1 3/29/99 19:30-23:00	2 03/30/99 09:21-11:55	REMARKS
LOAD (%MCR)	100.00	60.00	2GM-JT03
Megawatts (gross)	61.02	35.95	2GM-JT03
FLOWS-WATER, AIR AND STEAM (LB/HR)			
Steam Flow (lb/hr)	493865	295124	2fg-fi22
Feedwater Flow (lb/hr)	487855	291026	2FW-FT26
Attemperator Spray Flow (lb/hr)	12131	1392	2FW-FT04
Spray Valve Position	27.47	3.42	2FW-TY31-ST
Overfire Air Flow (klb/hr)	16.27	18.90	2BA-FT14A
Overfire Air Flow (klb/hr)	-2.15	-2.14	2BA-FT14B
Nox Port Airflow (klb/hr)	14.20	14.00	2BA-FT71A
Nox Port Airflow (klb/hr)	52.87	36.77	2BA-FT71B
TEMPERATURES - WATER AND STEAM			
HP Feedwater Heater Inlet No. 4	311.65	280.04	2FW-TE16
High Press Feedwater Outlet No. 4	371.86	334.73	2FW-TE21
HP Feedwater Heater Outlet No. 5	426.91	385.93	2FW-TE25
Economizer Feedwater Inlet	426.75	385.44	2FW-TE27
Drum Temperature (Bottom)	570.91	563.25	2BS-TE11
Drum Temperature (Top)	576.82	570.65	2BS-TE10
Primary Superheater Steam Inlet(Tube MetalTemp)	749.83	748.44	2BS-TE59B
Primary Superheater Steam Inlet(Tube Metal Temp)	741.81	733.63	2BS-TE59E
Primary Superheater Steam Outlet	828.02	816.16	2BS-TE17
Secondary Superheater Steam Inlet	769.80	781.93	2BS-TE18
Secondary Superheater Steam Outlet	956.58	954.08	2MS-TE05
PRESSURES - STEAM AND WATER (PSIG)			
Economizer Feedwater Inlet Pressure (psig)	1375.31	1302.12	2FW-PT39
Steam Drum Pressure (psig)	1336.03	1275.06	2BS-PT14
Primary Superheater Outlet (psig)	1319.50	1269.30	2BS-PT16
Secondary Supeheater Outlet (psig)	1308.00	1295.00	local gauge reading
Steam Drum Pressure (psig)	1336.03	1275.06	2BS-PT14
Turbine Throttle Pressure (psig)	1251.23	1243.83	2MS-PY10B
Turbine 1st Stage Pressure (psig)	1163.92	703.43	2MS-PT82
Turbine 1st Stage Pressure (psig)	1164.89	703.84	2MS-PT83

FOSTER WHEELER CORPORATION
TEST AND PERFORMANCE GROUP

CONTRACT NO. HCP-009
CUSTOMER: AIDEA
LOCATION: HEALY #2

TABLE 1
BOILER DATA
PERFORMANCE SUMMARY
PAGE 2

TEST	1	2	
DATE	3/29/99	03/30/99	
TIME	19:30-23:00	09:21-11:55	REMARKS
TEMPERATURES - AIR AND GAS (°F)			
Low Temp Airheater Air Inlet	95.54	107.69	2BA-TE04
Low Temp Airheater Air Inlet	94.65	106.57	2BA-TE05
Low Temp Airheater Air Outlet	438.60	408.74	2BA-TE08
Low Temp Airheater Air Outlet	439.01	409.91	2BA-TE09
High Temp Airheater Double Air Outlet	801.18	723.47	2BA-TE37
High Temp Airheater Double Air Outlet	801.03	723.75	2BA-TE38
Economizer Gas Outlet	613.76	555.79	2FG-TE11
Economizer Gas Outlet	614.95	557.61	2FG-TE13
Low Temp Airheater Gas Outlet	304.06	296.78	2FG-TE14
Low Temp Airheater Gas Outlet	304.17	296.96	2FG-TE15
High Temp Airheater Gas Inlet	906.52	808.44	2FG-TE05
High Temp Airheater Gas Inlet	903.85	810.07	2FG-TE06
High Temp Airheater Gas Outlet	696.96	630.94	2FG-TE07
High Temp Airheater Gas Outlet	693.81	627.47	2FG-TE08
PRESSURES - AIR AND GAS (IN. W.C.)			
Low Temp Airheater Air Inlet (in.wc.)	55.28	55.00	2BA-PT06
Low Temp Airheater Air Outlet (in.wc.)	50.35	51.70	2BA-PT07
High Temp Airheater Double Air Outlet (in.wc.)	45.01	48.68	2BA-PT12
High Temp Airheater Gas Inlet (in.wc.)	-3.07	-2.41	2FG-PT04
High Temp Airheater Gas Outlet (in.wc.)	-8.39	-6.04	2FG-PT09
Economizer Gas Outlet (in.wc.)	-11.34	-8.02	2FG-PT12
Furnace Draft (in.wc.)	-0.87	-1.01	2BA-PT21A
Furnace Draft (in.wc.)	-0.97	-1.12	2BA-PT21B
Furnace Draft (in.wc.)	-0.96	-1.08	2BA-PT21C
Boiler Gas Outlet Pressure	-16.84	-12.20	2FG-PT16
Baghouse Outlet Pressure (in.wc.)	-25.10	-18.05	2FG-PT20
DAMPER POSITIONS			
FD Fan Inlet Damper Position (%)	48.98	44.98	2BA-FY01-ST
ID Fan Inlet Damper Position (%)	40.49	26.27	2FG-FY01-ST
Mix Annulus Damper Position (%)	37.97	5.48	2BA-ZT39A
Mix Annulus Damper Position (%)	68.07	-0.02	2BA-ZT39B
PC Airflow Damper Postion (%)	73.57	16.38	2BA-ZT44A
Eco Bypass Damper Position	-4.99	-5.00	2FG-TY10-ST

FOSTER WHEELER CORPORATION
TEST AND PERFORMANCE GROUP

CONTRACT NO. HCP-009
CUSTOMER: AIDEA
LOCATION: HEALY #2

TABLE 1
BOILER DATA
PERFORMANCE SUMMARY
PAGE 3

TEST	1	2	
DATE	3/29/99	03/30/99	
TIME	19:30-23:00	09:21-11:55	REMARKS
OVERFIRED AIR			
OFA Damper Position	-0.75	-0.75	2BA-ZT15A
OFA Damper Position	2.87	2.87	2BA-ZT15B
OFA Damper Position	-2.50	-2.50	2BA-ZT15C
OFA Damper Position	0.17	0.17	2BA-ZT15D
OFA Damper Position	0.70	0.67	2BA-ZT15E
OFA Damper Position	-4.83	-4.85	2BA-ZT15F
OFA Damper Position	-1.90	-1.90	2BA-ZT15G
OFA Damper Position	-3.90	-3.90	2BA-ZT15H
NOx Air Damper Position	7.50	-4.91	2BA-FY58-ST
CEMS DATA			
CEMS SO2 (ppm)	4.86	17.06	2FG-UR22A
CEMS SO2 (lb/MMbtu)	0.01	0.05	2FG-UR22B
CEMS Nox (lb/Mmbtu)	0.24	0.38	2FG-UR22C
AIR HEATER O2 & CO			
Fluegas O2 WET	3.42	7.37	2FG-AT02A
Fluegas O2 WET	3.49	7.21	2FG-AT02B
Fluegas CO	0.43	0.40	2FG-AT03A
Fluegas CO	20.85	61.88	2FG-AT03B
PULVERIZER DATA			
Mill Hot Primary Air Inlet A	561.16	515.63	2BA-TE25A
Mill Hot Primary Air Inlet B	560.46	515.17	2BA-TE25B
Mill Primary Air InletA	527.45	470.28	2BA-TE31A
Mill Primary Air Inlet B	521.86	427.97	2BA-TE31B
Mill Outlet Temp A	130.87	135.83	2FC-TE07A
Mill Outlet Temp B	134.58	136.16	2FC-TE07B
Coal Flow (klb/hr) A	47.35	29.80	2FC-ST23-ST
Coal Flow (klb/hr) B	47.13	29.78	2FC-ST24-ST
Mill Primary Airflow (klb/hr) A	118.81	110.11	2BA-FT29A
Mill Primary Airflow (klb/hr) B	119.86	109.95	2BA-FT29B
Tempering/Seal Airflow (klb/hr)	73.02	109.25	2BA-FT48
Hot Air Damper Position (%) A	99.71	92.89	2BA-ZT26A
Hot Air Damper Position (%) B	76.45	76.39	2BA-ZT26B
Tempering Air Damper Position (%) A	0.00	10.76	2BA-ZT27A
Tempering Air Damper Position (%) B	3.49	25.45	2BA-ZT27B
Capacity Damper Position (%) A	64.68	13.70	2BA-ZT28A
Capacity Damper Position (%) B	76.99	84.08	2BA-ZT28B

FOSTER WHEELER CORPORATION
TEST AND PERFORMANCE GROUP

CONTRACT NO. HCP-009
CUSTOMER: AIDEA
LOCATION: HEALY #2

TABLE 1
BOILER DATA
PERFORMANCE SUMMARY
PAGE 4

TEST	1	2	
DATE	3/29/99	03/30/99	
TIME	19:30-23:00	09:21-11:55	REMARKS
PULVERIZER DATA (cont.)			
Table Seal Air Differential Pressure (in.wc.) A	7.10	27.30	2FC-PT01A
Table Seal Air Differential Pressure (in.wc.) B	8.06	23.09	2FC-PT01B
Mill Differential Pressure (in.wc.) A	28.68	14.23	2FC-PT05A
Mill Differential Pressure (in.wc.) B	23.74	12.30	2FC-PT05B
Roller Seal Air Differential Pressure (in.wc.) A	18.04	21.44	2FC-PT06A
Roller Seal Air Differential Pressure (in.wc.) B	14.58	15.20	2FC-PT06B
"A" PC Secondary Air Press	40.42	14.51	2BC-PT04A
"B" PC Secondary Air Press	38.65	21.33	2BC-PT04B
MISCELLANEOUS			
FW #5 Heater Drain	380	340	2HG-TE06
Turbine Control Valve Position	62.43	38.41	2MS-ZT81A
Stack Diluent %	12.05	9.48	2FG-UR22D
Stack Opacity (%)	2.82	2.69	2FG-UR22E
Steam Drum Level (in. wc.)	-0.03	0.03	2bw-lt01/07-sv
ELECTRICAL POWER INFORMATION			
BUS VOLTAGE	3996	4000	
I.D. FAN MOTOR AMPS	185.3	160.0	
F.D.FAN MOTOR AMPS	255.3	225.0	
MILL EXHAUSTER FAN "A" AMPS	64.00	60.00	
MILL EXHAUSTER FAN "B" AMPS	70.40	61.00	
PULVERIZER "A" MOTOR AMPS	52.90	45.30	
PULVERIZER "B" MOTOR AMPS	48.50	42.00	

FOSTER WHEELER CORPORATION
TEST AND PERFORMANCE GROUP

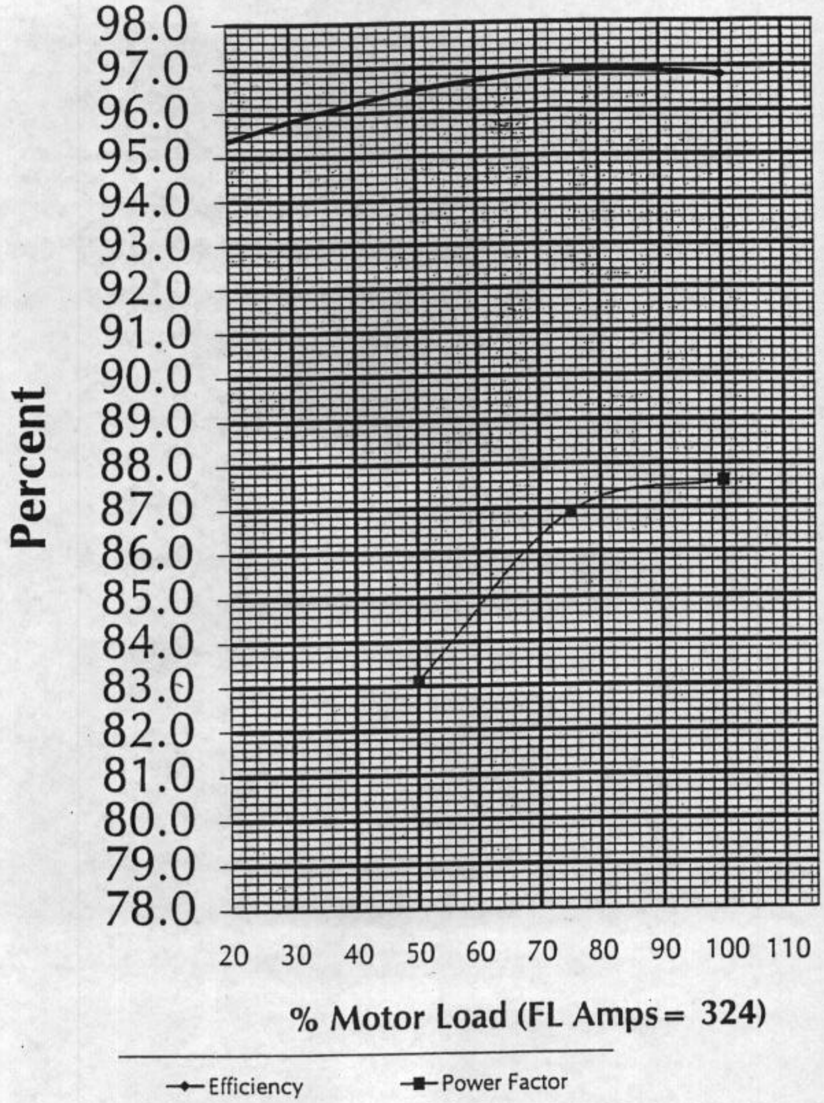
CONTRACT NO. HCP-009
CUSTOMER: AIDEA
LOCATION: HEALY #2

TABLE 1
BOILER DATA
PERFORMANCE SUMMARY
PAGE 5

TEST	1	2	
DATE	3/29/99	03/30/99	
TIME	19:30-23:00	09:21-11:55	REMARKS
COAL ANALYSIS			
FWDC Lab. Ref. No.	990316	990317	
Proximate Analysis, wt% (as received)			
Fixed Carbon	21.17	22.45	
Volitile Matter	38.76	33.57	
Ash	13.07	18.20	
Moisture	27.00	25.78	
Total	100.00	100.00	
Ultimate Analysis, wt% (as received)			
Carbon	42.38	39.13	
Hydrogen	3.35	3.00	
Oxygen	13.46	13.15	
Nitrogen	0.55	0.55	
Sulfur	0.19	0.19	
Ash	13.07	18.20	
Moisture	27.00	25.78	
Total	100.00	100.00	
Hardgrove Index (HGI)	33.00	40.00	
HHV (Btu/lb)	7025.00	6487.00	
Sizing - 100% sample thru screen (inches)	1.25	1.50	
Air Dry Loss (%)	15.95	16.38	

APPENDIX A

Healy 2 FD Fan Motors



WESTINGHOUSE MOTOR COMPANY
Round Rock, Texas U.S.A.

INDUCTION MOTOR DATA

Customer : Foster Wheeler
General Order : XH 20396
Shop Order : 3011AA

Rating

HP	: 2550	Voltage	: 4000	Service Factor	: 1.15
Phases	: 3	Amperes	: 324	F.L. Speed	: 1196 RPM
Hertz	: 60	Frame	: 6316	Insulation Class	: F

Temp. Rise: 80°C By Res At 1.00 S.F. Locked KVA Code : G

Calculated Performance

Load	1.00	0.75	0.50
% Efficiency	96.8	96.9	96.5
% Power Factor	87.6	86.9	83.1

Rated Torque : 11199 lb.-ft.
Breakdown Torque : 220 %
F.L. Slip : .367 %

Starting Torque : 87 %
Locked Rotor Current : 2095 Amps

Circuit Constants

Per Unit on *output* KVA Base

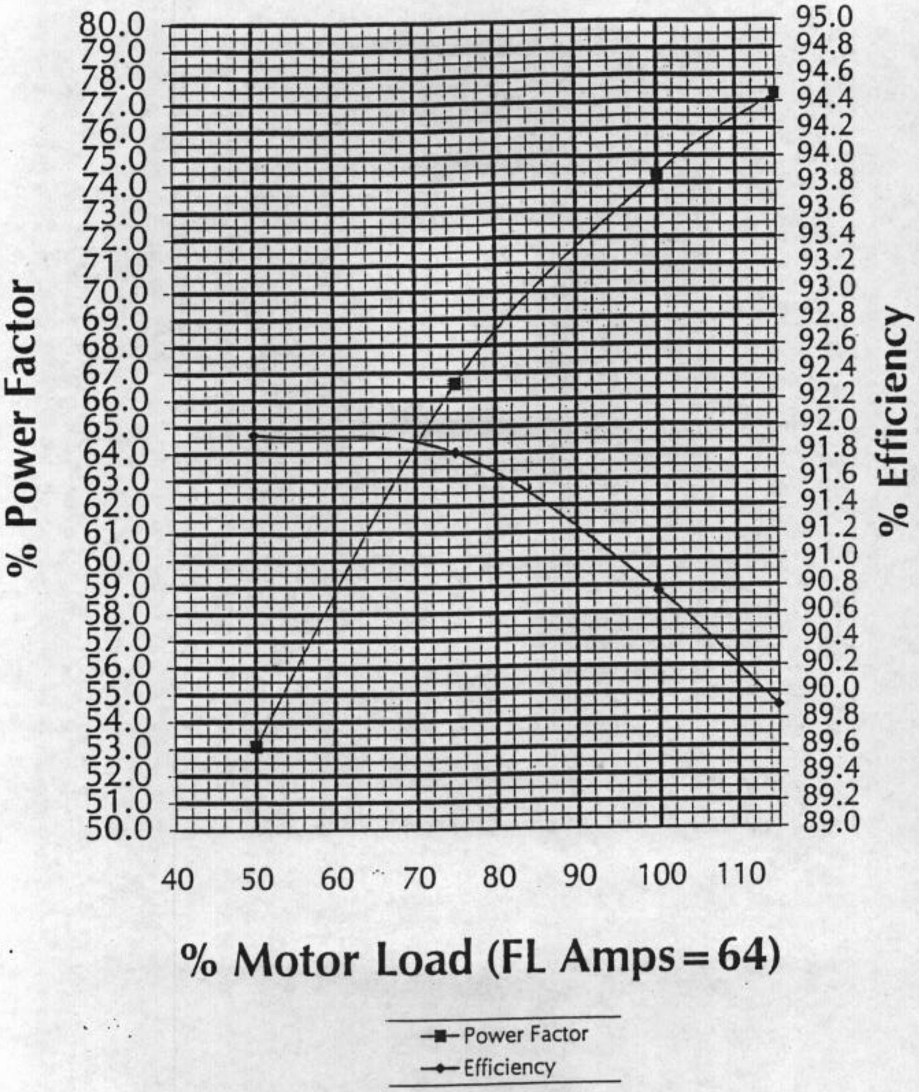
Transient Reactance, X'd : .190
Sub-Transient Reactance, X''d : .132
Open Circuit Time Constant, T'do : 3.23 Sec
Short Circuit Time Constant, T' : .1649 Sec

Engineer: Thuy Nguyen Date: April 8, 1999

REV DATA:
FORM # WMC-118

APPENDIX B

Healy 2 Pulverizer Motors



WESTINGHOUSE MOTOR COMPANY

ROUND ROCK, TEXAS - U.S.A.

Revised tagging 9/22/93

CUSTOMER FOSTER WHEELER C   DATE MAR 31,93
CUSTOMER ORDER NO. N-75369
APPLICATION PULVERIZER
S.O. 5816AA   G.O. NA75352

DATA FOR WORLD SERIES, HORIZONTAL, BRACKET TYPE INDUCTION MOTOR

1. RATING

HP	400	HERTZ	60	INSUL CLASS	F
RPM FL	853	SERVICE FACTOR	1.15	KVA CODE	G
VOLTS	4000	RISE C (1.15-SF)	90	DUTY	CONTINUOUS
AMPS FL	64	METHOD	RES		
PHASES	3	AMBIENT C	40		

2. MECHANICAL

FRAME	4509	BRG TYPE	SLEEVE	END PLAY INCH	0.25
ENCL TYPE	ODP	LUBE TYPE	SELF	MOTOR WK SQ	820
ROTATION (ODE)	BI	NO. BRGS	2	LOAD WK SQ	760
STATOR WT LBS	2936	ROTOR WT LBS	2295	TOTAL WT LBS	6020
SHAFT EXTENSION W37					

3. STARTING PERFORMANCE - NOMINAL, VALUES WITH (*) ARE GUARANTEED

		100% VOLTS		85% VOLTS	80% VOLTS
TEMPERATURE		75C	40C	40C	40C
AMPS (LR)		355	357	296	277
AMPS (LR)	%	557	559	465	435
POWER FACTOR	%	44.9	44.3	43.5	43.1
START TORQUE	%	306	307	214	187
PULL-UP TORQUE	%	306	307	214	187
ACCELERATION SEC			1.5	2.9	4.3
SAFE LOCK	SEC FROM HOT		18.4	26.4	30.3

AT 100% VOLTS:
PULLOUT TORQUE % = 355

4. EFFICIENCY - NOMINAL

LOAD	%	115	100	75	50
EFFICIENCY	%	89.90	90.76	91.80	91.94

5. POWER FACTOR - NOMINAL

LOAD	%	115	100	75	50
POWER FACTOR	%	77.3	74.3	66.6	53.1

MAX KVAR = 218   MAX FL P.F. = 97.4 %

F.W.E.C. CONTRACT 2-30-5950
F.W.E.C. REQUISITION NO. 5950-WZ
F.W.E.C. PURCHASE ORDER NO. N-75369
CUSTOMER ALASKA INDUSTRIAL DEVELOPMENT & EXPORT AUTHORITY
HEALY CLEAN COAL PROJECT
DRIVEN EQUIPMENT NO. 2FC-PLVIA, 2FC-PLVIB
S.W.E.C. J.O. 02765-1400
AIDEA CONTRACT NO. HCP-009

APPENDIX C

FOSTER WHEELER DEVELOPMENT CORPORATION
FUEL ANALYSIS

Sample Description: Coal, HEALY #2, 3/29/99

Charge No.: 925265000 | **Date:** 4/5/99 | **Lab. Ref. No.:** 990316

	As Received	Dry			
Air Dry Loss (%)	15.95		Equilibrium Moisture (%)		
Proximate Analysis, wt%			Reactivity Index (°C)		
Fixed Carbon	21.17	29.01	Activation Energy (cal/g-mol)		
Volatile Matter	38.76	53.09	Hardgrove Index	33	
Ash	13.07	17.90	Free Swelling Index		
Moisture	27	---	Specific Gravity		
Total	100.00	100.00	Viscosity		
Ultimate Analysis, wt%			**Ash Fusion Temperature, °F**		
Carbon	42.38	58.05		Red.	Oxid.
Hydrogen	3.35	4.59	Initial Deform.	2182	2264
Oxygen	13.46	18.44	Soft. Temp. Sph.	2222	2305
Nitrogen	.55	.76	Soft. Temp. Hem.	2285	2360
Sulfur	.19	.26	Fluid Temp.	2350	2410
Ash	13.07	17.90			
Moisture	27	---			
Total	**100.00**	**100.00**			
			Bulk Density (gr/ml)		
HHV, Btu/lb	7025	9623	Carbonate Carbon		
Sulfate S	---	---	Organic Carbon		
Pyritic S	---	---	Total Carbon		
Organic S	---	---	Chloride		
Dulong's =	9871	Btu/lb			
Remarks:					

Analyst: ______________

Approved: [signature]

FOSTER WHEELER DEVELOPMENT CORPORATION
FUEL ANALYSIS

Sample Description: Coal, HEALY#2, 3/30/99

Charge No.: 925265000 | **Date:** 4/5/99 | **Lab. Ref. No.:** 990317

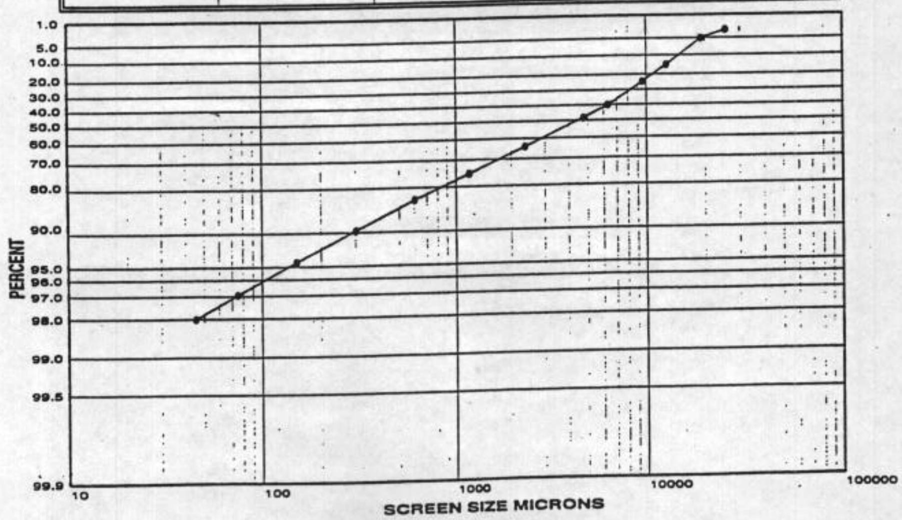
Air Dry Loss (%)	16.38		Equilibrium Moisture (%)		
	As Received	Dry			
Proximate Analysis, wt%			Reactivity Index (°C)		
Fixed Carbon	22.45	30.25	Activation Energy (cal/g-mol)		
Volatile Matter	33.57	45.23	Hardgrove Index	40	
Ash	18.20	24.52	Free Swelling Index		
Moisture	25.78	---	Specific Gravity		
Total	100.00	100.00	Viscosity		
Ultimate Analysis, wt%			**Ash Fusion Temperature, °F**		
Carbon	39.13	52.73		Red.	Oxid.
Hydrogen	3.00	4.05	Initial Deform.	2266	2316
Oxygen	13.15	17.70	Soft. Temp. Sph.	2313	2390
Nitrogen	.55	.74	Soft. Temp. Hem.	2347	2437
Sulfur	.19	.26	Fluid Temp.	2454	2508
Ash	18.20	24.52			
Moisture	25.78	---			
Total	100.00	100.00			
			Bulk Density (gr/ml)		
HHV, Btu/lb	6487	8740	Carbonate Carbon		
Sulfate S	---	---	Organic Carbon		
Pyritic S	---	---	Total Carbon		
Organic S	---	---	Chloride		
Dulong's =	8819	Btu/lb			
Remarks:					

Analyst: ____________________

Approved: ____________________

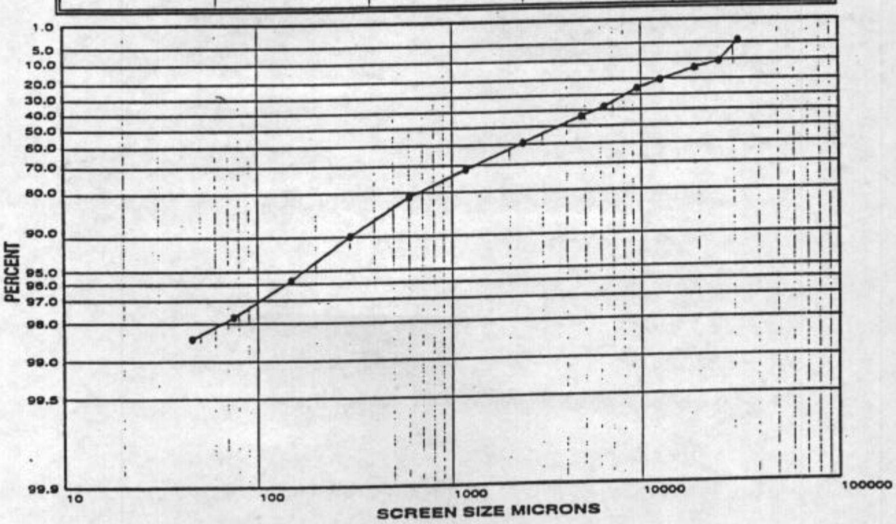
Sieve Analysis

Laboratory No.: 990316		Run/Sample No:		
Sample Description: Coal, HEALY #2, 3/29/99				
Screen	Mircrons	% On	% Thru	
3"	76200			
2-1/2"	63500			
2"	50800			
1-1/2"	38100			
1-1/4"	31750		100.00	
1"	25400	3.07	96.93	
3/4"	19050	1.93	95.00	
1/2"	12700	10.7	84.3	
3/8"	9525	9.98	74.32	
1/4"	6300	15.37	58.95	
NO. 4	4750	8.12	50.83	
NO. 8	2360	16.16	34.67	
NO. 16	1180	11.34	23.33	
NO. 30	600	7.81	15.52	
NO. 50	300	6.24	9.28	
NO. 100	150	3.87	5.41	
NO. 200	75	2.36	3.05	
NO. 325	45	1.06	1.99	
PAN	00	1.99	0	



Sieve Analysis

Laboratory No.: 990317		Run/Sample No:		
Sample Description: Coal, HEALY#2, 3/30/99				
Screen	Mircrons	% On	% Thru	
3"	76200			
2-1/2"	63500			
2"	50800			
1-1/2"	38100		100.00	
1-1/4"	31750	4.41	95.59	
1"	25400	7.36	88.23	
3/4"	19050	3.04	85.19	
1/2"	12700	6.68	78.51	
3/8"	9525	5.26	73.25	
1/4"	6300	11.96	61.29	
NO. 4	4750	5.91	55.38	
NO. 8	2360	15.57	39.81	
NO. 16	1180	12.6	27.21	
NO. 30	600	9.58	17.63	
NO. 50	300	8.55	9.08	
NO. 100	150	4.85	4.23	
NO. 200	75	2.00	2.23	
NO. 325	45	.73	1.50	
PAN	00	1.50	0	



ATTACHMENT 3
S&W Responses to GVEA Questions and Comments Regarding the Boiler Performance Guarantee Tests

MEMO

DATE: June 14, 1999

TO: Dennis McCrohan

FROM: Jim Knowlton

CC: Verle Bland
Steve Rosendahl
Bill Cleary
Nat Sekhar

SUBJECT: BOILER PERFORMANCE GUARANTEE TESTS

The Foster Wheeler boiler performance guarantee test for the Healy Clean Coal Project was executed on March 29 and 30, 1999. The test was directed by Ed LePage of Foster Wheeler Energy Corporation (FWEC) in accordance with their "Boiler Performance Guarantee Test Program And Procedures," document dated November 23, 1998. The test was witnessed by Jim Knowlton of Stone & Webster Engineers and Constructors, Inc. (S&W) and John Zarling of Strandberg Engineers. At the completion of the testing FWEC was to provide a report detailing the test results and confirming the validity of the test data.

On March 31, 1999, Frank Abegg (GVEA) sent a letter to Clive Herrington (AIDEA) addressing five concerns over the practices used during the tests, ultimately rejecting the test as meeting the requirements specified in the contract documents. S&W has drafted responses to each of the concerns raised by GVEA.

Issue 1 Pre-Test Meeting -

GVEA's CONCERN:
Test Pre-Meeting: Based on my memo to Dennis McCrohan last week and your verbal assurance to Ed Konnecke on Monday morning, John (Zarling) and Ed expected AIDEA to hold a meeting of the AIDEA, GVEA and FWEC representatives prior to beginning the boiler performance tests. However, a formal collective meeting of all parties never occurred. As a result, the GVEA inspection team was never provided the official testing procedures that AIDEA planned to use to determine the contract requirements for guaranteed performance. There was confusion on the required test procedures, even by the FWEC test representative. Ed and John feel AIDEA's lack of effective communication hampered the test preparation and organization, which raises GVEA's concern about the completeness, accuracy and resulting credibility of the tests.

S&W RESPONSE:
A pretest meeting was held at approximately 8:30 a.m. on March 29, 1999 in the office of Clive Herrington with Clive, Nabil Massarweh (AIDEA Contractor], Ed LaPage and Jim Knowlton. The Boiler Performance Guarantee Test Program and Procedures were discussed and the following items were concluded by FWEC and AIDEA:

The boiler maximum capacity rating (BMCR) test data would be recorded for four hours and the most representative two-hour period within the four hours would be considered the test.

- The feedwater flow nozzle is after the desuperheating spray water take off.
- The side to side oxygen imbalance requirement of +/- 0.5% measured at the economizer outlet is not controllable/practical for the TRW combustor design
- The excess air may be greater than the 18% called for in the test program due to high pulverizer airflow. The plant reports that they operate with the secondary air dampers closed, and the excess air is above 20%. This appeared to be acceptable as margin on the flue gas pressure drop guarantee because a higher flow rate would result in a higher demonstrated pressure drop.
- DCS data would be recorded in at least twelve-minute intervals.
- Local data (secondary superheater outlet pressure, pulverizer power, and FD fan power) recording will be every thirty minutes.
- Coal samples would be taken every hour. At the end of the test the samples will be mixed and quartered (1/4 - AIDEA. 1/4 - FWC. 1/4 -GVEA, 1/4 Ref)
- Pulverizer fines would be measured hourly.

At the conclusion of the meeting the unit was walked down by Nabil Massanweh, Ed LaPage. Ed Konnecke and Jim Knowlton.

Issue 2 Modified Test Procedures

GVEA's CONCERN:
Modified Test Procedures: Ed and John were informed Monday morning that AIDEA's HCCP boiler performance guarantee tests would not adhere to all of the requirements specified in the Foster Wheeler Contract HCP-009 and the HCCP DOE Test Plan. Ed and John were given the attached Boiler Performance Guarantee Test Program and Procedures for Healy #1 Clean Coal Project (dated November 23, 1998). This test program does not require FWEC to provide accurate test instrumentation, plus that test and calculations do not have to be in accordance with ASMA PTC 4.1) testing protocol. These changes are in conflict with the original contract documents, specifically the Boiler Design, Supply and Erection Contract #HCP-003, Division 3, Section 4.1, Field Testing. This Contract requires that the "Contractor shall furnish all test

equipment required. Evidence of proper calibration shall be submitted to the Owner at the time of tests. As a minimum, performance tests and performance calculations shall be made in accordance with the applicable ASME Test Form for Abbreviated Efficiency Tests in the latest edition of ASME PTC 4.1...". "Performance tests for boiler efficiency shall be made on the basis of the Heat Loss Method." GVEA is relying of AIDEA to adhere to the original contract requirements concerning performance guarantee testing and acceptance. These critical test requirements were apparently waived by AIDEA without the knowledge or consent of GVEA. Why wasn't GVEA consulted on these important contract changes or provided with the modified Test Procedure prior to the day of the boiler test? Why has AIDEA dropped the boiler efficiency calculations from their testing program? The DOE Test Plan requires this information by provided.

S&W RESPONSE:
The discussion in the Boiler Contract Specification, Section 301 Section 4.1 could be interpreted as standard specification content to be applied to the guarantees. Since boiler efficiency was not guaranteed (although it typically is), there is no requirement for a PTC 4.1 ASME Abbreviated Test. An ASME Abbreviated Test can be executed, but there is no guarantee requirement that necessitates it. The use of the word performance in Section 4.1 implies efficiency. The guarantees need to be itemized in accordance with the contract with FWEC; the test program and procedures should address all guarantees.

The DOE test plan was to be used as a guideline for an efficiency test; it does call for an ASME Abbreviated Test; however, this test is not required to address any contract guarantee.

It was S&W's understanding that the GVEA role was as witness. Variances in the guarantee/acceptance test were the responsibility of FWEC and AIDEA.

Issue 3 Test Instrumentation/Data Accuracy

GVEA's CONCERN:
Test Instrumentation/Data Accuracy: AIDEA's decision to use existing plant instrumentation has compromised the accuracy of the test data. Some of the field instruments were not operational and/or out of calibration and could not be used during the tests. As a result, some the required data had to be taken manually from standard gages, rather than precision test-grade instruments. AIDEA needs to provide GVEA certification that all instrumentation used during the tests were accurately calibrated just prior to the test, and all DCS data points used to document boiler performance were recently calibrated, including loop checks and data check (reference DOE Test Plan, Section 5.7). The instrumentation measurement error must meet the minimums specified in ASME PTC 4.1C. The instrument readings and DCS data stream will not be accepted as accurate without proper Q/A documentation; and, as a result, GVEA will not accept these tests as being performed in compliance with the original contract requirements.

S&W RESPONSE:
The specification clearly states that FWEC will provide all test instruments. This did not occur, however existing plant instrumentation is commonly used for testing and although separate

instrumentation may have been somewhat more accurate, it is unlikely that the actual test results would have been significantly affected if FWEC instrumentation had been used.

The instrumentation referred to as broken, and/or in question, are one of the two oxygen sensors (which was in alarm for CO but believed by the instrument tech to be accurate for oxygen measurements) and the secondary superheater outlet pressure which had to be read manually. FWEC, AIDEA and S&W agreed prior to the commencement of the testing that the instrumentation was acceptable.

After the completion of the testing, calibration data sheets were distributed to FWEC, GVEA, and S&W. It was noticed that the main steam temperature thermocouple needed to be properly calibrated to temperature levels experienced during full-load operation. If the main steam thermocouple issue is not addressed, then the test results are questionable.

AIDEA (Nabil) stated that they would calibrate this thermocouple or have its accuracy verified by heat balance calculations.

Calibration within six months is acceptable for modern instrumentation in a normal plant. For a performance/acceptance tests more recent calibration is desirable. Calibration data sheets were issued during the test. Loop checks are not typically done as part of a testing effort; loop checks are done during startup/commissioning. Data checks were done by all parties involved.

Issue 4 Test Duration

GVEA's CONCERN:
Test Duration: The boiler test procedures require the performance test to be a minimum four-hour continuous test (reference DOE Test Plan, Table 5.7-2, Boiler Performance Guarantee Test, and note on page 41). Why did AIDEA lower this industry test standard to a minimum of two-hour duration for HCCP in their November, 1998, Test Program? GVEA cannot accept AIDEA's reduced standard.

S&W RESPONSE:
The FWEC test report states in paragraph 3.1 that the test period was four (4) hours long.

Issue 5 Coal Fineness Test

GVEA's CONCERN:
Coal Fineness Test: The boiler contract performance guarantee section includes required coal fineness at the outlet of the pulverizers. During the boiler test there was difficulty obtaining a representative coal sample from the pulverizer outlets. Mr. Ed LaPage, the FWEC representative, was allowed to call off the fineness tests because the sampling techniques were not according to code. As a result, coal fineness samples were not taken during the test. According to the Field Testing, Section 4.1, of the HC-009 Contract. "All performance guarantees shall be simultaneously met at the appropriate loads." Since these coal samples

were not taken during the testing period, GVEA cannot accept these performance guarantee tests as valid.

S&W RESPONSE:
The coal fineness testing was abandoned after the sampling was observed to be non-compliant with PTC 4.2.

FWEC subsequently informed S&W that this requirement was deleted for combustor operation in contract Addendum 1 and is not a part of the latest contract Addendum 5 which was part of Change Order 7, dated March 6, 1996. FWEC further informed S&W that the fineness guarantee was to only apply to the low NOx burner configuration.

ATTACHMENT 4
Contract Change No. 7/Addendum 1/Addemdum 5

CHANGE ORDER

HEALY CLEAN COAL PROJECT

ALASKA INDUSTRIAL DEVELOPMENT AND EXPORT AUTHORITY
480 WEST TUDOR ROAD
ANCHORAGE, ALASKA 99503-6690

CONTRACTOR:

Foster Wheeler Energy Corporation
Perryville Corporate Park
Clinton, NJ 08809-4000

Contract No. HCP-009
Boiler Design and Supply
March 6, 1996

Attention: Mike Gulla
Telephone: (908) 236-1360

Page 1 of 1

CONTRACT CHANGE NO. 7

1.0 SCOPE OF CHANGE

Incorporate erection related changes to Division 1 - Contract Requirements, Division 2 - General Requirements, and Division 3 - Technical Requirements (Specification No. 19574-P201W) as delineated in Addendum No. 5 which is attached hereto and made a part hereof. Section 302 - Erection of Division 3 has been deleted in its entirety and the boiler and combustor erection has been removed from the Scope of Work.

2.0 CONTRACT PRICE

Section 302 - Erection is being deleted and new related items have been added. The Base Contract Price as shown in Article 1.0 of Section 102 has been adjusted to reflect these changes.

3.0 ALL OTHER TERMS AND CONDITIONS REMAIN UNCHANGED

4.0 PRICE SUMMARY

Original Contract Price	$21,923,198.00
Total of Previous Contract Changes	$3,497,800.00
Decrease per Contract Change No. 7	($10,491,234.00)
Revised Contract Price	$14,929,764.00

CONTRACTOR'S ACCEPTANCE:

BY: [signature] (Signature) (Date) 5/1/96

H. B. Highland
(Type or Print Name)

ALASKA INDUSTRIAL DEVELOPMENT AND EXPORT AUTHORITY APPROVAL

BY: ____ William R. Snell, Project Director (Date)

BY: ____ John B. Olson, Project Manager (Date)

	Guarantee* Values With TRW Combustors	Guarantee* Values With Foster Wheeler Low NO_x Burners	Allowable Variation From Stated Value
e. Gas temperature leaving main tubular air heater (without leakage), °F with 80°F at FD Fan Discharge	N/A	300	+20, -40
f. Total air to gas air heater leakage, lb/hr	N/A	***	+0
g. Maximum forced draft fan shaft input power at its guarantee point, Kw (if fan is furnished by the Contractor	***	***	+0
h. Flue gas flow, lb/hr	N/A	680,000**	+0
i. Maximum pulverizer gearbox shaft input power, each, Kw	330	330	+0
j. Pulverizer Coal Fineness			
% Passing 200 mesh		70	-0
% Passing 50 mesh		98	-0
k. Boiler efficiency loss due to unburned carbon	N/A	.4	+0
3. At all Boiler Operating Conditions			
a. NO_x (expressed as NO_2) emissions, lb/10^6 Btu	N/A	0.35	+0
b. CO emissions, ppm	N/A	< 200	+0

X

* The guarantees noted hereunder are based on the guarantee testing data being normalized for the characteristics of the coal utilized during testing and for other parameters such as air and sorbents

** Numbers as calculated by Stoichiometric combustion methods

*** Guarantees to be determined

	Guarantee* Values With TRW Combustors	Guarantee* Values With Foster Wheeler Low NO_x Burners	Allowable Variation From Stated Value
e. Gas temperature leaving main tubular air heater (without leakage), °F with 80°F at FD Fan Discharge	N/A	300	+20, -40
f. Total air to gas air heater leakage, lb/hr	N/A	***	+0
g. Maximum forced draft fan shaft input power at its guarantee point, Kw (if fan is furnished by the Contractor	***	***	+0
h. Flue gas flow, lb/hr	N/A	680,000**	+0
i. Maximum pulverizer gearbox shaft input power, each, Kw	330	330	-0
j. Pulverizer Coal Fineness			
% Passing 200 mesh		70	-0
% Passing 50 mesh		98	-0
k. Boiler efficiency loss due to unburned carbon	N/A	.4	+0
3. At all Boiler Operating Conditions			
a. NO_x (expressed as NO_2) emissions, lb/10^6 Btu	N/A	0.35	+0
b. CO emissions, ppm	N/A	< 200	+0

* The guarantees noted hereunder are based on the guarantee testing data being normalized for the characteristics of the coal utilized during testing and for other parameters such as air and sorbents

** Numbers as calculated by Stoichiometric combustion methods

*** Guarantees to be determined

Appendix B

Stone & Webster HCCP Boiler Efficiency Calculations- August 24, 1999

Stone & Webster

FOUNDED 1889

ATLANTA, GA
BOSTON, MA
CHATTANOOGA, TN
CHERRY HILL, NJ
DENVER, CO
HOUSTON, TX
NEW YORK, NY
WASHINGTON, DC
MIAMI, FL
PLEASANTON, CA

ABU DHABI, UAE
AL KHOBAR, SAUDI ARABIA
BANGKOK, THAILAND
DAMMAM, SAUDI ARABIA
KUALA LUMPUR, MALAYSIA
KUWAIT CITY, KUWAIT
MILTON KEYNES, ENGLAND
JAKARTA, INDONESIA
SEOUL, KOREA
TORONTO, CANADA

RECEIVED
AUG 30 1999
Alaska Industrial Development and Export Authority

Mr. Dennis V. McCrohan
Project Design/Construction Manager
Healy Clean Coal Project
Alaska Industrial Development and
Export Authority
480 West Tudor
Anchorage, Alaska 99503-6690

August 24, 1999

J.O. No. 07440.03

HCCP Boiler Efficiency Calculation

Dear Mr. McCrohan:

Although boiler efficiency was not a guaranteed parameter of the AIDEA/FWEC contract, it is of general interest in the context of boiler performance. Two methods have been used to calculate HCCP boiler efficiency based on data collected during recent boiler tests. J. S. Strandberg Consulting Engineers, Inc. used the input/output method while Stone & Webster Engineering Corp. used the heat loss method. Both of these methods are potentially acceptable. The following is a discussion of the use of these calculation approaches in determining boiler efficiency estimates for the HCCP.

The major difference between the input/output method and the heat loss method is the parameters that are used to calculate efficiency. These differences are summarized below:

- The input/output method used in the Strandberg Status Report uses the fuel flow/heating value, the steam, water and air flows, and temperatures to calculate efficiency.
- The heat loss method used in the Stone & Webster calculation uses the gas and air temperatures, ultimate fuel analysis, flue gas oxygen content, unburned carbon in the ash, radiation loss, and slag tap loss.

The input/output method relies on flow measurements that are inherently less accurate than the measurements that are required for the heat loss method. The combination of inaccuracies in the coal and steam flows could impact the efficiency calculation 2% - 4%. When sufficient information is available to calculate the boiler efficiency using the heat loss method, doing so will generally result in a more accurate estimate of boiler efficiency. In the case of the HCCP test, enough data was collected to use the heat loss method and Stone & Webster recommends that it be considered the accepted method.

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7677 East Berry Avenue, Englewood, Colorado 80111-2137
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It is noted that at the time the data was collected during the recent testing program it was not specifically intended to be used for establishing boiler efficiency. The accuracy/availability of some of the data required for an "iron clad" efficiency calculation is currently not available. If additional testing is done, the required data may be collected under stable operating conditions, which could be of sufficient protocol to calculate a more exact efficiency value.

The following comments are made pertaining to the data that is currently available for the efficiency calculation:

- Regarding the input/output efficiency calculation performed by Strandberg Consultants, there is a large discrepancy in the results with the Stone & Webster heat loss efficiency results. The difference in fuel analysis between the values reported in the FWEC test report, which was verifiably collected during the boiler performance test, and the Usibelli Coal Mine "grab sample and increment samples" dated 3/29/99 whose origin is unknown may be a contributing factor.

  The FWEC report indicates a higher heating value of 7,025 Btu and the Usibelli Coal Mine reports a 7,300 Btu heating value. Stone & Webster recommends that the FWEC coal analysis be used for all boiler efficiency calculations as it represents the actual fuel fired during the test.

  A referee sample of the test coal is being held by AIDEA to resolve this issue if it should become necessary.

Fuel analysis data:

Ultimate Analysis. %	Test Coal Sample FWEC 4/26/99 Report	Usibelli Mine Corp Grab Sample (estimated) used by Strandberg	Specification Performance Coal Referenced in Strandberg Report
Carbon	42.38	42.55	40.57
Hydrogen	3.35	3.22	3.07
Sulfur	0.19	0.16	0.15
Oxygen	13.46	14.63	13.94
Nitrogen	0.55	0.55	0.53
Moisture	27.00	25.60	25.11
Ash	13.07	13.29	16.60
HHV,Btu/lb	7,025	7,300	6,960.2

A breakdown of the efficiency calculations for the full load case is presented below:

	Calculated By S&W Based on 3/29/99 Performance Test Coal Analysis	Calculated By Strandberg Based on Strandberg Input/Output Method	Predicted by FWEC 2/22/93
Dry Gas Loss	5.03	--	4.89
Moisture Loss	9.35	--	8.66
Unburned Carbon	0.10	--	0.79
Slag Tap Loss	3.05	--	4.59
Radiation Loss	0.25	--	0.29
Unaccounted	0.00	--	1.63
Total Losses	17.78	22.80	20.85
Boiler Efficiency	82.22	77.20	79.15

- The UBC and slag tap losses predicted by FWEC were originally provided from a TRW heat balance dated 2/22/93. These were most likely predicted losses, or they were based on pilot combustor data, that may have been somewhat conservative for design purposes.

Given the significant difference in fuel analysis used in the respective calculations, and the independent method of calculating the slag tap heat loss, Stone & Webster expects that actual full load boiler efficiency is 82.2%. Part load boiler efficiency is calculated to be 79.6%.

If you have any questions regarding this information, please call me at your convenience.

Very truly yours,

Verle Bland
Project Manager

ATTACHMENTS:
1. Full Load Boiler Efficiency Calculation
2. Part Load Boiler Efficiency Calculation

Copy to: E. R. LePage, Foster Wheeler Energy Corp.
F. Abegg, Golden Valley Electric Association
C. Herrington, Healy Clean Coal Project
W. Steigers, Steigers Corp.
R. M Kornosky, US Dept of Energy

Combustion Calculations - Molal Basis

Based on Method Presented in Babcock & Wilcox Steam

Healy Clean Coal Project Boiler Guarantee Test - Full Load

	Fuel O2 and Air per Unit of Fuel					Flue Gas Composition - Moles per Fuel Uniit				
	Per Unit Fuel WT%	Mol WT Divisor	Moles	O2 Mult	Theo O2 Moles	CO2	O2	N2	H2O	CO
1 C to CO2	42.33%	12	3.53	1	3.53	3.53				
2 C to CO	0.00%	12	0.00	0.5	0.00					0.00
3 CO to CO2	0.00%	28	0.00	0.5	0.00					
5 C unburned	0.05%	12	0.00							
5 H2	3.35%	2	1.68	0.5	0.84				1.68	
6 S	0.19%	32	0.01	1	0.01	0.01				
7 O2	13.46%	32	0.42	-1	-0.42					
8 N2	0.55%	28	0.02					0.02		
9 CO2	0.00%	44								
10 H2O	27.00%	18	1.50						1.50	
11 ASH	13.07%									
12 SUM	100.00%									
			O2 (theo) required		3.95					
			O2 (excess)		0.91		0.91			
			O2 Supplied		4.86					
			N2 Supplied		18.28			18.28		
			Dry air Supplied		23.15					
			H2O in air		0.49				0.49	
			Wet Air Supplied		23.64					
			Flue Gas Constituants			3.53	0.91	18.30	3.67	0.00

Flue Gas Exit Temp 304.00 °F

Air Heater Air Inlet Temp 95.00 °F

Fuel He 7025 Btu/lb

	CO2	O2	N2	H2O	CO	Btu	%
Mcp	9.70	7.15	7.00	8.12	7.00		
In Dry Flue Gas	7,163	1,364	26,779		0	35,306	5.03%
In H2O in air				833		833	0.12%
In sens heat H2O in fuel				5,388		5,388	0.77%
In latent heat H2O in fuel				59,436		59,436	8.46%
Due to Carbon in Refuse						705	0.10%
Due to unburned CO in Flue Gas						0	0.00%
Radiation Losses						—	0.25%
Slag Tap Loss						—	3.05%
total						101,668	17.77%

Heat Value of Fuel Unit 702,500

Total Losses 17.77%

Boiler efficiency 82.23%

673,979,714 Heat In, Btu/hr
95,940 Coal Flow, pph
12,539 Slag/Ash Flow, pph

Slag Specific Heat Loss

0.26 cal/°C-g
2,170,929,320 cal to cool slag
8,614,248 BTU to cool slag
1.28% Efficiency Loss, Sensible heat, %

Slag Fusion Heat Loss

60 Mol. Wght of slag
209 Moles Slag/hr
6,120 Btu/lbmole
1,277,212 cal to fuse slag
0.19% Efficiency Loss, Solidification, %

Slag Radiation Heat Loss

2,700 Temp. of slag radiating to tank, F
78.49 Area of openings into the slag recovery zone @ 2 X 5.84X6.72, ft^2
0.80 Emissivity of PC flame leaving combustor
0.96 Emissivity(absorbtivity) of water surface in slag tank
212 Water temperature in slag tank, F
136,072 Heat loss, Btu/hr-ft^2 (Calc. By Stephan-Boltzman)
10,680,200 Total heat loss, Btu/hr
1.58% Efficiency Loss, Radiation, %

Combustion Calculations - Molal Basis

Based on Method Presented in Babcock & Wilcox Steam

Healy Clean Coal Project Boiler Guarantee Test - Part Load

	Fuel O2 and Air per Unit of Fuel					Flue Gas Composition - Moles per Fuel Uniit						
	Per Unit Fuel WT%	Mol WT Divisor	Moles	O2 Mult	Theo O2 Moles	CO2	O2	N2	H2O	CO		
1 C to CO2	39.09%	12	3.26	1	3.26	3.26						
2 C to CO	0.00%	12	0.00	0.5	0.00					0.00		
3 CO to CO2	0.00%	28	0.00	0.5	0.00							
5 C unburned	0.05%	12	0.00									
5 H2	3.00%	2	1.50	0.5	0.75				1.50			
6 S	0.19%	32	0.01	1	0.01	0.01						
7 O2	13.15%	32	0.41	-1	-0.41							
8 N2	0.55%	28	0.02					0.02				
9 CO2	0.00%	44										
10 H2O	25.78%	18	1.43						1.43			
11 ASH	18.20%											
12 SUM	100.00%											
O2 (theo) required					3.60			/				
O2 (excess)					2.27		2.27					
O2 Supplied					5.87							
N2 Supplied					22.08			22.08				
Dry air Supplied					27.95							
H2O in air					0.59				0.59			
Wet Air Supplied					28.54							
Flue Gas Constituants						3.26	2.27	22.10	3.52	0.00		
Flue Gas Exit Temp					297.00 °F							
Air Heater Air Inlet Temp					107.00 °F							
Fuel He				6487	Btu/lb							
Mcp						9.70	7.15	7.00	8.12	7.00	Btu	%
In Dry Flue Gas						6,014	3,083	29,388		0	38,484	5.93%
In H2O in air									914		914	0.14%
In sens heat H2O in fuel									4,524		4,524	0.70%
In latent heat H2O in fuel									54,891		54,891	8.46%
Due to Carbon in Refuse											635	0.10%
Due to unburned CO in Flue Gas											0	0.00%
Radiation Losses											----	0.55%
Slag Tap Loss											----	4.50%
total											99,448	20.38%
Heat Value of Fuel Unit											648,700	
Total Losses												20.38%
Boiler efficiency												79.62%

410,982,906 Heat In
63,355 Coal Flow
11,531 Slag/Ash Flow

Slag Specific Heat Loss

0.26 cal/°C-g
1,996,277,212 cal to cool slag
7,921,228 BTU to cool slag
1.93% Efficiency Loss, Sensible heat, %

Slag Fusion Heat Loss

60 Mol. Wght of slag
192 Moles Slag/hr
6,120 Btu/lbmole
1,174,460 cal to fuse slag
0.29% Efficiency Loss, Solidification, %

Slag Radiation Heat Loss

2,600 Temp. of slag radiating to tank, F
78.49 Area of openings into the slag recovery zone @ 2 X 5.84X6.72, ft^2
0.80 Emissivity of PC flame leaving combustor
0.96 Emissivity(absorbtivity) of water surface in slag tank
212 Water temperature in slag tank, F
119,607 Heat loss, Btu/hr-ft^2 (Calc. By Stephan-Boltzman)
9,387,935 Total heat loss, Btu/hr
2.28% Efficiency Loss, Radiation Loss, %

Appendix C

Golden Valley Electric HCCP Boiler Performance Test – October 13, 1998

GOLDEN VALLEY ELECTRIC ASSOCIATION INC. PO Box 71249 • Fairbanks, Alaska 99707-1249 • 907-452-1151

Mr. Dennis McCrohan
Deputy Director
Alaska Industrial Development
and Export Authority
480 West Tudor
Anchorage, Alaska 99503

October 13, 1998
GA-384

RE: HCCP Boiler Performance Test

Dear Dennis:

This letter is a continuation of our discussion with you concerning the questionable accuracy of AIDEA's March 1999 performance guarantee test of the HCCP boiler. We stated our initial concerns previously in our letter GA-374 to you dated May 28,1999. Since then we have received copies of two letters written by AIDEA's Engineer, Stone and Webster Engineering, that add additional light concerning these boiler tests. The first letter was dated June 14, 1999 from Mr. James Knowlton, and the second letter was dated August 24, 1999 from Mr. Verle Bland. These letters confirm that AIDEA failed to perform the HCCP boiler tests according to the industry standard ASME PTC 4.1 protocol, as required in the DOE Test Plan. As a result of AIDEA taking shortcuts prior to and during the test, adequate and accurate information was not obtained during the tests to define the boiler's efficiency. Specifically, all of the required test instrumentation should have been properly calibrated prior to the test, and proper sampling of the pulverized coal, bottom ash and fly ash should have been taken during these tests.

Dr. John Zarling witnessed AIDEA's HCCP boiler performance tests for Golden Valley. He is a registered professional engineer and a retired professor of mechanical engineering at the University of Alaska Fairbanks. Dr. Zarling reviewed the above referenced Stone and Webster letters, and his comments are attached. He agrees with Stone and Webster that some of the data required for an "iron clad" efficiency calculation were not collected during the March 1999 HCCP boiler performance tests. As a result Stone and Webster had to make a number of assumptions concerning flue gas composition, unburned carbon in the flyash/bottom ash and boiler radiation losses in order to calculate the HCCP boiler efficiency.

Stone and Webster's latest letter uses very "best case" assumptions to increase the boiler efficiency from their previous estimate of 79.12% to 82.2%. It is unlikely, however, that the flue gas had 0% carbon monoxide, the ash had only 0.05% unburned carbon and there

V Bland – SWEC Denv
J Knowlton – SWEC /Boston
E Lepage – FWEC

weren't any "unaccounted for losses". Stone and Webster and Foster Wheeler previously assumed 0.4% unburned carbon in the ash and higher radiation and convection losses than in the most recent calculation. GVEA requests that AIDEA provide their Engineer's rationale for the reductions made in the HCCP boiler losses, which yielded their present higher HCCP boiler efficiency estimate.

Based on Stone and Webster's analysis and our expert's review, an accurate estimate of HCCP boiler efficiency using the "loss method" can only be substantiated with a complete set of data taken during another performance test. Therefore, the March 1999 HCCP boiler performance tests did not satisfy the requirements of the DOE Test Plan and must be performed again. DOE or TRW should not use the March 1999 test data as documented evidence of the HCCP boiler or combustor efficiency.

Sincerely,

Frank Abegg
Vice President, Healy Generation

Cc:	Clive Herrington	w/attachments
	Robert Kornosky (DOE)	"
	Ruth Braswell (TRW)	"
	Denny Swann (HGI)	"
	Mike Kelly	
	Walt Lawson	
	Ed Konnecke	
	Dr. John Zarling	
	Ron Saxton	

Zarling Aero and Engineering

October 1, 1999

Frank Abegg
Vice President, Healy Generation Unit
Golden Valley Electric Association Inc.
758 Illinois Street
Fairbanks, Alaska
99701-1249

Dear Frank,

I have reviewed the two documents, described below, that were forwarded to me by your office.

1. James Knowlton's, Stone and Webster Engineering Corp., June 14, 1999 Memo to Dennis McCrohan, Project Design/Construction Manager of AIDEA

Mr. Knowlton of SWEC in this June 14, 1999 memo to Mr. Dennis McCrohan of AIDEA addressed a number GVEA's concerns over the conduct of the HCCP boiler performance guarantee test which occurred March 29 and 30, 1999. Frank Abegg of GVEA communicated these concerns in a letter dated March 31, 1999 to Clive Herrington of AIDEA. Mr. Knowlton makes the following statements in his response.

"Calibration within six months is acceptable for modern instrumentation in a normal plant. For a performance/acceptance test, more recent calibration is desirable. Calibration data sheets were issued during the test."

Below are listed the instruments that were necessary for accessing whether the HCCP boiler performance guarantees were met and their calibration dates. It is noted that calibration sheets for seven of these instruments were either not provided or out-of-date, two of the instruments had calibration dates just beyond the "six month" period, and three of the instruments had been calibrated within about three months of the test date.

Variable	**Tag No.**	**Calibration**
Main steam flow	2FG-FT22	Not provided
Feedwater flow	2FW-FT26	9/23/98
Attemperator spray flow	2FW-FT04	9/7/96 but out-of-date
Steam drum pressure	2BS-PT14	9/23/98
Secondary superheater outlet pressure	2MS-PT10	Broken instrument
Turbine throttle pressure	2MS-PY10B	Not provided
Steam temperature at superheater outlet	2MS-TE05	12/29/98 & 6/21/99
Economizer inlet pressure	2FW-PT39	12/28/98
Boiler gas outlet pressure	2FG-PT16	Not provided
Furnace draft	2BA-PT21A	Not provided

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e-mail zae@gci.net

Furnace draft	2BA-PT21B	Not provided
Furnace draft	2BA-PT21C	12/22/98

J. S. Strandberg Consulting Engineers' assessment was that the results of the performance guarantee tests had to be viewed as questionable because of the lack of complete and recent instrument calibrations. At best, only three of the instruments listed above would seem to fall into the "more recent" time frame of calibration with the other instruments outside that time frame or having no calibration sheets provided. The table presented above seems to substantiate the conclusion made by J. S. Strandberg Consulting Engineers.

The fluegas O2 sensor readings were used to calculate excess air and the CO sensors readings were used in the "loss method" approach to boiler efficiency calculations to determine unburned carbon in the flue gas. Again, no calibration sheets for these instruments were provided.

Fluegas O2	2FG-AT02A & B	Not provided
Fluegas CO	2FG-AT03A & B	Not provided

There are also no calibration data available for the voltmeters and ammeters whose readings were recorded for assessing the power requirements of the electric drive motors for the forced draft fan and the pulverizers.

2. James Knowlton's, Stone and Webster Engineering Corp., July 1, 1999 Letter to Dennis McCrohan, Project Design/Construction Manager of AIDEA

Mr. Knowlton of SWEC in this July 1, 1999 letter forwarded to Mr. Dennis McCrohan the results of the HCCP boiler performance guarantee test conducted on the 29 and 30 of March 1999. Included with this letter was documentation of calibration data sheets and Foster Wheeler Energy Corp.'s report, CR-351 Performance Testing.

There is disagreement over the status of the documentation of calibration data sheets for the instruments used during the HCCP boiler performance guarantee test. This issue was covered previously in this letter.

Overall, the results of FWEC's and J. S. Strandberg Consulting Engineer's analysis of the data from the March 1999 HCCP boiler performance guarantee tests are in agreement. FWEC used the DCS printed data to arrive at their averages whereas, J. S. Strandberg Consulting Engineers used the data recorded to a CD ROM to arrive at their averages. The only significant difference is in the assessment of the steam pressure loss from the boiler steam drum and the secondary superheater outlet. FWEC used the turbine throttle pressure and J. S. Strandberg Consulting Engineers used the secondary superheater outlet pressure in their calculations, respectively. Both calculations yield pressure drops that are within the guaranteed value.

If you have any questions concerning my review of these documents please give me a call.

Sincerely yours,

John P. Zarling, Ph.D., P.E.
Zarling Aero and Engineering

Zarling Aero and Engineering

October 1, 1999

Frank Abegg
Vice President, Healy Generation Unit
Golden Valley Electric Association Inc.
758 Illinois Street
Fairbanks, Alaska
99701-1249

Dear Frank,

I have reviewed the August 24, 1999 letter from Verle Bland, Project Manager, Stone and Webster Engineering Corporation (SWEC) to Dennis McCrohan, Project Design/Construction Manager of Alaska Industrial Development and Export Authority concerning the HCCP Boiler Efficiency Calculations. The following comments represent the results of this review.

I agree with SWEC's assessment that when determining boiler efficiency, the "loss method" is generally not as sensitive to measurement errors as the "input-output" method. However, as Mr. Bland points out in his letter, some of the data required for an "iron clad" efficiency calculation using the "loss method" were not collected during the March 1999 HCCP boiler performance guarantee testing. Samples or data required, but not collected for the combustion efficiency part of the "loss method" calculation, include samples of the flue gas for a complete flue gas analysis and samples of the fly/bottom ash for an unburned carbon analysis. Neither ambient air nor boiler wall temperatures were collected that are required for a more accurate radiation loss estimate. Because of the lack of these and other data, several assumptions were made in order to complete the calculations using the "loss method". Some of these assumptions were 0.0% carbon monoxide in the flue gas, and 0.05% unburned carbon in the residue, and an uncorrected radiation loss. Furthermore, SWEC's calculations of the slag tap losses do not seem to be supported by actual data but appear to be based on experience or nominal property values. Finally, SWEC did not include any "unaccounted for losses" in arriving at their present efficiency estimate. An accurate estimate of HCCP boiler efficiency using the "loss method" can only be substantiated with a complete set of data taken during another performance test.

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1. HCCP Boiler Efficiency by the "Input-Output Method"

J. S. Strandberg Consulting Engineers chose to use the "input-output" method to estimate HCCP boiler efficiency because the estimate was based on the data recorded during the boiler guarantee performance test. The "loss method" would have required assuming values for data not collected during the test.

J. S. Strandberg Consulting Engineers used 7,300 BTU/lb for the heating value of the coal burned during the HCCP guarantee performance test to estimate boiler efficiency using the "input-output" method. This value was provided to J. S. Strandberg Consulting Engineers by Golden Valley Electric Association and was the result of a laboratory analysis of the coal conducted by Usibelli Coal Mine Inc. If Foster Wheeler Energy Corporation's (FWEC) measured heating value of 7,025 BTU/lb is used in the calculation, then the "input-output" method yields a higher boiler efficiency estimate of **80.3%**.

2. HCCP Boiler Efficiency by the "Loss Method"

Combustion Losses

SWEC's calculations for combustion losses were reviewed and determined to be in general agreement with the methodology given in Steam – Its Generation and Use, Babcock and Wilcox. However, I believe the unburned carbon losses should have remained in the 0.79% to 0.83% (0.4% unburned carbon) range as used by FWEC and SWEC in previous calculations rather than the 0.10% (0.05% unburned carbon) used in the present calculation. Until the unburned carbon in the residue is measured as part of a performance test, it is recommended that continued use of about 0.8% for the unburned carbon loss in efficiency calculations is prudent.

Carbon monoxide in the flue gas was assumed zero in the calculations. However, any measurable CO in the flue gas results in a decrease in boiler efficiency. It is recognized that CO measurements were recorded during the HCCP performance guarantee tests, however, no calibration sheets have been provided for either the O2 or CO sensors. It was also reported that there was a problem with the O2 and/or CO sensors/system so it is unclear as to the accuracy of the existing CO data. Because HCCP was being operated at 23% excess air it would be expected that the boiler would be operating at a low CO level. However, higher levels of excess air lead to a reduction in boiler efficiency.

The temperature of the coal entering the system should have been 80°F in SWEC's calculations as this is the reference temperature also stated in the contract documents. The 95°F temperature used in SWEC's calculations is the temperature of the air entering the low temperature air heater and not the coal temperature. This air passes through the glycol heater and forced draft fan prior to arriving at the low temperature air heater, which results in a temperature rise. On the other hand, the coal from outdoors is loaded into the coal bunkers and then flows to the pulverizers. While it is in the bunkers it is warming to ambient plant temperature.

When these two changes, 0.4% unburned carbon and 80°F-coal temperature, are made to SWEC's calculation, estimated combustion losses including unburned carbon in the residue increases from 14.4% to 15.2%.

EPRI lists gradation of pulverized coal to minimize unburned carbon at no more than 2% retained on #50 sieve and at least 60% to 70% passing a #200 sieve. Had pulverized coal samples been taken during the HCCP performance guarantee testing as required by the test plan, and fineness measurements made on the samples, data would have been available to evaluate this element's effect on unburned carbon.

It is also noted that collection of coal samples for moisture determination was not carried out as required by ASME PTC 4.1 during the HCCP performance test. This test code requires great care in separating a special sample for moisture determination, placing it in a non-corrosive air tight container and sealing it immediately so no moisture is lost prior to the laboratory analysis. If samples are allowed to dry prior to laboratory moisture analysis, the water content will be reported low resulting in a higher estimate of boiler efficiency by the "loss method".

Radiation Loss

Radiation losses could be higher or lower than the value used by SWEC. The 0.25% value listed should be corrected for air velocity and furnace wall to ambient air temperature difference as shown in ASME PTC 4.1.

It is noted that FWEC's and SWEC's estimated radiation losses for the HCCP boiler ranged from 0.28% to 0.29% since 1991 and most recently confirmed in 1998, but now have been reduced to 0.25%.

Slag Tap Loss

If is difficult to evaluate SWEC's calculations for the slag tap losses presently estimated at 3.05% as very little detail is given. It appears the results agree with the input parameters listed for the slag tap losses on SWEC's spreadsheet. The slag properties and temperatures used in the calculations are not supported by any specifics.

It is noted that FWEC's and SWEC's estimated slag tank losses ranged from 4.29% in 1992 to 4.59% in 1998 for the HCCP boiler system but now have been reduced to 3.05%.

Unaccounted Losses

SWEC in their August 1999 boiler efficiency calculation list unaccounted losses at 0.0%, whereas in previous estimates back to 1991, unaccounted losses were estimated at 1.63%.

Estimates for the unaccounted losses typically range from 0.5% to 1.5% in the "loss method" calculation of boiler efficiency depending on the combustion characteristics of the coal and the quality of data acquired during testing according to ASME PTC 4.1.

Revised Boiler Efficiency

Using SWEC's radiation and slag tap losses as presented in their August 1999 letter and the recalculated combustion loss yields a revised boiler efficiency estimate of **81.5%**.

In March 1998, SWEC's reported the boiler efficiency at 79.12% compared to their present estimate of 82.2%. The 1998 lower efficiency estimate was based on higher unburned carbon losses at 0.83%, slag tap losses at 4.59%, radiation losses at 0.29%, and unaccounted for losses at 1.63%. Golden Valley Electric Association should request SWEC to provide the rationale for the reductions they made in these above mentioned losses, which yielded their present higher HCCP boiler efficiency estimate.

3. Final Comments

The revised efficiencies predicted by the two methods, "input–output" and "loss method", differ by 1.2%. In spite of the lack of recent calibration of some of the instruments required for the "input-output" method and the lack of data required for a number of the elements in the "loss method", these two predictions are still very close.

It is recommended that another boiler performance test be conducted and that all data necessary to substantiate the assumptions that SWEC made in their "loss method" analysis be collected during that test. It is important that calibrations of instruments used to record the data are current and that the test be conducted in accordance with ASME PTC 4.1.

I would welcome the opportunity to discuss these predictions with SWEC and FWEC engineers.

Sincerely yours,

John P. Zarling, Ph.D., P. E.
Zarling Aero and Engineering

Additional References:

Draft Memorandum to Dennis McCrohan from Steve, SWEC, Subject: HCCP Unit Heat Rate, Dated: March 12, 1998.

ASME PTC 4.1 – 1964, Reaffirmed 1991.

EPRI Heat Rate Improvement Reference Manual, TR-109546, July 1998.

Boiler Design Supply and Erection, Contract No. HCP-009, Volumes I and II.

Appendix D

Stone & Webster Engineering HCCP Boiler Efficiency Calculation – November 2, 1999

STONE & WEBSTER ENGINEERING
P.O. Box 5406, Denver, CO 80217-5406
7677 East Berry Avenue
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DOCUMENT TRANSMITTAL NO. SW/HEALY001L

Mr. Dennis V. McCrohan
Project Design/Construction Manager
Healy Clean Coal Project
Alaska Industrial Development and Export Authority
480 West Tudor
Anchorage, Alaska 99503-6690

2 November, 1999
J.O. No. 07440.02

RE: HCCP BOILER EFFICIENCY CALCULATION

Dear Mr. McCrohan:

Mr. Jim Knowlton along with our lead corporate boiler specialist, Mr. Roger Sirois, have reviewed the October 13, 1999 letter (and attachments) from Mr. Frank Abegg to you on this subject. Our comments on this information are discussed below.

The performance guarantee testing of the HCCP boiler was conducted to demonstrate the ability of the boiler to meet the performance guarantee requirements as presented in contract HCP-009. It is Stone & Webster's opinion that the testing was done in compliance with contract HCP-009, and that the guarantees were satisfactorily met using that protocol. There is no requirement in the AIDEA/FWEC contract for a minimum value of boiler efficiency. Boiler efficiency is of general interest in the context of boiler performance but is not a binding requirement. The PTC 4.1 protocol was referenced in the Demonstration Test Program document for general information had the boiler efficiency been a performance guarantee parameter. It was not.

The test performed and the respective data gathered during the testing was useful in establishing an approximate value of boiler efficiency as calculated by both Stone & Webster (employing the heat loss method) and by Strandberg Consulting Engineers (who used the input-output method). Zarling Aero and Engineering, consultant for Golden Valley Electric Association Inc. (GVEA), highlighted several issues regarding the assumptions and calculations made by Stone & Webster to provide an estimate of boiler efficiency. The following issues addressed by Zarling Aero and Engineering are discussed below:

- ***Unburned carbon***. No flyash samples were taken during the test, therefore, Stone & Webster based the unburned carbon loss value of 0.10 % on our experience with cyclone boiler designs that have a relatively low fly ash to total ash fraction similar to that of the HCCP.
- ***Carbon Monoxide (CO) Loss***. CO levels were measured in low parts-per-million concentrations during the test. Low values of CO are not sufficient to significantly impact the boiler efficiency calculation.

- ***Radiation Loss.*** The value of 0.25% comes from the ABMA Radiation Loss curve for an indoor unit and is considered by Stone & Webster to be the correct factor for the HCCP installation
- ***Omission of the "unaccounted for loss"***; The "unaccounted for loss" (also referred to as "manufacturer's margin") is used as a margin by the boiler supplier, as the name implies, to base a boiler efficiency guarantee during the contract stage of the project. When calculating the efficiency from test data, every heat loss is accounted for and, therefore, the "unaccounted for loss" is not an actual heat loss and thus should be zero and not included in the calculation. ASME PTC 4-1 does not account for this "loss".
- ***Revised Boiler Efficiency Estimate.*** One of Zarling Aero and Engineering's conclusions infers that the Stone & Webster full load efficiency should be shown as 81.5 % and not 82.2% in the August 1999 letter. Under the circumstances, this difference of 0.7 percent is considered within a reasonable range but even so, Stone & Webster maintains that the analysis submitted with the 8/24/99 correspondence is a reliable value representative of actual boiler efficiency.

This summarizes our comments on the letter and attachments that you recently received from GVEA concerning the HCCP boiler efficiency calculations. Should you have any questions regarding this information, please call me at your convenience.

Very truly yours,

Verle Bland
Project Manager

VVB:KMS

Appendix E

Schematic of TRW Clean Coal Combustion System

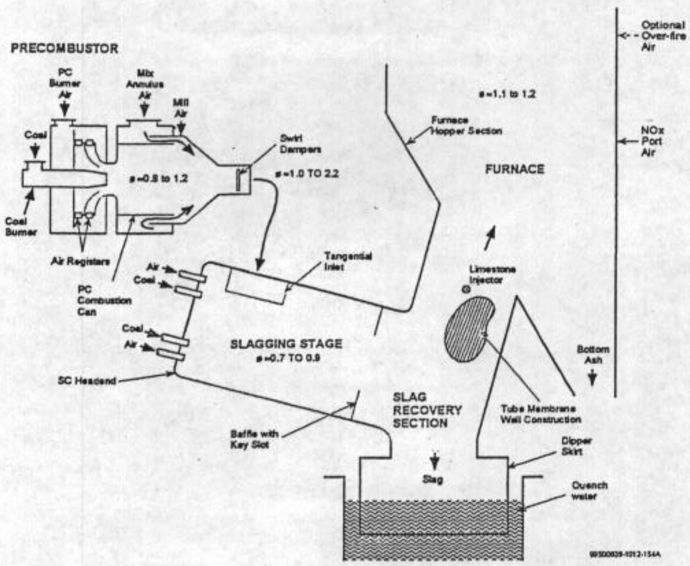
PRECOMBUSTOR
PC Burner Air
Mix Annulus Air
Mill Air
Coal
Coal Burner
Swirl Dampers
φ~0.8 to 1.2
φ~1.0 TO 2.2
Air Registers
PC Combustion Can
Tangential Inlet
Air
Coal
Coal
Air
SLAGGING STAGE
φ~0.7 TO 0.9
SC Headend
Baffle with Key Slot
SLAG RECOVERY SECTION
Slag
Furnace Hopper Section
φ~1.1 to 1.2
FURNACE
Optional Over-fire Air
NOx Port Air
Limestone Injector
Bottom Ash
Tube Membrane Wall Construction
Dipper Skirt
Quench water

FIGURE 1