Appendix F

Heat Pipe Performance Reports

McCoy, D. C., “Heat Pipe Performance Test Results - Interim Report No. 1,” CONSOL R&D Report to NYSEG, New York State Electric & Gas Corporation, Binghamton, New York, September 1996.

McCoy, D. C., “Heat Pipe Performance Test Results - Interim Report No. 2,” CONSOL R&D Report to NYSEG, New York State Electric & Gas Corporation, Binghamton, New York, February 1997.

McCoy, D. C., “Heat Pipe Fouled Condition Test Results - Interim Report No. 3,” CONSOL R&D Report To NYSEG, New York State Electric & Gas Corporation, Binghamton, New York, June 1997.

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MILLIKEN CLEAN COAL TECHNOLOGY DEMONSTRATION PROJECT

HEAT PIPE PERFORMANCE TEST RESULTS INTERIM REPORT NO. 1

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September 1996

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ACKNOWLEDGMENTS

The author wishes to acknowledge and thank the following New York State Electric & Gas Corporation personnel for their support and assistance in the testing of the heat pipe air heaters: Mr. Burt Marker for overall review of the test program and coordinating the installation of special test sample ports, pressure taps, and thermocouples: Mr. John Cooper for coordinating plant operations to achieve stable test periods; Mr. Al Vought for computer data logger programing support; and Mr. Jerry Goodenough for assistance in flue gas flow split balancing between heat pipes.

The author would also like to thank the CONSOL test team members, Mr. L. L. Anthony, Mr. O. C. Bedillion, Mr. G. L. Cairns, Mr. M. S. DeVito, Mr. M. L. Fenger, Mr. F. L. Lobodinsky, Mr. R. L. Oda, and Dr. J. A. Withum for their assistance in collecting the field data.

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LIST OF ABBREVIATIONS

ABB API	Asea Brown Boveri Air Preheater Inc.
ACFM	Actual Cubic Feet Per Minute
ASTM	American Society for Testing and Materials
Avg	Average
BD	Bone Dry
Btu	British Thermal Unit
C-Factor	Pitot Tube Flow Coefficient
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CONSOL R&D	CONSOL Inc., Research & Development
Cp	Specific Heat
°F	Degrees Fahrenheit
°R	Degrees Rankine
DB	Dry Bulb
DP	Differential Pressure
DSCFM	Dry Standard Cubic Feet Per Minute
EPA	Environmental Protection Agency
ESP	Electrostatic Precipitator
ext	Extension
FD	Forced Draft
FG	Flue Gas
FGD	Flue Gas Desulfurization
fpm	Feet per Minute
fps	Feet per Second
ft or '	Feet
ft^3	Cubic Feet
H_2O	Water
hr	Hour
ID	Inside Diameter
ID	Induced Draft (when referring to a fan)
in or "	Inches
in WC	Inches Water Column
lb/hr	Pounds per Hour
min.	Minute
MM	Million
MW	Mole Weight
MW_{net}	Net Megawatts
N_2	Nitrogen
NIST	National Institute of Standards and Technology
NYSEG	New York State Electric & Gas Corporation
O_2	Oxygen
OD	Outside Diameter

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LIST OF ABBREVIATIONS (Cont.)

P	Pressure
PA	Primary Air
PFG	Primary Flue Gas
ppm	Parts per Million
ppmv	Parts per Million by Volume
PTC	Performance Test Code
PVC	Poly Vinyl Chloride
SA	Secondary Air
SO_2	Sulfur Dioxide
spgr	Specific Gravity
Sq ft	Square Feet
SCFM	Standard Cubic Feet per Minute
SS	Stainless Steel
Temp	Temperature
TC or T/C	Thermocouple
Vol	Volume
WB	Wet Bulb
wt	Weight

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ABSTRACT

As part of the Clean Coal Technologies IV demonstration project at the NYSEG Milliken Station, the Unit 2 Ljungstrom air heaters were replaced with two heat pipe air heaters. The first detailed performance tests of the new heat pipe air heaters were conducted during the week of May 12, 1996. Testing was done approximately one month after a water wash cleaning of both heat pipes. The tests established the thermal performance of the heat pipes with respect to design performance, established the air side and gas side pressure drops with respect to design, and measured the air in leakages. This report documents the results of the testing.

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HEAT PIPE PERFORMANCE TEST RESULTS

INTRODUCTION

Milliken Station Unit 2 is equipped with two heat pipe air heaters designed and fabricated by ABB Air Preheater Inc. of Wellsville, New York. In this report, the air heaters are designated as "2A" and "2B." Heat pipe performance tests were conducted by CONSOL R&D and NYSEG during the week of May 12, 1996. Duplicate tests were conducted at high boiler load (nominally 150 MW_{net}) and one test was conducted at low load (80 MW_{net}). The test objectives were to: (1) determine the amount of air infiltration to each heat pipe, (2) determine the air and flue gas side operating pressure drops, and (3) determine the operating thermal performance as measured by the totally corrected flue gas outlet temperature (i.e., corrected for difference between actual and design operating conditions). The testing was done in general accordance with the procedures specified in the *ASME Performance Test Codes for Air Heaters, PTC 4.3* and as outlined in the heat pipe performance test plan.[1,2]

SUMMARY

1. Air infiltration is low. The unaccounted for air in-leakage for the 2A heat pipe is between 1.9 to 3.6 wt % of the inlet flue gas flow at full boiler load and is 3.6 wt % at low load. The unaccounted for air in-leakage for the 2B heat pipe is 1.2 wt % at full boiler load and 1.7 wt % at low load.
2. The flue gas side pressure drops for the heat pipes are essentially equal to the design value (3.65 in.WC). The 2A heat pipe gas side pressure loss corrected for deviation from design flow and temperature is 0.04-0.06 in.WC less than the design loss. The corrected gas side pressure loss for the 2B heat pipe is 0.2-0.3 in.WC greater than design.
3. The full load primary air side pressure drops for both heat pipes are typically 0.75 in.WC less than the design allowance (3.60 in.WC).
4. The secondary air side pressure drop for each unit is approximately equal to the design value (5.35 in. WC). The full load corrected pressure loss was 0.3-0.5 in. WC greater than design for the 2A heat pipe, and 0.1-0.2 in.WC greater than design for the 2B heat pipe.
5. The 2B heat pipe thermal performance is slightly better than that of the 2A heat pipe. At full load, the totally corrected flue gas outlet temperature of the 2B heat pipe was 265°F to 269°F (12°F to 16°F greater than design). For the 2A heat pipe, the totally corrected flue gas outlet temperature was 270°F to 271°F (17°F to 18°F greater than design).

RECOMMENDATIONS

Air Leakage Reduction

The test results indicate that air leakage into the heat pipes is relatively low. However, the 2A heat pipe air leakage is about double that of the 2B heat pipe. NYSEG could determine if air leakage can be further reduced. Since the air leakages are low, reducing the leakage further will have little effect on overall system performance. The ID fan power requirements may be reduced perhaps 1-3%. Further reducing leaks could have an effect on reducing local area corrosion rates at leak sites. Recommendations include:

1. Check for wear and proper fit on all spring-loaded seals at the retractable sootblower heat pipe shell penetrations.

2. Recheck seal on all manway doors for tight fit and integrity.

3. Measure the air flow to the infrasonic cleaner and confirm usage.

Flow Balancing Control Improvements

Before the heat pipe performance tests were conducted, the flue gas flows to the A and B heat pipes were balanced. The control system provided a reasonably good flue gas flow split. The inlet flow to the 2A heat pipe was 6%, 7%, and 9% higher than to the 2B heat pipe during the tests on 5/14/96, 5/15/96, and 5/16/96, respectively. Following the performance testing, NYSEG and CONSOL conducted a special test to achieve a 50/50 split on 5/17/96. The special test was not part of the performance evaluation program but was done to determine if minor changes to flow controls could further improve the flue gas flow split between the two heat pipes. NYSEG used the plant computer control system to calculate a control differential pressure from the heat pipe outlet pressure and ID fan inlet pressure. Balancing these differential pressures for the two heat pipes achieved a near 50/50 flue gas flow split. Based on pitot flow measurements, the flue gas flows at the outlets of the 2A and 2B heat pipes were within 1% of each other (see Appendix Tables F-43 and F44). In terms of inlet flows, the flow balance achieved is estimated to be 0.5-2.2% greater flow to the B heat pipe (based on assuming the same air leakages as determined for the high load tests). This balancing of flue gas flows did not significantly affect the thermal performance of either heat pipe.

The special test was conducted at high boiler load. If further tests show there is sufficient pressure differential for control at low loads, NYSEG could consider incorporating the control technique into the plant control system. Installing differential pressure transmitters, rather than use of individual point pressure measurements is suggested for reliability. Alternately, installation of multi-point flow averaging sensors, such as Annubars®, could be considered for measurement of the flue gas rates in the ductwork from the ESP to the ID fans. In this location, direct flow measurement should be reliable because solids concentrations are low.

Future Testing

The heat pipe performance tests were conducted about a month after the cold-end sections of both units were water washed to remove deposits. NYSEG plans to conduct a second set of tests in late 1996 or early 1997, to confirm heat pipe performance in a fouled condition. When the units are again washed, a third set of tests should be conducted to determine the performance.

SYSTEM DESCRIPTION

The process flow for the Unit 2 boiler flue gas stream is shown in Figure 1. Flue gas passes first through two parallel heat pipe air heaters for heat recovery. After heat recovery, the flue gases travel to the electrostatic precipitators for fly ash collection and then to the FGD for SO_2 removal before exiting the stack.

The A and B heat pipes are mirror image units and each is designed to preheat both the primary and secondary air streams. Figure 2 schematically shows the flue gas and air streams to and from each heat pipe. In the flue gas section, the main flow splits into a primary flue gas stream which heats the primary air, and a secondary flue gas stream which heats the secondary air. The gas rates to the primary and secondary flue gas sections are currently not individually controlled. The primary and secondary gas sections are separated by a divider wall with gas path communication at both the inlet and outlet ends. The entering flue gas flow splits depending upon the open flow areas of the two sections and level of fouling in each section.

The main sources of air infiltration are indicated in Figure 2. Because the heat pipe modules are seal welded, there should be no air leakage from the primary or secondary air sections into the flue gas

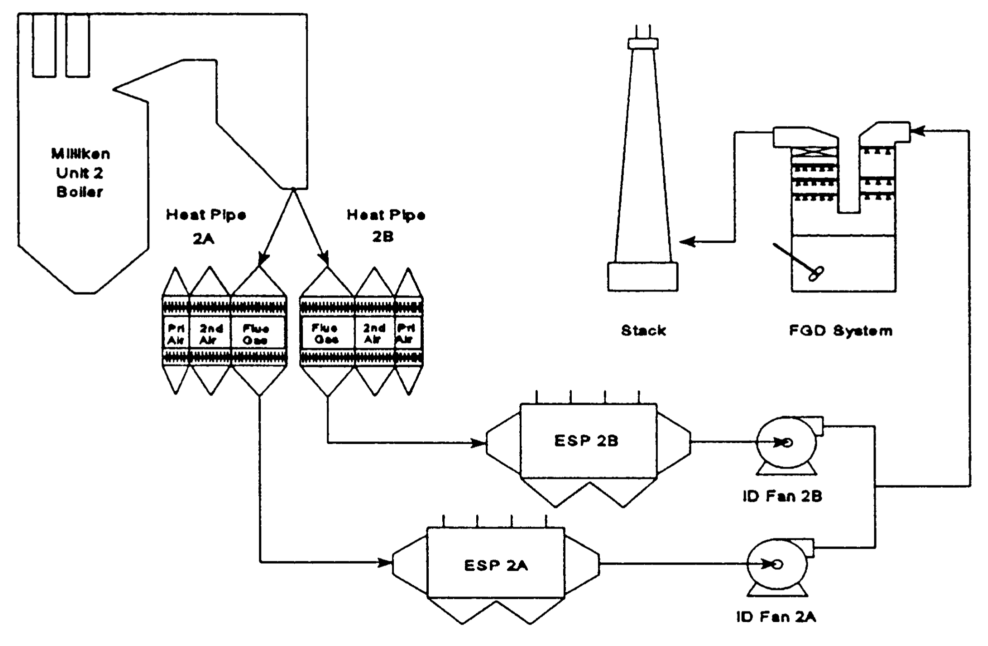

Figure 1
Flue Gas Flow Path

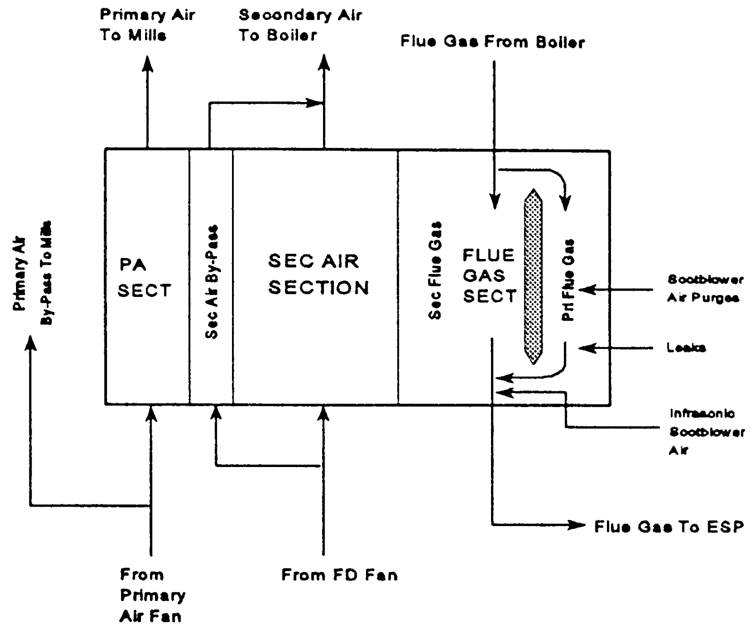

Figure 2
Heat Pipe Process Flows

sections. However, since the flue gas section operates under a slight vacuum, ambient air infiltration can occur at leaking manway doors, sample ports, duct expansion joints, and at the locations where the retractable sootblower lances penetrate the walls. Air purges on each retractable sootblower are another small source of air in-leakage. These purges prevent fly ash lay down inside the lances. The continuous operation of the infrasonic cleaner adds approximately 1,050 scfm air to the Unit 2 flue gases. The air addition occurs at the outlet of the heat pipe, ahead of the location where the outlet flue gas composition and temperature are measured. Performance test evaluation calculations account for this air.

Each heat pipe has dedicated primary and secondary air fans. The heat pipes are located directly above the fans and are connected to the fans by short expanding duct sections. Primary air which passes through a heat pipe provides the energy for coal drying in the mills. Bypassed primary air controls mill outlet temperature. The secondary air is directed to the burners. A secondary air bypass channel is integral to each heat pipe and is located between the primary and secondary air sections of each heat pipe. A damper in the secondary air bypass can be used to control the flow around the heating section. These dampers are normally maintained in a closed position and were closed for the performance tests.

TEST PROCEDURES AND RESULTS

Tests were conducted on each heat pipe separately. The testing was preformed in general accordance with the procedures outlined in the ASME Performance Test Code for Air Heaters, ASME PTC 4.3, and as detailed in the heat pipe test plan. Testing was completed over a five-day period. On Day 1, the test teams assembled at the site, team orientation was conducted, test equipment was set up and checked out, and the flue gas flow to the heat pipes was balanced. Two tests (i.e., one complete test of each heat pipe) were conducted on Days 2, 3, and 4. The tests on Days 2 and 3 were at 147-150 MW_{net} boiler load. On Day 4, the boiler load was 80 MW_{net}. On Day 5, a special test was conducted to rebalance the gas flow to the heat pipes with the boiler at 147 MW_{net} load, and the test equipment was removed from the plant site.

Data Collection

Performance calculations require average temperature determination for all gas streams entering and leaving a heat pipe. Most of the measurements require multipoint traverses of ductwork to obtain the required data. As shown in Figure 2, there are seven major streams around the heat pipe and one internal stream which require measurement (flue gas in, flue gas out, primary air in, primary air out, secondary air in, secondary air out, secondary air bypass and primary flue gas out). Ideally, all data would be collected simultaneously. This would require eight sampling teams. Since the boiler control allowed tight, stable operation of the heat pipes, three sampling teams were used. This reduced the number of required test personnel from 19 (2 people per team plus three people for manual data collection, solids sampling, and coordination) to 9 people.

The boiler and heat pipe operations were stabilized to minimize changes in operating temperatures, flows and compositions during a test period. Each heat pipe was tested separately. Generally, a test lasted two to three hours per heat pipe. Prior to a test, plant operations were adjusted to desired boiler load and the heat pipes were sootblown. While system operations were stabilizing, pitot measurements were taken to establish that there was little or no flow in the secondary air bypasses. Once the operation was stable, simultaneous traverse data were collected for three streams at a time. The stream groupings were: flue gas in, flue gas out, and secondary air out; or primary air in, primary air out, and primary flue gas out. Simultaneous flue gas inlet and outlet data collection was required to maximize the accuracy of the air leak determinations. After completing the first group of simultaneous measurements, the sampling teams moved to new positions and collected the second group data. The same procedure was applied to the second heat pipe.

By prior agreement with NYSEG and ABB Air Preheater Inc. (ABB API), pitot traverse data were not obtained for the secondary air at the heat pipe inlet. Because of the ductwork size and layout, pitot traversing in this area to calculate weighted average temperatures is impractical and not cost- effective. Instead, four special thermocouples were installed at the discharges of both FD fans. Each thermocouple was positioned at the center of an equal ductwork flow area. The thermocouple readings were recorded on a strip chart every five minutes. At ten minute intervals for each fan, the average FD fan discharge temperature was calculated using the four thermocouple readings. This setup provided an accurate average temperature estimate. At any given time, the four thermocouple temperatures agreed typically within 1-2°F.

The performance tests require that the air heater inlet and outlet flue gas flow rates be calculated based on coal rate, coal composition and gas composition. Coal rates (15 minute average values) were obtained from the plant computer records for the test periods. Coal samples were obtained using the coal feeder automatic samplers and according to ASTM method D-2234. Multi 3-4 lb samples were taken over the course of each test to obtain a 60 to 80 lb composite sample. This was riffled to a 15-20 lb sample size for analysis. Coal sampling logs are presented in Table A-1 along with the analyses in Table A-2(1).

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(1)Numbering convention -- Tables and Figures found in Appendices A-I are identified with appendix letter preceeding sequence number.

Fly ash samples were collected during each test period using the procedures proposed in the test plan. The samples were obtained using the sampler at the fly ash silo. Typically, every one-and-a half to two hours the boiler and ESP fly ash hoppers are emptied and the ash conveyed to the fly ash silo. The ash sampler allows continuous withdrawal of a sample from the pneumatically conveyed fly ash over the ash dumping period. Typically a three-to-five gallon fly ash sample was obtained for each test. Ash sample analyses are presented with the coal analyses in Table A-2.

Operational Stability

The plant operations were allowed to stabilize before heat pipe performance tests were conducted. Figures 3a-3f, 4a-4f, and 5a-5f show stability for the two high load tests (Tests 1 and 2) and the low load test (Test 3), respectively. Computer logged data were used to generate the 15-minute average values shown in these figures.

For each test, the plant load was tightly controlled. This resulted in little variation in the coal feed rate and economizer outlet oxygen concentration as shown in Figures 3a, 4a, and 5a. On May 14, the coal feed rate for the 2A heat pipe test was controlled at an average rate of 54.60 tph with a standard deviation of 0.014 tph. The minimum and maximum coal feed rates were 54.57 tph and 54.68 tph, respectively. The economizer oxygen concentration was controlled at 3.29 % with a standard deviation of 0.06%. Over the test period, the minimum 15-minute average oxygen level was 3.23% and the maximum was 3.49 %. The coal rates are well within the proposed test plan target level ± 3% (load swing) and the variation in oxygen level is within the ABB API proposed limit of ±0.3 % absolute change. Similar results were obtained for all tests.

Figures 3b, 4b, and 5b show that the total primary air and total secondary air flows were stable during all tests. The variation in flow expressed as a percent of the average ({max-min}/avg x 100) ranged from 0.3% to 1.1% for the primary air flows and 0.5% to 3.2% for the secondary air flows. Figures 3f, 4f, and 5f show good control of the secondary air outlet temperatures. Again, this indicates tight control of process operating conditions.

The largest change in the flue gas inlet temperature (8°F rise) occurred during the May 14 test of the 2A heat pipe (Figure 3c). This was accompanied by 3-4°F rise in the flue gas outlet temperature (Figure 3d). These temperature changes do not appear to have affected the thermal performance as measured by the totally corrected flue gas outlet temperature. The totally corrected temperature was essentially the same for the repeat test of the 2A heat pipe conducted on May 15, when the change in both inlet and outlet flue gas temperature was only about 2°F (Figures 4c and 4d).

The primary air outlet temperatures were the least stable of the system variables. Figures 3f and 4f show that at high load, the primary air temperature was still increasing seven to eight hours after the coal feed rate stabilized. The changes in primary air temperatures did not have much of an effect on the thermal performance because the same (within 1°F) totally corrected flue gas outlet temperature was obtained for both high load tests of the 2A heat pipe. There was no difference between the totally corrected flue gas outlet temperature for the May 14 test, when a 20°F change in primary air temperature occurred over the test period, and the May 15 test, when the primary air temperature was exceptionally stable (compare Figures 3f and 4f). Since the bulk of the heat pipe duty is heating the secondary air (typically 88 % for the high load cases), primary air temperature changes represent very little of the total duty and therefore heat pipe performance.

Figure 3a
Coal Rate & Economizer O2 -- Test 1

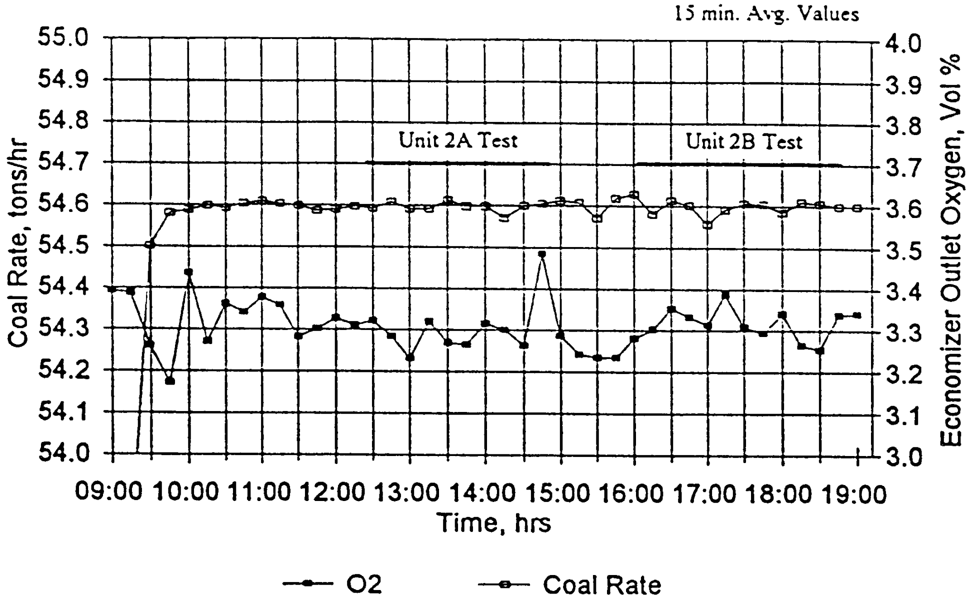


Figure 3b
Pri. & Sec. Air Flows -- Test 1

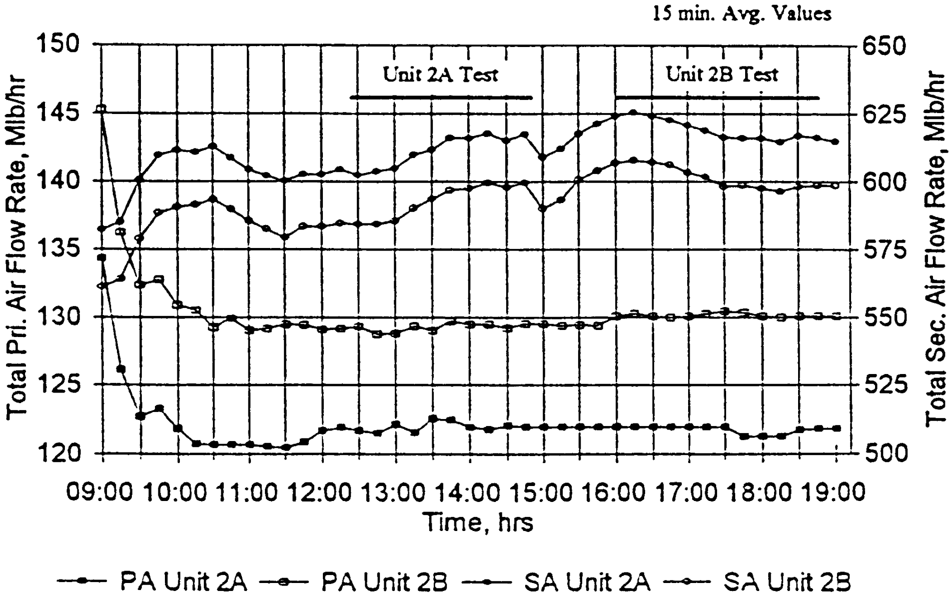


Figure 3c
Flue Gas Inlet Temperatures -- Test 1

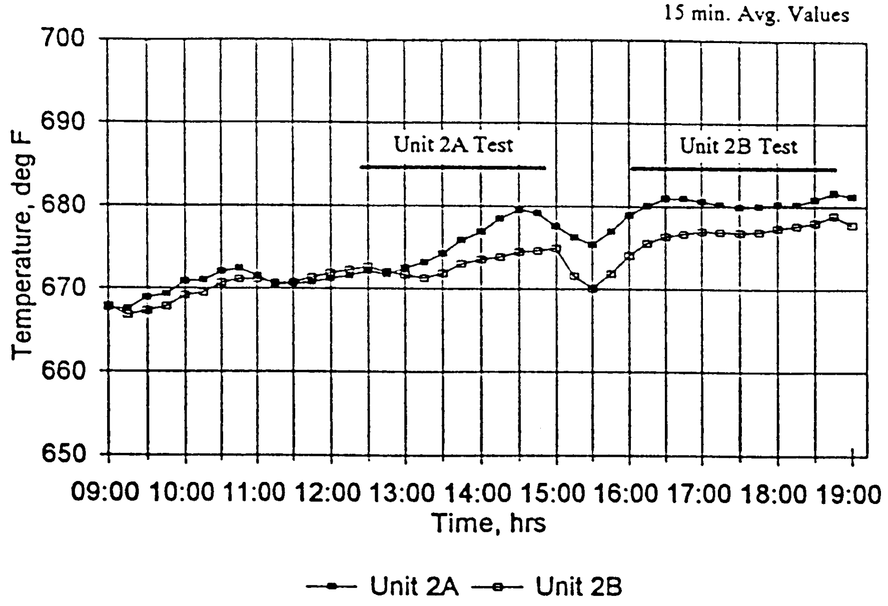


Figure 3d
Flue Gas Outlet Temperatures -- Test 1

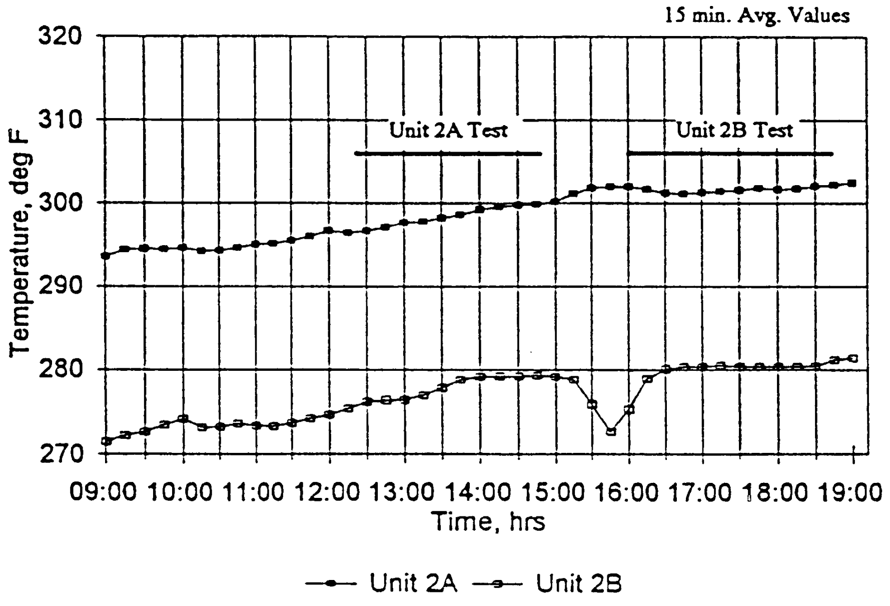


Figure 3e
Pri. & Sec. Air Inlet Temps -- Test 1

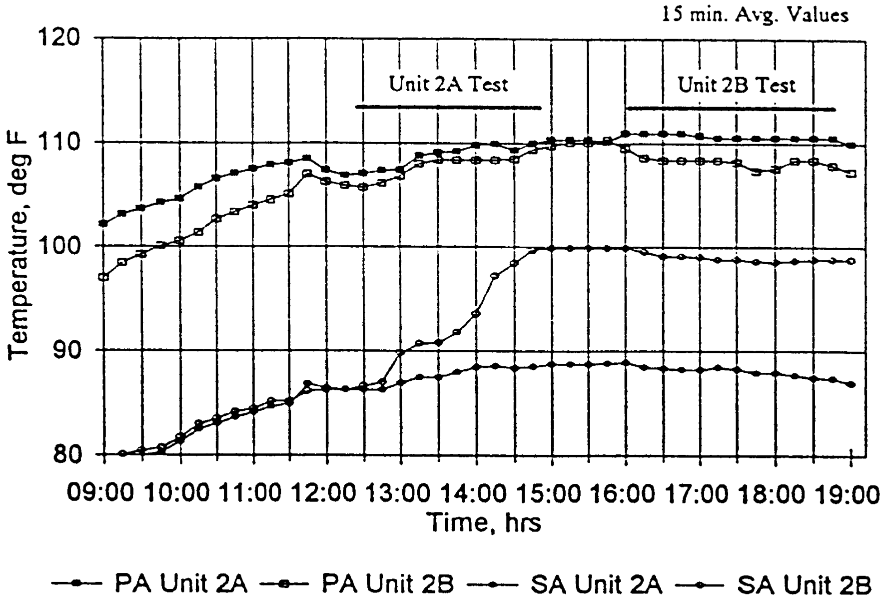


Figure 3f
Pri. & Sec. Air Outlet Temps -- Test 1

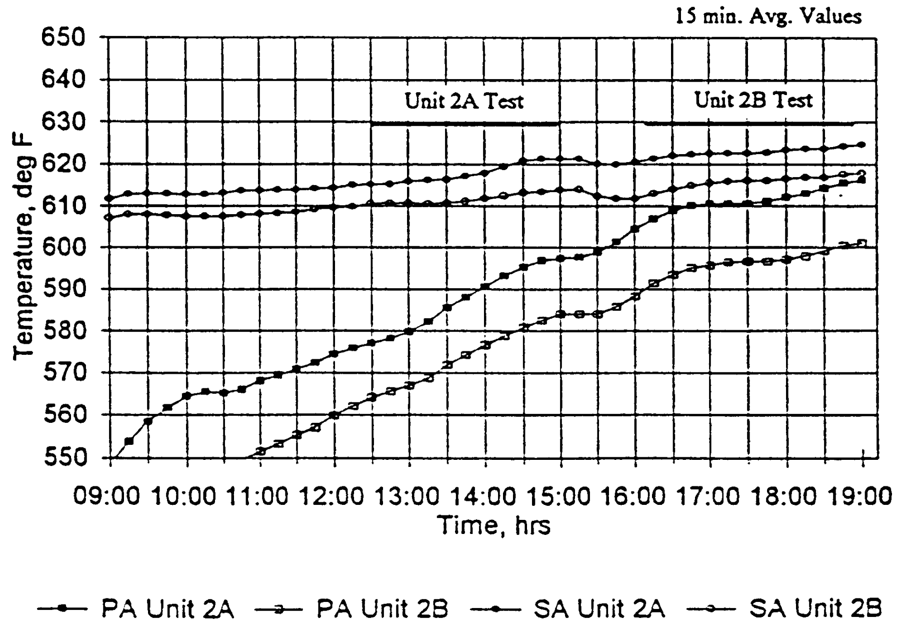


Figure 4a
Coal Rate & Economizer O2 -- Test 2

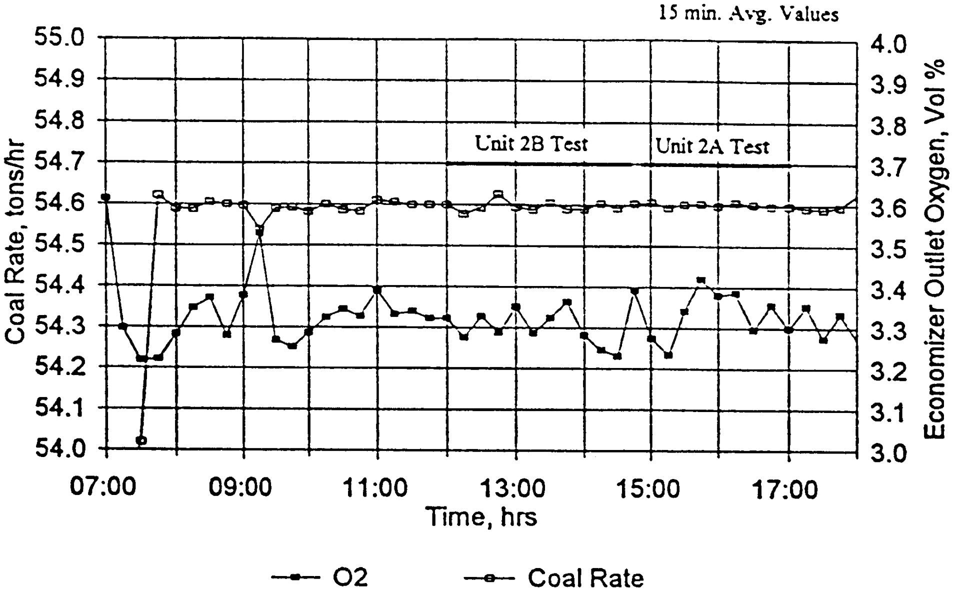


Figure 4b
Pri. & Sec. Air Flows -- Test 2

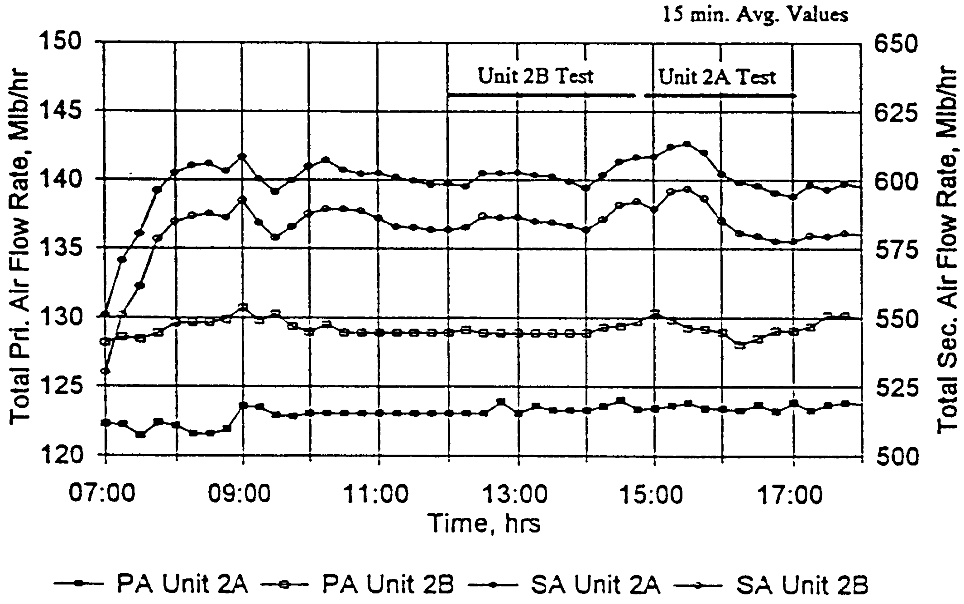


Figure 4c
Flue Gas Inlet Temperatures -- Test 2

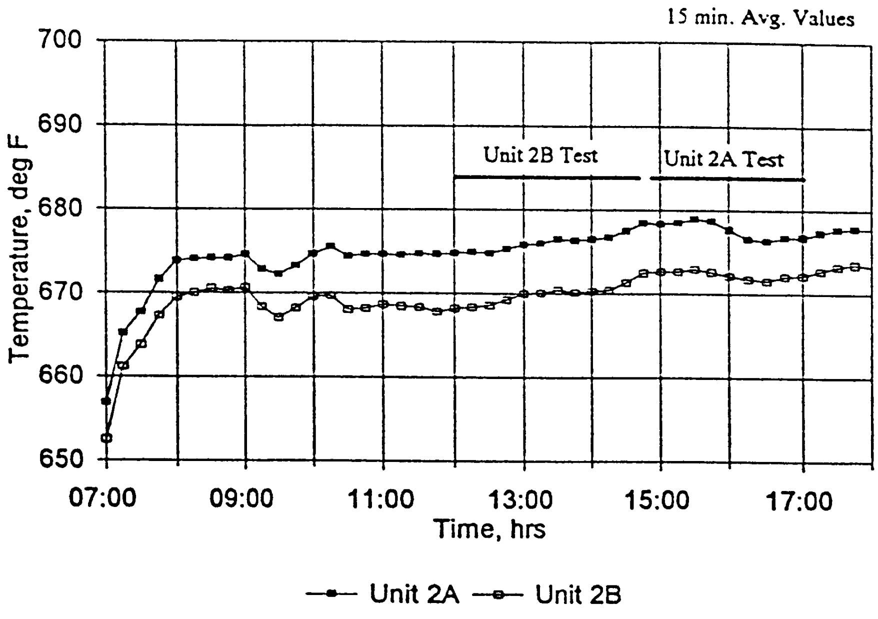


Figure 4d
Flue Gas Outlet Temperatures -- Test 2

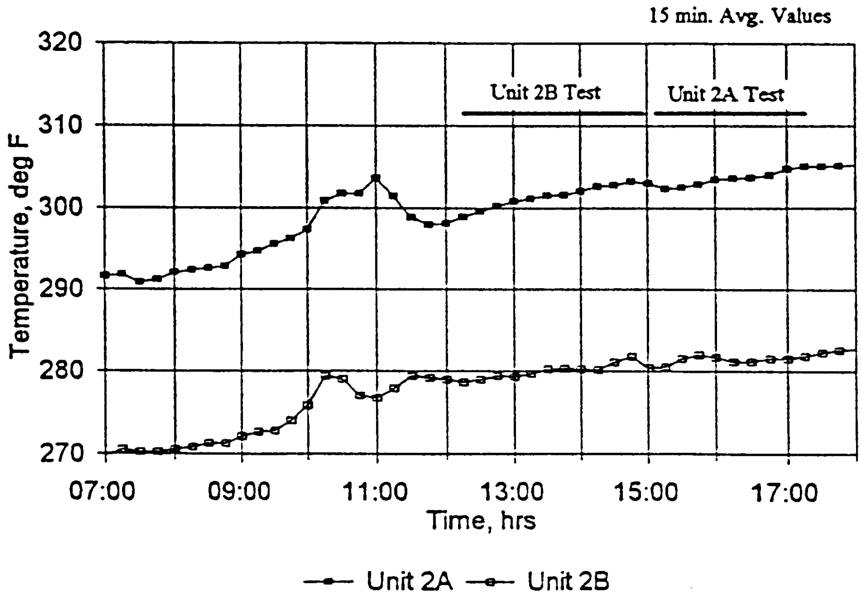


Figure 4e
Pri. & Sec. Air Inlet Temps -- Test 2

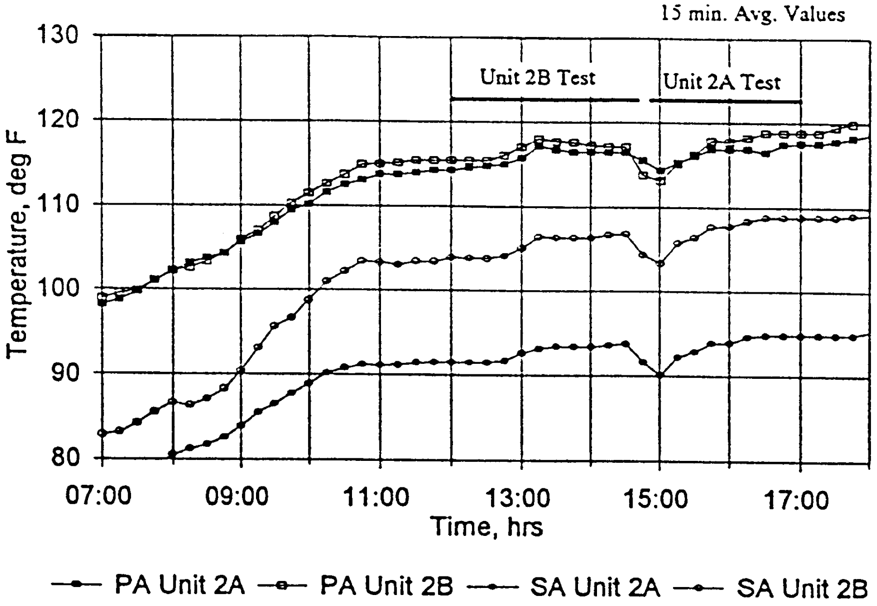


Figure 4f
Pri. & Sec. Air Outlet Temps -- Test 2

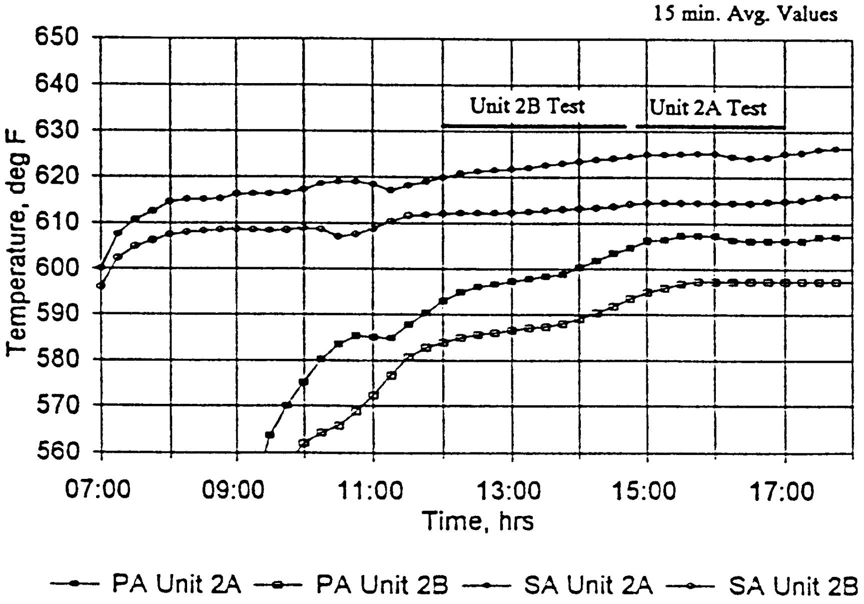


Figure 5a
Coal Rate & Economizer O2 -- Test 3

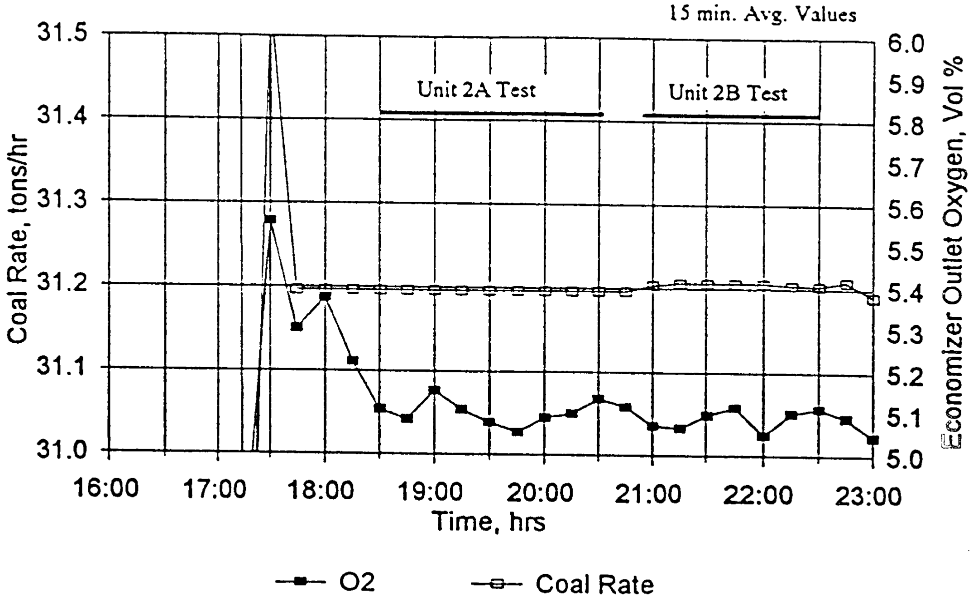


Figure 5b
Pri. & Sec. Air Flows -- Test 3

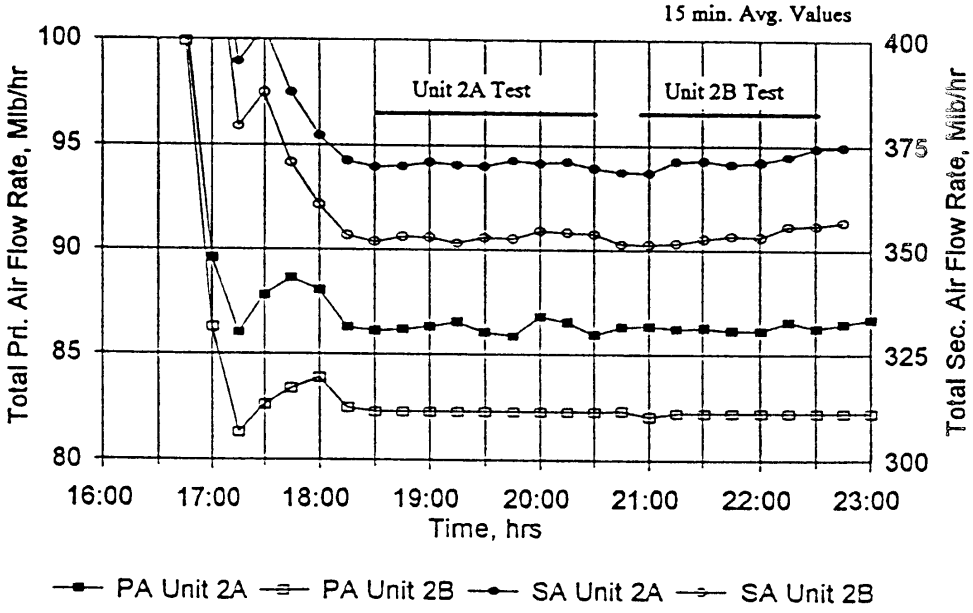


Figure 5c
Flue Gas Inlet Temperatures -- Test 3

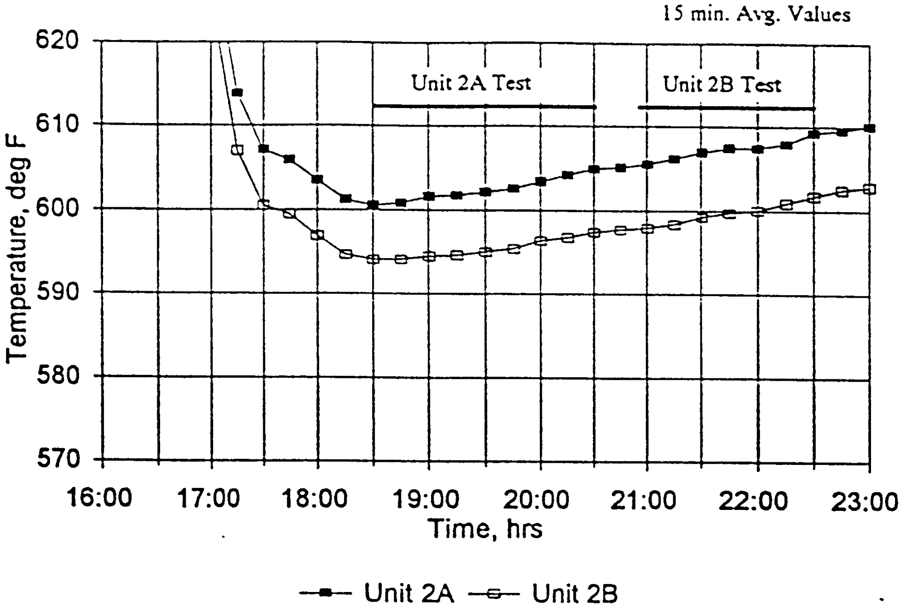


Figure 5d
Flue Gas Outlet Temperatures -- Test 3

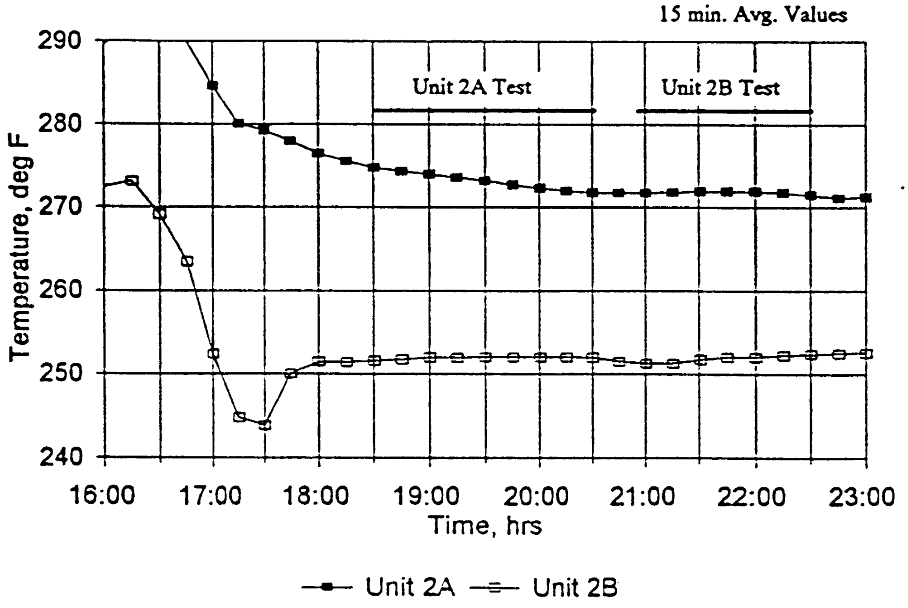


Figure 5e
Pr. & Sec. Air Inlet Temps -- Test 3

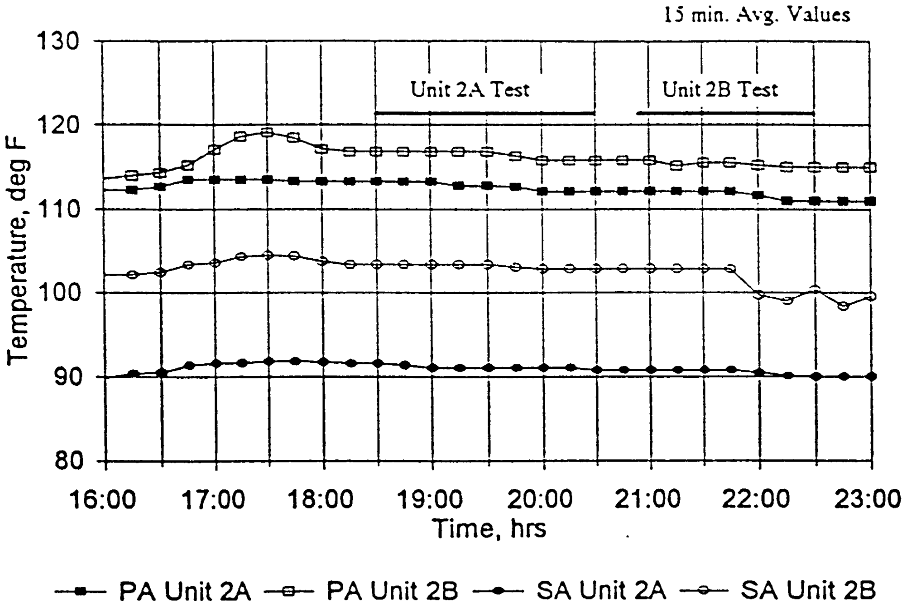
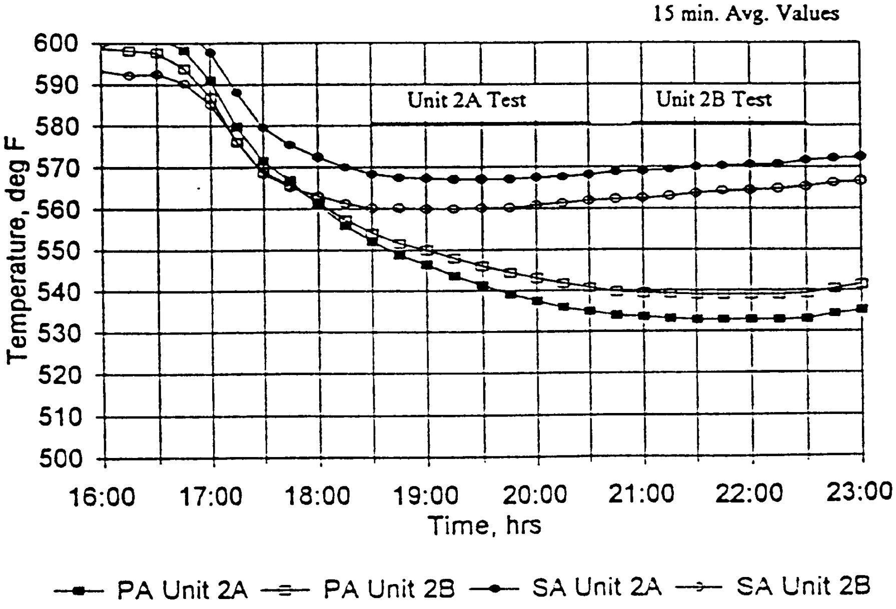


Figure 5f
Pri. & Sec Air Outlet Temps -- Test 3



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The primary and secondary air inlet temperatures are shown in Figures 3e, 4e, and 5e for the three test periods. These figures generally show that temperature changes were normally limited to only 2-3 °F during a test. In Figure 3e, a sudden 10-12°F change in the Unit 2B secondary air inlet temperature occurred. The readings of this thermocouple were often in error and 10°F high due to an instrumentation problem. This had no impact on the performance tests results since the readings of four specially installed, calibrated thermocouples were used instead for the performance evaluation calculations.

The data shown in Figures 3a through 5f are provided to show operational stability. The reader is cautioned that there will be some small differences between the temperature data shown in the aforementioned figures and the data used for the performance calculation evaluations. Reasons for the differences include: differences between traverse port location and the location of plant instrumentation, the use of simple temperature averages for the temperatures shown in the figures versus weighted average temperatures for the performance calculations, and the use of calibrated thermocouples for the performance calculations.

Air Leakage Determination

The ASME PTC 4.3 Procedure expresses the air leakage as a weight percent of the inlet flue gas flow. The total leakage is determined from the difference between the inlet and outlet flue gas rates. The code provides equations for calculating the flue gas flow rates from the measured coal rate and composition, measured or estimated ash rates, measured ash composition, and the weighted average inlet and outlet flue gas compositions (based on pitot gas sampling).

The determined air leakages, categorized as total, measured, and unaccounted, are summarized in Table 1. Total air leakage is the difference between the inlet and outlet flue gas flows. The measured leakage is the air flow to the infrasonic cleaner (rate provided by NYSEG) and the sootblower lance purge air (Appendix H). The difference between the total and measured leakages is the unaccounted leakage. At full boiler load, the 2A heat pipe total air leakage was between 2.7 to 4.4 wt % of the inlet flue gas flow. Unaccounted leakages were 1.9 to 3.6 wt %. For the low load test, the total and unaccounted leakages were 4.9 and 3.6 wt %, respectively.

After the May 14 2B heat pipe test was completed, the inlet flue gas analyses were determined to be inaccurate due to an equipment problem. Use of the 2B inlet gas analyses resulted in calculation of a negative leak rate (Table 1), a nonsense condition. To salvage as much data as possible from this test, the average inlet gas composition was calculated from the outlet flue gas composition and the full load leak rate obtained for the May 15 test. Using this procedure, the inlet flue gas flow rate was estimated and the corrected pressure drop and thermal performances calculated.

The total 2B heat pipe air leakage was between 1.4 to 2.0 wt % with the unaccounted leakage between 1.2 to 1.7 wt % of inlet flue gas flow. These rates are one-half to one-third the leakage obtained for the 2A heat pipe.

Table 1
Performance Summary -- Air Leakages

Unit	2A			2B			
Date	05/14/96	05/15/96	05/16/96	05/14/96	05/14/96	05/15/96	05/16/96
Time	12:00-15:00	14:50-17:00	18:30-20:30	16:00-19:00	16:00-19:00	12:00-14:45	20:50-22:30
Boiler Load, MW net	149.0	147.2	79.6	150.5	150.5	147.2	80.1
				(1)	(2)		
Flue Gas Rate In, lb/hr	747,200	742,000	482,600	740,200	702,700	692,000	443,000
Flue Gas Rate Out, lb/hr	767,200	774,800	506,000	712,300	712,300	701,400	451,900
Total Air Leakage, lb/hr	20,000	32,800	23,400	(27,900)	9,600	9,400	8,900
Measured Air Leaks, lb/hr							
Infrasonic Cleaner Air Rate, lb/hr	4,800	4,800	4,800				
Sootblower Purge Air Rate, lb/hr	1,360	1,360	1,360	1,300	1,300	1,300	1,300
Unaccounted Air Leak, lb/hr	13,840	26,640	17,240	(29,200)	8,300	8,100	7,600
Total Air Leakage, % Inlet FG Flow	**2.7**	**4.4**	**4.9**	-3.8 (1)	**1.4**	**1.4**	**2.0**
Unaccounted Leak, % Inlet Flow	**1.9**	**3.6**	**3.6**	-3.9 (1)	**1.2**	**1.2**	**1.7**

(1) Problem With Inlet Flue Gas Composition Measurements.
(2) Inlet Flue Gas Rate based on Average Outlet Gas Composition (This Test) and 1.36 % Air Leak For 5/15/96.

Because the heat pipe modules are seal welded together, leakage between the air and flue gas sides is unlikely. The unaccounted leaks are most likely due to leakage at the retractable sootblower wall penetrations and at manway doors where seals may be leaking. At the wall penetrations, the sootblower lances fit through a spring-loaded wall box plate. A 3/32" gap exists between the sootblower lance OD and the ID of the wall box plate. At a 10 in. WC differential pressure between the ambient air and the heat pipe, the gap leak is about 4000 lb/hr per heat pipe. This would account for 15-29% of the unaccounted leak in the 2A heat pipe and 50% of the unaccounted leak in the 2B heat pipe. If future testing indicates that leakage is increasing, the wall box plates should be inspected for wear.

Heat Pipe Pressure Drops

Manually read, U-tube manometers filled with water or red oil were used to measure the pressure drops across the flue gas, primary air, and secondary air heat pipe tube banks. Before the tests were conducted, special taps were installed on the heat pipes to insure that the measured pressure drops would be across the heat pipe modules only and not include losses for ductwork. The manometer readings are presented in Appendix G. Before comparing measured pressure drops with the design values, corrections must be made for differences between actual and design gas and air flow rates and temperatures according to the following general equation:

$$DP_{corr} = DP_M \left(\frac{W_D^{\,2}(T_{DI} + T_{DO})}{W_M^{\,2}(T_{MI} + T_{MO})} \right) \qquad \textbf{(1)}$$

Where:

DP_{corr} = *Corrected Pressure Drop, in. WC*

DP_M = *Measured Pressure Drop , in. WC*

T_{DI} = *Design Inlet Temperature, ° R*

T_{DO} = *Design Outlet Temperature, ° R*

T_{MI} = *Measured Inlet Temperature, ° R*

T_{MO} = *Measured Outlet Temperature, ° R*

W_D = *Design Gas Or Air Flow Rate, lb/hr*

W_M = *Measured Gas Or Air Flow Rate, lb/hr*

Actual performance equals design or is better than design if the corrected DP equals or is less than the design value. The totally corrected pressure drops along with the information needed to calculate the corrected pressure drops are shown in Table 2. The results for the high load tests show that the actual performance essentially meets design. For the 2A heat pipe, the corrected flue gas side pressure drops were determined to be just slightly less than design (-0.06 and -0.04 in. WC differences). For the 2B heat pipe, the full load corrected pressure drops were just slightly above design (0.21 and 0.27 in. WC differences). The low load corrected pressure drop results shown in Table 2 should not be used for comparisons with design. Using the low load data results in an over estimate of the corrected pressure drop due the large calculation extrapolation.

For both heat pipes and all cases, the primary air section corrected pressure drops meet the design guarantee and are well below the design value of 3.60 in. WC.

The secondary air section pressure drops essentially meet design requirments. For the 2A heat pipe full load tests, the corrected secondary air side pressure drops ranged from 0.3 to 0.5 in. WC greater than the 5.35 in. WC design loss. For the 2B heat pipe, the corrected pressure drops are 0.09 to 0.22 in. WC greater than design. These differences are insignificant from an operating perspective.

Table 2
Performance Summary -- Heat Pipe Pressure Drops

Unit		**2A**			**2B**		
Date		05/14/96	05/15/96	05/16/96	05/14/96	05/15/96	05/16/96
Time		12:00-15:00	14:50-17:00	18:30-20:30	16:00-19:00	12:00-14:45	20:50-22:30
Boiler Load, MW net		149.0	147.2	79.6	150.5	147.2	80.1
Flue Gas Section							
Design Flue Gas Rate, lb/hr	750,000						
Design Pressure Drop, In. WC	3.65						
Design Inlet Temp, °F	680						
Design Outlet Temp, °F	253						
Flue Gas Rate In, lb/hr		747,200	742,000	482,600	702,700 (1)	692,000	443,000
Flue Gas Rate Out, lb/hr	(2)	762,400	770,000	501,200	712,300	701,400	451,900
Avg Flue Gas Rate, lb/hr		754,800	756,000	491,900	707,500	696,700	447,450
Flue Gas Temp In, °F		675	677	599	678	671	603
Flue Gas Temp Out, °F		295	302	272	281	279	253
Measured DP, in. WC		3.71	3.76	1.85	3.48	3.41	1.68
Totally corrected DP, In. WC		**3.59**	**3.61**	**4.45 (3)**	**3.86**	**3.92**	**4.92 (3)**
Corrected - Design DP, In. WC		-0.06	-0.04	0.80	0.21	0.27	1.27
Primary Air Section							
Design Air Rate, lb/hr	62,500						
Design Pressure Drop, In. WC	3.60						
Design Inlet Temp, °F	80						
Design Outlet Temp, °F	644						
Average Air Rate, lb/hr		75,920	73,650	53,200	74,370	73,450	47,430
Air Temp In, °F		111	116	112	109	116	115
Air Temp Out, °F		593	605	534	592	590	538
Measured DP, in. WC		3.91	3.64	1.94	3.79	3.84	1.84
Totally corrected DP, In. WC		**2.68**	**2.63**	**2.81**	**2.71**	**2.81**	**3.34**
Corrected - Design DP, In. WC		-0.92	-0.97	-0.79	-0.89	-0.79	-0.26
Secondary Air Section							
Design Air Rate, lb/hr	562,500						
Design Pressure Drop, In. WC	5.35						
Design Inlet Temp, °F	80						
Design Outlet Temp, °F	616						
Average Air Rate, lb/hr		497,200	481,200	296,200	491,300	482,100	301,000
Air Temp In, °F		88.7	94.9	92.3	88.9	93.9	91.5
Air Temp Out, °F		612	619	562	612	612	559
Measured DP, in. WC		4.43	4.36	1.93	4.26	4.02	1.75
Totally corrected DP, In. WC		**5.65**	**5.89**	**7.14 (3)**	**5.57**	**5.44**	**6.29 (3)**
Corrected - Design DP, In. WC		0.30	0.54	1.79	0.22	0.09	0.94

(1) Inlet Flue Gas Rate based on Average Outlet Gas Composition (This Test) and 1.36 % Air Leak For 5/15/96.
(2) For Unit 2A Value Excludes Air From Infrasonic Cleaner Since Flow Does Not Pass Through Heat Pipe Module.
(3) Totally corrected DP May Not Be Accurate Due To Large Extrapolation For Low Load Operation.

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Thermal Performance

The overall thermal performance of each heat pipe is summarized in Table 3. The table presents overall heat balances and the net flue gas side duties. The net duties represent the amount of energy transferred back to the boiler from the exiting flue gas. The energy transferred to the air leaks is lost. Total energy recovered is the sum of the net flue gas side duties for both heat pipes. Under high load conditions, each heat pipe recovers about 5.1% of the fuel energy from the flue gas. Together, the heat pipes recycle approximately 10.2% of the fuel energy to the boiler. Under low load conditions, the combined energy recovery is about 9.7%. The lower recovery is due to the reduction in inlet flue gas temperature which reduces the thermal head, or driving force, for heat transfer and reduced gas side and air side heat transfer coefficients due to the lower velocities through the tube banks.

To determine if the measured performance meets the design performance, a corrected flue gas outlet temperature is calculated for each heat pipe test. Design performance is achieved if the corrected temperature equals or is less than the design flue gas outlet temperature. Temperature corrections are made for differences between design and actual flue gas inlet temperature, air inlet temperature, X-ratio, and flue gas flow rate. Procedures for calculating the corrections are presented in the PTC 4.3 Test Code and in an uncertainty analysis.[3]

Table 4 presents the results of the performance evaluations and shows all temperature corrections for differences from design bases. Since each heat pipe heats both primary air and secondary air streams, the calculation method treats each heat pipe as two heat exchangers. Corrected temperatures are obtained for the primary flue gas section which heats the primary air stream and for the secondary flue gas section which heats the secondary air stream. The primary and secondary flue gas, totally corrected outlet temperatures are combined by heat balance to obtain the final totally corrected outlet temperature (see uncertainty analysis). The performance summary results show that the totally corrected flue gas outlet temperature for the 2A heat pipe exceeded the design by 17°F to 18°F for the high load performance tests. The performance of the 2B heat pipe is better. The totally corrected flue gas outlet temperature exceeded the design by 12°F for the May 15 high load test. The uncertainty in the combined corrected flue gas outlet temperture for all tests is about ±4 °F based on the previously published uncertainty analysis.

As discussed in the section covering air leakage, the 2B heat pipe inlet flue gas composition was estimated from the outlet flue gas composition and an assumed air leak for the May 14 test period. The air leak was assumed to be the same as obtained for the 2B heat pipe on May 15. Since operating conditions were nearly identical for the two tests, the adjustment allows use of the May 14 test data to estimate the performance. The calculated result is a totally corrected flue gas outlet temperature which is 16°F greater than design. This is in general agreement with the 12°F May 15 test result. Both results indicate that the performance of the 2B heat pipe is somewhat better than that for the 2A heat pipe.

The heat pipe washing operations conducted in April were cut short due to the need to bring the Unit 2 boiler back on line. The possible presence of some cold-end deposits in the 2A heat pipe may account for the thermal performance difference of the 2A and 2B units.

Table 3
Performance Summary – Heat Balances and Duties

Unit	2A			2B		
Date	05/14/96	05/15/96	05/16/96	05/14/96	05/15/96	05/16/96
Boiler Load, MW net	149.0	147.2	79.6	150.5	147.2	80.1
Inputs						
Flue Gas Rate In, lb/hr	747,200	742,000	482,600	702,700 (1)	692,000	443,000
Temperature In, °F	675	677	599	678	671	603
Temperature Out With Air Leak, °F	295	302	272	281	279	253
Cp, Btu/lb-°F	0.2618	0.2622	0.2594	0.2613	0.2612	0.2588
Overall Duty, MM Btu/hr	**74.33**	**72.96**	**40.93**	**72.90**	**70.85**	**40.13**
Outputs						
Primary Air Rate, lb/hr	75,920	73,650	53,200	74,370	73,450	47,430
Temperature In, °F	111	116	112	109	116	115
Temperature Out, °F	593	605	534	592	590	538
Cp, Btu/lb-°F	0.2475	0.2477	0.2473	0.2475	0.2476	0.2475
Duty, MM Btu/hr	9.06	8.92	5.55	8.89	8.62	4.97
Secondary Air Rate, lb/hr	497,200	481,200	296,200	491,300	482,100	301,000
Temperature In, °F	89	94.9	92	89	93.9	92
Temperature Out, °F	612	619	562	612	612	559
Cp, Btu/lb-°F	0.2474	0.2476	0.2474	0.2474	0.2475	0.2475
Duty, MM Btu/hr	64.37	62.44	34.43	63.58	61.81	34.82
Air Leak Rate, lb/hr	15,170	28,040	18,660	9,580	9,400	8,840
Temperature In, °F	96	95	95	96	95	95
Temperature Out, °F	295	302	272	281	279	253
Cp, Btu/lb-°F	0.2431	0.2431	0.2433	0.2429	0.2428	0.2432
Duty, MM Btu/hr	0.73	1.41	0.80	0.43	0.42	0.34
Downstream Air Leak Rate, lb/hr (2)	4,800	4,800	4,800	0	0	0
Temperature In, °F	148	148	148			
Temperature Out, °F	295	302	272			
Cp, Btu/lb-°F	0.2438	0.2439	0.2441			
Duty, MM Btu/hr	0.17	0.18	0.15	0.00	0.00	0.00
Overall Duty, MM Btu/hr	**74.33**	**72.96**	**40.93**	**72.90**	**70.85**	**40.13**
Flue Gas Side Duties						
Primary Flue Gas Rate In, lb/hr	98,070	105,700	69,120	86,760	85,900	54,840
Temperature In, °F	675	677	599	678	671	603
Temperature Out No Leak, °F	323	356	290	286	287	253
Cp, Btu/lb-°F	0.2624	0.2632	0.2597	0.2614	0.2614	0.2587
Duty, MM Btu/hr	9.06	8.92	5.55	8.89	8.62	4.97
Secondary Flue Gas Rate In, lb/hr	649,100	636,300	413,500	616,000	606,100	388,200
Temperature In, °F	675	677	599	678	671	603
Temperature Out No Leak, °F	296	303	278	283	281	256
Cp, Btu/lb-°F	0.2618	0.2622	0.2594	0.2613	0.2612	0.2588
Duty, MM Btu/hr	64.37	62.44	34.43	63.58	61.81	34.82
Net Energy Recovery, % of Fuel	**5.14**	**5.10**	**4.84**	**5.07**	**5.03**	**4.82**

(1) Inlet Flue Gas Rate based on Average Outlet Gas Composition (This Test) and 1.36 % Air Leak For 5/15/96.

(2) Infrasonic Cleaner Air Flow.

Table 4
Performance Summary -- Totally Corrected Flue Gas Outlet Temperatures

Unit	2A			2B		
Date	05/14/96	05/15/96	05/16/96	05/14/96	05/15/96	05/16/96
Time	12:00-15:00	14:50-17:00	18:30-20:30	16:00-19:00	12:00-14:45	20:50-22:30
Boiler Load, MW net	149.0	147.2	79.6	150.5	147.2	80.1
Primary Flue Gas Section				(1)		
Primary Flue Gas Flow, lb/hr	98,070	105,700	69,120	86,760	85,900	54,840
Measured Outlet Temp, °F	294	304	250	268	269	232
Temp. Corrections For Differences From:						
Design Entering Air Temp, °F	273	280	227	247	243	205
Design Entering Flue Gas Temp, °F	296	305	273	269	271	250
Design X-Ratio, °F	356	359	323	347	348	319
Design Flue Gas Flow Rate, °F	292	300	256	269	270	241
Totally corrected Outlet Temp, °F	335	332	329	328	325	320
Secondary Flue Gas Section				(1)		
Secondary Flue Gas Flow, lb/hr	649,200	636,300	413,400	616,000	606,200	388,200
Outlet Temp (Ht Bal), °F	296	303	278	283	281	256
Temp. Corrections for Differences From:						
Design Entering Air Temp, °F	291	293	270	277	271	249
Design Entering Flue Gas Temp, °F	298	304	308	284	283	281
Design X-Ratio, °F	264	267	229	263	260	231
Design Flue Gas Flow Rate, °F	297	304	292	286	284	272
Totally corrected Outlet Temp, °F	261	260	266	260	257	264
Totally corrected Temperatures						
Combined Flue Gas Outlet, °F	**271**	**270**	**275**	**269**	**265**	**271**
Design Flue Gas Outlet Temp, °F	253	253	253	253	253	253
Outlet Temp Approach To Design, °F	**18**	**17**	**22**	**16**	**12**	**18**

(1) Inlet Flue Gas Rate based on Average Outlet Gas Composition (This Test) and 1.36 % Air Leak For 5/15/96.

To characterize the heat pipe performance at off load conditions, a test was conducted at about 80 MW_{net}. For this test, the totally corrected flue gas outlet temperature exceeded the design temperature by 22°F for the 2A heat pipe and by 18°F for the 2B heat pipe. These results again indicate that the performance of the 2B heat pipe is better than that of the 2A heat pipe. Only the high load tests should be used when the heat pipe performance is compared with guarantee performance since the high load conditions more closely approximate design conditions and there is much less extrapolation.

To facilitate the thermal performance evaluations, a Quattro® Pro for Windows® spreadsheet program was developed. The detailed program results for all test cases are presented in Appendix I. Boxed cells in the printouts are user input values obtained from the performance test data.

Data Handling and Quality Control

A. Temperature Measurement. All thermocouples used for gas or air measurements were calibrated by comparing the readings of individual thermocouples with the readings of a calibrated thermocouple traceable to a NIST standard. The traceable thermocouple calibration is shown in Table B-1. Since the traceable thermocouple calibration showed no discernable trend with temperature and the maximum reading error was only +1.1°F at 700°F, the traceable thermocouple readings were considered to be correct for secondary standard calibration of all other test thermocouples.

Thermocouples used for the pitot probes were made from special high accuracy (0.4%) Type K thermocouple wire. Each thermocouple was calibrated between 32°F and 700°F. An ice bath was used for the 32°F data point, a constant temperature oven for the 100°F point, and a temperature controlled sand bath for all higher temperatures. For each application, three thermocouples were constructed to insure a sufficient supply of spares.

The differences between the thermocouple temperature indication and the traceable thermocouple indication were plotted against thermocouple indication. A least squares linear fit was used to correlate the data for each thermocouple. The heat pipe test measured temperatures were corrected using the following equation:

$$T_{act} = T_M + a + bT_M \tag{1}$$

Where:

T_{act} = *Actual Temperature*, °*F*

T_M = *Measured Temperature*, °*F*

a & b = *Correlation Constants For Difference Correction*

The calibration data for pitot tube thermocouples actually used during the testing are presented in Table B-2 and correction correlation coefficients in Table B-5. Data plots are provided in Figure B-1.

The hand held temperature readout devices used in the field were factory calibrated NIST traceable units. The accuracy of these units was checked the week before the tests were conducted. All units were within specifications. The data are presented in Table B-3.

In the field, the connection between probe thermocouples and the hand-held readout devices is usually made with expanding telephone-style cable thermocouple extension wires. Data were taken to determine if the wire extensions affected the temperature measurements. These data are shown in Appendix Table B-3. The use of the extension wire did not affect the temperature measurements.

Special thermocouples were installed in the FD fan discharges to obtain the secondary air temperatures to the heat pipes. These thermocouples were connected to a local data logger (with Chessell recorder). Because of location, approximately a 120' of thermocouple extension wire was needed to connect the thermocouples to the data logger. To insure measurement accuracy of 1% of reading, the complete system was calibrated. Because secondary air temperatures were expected to be in the range of 80-90°F, calibration readings were obtained at 32°F and 100°F only. A linear fit of the data was used to develop correction correlation coefficients. Calibration data are presented in Table B-4 and correction correlation coefficients are listed in Table B-5.

The secondary air inlet temperature data are presented in Tables B-6, B-7, and B-8 for the three tests. The tables include both recorded and corrected values. Corrected values are plotted in Figure B-2. The plot shows that the secondary air temperatures from FD fans were essentially the same for all tests. This contrasts with the plant data logger readings which show a 10-12°F higher temperature for the B side secondary air temperature (see Figure 3e). The plant recorded B side temperature was found to be incorrect due to an instrumentation problem. As explained in the section on Operational Stability, this did not affect the test results.

B. Pitot Tube Calibrations. EPA Method 2 was followed to obtain velocity data for weighted average flue gas and air temperature determinations and weighted average flue gas compositions. All pitot tubes were calibrated before and after testing. Only the before test calibration coefficients were used since the post test calibrations showed no significant changes from the pre-test results. Pitot tube coefficients are summarized in Table C-1 and the complete data set is included as Table C-2.

Shortridge Instruments Inc. AirData Multimeters were used to measure the pitot tube differential pressures. These units are highly accurate electronic manometers which can read differential pressures to 0.0001 in. WC. Prior to the tests, all electronic manometers were sent to the manufacturer for checkout and calibration. The calibration certifications are presented in the as Figures C1 and C-2.

C. Gas Composition Determinations. Teledyne Max 5 combustion gas analyzers were used for oxygen measurements. The units were calibrated during each test against air and an oxygen standard calibration gas (3.5% O_2, 100 ppm CO, 0.5% CH_4, bal N_2).

The gas analyzers used for the testing did not measure CO_2. In lieu of direct CO_2 measurement for each flue gas duct traverse point, ABB API suggested that a fuel line plot be developed for the specific fuel burned. The plot is constructed using Orsat gas analysis data on special three coordinate paper and is shown in Figure D-1. When gas compositions were required for EPA Method 2 duct traverses, the O_2 and CO concentrations were determined using the Teledyne gas analyzers, then the CO_2 was determined using Figure D-1. The plot was developed using Orsat data for gas samples obtained during the high load tests. The data are provided in Table D-1. Figure D-2 is a parity plot of the Teledyne versus Orsat O_2 measurements. Agreement between the two measurement methods was good. Over the range of 3.5 % to 6.1% O_2, the average difference between the two measurement methods was 0.037 % O_2 with a standard deviation of 0.074 %.

The multipoint flue gas stream traverse data includes gas composition measurements for O_2, CO, and % combustibles. For the high load tests, all flue gas analyses indicated average CO levels less than 10 ppmv. This indicates near complete combustion of the coal. Another indication of combustion is the % combustibles measurements. The % combustibles represent combustible materials such as methane, ethane, or other hydrocarbons in the flue gases. The numbers are provided only as an indication of the completeness of combustion and are not used in the heat pipe performance calculations. All inlet flue gas composition data indicate low levels of combustibles, i.e., typically, 0 to 0.1%. The higher levels of % combustibles for some of the flue gas outlet streams are likely due to an imbalance in the sample gas flow rates through the CO and combustion cells of the Teledyne gas analyzer. A difference signal is used by the analyzer to represent the % combustibles concentrations. The gas rates through the two cells must be exactly matched; otherwise inaccurate results can be obtained for the % combustibles. Gas samples which in the field showed 0.2 and 0.3% combustibles were analyzed in the CONSOL laboratory by complete sample absorption on charcoal, thermal desorption with head space gas chromatography of devolved products. The analysis showed low levels of CO (26-28 ppm) and no detectable combustible hydrocarbons (<100 ppm).

D. Temperature and Velocity Traverse Data. Appendix E contains the field data sheets for temperature, velocity head, and gas composition traverse measurements. The data sheets include QA/QC check lists. The reduced field data are shown in the completed calculation sheets in Appendix F. These sheets, show: thermocouple calibration corrected temperatures, simple average and weight average temperatures, simple and weight average gas compositions and mass flow rates. Because of the flatness of the temperature and/or velocity profiles, the traverse results generally show no significant difference between the simple and weight averaged values.

Except for the primary air outlet flows, the performance calculations do not use air and flue gas flow rates based on pitot velocity head measurements. This is because the Performance Test Code procedures require that the overall flue gas rates be calculated from the measured fuel rate, and the fuel and gas compositions; the overall air rate is calculated by heat balance. The velocity head based mass flow rates are provided for completeness and to check the Code calculation flow rates. A comparison summary is provided in Table 5. The results show good agreement between the calculated flue gas rates, both inlet and outlet, and the gas rates determined by pitot measurements. For the high load cases, the inlet flue gas rates were essentially identical to the pitot traverse rates. For the low load case, the pitot and calculated rates were within 3%. For the outlet flue gas rates, the pitot traverse determined rates were 2% to 5.6% higher than the calculated rates.

The pitot traverse secondary air rates agree with the calculated rates which are base on an overall heat pipe heat balance. The pitot rates are 2% to 5% higher than the calculated rates. These results demonstrate that the test data are consistent and accurate.

The calculated and pitot traverse based secondary air rates did not agree well with the plant data logger indicated rate. The data logger rates are 17% to 25% higher than the pitot traverse rates. The data logger rates represent the total secondary air flow through the FD fans and are measured at the FD fan inlets. Since the secondary air bypasses were closed, the pitot and plant data logger rates should agree. The data logger rates are high due to a problem with flow element calibration.

The primary air inlet and outlet rates based on pitot traverse data did not agree because the inlet pitot pressure differentials were very low. The outlet flow is considered to be correct since the pitot measurement location is essentially ideal for accurate flow determination. The inlet primary air pitot ports meet code layout requirements for determination of the weighted average temperature, but the location is not ideal for accurate flow measurement. This is not a concern for the performance evaluations. Gross errors in the primary air inlet flow measurement had no effect on weighted average temperature since the temperature variation in the duct was always less than 3 °F.

Table 5
Performance Summary -- Gas And Air Rate Comparisons

Unit	2A			2B		
Date	05/14/96	05/15/96	05/16/96	05/14/96	05/15/96	05/16/96
Time	12:00-15:00	14:50-17:00	18:30-20:30	16:00-19:00	12:00-14:45	20:50-22:30
Boiler Load, MW net	149.0	147.2	79.6	150.5	147.2	80.1
Flue Gas Rate In, lb/hr				(1)		
Calculated	747,200	742,000	482,600	702,700	692,000	443,000
Pitot	746,500	741,300	469,100	705,300	691,300	430,600
Pitot/Calc	0.999	0.999	0.972	1.004	0.999	0.972
Flue Gas Rate Out, lb/hr						
Calculated	767,200	774,806	506,000	712,300	701,400	451,900
Pitot	810,100	790,800	517,800	752,200	737,400	469,500
Pitot/Calc	1.056	1.021	1.023	1.056	1.051	1.039
Secondary Air Rate Out, lb/hr						
Calculated	497,200	481,200	296,200	491,300	482,100	301,000
Pitot	509,100	502,400	308,400	515,800	504,300	311,600
Pitot/Calc	1.024	1.044	1.041	1.050	1.046	1.035
Data Logger	611,200	602,100	370,700	608,700	585,300	353,400
Data Logger/Calc	1.229	1.251	1.252	1.239	1.214	1.174
Primary Air Rates, lb/hr						
Inlet Pitot (2)	124,600	130,500	96,370	121,000	122,900	96,850
Outlet Pitot	75,920	73,650	53,200	74,370	73,450	47,430
In/Out	1.64	1.77	1.81	1.63	1.67	2.04

(1) Inlet Flue Gas Rate based on Average Outlet Gas Composition (This Test) and 1.36 % Air Leak For 5/15/96.
(2) Inlet Primary Air Rate Is Unreliable Due To Large Duct Size and Low Measured Velocity Heads.

E. Heat Pipe Pressure Drop Data. Special pressure taps were installed for heat pipe pressure drop measurements. During the tests, U-tube manometers were connected to these taps and manually read. Depending upon the instrument, the manometeres were filled with either water or 0.826 spgr. red oil. For each heat pipe the pressure drop was measured across the primary air, secondary air, primary flue gas, and secondary flue gas sections. The data are provided in Appendix G. An explaination of the data is provided in the previous section, Heat Pipe Pressure Drops.

F. Sootblower Lance Air Purges. Each heat pipe has 16 sootblowers with retractable lances which can be extended to clean the 27'-71/4" wide flue gas side cross section. When fully retracted, each lance extends about halfway across the tube bank cross section. Sootblowing nozzles at the lance tip and in the middle of each lance allow full cleaning of the flue gas side heat pipe tubes with only 13'-6" blowing travel. A small air purge through each lance is used to cool the lances and prevent fly ash from entering the lances when the sootblowers are not operating. The air purge is controlled by a small check valve which operates on the negative pressure differential between the flue gas side and the ambient air.

To help reduce the amount of unaccounted for air leakage, the air purges were measured once during the high load tests. The same air purge rates were assumed for all tests since the measured rates were small. The measured air purge air rates were 1,360 lb/hr and 1,300 lb/hr for the 2A and 2B heat pipes, respectively. Data and calculated rates are presented in Appendix H. To measure the air purges, a 2" ID by 5' long PVC pipe was placed over each sootblower purge air check valve. The maximum velocity at the center of the pipe was measured using a miniature, direct-impact pitot tube inserted through the side of the PVC pipe, 2' from the inlet end. Velocity head measurements were taken and the maximum pipe velocity calculated. Since Reynolds number calculations indicated that the flow was turbulent, the average velocity through the pipe was taken to be 0.8 times the maximum velocity.[4]

No attempt was made to directly measure the individual air leak rates for the sootblower wall penetrations. Obtaining the data is difficult and expensive since lagging and insulation must be removed from the heat pipe area around each sootblower. For this performance report, the air leak at the wall penetrations remains a part of the unaccounted leaks.

REFERENCES

1. *Air Heaters, Supplement to Performance Test Code for Steam Generating Units, PTC 4.1,* ASME Performance Test Codes, ASME PTC 4.3, The American Society of Mechanical Engineers, New York, 1968.

2. McCoy, D. C., "Heat Pipe Performance Evaluation and Acceptance Testing," CONSOL Report to NYSEG, New York State Electric & Gas Corporation, Binghamton, New York, April 1996.

3. Maskew, J. T., "Milliken Station Heat Pipe Air Heater Performance Uncertainty Analysis of 'Totally Corrected Gas Temperature Leaving The Air Heater,'" CONSOL Report to NYSEG, New York State Electric & Gas Corporation, Binghamton, New York, April 1996.

4. McCabe, W.L., and Smith, J.C., *Unit Operations of Chemical Engineering*,, McGraw-Hill Book Company, Inc., New York, 1956, pp. 54-55.

APPENDIX A

COAL SAMPLING LOGS
COAL AND ASH ANALYSES

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Table A-1

Research & Development
Coal Sampling Log Sheet

Plant/Mine Milliken - Unit 2 Date 5-14-96

Clean Coal					
Top Size, in	5/8		2		6
Minumum Increments	15		15		15
Minimum Wt, lb	2		6		15
Raw Coal					
Top Size, in	5/8		2		6
Minumum Increments	35		35		35
Minimum Wt, lb	2		6		15

Increment	Time	Location	Weight, lb	10 gal Stored	Sampler
1	~~12:30~~	2B 4	3.4 lb	covered container	J. not operating
2	12:30	2A 3	"	"	J. Bedellion
3	1:00	2B 2	"	"	J. Bedellion
4	1:30	2A 1	"	"	J. Bedellion
5	2:00	2B 4	"	"	J. Bedellion
6	2:30	2A 3	"	"	J. Bedellion
7	3:00	2B 2	"	"	J. Bedellion
8	3:30	2A 1	"	"	J. Bedellion
9	4:00	2B 4	"	"	J. Bedellion
10	~~4:20~~	2A3	"	"	J. Bedellion not operating
11	4:20	2B2	"	"	J. Bedellion
12	4:40	2A 1	"	"	J. Bedellion
13	5:00	2B 4	"	"	J. Bedellion
14	5:20	2A3	"	"	J. Bedellion
15	5:40	2B2	"	"	J. Bedellion
16	5:55	2A 1	"	"	J. Bedellion
17	6:10	2B 4	"	"	J. Bedellion
18					
19					
20					

Increment Storage Yes

Final Weight (Approximate) ~70 lbs

Field Preparation Riffled

Final Sample Wt ~15 lbs

Sample ID COAL-Milliken-5-14-96

Checked by MSD

Table A-1 (Continued)

Coal Sampling Log Sheet

Plant/Mine Milliken - Unit 2 Date 5-15-96

Clean Coal					
Top Size, in	5/8		2		6
Minumum Increments	15		15		15
Minimum Wt, lb	2		6		15
Raw Coal					
Top Size, in	5/8		2		6
Minumum Increments	35		35		35
Minimum Wt, lb	2		6		15

Increment	Time	Location	Weight, lb	Stored 30 gal	Sampler
1	1200 N	2B4	3-4 lb	Plastic w/ Lid	OB
2	12:15	2A3	"	"	OB
3	12:30	2B2	"	"	OB
4	12:45	2A1	"	"	OB
5	1:00	2B4	"	"	OB
6	1:15	2A3	"	"	OB
7	1:30	2B2	"	"	OB
8	1:45	2A1	"	"	OB
9	2:00	2B4	"	"	OB
10	2:15	2A3	"	"	OB
11	2:30	2B2	"	"	OB
12	2:45	2A1	"	"	OB
13	3:10	2B4	"	"	OB
14	3:30	2A3	"	"	OB
15	3:50	2B2	"	"	OB
16	4:10	2A1	"	"	OB
17	4:30	2B4	"	"	OB
18	4:50	2A3	"	"	OB
19					
20					

Increment Storage Yes

Final Weight (Approximate) 80 lb

Field Preparation Riffled

Final Sample Wt 15 lb

Sample ID Coal Milliken 5-15-96

Checked by

Table A-1 (Continued)

Research & Development
Coal Sampling Log Sheet

Plant/Mine Milliken Unit 2 Date 5-16-96

Clean Coal					
Top Size, in	5/8		2		6
Minumum Increments	15		15		15
Minimum Wt, lb	2		6		15
Raw Coal					
Top Size, in	5/8		2		6
Minumum Increments	35		35		35
Minimum Wt, lb	2		6		15

Increment	Time	Location	Weight, lb	30 gal Stored	Sampler
1	6:35 pm	2B4	2-3 lb	Plastic w/lid	OB
2	6:50	2A3	3-4	"	OB
3	7:05	2B2	2-3	"	OB
4	7:20	2B4	3.4	"	OB
5	7:35	2A3	3-4	"	OB
6	7:50	2B2	3-4	"	OB
7	8:05	2B4	3-4	"	OB
8	8:20	2A3	3-4	"	OB
9	8:35	2B2	3-4	"	OB
10	8:50	2B4	3-4	"	OB
11	9:05	2A3	3-4	"	OB
12	9:20	2B2	3-4	"	OB
13	9:35	2B4	3-4	"	OB
14	9:50	2A3	3-4	"	OB
15	10:05	2B2	3-4	"	OB
16	10:20	2B4	3-4	"	OB
17					
18					
19					
20					

Increment Storage yes

Final Weight (Approximate) 60 lb

Field Preparation Riffled

Final Sample Wt 20 lb

Sample ID Milliken Coal 5-16-96

Checked by MSY

mill next to control room 2A1 Not running

Table A-2
Coal and Fly Ash Analyses

	Coal Analysis			Fly Ash Analysis		
Date	05/14/96	05/15/96	05/16/96	05/14/96	05/15/96	05/16/96
As Received Moisture, wt %	6.43	7.94	4.92	0.35	0.12	0.28
PROXIMATE, wt % (Dry)						
Volatile Matter	37.67	37.86	38.25			
Fixed Carbon	54.43	53.79	53.43			
Ash	7.90	8.35	8.32			
Total	100.00	100.00	100.00			
ULTIMATE (Dry)						
Carbon	78.66	78.55	78.44	2.89	1.89	2.27
Hydrogen	5.19	5.11	5.08	-0.01	0.02	0.01
Nitrogen	1.63	1.62	1.63	0.04	0.01	0.02
Sulfur	2.00	2.04	2.1	0.59	0.57	0.68
Oxygen (by diff)	4.62	4.33	4.43			
Ash	7.90	8.35	8.32	96.16	97.42	96.88
Total	100.00	100.00	100.00			
Higher Heating Value						
Dry, Btu/lb	13,994	13,914	13,912			
Moist/Ash Free, Btu/lb	15,194	15,182	15,175			

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APPENDIX B

THERMOCOUPLE CALIBRATION INFORMATION SECONDARY AIR TEMPERATURES

Table B-1

04/24/1996

WATLOW
GORDON
5710 KENOSHA STREET, BOX 500
RICHMOND, ILLINOIS 60071

Report of Calibration

For :Consol

Calibration Date :01/11/1995

P.O. # :030653
Gordon Order # :G31571
Lot # :GX7233
Calibrated by :C.Scherrer

Catalog # :ACGA00F360U4000
Items calibrated :AC Style T/C
ANSI Type :K
ANSI Limits :Special

If deviation reads positive, subtract to correct. If deviation reads negative, add to correct. All values are positive unless otherwise shown.

Item No.	I.D. No.	Actual Temp	Std mVolts Reading	Item mVolts Reading	Item Temp	Fahrenheit Deviation	+/- ANSI Limits Deg. F
5	1	99.80	1.526	1.506	99.35	-0.45	1.98
		298.34	6.164	6.064	298.68	0.33	1.98
		497.91	10.662	10.503	497.43	-0.48	1.98
		701.96	15.398	15.251	703.06	1.10	2.67

Calibrated in accordance with one or more of the following specifications:ASTM E-207, E-220, E-230, MIL-STD-45662A AND ITS 90.

PHONE 815-678-2211 FAX 815-678-3961

TABLE B-2
Pitot Tube Thermocouple Calibration Data

Calibration @ 32 °F		TC Length = 12' - 8"		TC Length = 6' - 5"		TC Length = 5' - 0"	
Readout Device	TC	#2B	#3A	#4A	#5A	#6C	#7B
ANALOGIC w/o ext		31.9	32.0	32.0	32.3	32.3	32.2
ANALOGIC w/ ext		32.1	32.0	32.0	32.0	32.0	31.9
	TC	NIST Certified Reference TC					
ANALOGIC w/o ext		31.9	31.9	31.9	31.9	31.9	31.9

Calibration @ 100 °F		TC Length = 12' - 8"		TC Length = 6' - 5"		TC Length = 5' - 0"	
Readout Device	TC	#2B	#3A	#4A	#5A	#6C	#7B
ANALOGIC w/o ext		100.2	100.3	100.1	100.2	100.1	99.9
ANALOGIC w/ ext		100.2	100.2	100.1	100.2	100.1	100.0
	TC	NIST Certified Reference TC					
ANALOGIC w/o ext		100.0	100.0	100.0	100.0	100.0	100.0

Calibration @ 290 °F		TC Length = 12' - 8"		TC Length = 6' - 5"		TC Length = 5' - 0"	
Readout Device	TC	#2B	#3A	#4A	#5A	#6C	#7B
ANALOGIC w/o ext		290.4	290.3	290.4	290.6	290.5	290.1
ANALOGIC w/ ext							
	TC	NIST Certified Reference TC					
ANALOGIC w/o ext		291.0	290.8	291.1	291.0	290.7	291.0

Calibration @ 570 °F		TC Length = 12' - 8"		TC Length = 6' - 5"		TC Length = 5' - 0"	
Readout Device	TC	#2B	#3A	#4A	#5A	#6C	#7B
ANALOGIC w/o ext		570.0	571.5	568.8	568.1	568.5	568.3
ANALOGIC w/ ext							
	TC	NIST Certified Reference TC					
ANALOGIC w/o ext		572.4	572.4	571.9	571.9	570.4	570.4

Calibration @ 580 °F		TC Length = 12' - 8"		TC Length = 6' - 5"		TC Length = 5' - 0"	
Readout Device	TC	#2B	#3A	#4A	#5A	#6C	#7B
ANALOGIC w/o ext		577.0	577.1	576.0	576.1	574.4	573.5
ANALOGIC w/ ext							
	TC	NIST Certified Reference TC					
ANALOGIC w/o ext		580.0	580.0	577.0	577.0	575.0	575.0

Calibration @ 690 °F		TC Length = 12' - 8"		TC Length = 6' - 5"		TC Length = 5' - 0"	
Readout Device	TC	#2B	#3A	#4A	#5A	#6C	#7B
ANALOGIC w/o ext		691.3	691.2	691.0	689.0	690.5	690.7
ANALOGIC w/ ext							
	TC	NIST Certified Reference TC					
ANALOGIC w/o ext		692.6	691.5	694.5	692.5	694.4	694.3

ANALOGIC Universal Calibrator = M/#AN6520, S/#6553
Handeld #1 = Watlow/Gordon M/#5401, S/#D96002614
Handeld #2 = Watlow/Gordon M/#5401, S/#M95001829
Handeld #3 = Watlow/Gordon M/#5401, S/#K94002792
Handeld #4 = Watlow/Gordon M/#5401, S/#L94003776
Handeld #5 = Watlow/Gordon M/#5401, S/#L94003789

File: TCCALRED.WB2 09/04/96 09:55:41

TABLE B-3
Calibration Check of Handheld Pyrometers And Effect Of Extension Wire On Readings

Readout Device (1)	Temperature, °F					
	NIST Certified Reference TC				Generated EMF Input	
ANALOGIC w/o ext	31.9	100.0	269.9	516.5	500.0	700.1
ANALOGIC w/ ext	31.9	100.0	269.6			
Handheld #1 w/o ext	31.9	100.0	270.8	517.4	500.0	700.7
Handheld #2 w/o ext	31.9	100.0	269.4	517.4	500.0	700.7
Handheld #3 w/o ext	31.9	100.0	269.5	517.4	500.0	700.6
Handheld #4 w/o ext	31.9	100.0	269.4	517.4	500.0	700.6

(1) Ext Refers To Use Of Extension Wire Between TC And Readout Device.
ANALOGIC Universal Calibrator = Model # AN6520, Serial # 6553
Handeld #1 = Watlow/Gordon Model # 5401, Serial # D96002614
Handeld #2 = Watlow/Gordon Model # 5401, Serial # M95001829
Handeld #3 = Watlow/Gordon Model # 5401, Serial # K94002792
Handeld #4 = Watlow/Gordon Model # 5401, Serial # L94003776

TABLE B-4
Secondary Air Fan Outlet TC Calibration Data

Readout Device	Temperature, °F								
	NIST Certified Reference TC	3/8" Dia. x 40" L. Type K TC with ~100' of KX extension cable							
		#1	#2	#3	#4	#5	#6	#7	#8
ANALOGIC w/o ext	32.0	32.0	32.1	32.1	32.0	32.0	32.0	32.0	32.0
CHESSELL w/ext	33.1	33.3	33.3	33.3	33.0	33.3	33.0	33.0	33.1

Readout Device	Temperature, °F								
	NIST Certified Reference TC	3/8" Dia. x 40" L. Type K TC with ~100' of KX extension cable							
		#1	#2	#3	#4	#5	#6	#7	#8
ANALOGIC w/o ext	100.0	100.0	100.1	100.0	100.0	99.9	100.1	100.2	100.2
CHESSELL w/ext	101.2	101.3	101.4	101.2	101.5	101.4	101.8	100.6	100.8

ANALOGIC Universal Calibrator = Model # AN6520, Serial # 6553
CHESSELL = Model # 4001, Serial # 0687-412944

Table B-5
Thermocouple Calibration Correlation Coefficients

Pitot Probe TC's

TC #	a	b
2B	-0.2977	0.00393
3A	-0.0405	0.00214
4A	-0.4450	0.00486
5A	-0.3819	0.00496
6C	-0.4364	0.00422
7B	-0.2933	0.00446

Sec. Air Fan TC's

TC #	a	b
1	-1.3000	0.00000
2	-1.2511	-0.00147
3	-1.3490	0.00147
4	-0.7591	-0.00730
5	-1.2511	-0.00147
6	-0.6161	-0.01163
7	-1.1953	0.00592
8	-1.2467	0.00443

$Ta = Tm + (a + bTm)$

Where:

Ta = Actual Temperature, °F

Tm = Measured Temperature, °F

a, b = Correction Correlation Constants

TABLE B-6
Secondary Air Fan Outlet Temperatures (Heat Pipe Inlet) -- Test 1

Date 05/14/96

Uncorrected Recorder Readings, °F

	Unit 2A Thermocouples				Unit 2B Thermocouples			
Time	TC-1	TC-2	TC-3	TC-4	TC-5	TC-6	TC-7	TC-8
12:19	88.7	88.8	89.2	88.6	87.8	89.7	88.0	87.3
12:29	88.8	88.7	89.2	88.4	87.9	89.5	87.7	87.3
12:39	88.7	88.6	89.3	88.7	88.1	89.9	88.0	87.6
12:49	89.2	89.1	89.7	89.1	88.3	90.2	88.2	87.8
12:59	89.4	89.6	90.3	89.6	88.9	90.9	89.0	88.4
13:09	90.0	89.7	90.5	90.0	89.1	91.1	89.0	88.5
13:19	89.6	89.6	90.2	90.2	89.1	91.4	89.3	88.6
13:29	90.0	89.8	90.8	90.1	89.1	91.2	89.1	88.5
13:39	90.1	90.1	90.9	90.4	89.4	91.5	89.4	88.6
13:49	90.6	90.4	91.4	90.9	89.2	91.6	89.7	88.8
13:59	90.6	90.5	91.1	90.8	89.8	91.8	89.8	89.1
14:09	90.7	90.5	91.4	90.7	89.9	92.0	90.3	89.3
14:19	90.0	90.2	91.0	90.3	89.4	91.6	89.7	88.8
14:29	90.3	90.2	91.2	90.6	90.2	92.1	90.2	89.7
14:39	90.9	90.8	91.7	90.8	90.6	92.3	90.6	89.9
14:49	91.0	91.0	91.6	90.9	90.8	92.5	90.5	90.0
Average Temps			90.1	Unit 2A			89.6	Unit 2B
15:59	90.9	90.7	91.3	91.2	90.1	92.1	90.0	89.2
16:09	91.0	90.8	91.3	91.6	90.3	92.3	90.3	89.5
16:19	90.8	90.1	91.2	91.1	90.4	92.2	89.9	89.3
16:29	91.3	90.9	91.5	91.7	90.7	92.7	90.5	90.0
16:39	91.0	90.3	91.1	91.1	90.2	91.8	90.1	89.4
16:49	90.8	90.3	90.7	91.3	90.1	91.7	89.6	89.1
16:59	90.9	90.5	91.0	91.8	89.9	92.1	89.9	89.1
17:09	91.0	90.5	90.9	91.6	90.1	91.8	89.7	89.2
17:19	90.9	90.5	90.8	91.5	89.6	92.0	89.8	89.0
17:29	90.4	89.9	90.4	91.1	89.4	91.2	89.2	88.5
17:39	90.0	89.6	90.1	91.0	89.5	90.8	89.1	88.5
17:49	90.2	89.8	90.4	90.9	89.5	91.1	89.1	88.6
17:59	90.5	89.9	90.5	91.2	89.3	91.4	89.2	88.7
18:09	90.7	90.0	90.6	91.0	89.8	91.4	89.4	88.7
18:19	90.4	90.0	90.6	91.3	89.6	91.6	89.4	88.8
18:29	90.2	89.6	90.2	90.7	89.4	91.3	89.2	88.6
18:39	90.0	89.4	90.1	90.7	89.3	91.2	89.2	88.5
Average Temps			90.7	Unit 2A			90.0	Unit 2B

Corrected Recorder Readings, °F

	Unit 2A Thermocouples				Unit 2B Thermocouples			
Time	TC-1	TC-2	TC-3	TC-4	TC-5	TC-6	TC-7	TC-8
12:19	87.4	87.4	88.0	87.2	86.4	88.1	87.3	86.4
12:29	87.5	87.3	88.0	87.0	86.5	87.9	87.0	86.4
12:39	87.4	87.2	88.1	87.2	86.7	88.2	87.3	86.8
12:49	87.9	87.7	88.5	87.7	86.9	88.5	87.5	86.9
12:59	88.1	88.2	89.1	88.2	87.5	89.2	88.3	87.5
13:09	88.7	88.3	89.2	88.5	87.7	89.4	88.4	87.6
13:19	88.3	88.2	89.0	88.7	87.7	89.8	88.6	87.8
13:29	88.7	88.4	89.6	88.6	87.7	89.5	88.5	87.6
13:39	88.8	88.7	89.7	89.0	88.0	89.8	88.8	87.7
13:49	89.3	89.0	90.2	89.5	87.8	89.9	89.0	87.9
13:59	89.3	89.1	89.9	89.4	88.5	90.1	89.1	88.2
14:09	89.4	89.1	90.1	89.3	88.5	90.3	89.6	88.4
14:19	88.7	88.8	89.8	88.8	88.0	89.9	89.0	87.9
14:29	89.0	88.8	90.0	89.2	88.8	90.4	89.5	88.8
14:39	89.6	89.4	90.5	89.4	89.2	90.6	89.9	89.1
14:49	89.7	89.6	90.4	89.5	89.4	90.8	89.9	89.2
Average Temps			88.7	Unit 2A			88.4	Unit 2B
15:59	89.6	89.4	90.1	89.8	88.8	90.4	89.4	88.3
16:09	89.7	89.4	90.1	90.2	89.0	90.6	89.6	88.6
16:19	89.5	88.8	90.0	89.7	89.0	90.5	89.3	88.5
16:29	90.0	89.5	90.3	90.3	89.3	91.0	89.8	89.2
16:39	89.7	88.9	89.9	89.7	88.8	90.2	89.4	88.6
16:49	89.5	88.9	89.5	89.9	88.7	90.0	88.9	88.2
16:59	89.6	89.1	89.8	90.3	88.5	90.4	89.2	88.2
17:09	89.7	89.1	89.7	90.2	88.7	90.1	89.1	88.3
17:19	89.6	89.1	89.6	90.0	88.2	90.3	89.1	88.1
17:29	89.1	88.5	89.1	89.7	88.0	89.5	88.5	87.7
17:39	88.7	88.2	88.9	89.5	88.1	89.1	88.5	87.7
17:49	88.9	88.4	89.2	89.5	88.1	89.4	88.4	87.7
17:59	89.2	88.5	89.2	89.7	87.9	89.7	88.5	87.9
18:09	89.4	88.6	89.3	89.6	88.4	89.8	88.8	87.9
18:19	89.1	88.6	89.4	89.9	88.2	90.0	88.7	87.9
18:29	88.9	88.2	89.0	89.3	88.0	89.6	88.6	87.7
18:39	88.7	88.0	88.9	89.2	87.9	89.5	88.5	87.6
Average Temps			89.4	Unit 2A			88.9	Unit 2B

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TABLE B-7

Secondary Air Fan Outlet Temperatures (Heat Pipe Inlet) -- Test 2

Date 05/15/96

	Uncorrected Recorder Readings, °F								Corrected Recorder Readings, °F							
	Unit 2A Thermocouples				Unit 2B Thermocouples				Unit 2A Thermocouples				Unit 2B Thermocouples			
Time	TC-1	TC-2	TC-3	TC-4	TC-5	TC-6	TC-7	TC-8	TC-1	TC-2	TC-3	TC-4	TC-5	TC-6	TC-7	TC-8
12:01	94.4	94.2	94.7	94.5	94.8	94.9	93.4	93.5	93.1	92.8	93.5	93.0	93.4	93.2	92.7	92.7
12:11	94.4	94.1	94.8	94.7	95.0	95.0	93.3	93.4	93.1	92.7	93.6	93.3	93.6	93.3	92.6	92.6
12:21	94.6	94.6	95.1	95.1	95.2	95.2	93.8	93.6	93.3	93.2	93.9	93.6	93.8	93.4	93.2	92.8
12:31	95.0	94.7	95.4	95.2	95.3	95.4	93.7	93.6	93.7	93.3	94.2	93.8	93.9	93.7	93.1	92.8
12:41	95.4	95.0	95.7	95.8	95.4	96.0	94.1	94.0	94.1	93.6	94.4	94.3	94.0	94.3	93.5	93.1
12:51	95.8	96.0	96.7	95.7	95.9	96.7	95.0	94.7	94.5	94.6	95.5	94.3	94.5	95.0	94.4	93.9
13:01	96.8	96.6	97.2	96.7	96.8	97.6	95.8	95.8	95.5	95.2	96.0	95.2	95.4	95.8	95.2	95.0
13:11	96.1	96.3	96.9	96.8	97.0	97.5	95.6	95.4	94.8	94.9	95.7	95.3	95.6	95.8	94.9	94.6
13:21	95.7	95.6	96.3	96.0	96.0	96.7	94.9	94.6	94.4	94.2	95.1	94.5	94.6	95.0	94.2	93.8
13:31	96.0	96.0	96.8	96.4	96.5	97.3	95.1	95.0	94.7	94.6	95.6	94.9	95.1	95.6	94.5	94.2
13:41	95.9	95.9	96.6	96.1	96.3	96.7	94.8	94.7	94.6	94.5	95.4	94.6	94.9	94.9	94.2	93.9
13:51	95.7	95.7	96.2	96.2	96.2	96.8	94.9	94.8	94.4	94.3	95.0	94.7	94.8	95.0	94.2	93.9
14:01	96.1	95.7	96.4	96.7	96.6	96.8	95.0	95.2	94.8	94.3	95.2	95.2	95.2	95.0	94.4	94.3
14:11	96.4	96.1	96.8	96.6	96.7	96.9	95.4	95.2	95.1	94.7	95.6	95.1	95.3	95.2	94.7	94.4
14:21	96.0	95.7	96.3	96.4	96.7	96.8	95.1	95.0	94.7	94.3	95.0	94.9	95.3	95.1	94.5	94.2
14:31	96.3	95.9	96.4	96.7	96.8	96.8	95.2	95.4	95.0	94.5	95.2	95.3	95.4	95.1	94.6	94.6
14:41	92.1	92.0	92.4	92.6	92.1	93.8	92.0	91.4	90.8	90.6	91.2	91.1	90.7	92.1	91.3	90.5
14:51	92.3	92.2	92.3	92.6	91.1	92.9	91.0	90.2	91.0	90.8	91.1	91.2	89.7	91.2	90.3	89.3
Average Temps			95.4	Unit 2A			95.0	Unit 2B			94.1	Unit 2A			93.9	Unit 2B
14:51	92.3	92.2	92.3	92.6	91.1	92.9	91.0	90.2	91.0	90.8	91.1	91.2	89.7	91.2	90.3	89.3
15:01	95.8	95.5	96.1	95.6	95.5	96.0	94.4	94.4	94.5	94.1	94.8	94.1	94.1	94.3	93.8	93.6
15:11	95.8	95.7	96.3	96.1	96.2	96.5	94.6	94.8	94.5	94.3	95.1	94.6	94.8	94.8	93.9	94.0
15:21	95.4	95.1	95.6	95.9	96.3	96.2	94.6	94.7	94.1	93.7	94.4	94.5	94.9	94.5	94.0	93.9
15:31	96.7	96.5	97.3	97.0	97.4	98.1	96.0	95.9	95.4	95.1	96.1	95.5	96.0	96.4	95.4	95.0
15:41	97.1	96.9	98.0	97.1	97.5	98.5	96.3	96.0	95.8	95.5	96.8	95.7	96.1	96.7	95.7	95.2
15:51	95.6	95.5	96.5	95.7	96.1	97.3	95.2	94.8	94.3	94.1	95.2	94.3	94.7	95.6	94.5	93.9
16:01	96.9	96.7	97.6	96.9	97.2	98.5	96.2	95.9	95.6	95.3	96.4	95.4	95.8	96.7	95.6	95.1
16:11	96.6	96.4	97.4	96.5	96.8	98.0	96.0	95.7	95.3	95.0	96.2	95.1	95.4	96.2	95.3	94.8
16:21	97.0	96.9	97.6	96.8	97.1	98.5	96.2	96.0	95.7	95.5	96.4	95.4	95.7	96.7	95.6	95.2
16:31	96.9	96.7	97.6	97.1	97.2	98.6	96.2	95.9	95.6	95.3	96.4	95.6	95.8	96.8	95.5	95.1
16:41	96.7	96.6	97.7	96.7	97.1	98.4	96.1	95.8	95.4	95.2	96.5	95.2	95.7	96.6	95.5	95.0
16:51	96.8	96.5	97.5	96.7	97.2	98.2	96.2	95.7	95.5	95.1	96.3	95.2	95.8	96.5	95.6	94.8
17:01	96.6	96.4	97.2	96.7	97.2	98.3	96.0	95.7	95.3	95.0	96.0	95.2	95.8	96.5	95.4	94.9
Average Temps			96.3	Unit 2A			96.1	Unit 2B			94.9	Unit 2A			94.9	Unit 2B

TABLE B-8
Secondary Air Fan Outlet Temperatures (Heat Pipe Inlet)-- Test 3

Date 05/16/96

	Uncorrected Recorder Readings, °F								Corrected Recorder Readings, °F							
	Unit 2A Thermocouples				Unit 2B Thermocouples				Unit 2A Thermocouples				Unit 2B Thermocouples			
Time	TC-1	TC-2	TC-3	TC-4	TC-5	TC-6	TC-7	TC-8	TC-1	TC-2	TC-3	TC-4	TC-5	TC-6	TC-7	TC-8
18:31	94.0	93.7	93.8	94.1	94.3	94.5	93.4	93.4	92.7	92.3	92.6	92.6	92.9	92.7	92.7	92.6
18:41	94.2	93.9	94.0	94.0	94.5	94.5	93.4	93.5	92.9	92.5	92.8	92.6	93.1	92.8	92.8	92.6
18:51	93.9	93.9	93.9	93.8	94.3	94.4	93.2	93.3	92.6	92.5	92.7	92.4	93.0	92.7	92.6	92.5
19:01	94.1	93.9	94.1	93.9	94.3	94.6	93.3	93.5	92.8	92.5	92.9	92.4	92.9	92.9	92.7	92.6
19:11	93.9	93.7	93.9	93.7	94.1	94.2	93.3	93.2	92.6	92.3	92.7	92.3	92.7	92.4	92.6	92.3
19:21	93.8	93.7	93.6	93.5	94.0	94.3	93.1	92.9	92.5	92.3	92.4	92.0	92.6	92.5	92.4	92.1
19:31	93.6	93.6	93.3	93.2	93.7	93.9	92.8	92.6	92.3	92.2	92.1	91.8	92.3	92.2	92.2	91.8
19:41	93.5	93.3	93.2	93.2	93.5	93.8	92.7	92.5	92.2	91.9	92.0	91.7	92.2	92.1	92.1	91.7
19:51	93.5	93.2	93.3	93.1	93.6	93.9	92.7	92.6	92.2	91.8	92.1	91.7	92.2	92.2	92.0	91.8
20:01	93.6	93.2	93.3	93.2	93.6	93.7	92.6	92.7	92.3	91.8	92.1	91.7	92.2	92.0	92.0	91.9
20:11	93.6	93.4	93.3	93.1	93.7	93.7	92.6	92.4	92.3	92.0	92.1	91.6	92.3	91.9	91.9	91.6
20:21	93.5	93.2	93.4	93.5	93.4	93.7	92.6	92.4	92.2	91.8	92.2	92.0	92.0	92.0	92.0	91.5
Average Temps			93.6	Unit 2A			93.5	Unit 2B			92.3	Unit 2A			92.3	Unit 2B
20:41	93.6	93.5	93.6	93.2	93.4	93.7	92.5	92.5	92.3	92.1	92.4	91.8	92.0	92.0	91.8	91.7
20:51	93.7	93.6	93.7	93.6	93.5	93.8	92.5	92.6	92.4	92.2	92.5	92.2	92.1	92.1	91.8	91.7
21:01	93.7	93.6	93.7	93.6	93.5	93.9	92.4	92.2	92.4	92.2	92.5	92.1	92.1	92.2	91.8	91.4
21:11	93.8	93.5	93.7	93.6	93.5	93.6	92.3	92.2	92.5	92.1	92.4	92.1	92.2	91.9	91.7	91.4
21:21	93.7	93.6	93.5	93.7	93.4	93.6	92.4	92.3	92.4	92.2	92.3	92.2	92.0	91.9	91.7	91.5
21:31	93.8	93.6	93.5	93.5	93.5	93.6	92.4	92.4	92.5	92.2	92.3	92.0	92.1	91.9	91.8	91.6
21:41	93.8	93.7	93.9	93.6	93.7	93.6	92.4	92.6	92.5	92.3	92.6	92.1	92.4	91.9	91.8	91.8
21:51	93.1	92.9	92.9	92.9	92.7	92.6	91.7	91.5	91.8	91.5	91.7	91.5	91.3	90.9	91.1	90.7
22:01	92.9	92.6	92.7	92.5	92.5	92.5	92.5	91.5	91.6	91.2	91.5	91.1	91.1	90.8	91.9	90.6
22:11	93.2	92.6	92.9	92.7	92.4	92.7	91.6	91.3	91.9	91.2	91.7	91.3	91.0	91.0	91.0	90.5
22:21	92.9	92.8	92.7	92.7	92.4	92.6	91.4	91.5	91.6	91.4	91.5	91.3	91.0	90.9	90.7	90.6
22:31	92.8	92.6	92.7	92.8	92.3	92.6	91.4	91.5	91.5	91.2	91.5	91.3	91.0	90.9	90.7	90.6
Average Temps			93.3	Unit 2A			92.6	Unit 2B			91.9	Unit 2A			91.5	Unit 2B

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Figure B-1
Thermocouple Calibration Temperature Differences For TC's Used During Milliken Heat Pipe Tests

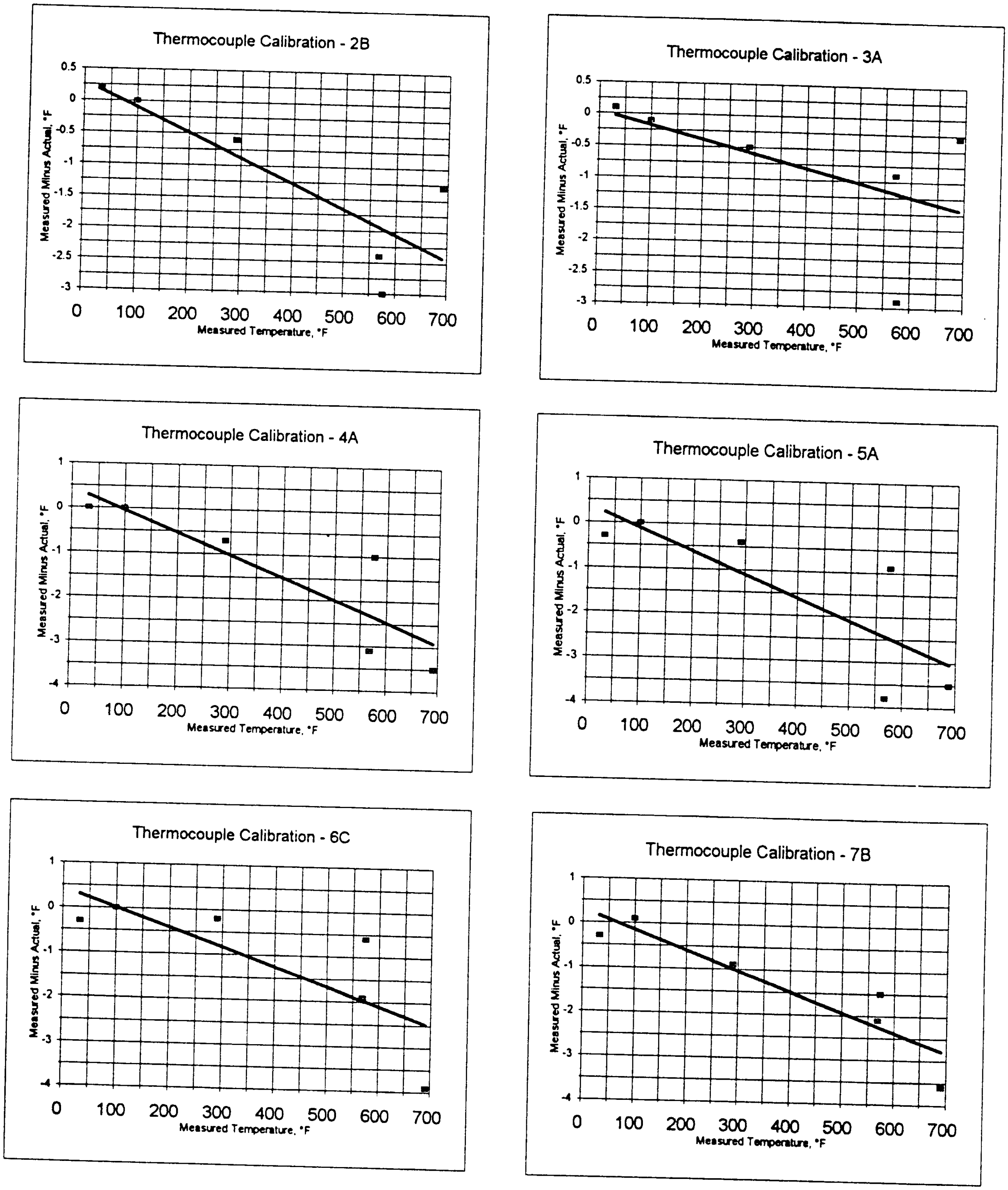
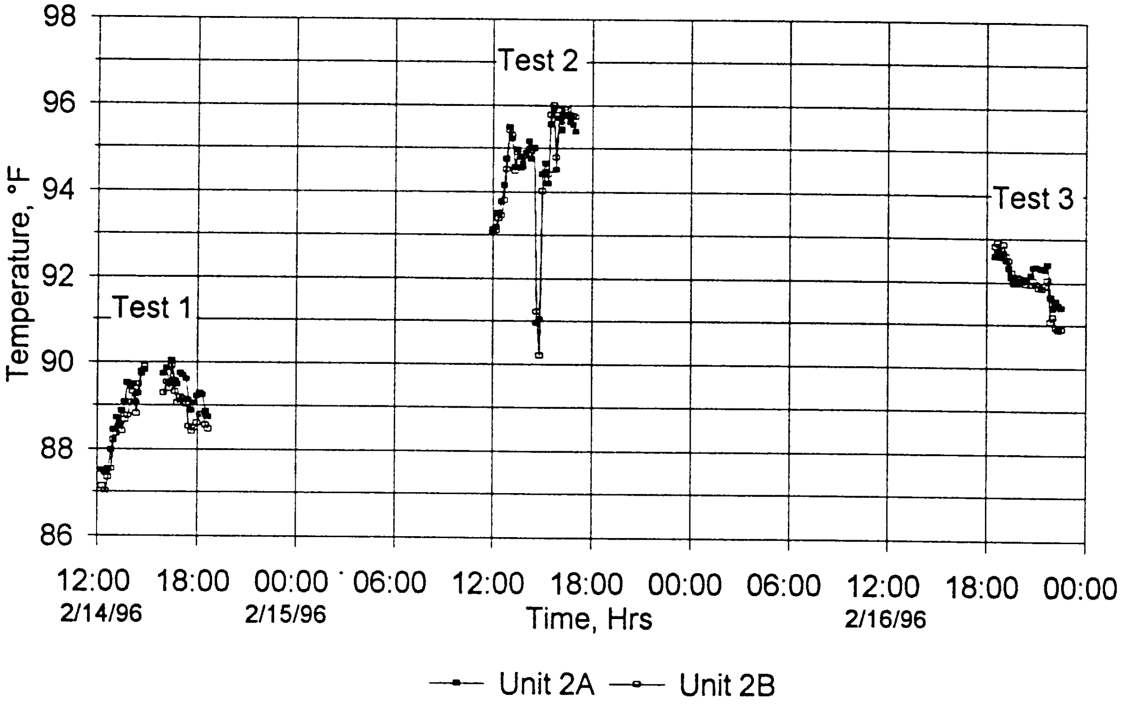


Figure B-2

Secondary Air Fan Outlet (Heat Pipe Inlet) Temps

10 Min. Interval Readings -- Chessell Recorder



APPENDIX C

PITOT TUBE AND ELECTRONIC MANOMETER CALIBRATION INFORMATION

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Table C-1
Pitot Calibration C-Factor Summary

Pitot ID	C-Factor Pre-Test		C-Factor Post-Test		% Change	
	A Side	B Side	A Side	B Side	A Side	B Side
S-49	0.806	0.814	0.802	0.796	-0.496	-2.211
S-50	0.789	0.786	0.810	0.802	2.662	2.036
S-51	0.824	0.827	0.822	0.823	-0.243	-0.484
S-52	0.798	0.807	0.813	0.809	1.880	0.248
S-53	0.808	0.811	0.816	0.813	0.990	0.247
S-54	0.816	0.816	0.806	0.811	-1.225	-0.613

Note "A" side is normally faced into flow.

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Table C-2
Pre-Test Pitot Tube Calibrations

PITOT TUBE ID NUMBER– S–49
PITOT TUBE DESCRIPTION– 5', 1" OD, SS
DATE CALIBRATED– 5/6/96
CALIBRATED BY– OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S–TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.17	0.27	0.802	0.802	0.000	27
	2		0.17	0.27	0.802			
	3		0.17	0.27	0.802			
LOW	1	B	0.17	0.26	0.801	0.811	0.007	27
	2		0.17	0.25	0.816			
	3		0.17	0.25	0.816			
MEDIUM	1	A	0.42	0.65	0.796	0.798	0.003	42
	2		0.42	0.65	0.796			
	3		0.42	0.64	0.802			
MEDIUM	1	B	0.43	0.66	0.806	0.805	0.001	43
	2		0.43	0.66	0.806			
	3		0.42	0.65	0.803			
HIGH	1	A	0.87	1.27	0.818	0.818	0.000	61
	2		0.87	1.27	0.818			
	3		0.87	1.27	0.818			
HIGH	1	B	0.87	1.23	0.829	0.827	0.002	61
	2		0.87	1.23	0.829			
	3		0.86	1.23	0.824			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C–FACTOR	DEVIATION
A	0.806	0.008
B	0.814	0.009

[PITS–49B;RLO;5/6/96;1345]

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M.S. DeV 5-10-96

Signed Date

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Table C-2 (Continued)
Pre-Test Pitot Tube Calibrations

PITOT TUBE ID NUMBER- S-50
PITOT TUBE DESCRIPTION- 5', 1" OD, SS
DATE CALIBRATED- 5/6/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.17	0.29	0.774	0.775	0.008	27
	2		0.16	0.28	0.765			
	3		0.17	0.28	0.787			
LOW	1	B	0.17	0.29	0.774	0.774	0.000	27
	2		0.17	0.29	0.774			
	3		0.17	0.29	0.774			
MEDIUM	1	A	0.40	0.60	0.801	0.797	0.005	41
	2		0.40	0.60	0.801			
	3		0.39	0.60	0.790			
MEDIUM	1	B	0.39	0.61	0.792	0.792	0.000	41
	2		0.39	0.61	0.792			
	3		0.39	0.61	0.792			
HIGH	1	A	0.87	1.35	0.791	0.793	0.001	61
	2		0.87	1.34	0.794			
	3		0.87	1.34	0.794			
HIGH	1	B	0.86	1.35	0.790	0.793	0.002	61
	2		0.87	1.35	0.795			
	3		0.87	1.35	0.795			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.789	0.009
B	0.786	0.008

[PITS-50B;RLO;5/6/96;1430]

MSD

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Date

M.S. DeVito

5-10-96

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Table C-2 (Continued)
Pre-Test Pitot Tube Calibrations

PITOT TUBE ID NUMBER- S-51
PITOT TUBE DESCRIPTION- 42", 1" OD, SS
DATE CALIBRATED- 5/6/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1 2 3	A	0.17 0.17 0.17	0.26 0.26 0.26	0.818 0.818 0.818	0.818	0.000	27
LOW	1 2 3	B	0.17 0.16 0.17	0.25 0.25 0.26	0.834 0.810 0.818	0.821	0.009	27
MEDIUM	1 2 3	A	0.40 0.40 0.41	0.59 0.59 0.59	0.815 0.819 0.825	0.820	0.004	42
MEDIUM	1 2 3	B	0.41 0.41 0.40	0.58 0.58 0.58	0.832 0.832 0.822	0.829	0.005	42
HIGH	1 2 3	A	0.87 0.86 0.87	1.21 1.20 1.21	0.836 0.834 0.836	0.835	0.001	61
HIGH	1 2 3	B	0.88 0.87 0.87	1.23 1.23 1.23	0.834 0.829 0.829	0.830	0.002	61

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.824	0.007
B	0.827	0.004

[PITS-51B;RLO;5/6/96;1430]

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M.S DeVito Signed 5-10-96 Date

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Table C-2 (Continued)
Pre-Test Pitot Tube Calibrations

PITOT TUBE ID NUMBER- S-52
PITOT TUBE DESCRIPTION- 42", 1" OD, SS
DATE CALIBRATED- 5/6/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.17	0.26	0.801	0.791	0.007	27
	2		0.17	0.27	0.786			
	3		0.17	0.27	0.786			
LOW	1	B	0.17	0.27	0.793	0.793	0.000	27
	2		0.17	0.27	0.793			
	3		0.17	0.27	0.793			
MEDIUM	1	A	0.39	0.61	0.795	0.797	0.002	41
	2		0.40	0.62	0.798			
	3		0.40	0.62	0.798			
MEDIUM	1	B	0.41	0.61	0.809	0.810	0.004	42
	2		0.41	0.60	0.816			
	3		0.40	0.60	0.806			
HIGH	1	A	0.86	1.30	0.805	0.807	0.002	61
	2		0.87	1.30	0.810			
	3		0.86	1.30	0.805			
HIGH	1	B	0.87	1.26	0.819	0.818	0.001	61
	2		0.87	1.26	0.819			
	3		0.86	1.25	0.817			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.798	0.006
B	0.807	0.009

[PITS-52B;RLO;5/6/96;1330]

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M. S. DeVito
Signed

5-10-96
Date

PROJECT 1621-26-23 Notebook No. ________

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Table C-2 (Continued)
Pre-Test Pitot Tube Calibrations

PITOT TUBE ID NUMBER- S-53
PITOT TUBE DESCRIPTION- 11', 1" OD, SS
DATE CALIBRATED- 5/6/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.17	0.26	0.801	0.803	0.009	27
	2		0.16	0.25	0.792			
	3		0.17	0.25	0.816			
LOW	1	B	0.17	0.26	0.808	0.804	0.006	27
	2		0.16	0.26	0.794			
	3		0.17	0.26	0.808			
MEDIUM	1	A	0.40	0.61	0.802	0.802	0.000	41
	2		0.39	0.60	0.802			
	3		0.39	0.60	0.802			
MEDIUM	1	B	0.40	0.59	0.815	0.813	0.003	41
	2		0.40	0.59	0.815			
	3		0.40	0.60	0.808			
HIGH	1	A	0.88	1.28	0.821	0.819	0.001	61
	2		0.88	1.29	0.818			
	3		0.88	1.29	0.818			
HIGH	1	B	0.89	1.31	0.816	0.817	0.002	61
	2		0.88	1.30	0.815			
	3		0.89	1.30	0.819			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.808	0.007
B	0.811	0.005

[PITS-53B;RLO;5/6/96;1410]

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		M. S. DiVito	5-10-96

PROJECT 1621-26-23

Notebook No. 778

Continued From Page

Table C-2 (Continued)
Pre-Test Pitot Tube Calibrations

PITOT TUBE ID NUMBER- S-54
PITOT TUBE DESCRIPTION- 11', 1" OD, SS
DATE CALIBRATED- 5/6/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.19	0.29	0.817	0.803	0.009	28
	2		0.18	0.29	0.795			
	3		0.18	0.29	0.795			
LOW	1	B	0.19	0.29	0.817	0.812	0.003	28
	2		0.18	0.28	0.810			
	3		0.18	0.28	0.810			
MEDIUM	1	A	0.44	0.64	0.821	0.816	0.003	43
	2		0.43	0.64	0.811			
	3		0.44	0.65	0.815			
MEDIUM	1	B	0.43	0.65	0.812	0.811	0.003	43
	2		0.43	0.66	0.806			
	3		0.44	0.66	0.815			
HIGH	1	A	0.88	1.24	0.830	0.831	0.001	61
	2		0.89	1.25	0.832			
	3		0.88	1.24	0.830			
HIGH	1	B	0.88	1.26	0.824	0.826	0.002	61
	2		0.89	1.26	0.828			
	3		0.89	1.27	0.825			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.816	0.010
B	0.816	0.006

MSD

[PITS-54B;RLO;5/6/96;1415]

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Signed	Date	Signed	Date
		M. S. DeVito	5-10-96

779

Table C-3
Post-Test Pitot Tube Calibrations

PITOT TUBE ID NUMBER- S-49
PITOT TUBE DESCRIPTION- 5', 1" OD, SS
DATE CALIBRATED- 6/3/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.19	0.27	0.813	0.813	0.000	28
	2		0.19	0.27	0.813			
	3		0.19	0.27	0.813			
LOW	1	B	0.19	0.28	0.799	0.804	0.006	28
	2		0.19	0.27	0.813			
	3		0.19	0.28	0.799			
MEDIUM	1	A	0.42	0.67	0.791	0.794	0.004	43
	2		0.42	0.67	0.791			
	3		0.43	0.67	0.800			
MEDIUM	1	B	0.42	0.67	0.791	0.794	0.004	43
	2		0.43	0.67	0.800			
	3		0.42	0.67	0.791			
HIGH	1	A	0.89	1.38	0.798	0.798	0.000	62
	2		0.89	1.38	0.798			
	3		0.89	1.38	0.798			
HIGH	1	B	0.88	1.37	0.797	0.798	0.001	61
	2		0.88	1.36	0.800			
	3		0.88	1.37	0.797			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.802	0.008
B	0.798	0.004

[PITS-49C.RLO;6/3/96.1545]

PITOT TUBE CALIBRATIONS

PITOT TUBE ID NUMBER- S-50
PITOT TUBE DESCRIPTION- 5', 1" OD, SS
DATE CALIBRATED- 6/3/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.16	0.25	0.810	0.799	0.007	26
	2		0.16	0.26	0.794			
	3		0.16	0.26	0.794			
LOW	1	B	0.16	0.26	0.794	0.789	0.007	26
	2		0.16	0.26	0.794			
	3		0.16	0.27	0.779			
MEDIUM	1	A	0.46	0.69	0.808	0.805	0.004	44
	2		0.46	0.69	0.808			
	3		0.45	0.69	0.799			
MEDIUM	1	B	0.45	0.69	0.799	0.801	0.003	44
	2		0.45	0.68	0.805			
	3		0.45	0.69	0.799			
HIGH	1	A	0.88	1.26	0.824	0.826	0.002	61
	2		0.89	1.27	0.825			
	3		0.89	1.26	0.828			
HIGH	1	B	0.89	1.30	0.816	0.816	0.002	61
	2		0.88	1.29	0.814			
	3		0.89	1.29	0.819			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.810	0.010
B	0.802	0.009

[PITS-50C.RLO;6/4/96.0800]

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Signed	Date	Signed	Date
		MSD	6-14-96

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Table C-3 (Continued)
Post-Test Pitot Tube Calibrations

PITOT TUBE ID NUMBER- S-51
PITOT TUBE DESCRIPTION- 42", 1" OD, SS
DATE CALIBRATED- 6/3/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.17	0.25	0.834	0.823	0.007	27
	2		0.17	0.26	0.818			
	3		0.17	0.26	0.818			
LOW	1	B	0.17	0.26	0.818	0.815	0.003	27
	2		0.17	0.26	0.818			
	3		0.16	0.25	0.810			
MEDIUM	1	A	0.45	0.66	0.817	0.816	0.001	43
	2		0.44	0.65	0.815			
	3		0.44	0.65	0.815			
MEDIUM	1	B	0.45	0.65	0.824	0.821	0.004	44
	2		0.45	0.65	0.824			
	3		0.44	0.65	0.815			
HIGH	1	A	0.88	1.25	0.827	0.827	0.001	61
	2		0.88	1.25	0.827			
	3		0.89	1.26	0.828			
HIGH	1	B	0.89	1.24	0.835	0.832	0.002	61
	2		0.88	1.24	0.830			
	3		0.88	1.24	0.830			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.822	0.004
B	0.823	0.006

[PITS-51C.XLO;6/4/96;0830]

PITOT TUBE CALIBRATIONS

PITOT TUBE ID NUMBER- S-52
PITOT TUBE DESCRIPTION- 42", 1" OD, SS
DATE CALIBRATED- 6/3/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.19	0.28	0.805	0.805	0.000	28
	2		0.19	0.28	0.805			
	3		0.19	0.28	0.805			
LOW	1	B	0.19	0.29	0.791	0.795	0.006	28
	2		0.19	0.28	0.805			
	3		0.19	0.29	0.791			
MEDIUM	1	A	0.44	0.65	0.810	0.809	0.003	43
	2		0.44	0.66	0.804			
	3		0.45	0.66	0.813			
MEDIUM	1	B	0.44	0.65	0.815	0.812	0.003	43
	2		0.44	0.66	0.808			
	3		0.44	0.65	0.815			
HIGH	1	A	0.88	1.26	0.824	0.826	0.001	61
	2		0.88	1.25	0.827			
	3		0.88	1.25	0.827			
HIGH	1	B	0.89	1.29	0.819	0.818	0.001	61
	2		0.88	1.28	0.817			
	3		0.88	1.28	0.817			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.813	0.008
B	0.809	0.009

[PITS-52C.XLO;6/4/96;0845]

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Signed Date Signed Date

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Table C-3 (Continued)
Post-Test Pitot Tube Calibrations

PITOT TUBE ID NUMBER- S-53
PITOT TUBE DESCRIPTION- 10', 1" OD, SS
DATE CALIBRATED- 6/3/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1 2 3	A	0.21 0.20 0.21	0.32 0.32 0.32	0.816 0.797 0.816	0.810	0.009	30
LOW	1 2 3	B	0.20 0.20 0.20	0.31 0.32 0.31	0.810 0.797 0.810	0.805	0.006	29
MEDIUM	1 2 3	A	0.44 0.44 0.43	0.67 0.66 0.66	0.809 0.815 0.806	0.810	0.003	43
MEDIUM	1 2 3	B	0.43 0.43 0.44	0.66 0.65 0.65	0.803 0.809 0.818	0.810	0.005	43
HIGH	1 2 3	A	0.88 0.88 0.88	1.24 1.25 1.25	0.830 0.827 0.827	0.828	0.001	61
HIGH	1 2 3	B	0.88 0.89 0.88	1.26 1.27 1.26	0.824 0.825 0.824	0.824	0.001	61

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.816	0.008
B	0.813	0.007

[PTTS-53C,RLO;[illegible]0900]

PITOT TUBE CALIBRATIONS

PITOT TUBE ID NUMBER- S-54
PITOT TUBE DESCRIPTION- 11', 1" OD, SS
DATE CALIBRATED- 6/3/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1 2 3	A	0.18 0.17 0.17	0.28 0.27 0.27	0.810 0.802 0.802	0.805	0.003	27
LOW	1 2 3	B	0.17 0.17 0.17	0.27 0.26 0.26	0.802 0.818 0.818	0.813	0.007	27
MEDIUM	1 2 3	A	0.43 0.42 0.42	0.66 0.65 0.65	0.806 0.803 0.803	0.804	0.001	43
MEDIUM	1 2 3	B	0.42 0.42 0.42	0.64 0.64 0.64	0.802 0.802 0.802	0.802	0.000	42
HIGH	1 2 3	A	0.85 0.85 0.84	1.27 1.27 1.26	0.810 0.810 0.806	0.809	0.001	60
HIGH	1 2 3	B	0.85 0.85 0.85	1.25 1.25 1.24	0.816 0.816 0.820	0.817	0.001	60

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.806	0.002
B	0.811	0.006

[PTTS-54C,RLO;[illegible]0910]

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6-14-96
Date

Figure C-1

PROJECT 1621-26-23

Shortridge Instruments, Inc.
7855 EAST REDFIELD ROAD SCOTTSDALE, ARIZONA 85260
TELEPHONE (602) 991-6744 FAX (602) 443-1267

CERTIFICATE OF CALIBRATION

INSTRUMENT AirData Multimeter

MODEL ADM-870 SERIAL NO M87129

TEST BY L. Laubmeier DATE 3-9-96

This is to certify that this instrument has been calibrated using instrumentation which is traceable to masters at the National Institute of Standards and Technology. Quality Assurance Program and calibration procedures meet the requirements for 10CFR50, Appendix B; 10CFR21; ANSI/N45.2; and MIL-STD45662A.

CERTIFIED BY Ernest R. Shortridge

Shortridge Instruments, Inc.
7855 EAST REDFIELD ROAD SCOTTSDALE, ARIZONA 85260
TELEPHONE (602) 991-6744 FAX (602) 443-1267

CERTIFICATE OF CALIBRATION

INSTRUMENT AirData Multimeter

MODEL ADM-870 SERIAL NO M89172

TEST BY L. Laubmeier DATE 3-11-96

This is to certify that this instrument has been calibrated using instrumentation which is traceable to masters at the National Institute of Standards and Technology. Quality Assurance Program and calibration procedures meet the requirements for 10CFR50, Appendix B; 10CFR21; ANSI/N45.2; and MIL-STD45662A.

CERTIFIED BY Ernest R. Shortridge

M50

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Date

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Date 5-10-96

Figure C-2

54
PROJECT

16 21-26-23

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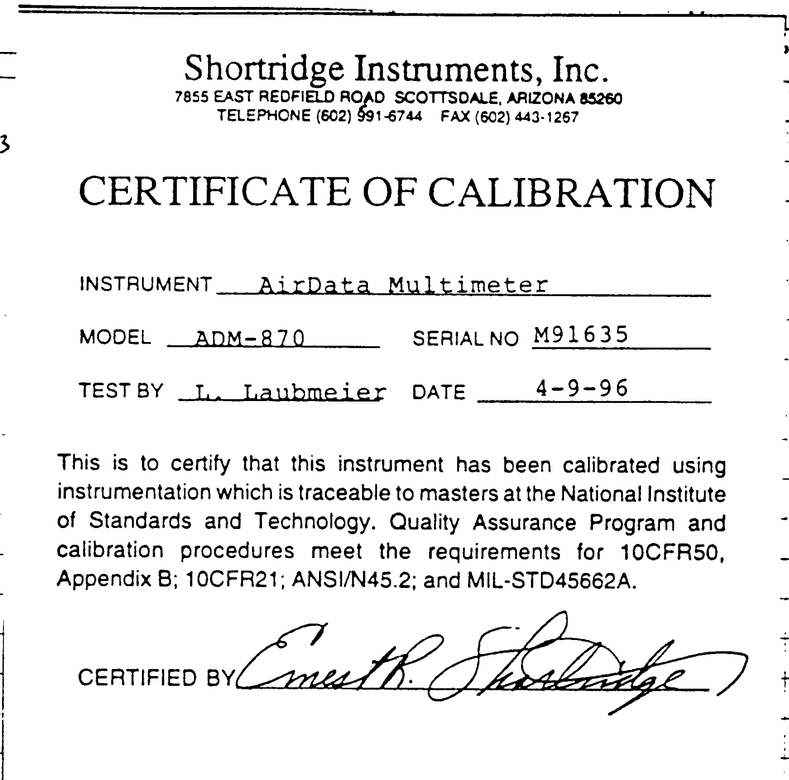


Shortridge Instruments, Inc.

7855 EAST REDFIELD ROAD SCOTTSDALE, ARIZONA 85260
TELEPHONE (602) 991-6744 FAX (602) 443-1267

CERTIFICATE OF CALIBRATION

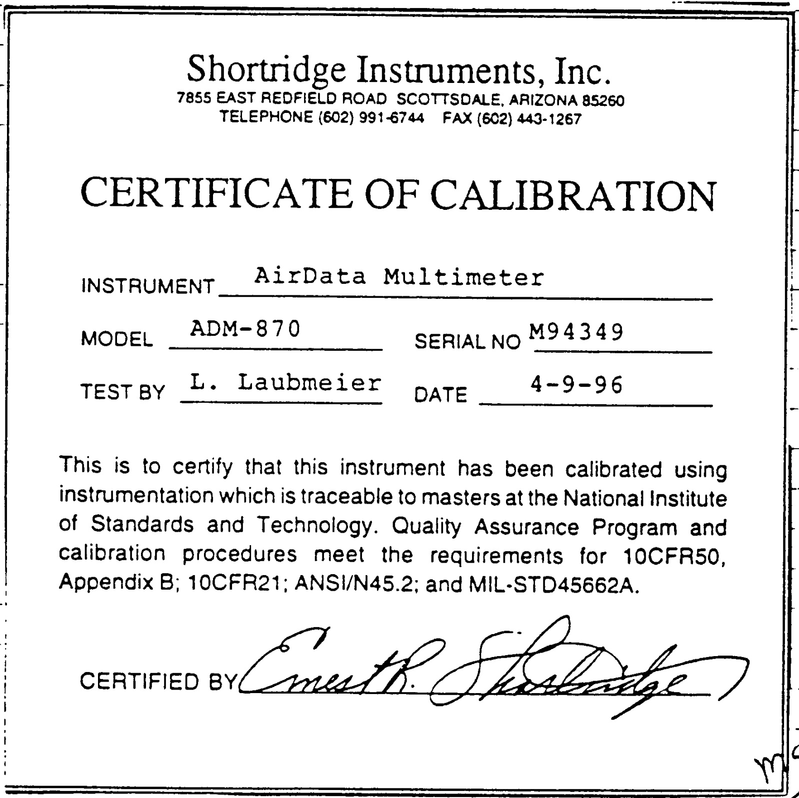
INSTRUMENT AirData Multimeter

MODEL ADM-870 SERIAL NO M91635

TEST BY L. Laubmeier DATE 4-9-96

This is to certify that this instrument has been calibrated using instrumentation which is traceable to masters at the National Institute of Standards and Technology. Quality Assurance Program and calibration procedures meet the requirements for 10CFR50, Appendix B; 10CFR21; ANSI/N45.2; and MIL-STD45662A.

CERTIFIED BY Ernest R. Shortridge



Shortridge Instruments, Inc.

7855 EAST REDFIELD ROAD SCOTTSDALE, ARIZONA 85260
TELEPHONE (602) 991-6744 FAX (602) 443-1267

CERTIFICATE OF CALIBRATION

INSTRUMENT AirData Multimeter

MODEL ADM-870 SERIAL NO M94349

TEST BY L. Laubmeier DATE 4-9-96

This is to certify that this instrument has been calibrated using instrumentation which is traceable to masters at the National Institute of Standards and Technology. Quality Assurance Program and calibration procedures meet the requirements for 10CFR50, Appendix B; 10CFR21; ANSI/N45.2; and MIL-STD45662A.

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Signed	Date	Signed	Date
		MSD	5-10-96

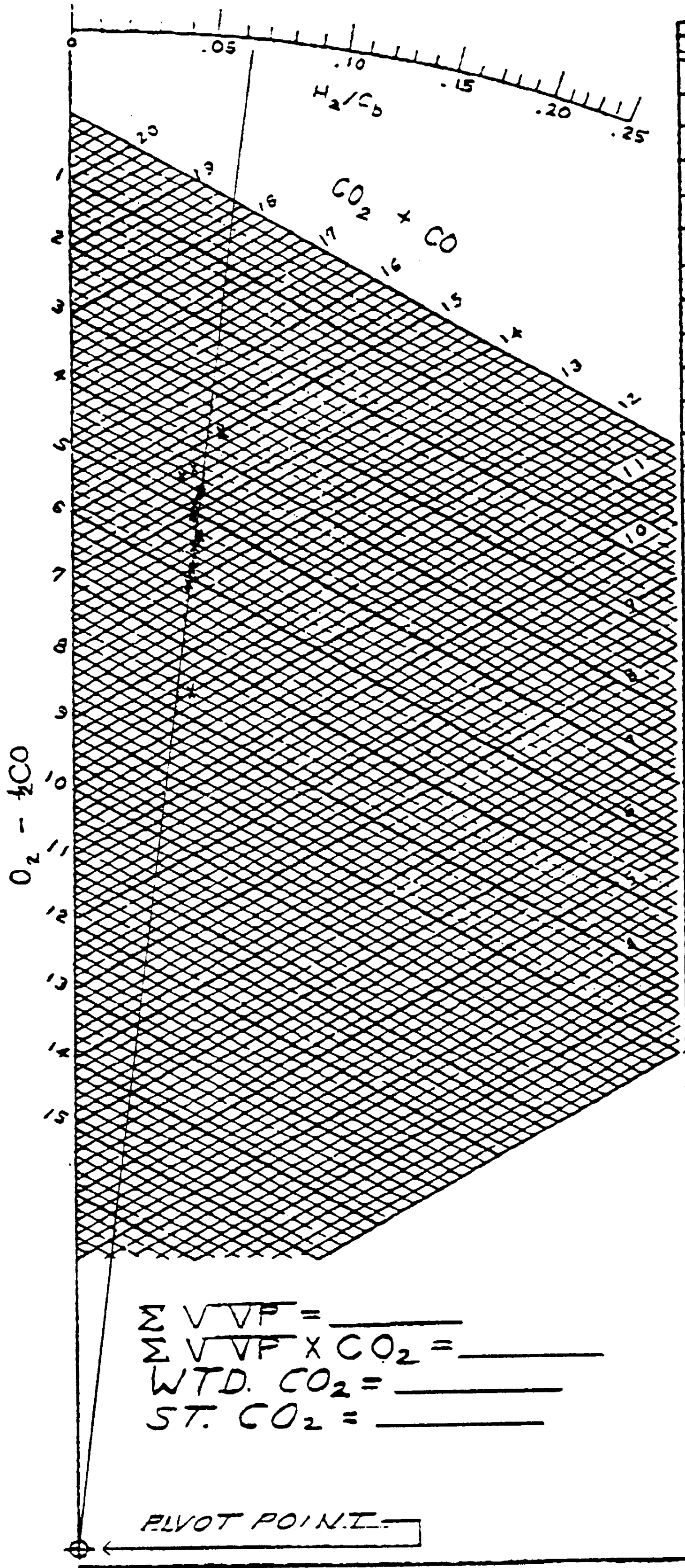
APPENDIX D

ORSAT ANALYSES
FUEL LINE PLOT

Table D-1
Gas Analyses

Location	Date	Time		Orsat				Electronic Gas Analyzer		
				CO2 %	CO2+O2 %	O2 %		CO ppm	O2 %	Combustible %
Flue Gas In	Pre-Test			13.5	18.8	5.3				
				13.6	18.9	5.3				
				13.7	19.1	5.4				
			Avg	13.6		5.3		0	5.3	
Flue Gas To Heat Pipe -- A Side Bag 10	05/14/96	12:50		15.0	18.5	3.5				
				15.0	18.5	3.5				
				15.0	18.5	3.5				
			Avg	15.0		3.5		7	3.6	0.2
Flue Gas From Heat Pipe -- A Side Bag 4	05/14/96	13:00		14.2	19.0	4.8				
				14.2	19.0	4.8				
				14.0	19.0	5.0				
			Avg	14.1		4.9				
Primary Flue Gas Outlet -- A Side Bag 3	05/14/96	14:20		13.0	19.0	6.0				
				13.0	19.2	6.2				
				13.0	19.1	6.1				
			Avg	13.0		6.1		6	6.2	0.1
Primary Flue Gas Outlet -- B Side Bag 5	05/14/96	16:30		13.2	19.0	5.8				
				13.2	19.0	5.8				
				13.2	19.0	5.8				
			Avg	13.2		5.8		8	5.8	0.1
Flue Gas From Heat Pipe - B Side Bag 6	05/14/96	17:30		14.3	18.8	4.5				
				14.3	19.0	4.7				
				14.3	18.9	4.6				
			Avg	14.3		4.6		12	4.6	0.1
Flue Gas To Heat Pipe -- B Side Bag 9	05/14/96	17:40		14.8	19.4	4.6				
				14.7	19.0	4.3				
				14.7	19.2	4.5				
			Avg	14.7		4.5		8	4.4	0.2
Flue Gas To Heat Pipe -- B Side Bag 20	05/15/96	12:30		14.0	19.0	5.0				
				14.0	19.0	5.0				
				13.9	19.0	5.1				
			Avg	14.0		5.0		0	5.2	1.3
Primary Flue Gas Outlet -- B Side Bag 25	05/15/96	14:20		13.5	19.0	5.5				
				13.6	19.0	5.4				
				13.5	19.1	5.6				
			Avg	13.5		5.5		0	5.5	0.4
Primary Flue Gas Outlet -- A Side Bag 23	05/15/96	15:20		11.4	19.0	7.6				
				11.4	19.0	7.6				
				11.4	19.0	7.6				
			Avg	11.4		7.6		0	8	0.4
Flue Gas To Heat Pipe -- A Side Bag 21	05/15/96	16:30		13.5	19.0	5.5				
				13.5	19.0	5.5				
			Avg	13.5		5.5		5	5.5	0.5
Primary Flue Gas Outlet -- A Side Bag 24	05/15/96	16:30		14.8	19.0	4.2				
				14.7	19.0	4.3				
				14.7	19.1	4.4				
			Avg	14.7		4.3		2	4.4	0.4

Figure D-1
Dry Flue Gas Volumetric Combustion Chart



$\Sigma \sqrt{VF}$ = ________

$\Sigma \sqrt{VF} \times CO_2$ = ________

WTD. CO_2 = ________

ST. CO_2 = ________

LOC	$\sqrt{VF}$	CO_2	$+O_2$	O_2	LOC	$\sqrt{VF}$	CO_2	$+O_2$	O_2

SUBJECT

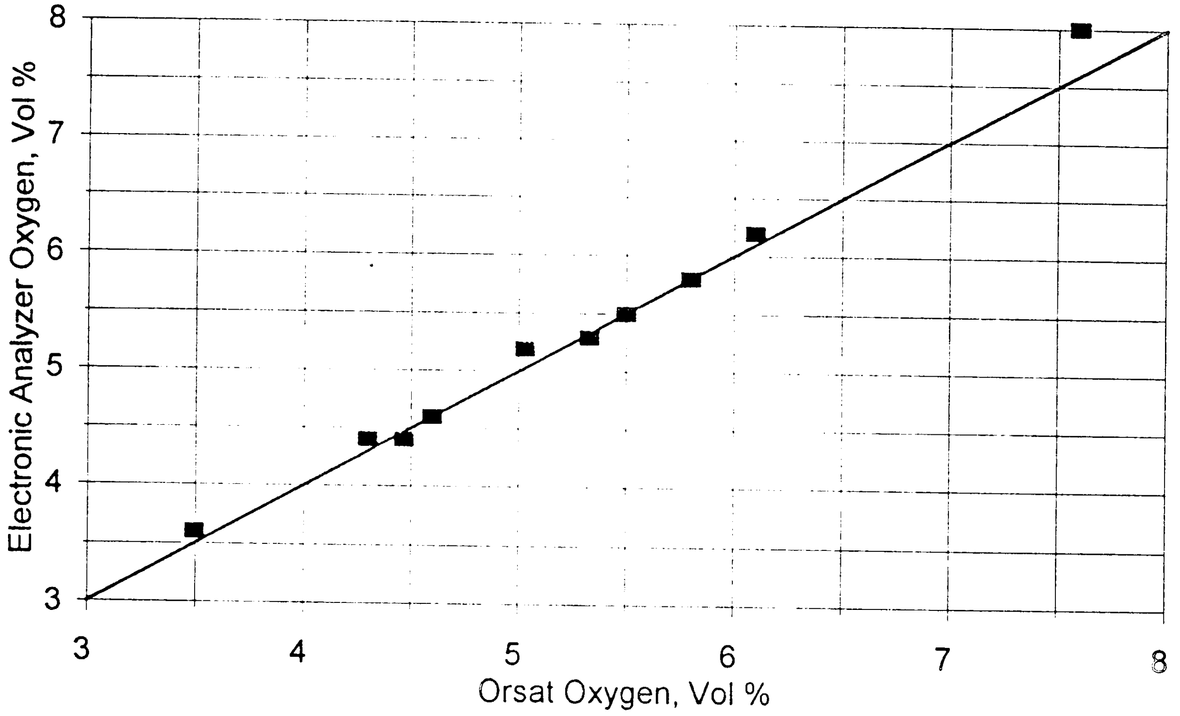
FILE NO.

BY

DATE

TEST NO.

Figure D-2
Comparison - Gas Analyzer Versus Orsat



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APPENDIX E

PITOT TRAVERSE DATA SHEETS

TC-6c

789

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Flue Gas Outlet - (Rectangular Duct)

flow up, A side into flow

Wet 38 °F
Dry 46 °F

Wet 40 °F
Dry 50 °F

Location 2B Flue Gas Out A or [✓ B] Duct
Date 5/13/96
Time Begin 1650-1720 End

TC #2 pendent
Bar., " Hg 29.55
Static, " H2O

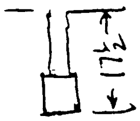
Tube I.D. 5-51
C-Factor 0.824
Operator(s) RLO, FUZ

No. Points 24
Duct Width 34 ft
Duct Height 2.5 ft
Duct Area 85.00 Sq ft

Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

[redacted]

PORT/ POINT	DISTANCE near " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	7-1/2"	278	0.2583				
A-2	22-1/2"	279	0.3175				
B-1	7-1/2"	278	0.3887				
B-2	22-1/2"	279	0.4128				
C-1	7-1/2"	277	0.5531				
C-2	22-1/2"	277	0.5860				
[illegible]	7-1/2"	274	0.4650				
D-2	22-1/2"	274	0.5142				
E-1	7-1/2"	272	0.4972				
E-2	22-1/2"	272	0.3719				
F-1	7-1/2"	272	0.2557				
F-2	22-1/2"	273	0.3368				
G-1	7-1/2"	274	0.7592				
G-2	22-1/2"	274	0.7789				
H-1	7-1/2"	274	0.8336				
H-2	22-1/2"	275	0.9975				
I-1	7-1/2"	272	0.7315				
I-2	22-1/2"	273	0.6902				
J-1	7-1/2"	268	0.6435				
J-2	22-1/2"	266	0.6196				
K-1	7-1/2"	268	0.4001				
K-2	22-1/2"	266	0.4886				
L-1	7-1/2"						
L-2	22-1/2"						



Static -1337

Static -13.33

Port A = ~~South~~ N, L = ~~North~~ S

273 279 - 266 σ = 4.

Sampling Notes:

Vel = 47.25 fpm 47.48
iCFM = 240,979 242 126
SCFM = 163,294 164080
lb/hr = 766,235 770434

DSCFM = 151401 152548

File: FGOTPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: 2B Flue Gas Outlet
Date: 5/13/96
Start Time: 1650 Stop Time: 1720
Unit ID: 2B Duct ID: Flue Gas Outlet
Testers: RIO - FUZ

Pitot ID S-51 Cp 0.824 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? RIO, FUZ Condition? OK

Leak Check of System? ✓ By Whom? RIO, FUZ Condition? OK

Dp Gauge ID M94349 Static Pressure Gauge ID M94348

TC ID 6C Handheld TC Readout ID 2

Barometer ID

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Flue Gas Outlet - (Rectangular Duct)

791

TC- 7B

Location 2A -Flu Gas [✓ A] or B Duct
Date 5-13-96
Time Begin 1645 End 1730

Bar., " Hg 29.55
Static, " H2O -14.00

Tube I.D. S-52
C-Factor 0.798
Operator(s) MSO/ SAW LGR
No. Points 24
Duct Width 34 ft
Duct Height 2.5 ft
Duct Area 85.00 Sq ft

Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	7-1/2"	282	0.8820				
A-2	22-1/2"	290	0.7354				
B-1	7-1/2"	283	0.6726				
B-2	22-1/2"	283	0.6988				
C-1	7-1/2"	281	0.9361				
C-2	22-1/2"	281	0.8498				
D-1	7-1/2"	291	0.8426				
D-2	22-1/2"	289	0.8002				
E-1	7-1/2"	285	0.7297				
E-2	22-1/2"	289	0.7899				
F-1	7-1/2"	285	0.8227				
F-2	22-1/2"	290	0.6916				
G-1	7-1/2"	286	0.5265				
G-2	22-1/2"	290	0 4115				
H-1	7-1/2"	292	0.5169				
H-2	22-1/2"	291	0.5207				
I-1	7-1/2"	298	0.5501				
I-2	22-1/2"	301	0.5262				
J-1	7-1/2"	305	0.5587				
J-2	22-1/2"	305	0.5754				
K-1	7-1/2"	305	0.6269				
K-2	22-1/2"	305	0.4952				
L-1	7-1/2"	305	0.5449				
L-2	22-1/2"	303	0.5710				

Port A = ~~South~~ N, L = ~~North~~ S 292

Sampling Notes:

Vel =	51.98	51.95
ACFM =	~~264,979~~	264,921
SCFM =	174,798	174,694
lb/HR =	820,213	820699
DSCFM =	162067	162459

File: FGOTPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: milliken
Date: 5/17/96
Start Time: 1645 Stop Time: 1730
Unit ID: 2 Duct ID:
Testers: MSD / JAW / LLA

Pitot ID S-52 Cp 0.798 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? MSD Condition? OK

Leak Check of System? ✓ By Whom? MSD Condition? OK

Dp Gauge ID ADM Static Pressure Gauge ID ADM

TC ID 7B Handheld TC Readout ID ONE

Barometer ID ONE

Leak Check of Gas Sampling System? NA By Whom? Condition?

Gas Meter ID ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Secondary Air Bypass - (Rectangular Duct)

793

TC wire 2B
TC readout 1

Location [✓ A] or ~~B Duct~~
Date 5/14/96
Time Begin 0940 End 1030
Bar., " Hg 29.74
Static, " H2O 3.695

Tube I.D. S-53
C-Factor 0.808
Operator(s) RW, Faz
No. Points 8
Duct Width 17.5 ft
Duct Height 2.09 ft
Duct Area 36.64 Sq ft
Amb Air DB, deg F ____
Amb Air WB, deg F ____
Humd, lb/lb BD Air ____

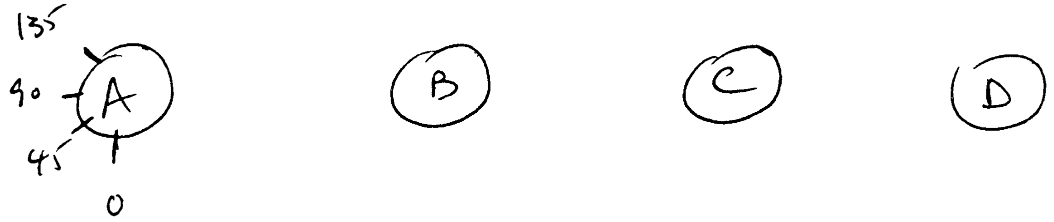
PORT/ POINT	DISTANCE Far From Wall	TEMP Deg-F	DELTA P [" H2O]	0°	45°	90°	135°	Static
A-1	6-5/16"		232	-0.0001	0.0000	-0.0001	0.0000	3.724
A-2	18-7/8"		232	0.0000	0.0001	0.0000	0.0000	—
B-1	6-5/16"		219	0.0000	-0.0001	0.0000	0.0000	3.648
B-2	18-7/8"		220	-0.0001	0.0000	+0.0001	0.0001	—
C-1	6-5/16"		215	-0.0001	0.0000	0.0000	0.0000	—
C-2	18-7/8"		213	0.0000	0.0000	0.0000	0.0001	3.688
D-1	6-5/16"		209	-0.0001	0.0000	0.0000	0.0000	—
D-2	18-7/8"		206	0.0000	0.0000	0.0000	0.0000	3.721

Port A = South, D = North

Sampling Notes:

File: SA-BPTPL.WQ2

09-May-96



194

Method 2 QA/QC Checklist

Plant: 2A 2nd Air Bypass
Date: 5/14/96
Start Time: 0940 Stop Time: 1030
Unit ID: 2A Duct ID: 2nd Air Bypass
Testers: Rro, FUZ

Pitot ID S-53 Cp 0.808 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? RO, FUZ Condition? OK

Leak Check of System? ✓ By Whom? RO, FUZ Condition? OK

Dp Gauge ID M94349 Static Pressure Gauge ID M94349

TC ID 2B Handheld TC Readout ID 1

Barometer ID

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Flue Gas Inlet - (Rectangular Duct)

Location [✓ A] or ~~B Duct~~

Date 5/14/96

Time Begin 1220 End 1320

Bar., " Hg 29.74

Static, " H2O -9.269

Tube I.D. S-53

No. Points 20

C-Factor 0.808

Duct Width 14.5 ft

Operator(s) Rio, Fuz

Duct Height 5.5 ft

Duct Area 79.75 Sq ft

Amb Air DB, deg F

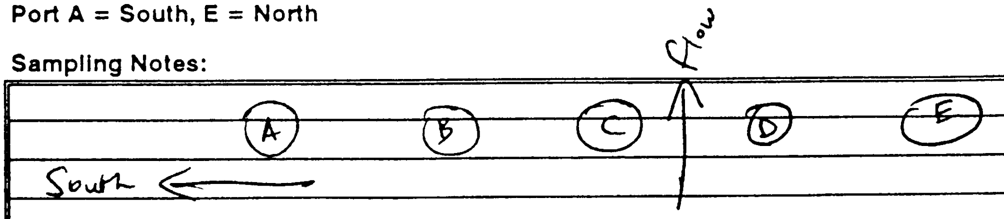
Amb Air WB, deg F

Humd, lb/lb BD Air

PORT/ POINT	DISTANCE " ~~From~~ far Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.	Static
A-1	8-1/4"	696	0.7277	3.6	15.15	15	0.1	
A-2	24-3/4"	700	0.8552	4.0	14.8	6	0.1	-9.209
A-3	41-1/4"	697	0.7826	3.9	14.9	6	0.1	
A-4	57-3/4"	686	0.7646	3.7	15.05	7	0.1	
B-1	8-1/4"	655	0.7867	3.0	15.7	5	0.1	
B-2	24-3/4"	661	1.064	3.4	15.3	6	0.1	
B-3	41-1/4"	667	0.9219	3.9	14.9	5	0.1	-9.215
B-4	57-3/4"	669	0.9460	4.5	14.3	5	0.1	
C-1	8-1/4"	663	0.7935	3.1	15.6	5	0.1	
C-2	24-3/4"	659	1.124	3.4	15.3	2	0.1	-9.230
C-3	41-1/4"	653	1.004	3.6	15.15	3	0.1	← 928 by #70
C-4	57-3/4"	656	0.8974	3.9	14.9	4	0.1	
D-1	8-1/4"	684	0.7711	3.5	15.2	2	0.1	
D-2	24-3/4"	673	1.068	3.6	15.15	2	0.1	
D-3	41-1/4"	663	1.017	3.7	15.05	2	0.1	-9.384
D-4	57-3/4"	661	0.9340	4.0	14.8	2	0.1	
E-1	8-1/4"	702	0.7441	3.8	14.95	2	0.1	
E-2	24-3/4"	687	0.8996	3.8	14.95	2	0.1	
E-3	41-1/4"	673	0.8815	3.8	14.95	1	0.1	-9.306
E-5	57-3/4"	661	0.8609	3.9	14.90	2	0.1	

Port A = South, E = North

Sampling Notes:



A side into flow

File FGITPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: Milliken
Date: 5/14/96
Start Time: 1220 Stop Time: 1320
Unit ID: 2A Duct ID: Flue Gas Inlet
Testers: RWO, FVB

Pitot ID S-53 Cp 0.808 Calibration Date 5/96

Pitot Opening Checked? OK By Whom? RWO, FVB Condition? OK

Leak Check of System? OK By Whom? RWO, FVB Condition? OK

Dp Gauge ID M94349 Static Pressure Gauge ID M94349

TC ID 2B Handheld TC Readout ID 2

Barometer ID

Leak Check of Gas Sampling System? OK By Whom? RWO, FVB Condition? OK

Gas Meter ID 154949 ORSAT Bag ID 10

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Flue Gas Outlet - (Rectangular Duct)

797

Location ________ [✓ A] or B Duct
Date 5-14-96
Time Begin 1220 End 13:15
Bar., " Hg 29.75
Static, " H2O -13.93 "WC

Tube I.D. S-52
C-Factor 0.798
Operator(s) MSD
No. Points 24
Duct Width 34 ft
Duct Height 2.5 ft
Duct Area 85.00 Sq ft
Amb Air DB, deg F ________
Amb Air WB, deg F ________
Humd, lb/lb BD Air ________

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	7-1/2"	290	0.8734	4.3	14.5	1	
A-2	22-1/2"	293	0.7064	4.2	14.65	0	
B-1	7-1/2"	293	0.6432	4.1	14.7	1	
B-2	22-1/2"	293	0.6759	4.2	14.65	1	
C-1	7-1/2"	291	0.8642	4.2	14.65	2	
C-2	22-1/2"	290	0.8341	4.2	14.65	2	
D-1	7-1/2"	292	0.8280	4.1	14.7	2	
D-2	22-1/2"	291	0.7919	4.2	14.65	2	
E-1	7-1/2"	291	0.6506	4.2	14.65	3	
E-2	22-1/2"	293	0.7634	4.1	14.7	2	
F-1	7-1/2"	291	0.8046	4.3	14.5	4	
F-2	22-1/2"	293	0.6543	4.1	14.7	3	
G-1	7-1/2"	289	0.4858	4.2	14.65	1	
G-2	22-1/2"	290	0.3909	4.2	14.65	1	
H-1	7-1/2"	292	0.4633	4.2	14.65	2	
H-2	22-1/2"	291	0.5263	4.2	14.65	2	
I-1	7-1/2"	297	0.5490	4.1	14.7	2	
I-2	22-1/2"	296	0.5029	4.1	14.7	4	
J-1	7-1/2"	301	0.585	3.9	14.9	4	
J-2	22-1/2"	301	0.6084	4.0	14.8	3	
K-1	7-1/2"	302	0.5340	4.4	14.45	3	
K-2	22-1/2"	302	0.5852	4.4	14.45	3	—
L-1	7-1/2"	302	0.5614	4.4	14.45	4	—
L-2	22-1/2"	300	0.5654	4.7	14.2	5	—

* O2 Cal

Port A = ~~South~~ Nort, L = ~~North~~ Sou

Sampling Notes:

T/C #7B

Point #1 = ~~Nearest~~ Far Wall

Orsat Bay #4

File: FGOTPL.WQ2

09-May-96

M98

Method 2 QA/QC Checklist

Plant: Milliken
Date: 5-14-96
Start Time: ______ Stop Time: ______
Unit ID: 2 Duct ID: Flue Gas Outlet - A
Testers: MSP GC

Pitot ID S-52 Cp 0.798 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? MSP Condition? OK

Leak Check of System? ✓ By Whom? MSP Condition? OK

Dp Gauge ID AD -1 Static Pressure Gauge ID AD-1

TC ID 7B Handheld TC Readout ID ONE

Barometer ID ONE

Leak Check of Gas Sampling System? ✓ By Whom? MSP Condition? OK

Gas Meter ID TSS- A ORSAT Bag ID 4

QA/QC Check List:

Proper sampling points identified? Yes
Pitot orientation properly marked? Yes
Reference point for pitot depth marked? Yes
Pitot leak check? Yes
Gas sampling system leak check? Yes
Gas Meter Calibrated? Yes
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? Yes
Proper probe orientation while traversing? Yes
Process at steady state prior to testing? ______

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Primary Flue Gas Outlet - (Rectangular Duct)

799

Location [✓ A] or B Duct

Date 5/14

Time Begin 1400 End 1440

Tube I.D. ~~S-22~~ S-52 No. Points 14

C-Factor 0.798 Duct Width 17.92 ft

Operator(s) GLC MJD Duct Height 3.28 ft

Duct Area 58.79 Sq ft

Bar., " Hg

Static, " H2O -12.92" wc 5/14/9 1:50pm

Amb Air DB, deg F 64 62

Amb Air WB, deg F 50 48

Humd, lb/lb BD Air

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB. <1%
A-1	9-7/8"	288	0.0600	5.3	13.72	2	
A-2	29-9/16"	291	0.0427	4.9	14.02	2	
B-1	9-7/8"	290	0.0610	4.7	14.2	2	
B-2	29-9/16"	302	0.0309	3.4	15.3	2	
C-1	9-7/8"	285	0.0192	5.7	13.30	1	
C-2	29-9/16"	298	0.0172	5.4	13.55	0	
D-1	9-7/8"	288	0.0415	4.4	14.45	0	
D-2	29-9/16"	300	0.0234	5.4	13.54	0	
E-1	9-7/8"	288	0.0463	5.6	13.35	0	
E-2	29-9/16"	302	0.0312	4.2	14.65	0	
F-1	9-7/8"	291	0.0546	4.4	14.45	0	
F-2	29-9/16"	298	0.0224	5.1	13.45	0	
G-1	9-7/8"	290	0.0485	4.7	14.2	2	
G-2	29-9/16"	292	0.0163	4.5	14.3	1	

→ GAS Bag #3

Port A = South, L = North

Sampling Notes:

File: PFGOTPL.WQ2

09-May-96

800

Method 2 QA/QC Checklist

Plant: Milliken Unit 2
Date: 5-14-96
Start Time: ______ Stop Time: ______
Unit ID: ______ Duct ID: Flue Gas
Testers: MSP GLC

Pitot ID S-52 Cp 0.798 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? MSP Condition? OK

Leak Check of System? ✓ By Whom? MSP Condition? OK

Dp Gauge ID (1) Static Pressure Gauge ID (1)

TC ID 7B Handheld TC Readout ID ONE

Barometer ID ______

Leak Check of Gas Sampling System? ✓ By Whom? MS Condition? OK

Gas Meter ID TSS 1 ORSAT Bag ID 3

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Inlet - (Rectangular Duct)

Location A A or B Duct
Date 5/14/96
Time Begin 14:15 End 14:50

Tube I.D. 5 - 50
C-Factor 0.788
Operator(s) JHW & LLA

No. Points 12
Duct Width 17.5 ft
Duct Height 3.28 ft
Duct Area 57.42 Sq ft

Bar., " Hg 29.74 5/14/96
Static, " H2O +53.44 1:50 pm
NEW OLD
Amb Air DB, deg F 64 62
Amb Air WB, deg F 50 48
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	9-7/8"	111.0	-0.0006
A-2	29-9/16"	111.5	0.0022
B-1	9-7/8"	110.4	0.0361
B-2	29-9/16"	110.6	0.0117
C-1	9-7/8"	109.9	0.0593
C-2	29-9/16"	110.6	0.0101
D-1	9-7/8"	110.4	0.0298
D-2	29-9/16"	[illegible]	[illegible]
E-1	9-7/8"	110.4	0.0469
E-2	29-9/16"	111.7	0.0087
F-1	9-7/8"	109.9	0.1432
F-2	29-9/16"	111.0	0.0293

14:25

* see below

61
29
31

Port A = South, F = North

Sampling Notes:

* Point D-2: Unable to take point due to I-beam blocking port. Opening cut in I-beam not large enough.

802

Method 2 QA/QC Checklist

Plant: Milliken
Date: May 14
Start Time: 14:15 Stop Time: 14:50
Unit ID: Unit 2 Duct ID: 2A PRIMARY AIR INLET
Testers: JAW & LLA

Pitot ID 550 Cp 0.788 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? LLA Condition? OK

Leak Check of System? ✓ By Whom? JAW Condition? OK 8"

Dp Gauge ID M91635 Static Pressure Gauge ID (same as ODA)

TC ID 5A Handheld TC Readout ID THREE

Barometer ID ______

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓ per DCM

803

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Outlet - (Circular Duct)

Location [✓ A] ~~or B Duct~~
Date 5/14/96
Time Begin 1345 End 1430

Bar., " Hg 29.74
Static, " H2O 48.80

Tube I.D. S-49 No. Points 20
C-Factor 0.806
Operator(s) PW, FW Duct Dia. 47.5 inches
Duct Area 12.31 Sq ft

Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

5/14/96
1:50 pm
NEW OLD
64 62
50 48

no cyclonic flow

PORT/ POINT	DISTANCE Far From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	1-3/16"	586	0.2126
A-2	3-7/8"	587	0.2684
A-3	6-15/16"	588	0.2936
A-4	10-3/4"	589	0.3452
A-5	16-1/4"	590	0.3123
A-6	31-1/4"	590	0.4194
A-7	36-3/4"	590	0.4181
A-8	40-9/16"	589	0.4136
A-9	43-5/8"	589	0.3844
A-10	46-5/16"	588	0.3230
B-1	1-3/16"	593	0.3239
B-2	3-7/8"	593	0.3754
B-3	6-15/16"	594	0.3934
B-4	10-3/4"	594	0.3661
B-5	16-1/4"	595	0.4030
B-6	31-1/4"	595	0.3191
B-7	36-3/4"	594	0.2885
B-8	40-9/16"	593	0.2493
B-9	43-5/8"	591	0.2338
B-10	46-5/16"	588	0.1909

Static

48.85 static

A — flow down

B

South

no cyclonic flow

48.74 - static

"A" pitot into stream flow

→ no cyclonic flow

Port A = South or North, B = East

Sampling Notes:

File PAOTPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: 2A Primary Air Outlet
Date: 5/14/95
Start Time: 1345 Stop Time: 1430
Unit ID: 2A Duct ID: Primary Air Outlet
Testers: RW, FWZ

Pitot ID S-49 Cp 0.806 Calibration Date 5/96

Pitot Opening Checked? OK By Whom? RW Condition? OK

Leak Check of System? OK By Whom? RW, FWZ Condition? OK

Dp Gauge ID M 94349 Static Pressure Gauge ID M 94349

TC ID 4A Handheld TC Readout ID 2

Barometer ID

Leak Check of Gas Sampling System? ~~OK~~ NA By Whom? ~~RW~~ NA Condition? ~~OK~~ NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Secondary Air Bypass - (Rectangular Duct)

TC readout #1
TC wire #2B

Location ________ A or [✓ B] Duct
Date 5/14/96
Time Begin 0845 End 0935
Bar., " Hg 29.74
Static, " H2O 3.720

Tube I.D. S-53
C-Factor 0.808
Operator(s) Rlo, Fuz
No. Points 8
Duct Width 17.5 ft
Duct Height 2.09 ft
Duct Area 36.64 Sq ft
Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE (Far) From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	6-5/16"	120	
A-2	18-7/8"	118	
B-1	6-5/16"	95	
B-2	18-7/8"	104	
C-1	6-5/16"	109	
C-2	18-7/8"	127	
D-1	6-5/16"	146	
D-2	18-7/8"	153	

Port A = South, D = North

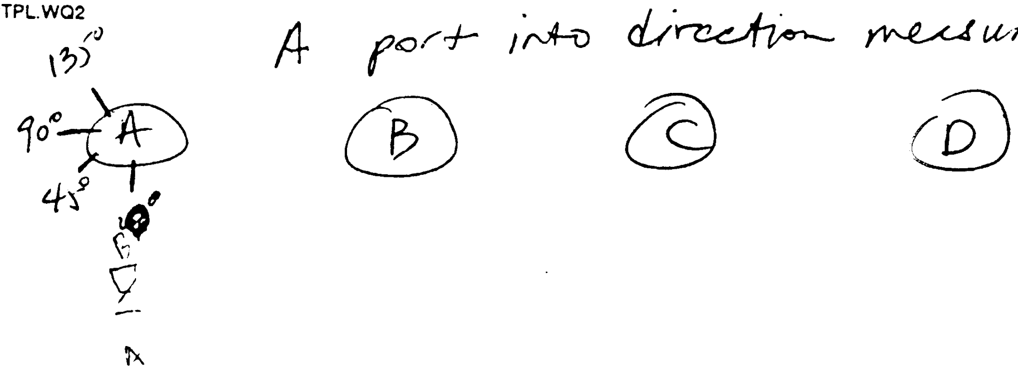
0° Straight	45°	90°	135°	Static
0.0000	0.0004	0.0003	-0.0003	4.481
-0.0002	-0.0003	-0.0004	0.0004	—
0.0017	0.0009	-0.0002	-0.0015	—
0.0003	-0.0006	-0.0019	-0.0015	3.3
-0.0001	0.0002	-0.0002	-0.0002	—
0.0000	-0.0001	-0.0003	-0.0001	3.53
0.0000	-0.0001	-0.0001	-0.0009	3.56
0.0000	-0.0002	-0.0002	0.0000	—

Sampling Notes:

File: SA-BPTPL.WQ2

09-May-96

A port into direction measured



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Method 2 QA/QC Checklist

Plant: 2B 2nd Air Bypass
Date: 5/14/96
Start Time: 0845 Stop Time: 0935
Unit ID: 2B Duct ID: 2nd Air Bypass
Testers: RLO, FVZ

Pitot ID S-53 Cp 0.808 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? RLO, FVZ Condition? OK

Leak Check of System? ✓ By Whom? RLO, FVZ Condition? OK

Dp Gauge ID M94349 Static Pressure Gauge ID M94349

TC ID 2B Handheld TC Readout ID 1

Barometer ID ______

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Secondary Air Outlet - (Rectangular Duct)

Location A A or B Duct

Date May 14 1996

Time Begin 12:23 End 13:16

Bar., " Hg 29.74

Static, " H2O +1,973

Tube I.D. S-54

No. Points 24

C-Factor 0.848

Duct Width 6.0 ft

Operator(s) JAW LCA

Duct Height 9.0 ft

Duct Area 54.00 Sq ft

Amb Air DB, deg F 95.7 °F

Amb Air WB, deg F

Humd, lb/lb BD Air

	PORT/ POINT	DISTANCE From ~~Wall~~ Bottom	TEMP Deg-F	DELTA P [" H2O]
12:23	A-1	9"	602.7	0.7361
	A-2	27"	603.1	0.8396
	A-3	45"	602.2	0.8180
	A-4	63"	602.4	0.6702
	A-5	81"	600.0	0.5907
12:33	A-6	99"	595.9	0.7854
12:44	B-1	9"	608.3	0.9801
	B-2	27"	610.7	0.9652
	B-3	45"	613.0	0.8031
	B-4	63"	615.3	0.7182
	B-5	81"	612.3	0.7579
12:53	B-6	99"	602.4	0.7033
12:56	C-1	9"	603.1	0.9273
	C-2	27"	611.7	1.066
	C-3	45"	617.3	0.7930
	C-4	63"	622.4	0.7916
	C-5	81"	623.6	0.9004
13:05	C-6	99"	620.7	1.058
13:09	D-1	9"	596.8	0.7731
	D-2	27"	607.1	0.9814
	D-3	45"	615.2	0.8351
	D-4	63"	621.3	0.8593
	D-5	81"	623.3	0.7635
13:16	D-6	99"	622.9	1.052

Port A = South, D = North

Sampling Notes:

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Method 2 QA/QC Checklist

Plant: Milliken Unit 2
Date: May 14, 1996
Start Time: ______ Stop Time: ______
Unit ID: Unit 2 Duct ID: ______
Testers: JA Withum L.L. Anthony

Pitot ID 5-54 Cp 0.816 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? LLA & JAW Condition? OK

Leak Check of System? ✓ By Whom? LLA & JAW Condition? -4.5" VAC. Recheck @ 7" VAC OK

Dp Gauge ID M91635 Static Pressure Gauge ID [illegible] 8WG

TC ID 3-A Handheld TC Readout ID THREE

Barometer ID 29.74

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓ per DCM

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NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Flue Gas Inlet - (Rectangular Duct)

#9 Gas Bag

Location ~~A~~ or [✓ B] Duct

Date 5/14/96

Time Begin 1705 End 18:40

Bar., " Hg 29.68

Static, " H2O -9.351

Tube I.D. S-53

C-Factor 0.808

Operator(s) RO, FWZ

No. Points 20

Duct Width 14.5 ft

Duct Height 5.5 ft

Duct Area 79.75 Sq ft

Amb Air DB, deg F

Amb Air WB, deg F

Humd, lb/lb BD Air

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.	Static
A-1	8-1/4"	667	0.7616	6.8	12.35	1	0.2	
A-2	24-3/4"	663	0.8729	6.0	13.05	1	0.2	
A-3	41-1/4"	667	0.8471	5.5	13.50	1	0.2	-9.305
A-4	57-3/4"	674	0.6765	~~8.2~~ 4.4	14.45	1	0.2	
B-1	8-1/4"	668	0.7248	3.6	15.15	2	0.1	
B-2	24-3/4"	663	1.006	3.7	15.05	2	0.1	
B-3	41-1/4"	659	0.9792	3.9	14.9	2	0.1	←
B-4	57-3/4"	668 ~~805~~	0.8050	4.3	14.5	3	0.1	-9.193
C-1	8-1/4"	662 ~~655~~	0.7236 ~~0.8580~~	4.2	14.65	4	0.1	
C-2	24-3/4"	656	0.9473	4.7	14.2	4	0.1	
C-3	41-1/4"	652	0.8964	3.8	14.95	3	0.2	← -9.4
C-4	57-3/4"	655	0.8580	4.2	14.65	3	0.1	gas bag #9
D-1	8-1/4"	688	0.7278	7.5	11.7	4	0	
D-2	24-3/4"	689	0.8947	7.8	11.45	3	0	←
D-3	41-1/4"	690	0.8915	6.1	12.95	3	0	-9.43
D-4	57-3/4"	682	0.8802	6.1	12.95	3	0	
E-1	8-1/4"	723	0.4202	5.0	13.95	4	0	
E-2	24-3/4"	724	0.5619	5.9	13.1	5	0	
E-3	41-1/4"	714	0.748	5.8	13.2	3	0	← -9.40
E-5	57-3/4"	686	0.9025	5.1	13.85	3	0	

Port A = South, E = North

Sampling Notes:

(A) (B) (C) (D) (E)

← South ↑ flow Δ pitot into flow

Co cal on 100 ppm prior to test

File FGITPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: 2B Flue Gas Inlet
Date: 5/14/96
Start Time: 1705 Stop Time: 1840
Unit ID: 2B Duct ID: Flue Gas Inlet
Testers: RW, FuZ

Pitot ID S-53 Cp 0.808 Calibration Date 5/96

Pitot Opening Checked? OK By Whom? RW Condition? OK

Leak Check of System? OK By Whom? RW Condition? OK

Dp Gauge ID M94349 Static Pressure Gauge ID M94349

TC ID 2B Handheld TC Readout ID 2

Barometer ID ________

Leak Check of Gas Sampling System? OK By Whom? RW Condition? OK

Gas Meter ID #154949 ORSAT Bag ID #9 (9)

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

8/11

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Flue Gas Outlet - (Rectangular Duct)

Location ____ A or [✓ B Duct]

Date 5/14

Time Begin 1715 End 1800

Bar., " Hg 29.68

Static, " H2O -13.85 "WC

Tube I.D. 552

No. Points 24

C-Factor 0.798

Duct Width 34 ft

Duct Height 2.5 ft

Duct Area 85.00 Sq ft

Operator(s) mso GLL

Amb Air DB, deg F ____

Amb Air WB, deg F ____

Humd, lb/lb BD Air ____

0.3044 →

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	7-1/2"						
A-2	22-1/2"						
B-1	7-1/2"	282	0.3044	4.5	14.3	3	
B-2	22-1/2"	282	0.3184	4.6	14.25	3	
C-1	7-1/2"	282	0.4246	4.6	14.25	3	
C-2	22-1/2"	282	0.4419	4.5	14.3	3	
D-1	7-1/2"	281	0.5977	4.4	14.45	2	
D-2	22-1/2"	282	0.6179	4.5	14.3	3	
E-1	7-1/2"	280	0.5298	4.5	14.3	1	
E-2	22-1/2"	280	0.5348	4.6	14.25	1	
F-1	7-1/2"	280	0.4140	4.6	14.25	0	
F-2	22-1/2"	280	0.5449	4.3	14.5	0	
G-1	7-1/2"	280	0.3303	4.5	14.3	1	
G-2	22-1/2"	280	0.3020	4.6	14.25	0	
H-1	7-1/2"	280	0.8070	4.2	14.45	0	
H-2	22-1/2"	281	0.8227	4.3	14.50	0	
I-1	7-1/2"	280	0.9855	4.4	14.45	0	
I-2	22-1/2"	280	0.8914	4.3	14.50	0	
J-1	7-1/2"	280	0.6863	4.5	14.3	1	
J-2	22-1/2"	279	0.7863	4.5	14.3	0	
K-1	7-1/2"	277	0.6303	4.6	14.25	2	
K-2	22-1/2"	278	0.8159	4.6	14.25	1	
L-1	7-1/2"	277	0.5471	4.8	14.1	0	
L-2	22-1/2"	278	0.4477	4.7	14.2	2	

← GAS BA #6

Port A = ~~South~~ N, L = ~~North~~ S

Sampling Notes:

File: FGOTPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: Milliken
Date: 5/14/96
Start Time: 1715 Stop Time: 1800
Unit ID: #2 Duct ID: F.G. OUTLET – B
Testers: GLC-MSD

Pitot ID ~~0.520''~~ 552 Cp 0.798 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? MSD Condition? GOOD

Leak Check of System? ✓ By Whom? MSD Condition? GOOD

Dp Gauge ID #1 Static Pressure Gauge ID #1

TC ID #7B Handheld TC Readout ID #1

Barometer ID ______

Leak Check of Gas Sampling System? ✓ By Whom? MSD Condition? OK

Gas Meter ID TSS-A ORSAT Bag ID #6

QA/QC Check List:

Proper sampling points identified? YES
Pitot orientation properly marked? YES
Reference point for pitot depth marked? YES
Pitot leak check? YES
Gas sampling system leak check? YES
Gas Meter Calibrated? YES
Safety equipment utilized? YES
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? YES
Proper probe orientation while traversing? YES
Process at steady state prior to testing? ✓

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NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Flue Gas Outlet - (Rectangular Duct)

Location ______ A or [✓ B] Duct
Date 5/14
Time Begin 1610 End 1645
Bar., " Hg 29.68"
Static, " H2O -12.39"WC

Tube I.D. S-5L
C-Factor 0.798
Operator(s) MSD
GLC
No. Points 14
Duct Width 17.92 ft
Duct Height 3.28 ft
Duct Area 58.79 Sq ft
Amb Air DB, deg F ______
Amb Air WB, deg F ______
Humd, lb/lb BD Air ______

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	9-7/8"	264	0.0595	7.4	11.85	0	
A-2	29-9/16"	263	0.0157	7.2	12.0	0	
B-1	9-7/8"	271	6.0309	6.3	12.75	0	
B-2	29-9/16"	277	0.0297	5.3	13.72	0	
C-1	9-7/8"	270	0.0410	6.4	12.70	0	
C-2	29-9/16"	273	0.0022	5.2	13.75	0	→ Gas Bag #5
D-1	9-7/8"	266	0.0207	5.0	13.95	0	
D-2	29-9/16"	270	0.0066	6.1	12.95	0	
E-1	9-7/8"	262	0.0346	5.3	13.72	0	
E-2	29-9/16"	273	-.0027	4.4	14.45	0	
F-1	9-7/8"	264	0.0367	5.7	13.30	0	
F-2	29-9/16"	258	0.0096	7.7	11.55	4	
G-1	9-7/8"	264	0.0511	5.9	13.1	5	
G-2	29-9/16"	270	0.0001	5.5	13.5	12	

Port A = ~~South~~ North, G = ~~North~~ South

Sampling Notes:

File: PFGOTPL.WQ2

09-May-96

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Method 2 QA/QC Checklist

Plant: Milliken
Date: 5/14/96
Start Time: 1610 Stop Time: 1645
Unit ID: #2 Duct ID: PRIM. FG. OUTLET - B
Testers: GLC/MSD

Pitot ID S52 Cp 0.798 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? MSD Condition? ✓

Leak Check of System? ✓ By Whom? MSD Condition? ✓

Dp Gauge ID #1 Static Pressure Gauge ID #1

TC ID #7B Handheld TC Readout ID #1

Barometer ID ____

Leak Check of Gas Sampling System? ✓ By Whom? MSD Condition? OK

Gas Meter ID TSS-A ORSAT Bag ID #5

QA/QC Check List:

Proper sampling points identified? YES
Pitot orientation properly marked? YES
Reference point for pitot depth marked? YES
Pitot leak check? Yes
Gas sampling system leak check? Yes
Gas Meter Calibrated? Yes
Safety equipment utilized? Yes
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? YES
Proper probe orientation while traversing? YES
Process at steady state prior to testing? Yes

815

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Primary Air Inlet - (Rectangular Duct)

Location B A or B Duct

Date 5/14/96

Time Begin 16:10 End 16:41

Tube I.D. S-50

C-Factor 0788

Operator(s) JAW/LLA

No. Points 12

Duct Width 17.5 ft

Duct Height 3.28 ft

Duct Area 57.42 Sq ft

Bar., " Hg 29.68

Static, " H2O +53.26

Amb Air DB, deg F

Amb Air WB, deg F

Humd, lb/lb BD Air

	PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
16:10	A-1	9-7/8"	108.3	0.0562
	A-2	29-9/16"	109.7	0.0143
	B-1	9-7/8"	108.3	0.0476
	B-2	29-9/16"	109.2	0.0046
	C-1	9-7/8"	108.1	0.1055
	C-2	29-9/16"	108.6	0.0141
	D-1	9-7/8"	107.9	0.0937
	D-2	29-9/16"	108.8	0.0056
	E-1	9-7/8"	108.3	0.0388
	E-2	29-9/16"	108.3	0.0124
	F-1	9-7/8"	108.1	-0.0020
16:41	F-2	29-9/16"	107.9	0.0001

Port A = South, F = North

Sampling Notes:

File PAITPL.WQ2 09-May-96

Method 2 QA/QC Checklist

Plant: Milliken
Date: 5/14/96
Start Time: 16:10 Stop Time: 16:41
Unit ID: Unit 2 Duct ID: 2-B Primary Air INLET
Testers: JAW & LLA

Pitot ID S-50 Cp 0.788 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? JAW Condition? OK

Leak Check of System? ✓ By Whom? JAW Condition? OK 8"

Dp Gauge ID M91635 Static Pressure Gauge ID (ODA's)

TC ID 5A Handheld TC Readout ID THREE

Barometer ID ______

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓ per DCM

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NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

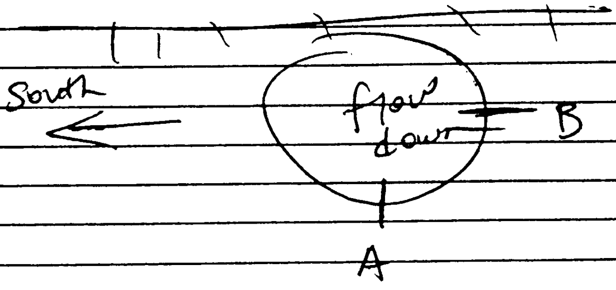
Primary Air Outlet - (Circular Duct)

Location	~~A~~ or B Duct			Bar., " Hg	29.68
Date	5/14/96			Static, " H2O	48.79
Time Begin	1600	End	1630		
Tube I.D.	S-49	No. Points	20	Amb Air DB, deg F	
C-Factor	0.806			Amb Air WB, deg F	
Operator(s)	RO, Fuz	Duct Dia.	47.5 inches	Humd, lb/lb BD Air	
		Duct Area	12.31 Sq ft		

PORT/ POINT	~~DISTANCE~~ From Wall	TEMP Deg-F	DELTA P [" H2O]	
A-1	1-3/16"	589	0,3216	
A-2	3-7/8"	589	0,3320	
A-3	6-15/16"	590	0,3613	
A-4	10-3/4"	590	0.3945	
A-5	16-1/4"	590	0,3693	
A-6	31-1/4"	590	0,2816	48.71 Static
A-7	36-3/4"	590	0,2565	
A-8	40-9/16"	589	0.2427	
A-9	43-5/8"	589	0,2354	
A-10	46-5/16"	588	0.2006	
B-1	1-3/16"	589	0.2980	
B-2	3-7/8"	590	0.3386	
B-3	6-15/16"	590	0.3597	
B-4	10-3/4"	591	0.4070	
B-5	16-1/4"	591	0.4244	48.87 static
B-6	31-1/4"	591	0.3490	
B-7	36-3/4"	590	0.3121	
B-8	40-9/16"	590	0.2875	
B-9	43-5/8"	589	0.2593	
B-10	46-5/16"	587	0.2300	

Port A = South or North, B = East

Sampling Notes:



A pitot side into flow

File PAOTPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: 2B Primary Air Outlet
Date: ~~[illegible]~~ 5/14/96
Start Time: 1600 Stop Time: 1630
Unit ID: 2B Duct ID: Primary Air Outlet
Testers: Rio, Fuz

Pitot ID 849 Cp 0.806 Calibration Date 5/96

Pitot Opening Checked? OK By Whom? Fuz Condition? OK

Leak Check of System? OK By Whom? Rio, Fuz Condition? OK

Dp Gauge ID M94349 Static Pressure Gauge ID M94349

TC ID 4A Handheld TC Readout ID #2

Barometer ID ________

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Secondary Air Bypass - (Rectangular Duct)

819

Location [✓ A] or ~~B Duct~~

Date 5/15/96

Time Begin 0810 End 0820

Bar., " Hg 29.76

Static, " H2O 5,100

Tube I.D. S-53

No. Points 8

C-Factor 0.808

Duct Width 17.5 ft

Operator(s) RW, FUZ

Duct Height 2.09 ft

Duct Area 36.64 Sq ft

Amb Air DB, deg F

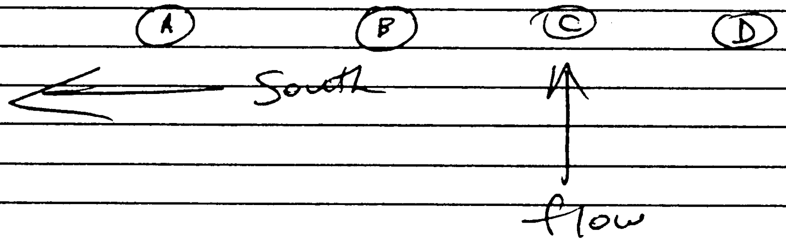
Amb Air WB, deg F

Humd, lb/lb BD Air

PORT/ POINT	DISTANCE Far From Wall	TEMP Deg-F	DELTA P [" H2O]	Static
A-1	6-5/16"	231	0.0000	5.169
A-2	18-7/8"	227	0.0003	
B-1	6-5/16"	210	0.0001	5.103
B-2	18-7/8"	211	0.0000	
C-1	6-5/16"	203	0.0000	5.072
C-2	18-7/8"	202	0.0000	
D-1	6-5/16"	198	0.0000	5.057
D-2	18-7/8"	197	0.0000	

Port A = South, D = North

Sampling Notes:



~~A pitot pointing dou~~

File: SA-BPTPL.WQ2

09-May-96

820

Method 2 QA/QC Checklist

Plant: 2A 2nd Air Bypass
Date: 5/15/96
Start Time: 0810 Stop Time: 0820
Unit ID: 2A Duct ID: 2nd Air Bypass
Testers: RW, Fuz

Pitot ID 5-53 Cp ____ Calibration Date ____

Pitot Opening Checked? ✓ By Whom? RW, Fuz Condition? OK

Leak Check of System? ✓ By Whom? RW, Fuz Condition? OK

Dp Gauge ID M89172 Static Pressure Gauge ID M89172

TC ID 2B Handheld TC Readout ID 2

Barometer ID ____

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

.821

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Secondary Air Outlet - (Rectangular Duct)

Location B A or B Duct

Date 5/14/96

Time Begin 17:17 End 17:57

Bar., " Hg 29.68

Static, " H2O +2.015

Tube I.D. 5-54

C-Factor 0.816

Operator(s) JAW LLA

No. Points 24

Duct Width 6.0 ft

Duct Height 9.0 ft

Duct Area 54.00 Sq ft

Amb Air DB, deg F

Amb Air WB, deg F

Humd, lb/lb BD Air

	PORT/ POINT	DISTANCE From ~~Wall~~ Floor	TEMP Deg-F	DELTA P [" H2O]
17:17	A-1	9"	595.9	0.7618
	A-2	27"	609.9	0.9180
	A-3	45"	618.6	0.8127
	A-4	63"	627.7	0.8059
	A-5	81"	623.4	0.8257
17:24	A-6	99"	621.6	1.105
17:28	B-1	9"	608.7	0.9899
	B-2	27"	614.4	0.8660
	B-3	45"	618.2	0.7751
	B-4	63"	620.7	0.7716
	B-5	81"	620.6	0.9656
17:37	B-6	99"	617.5	1.080
17:40	C-1	9"	612.3	0.9623
	C-2	27"	611.9	1.022
	C-3	45"	611.6	0.7634
	C-4	63"	614.1	0.7147
	C-5	81"	609.6	0.8706
17:46	C-6	99"	601.3	1.043
17:49	D-1	9"	602.4	0.8974
	D-2	27"	599.7	0.8003
	D-3	45"	599.1	0.7751
	D-4	63"	599.3	0.6387
	D-5	81"	599.1	0.7752
17:56	D-6	99"	595.9	0.8255

Port A = South, D = North

Sampling Notes:

File: SAOTPL WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: Milliken
Date: 5/14/96
Start Time: 17:17 Stop Time: 17:57
Unit ID: UNIT 2 Duct ID: 2B Secondary Air Outlet.
Testers: JAW LLA

Pitot ID S-54 Cp 0.816 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? JAW Condition? OK

Leak Check of System? ✓ By Whom? JAW Condition? OK 8"

Dp Gauge ID________ Static Pressure Gauge ID 8WG

TC ID 3A Handheld TC Readout ID THREE

Barometer ID ________

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio) ✓
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

823

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Flue Gas Inlet - (Rectangular Duct)

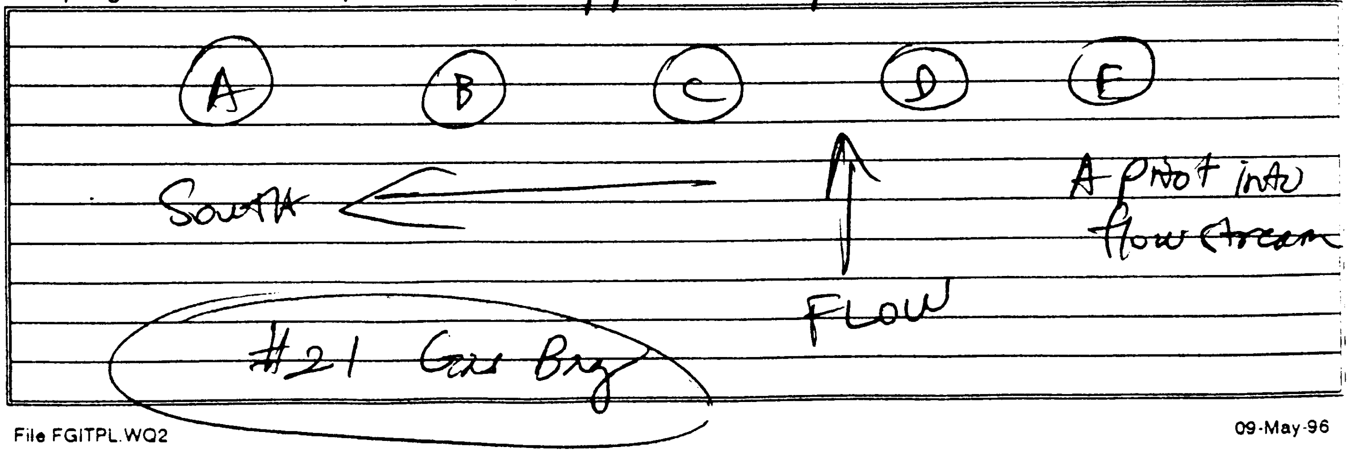
Location [✓ A] or ~~B Duct~~
Date 5/15/96
Time Begin 1605 End ~~1500~~ 1700
Bar., " Hg 29.65
Static, " H2O -9.136

Tube I.D. S-53
No. Points 20
C-Factor 0.808
Duct Width 14.5 ft
Operator(s) RW, FaZ
Duct Height 5.5 ft
Duct Area 79.75 Sq ft
Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.	
A-1	8-1/4"	696	0.7231	3.7		7	0.1	
A-2	24-3/4"	703	0.8579	4.0		14	0.1	
A-3	41-1/4"	702	0.7737	4.5		20	0.1	-9.142
A-4	57-3/4"	692	0.7722	4.9		25	0.1	
B-1	8-1/4"	657	0.7463	3.1		3	0.1	
B-2	24-3/4"	662	0.9926	3.4		3	0.1	-9.096
B-3	41-1/4"	668	0.8989	3.7		3	0.1	
B-4	57-3/4"	670	1.003	4.5		4	0.1	
C-1	8-1/4"	660	0.8131	2.8		13	0	
C-2	24-3/4"	658	1.104	2.9	gas	4	0	-9.18
C-3	41-1/4"	654	1.001	3.5	bag	3	0.1	
C-4	57-3/4"	655	1.060	4.4	#21	3	0.1	
D-1	8-1/4"	689	0.7189	2.8		1	0	
D-2	24-3/4"	680	1.031	3.1		1	0	-9.1
D-3	41-1/4"	667	0.9467	3.5		2	0	
D-4	57-3/4"	662	0.9896	4.1		3	0	
E-1	8-1/4"	704	0.7094	3.4		1	0	
E-2	24-3/4"	693	0.8359	3.5		1	0	-9.08
E-3	41-1/4"	673	0.8783	3.8		1	0	
E-5	57-3/4"	666	0.8429	4.0		1	0	

Port A = South, E = North

Sampling Notes: recal 100 ppm CO prior to test



Method 2 QA/QC Checklist

Plant: 2A Flue Gas Inlet
Date: 5/15/96
Start Time: 1605 Stop Time: 1700
Unit ID: 2A Duct ID: Flue Gas Inlet
Testers: RW, FVB

Pitot ID S-53 Cp 0.808 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? RW, FVB Condition? OK

Leak Check of System? ✓ By Whom? RW, FVB Condition? OK

Dp Gauge ID M89172 Static Pressure Gauge ID M89172

TC ID 2B Handheld TC Readout ID 2

Barometer ID ______

Leak Check of Gas Sampling System? ✓ By Whom? RW, FVB Condition? OK

Gas Meter ID #154943 ORSAT Bag ID #21

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

825

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Flue Gas Outlet - (Rectangular Duct)

Location [✓ A] or B Duct

Date 5/15/96

Time Begin 1[illegible]05 1605 End 1700

Tube I.D. 5-52

No. Points 24

C-Factor 0.798

Duct Width 34 ft

Operator(s) MSO GLC

Duct Height 2.5 ft

Duct Area 85.00 Sq ft

Bar., " Hg 29.65

Static, " H2O -13.95" WC

Amb Air DB, deg F

Amb Air WB, deg F

Humd, lb/lb BD Air

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	7-1/2"	299	0.8391	4.5		0	.4
A-2	22-1/2"	300	0.7115	4.4		0	.3
B-1	7-1/2"	300	0.6178	4.3		0	.4
B-2	22-1/2"	300	0.6669	4.3		0	.3
C-1	7-1/2"	298	0.8788	4.2		0	.3
C-2	22-1/2"	297	0.7640	4.2		0	.3
D-1	7-1/2"	299	0.7960	4.5		0	.2
D-2	22-1/2"	299	0.7513	4.2		0	.3
E-1	7-1/2"	300	0.6770	4.6		0	.4
E-2	22-1/2"	300	0.7387	4.7		0	.3
F-1	7-1/2"	298	0.7646	4.6		0	.3
F-2	22-1/2"	300	0.6042	4.5		0	.3
G-1	7-1/2"	296	0.4351	4.8		0	.4
G-2	22-1/2"	297	0.3710	4.7		0	.4
H-1	7-1/2"	299	0.4539	4.6		0	.4
H-2	22-1/2"	297	0.5080	4.6		0	.4
I-1	7-1/2"	302	0.4911	4.5		0	.3
I-2	22-1/2"	303	0.5186	4.5		0	.3
J-1	7-1/2"	306	0.5573	4.6		0	.3
J-2	22-1/2"	306	0.5739	4.4		0	.3
K-1	7-1/2"	307	0.6035	4.6		0	.4
K-2	22-1/2"	306	0.5499	4.6		0	.3
L-1	7-1/2"	307	0.5094	4.9		1	.4
L-2	22-1/2"	306	0.5458	4.7		0	.4

Port A = ~~South~~ N, L = ~~North~~ S

Sampling Notes:

#27

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Flue Gas Outlet - (Rectangular Duct)

Location ________ [✓ A] or B Duct

Date 5/15/96

Time Begin 1455 **End** 1535

Bar., " Hg ________

Static, " H2O -12.66"

Tube I.D. S-5L

C-Factor 0.798

Operator(s) MSD
GLC

No. Points 14

Duct Width 17.92 ft

Duct Height 3.28 ft

Duct Area 58.79 Sq ft

Amb Air DB, deg F ________

Amb Air WB, deg F ________

Humd, lb/lb BD Air ________

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	9-7/8"	284	0,0152	5.7		26 x	1.1
A-2	29-9/16"	303	0.0119	4.8		38 x	.6
B-1	9-7/8"	301	0.0302	4.8		48 x	0
B-2	29-9/16"	312	0.0195	3.9		66 x	0
C-1	9-7/8"	295	0.0115	6.0		5	.4
C-2	29-9/16"	306	0.0264	5.8		6	.7
D-1	9-7/8"	301	0.0523	7.3		5	.8
D-2	29-9/16"	311	0.0365	7.8		5	.8
E-1	9-7/8"	298	0.0689	5.8		1	.3
E-2	29-9/16"	312	0.0399	5.0		1	.4
F-1	9-7/8"	305	0.0561	4.9		0	.6
F-2	29-9/16"	314	0.0303	4.5		0	.4
G-1	9-7/8"	299	0.0514	5.3		0	.3
G-2	29-9/16"	294	0.0117	6.2		0	.4

305

X → CHANG INLET SCRUB

← GAS B #23

Port A = South, L = North

Sampling Notes:

File: PFGOTPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: milliken
Date: 5-15-96
Start Time: 1500 Stop Time:
Unit ID: 2 Duct ID:
Testers: MSD GLC

Pitot ID 5-52 Cp 0.798 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? MSD Condition? OK

Leak Check of System? ✓ By Whom? MSD Condition? OK

Dp Gauge ID ~~Static~~ ADm Static Pressure Gauge ID ADm

TC ID 5-B Handheld TC Readout ID ONE

Barometer ID

Leak Check of Gas Sampling System? ✓ By Whom? MSD Condition? OK

Gas Meter ID ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Inlet - (Rectangular Duct)

Location A A or B Duct

Date 5/15/96

Time Begin 14:52 End 15:21

Tube I.D. S-50

C-Factor 0.788

Operator(s) JMW LLA

No. Points 12

Duct Width 17.5 ft

Duct Height 3.28 ft

Duct Area 57.42 Sq ft

Bar., " Hg 29.67

Static, " H2O 53.47

Amb Air DB, deg F

Amb Air WB, deg F

Humd, lb/lb BD Air

	PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]	
14:52	A-1	9-7/8"	115.3	-0,0036	
	A-2	29-9/16"	116.7	0,0030	
	B-1	9-7/8"	115.8	0.0348	
	B-2	29-9/16"	116.4	0.0152	
	C-1	9-7/8"	115.7	0,0401	
	C-2	29-9/16"	116.7	0,0107	
	D-1	9-7/8"	115.8	0,0308	
	D-2	29-9/16"	—	—	*
	E-1	9-7/8"	116.0	0,0472	
	E-2	29-9/16"	117.5	0,0167	
	F-1	9-7/8"	115.5	0,1721	
15:21	F-2	29-9/16"	116.9	0,0516	

Port A = South, F = North

Sampling Notes:

I-beam blocking port - No measurement

File PAITPL.WQ2 09-May-96

830

Method 2 QA/QC Checklist

Plant: Milliken
Date: 5/15/96
Start Time: 14:52 Stop Time: 15:21
Unit ID: UNIT 2 Duct ID: 2A PRIMARY AIR INLET
Testers: JAW LLA

Pitot ID S-50 Cp 0.788 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? JAW Condition? OK

Leak Check of System? ✓ By Whom? JAW Condition? OK 8"

Dp Gauge ID M 91635 Static Pressure Gauge ID (ODA's)

TC ID 5A Handheld TC Readout ID THROE

Barometer ID ________

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

831

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Primary Air Outlet - (Circular Duct)

Location, [✓ A] or ~~B Duct~~
Date 5/15/96
Time Begin 1450 End 1510
Tube I.D. S-49 No. Points 20
C-Factor 0.806
Operator(s) Rio Fuz Duct Dia. 47.5 inches
Duct Area 12.31 Sq ft

Bar., " Hg 29.67
Static, " H2O 49.32
Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	1-3/16"	602	0.3167
A-2	3-7/8"	603	0.3543
A-3	6-15/16"	603	0.3769
A-4	10-3/4"	604	0.4037
A-5	16-1/4"	604	0.3977
A-6	31-1/4"	604	0.3312
A-7	36-3/4"	604	0.3132
A-8	40-9/16"	603	0.2950
A-9	43-5/8"	601	0.2522
A-10	46-5/16"	599	0.2044
B-1	1-3/16"	602	0.3072
B-2	3-7/8"	603	0.3330
B-3	6-15/16"	603	0.3673
B-4	10-3/4"	603	0.3744
B-5	16-1/4"	603	0.3733
B-6	31-1/4"	603	0.2907
B-7	36-3/4"	602	0.2759
B-8	40-9/16"	601	0.2485
B-9	43-5/8"	599	0.2238
B-10	46-5/16"	596	0.1769

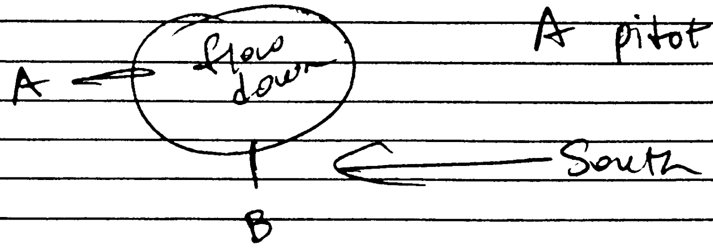
Static

— 49.19

— 49.44

Port A = South or North, B = East

Sampling Notes:



A pitot into stream

Method 2 QA/QC Checklist

Plant: Primary Air Outlet 2A
Date: 5/15/96
Start Time: 1450 Stop Time: 1510
Unit ID: 2A Duct ID: Primary Air Outlet
Testers: Pro - FUZ

Pitot ID S-49 Cp 0806 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? Pro, FUZ Condition? OK

Leak Check of System? ✓ By Whom? Pro, FUZ Condition? OK

Dp Gauge ID M89172 Static Pressure Gauge ID M89172

TC ID 2 Handheld TC Readout ID ~~8~~ 4A

Barometer ID

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

833

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Secondary Air Bypass - (Rectangular Duct)

Location B Duct

Date 5/15/96

Time Begin 0745 End 0800

Bar., " Hg 29.78

Static, " H2O 5.041

Tube I.D. S-53

No. Points 8

C-Factor 0.808

Duct Width 17.5 ft

Operator(s) RW, FuZ

Duct Height 2.09 ft

Duct Area 36.64 Sq ft

Amb Air DB, deg F

Amb Air WB, deg F

Humd, lb/lb BD Air

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	6-5/16"	~~1~~ 125	0.0000
A-2	18-7/8"	119	-0.0003
B-1	6-5/16"	95	0.0018
B-2	18-7/8"	103	0.0002
C-1	6-5/16"	108	0.0004
C-2	18-7/8"	122	0.0000
D-1	6-5/16"	147	-0.0001
D-2	18-7/8"	148	0.0000

Static

5.089

4.982

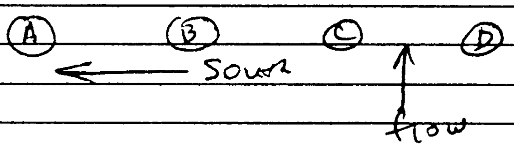
5.048

5.045

Port A = South, D = North

Sampling Notes:

flow up, A pitot pointing down



File: SA-BPTPL.WQ2

09-May-96

834

Method 2 QA/QC Checklist

Plant: 2B 2nd Air Bypass
Date: 5/15/96
Start Time: 0745 Stop Time: 0800
Unit ID: 2B Duct ID: 2nd Air Bypass
Testers: RIO, FUZ

Pitot ID S-53 Cp 0.808 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? RIO, FUZ Condition? OK

Leak Check of System? ✓ By Whom? RIO, FUZ Condition? OK

Dp Gauge ID M89172 Static Pressure Gauge ID M89172

TC ID 2B Handheld TC Readout ID 2

Barometer ID

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

835

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Secondary Air Outlet - (Rectangular Duct)

Location A A or B Duct

Date 5/15/96

Time Begin 16:09 End 16:43

Bar., " Hg 29.65

Static, " H2O +3.570

Tube I.D. S-54

No. Points 24

C-Factor 0.816

Duct Width 6.0 ft

Operator(s) JAW LLA

Duct Height 9.0 ft

Duct Area 54.00 Sq ft

Amb Air DB, deg F 113.0

Amb Air WB, deg F

Humd, lb/lb BD Air

	PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
16:09	A-1	9"	615.0	0.8267
	A-2	27"	613.4	0.8831
	A-3	45"	611.6	0.8113
	A-4	63"	610.1	0.6463
	A-5	81"	607.4	0.5829
16:15	A-6	99"	602.7	0.6130
16:19	B-1	9"	616.1	0.9081
	B-2	27"	618.4	0.9509
	B-3	45"	620.0	0.7669
	B-4	63"	620.9	0.7396
	B-5	81"	617.3	0.7359
16:25	B-6	99"	608.0	0.6927
16:28	C-1	9"	611.6	0.9476
	C-2	27"	619.1	1.079
	C-3	45"	624.0	0.7915
	C-4	63"	627.8	0.7699
	C-5	81"	628.5	0.8957
16:34	C-6	99"	625.4	0.9639
16:37	D-1	9"	606.5	0.6921
	D-2	27"	616.2	0.9668
	D-3	45"	621.8	0.8276
	D-4	63"	626.3	0.8647
	D-5	81"	627.4	0.7389
16:43	D-6	99"	627.0	1.027

Port A = South, D = North

Sampling Notes:

At end of test, ⊖ pitot tube: slight chip found
Was fine at beginning of test

836

Method 2 QA/QC Checklist

Plant: Milliken
Date: 5/15/96
Start Time: ______ Stop Time: ______
Unit ID: UNIT 2 Duct ID: 24 Secondary Air Outlet
Testers: JAW LLA

Pitot ID S-54 Cp 0.816 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? JAW Condition? OK

Leak Check of System? ✓ By Whom? JAW Condition? OK 7"

Dp Gauge ID M91635 Static Pressure Gauge ID 8W6

TC ID 3A Handheld TC Readout ID THREE

Barometer ID ______

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓ per OCM

837

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Flue Gas Inlet - (Rectangular Duct)

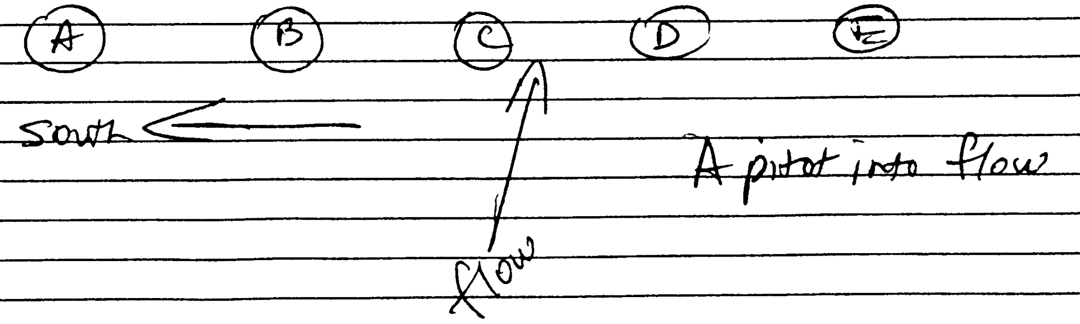
Location ~~[illegible]~~ or [✓ B Duct]
Date 5/15/96
Time Begin 1200 End 1250
Bar., " Hg 29.70
Static, " H2O -9.055

Tube I.D. S 53
No. Points 20
C-Factor 0.808
Duct Width 14.5 ft
Operator(s) Rio - Fuz
Duct Height 5.5 ft
Duct Area 79.75 Sq ft
Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	Far DISTANCE ~~" From Wall~~	TEMP Deg-F	DELTA P 0.6702 [" H2O]	% O2	% CO2	CO ppmv	%COMB.	Static
A-1	8-1/4"	666	~~[illegible]~~	~~4.1~~ 3.8		~~37~~ 14	0.1	
A-2	24-3/4"	662	0.7726	3.7		13	0.1	-8.902
A-3	41-1/4"	658	0.8198	3.9		14	0.1	
A-4	57-3/4"	660	0.7292	4.1		15	0.1	
B-1	8-1/4"	663	0.6583	3.8		30	0.1	
B-2	24-3/4"	659	0.9312	3.7		29	0.1	-9.227
B-3	41-1/4"	655	0.9333	4.1		19	0.1	
B-4	57-3/4"	659	0.7858	4.4		13	0.1	
C-1	8-1/4"	657	0.6868	4.6		0	0	
C-2	24-3/4"	653	0.9500	4.65		0	0	
C-3	41-1/4"	650	0.8281	4.4	G28 $107 #20	2	0	-9.020
C-4	57-3/4"	654	0.8677	4.4		2	1	
D-1	8-1/4"	681	0.6929	4.7		4	0.1	
D-2	24-3/4"	685	0.8801	4.5		4	0.1	
D-3	41-1/4"	680	0.8454	4.5		4	0.1	-9.120
D-4	57-3/4"	670	0.7584	4.9		7	0	
E-1	8-1/4"	711	0.4485	6.0		2	0	
E-2	24-3/4"	712	0.5698	5.8		3	0.1	-9.006
E-3	41-1/4"	698	0.6671	5.3		3	0.1	
E-5	57-3/4"	674	0.8569	5.2		3	0.1	

Port A = South, E = North

Sampling Notes:



A pitot into flow

File FGITPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: 2B Flue Gas Inlet
Date: 5/15/96
Start Time: 1200 Stop Time: 1250
Unit ID: 2B Duct ID: Flue Gas Inlet
Testers: PLO, FVZ

Pitot ID S-53 Cp 0.808 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? PLO, FVZ Condition? OK

Leak Check of System? ✓ By Whom? PLO, FVZ Condition? OK

Dp Gauge ID M89172 Static Pressure Gauge ID M89172

TC ID 2B Handheld TC Readout ID 2

Barometer ID ____

Leak Check of Gas Sampling System? ✓ By Whom? PLO FVZ Condition? OK

Gas Meter ID 154949 (Coolside) ORSAT Bag ID 20

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

839

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Flue Gas Outlet - (Rectangular Duct)

Location ______ A or [✓ B] Duct
Date 5-15-96
Time Begin 1200 End 1240
Bar., " Hg 29.70
Static, " H2O -13.13" wc

Tube I.D. S-52
C-Factor 0.798
Operator(s) msO
GLC
No. Points 24
Duct Width 34 ft
Duct Height 2.5 ft
Duct Area 85.00 Sq ft
Amb Air DB, deg F ______
Amb Air WB, deg F ______
Humd, lb/lb BD Air ______

NORTH

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
~~A-1~~	~~7-1/2"~~						
~~A-2~~	~~22-1/2"~~						
B-1	7-1/2"	280	0.3006	4.7		3	.20
B-2	22-1/2"	280	0.2908	4.8		3	.1
C-1	7-1/2"	280	0.3968	4.7		2	0
C-2	22-1/2"	280	0.3988	4.8		2	0
D-1	7-1/2"	279	0.5843	4.8		1	0
D-2	22-1/2"	280	0.5803	4.9		1	0
E-1	7-1/2"	278	0.5299	4.6		0	0
E-2	22-1/2"	278	0.5080	4.8		0	0
F-1	7-1/2"	278	0.3555	4.8		0	0
F-2	22-1/2"	278	0.5248	4.8		0	0
G-1	7-1/2"	278	0.3310	4.7		0	0
G-2	22-1/2"	278	0.2964	4.7		0	0
H-1	7-1/2"	279	0.7879	4.7		3	.2
H-2	22-1/2"	280	0.8029	4.7		3	.3
I-1	7-1/2"	280	0.9817	4.6		3	.3
I-2	22-1/2"	280	0.9137	4.6		3	.3
J-1	7-1/2"	279	0.6724	4.6		3	.3
J-2	22-1/2"	278	0.7703	4.5		3	.3
K-1	7-1/2"	275	0.5963	4.9		2	.3
K-2	22-1/2"	276	0.7567	4.9		2	.3
L-1	7-1/2"	274	0.5091	4.9		2	.3
L-2	22-1/2"	275	0.3952	4.9		2	.3

→GAS Bag #26

~~Port A = South, L = North~~

Sampling Notes:

File: FGOTPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: Milliken
Date: 5-15-96
Start Time: ______ Stop Time: ______
Unit ID: 2 Duct ID: Flue Gas Out 2B
Testers: MSO - GLC

Pitot ID S-52 Cp 0 798 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? MSO Condition? ok

Leak Check of System? ✓ By Whom? MSO Condition? ok

Dp Gauge ID M-94349 Static Pressure Gauge ID M-94341

TC ID 7B Handheld TC Readout ID ONE

Barometer ID ONE

Leak Check of Gas Sampling System? ✓ By Whom? MS Condition? ok

Gas Meter ID TSS1 ORSAT Bag ID 26

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

8411

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Primary Flue Gas Outlet - (Rectangular Duct)

Location ________ A or [✓ B Duct]

Date 5/15/96

Time Begin 1400 End 1445

Bar., " Hg 29.67

Static, " H2O -11.99 "WC

Tube I.D. 5-52

C-Factor 0798

Operator(s) MSD/GLC

No. Points 14

Duct Width 17.92 ft

Duct Height 3.28 ft

Duct Area 58.79 Sq ft

Amb Air DB, deg F ________

Amb Air WB, deg F ________

Humd, lb/lb BD Air ________

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	9-7/8"	262	0.0586	7.4		1	.4
A-2	29-9/16"	270	0.0251	6.0		1	.3
B-1	9-7/8"	271	0.0276	5.8		0	.3
B-2	29-9/16"	275	0.0254	4.9		0	.3
C-1	9-7/8"	267	0.0206	6.5		0	.4
C-2	29-9/16"	272	0.0088	6.3		0	.4
D-1	9-7/8"	267	0.0196	5.5		0	.5
D-2	29-9/16"	272	0.0198	5.8		0	.3
E-1	9-7/8"	260	0.0308	5.9		7	1.3
E-2	29-9/16"	273	0.0234	4.9		12	1.6
F-1	9-7/8"	266	0.0400	6.7		1	.5
F-2	29-9/16"	275	0.0361	5.0		10	.6
G-1	9-7/8"	263	0.0499	6.3		9	.4
G-2	29-9/16"	273	0.0102	5.3		20	.4

GAS BA #25

RECAL

Port A = ~~South~~ N, G = ~~North~~ S

Sampling Notes:

File: PFGOTPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: Milliken

Date: 5/15

Start Time: ________ Stop Time: ________

Unit ID: 2 Duct ID: PRIMARY F.G. OUT - B

Testers: MSD - GLC

Pitot ID 5-52 Cp 0.798 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? MSD Condition? OK

Leak Check of System? ✓ By Whom? MSD Condition? OK

Dp Gauge ID M-94349 Static Pressure Gauge ID M94349

TC ID #7B Handheld TC Readout ID # ONE

Barometer ID ONE

Leak Check of Gas Sampling System? ✓ By Whom? MSD Condition? OK

Gas Meter ID JSS-1 ORSAT Bag ID #

QA/QC Check List:

Proper sampling points identified? ✓

Pitot orientation properly marked? ✓

Reference point for pitot depth marked? ✓

Pitot leak check? ✓

Gas sampling system leak check? ✓

Gas Meter Calibrated? ✓

Safety equipment utilized? ✓

(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)

Tight seal around probe entry port? ✓

Proper probe orientation while traversing? ✓

Process at steady state prior to testing? ✓

843

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Inlet - (Rectangular Duct)

Location B A or B Duct
Date 5/15/96
Time Begin 14:08 End 14:35

Bar., " Hg 29.67
Static, " H2O 53.43

Tube I.D. 5-50
C-Factor 0.788
Operator(s) JAW LLA

No. Points 12
Duct Width 17.5 ft
Duct Height 3.28 ft
Duct Area 57.42 Sq ft

Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

	PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
14:08	A-1	9-7/8"	116.6	0.0656
	A-2	29-9/16"	117.6	0.0198
	B-1	9-7/8"	116.0	0.0430
	B-2	29-9/16"	116.7	0.0068
	C-1	9-7/8"	115.8	0.1106
	C-2	29-9/16"	116.2	0.0141
	D-1	9-7/8"	115.8	0.0845
	D-2	29-9/16"	116.2	0.0054
	E-1	9-7/8"	115.8	0.0291
	E-2	29-9/16"	116.4	0.0139
	F-1	9-7/8"	116.2	-0.0017
14:35	F-2	29-9/16"	114.6	0.0009

Port A = South, F = North

Sampling Notes:

File PAITPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: Milliken
Date: 5/15/96
Start Time: 14:08 Stop Time: 14:35
Unit ID: UNIT 2 Duct ID: 2B PRIMARY AIR INLET
Testers: JAW LLA

Pitot ID 5-50 Cp 0 788 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? JAW Condition? OK

Leak Check of System? ✓ By Whom? JAW Condition? OK 8"

Dp Gauge ID M91635 Static Pressure Gauge ID (ODA's)

TC ID 5A Handheld TC Readout ID THREE

Barometer ID __________

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Outlet - (Circular Duct)

Location ~~A~~ or B Duct
Date 5/15/96
Time Begin 1400 End 1425
Bar., " Hg 29.67
Static, " H2O 49.48

Tube I.D. S-49
No. Points 20
C-Factor 0.806
Operator(s) RW, FWZ
Duct Dia. 47.5 inches
Duct Area 12.31 Sq ft
Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

Static

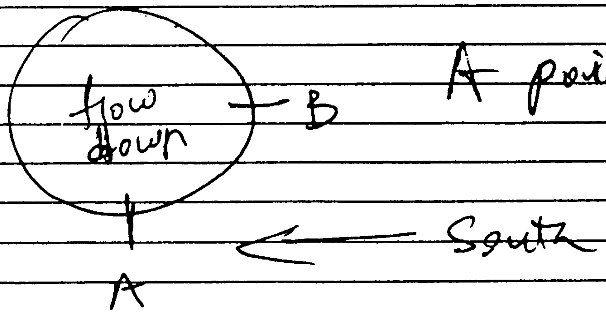
PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	1-3/16"	586	0.3029
A-2	3-7/8"	586	0.3277
A-3	6-15/16"	587	0.3558
A-4	10-3/4"	587	0.3651
A-5	16-1/4"	588	0.3524
A-6	31-1/4"	588	0.2744
A-7	36-3/4"	588	0.2405
A-8	40-9/16"	588	0.2509
A-9	43-5/8"	587	0.2296
A-10	46-5/16"	586	0.2028
B-1	1-3/16"	587	0.2695
B-2	3-7/8"	587	0.3214
B-3	6-15/16"	588	0.3453
B-4	10-3/4"	588	0.4241
B-5	16-1/4"	589	0.4212
B-6	31-1/4"	588	0.3445
B-7	36-3/4"	588	0.2794
B-8	40-9/16"	587	0.2833
B-9	43-5/8"	586	0.2617
B-10	46-5/16"	583	0.2338

← 49.38

← 49.57

Port A = South or North, B = East

Sampling Notes:



A pointing into stream

File PAOTPL.WQ2 09-May-96

846

Method 2 QA/QC Checklist

Plant: Primary Air Outlet 2B
Date: 5/15/96
Start Time: 1400 Stop Time: 1425
Unit ID: 2B Duct ID: Primary Air Outlet
Testers: Pro, FUZ

Pitot ID S-49 Cp_____ Calibration Date_____

Pitot Opening Checked? ✓ By Whom? Pro, FUZ Condition? OK

Leak Check of System? ✓ By Whom? Pro, FUZ Condition? OK

Dp Gauge ID M89172 Static Pressure Gauge ID M89172

TC ID 2 Handheld TC Readout ID 4A

Barometer ID _____

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

247

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Secondary Air Bypass - (Rectangular Duct)

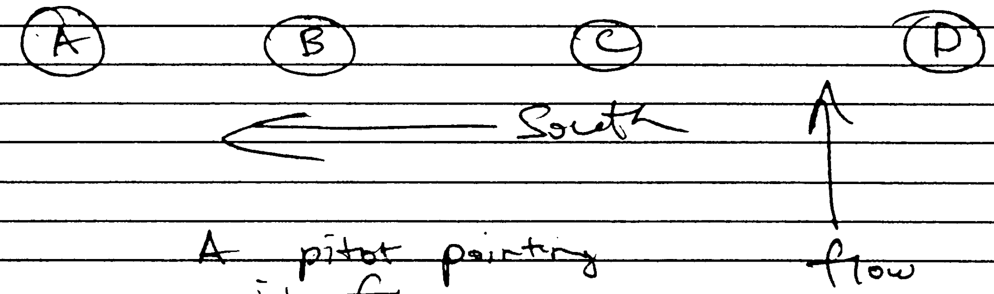
Location [✓ A] ~~or B Duct~~
Date 5/16/96
Time Begin 1705 End 1725
Bar., " Hg 2957
Static, " H2O 2.0950

Tube I.D. S-53
C-Factor 0.808
Operator(s) Rio Fuz Far
No. Points 8
Duct Width 17.5 ft
Duct Height 2.09 ft
Duct Area 36.64 Sq ft
Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]	Static
A-1	6-5/16"	256	0.0000	1.878
A-2	18-7/8"	262	0.0000	
B-1	6-5/16"	248	0.0000	2.214
B-2	18-7/8"	247	0.0000	
C-1	6-5/16"	247	0.0000	2.317
C-2	18-7/8"	246	0.0000	
D-1	6-5/16"	242	0.0000	1.971
D-2	18-7/8"	242	0.0000	

Port A = South, D = North

Sampling Notes:



A pitot pointing into flow

File: SA-BPTPL.WQ2 09-May-96

848

Method 2 QA/QC Checklist

Plant: 2A 2nd Air Bypass
Date: 5/16/96
Start Time: 1705
Stop Time: 1725
Unit ID: 2A
Duct ID: 2nd Air Bypass
Testers: Rw, Fuz

Pitot ID 5-53
Cp 0.808
Calibration Date 5/96

Pitot Opening Checked? ✓
By Whom? Rw-Fuz
Condition? OK

Leak Check of System? ✓
By Whom? Rw, Fuz
Condition? OK

Dp Gauge ID M91635
Static Pressure Gauge ID M91635

TC ID 2B
Handheld TC Readout ID 2

Barometer ID ON9

Leak Check of Gas Sampling System? N/A
By Whom? ____
Condition? ____

Gas Meter ID N/A
ORSAT Bag ID N/A

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

8-19

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Secondary Air Outlet - (Rectangular Duct)

Location B A or B Duct
Date 5/15/96
Time Begin 12:00 **End** 13:02

Bar., " Hg 29.70
Static, " H2O +3.457

Tube I.D. S-54
C-Factor 0.816
Operator(s) JAW LLA

No. Points 24
Duct Width 6.0 ft
Duct Height 9.0 ft
Duct Area 54.00 Sq ft

Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

11:45HR

	OLD	NEW	OLD	NEW
WET	50	52		
Dry	66	68		

	PORT/ POINT	DISTANCE From ~~Wall~~ Bottom	TEMP Deg F	DELTA P [" H2O]		
:37 ~~12:05~~	A-1	9"	~~586.4~~	~~0.8674~~	0.8423	602.7°F
	A-2	27"	~~603.8~~ 625.2	~~0.8586~~	0.8884	625.2°F
	A-3	45"	~~611.2~~	~~0.7449~~	0.7723	626.3°F
	A-4	63"	~~614.6~~	~~0.4176~~	0.7644	618.8°F
	A-5	81"	~~615.3~~	~~0.4240~~	0.7973	617.1°F
:41 ~~12:05~~	A-6	99"	~~614.1~~	0.4985	1.041	616.1°F
:46 ~~12:15~~	B-1	9"	601.5	~~0.1576~~	* 0.9749	
	B-2	27"	607.8	~~0.1392~~	$ 0.8605	
	B-3	45"	611.6	0.7481		
	B-4	63"	614.8	0.7206		
	B-5	81"	614.4	0.9202		
12:33	B-6	99"	610.5	0.9952		
12:47	C-1	9"	625.4	0.9111		
	C-2	27"	617.1	0.9596		
	C-3	45"	610.3	0.7415		
	C-4	63"	611.2	0.6774		
	C-5	81"	609.2	0.8060		
12:54	C-6	99"	603.8	0.7879		
	D-1	9"	608.1	0.8388		
	D-2	27"	606.7	0.7532		
	D-3	45"	604.5	0.7344		
	D-4	63"	601.8	0.6037		
	D-5	81"	600.4	0.7560		
13:02	D-6	99"	597.2	0.8144		

Port A = South, D = North

Amb Temp 'O' [illegible]
1400 HRS. 93.3°F

Sampling Notes:

$ leak in pitot tube; remeasured after plugging leak
Pressure test after end of test 13:12 OK @ 7"

Method 2 QA/QC Checklist

Plant: Milliken

Date: May 15, 1996

Start Time: ~~12:00~~ 12:26 Stop Time: 13:02

Unit ID: UNIT 2 Duct ID: 2B Secondary Air Outlet

Testers: J.A. WITHUM L.L. ANTHONY

Pitot ID S-54 Cp 0.816 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? JAW Condition? OK

Leak Check of System? ✓ By Whom? JAW Condition? 7" OK

Dp Gauge ID M91635 Static Pressure Gauge ID 8 WG

TC ID 3A Handheld TC Readout ID THREE

Barometer ID

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓

Pitot orientation properly marked? ✓

Reference point for pitot depth marked? ✓

Pitot leak check? ✓

Gas sampling system leak check? NA

Gas Meter Calibrated? NA

Safety equipment utilized? ✓

(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)

Tight seal around probe entry port? ✓

Proper probe orientation while traversing? ✓

Process at steady state prior to testing? ✓ per DCM

851

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Flue Gas Inlet - (Rectangular Duct)

Location 2 [✓ A] or ~~B Duct~~
Date 5/16/96
Time Begin 1836 End 1930

Bar., " Hg 29.49
Static, " H2O -3.7908

Tube I.D. S-53
C-Factor 0.808
Operator(s) RO, FCZ

No. Points 20
Duct Width 14.5 ft
Duct Height 5.5 ft
Duct Area 79.75 Sq ft

Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

far

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.	
A-1	8-1/4"	603	0.2710	5.0		8	0.1	
A-2	24-3/4"	604	03267	5.4		8	0.1	
A-3	41-1/4"	602	0.3054	5.4		7	0.1	-3.795
A-4	57-3/4"	591	0.2881	6.0		6	0.1	
B-1	8-1/4"	592	0.2745	4.3		9	0.1	
B-2	24-3/4"	593	0.3928	4.6		9	0.1	
B-3	41-1/4"	593	0.3623	5.3		8	0.1	-3.721
B-4	57-3/4"	590	0.3516	5.9		5	0.1	
C-1	8-1/4"	592	0.2925	4.6		10	0.1	
C-2	24-3/4"	591	0.3995	4.7		10	0.1	-3.876
C-3	41-1/4"	589	0.3489	4.8		10	0.1	
C-4	57-3/4"	589	0.3693	5.2		10	0.1	
D-1	8-1/4"	609	0.2742	5.0		12	0.1	
D-2	24-3/4"	604	0.3864	5.4		11	0.1	
D-3	41-1/4"	591	0.3545	5.2		10	0.1	-3.757
D-4	57-3/4"	594	0.3594	5.4		10	0.1	
E-1	8-1/4"	611	0.2700	5.4		12	0.1	
E-2	24-3/4"	605	0.3231	5.7		12	0.1	-3.805
E-3	41-1/4"	597	0.3117	5.4		10	0.1	
E-5	57-3/4"	593	0.3113	5.7		11	0.1	

Port A = South, E = North

Sampling Notes:

Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ

← South

A pitot into flow

↑ flow

File FGITPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: 2A Flue Gas Inlet
Date: 5/16/96
Start Time: 1830 Stop Time: 1930
Unit ID: 2A Duct ID: Flue Gas Inlet
Testers: Rw, Fuz

Pitot ID S-53 Cp 0.808 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? Rw, Fuz Condition? OK

Leak Check of System? ✓ By Whom? Rw, Fuz Condition? OK

Dp Gauge ID M91635 Static Pressure Gauge ID M91635

TC ID 2B Handheld TC Readout ID ~~2B~~ 2

Barometer ID ON4

Leak Check of Gas Sampling System? ~~NA~~ ✓ By Whom? ~~NA~~ Rw, Fuz Condition? ~~NA~~ OK

Gas Meter ID ~~NA~~ 154949 ORSAT Bag ID ~~NA~~ Not Sampled

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ~~NA~~ ✓
Gas Meter Calibrated? ✓ ~~NA~~
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

853

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Flue Gas Outlet - (Rectangular Duct)

Location ________ [✓ A] or B Duct
Date 5-16-96
Time Begin 1835 End 1920

Bar., " Hg 29.49
Static, " H2O -6.118" wc

Tube I.D. 5-52
C-Factor 0.778
Operator(s) MSO
62C

No. Points 24
Duct Width 34 ft
Duct Height 2.5 ft
Duct Area 85.00 Sq ft

Amb Air DB, deg F ________
Amb Air WB, deg F ________
Humd, lb/lb BD Air ________

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	7-1/2"	270	0.3633	6.0		2	.2
A-2	22-1/2"	271	0.2828	5.9		2	.–
B-1	7-1/2"	270	0.2493	6.0		4	.2
B-2	22-1/2"	271	0.2798	6.0		3	.2
C-1	7-1/2"	269	0.3593	6.0		4	.1
C-2	22-1/2"	268	0.3140	6.2		4	.1
D-1	7-1/2"	270	0.3318	6.0		4	.1
D-2	22-1/2"	268	0.2840	6.0		4	.1
E-1	7-1/2"	270	0.2662	6.0		4	.1
E-2	22-1/2"	270	0.2810	6.0		4	.1
F-1	7-1/2"	267	0.3370	5.9		5	.1
F-2	22-1/2"	270	0.2627	6.1		5	.1
G-1	7-1/2"	268	0.1583	6.1		2	.3
G-2	22-1/2"	268	0.1445	6.1		1	.3
H-1	7-1/2"	270	0.1785	6.0		2	.3
H-2	22-1/2"	269	0.1959	6.1		2	.3
I-1	7-1/2"	272	0.2181	6.0		2	.3
I-2	22-1/2"	272	0.2174	6.0		2	.3
J-1	7-1/2"	276	0.2320	6.0		3	.4
J-2	22-1/2"	275	0.2228	6.0		2	.4
K-1	7-1/2"	278	0.2318	6.0		4	.3
K-2	22-1/2"	277	0.2198	6.0		4	.3
L-1	7-1/2"	279	0.2331	6.0		5	.3
L-2	22-1/2"	276	0.2255	6.0		5	.4

→ Gas Bag #30

Port A = South, L = North

Sampling Notes:

File: FGOTPL.WQ2

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854

Method 2 QA/QC Checklist

Plant: Milliken
Date: 5-16-96
Start Time: 1835 Stop Time: 1920
Unit ID: 2 Duct ID: Flue Gas Out (A)
Testers: MSO - GLC

Pitot ID S-52 Cp 0.798 Ⓐ Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? MSO Condition? OK

Leak Check of System? ✓ By Whom? MSO Condition? OK

Dp Gauge ID M-89172 Static Pressure Gauge ID M-89172

TC ID 7B Handheld TC Readout ID ONE

Barometer ID ONE

Leak Check of Gas Sampling System? ✓ By Whom? MSO Condition? OK

Gas Meter ID TSS-A ORSAT Bag ID 30

Saved for Bicarbe

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

855

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Primary Flue Gas Outlet - (Rectangular Duct)

Location ______ [✓ A] or B Duct

Date 5-16-96

Time Begin 1945 **End** 2020

Bar., " Hg 29.49

Static, " H2O -5.551 "WC

Tube I.D. S-52

No. Points 14

C-Factor 0.798

Duct Width 17.92 ft

Operator(s) MJD
GLC

Duct Height 3.28 ft

Duct Area 58.79 Sq ft

Amb Air DB, deg F ______

Amb Air WB, deg F ______

Humd, lb/lb BD Air ______

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	9-7/8"	246	0.0178	7.2		0	.8
A-2	29-9/16"	252	0.0132	6.7		1	.5
B-1	9-7/8"	247	0.0241	6.8		13	.3
B-2	29-9/16"	250	0.0088	5.8		24	.2
C-1	9-7/8"	246	0.0122	7.1		28	.3
C-2	29-9/16"	255	0.0127	7.4		39	.2
D-1	9-7/8"	248	0.0266	6.2		49	.5
D-2	29-9/16"	246	0.0055	7.5		62	.2
E-1	9-7/8"	247	0.0309	7.1		64	.1
E-2	29-9/16"	258	0.0176	6.3		80	.3
F-1	9-7/8"	249	0.0250	6.7		63	.3
F-2	29-9/16"	254	0.0277	7.3		78	.2
G-1	9-7/8"	246	0.0278	7.3		64	.4
G-2	29-9/16"	250	0.0095	7.2		83	.3

→ Gas Bag #32

Port A = South, L = North

Sampling Notes:

TIME	OLD	NEW	
18:50 HRS			
WET BULB	51	52°F	
DRY	56	55°F	
21:10 HRS	51	52°F	WET BULB
	53	54°F	DRY BULB.

File: PFGOTPL.WQ2

09-May-96

856

Method 2 QA/QC Checklist

Plant: Milliken
Date: 5 16 96
Start Time: 1945 Stop Time: 2020
Unit ID: 2 Duct ID: PF60 - A
Testers: MSO/ GLC

Pitot ID S-52 Cp 0 798 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? MSO Condition?

Leak Check of System? ✓ By Whom? MSO Condition?

Dp Gauge ID M-89172 Static Pressure Gauge ID M-89172

TC ID 7B Handheld TC Readout ID ONE

Barometer ID ONE

Leak Check of Gas Sampling System? ✓ By Whom? ✓ Condition?

Gas Meter ID JSS-A ORSAT Bag ID 32
Sand Sea Branlee

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

857

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Inlet - (Rectangular Duct)

Location A A or B Duct
Date 5/16/96
Time Begin 19:48 End 20:25
Tube I.D. 5-50
C-Factor 0.788
Operator(s) JAW LLA
No. Points 12
Duct Width 17.5 ft
Duct Height 3.28 ft
Duct Area 57.42 Sq ft

Bar., " Hg 29.49
Static, " H2O 52.27
Amb Air DB, deg F 95.3
Amb Air WB, deg F
Humd, lb/lb BD Air

18:50

	OLD	NEW
WET BULB	51	52
DRY BULB	56	55

0.00729

	PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
19:48	A-1	9-7/8"	113.9	0.0013
	A-2	29-9/16"	114.2	0.0016
	B-1	9-7/8"	112.6	0.0180
	B-2	29-9/16"	112.8	0.0049
	C-1	9-7/8"	111.9	0.0346
	C-2	29-9/16"	112.6	0.0127
	D-1	9-7/8"	112.1	0.0149
	D-2	29-9/16"	—	— *
	E-1	9-7/8"	112.2	0.0129
	E-2	29-9/16"	113.1	0.0085
	F-1	9-7/8"	111.3	0.0665
20:25	F-2	29-9/16"	112.2	0.0170

Port A = South, F = North

Sampling Notes:

* UNABLE TO GET THIS POINT DUE TO I-BEAM

File PAITPL.WQ2 09-May-96

858

Method 2 QA/QC Checklist

Plant: MILLIKEN
Date: 5/16/96
Start Time: 19:48 Stop Time: 20:25
Unit ID: UNIT 2 Duct ID: 2A PRIMARY AIR FAN EAST
Testers: JAW LLA

Pitot ID S-50 Cp 0.785 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? JAW Condition? OK

Leak Check of System? ✓ By Whom? JAW Condition? OK 8

Dp Gauge ID M94349 Static Pressure Gauge ID (ODA'L)

TC ID 5A Handheld TC Readout ID THREE

Barometer ID ______

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

859

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Outlet - (Circular Duct)

Location [✓ A] or ~~B Duct~~
Date ~~4~~ 5/16/96
Time Begin 1945 End 2010

Bar., " Hg 29.49
Static, " H2O 50.27

Tube I.D. S-49 No. Points 20
C-Factor 0.806
Operator(s) RW - Fuz Duct Dia. 47.5 inches
Duct Area 12.31 Sq ft

Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

Static

PORT/ POINT	~~DISTANCE~~ Far From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	1-3/16"	532	0.1480
A-2	3-7/8"	533	0.1586
A-3	6-15/16"	533	0.1871
A-4	10-3/4"	533	0.1883
A-5	16-1/4"	534	0.2019
A-6	31-1/4"	534	0.1575
A-7	36-3/4"	534	0.1572
A-8	40-9/16"	533	0.1376
A-9	43-5/8"	532	0.1229
A-10	46-5/16"	531	0.1107
B-1	1-3/16"	531	0.1423
B-2	3-7/8"	532	0.1591
B-3	6-15/16"	532	0.1688
B-4	10-3/4"	532	0.1761
B-5	16-1/4"	532	0.1810
B-6	31-1/4"	532	0.1504
B-7	36-3/4"	532	0.1386
B-8	40-9/16"	531	0.1318
B-9	43-5/8"	530	0.1129
B-10	46-5/16"	529	0.0975

50.20

50.34

Port A = South or North, B = East

Sampling Notes:

A ← flow cover ⟸ South

~~A pitot into flow~~

B

09-May-96

File PAOTPL.WQ2

Method 2 QA/QC Checklist

Plant: 2A Primary Air Outlet
Date: 5/16/96
Start Time: 1945 Stop Time: 2010
Unit ID: 2A Duct ID: Primary Air Outlet
Testers: RW-FUB

Pitot ID S-49 Cp____ Calibration Date____

Pitot Opening Checked? ✓ By Whom? RLO Condition? OK

Leak Check of System? ✓ By Whom? RLO Condition? OK

Dp Gauge ID M91635 Static Pressure Gauge ID M91635

TC ID 4A Handheld TC Readout ID 2

Barometer ID ____

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

861

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Secondary Air Bypass - (Rectangular Duct)

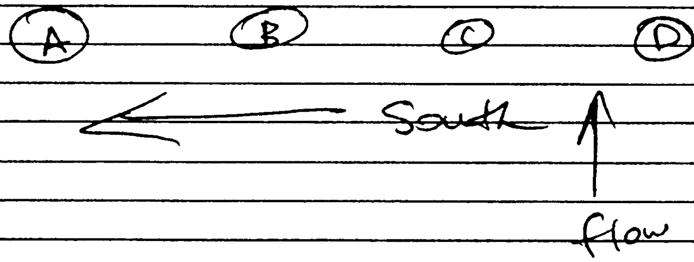
Location or B Duct
Date 5/16/96
Time Begin 1645 End 1700
Bar., " Hg 29.51
Static, " H2O 2.386

Tube I.D. S-53
C-Factor 0.808
Operator(s) Rw, Fuz
for
No. Points 8
Duct Width 17.5 ft
Duct Height 2.09 ft
Duct Area 36.64 Sq ft
Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]	Static
A-1	6-5/16"	141	0.0000	2.416
A-2	18-7/8"	147	0.0000	
B-1	6-5/16"	117	- 0.0004	2.435
B-2	18-7/8"	123	- 0.0002	
C-1	6-5/16"	177	0.0007	2.538
C-2	18-7/8"	171	0.0000	
D-1	6-5/16"	199	- 0.0001	2.156
D-2	18-7/8"	204	0.0000	

Port A = South, D = North

Sampling Notes:



A pitot pointing into flow

File: SA-BPTPL.WQ2

09-May-96

862

Method 2 QA/QC Checklist

Plant: 2B 2nd Air Bypass
Date: 5/16/96
Start Time: 1645 Stop Time: 1700
Unit ID: 2B Duct ID: 2nd Air Bypass
Testers: Rio, Fuz

Pitot ID S-53 Cp 0.808 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? Rio, Fuz Condition? OK

Leak Check of System? ✓ By Whom? Rio, Fuz Condition? OK

Dp Gauge ID M91635 Static Pressure Gauge ID M91635

TC ID 2B Handheld TC Readout ID 2

Barometer ID ________

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

863

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Secondary Air Outlet - (Rectangular Duct)

Location A A or B Duct
Date 5/16/96
Time Begin 18:39 End 19:19
Bar., " Hg 29.49
Static, " H2O 1,241

Tube I.D. 5-54
C-Factor 0.816
Operator(s) JMD LLA
No. Points 24
Duct Width 6.0 ft
Duct Height 9.0 ft
Duct Area 54.00 Sq ft
Amb Air DB, deg F 103.8
Amb Air WB, deg F
Humd, lb/lb BD Air

	PORT/ POINT	DISTANCE From ~~Wall~~ Datum	TEMP Deg-F	DELTA P [" H2O]
18:39	A-1	9"	555.4	0,2672
	A-2	27"	554.1	0.3072
	A-3	45"	552.7	0.2966
	A-4	63"	550.2	0.2458
	A-5	81"	547.8	0.1376
	A-6	99"	545,7	0,3030
	B-1	9"	563,0	0.3437
	B-2	27"	563.0	0,3595
	B-3	45"	561,3	0.2950
	B-4	63"	560.1	0.2665
	B-5	81"	556.5	0,2834
18:56	B-6	99"	549.6	0,2594
	C-1	9"	560.4	0,3514
	C-2	27"	566.2	0.3659
	C-3	45"	566.7	0.2847
	C-4	63"	568.5	0,2646
	C-5	81"	567.8	0.3238
19:08	C-6	99"	565.1	0,3653
19:12	D-1	9"	552,7	0.2643
	D-2	27"	563.9	0,3438
	D-3	45"	568.4	0.2813
	D-4	63"	570.3	0.2890
	D-5	81"	571.1	0,2745
19:19	D-6	99"	570.9	0,3932

Port A = South, D = North

(ADD 3" TO EACH MEASUREMENT OFF-SET INITIALLY COULD NOT BE MEASURED ACCURATELY AT HIGH LOAD) TOO MUCH HOT AIR BLOWING OUT OF PORT.

Sampling Notes:

File: SAOTPL.WQ2 09-May-96

Method 2 QA/QC Checklist

Plant: Milliken
Date: 5/16/96
Start Time:
Stop Time:
Unit ID: UNIT 2
Duct ID: 2A Secondary Air Outlet
Testers: J.A. Witham C.L. Anthony

Pitot ID S-54
Cp 0.816
Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? JAW Condition? Nick in ⊖ end; otherwise OK

Leak Check of System? ✓ By Whom? JAW Condition? OK 7"

Dp Gauge ID M94349
Static Pressure Gauge ID 8WG

TC ID 3A
Handheld TC Readout ID THREE

Barometer ID

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA
ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓ per DCM

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Flue Gas Inlet - (Rectangular Duct)

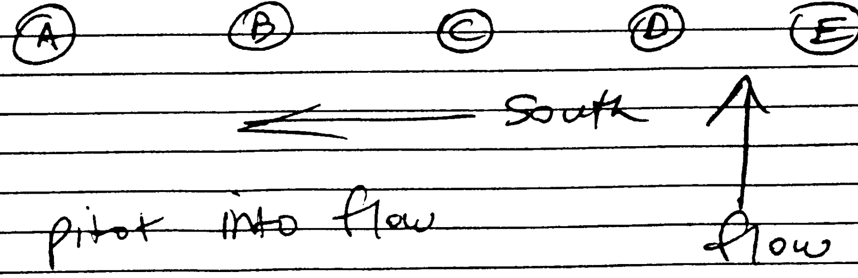
Location or B Duct
Date 5/16/96
Time Begin 2140 End 2220
Bar., " Hg 29.48
Static, " H2O -3.768

Tube I.D. 8-53
No. Points 20
C-Factor 0.808
Duct Width 14.5 ft
Operator(s) RWO, Faz
Duct Height 5.5 ft
Duct Area 79.75 Sq ft
Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	far DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.	Static
A-1	8-1/4"	602	0.2357	6.2		0	0.1	
A-2	24-3/4"	599	0.2986	5.8		1	0.1	-3.686
A-3	41-1/4"	598	0.2848	5.8		~~0~~ 1	0.2	
A-4	57-3/4"	598	0.2682	5.8		~~0~~ 2	0.1	
B-1	8-1/4"	598	0.2408	6.1		0	0.1	
B-2	24-3/4"	596	0.3471	5.9		0	0.1	
B-3	41-1/4"	596	0.3148	5.9		0	0.2	-3.724
B-4	57-3/4"	599	0.2817	5.8		0	0.3	
C-1	8-1/4"	591	0.2617	6.0		0	0.1	
C-2	24-3/4"	591	0.3206	6.0		0	0.1	-3.782
C-3	41-1/4"	592	0.3057	5.7		0	0.1	
C-4	57-3/4"	597	0.2940	5.8		0	0.2	
D-1	8-1/4"	605	0.2448	6.2		1	0.1	
D-2	24-3/4"	606	0.3285	6.2		1	0.1	-3.851
D-3	41-1/4"	605	0.3160	6.4		1	0.1	
D-4	57-3/4"	603	0.3068	6.3		0	0.1	
E-1	8-1/4"	623	0.1463	6.7		3	0.1	
E-2	24-3/4"	624	0.2259	6.5		3	0.1	-3.788
E-3	41-1/4"	613	0.2797	6.6		2	0.1	
E-5	57-3/4"	596	0.2820	6.9		1	0.1	

Port A = South, E = North

Sampling Notes:



A pitot into flow

recal Max 5 w/ 100 ppm CO prior to test

869

Method 2 QA/QC Checklist

Plant: 2B Flue Gas Inlet
Date: 5/16/96
Start Time: 2140 Stop Time: 2220
Unit ID: 2B Duct ID: Flue Gas Inlet
Testers: Rw, Fwz

Pitot ID S-53 Cp 0.808 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? Rw, Fwz Condition? OK

Leak Check of System? ✓ By Whom? Rw, Fwz Condition? OK

Dp Gauge ID M91635 Static Pressure Gauge ID M91635

TC ID 2B Handheld TC Readout ID 2

Barometer ID ______

Leak Check of Gas Sampling System? ✓ By Whom? Rw Condition? OK

Gas Meter ID 118844 ORSAT Bag ID No samples taken

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

8 70

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Flue Gas Outlet - (Rectangular Duct)

Location ______ A or [✓ B] Duct
Date 5-16-96
Time Begin 2145 End 2230

Bar., " Hg 29.48
Static, " H2O -5.799"

Tube I.D. S-52
C-Factor 0.795
Operator(s) GLC
MSN

No. Points 24
Duct Width 34 ft
Duct Height 2.5 ft
Duct Area 85.00 Sq ft

Amb Air DB, deg F ______
Amb Air WB, deg F ______
Humd, lb/lb BD Air ______

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	7-1/2"	256	0.1262	6.4		43	.1
A-2	22-1/2"	256	0.1125	6.3		57	.1
B-1	7-1/2"	255	0.1537	6.3		50	.1
B-2	22-1/2"	255	0.1504	6.2		30	.1
C-1	7-1/2"	253	0.2386	6.2		22	.2
C-2	22-1/2"	254	0.2330	6.3		30	.2
D-1	7-1/2"	252	0.2013	6.4		42	.1
D-2	22-1/2"	252	0.2007	6.1		55	.1
E-1	7-1/2"	251	0.1500	6.7		50	.1
E-2	22-1/2"	251	0.1934	6.6		49	.1
F-1	7-1/2"	257	0.1133	6.8		64	0
F-2	22-1/2"	251	0.1148	6.8		67	0
G-1	7-1/2"	253	0.3062	6.3		33	0
G-2	22-1/2"	254	0.3064	6.4		57	0
H-1	7-1/2"	255	0.3765	6.3		37	0
H-2	22-1/2"	253	0.3178	6.7		49	0
I-1	7-1/2"	253	0.2636	6.4		87	0
I-2	22-1/2"	252	0.2801	6.4		102	0
J-1	7-1/2"	248	0.2529	6.7		89	0
J-2	22-1/2"	250	0.2938	6.5		104	0
K-1	7-1/2"	246	0.2047	6.7		110	0
K-2	22-1/2"	248	0.1558	6.6		124	0
L-1	7-1/2"						
L-2	22-1/2"						

Port A = South, L = North

Sampling Notes:

Letters ARE off by ONE ie A = B
B = C
There is No 'A' PORT. C = D ...

SWITCHED METERS [illegible] RLO/EJE [illegible]

[illegible]

File: FGOTPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: Milliken
Date: 5-16-96
Start Time: ____ Stop Time: ____
Unit ID: 2 Duct ID: F.G. OUTLET B
Testers: MSD - GLC

Pitot ID S-52 Cp 0.798 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? MSD Condition? OK

Leak Check of System? ✓ By Whom? MSD Condition? OK

Dp Gauge ID M-89172 Static Pressure Gauge ID M-89172

TC ID #7B Handheld TC Readout ID #1

Barometer ID ONE

Leak Check of Gas Sampling System? ✓ By Whom? MSD Condition? OK

Gas Meter ID ~~BS-A~~ COOLSIDE ORSAT Bag ID ~~#~~ NONE

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

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NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Primary Flue Gas Outlet - (Rectangular Duct)

Location ______ A or [✓ B] Duct

Date 5-16-96

Time Begin 2045 End 2115

Bar., " Hg 29.51

Static, " H2O -5.257"

Tube I.D. 5-52

No. Points 14

C-Factor 0.798

Duct Width 17.92 ft

Operator(s) MSD GLC

Duct Height 3.28 ft

Duct Area 58.79 Sq ft

Amb Air DB, deg F ______

Amb Air WB, deg F ______

Humd, lb/lb BD Air ______

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	9-7/8"	228	0.0145	9.3		40	.9
A-2	29-9/16"	232	0.0239	8.8		55	.9
B-1	9-7/8"	229	0.0121	8.5		60	.6
B-2	29-9/16"	234	0.0088	8.1		80	.1
C-1	9-7/8"	230	0.0111	8.4		85	.4
C-2	29-9/16"	232	0.0052	8.6		90	.4
D-1	9-7/8"	226	0.0042	8.2		92	.4
D-2	29-9/16"	232	0.0064	8.4		113	.4
E-1	9-7/8"	225	0.0093	8.6		90	.4
E-2	29-9/16"	235	0.0095	7.9		123	.4
F-1	9-7/8"	231	0.0234	9.4		102	.4
F-2	29-9/16"	238	0.0115	8.3		121	.4
G-1	9-7/8"	226	0.0175	8.7		71	.6
G-2	29-9/16"	236	0.0023	8.1		102	.6

Port A = South, L = North

Sampling Notes:

Method 2 QA/QC Checklist

Plant: Milliken
Date: 5-16-96
Start Time: 2045 Stop Time:
Unit ID: 2 Duct ID: PF60-A
Testers: MSO/LLC

Pitot ID 5-52 Cp 0.798 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? MSO Condition? ✓

Leak Check of System? ✓ By Whom? MSO Condition? ✓

Dp Gauge ID ~~7B~~ M-89172 Static Pressure Gauge ID M-89172

TC ID 7B Handheld TC Readout ID ONE

Barometer ID ONE

Leak Check of Gas Sampling System? ✓ By Whom? ✓ Condition? OK

Gas Meter ID TSS-A ORSAT Bag ID NONE

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Inlet - (Rectangular Duct)

Location B A or B Duct

Date 5/16/96

Time Begin 20:53 End 21:18

Bar., " Hg 29.51

Static, " H2O 52.02

Tube I.D. S-50

C-Factor 0.788

Operator(s) LLA JAW

No. Points 12

Duct Width 17.5 ft

Duct Height 3.28 ft

Duct Area 57.42 Sq ft

Amb Air DB, deg F ________

Amb Air WB, deg F ________

Humd, lb/lb BD Air ________

	PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
20:53	A-1	9-7/8"	114.8	0.1080
	A-2	29-9/16"	115.5	0.0263
	B-1	9-7/8"	114.8	0.0438
	B-2	29-9/16"	115.7	0.0099
	C-1	9-7/8"	114.6	0.0295
	C-2	29-9/16"	115.3	0.0100
	D-1	9-7/8"	114.6	0.0194
	D-2	29-9/16"	114.9	0.0111
	E-1	9-7/8"	114.6	0.0033
	E-2	29-9/16"	114.9	0.0077
	F-1	9-7/8"	114.8	-0.0028
21:18	F-2	29-9/16"	114.8	0.0000

Port A = South, F = North

Sampling Notes:

Method 2 QA/QC Checklist

Plant: MILLIKEN
Date: 5/16/96
Start Time: 20:53
Stop Time: 21:18
Unit ID: UNIT 2
Duct ID: 2B PRIMARY AIR INLET
Testers: JAW LLA

Pitot ID S-50 Cp 0.788 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? JAW Condition? OK

Leak Check of System? ✓ By Whom? JAW Condition? OK 6"

Dp Gauge ID M94349 Static Pressure Gauge ID (Devito's)

TC ID 5A Handheld TC Readout ID THREE

Barometer ID

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓ per DCS

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Outlet - (Circular Duct)

876

Location ~~A~~ or B Duct

Date 5/16/96

Time Begin 2050 End 2106

Bar., " Hg 29.51

Static, " H2O 50.23

Tube I.D. S-49

No. Points 20

C-Factor 0.806

Operator(s) RW, Fut

Duct Dia. 47.5 inches

Duct Area 12.31 Sq ft

Amb Air DB, deg F

Amb Air WB, deg F

Humd, lb/lb BD Air

Far

Stat

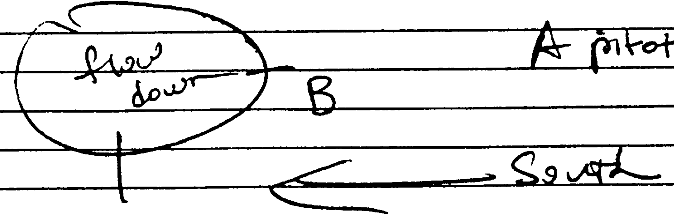
PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	1-3/16"	535	0.1083
A-2	3-7/8"	536	0.1237
A-3	6-15/16"	536	0.1420
A-4	10-3/4"	537	0.1440
A-5	16-1/4"	537	0.1454
A-6	31-1/4"	538	0.1089
A-7	36-3/4"	538	0.0971
A-8	40-9/16"	538	0.0956
A-9	43-5/8"	537	0.0855
A-10	46-5/16"	536	0.0785
B-1	1-3/16"	534	0.1094
B-2	3-7/8"	535	0.1330
B-3	6-15/16"	535	0.1542
B-4	10-3/4"	536	0.1736
B-5	16-1/4"	536	0.1684
B-6	31-1/4"	536	0.1410
B-7	36-3/4"	536	0.1134
B-8	40-9/16"	536	0.1116
B-9	43-5/8"	535	0.1062
B-10	46-5/16"	535	0.0896

50.20

50.27

Port A = South or North, B = East

Sampling Notes:



A pitot into flow

File PAOTPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: 2B Primary Air Outlet
Date: 5/16/96
Start Time: 2050 Stop Time: 2105
Unit ID: 2B Duct ID: Primary Air Outlet
Testers: PW, FUZ

Pitot ID S-49 Cp 0.806 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? PW, FUZ Condition? OK

Leak Check of System? ✓ By Whom? PW, FUZ Condition? OK

Dp Gauge ID M91635 Static Pressure Gauge ID M91635

TC ID ~~2~~ 4A Handheld TC Readout ID 2

Barometer ID ______

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

878

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Secondary Air Outlet - (Rectangular Duct)

Location B A or B Duct

Date 3/16/96

Time Begin 21:46 End 22:29

Tube I.D. S-54

C-Factor 0.816

Operator(s) JMW LLA

No. Points 24

Duct Width 6.0 ft

Duct Height 9.0 ft

Duct Area 54.00 Sq ft

Bar., " Hg 29.48

Static, " H2O 1.183

Amb Air DB, deg F

Amb Air WB, deg F

Humd, lb/lb BD Air

	PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
21:46	A-1	9"	545.5	0.3162
	A-2	27"	560.3	0.3119
	A-3	45"	566.2	0.2663
	A-4	63"	568.9	0.2801
	A-5	81"	569.4	0.3026
	A-6	99"	569.3	0.3657
21:56	B-1	9"	557.9	0.3482
	B-2	27"	564.6	0.3189
	B-3	45"	565.5	0.2741
	B-4	63"	568.5	0.2674
	B-5	81"	568.9	0.3274
22:04	B-6	99"	565.8	0.3640
22:08	C-1	9"	558.5	0.3498
	C-2	27"	560.1	0.3673
	C-3	45"	558.5	0.2773
	C-4	63"	560.3	0.2558
	C-5	81"	557.9	0.3015
22:17	C-6	99"	550.9	0.2873
22:20	D-1	9"	547.3	0.3219
	D-2	27"	545.3	0.2942
	D-3	45"	544.8	0.2823
	D-4	63"	544.4	0.2161
	D-5	81"	543.2	0.2647
22:29	D-6	99"	540.5	0.2863

Port A = South, D = North

Sampling Notes:

879

Method 2 QA/QC Checklist

Plant: Milliken
Date: 5/16/96
Start Time: 21:46
Stop Time: 22:29
Unit ID: UNIT 2
Duct ID: 2B Secondary Air Airfoil
Testers: LLA JAW

Pitot ID 5-54 Cp 0.816 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? JAW Condition? Small nick in ⊖ side

Leak Check of System? ✓ By Whom? JAW Condition? OK 3"

Dp Gauge ID M94349 Static Pressure Gauge ID 8WG

TC ID 3A Handheld TC Readout ID THREE

Barometer ID ________

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

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NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Flue Gas Outlet - (Rectangular Duct)

Location A A or B Duct

Date 5/17/96

Time Begin 08:54 End 09:25

Bar., " Hg 29.48

Static, " H2O -13.89

Tube I.D. 5-51

C-Factor 0.824

Operator(s) JHW RLO

No. Points 24

Duct Width 34 ft

Duct Height 2.5 ft

Duct Area 85.00 Sq ft

Amb Air DB, deg F

Amb Air WB, deg F

Humd, lb/lb BD Air

PORT/ POINT	DISTANCE WEST " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	7-1/2"	279.6	0.6589				
A-2	22-1/2"	280.4	0.7986				
B-1	7-1/2"	279.3	0.5964				
B-2	22-1/2"	280.0	0.6051				
C-1	7-1/2"	278.4	0.7490				
C-2	22-1/2"	279.5	0.8002				
D-1	7-1/2"	279.3	0.6866				
D-2	22-1/2"	280.4	0.7795				
E-1	7-1/2"	281.1	0.6404				
E-2	22-1/2"	281.8	0.6386				
F-1	7-1/2"	281.3	0.5611				
F-2	22-1/2"	281.8	0.7025				
G-1	7-1/2"	279.6	0.3252				
G-2	22-1/2"	281.1	0.4210				
H-1	7-1/2"	280.4	0.4324				
H-2	22-1/2"	281.1	0.4330				
I-1	7-1/2"	281.4	0.4917				
I-2	22-1/2"	281.6	0.4708				
J-1	7-1/2"	282.5	0.5423				
J-2	22-1/2"	283.4	0.5325				
K-1	7-1/2"	281.4	0.5310				
K-2	22-1/2"	283.2	0.6011				
L-1	7-1/2"	280.9	0.5087				
L-2	22-1/2"	283.1	0.5060				

08:54

Port A = South, L = North

Sampling Notes:

File: FGOTPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: MILLIKEN
Date: 5/17/96
Start Time: ______ Stop Time: ______
Unit ID: UNIT 2 Duct ID: 2A FLUE GAS OUTLET
Testers: JAW RLO

Pitot ID S-51 Cp 0.824 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? JAW Condition? OK

Leak Check of System? ✓ By Whom? JAW Condition? OK 8"

Dp Gauge ID M94349 Static Pressure Gauge ID DAN'S

TC ID 6-C Handheld TC Readout ID TWO

Barometer ID ______

Leak Check of Gas Sampling System? NA By Whom? NA Condition? NA

Gas Meter ID NA ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

-4.412

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NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Flue Gas Outlet - (Rectangular Duct)

Location ______ A or [✓ B Duct]
Date 5-17-96
Time Begin 0853 End 0920
Tube I.D. S-52
No. Points 24
C-Factor 0.798
Duct Width 34 ft
Operator(s) GLC, LLA
Duct Height 2.5 ft
Duct Area 85.00 Sq ft
Bar., " Hg 29.48
Static, " H2O -13.95"
Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	7-1/2"						
A-2	22-1/2"						
B-1	7-1/2"	277	0.3477				
B-2	22-1/2"	277	0.3163				
C-1	7-1/2"	279	0.4419				
C-2	22-1/2"	278	0.4590				
D-1	7-1/2"	280	0.6331				
D-2	22-1/2"	280	0.6474				
E-1	7-1/2"	282	0.5638				
E-2	22-1/2"	281	0.5643				
F-1	7-1/2"	283	0.4389				
F-2	22-1/2"	283	0.5556				
G-1	7-1/2"	282	0.3500				
G-2	22-1/2"	281	0.3083				
H-1	7-1/2"	280	0.9035				
H-2	22-1/2"	280	0.8744				
I-1	7-1/2"	280	1.083				
I-2	22-1/2"	281	0.9347				
J-1	7-1/2"	283	0.7350				
J-2	22-1/2"	283	0.8184				
K-1	7-1/2"	287	0.6442				
K-2	22-1/2"	287	0.7890				
L-1	7-1/2"	288	0.5863				
L-2	22-1/2"	287	0.4438				

Port A = ~~South~~ NORTH, L = ~~North~~

Sampling Notes:

Method 2 QA/QC Checklist

Plant: Milliken
Date: ~~5-16~~ 5-17-96
Start Time: 0853 Stop Time: 0920
Unit ID: #2 Duct ID: F.G. OUTLET B
Testers: LLA - GLC

Pitot ID S-52 Cp 0.798 Calibration Date 5/96

Pitot Opening Checked? ✓ By Whom? LLA Condition? OK

Leak Check of System? ✓ By Whom? LLA Condition? OK

Dp Gauge ID ADM Static Pressure Gauge ID ADM

TC ID #7B Handheld TC Readout ID #1

Barometer ID ONE

Leak Check of Gas Sampling System? N/A By Whom?____ Condition?____

Gas Meter ID N/A ORSAT Bag ID NONE

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? N/A
Gas Meter Calibrated? N/A
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

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APPENDIX F

TRAVERSE DATA CALCULATED RESULTS

Table F-1

Traverse Data Calculated Results – 2A Heat Pipe Flue Gas Inlet Duct
NYSEG Milliken Station

Coal Composition

Moisture	6.43%
C	73.60%
H	4.86%
N	1.53%
S	1.87%
O	4.32%
Ash	7.39%
Total	100.00%

Overhead Ash	90.00%
C in Ash	2.89%
Amb Air DB, deg F	63
Amb Air WB, deg F	49
Humd, lb/lb BD Air	0.00422

Std. Conditions

T, deg F	60
P, in. Hg	29.92

Date	05/14/96
Time	12:20-13:20
Tube I.D.	S-53
C-Factor	0.808
Operator(s)	RLO/FUZ

No. Of Points	20
Duct Width	14.5 ft
Duct Height	5.5 ft
Duct Area	79.75 Sq ft
Avg % O2	3.71
Avg % CO2	15.05
Avg % N2	81.25

Bar., " Hg	29.74
Static, " H2O	-9.27
Avg % H2O	6.92
Dry MW	30.57
Wet MW	29.70

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	8-1/4"	698	0.7277	68.25	3.6	15.2	15	0.1
A-2	24-3/4"	702	0.8552	74.14	4.0	14.8	6	0.1
A-3	41-1/4"	699	0.7826	70.82	3.9	14.9	6	0.1
A-4	57-3/4"	688	0.7646	69.66	3.7	15.1	7	0.1
B-1	8-1/4"	657	0.7967	70.09	3.0	15.7	5	0.1
B-2	24-3/4"	663	1.0640	81.26	3.4	15.3	6	0.1
B-3	41-1/4"	669	0.9219	75.86	3.9	14.9	5	0.1
B-4	57-3/4"	671	0.9460	76.97	4.5	14.3	5	0.1
C-1	8-1/4"	665	0.7935	70.21	3.1	15.6	5	0.1
C-2	24-3/4"	661	1.1240	83.44	3.4	15.3	2	0.1
C-3	41-1/4"	655	1.0040	78.66	3.6	15.2	3	0.1
C-4	57-3/4"	658	0.8974	74.48	3.9	14.9	4	0.1
D-1	8-1/4"	686	0.7711	69.89	3.5	15.2	2	0.1
D-2	24-3/4"	675	1.0680	81.85	3.6	15.2	2	0.1
D-3	41-1/4"	665	1.0170	79.53	3.7	15.1	2	0.1
D-4	57-3/4"	663	0.9340	76.17	4.0	14.8	2	0.1
E-1	8-1/4"	704	0.7441	69.21	3.8	15.0	2	0.1
E-2	24-3/4"	689	0.8996	75.60	3.8	15.0	2	0.1
E-3	41-1/4"	675	0.8815	74.38	3.8	15.0	1	0.1
E-5	57-3/4"	669	0.8609	73.31	3.9	14.9	2	0.1
Average, (group mean)		676	0.8927	74.69	3.7	15.1	4	0.10
Average, (wt mean)		675	---	---	3.7	15.0	4	0.10
Maximum		704	1.1240	83.44	4.5	15.7	15	0.10
Minimum		655	0.7277	68.25	3.0	14.3	1	0.10
Standard Deviation		16	0.1143	4.46	0.3	0.3	3	0.00

Port A = South, E = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	74.69
Velocity, [fpm]	4,481
ACFM	357,389
SCFM	158,987
DSCFM	147,982
Ex Air Free	121,742
lb/hr Flue Gas (dry)	715,127
lb/hr Flue Gas (wet)	746,467

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	74.69
Velocity, [fpm]	4,481
ACFM	357,389
SCFM	158,987
DSCFM	147,981
Ex Air Free	121,742
lb/hr Flue Gas (dry)	715,125
lb/hr Flue Gas (wet)	746,465

Table F-2

Traverse Data Calculated Results – 2A Heat Pipe Flue Gas Outlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	6.43%	Overhead Ash	90.00%	Std. Conditions	
C	73.60%	C in Ash	2.89%	T, deg F	60
H	4.86%			P, in. Hg	29.92
N	1.53%	Amb Air DB, deg F	63		
S	1.87%	Amb Air WB, deg F	49		
O	4.32%	Humd, lb/lb BD Air	0.00422		
Ash	7.39%				
Total	100.00%				
		No. Of Points	24		
		Duct Width	34.0 ft	Bar., " Hg	29.75
Date	05/14/96	Duct Depth	2.5 ft	Static, " H2O	-13.93
Time	12:20-13:15	Duct Area	85.00 Sq ft		
Tube I.D.	S-52	Avg % O2	4.21	% H20	6.76
C-Factor	0.798	Avg % CO2	14.62	Dry MW	30.53
Operator(s)	MSD/GLC	Avg % N2	81.17	Wet MW	29.68

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	7-1/2"	291	0.8734	59.84	4.3	14.5	1	0.0
A-2	22-1/2"	294	0.7064	53.91	4.2	14.7	0	0.0
B-1	7-1/2"	294	0.6432	51.44	4.1	14.7	1	0.0
B-2	22-1/2"	294	0.6759	52.74	4.2	14.7	1	0.0
C-1	7-1/2"	292	0.8642	59.55	4.2	14.7	2	0.0
C-2	22-1/2"	291	0.8341	58.47	4.2	14.7	2	0.0
D-1	7-1/2"	293	0.8280	58.33	4.1	14.7	2	0.0
D-2	22-1/2"	292	0.7919	57.01	4.2	14.7	2	0.0
E-1	7-1/2"	292	0.6506	51.67	4.2	14.7	3	0.0
E-2	22-1/2"	294	0.7634	56.05	4.1	14.7	2	0.0
F-1	7-1/2"	292	0.8046	57.47	4.3	14.5	4	0.0
F-2	22-1/2"	294	0.6543	51.89	4.1	14.7	3	0.0
G-1	7-1/2"	290	0.4858	44.59	4.2	14.7	1	0.0
G-2	22-1/2"	291	0.3909	40.03	4.2	14.7	1	0.0
H-1	7-1/2"	293	0.4633	43.63	4.2	14.7	2	0.0
H-2	22-1/2"	292	0.5263	46.47	4.2	14.7	2	0.0
I-1	7-1/2"	297	0.5029	45.58	4.1	14.7	4	0.0
I-2	22-1/2"	298	0.5490	47.65	4.1	14.7	2	0.0
J-1	7-1/2"	302	0.6084	50.29	4.0	14.8	3	0.0
J-2	22-1/2"	302	0.5850	49.31	3.9	14.9	4	0.0
K-1	7-1/2"	303	0.5340	47.17	4.4	14.5	3	0.0
K-2	22-1/2"	303	0.5852	49.37	4.4	14.5	3	0.0
L-1	7-1/2"	303	0.5614	48.36	4.4	14.5	4	0.0
L-2	22-1/2"	301	0.5654	48.48	4.7	14.2	5	0.0
Average, (group mean)		295	0.6437	51.22	4.2	14.6	2	0.0
Average, (wt mean)		295	---	---	4.2	14.6	2	0.00
Maximum		303	0.8734	59.84	4.7	14.9	5	0.0
Minimum		290	0.3909	40.03	3.9	14.2	0	0.0
Standard Deviation		4	0.1348	5.35	0.2	0.1	1	0.0

Port A = North, L = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	51.22
Velocity, [fpm]	3,073
ACFM	261,229
SCFM	172,690
DSCFM	161,023
Ex Air Free	128,609
lb/hr Flue Gas (dry)	776,925
lb/hr Flue Gas (wet)	810,149

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	51.22
Velocity, [fpm]	3,073
ACFM	261,229
SCFM	172,690
DSCFM	161,023
Ex Air Free	128,609
lb/hr Flue Gas (dry)	776,925
lb/hr Flue Gas (wet)	810,149

Table F-3

Traverse Data Calculated Results – 2A Heat Pipe Primary Flue Gas Out Duct
NYSEG Milliken Station

Coal Composition

Moisture	6.43%
C	73.60%
H	4.86%
N	1.53%
S	1.87%
O	4.32%
Ash	7.39%
Total	100.00%

Overhead Ash	90.00%
C in Ash	2.89%
Amb Air DB, deg F	63
Amb Air WB, deg F	49
Humd, lb/lb BD Air	0.00422

Std. Conditions

T, deg F	60
P, in. Hg	29.92

Date	05/14/96
Time	14:00-14:40
Tube I.D.	S-52
C-Factor	0.809
Operator(s)	MSD/GLC

No. Of Points	14
Duct Width	17.92 ft
Duct Height	3.28 ft
Duct Area	58.79 Sq ft
Avg % O2	4.82
Avg % CO2	14.08
Avg % N2	81.10

Bar., " Hg	29.74
Static, " H2O	-12.92
% H2O	6.54
Dry MW	30.46
Wet MW	29.65

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	9-7/8"	289	0.0600	15.87	5.3	13.7	2	0.1
A-2	29-9/16"	292	0.0427	13.41	4.9	14.0	2	0.1
B-1	9-7/8"	291	0.0610	16.02	4.7	14.2	2	0.1
B-2	29-9/16"	303	0.0309	11.48	3.4	15.3	2	0.1
C-1	9-7/8"	286	0.0192	8.96	5.7	13.3	1	0.1
C-2	29-9/16"	299	0.0172	8.56	5.4	13.6	0	0.1
D-1	9-7/8"	289	0.0415	13.19	4.4	14.5	0	0.1
D-2	29-9/16"	301	0.0234	9.99	5.4	13.6	0	0.1
E-1	9-7/8"	289	0.0463	13.95	5.6	13.4	0	0.1
E-2	29-9/16"	303	0.0312	11.54	4.2	14.7	0	0.1
F-1	9-7/8"	292	0.0546	15.16	4.4	14.5	0	0.1
F-2	29-9/16"	299	0.0224	9.76	5.1	13.9	0	0.1
G-1	9-7/8"	291	0.0485	14.28	4.7	14.2	2	0.1
G-2	29-9/16"	293	0.0163	8.29	4.5	14.3	1	0.1
Average, (group mean)		294	0.0368	12.18	4.84	14.06	0.86	0.10
Average, (wt mean)		294	---	---	4.8	14.1	1	0.10
Maximum		303	0.0610	16.02	5.70	15.30	2.00	0.10
Minimum		286	0.0163	8.29	3.40	13.30	0.00	0.10
Standard Deviation		6	0.0153	2.64	0.61	0.54	0.91	0.00

Port A = South, G = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	12.18
Velocity, [fpm]	731
ACFM	42,954
SCFM	28,521
DSCFM	26,655
Ex Air Free	20,509
lb/hr Flue Gas (dry)	128,344
lb/hr Flue Gas (wet)	133,659

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	12.19
Velocity, [fpm]	731
ACFM	42,999
SCFM	28,552
DSCFM	26,684
Ex Air Free	20,531
lb/hr Flue Gas (dry)	128,485
lb/hr Flue Gas (wet)	133,806

Table F-4

Traverse Data Calculated Results -- 2A Heat Pipe Primary Air Inlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	63
Amb Air WB, deg F	49
Humd, lb/lb BD Air	0.00422

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

Date	05/14/96
Time	14:15-14:50
Tube I.D.	S-50
C-Factor	0.789
Operator(s)	JAW/LLA

No. Of Point	12
Duct Width	17.5 ft
Duct Depth	3.28 ft
Duct Area	57.42 Sq ft
Avg % O2	21.0
Avg % N2	79.0

Bar., " Hg	29.74
Static, " H20	53.44
% H20	0.67
Dry MW	28.97
Wet MW	28.90

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	9-7/8"	111	-0.0006	-1.27
A-2	29-9/16"	112	0.0022	2.42
B-1	9-7/8"	111	0.0361	9.81
B-2	29-9/16"	111	0.0117	5.59
C-1	9-7/8"	110	0.0593	12.57
C-2	29-9/16"	111	0.0101	5.19
D-1	9-7/8"	111	0.0298	8.92
D-2 (1)	29-9/16"	111	0.0094	5.01
E-1	9-7/8"	111	0.0469	11.18
E-2	29-9/16"	112	0.0087	4.82
F-1	9-7/8"	110	0.1432	19.54
F-2	29-9/16"	111	0.0293	8.85
Average, (group mean)		111	0.0322	7.72
Average, (wt mean)		111	---	---
Maximum		112	0.1432	19.54
Minimum		110	-0.0006	-1.27
Standard Deviation		1	0.0379	5.15

Ports A = South, F = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	7.72
Velocity, [fpm]	463
ACFM	26,596
SCFM	27,277
DSCFM	27,093
lb/hr Air (dry)	124,060
lb/hr Air (wet)	124,583

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	7.72
Velocity, [fpm]	463
ACFM	26,596
SCFM	27,278
DSCFM	27,094
lb/hr Flue Gas (dry)	124,063
lb/hr Flue Gas (wet)	124,587

(1) Port Obstructed By I-Beam. Averaged Values For Points C-2 and E-2.

Table F-5

Traverse Data Calculated Results -- 2A Heat Pipe Primary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F 63
Amb Air WB, deg F 49
Humd, lb/lb BD Air 0.00422

Std. Conditions
T, deg F 60
P, In. Hg 29.92

Date 05/14/96
Time 13:45-14:30
Tube I.D. S-49
C-Factor 0.806
Operator(s) RLO/FUZ

No. Of Points 20
Duct Dia 47.5 inches
Duct Area 12.31 Sq ft
Avg % O2 21.0
Avg % N2 79.0

Bar., " Hg 29.74
Static, " H20 48.79

% H20 0.67
Dry MW 28.97
Wet MW 28.90

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	1-3/16"	588	0.2126	33.14
A-2	3-7/8"	589	0.2684	37.26
A-3	6-15/16"	590	0.2936	38.99
A-4	10-3/4"	591	0.3452	42.29
A-5	16-1/4"	592	0.3123	40.25
A-6	31-1/4"	592	0.4194	46.64
A-7	36-3/4"	592	0.4181	46.57
A-8	40-9/16"	591	0.4136	46.30
A-9	43-5/8"	591	0.3844	44.63
A-10	46-5/16"	590	0.3230	40.89
B-1	1-3/16"	595	0.3239	41.05
B-2	3-7/8"	595	0.3754	44.19
B-3	6-15/16"	596	0.3934	45.26
B-4	10-3/4"	596	0.3661	43.66
B-5	16-1/4"	597	0.4030	45.83
B-6	31-1/4"	597	0.3191	40.78
B-7	36-3/4"	596	0.2885	38.76
B-8	40-9/16"	595	0.2493	36.01
B-9	43-5/8"	593	0.2338	34.84
B-10	46-5/16"	590	0.1909	31.44
Average, (group mean)		593	0.3267	40.94
Average, (wt mean)		593	---	---
Maximum		597	0.4194	46.64
Minimum		588	0.1909	31.44
Standard Deviation		3	0.0688	4.49

Ports A = South, B = East

Data Summary Straight Avg'd Data	
Velocity, [fps]	40.94
Velocity, [fpm]	2,456
ACFM	30,227
SCFM	16,623
DSCFM	16,511
lb/hr Air (dry)	75,605
lb/hr Air (wet)	75,924

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	40.94
Velocity, [fpm]	2,456
ACFM	30,227
SCFM	16,623
DSCFM	16,511
lb/hr Flue Gas (dry)	75,605
lb/hr Flue Gas (wet)	75,924

Table F-6

Traverse Data Calculated Results -- 2A Heat Pipe Secondary Air By-Pass Duct
NYSEG Milliken Station

Amb Air DB, deg F	63
Amb Air WB, deg F	49
Humd, lb/lb BD Air	0.00422

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

Date	5/14/96
Time	09:40 hrs
Tube I.D.	S-53
C-Factor	0.808
Operator(s)	RLO/FUZ

No. Of Point	8	
Duct Width	17.5	ft
Duct Depth	2.09	ft
Duct Area	36.64	Sq ft
Avg % O2	21.0	
Avg % N2	79.0	

Bar., " Hg	29.74
Static, " H2	3.70
% H20	0.67
Dry MW	28.97
Wet MW	28.90

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	6-5/16"	233	-0.0001	-0.62
A-2	18-7/8"	233	0.0000	0.00
B-1	6-5/16"	220	0.0000	0.00
B-2	18-7/8"	221	-0.0001	-0.61
C-1	6-5/16"	216	-0.0001	-0.61
C-2	18-7/8"	214	0.0000	0.00
D-1	6-5/16"	210	-0.0001	-0.61
D-2	18-7/8"	207	0.0000	0.00
Average, (group mean)		219	-0.0001	-0.31
Average, (wt mean)		220	---	---
Maximum		233	0.0000	0.00
Minimum		207	-0.0001	-0.62
Standard Deviation		9	0.0001	0.31

Ports A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	-0.31
Velocity, [fpm]	-18
ACFM	(672)
SCFM	(516)
DSCFM	(512)
lb/hr Air (dry)	(2,346)
lb/hr Air (wet)	(2,356)

Summary Weighted Avg Results	
Velocity, [fps]	-0.31
Velocity, [fpm]	-18
ACFM	(672)
SCFM	(516)
DSCFM	(512)
lb/hr Flue Gas (dry)	(2,346)
lb/hr Flue Gas (wet)	(2,356)

Table F-7

Traverse Data Calculated Results -- 2A Heat Pipe Secondary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	63
Amb Air WB, deg F	49
Humd, lb/lb BD Air	0.00422

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

Date	05/14/96
Time	12:23-13:16
Tube I.D.	S-54
C-Factor	0.816
Operator(s)	JAW/LLA

No. Of Points	24	
Duct Width	6.0	ft
Duct Depth	9.0	ft
Duct Area	54.00	Sq ft
Avg % O2	21.0	
Avg % N2	79.0	

Bar., " Hg	29.74
Static, " H20	1.97
% " H20	0.67
Dry MW	28.97
Wet MW	28.90

PORT/ POINT	DISTANCE Fr Bottom (1)	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	12"	604	0.7361	66.43
A-2	30"	604	0.8396	70.96
A-3	48"	603	0.8180	70.01
A-4	66"	604	0.6702	63.37
A-5	84"	601	0.5907	59.43
A-6	102"	597	0.7854	68.39
B-1	12"	610	0.9801	76.85
B-2	30"	612	0.9652	76.35
B-3	48"	614	0.8031	69.72
B-4	66"	617	0.7182	66.00
B-5	84"	614	0.7579	67.71
B-6	102"	604	0.7033	64.92
C-1	12"	604	0.9273	74.57
C-2	30"	613	1.0660	80.27
C-3	48"	619	0.7930	69.42
C-4	66"	624	0.7916	69.52
C-5	84"	625	0.9004	74.19
C-6	102"	622	1.0580	80.31
D-1	12"	598	0.7731	67.89
D-2	30"	608	0.9814	76.86
D-3	48"	616	0.8351	71.17
D-4	66"	623	0.8593	72.40
D-5	84"	625	0.7635	68.30
D-6	102"	624	1.0520	80.16
Average, (group mean)		612	0.8404	71.05
Average, (wt mean)		612	---	---
Maximum		625	1.0660	80.31
Minimum		597	0.5907	59.43
Standard Deviation		9	0.1245	5.38

Port A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	71.05
Velocity, [fpm]	4,263
ACFM	230,199
SCFM	111,553
DSCFM	110,802
lb/hr Air (dry)	507,364
lb/hr Air (wet)	509,505

Summary Weighted Avg Results	
Velocity, [fps]	70.99
Velocity, [fpm]	4,260
ACFM	230,017
SCFM	111,466
DSCFM	110,714
lb/hr Flue Gas (dry)	506,965
lb/hr Flue Gas (wet)	509,104

(1) Due to additional offset, distances are 3" higher than desired. Unequal areas at top and bottom of duct are accounted for in weighted average value results.

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Table F-8

Traverse Data Calculated Results -- 2B Heat Pipe Flue Gas Inlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	6.43%	Overhead Ash	90.00%	**Std. Conditions**	
C	73.60%	C in Ash	2.89%	T, deg F	60
H	4.86%			P, in. Hg	29.92
N	1.53%	Amb Air DB, deg F	63		
S	1.87%	Amb Air WB, deg F	49		
O	4.32%	Humd, lb/lb BD Air	0.00422		
Ash	7.39%				
Total	100.00%				
		No. Of Points	20		
		Duct Width	14.5 ft	Bar., " Hg	29.68
Date	05/14/96	Duct Height	5.5 ft	Static, " H2O	-9.35
Time	17:05-18:40	Duct Area	79.75 Sq ft		
Tube I.D.	S-53	Avg % O2	5.21	Avg % H2O	6.41
C-Factor	0.808	Avg % CO2	13.74	Dry MW	30.42
Operator(s)	RLO/FUZ	Avg % N2	81.05	Wet MW	29.63

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	8-1/4"	669	0.7616	69.21	6.8	12.4	1	0.2
A-2	24-3/4"	665	0.8729	73.91	6.0	13.1	1	0.2
A-3	41-1/4"	669	0.8471	72.90	5.5	13.5	1	0.2
A-4	57-3/4"	676	0.6765	65.29	4.4	14.5	1	0.2
B-1	8-1/4"	670	0.7248	67.36	3.6	15.2	2	0.1
B-2	24-3/4"	665	1.0060	79.19	3.7	15.1	2	0.1
B-3	41-1/4"	661	0.9792	78.00	3.9	14.9	2	0.1
B-4	57-3/4"	670	0.8050	71.03	4.3	14.5	3	0.1
C-1	8-1/4"	664	0.7276	67.34	4.2	14.7	4	0.1
C-2	24-3/4"	658	0.9473	76.67	4.7	14.2	4	0.1
C-3	41-1/4"	654	0.8964	74.39	3.8	15.0	3	0.2
C-4	57-3/4"	657	0.8580	72.90	4.2	14.7	3	0.1
D-1	8-1/4"	690	0.7278	68.33	7.5	11.7	4	0.0
D-2	24-3/4"	691	0.8947	75.81	7.8	11.5	3	0.0
D-3	41-1/4"	692	0.8915	75.59	6.1	13.0	3	0.0
D-4	57-3/4"	684	0.8802	74.85	6.1	13.0	3	0.0
E-1	8-1/4"	726	0.4202	52.59	5.0	14.0	4	0.0
E-2	24-3/4"	727	0.5619	60.89	5.9	13.1	5	0.0
E-3	41-1/4"	717	0.7495	70.02	5.8	13.2	3	0.0
E-5	57-3/4"	688	0.9025	75.86	5.1	13.9	3	0.0
Average, (group mean)		680	0.8065	71.11	5.2	13.7	3	0.09
Average, (wt mean)		678	---	---	5.2	13.7	3	0.09
Maximum		727	1.0060	79.19	7.8	15.2	5	0.20
Minimum		654	0.4202	52.59	3.6	11.5	1	0.00
Standard Deviation		21	0.1390	6.20	1.2	1.1	1	0.08

Port A = South, E = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	71.11
Velocity, [fpm]	4,266
ACFM	340,241
SCFM	150,604
DSCFM	140,953
Ex Air Free	105,818
lb/hr Flue Gas (dry)	677,817
lb/hr Flue Gas (wet)	705,301

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	71.11
Velocity, [fpm]	4,266
ACFM	340,241
SCFM	150,602
DSCFM	140,950
Ex Air Free	105,816
lb/hr Flue Gas (dry)	677,804
lb/hr Flue Gas (wet)	705,288

Table F-9

Traverse Data Calculated Results -- 2B Heat Pipe Flue Gas Outlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	6.43%	Overhead Ash	90.00%	Std. Conditions	
C	73.60%	C in Ash	2.89%	T, deg F	60
H	4.86%			P, in. Hg	29.92
N	1.53%	Amb Air DB, deg F	63		
S	1.87%	Amb Air WB, deg F	49		
O	4.32%	Humd, lb/lb BD Air	0.00422		
Ash	7.39%				
Total	100.00%				
		No. Of Points	24		
		Duct Width	34.0 ft	Bar., " Hg	29.68
Date	05/14/96	Duct Depth	2.5 ft	Static, " H2O	-13.85
Time	17:15-18:00	Duct Area	85.00 Sq ft		
Tube I.D.	S-52	Avg % O2	4.50	% H20	6.64
C-Factor	0.798	Avg % CO2	14.33	Dry MW	30.49
Operator(s)	MSD/GLC	Avg % N2	81.17	Wet MW	29.66

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1 (1)	7-1/2"	283	0.3044	35.18	4.5	14.3	3	0.0
A-2 (1)	22-1/2"	283	0.3184	35.99	4.6	14.3	3	0.0
B-1	7-1/2"	283	0.3044	35.18	4.5	14.3	3	0.0
B-2	22-1/2"	283	0.3184	35.99	4.6	14.3	3	0.0
C-1	7-1/2"	283	0.4246	41.56	4.6	14.3	3	0.0
C-2	22-1/2"	283	0.4419	42.39	4.5	14.3	3	0.0
D-1	7-1/2"	282	0.5977	49.26	4.4	14.5	2	0.0
D-2	22-1/2"	283	0.6179	50.13	4.5	14.3	3	0.0
E-1	7-1/2"	281	0.5298	46.36	4.5	14.3	1	0.0
E-2	22-1/2"	281	0.5348	46.57	4.6	14.3	1	0.0
F-1	7-1/2"	281	0.4140	40.98	4.6	14.3	0	0.0
F-2	22-1/2"	281	0.5449	47.00	4.3	14.5	0	0.0
G-1	7-1/2"	281	0.3303	36.60	4.5	14.3	1	0.0
G-2	22-1/2"	281	0.3020	35.00	4.6	14.3	0	0.0
H-1	7-1/2"	281	0.8070	57.19	4.2	14.7	0	0.0
H-2	22-1/2"	282	0.8227	57.79	4.3	14.5	0	0.0
I-1	7-1/2"	281	0.9855	63.21	4.4	14.5	0	0.0
I-2	22-1/2"	281	0.8914	60.12	4.3	14.5	0	0.0
J-1	7-1/2"	281	0.6863	52.76	4.5	14.3	1	0.0
J-2	22-1/2"	280	0.7863	56.43	4.5	14.3	0	0.0
K-1	7-1/2"	278	0.6303	50.46	4.6	14.3	2	0.0
K-2	22-1/2"	279	0.8159	57.45	4.6	14.3	1	0.0
L-1	7-1/2"	278	0.5471	47.02	4.8	14.1	0	0.0
L-2	22-1/2"	279	0.4477	42.56	4.7	14.2	2	0.0
Average, (group mean)		281	0.5585	46.80	4.5	14.3	1	0.0
Average, (wt mean)		281	---	---	4.5	14.3	1	0.00
Maximum		283	0.9855	63.21	4.8	14.7	3	0.0
Minimum		278	0.3020	35.00	4.2	14.1	0	0.0
Standard Deviation		2	0.2039	8.65	0.1	0.1	1	0.0

Port A = North, L = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	46.80
Velocity, [fpm]	2,808
ACFM	238,672
SCFM	160,429
DSCFM	149,771
Ex Air Free	117,538
lb/hr Flue Gas (dry)	721,817
lb/hr Flue Gas (wet)	752,168

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	46.80
Velocity, [fpm]	2,808
ACFM	238,672
SCFM	160,430
DSCFM	149,771
Ex Air Free	117,538
lb/hr Flue Gas (dry)	721,817
lb/hr Flue Gas (wet)	752,168

(1) No Port at Location Due to Structural Steel Support. Used Values For Port "B".

Table F-10

Traverse Data Calculated Results -- 2B Heat Pipe Primary Flue Gas Out Duct
NYSEG Milliken Station

Coal Composition					
Moisture	6.43%	Overhead Ash	90.00%	**Std. Conditions**	
C	73.60%	C in Ash	2.89%	**T, deg F**	60
H	4.86%			**P, in. Hg**	29.92
N	1.53%	Amb Air DB, deg F	63		
S	1.87%	Amb Air WB, deg F	49		
O	4.32%	Humd, lb/lb BD Air	0.00422		
Ash	7.39%				
Total	100.00%				

		No. Of Points	14	Bar., " Hg	29.68
Date	05/14/96	Duct Width	17.92 ft	Static, " H2O	-12.39
Time	16:10-16:45	Duct Height	3.28 ft		
Tube I.D.	S-52	Duct Area	58.79 Sq ft	% H2O	6.10
C-Factor	0.798	Avg % O2	6.11	Dry MW	30.34
Operator(s)	MSD/GLC	Avg % CO2	12.96	Wet MW	29.58
		Avg % N2	80.93		

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	9-7/8"	265	0.0595	15.37	7.4	11.9	0	0.1
A-2	29-9/16"	264	0.0157	7.89	7.2	12.0	0	0.1
B-1	9-7/8"	272	0.0309	11.12	6.3	12.8	0	0.1
B-2	29-9/16"	278	0.0297	10.94	5.3	13.7	0	0.1
C-1	9-7/8"	271	0.0410	12.80	6.4	12.7	0	0.1
C-2	29-9/16"	274	0.0022	2.97	5.2	13.8	0	0.1
D-1	9-7/8"	267	0.0207	9.06	5.0	14.0	0	0.1
D-2	29-9/16"	271	0.0066	5.14	6.1	13.0	0	0.1
E-1	9-7/8"	263	0.0346	11.68	5.3	13.7	0	0.1
E-2	29-9/16"	274	-0.0027	-3.32	4.4	14.5	0	0.1
F-1	9-7/8"	265	0.0367	12.06	5.7	13.3	0	0.1
F-2	29-9/16"	259	0.0096	6.15	7.7	11.6	4	0.1
G-1	9-7/8"	265	0.0511	14.23	5.9	13.1	5	0.1
G-2	29-9/16"	271	0.0001	0.63	5.5	13.5	12	0.1
Average, (group mean)		268	0.0240	8.34	5.96	13.09	1.50	0.10
Average, (wt mean)		268	---	---	6.1	13.0	1	0.10
Maximum		278	0.0595	15.37	7.70	14.45	12.00	0.10
Minimum		259	-0.0027	-3.32	4.40	11.55	0.00	0.10
Standard Deviation		5	0.0189	5.23	0.93	0.82	3.31	0.00

Port A = North, G = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	8.34
Velocity, [fpm]	500
ACFM	29,408
SCFM	20,208
DSCFM	18,975
Ex Air Free	13,431
lb/hr Flue Gas (dry)	90,983
lb/hr Flue Gas (wet)	94,495

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	8.37
Velocity, [fpm]	502
ACFM	29,536
SCFM	20,305
DSCFM	19,066
Ex Air Free	13,495
lb/hr Flue Gas (dry)	91,420
lb/hr Flue Gas (wet)	94,948

Table F-11

Traverse Data Calculated Results -- 2B Heat Pipe Primary Air Inlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	63
Amb Air WB, deg F	49
Humd, lb/lb BD Air	0.00422

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

Date	05/14/96
Time	16:10-16:41
Tube I.D.	S-50
C-Factor	0.789
Operator(s)	JAW/LLA

No. Of Points	12
Duct Width	17.5 ft
Duct Depth	3.28 ft
Duct Area	57.42 Sq ft
Avg % O2	21.0
Avg % N2	79.0

Bar., " Hg	29.68
Static, " H20	53.26
% H20	0.67
Dry MW	28.97
Wet MW	28.90

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	9-7/8"	108	0.0562	12.23
A-2	29-9/16"	110	0.0143	6.18
B-1	9-7/8"	108	0.0476	11.26
B-2	29-9/16"	109	0.0046	3.50
C-1	9-7/8"	108	0.1055	16.76
C-2	29-9/16"	109	0.0141	6.13
D-1	9-7/8"	108	0.0937	15.79
D-2	29-9/16"	109	0.0056	3.86
E-1	9-7/8"	108	0.0388	10.17
E-2	29-9/16"	108	0.0124	5.75
F-1	9-7/8"	108	-0.0020	-2.30
F-2	29-9/16"	108	0.0001	0.52
Average, (group mean)		109	0.0326	7.49
Average, (wt mean)		109	---	---
Maximum		110	0.1055	16.76
Minimum		108	-0.0020	-2.30
Standard Deviation		1	0.0350	5.62

Ports A = South, F = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	7.49
Velocity, [fpm]	449
ACFM	25,796
SCFM	26,496
DSCFM	26,318
lb/hr Air (dry)	120,510
lb/hr Air (wet)	121,019

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	7.49
Velocity, [fpm]	449
ACFM	25,796
SCFM	26,496
DSCFM	26,317
lb/hr Flue Gas (dry)	120,507
lb/hr Flue Gas (wet)	121,016

Table F-12

Traverse Data Calculated Results -- 2B Heat Pipe Primary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	63
Amb Air WB, deg F	49
Humd, lb/lb BD Air	0.00422

Std. Conditions

T, deg F	60
P, in. Hg	29.92
Bar., " Hg	29.68
Static, " H20	48.79
% H20	0.67
Dry MW	28.97
Wet MW	28.90

Date	05/14/96
Time	16:00-16:30
Tube I.D.	S-49
C-Factor	0.806
Operator(s)	RLO/FUZ

No. Of Points	20
Duct Dia	47.5 inches
Duct Area	12.31 Sq ft
Avg % O2	21.0
Avg % N2	79.0

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	1-3/16"	591	0.3216	40.86
A-2	3-7/8"	591	0.3320	41.52
A-3	6-15/16"	592	0.3613	43.33
A-4	10-3/4"	592	0.3945	45.28
A-5	16-1/4"	592	0.3693	43.81
A-6	31-1/4"	592	0.2816	38.25
A-7	36-3/4"	592	0.2565	36.51
A-8	40-9/16"	591	0.2427	35.50
A-9	43-5/8"	591	0.2354	34.96
A-10	46-5/16"	590	0.2006	32.26
B-1	1-3/16"	591	0.2980	39.33
B-2	3-7/8"	592	0.3386	41.95
B-3	6-15/16"	592	0.3597	43.23
B-4	10-3/4"	593	0.4070	46.01
B-5	16-1/4"	593	0.4244	46.98
B-6	31-1/4"	593	0.3490	42.61
B-7	36-3/4"	592	0.3121	40.27
B-8	40-9/16"	592	0.2875	38.65
B-9	43-5/8"	591	0.2593	36.69
B-10	46-5/16"	589	0.2300	34.52
Average, (group mean)		592	0.3131	40.13
Average, (wt mean)		592	---	---
Maximum		593	0.4244	46.98
Minimum		589	0.2006	32.26
Standard Deviation		1	0.0618	4.04

Ports A = North, B = East

Data Summary Straight Avg'd Data	
Velocity, [fps]	40.13
Velocity, [fpm]	2,408
ACFM	29,627
SCFM	16,283
DSCFM	16,173
lb/hr Air (dry)	74,056
lb/hr Air (wet)	74,368

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	40.13
Velocity, [fpm]	2,408
ACFM	29,627
SCFM	16,283
DSCFM	16,173
lb/hr Flue Gas (dry)	74,056
lb/hr Flue Gas (wet)	74,368

Table F-13

Traverse Data Calculated Results -- 2B Heat Pipe Secondary Air By-Pass Duct
NYSEG Milliken Station

Amb Air DB, deg F	63	**Std. Conditions**	
Amb Air WB, deg F	49	T, deg F	60
Humd, lb/lb BD Air	0.00422	P, in. Hg	29.92

		No. Of Point	8	Bar., " Hg	29.74
Date	5/14/96	Duct Width	17.5 ft	Static, " H2	3.72
Time	08:45 hrs	Duct Depth	2.09 ft		
Tube I.D.	S-53	Duct Area	36.64 Sq ft	% H20	0.67
C-Factor	0.808	Avg % O2	21.0	Dry MW	28.97
Operator(s)	RLO/FUZ	Avg % N2	79.0	Wet MW	28.90

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	6-5/16"	120	0.0000	0.00
A-2	18-7/8"	118	-0.0002	-0.80
B-1	6-5/16"	95	0.0017	2.28
B-2	18-7/8"	104	0.0003	0.96
C-1	6-5/16"	109	-0.0001	-0.56
C-2	18-7/8"	127	0.0000	0.00
D-1	6-5/16"	146	0.0000	0.00
D-2	18-7/8"	153	0.0000	0.00
Average, (group mean)		122	0.0002	0.24
Average, (wt mean)		103	---	---
Maximum		153	0.0017	2.28
Minimum		95	-0.0002	-0.80
Standard Deviation		19	0.0006	0.91

Ports A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	0.24
Velocity, [fpm]	14
ACFM	518
SCFM	481
DSCFM	477
lb/hr Air (dry)	2,186
lb/hr Air (wet)	2,195

Summary Weighted Avg Results	
Velocity, [fps]	0.24
Velocity, [fpm]	14
ACFM	518
SCFM	495
DSCFM	492
lb/hr Flue Gas (dry)	2,251
lb/hr Flue Gas (wet)	2,260

Table F-14

Traverse Data Calculated Results – 2B Heat Pipe Secondary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	63
Amb Air WB, deg F	49
Humd, lb/lb BD Air	0.00422

Std. Conditions

T, deg F	60
P, in. Hg	29.92

		No. Points	24
Date	05/14/96	Duct Width	6.0 ft
Time	17:17-17:57	Duct Depth	9.0 ft
Tube I.D.	S-54	Duct Area	54.00 Sq ft
C-Factor	0.816	Avg % O2	21.0
Operator(s)	JAW/LLA	Avg % N2	79.0

Bar., " Hg	29.68
Static, " H20	2.02
% " H20	0.67
Dry MW	28.97
Wet MW	28.90

PORT/ POINT	DISTANCE Fr Bottom (1)	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	12"	597	0.7618	67.42
A-2	30"	611	0.9180	74.50
A-3	48"	620	0.8127	70.38
A-4	66"	624	0.8059	70.22
A-5	84"	625	0.8257	71.10
A-6	102"	623	1.1050	82.19
B-1	12"	610	0.9899	77.32
B-2	30"	616	0.8660	72.51
B-3	48"	619	0.7751	68.72
B-4	66"	622	0.7716	68.65
B-5	84"	622	0.9656	76.79
B-6	102"	619	1.0800	81.10
C-1	12"	614	0.9623	76.36
C-2	30"	613	1.0220	78.68
C-3	48"	613	0.7634	67.99
C-4	66"	615	0.7147	65.87
C-5	84"	611	0.8706	72.54
C-6	102"	603	1.0430	79.09
D-1	12"	604	0.8974	73.40
D-2	30"	601	0.8003	69.23
D-3	48"	600	0.7751	68.11
D-4	66"	601	0.6387	61.83
D-5	84"	600	0.7752	68.12
D-6	102"	597	0.8255	70.18
Average, (group mean)		612	0.8652	72.18
Average, (wt mean)		612	---	---
Maximum		625	1.1050	82.19
Minimum		597	0.6387	61.83
Standard Deviation		9	0.1191	5.03

Port A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	72.18
Velocity, [fpm]	4,331
ACFM	233,865
SCFM	113,134
DSCFM	112,372
lb/hr Air (dry)	514,553
lb/hr Air (wet)	516,724

Summary Weighted Avg Results	
Velocity, [fps]	72.06
Velocity, [fpm]	4,323
ACFM	233,459
SCFM	112,938
DSCFM	112,177
lb/hr Flue Gas (dry)	513,660
lb/hr Flue Gas (wet)	515,827

(1) Due to additional offset, distances are 3" higher than desired. Unequal areas at top and bottom of duct are accounted for in weighted average value results.

Table F-15

Traverse Data Calculated Results -- 2A Heat Pipe Flue Gas Inlet Duct
NYSEG Milliken Station

Coal Composition						
Moisture	7.94%	Overhead Ash	90.00%		Std. Conditions	
C	72.31%	C in Ash	1.89%		T, deg F	60
H	4.70%				P, in. Hg	29.92
N	1.49%	Amb Air DB, deg F	67			
S	1.88%	Amb Air WB, deg F	51			
O	3.99%	Humd, lb/lb BD Air	0.00410			
Ash	7.69%					
Total	100.00%					
		No. Points	20			
		Duct Width	14.5	ft	Bar., " Hg	29.65
Date	05/15/96	Duct Height	5.5	ft	Static, " H2O	-9.14
Time	16:05-17:00	Duct Area	79.75	Sq ft		
Tube I.D.	S-53	Avg % O2	3.68		% H2O	7.03
C-Factor	0.808	Avg % CO2	15.07		Dry MW	30.58
Operator(s)	RLO/FUZ	Avg % N2	81.25		Wet MW	29.69

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	8-1/4"	698	0.7231	68.15	3.7	15.1	9	0.1
A-2	24-3/4"	705	0.8579	74.47	4.0	14.8	14	0.1
A-3	41-1/4"	704	0.7737	70.73	4.5	14.3	20	0.1
A-4	57-3/4"	694	0.7772	70.60	4.9	14.0	29	0.1
B-1	8-1/4"	659	0.7463	68.02	3.1	15.6	3	0.1
B-2	24-3/4"	664	0.9926	78.64	3.4	15.3	3	0.1
B-3	41-1/4"	670	0.8989	75.06	3.7	15.1	3	0.1
B-4	57-3/4"	672	1.0030	79.41	4.5	14.3	4	0.1
C-1	8-1/4"	662	0.8131	71.07	2.8	15.9	13	0.0
C-2	24-3/4"	660	1.1040	82.75	2.9	15.8	4	0.0
C-3	41-1/4"	656	1.0010	78.70	3.5	15.2	3	0.1
C-4	57-3/4"	657	1.0600	81.08	4.4	14.5	3	0.1
D-1	8-1/4"	691	0.7189	67.69	2.8	15.9	1	0.0
D-2	24-3/4"	682	1.0310	80.76	3.1	15.6	1	0.0
D-3	41-1/4"	669	0.9467	76.98	3.5	15.2	2	0.0
D-4	57-3/4"	664	0.9896	78.57	4.1	14.7	3	0.0
E-1	8-1/4"	706	0.7094	67.72	3.4	15.3	1	0.0
E-2	24-3/4"	695	0.8359	73.17	3.5	15.2	1	0.0
E-3	41-1/4"	675	0.8783	74.36	3.8	15.0	1	0.0
E-5	57-3/4"	668	0.8429	72.63	4.0	14.8	1	0.0
Average, (group mean)		678	0.8852	74.53	3.7	15.1	6	0.05
Average, (wt mean)		677	---	---	3.7	15.1	6	0.05
Maximum		706	1.1040	82.75	4.9	15.9	29	0.10
Minimum		656	0.7094	67.69	2.8	14.0	1	0.00
Standard Deviation		17	0.1208	4.76	0.6	0.5	7	0.05

Port A = South, E = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	74.53
Velocity, [fpm]	4,472
ACFM	356,615
SCFM	157,955
DSCFM	146,852
Ex Air Free	120,978
lb/hr Flue Gas (dry)	709,717
lb/hr Flue Gas (wet)	741,335

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	74.53
Velocity, [fpm]	4,472
ACFM	356,615
SCFM	157,954
DSCFM	146,851
Ex Air Free	120,977
lb/hr Flue Gas (dry)	709,715
lb/hr Flue Gas (wet)	741,332

Table F-16

Traverse Data Calculated Results -- 2A Heat Pipe Flue Gas Outlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	7.94%	Overhead Ash	90.00%	Std. Conditions	
C	72.31%	C in Ash	1.89%	T, deg F	60
H	4.70%			P, in. Hg	29.92
N	1.49%	Amb Air DB, deg F	67		
S	1.88%	Amb Air WB, deg F	51		
O	3.99%	Humd, lb/lb BD Air	0.00410		
Ash	7.69%				
Total	100.00%				
		No. Of Points	24		
		Duct Width	34.0 ft	Bar., " Hg	29.65
Date	05/15/96	Duct Depth	2.5 ft	Static, " H2O	-13.95
Time	16:05-17:00	Duct Area	85.00 Sq ft		
Tube I.D.	S-52	Avg % O2	4.51	% H20	6.75
C-Factor	0.798	Avg % CO2	14.37	Dry MW	30.50
Operator(s)	MSD/GLC	Avg % N2	81.12	Wet MW	29.65

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	7-1/2"	300	0.8391	59.13	4.5	14.3	0	0.4
A-2	22-1/2"	301	0.7115	54.48	4.4	14.5	0	0.3
B-1	7-1/2"	301	0.6178	50.76	4.3	14.5	0	0.4
B-2	22-1/2"	301	0.6609	52.50	4.3	14.5	0	0.3
C-1	7-1/2"	299	0.8788	60.45	4.2	14.7	0	0.3
C-2	22-1/2"	298	0.7640	56.33	4.2	14.7	0	0.3
D-1	7-1/2"	300	0.7960	57.60	4.5	14.3	0	0.2
D-2	22-1/2"	300	0.7513	55.93	4.2	14.7	0	0.3
E-1	7-1/2"	301	0.6770	53.15	4.6	14.3	0	0.4
E-2	22-1/2"	301	0.7387	55.52	4.7	14.2	0	0.3
F-1	7-1/2"	299	0.7646	56.41	4.6	14.3	0	0.3
F-2	22-1/2"	301	0.6042	50.21	4.5	14.3	0	0.3
G-1	7-1/2"	297	0.4351	42.50	4.8	14.1	0	0.4
G-2	22-1/2"	298	0.3710	39.27	4.7	14.2	0	0.4
H-1	7-1/2"	300	0.4539	43.49	4.6	14.3	0	0.4
H-2	22-1/2"	298	0.5080	45.95	4.6	14.3	0	0.4
I-1	7-1/2"	303	0.4911	45.33	4.5	14.3	0	0.3
I-2	22-1/2"	304	0.5186	46.61	4.5	14.3	0	0.3
J-1	7-1/2"	307	0.5573	48.42	4.6	14.3	0	0.3
J-2	22-1/2"	307	0.5739	49.12	4.4	14.5	0	0.3
K-1	7-1/2"	308	0.6035	50.40	4.6	14.5	0	0.4
K-2	22-1/2"	307	0.5499	48.08	4.6	14.5	0	0.3
L-1	7-1/2"	308	0.5094	46.29	4.9	14.5	1	0.4
L-2	22-1/2"	307	0.5458	47.91	4.7	14.2	0	0.4
Average, (group mean)		302	0.6217	50.66	4.5	14.4	0	0.3
Average, (wt mean)		302	---	---	4.5	14.4	0	0.33
Maximum		308	0.8788	60.45	4.9	14.7	1	0.4
Minimum		297	0.3710	39.27	4.2	14.1	0	0.2
SDEV		3	0.1330	5.45	0.2	0.2	0	0.1

Port A = North, L = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	50.66
Velocity, [fpm]	3,040
ACFM	258,372
SCFM	168,704
DSCFM	157,316
Ex Air Free	123,373
lb/hr Flue Gas (dry)	758,322
lb/hr Flue Gas (wet)	790,753

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	50.66
Velocity, [fpm]	3,040
ACFM	258,372
SCFM	168,704
DSCFM	157,316
Ex Air Free	123,374
lb/hr Flue Gas (dry)	758,323
lb/hr Flue Gas (wet)	790,753

Table F-17

Traverse Data Calculated Results -- 2A Heat Pipe Primary Flue Gas Out Duct
NYSEG Milliken Station

Coal Composition

Moisture	7.94%
C	72.31%
H	4.70%
N	1.49%
S	1.88%
O	3.99%
Ash	7.69%
Total	100.00%

Overhead Ash	90.00%
C in Ash	1.89%
Amb Air DB, deg F	67
Amb Air WB, deg F	51
Humd, lb/lb BD Air	0.00410

Std. Conditions

T, deg F	60
P, In. Hg	29.92

Date	05/15/96
Time	14:55-15:35
Tube I.D.	S-52
C-Factor	0.809
Operator(s)	MSD/GLC

No. Of Points	14
Duct Width	17.92 ft
Duct Height	3.28 ft
Duct Area	58.79 Sq ft
Avg % O2	5.61
Avg % CO2	13.39
Avg % N2	81.00

Bar., " Hg	29.65
Static, " H2O	-12.66
% H2O	6.36
Dry MW	30.38
Wet MW	29.60

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	9-7/8"	285	0.0152	7.98	5.70	13.3		1.1
A-2	29-9/16"	304	0.0119	7.15	4.80	14.1		0.6
B-1	9-7/8"	302	0.0302	11.37	4.80	14.1		0.0
B-2	29-9/16"	313	0.0195	9.20	3.90	14.9		0.0
C-1	9-7/8"	296	0.0115	7.00	6.00	13.1	5	0.4
C-2	29-9/16"	307	0.0264	10.68	5.80	13.2	6	0.7
D-1	9-7/8"	302	0.0523	15.00	7.30	11.9	5	0.8
D-2	29-9/16"	312	0.0365	12.62	7.80	11.5	5	0.8
E-1	9-7/8"	299	0.0689	17.16	5.80	13.2	1	0.3
E-2	29-9/16"	313	0.0399	13.17	5.00	14.0	1	0.4
F-1	9-7/8"	306	0.0561	15.54	4.90	14.0	0	0.6
F-2	29-9/16"	315	0.0303	11.49	4.50	14.3	0	0.4
G-1	9-7/8"	300	0.0514	14.82	5.30	13.7	0	0.3
G-2	29-9/16"	295	0.0117	7.05	6.20	12.9	0	0.4
Average, (group mean)		304	0.0330	11.44	5.56	13.43	2.30	0.49
Average, (wt mean)		304	---	---	5.61	13.39	2	0.48
Maximum		315	0.0689	17.16	7.80	14.90	6.00	1.10
Minimum		285	0.0115	7.00	3.90	11.45	0.00	0.00
Standard Deviation		8	0.0180	3.30	1.02	0.90	2.45	0.29

Port A = South, G = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	11.44
Velocity, [fpm]	687
ACFM	40,364
SCFM	26,365
DSCFM	24,688
Ex Air Free	18,064
lb/hr Flue Gas (dry)	118,567
lb/hr Flue Gas (wet)	123,341

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	11.39
Velocity, [fpm]	683
ACFM	40,178
SCFM	26,247
DSCFM	24,578
Ex Air Free	17,982
lb/hr Flue Gas (dry)	118,034
lb/hr Flue Gas (wet)	122,787

Table F-18

Traverse Data Calculated Results -- 2A Heat Pipe Primary Air Inlet Duct
NYSEG Milliken Station

Amb Air DB, deg F 67
Amb Air WB, deg F 51
Humd, lb/lb BD Air 0.00410

Std. Conditions
T, deg F 60
P, in. Hg 29.92

Date 05/15/96
Time 14:52-15:21
Tube I.D. S-50
C-Factor 0.789
Operator(s) JAW/LLA

No. Of Point 12
Duct Width 17.5 ft
Duct Depth 3.28 ft
Duct Area 57.42 Sq ft
Avg % O2 21.0
Avg % N2 79.0

Bar., " Hg 29.67
Static, " H20 53.47

% H20 0.65
Dry MW 28.97
Wet MW 28.90

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	9-7/8"	115	-0.0036	-3.10
A-2	29-9/16"	117	0.0030	2.85
B-1	9-7/8"	116	0.0348	9.69
B-2	29-9/16"	117	0.0152	6.41
C-1	9-7/8"	116	0.0401	10.40
C-2	29-9/16"	117	0.0107	5.38
D-1	9-7/8"	116	0.0308	9.12
D-2 (1)	29-9/16"	117	0.0137	6.09
E-1	9-7/8"	116	0.0472	11.29
E-2	29-9/16"	118	0.0167	6.72
F-1	9-7/8"	116	0.1721	21.54
F-2	29-9/16"	117	0.0516	11.81
Average, (group mean)		116	0.0360	8.18
Average, (wt mean)		116	---	---
Maximum		118	0.1721	21.54
Minimum		115	-0.0036	-3.10
Standard Deviation		1	0.0443	5.65

Ports A = South, F = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	8.18
Velocity, [fpm]	491
ACFM	28,189
SCFM	28,565
DSCFM	28,378
lb/hr Air (dry)	129,943
lb/hr Air (wet)	130,476

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	8.18
Velocity, [fpm]	491
ACFM	28,189
SCFM	28,562
DSCFM	28,375
lb/hr Flue Gas (dry)	129,931
lb/hr Flue Gas (wet)	130,464

(1) Port Obstructed By I-Beam. Averaged Values For Points C-2 and E-2.

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Table F-19

Traverse Data Calculated Results -- 2A Heat Pipe Primary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	67
Amb Air WB, deg F	51
Humd, lb/lb BD Air	0.00410

Std. Conditions

T, deg F	60
P, in. Hg	29.92

Bar., " Hg	29.67
Static, " H20	49.32

Date	05/15/96
Time	14:50-15:10
Tube I.D.	S-49
C-Factor	0.806
Operator(s)	RLO/FUZ

No. Of Points	20
Duct Dia	47.5 inches
Duct Area	12.31 Sq ft
Avg % O2	21.0
Avg % N2	79.0

% H20	0.65
Dry MW	28.97
Wet MW	28.90

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	1-3/16"	604	0.3167	40.78
A-2	3-7/8"	605	0.3543	43.15
A-3	6-15/16"	605	0.3769	44.51
A-4	10-3/4"	606	0.4037	46.08
A-5	16-1/4"	606	0.3977	45.74
A-6	31-1/4"	606	0.3312	41.74
A-7	36-3/4"	606	0.3132	40.59
A-8	40-9/16"	605	0.2950	39.38
A-9	43-5/8"	603	0.2522	36.37
A-10	46-5/16"	601	0.2044	32.71
B-1	1-3/16"	604	0.3072	40.16
B-2	3-7/8"	605	0.3330	41.84
B-3	6-15/16"	605	0.3673	43.94
B-4	10-3/4"	605	0.3744	44.36
B-5	16-1/4"	605	0.3733	44.29
B-6	31-1/4"	605	0.2907	39.09
B-7	36-3/4"	604	0.2759	38.06
B-8	40-9/16"	603	0.2485	36.11
B-9	43-5/8"	601	0.2238	34.23
B-10	46-5/16"	598	0.1769	30.39
Average, (group mean)		605	0.3108	40.18
Average, (wt mean)		605	---	---
Maximum		606	0.4037	46.08
Minimum		598	0.1769	30.39
Standard Deviation		2	0.0635	4.31

Ports A = South, B = East

Summary Straight Avg'd Results	
Velocity, [fps]	40.18
Velocity, [fpm]	2,411
ACFM	29,665
SCFM	16,123
DSCFM	16,018
lb/hr Air (dry)	73,346
lb/hr Air (wet)	73,646

Summary Weighted Avg Results	
Velocity, [fps]	40.18
Velocity, [fpm]	2,411
ACFM	29,665
SCFM	16,123
DSCFM	16,018
lb/hr Flue Gas (dry)	73,346
lb/hr Flue Gas (wet)	73,646

Table F-20

Traverse Data Calculated Results -- 2A Heat Pipe Secondary Air By-Pass Duct
NYSEG Milliken Station

Amb Air DB, deg F	67
Amb Air WB, deg F	51
Humd, lb/lb BD Air	0.00410

Std. Conditions

T, deg F	60
P, in. Hg	29.92

		No. Of Point	8	Bar., " Hg	29.76
Date	5/15/96	Duct Width	17.5 ft	Static, " H2	5.10
Time	08:10 hrs	Duct Depth	2.09 ft		
Tube I.D.	S-53	Duct Area	36.64 Sq ft	% H20	0.65
C-Factor	0.808	Avg % O2	21.0	Dry MW	28.97
Operator(s)	RLO/FUZ	Avg % N2	79.0	Wet MW	28.90

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	6-5/16"	232	0.0000	0.00
A-2	18-7/8"	228	0.0003	1.06
B-1	6-5/16"	211	0.0001	0.61
B-2	18-7/8"	212	0.0000	0.00
C-1	6-5/16"	204	0.0000	0.00
C-2	18-7/8"	202	0.0000	0.00
D-1	6-5/16"	198	0.0000	0.00
D-2	18-7/8"	197	0.0000	0.00
Average, (group mean)		210	0.0001	0.21
Average, (wt mean)		221	---	---
Maximum		232	0.0003	1.06
Minimum		197	0.0000	0.00
Standard Deviation		12	0.0001	0.38

Ports A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	0.21
Velocity, [fpm]	13
ACFM	459
SCFM	353
DSCFM	350
lb/hr Air (dry)	1,604
lb/hr Air (wet)	1,611

Summary Weighted Avg Results	
Velocity, [fps]	0.21
Velocity, [fpm]	13
ACFM	459
SCFM	353
DSCFM	350
lb/hr Flue Gas (dry)	1,604
lb/hr Flue Gas (wet)	1,611

Table F-21

Traverse Data Calculated Results -- 2A Heat Pipe Secondary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	67
Amb Air WB, deg F	51
Humd, lb/lb BD Air	0.00410

Date	05/15/96
Time	16:09-16:43
Tube I.D.	S-54
C-Factor	0.816
Operator(s)	JAW/LLA

No. Points	24	
Duct Width	6.0	ft
Duct Depth	9.0	ft
Duct Area	54.00	Sq ft
Avg % O2	21.0	
Avg % N2	79.0	

Std. Conditions

T, deg F	**60**
P, in. Hg	**29.92**
Bar., " Hg	**29.65**
Static, " H20	**3.57**
% " H20	**0.65**
Dry MW	**28.97**
Wet MW	**28.90**

PORT/ POINT	DISTANCE Fr Bottom (1)	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	12"	616	0.8267	70.77
A-2	30"	615	0.8831	73.09
A-3	48"	613	0.8113	69.99
A-4	66"	611	0.6463	62.43
A-5	84"	609	0.5829	59.21
A-6	102"	604	0.6130	60.59
B-1	12"	617	0.9081	74.21
B-2	30"	620	0.9509	76.02
B-3	48"	621	0.7669	68.32
B-4	66"	622	0.7396	67.12
B-5	84"	619	0.7359	66.84
B-6	102"	609	0.6927	64.57
C-1	12"	613	0.9476	75.64
C-2	30"	620	1.0790	81.00
C-3	48"	625	0.7915	69.53
C-4	66"	629	0.7699	68.70
C-5	84"	630	0.8957	74.12
C-6	102"	627	0.9639	76.78
D-1	12"	608	0.6921	64.49
D-2	30"	617	0.9668	76.57
D-3	48"	623	0.8276	71.03
D-4	66"	628	0.8647	72.75
D-5	84"	629	0.7389	67.29
D-6	102"	628	1.0270	79.31
Average, (group mean)		619	0.8218	70.43
Average, (wt mean)		619	---	---
Maximum		630	1.0790	81.00
Minimum		604	0.5829	59.21
Standard Deviation		7	0.1280	5.65

Port A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	70.43
Velocity, [fpm]	4,226
ACFM	228,199
SCFM	109,946
DSCFM	109,226
lb/hr Air (dry)	500,148
lb/hr Air (wet)	502,198

Summary Weighted Avg Results	
Velocity, [fps]	**70.46**
Velocity, [fpm]	**4,228**
ACFM	**228,286**
SCFM	**109,988**
DSCFM	**109,267**
lb/hr Flue Gas (dry)	**500,338**
lb/hr Flue Gas (wet)	**502,390**

(1) Due to additional offset, distances are 3" higher than desired. Unequal areas at top and bottom of duct are accounted for in weighted average value results.

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Table F-22

Traverse Data Calculated Results -- 2B Heat Pipe Flue Gas Inlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	7.94%	Overhead Ash	90.00%	**Std. Conditions**	
C	72.31%	C in Ash	1.89%	**T, deg F**	**60**
H	4.70%			**P, in. Hg**	**29.92**
N	1.49%	Amb Air DB, deg F	67		
S	1.88%	Amb Air WB, deg F	51		
O	3.99%	Humd, lb/lb BD Air	0.00435		
Ash	7.69%				
Total	100.00%				
		No. Points	20		
		Duct Width	14.5 ft	Bar., " Hg	29.70
Date	05/15/96	Duct Height	5.5 ft	Static, " H2O	-9.06
Time	12:00-12:50	Duct Area	79.75 Sq. ft		
Tube I.D.	S-53	Avg % O2	**4.49**	**% H2O**	**6.78**
C-Factor	0.808	Avg % CO2	**14.36**	**Dry MW**	**30.50**
Operator(s)	RLO/FUZ	Avg % N2	**81.15**	**Wet MW**	**29.65**

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	8-1/4"	668	0.6702	64.70	3.8	15.0	14	0.1
A-2	24-3/4"	664	0.7726	69.34	3.7	15.1	13	0.1
A-3	41-1/4"	660	0.8198	71.30	3.9	14.9	14	0.1
A-4	57-3/4"	662	0.7292	67.32	4.1	14.7	15	0.1
B-1	8-1/4"	665	0.6583	64.04	3.8	15.0	30	0.1
B-2	24-3/4"	661	0.9312	76.02	3.7	15.1	29	0.1
B-3	41-1/4"	657	0.9333	75.99	4.1	14.7	19	0.1
B-4	57-3/4"	661	0.7858	69.87	4.4	14.5	13	0.1
C-1	8-1/4"	659	0.6868	65.28	4.6	14.3	0	0.0
C-2	24-3/4"	655	0.9500	76.63	4.6	14.3	0	0.0
C-3	41-1/4"	652	0.8281	71.44	4.4	14.5	2	0.0
C-4	57-3/4"	656	0.8677	73.26	4.4	14.5	2	0.1
D-1	8-1/4"	683	0.6929	66.27	4.7	14.2	4	0.1
D-2	24-3/4"	687	0.8801	74.81	4.5	14.3	4	0.1
D-3	41-1/4"	682	0.8454	73.16	4.5	14.3	4	0.1
D-4	57-3/4"	672	0.7584	69.01	4.9	14.0	7	0.0
E-1	8-1/4"	713	0.4485	54.07	6.0	13.1	2	0.0
E-2	24-3/4"	715	0.5698	60.97	5.8	13.2	3	0.1
E-3	41-1/4"	700	0.6671	65.54	5.3	13.7	3	0.1
E-4	57-3/4"	676	0.8569	73.50	5.2	13.8	3	0.1
Average, (group mean)		**673**	**0.7676**	**69.13**	**4.5**	**14.3**	**9**	**0.08**
Average, (wt mean)		**671**	---	---	**4.5**	**14.4**	**9**	**0.08**
Maximum		**715**	**0.9500**	**76.63**	**6.0**	**15.1**	**30**	**0.10**
Minimum		**652**	**0.4485**	**54.07**	**3.7**	**13.1**	**0**	**0.00**
Standard Deviation		**18**	**0.1259**	**5.59**	**0.6**	**0.6**	**9**	**0.04**

Port A = South, E = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	69.13
Velocity, [fpm]	4,148
ACFM	330,771
SCFM	147,512
DSCFM	137,504
Ex Air Free	107,977
lb/hr Flue Gas (dry)	662,781
lb/hr Flue Gas (wet)	691,280

Data Summary Wt'd Avg Calculation	
Velocity, [fps]	**69.13**
Velocity, [fpm]	**4,148**
ACFM	**330,771**
SCFM	**147,510**
DSCFM	**137,502**
Ex Air Free	**107,976**
lb/hr Flue Gas (dry)	**662,774**
lb/hr Flue Gas (wet)	**691,272**

Table F-23

Traverse Data Calculated Results -- 2B Heat Pipe Flue Gas Outlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	7.94%	**Overhead Ash**	90.00%	**Std. Conditions**	
C	72.31%	**C in Ash**	1.89%	**T, deg F**	60
H	4.70%			**P, in. Hg**	29.92
N	1.49%	**Amb Air DB, deg F**	67		
S	1.88%	**Amb Air WB, deg F**	51		
O	3.99%	**Humd, lb/lb BD Air**	0.00435		
Ash	7.69%				
Total	100.00%				
		No. Of Points	24		
		Duct Width	34.0 ft	**Bar., " Hg**	29.70
Date	05/15/96	**Duct Depth**	2.5 ft	**Static, " H2O**	-13.13
Time	12:00-12:40	**Duct Area**	85.00 Sq ft		
Tube I.D.	S-52	**Avg % O2**	4.74	**% H20**	6.70
C-Factor	0.798	**Avg % CO2**	14.15	**Dry MW**	30.47
Operator(s)	MSD/GLC	**Avg % N2**	81.11	**Wet MW**	29.64

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1 (1)	7-1/2"	281	0.3006	34.88	4.7	14.2	3	0.2
A-2 (1)	22-1/2"	281	0.2908	34.31	4.8	14.1	3	0.1
B-1	7-1/2"	281	0.3006	34.88	4.7	14.2	3	0.2
B-2	22-1/2"	281	0.2908	34.31	4.8	14.1	3	0.1
C-1	7-1/2"	281	0.3968	40.08	4.7	14.3	2	0.0
C-2	22-1/2"	281	0.3988	40.18	4.8	14.1	2	0.0
D-1	7-1/2"	280	0.5843	48.61	4.8	14.1	1	0.0
D-2	22-1/2"	281	0.5803	48.48	4.9	14.0	1	0.0
E-1	7-1/2"	279	0.5299	46.25	4.6	14.3	0	0.0
E-2	22-1/2"	279	0.5080	45.29	4.8	14.1	0	0.0
F-1	7-1/2"	279	0.3555	37.89	4.8	14.1	0	0.0
F-2	22-1/2"	279	0.5248	46.03	4.8	14.1	0	0.0
G-1	7-1/2"	279	0.3310	36.56	4.7	14.2	0	0.0
G-2	22-1/2"	279	0.2964	34.59	4.7	14.2	0	0.0
H-1	7-1/2"	280	0.7879	56.44	4.7	14.2	3	0.2
H-2	22-1/2"	281	0.8029	57.01	4.7	14.2	3	0.3
I-1	7-1/2"	281	0.9817	63.04	4.6	14.3	3	0.3
I-2	22-1/2"	281	0.9137	60.82	4.6	14.3	3	0.3
J-1	7-1/2"	280	0.6724	52.14	4.6	14.3	3	0.3
J-2	22-1/2"	279	0.7703	55.76	4.5	14.3	3	0.3
K-1	7-1/2"	276	0.5963	48.97	4.9	14.0	2	0.3
K-2	22-1/2"	277	0.7567	55.21	4.9	14.0	2	0.3
L-1	7-1/2"	275	0.5091	45.22	4.9	14.0	2	0.3
L-2	22-1/2"	276	0.3952	39.87	4.9	14.0	2	0.3
Average, (group mean)		279	0.5365	45.70	4.7	14.1	2	0.1
Average, (wt mean)		279	---	---	4.7	14.2	2	0.16
Maximum		281	0.9817	63.04	4.9	14.3	3	0.3
Minimum		275	0.2908	34.31	4.5	14.0	0	0.0
Standard Deviation		2	0.2071	8.88	0.1	0.1	1	0.1

Port A = North, L = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	45.70
Velocity, [fpm]	2,742
ACFM	233,074
SCFM	157,417
DSCFM	146,870
Ex Air Free	113,566
lb/hr Flue Gas (dry)	707,377
lb/hr Flue Gas (wet)	737,412

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	**45.70**
Velocity, [fpm]	**2,742**
ACFM	**233,074**
SCFM	**157,417**
DSCFM	**146,870**
Ex Air Free	**113,566**
lb/hr Flue Gas (dry)	**707,377**
lb/hr Flue Gas (wet)	**737,412**

(1) No Port at Location Due to Structural Steel Support. Used Values For Port "B".

Table F-24

Traverse Data Calculated Results -- 2B Heat Pipe Primary Flue Gas Out Duct
NYSEG Milliken Station

Coal Composition

Moisture	7.94%
C	72.31%
H	4.70%
N	1.49%
S	1.88%
O	3.99%
Ash	7.69%
Total	100.00%

Overhead Ash	90.00%
C in Ash	1.89%
Amb Air DB, deg F	67
Amb Air WB, deg F	51
Humd, lb/lb BD Air	0.00410

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

Date	05/15/96
Time	14:00-14:45
Tube I.D.	S-52
C-Factor	0.798
Operator(s)	MSD/GLC

No. Of Points	14	
Duct Width	17.92	ft
Duct Height	3.28	ft
Duct Area	58.79	Sq ft
Avg % O2	5.96	
Avg % CO2	13.09	
Avg % N2	80.96	

Bar., " Hg	29.67
Static, " H2O	-11.99
% H2O	6.24
Dry MW	30.35
Wet MW	29.58

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	9-7/8"	263	0.0586	15.23	7.4	11.9	1	0.4
A-2	29-9/16"	271	0.0251	10.01	6.0	13.1	1	0.3
B-1	9-7/8"	272	0.0276	10.51	5.8	13.2	0	0.3
B-2	29-9/16"	276	0.0254	10.10	4.9	14.0	0	0.3
C-1	9-7/8"	268	0.0206	9.06	6.5	12.6	0	0.4
C-2	29-9/16"	273	0.0088	5.94	6.3	12.8	0	0.4
D-1	9-7/8"	268	0.0196	8.83	5.5	13.5	0	0.5
D-2	29-9/16"	273	0.0198	8.90	5.8	13.2	0	0.3
E-1	9-7/8"	261	0.0308	11.01	5.9	13.1	7	1.3
E-2	29-9/16"	274	0.0234	-9.68	4.9	14.0	12	1.6
F-1	9-7/8"	267	0.0400	12.61	6.7	12.5	1	0.5
F-2	29-9/16"	276	0.0361	12.04	5.0	14.0	10	0.6
G-1	9-7/8"	264	0.0499	14.05	6.3	12.8	9	0.4
G-2	29-9/16"	274	0.0102	6.39	5.3	13.7	20	0.4
Average, (group mean)		270	0.0283	8.93	5.88	13.15	4.36	0.55
Average, (wt mean)		269	---	---	6.0	13.1	4	0.55
Maximum		276	0.0586	15.23	7.40	14.02	20.00	1.60
Minimum		261	0.0088	-9.68	4.90	11.85	0.00	0.30
Standard Deviation		5	0.0135	5.73	0.70	0.62	6.04	0.38

Port A = North, G = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	8.93
Velocity, [fpm]	536
ACFM	31,495
SCFM	21,608
DSCFM	20,261
Ex Air Free	14,485
lb/hr Flue Gas (dry)	97,191
lb/hr Flue Gas (wet)	101,029

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	8.96
Velocity, [fpm]	538
ACFM	31,607
SCFM	21,707
DSCFM	20,353
Ex Air Free	14,551
lb/hr Flue Gas (dry)	97,634
lb/hr Flue Gas (wet)	101,489

Table F-25

Traverse Data Calculated Results -- 2B Heat Pipe Primary Air Inlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	67
Amb Air WB, deg F	51
Humd, lb/lb BD Air	0.00410

Date	05/15/96
Time	14:08-14:35
Tube I.D.	S-50
C-Factor	0.789
Operator(s)	JAW/LLA

No. Points	12	
Duct Width	17.5	ft
Duct Depth	3.28	ft
Duct Area	57.42	Sq ft
Avg % O2	21.0	
Avg % N2	79.0	

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

Bar., " Hg	29.67
Static, " H20	53.43

% H20	0.65
Dry MW	28.97
Wet MW	28.90

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	9-7/8"	117	0.0656	13.31
A-2	29-9/16"	118	0.0198	7.32
B-1	9-7/8"	116	0.0430	10.77
B-2	29-9/16"	117	0.0068	4.29
C-1	9-7/8"	116	0.1106	17.27
C-2	29-9/16"	116	0.0141	6.17
D-1	9-7/8"	116	0.0845	15.10
D-2	29-9/16"	116	0.0054	3.82
E-1	9-7/8"	116	0.0291	8.86
E-2	29-9/16"	117	0.0139	6.13
F-1	9-7/8"	116	-0.0017	-2.13
F-2	29-9/16"	115	0.0009	1.56
Average, (group mean)		116	0.0327	7.71
Average, (wt mean)		116	---	---
Maximum		118	0.1106	17.27
Minimum		115	-0.0017	-2.13
Standard Deviation		1	0.0347	5.44

Ports A = South, F = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	7.71
Velocity, [fpm]	462
ACFM	26,548
SCFM	26,899
DSCFM	26,723
lb/hr Air (dry)	122,364
lb/hr Air (wet)	122,866

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	7.71
Velocity, [fpm]	462
ACFM	26,548
SCFM	26,899
DSCFM	26,723
lb/hr Flue Gas (dry)	122,365
lb/hr Flue Gas (wet)	122,866

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Table F-26

Traverse Data Calculated Results -- 2B Heat Pipe Primary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	67
Amb Air WB, deg F	51
Humd, lb/lb BD Air	0.00410

Std. Conditions

T, deg F	**60**
P, in. Hg	**29.92**

Bar., " Hg	**29.67**
Static, " H20	**49.48**

Date	05/15/96	No. Of Points	20	
Time	14:00-14:25	Duct Dia	47.5	inches
Tube I.D.	S-49	Duct Area	12.31	Sq ft
C-Factor	0.806	Avg % O2	21.0	
Operator(s)	RLO/FUZ	Avg % N2	79.0	

% H20	**0.65**
Dry MW	**28.97**
Wet MW	**28.90**

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	1-3/16"	588	0.3029	39.57
A-2	3-7/8"	588	0.3277	41.16
A-3	6-15/16"	589	0.3558	42.91
A-4	10-3/4"	589	0.3651	43.47
A-5	16-1/4"	590	0.3524	42.72
A-6	31-1/4"	590	0.2744	37.70
A-7	36-3/4"	590	0.2405	35.29
A-8	40-9/16"	590	0.2509	36.05
A-9	43-5/8"	589	0.2276	34.32
A-10	46-5/16"	588	0.2028	32.38
B-1	1-3/16"	589	0.2695	37.34
B-2	3-7/8"	589	0.3214	40.78
B-3	6-15/16"	590	0.3453	42.29
B-4	10-3/4"	590	0.4241	46.87
B-5	16-1/4"	590	0.4212	46.71
B-6	31-1/4"	590	0.3445	42.24
B-7	36-3/4"	590	0.2794	38.04
B-8	40-9/16"	589	0.2833	38.29
B-9	43-5/8"	588	0.2617	36.78
B-10	46-5/16"	585	0.2338	34.72
Average, (group mean)		589	0.3042	39.48
Average, (wt mean)		590	---	---
Maximum		590	0.4241	46.87
Minimum		585	0.2028	32.38
Standard Deviation		1	0.0608	3.95

Ports A = North, B = East

Summary Straight Avg'd Results	
Velocity, [fps]	39.48
Velocity, [fpm]	2,369
ACFM	29,152
SCFM	16,081
DSCFM	15,975
lb/hr Air (dry)	73,151
lb/hr Air (wet)	73,451

Summary Weighted Avg Results	
Velocity, [fps]	**39.48**
Velocity, [fpm]	**2,369**
ACFM	**29,152**
SCFM	**16,081**
DSCFM	**15,975**
lb/hr Flue Gas (dry)	**73,151**
lb/hr Flue Gas (wet)	**73,451**

Table F-27

Traverse Data Calculated Results -- 2B Heat Pipe Secondary Air By-Pass Duct
NYSEG Milliken Station

Amb Air DB, deg F 67
Amb Air WB, deg F 51
Humd, lb/lb BD Air 0.00410

Std. Conditions
T, deg F 60
P, in. Hg 29.92

No. Of Point 8

Bar., " Hg 29.76
Static, " H2 5.10

Date 5/15/96
Time 07:45 hrs
Tube I.D. S-53
C-Factor 0.808
Operator(s) RLO/FUZ

Duct Width 17.5 ft
Duct Depth 2.09 ft
Duct Area 36.64 Sq ft
% O2 21.0
% N2 79.0

% H20 0.65
Dry MW 28.97
Wet MW 28.90

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	6-5/16"	125	0.0000	0.00
A-2	18-7/8"	119	-0.0003	-0.98
B-1	6-5/16"	95	0.0018	2.34
B-2	18-7/8"	103	0.0002	0.79
C-1	6-5/16"	108	0.0004	1.12
C-2	18-7/8"	122	0.0000	0.00
D-1	6-5/16"	147	-0.0001	-0.58
D-2	18-7/8"	148	0.0000	0.00
Average, (group mean)		121	0.0003	0.34
Average, (wt mean)		108	---	---
Maximum		148	0.0018	2.34
Minimum		95	-0.0003	-0.98
Standard Deviation		18	0.0006	0.98

Ports A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	0.34
Velocity, [fpm]	20
ACFM	739
SCFM	682
DSCFM	677
lb/hr Air (dry)	3,101
lb/hr Air (wet)	3,114

Summary Weighted Avg Results	
Velocity, [fps]	0.34
Velocity, [fpm]	20
ACFM	739
SCFM	711
DSCFM	706
lb/hr Flue Gas (dry)	3,234
lb/hr Flue Gas (wet)	3,247

Table F-28

Traverse Data Calculated Results -- 2B Heat Pipe Secondary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	67
Amb Air WB, deg F	51
Humd, lb/lb BD Air	0.00435

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

Date	05/15/96
Time	12:00-13:02
Tube I.D.	S-54
C-Factor	0.816
Operator(s)	JAW/LLA

No. Of Points	24	
Duct Width	6.0	ft
Duct Depth	9.0	ft
Duct Area	54.00	Sq ft
% O2	21.0	
% N2	79.0	

Bar., " Hg	29.70
Static, " H20	3.46
% " H20	0.69
Dry MW	28.97
Wet MW	28.89

PORT/ POINT	DISTANCE Fr Bottom (1)	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	12"	604	0.8423	70.98
A-2	30"	626	0.8884	73.66
A-3	48"	628	0.7723	68.71
A-4	66"	620	0.7644	68.13
A-5	84"	618	0.7973	69.52
A-6	102"	617	1.0410	79.40
B-1	12"	603	0.9749	76.32
B-2	30"	609	0.8605	71.91
B-3	48"	613	0.7481	67.17
B-4	66"	616	0.7206	66.02
B-5	84"	616	0.9202	74.59
B-6	102"	612	0.9952	77.43
C-1	12"	627	0.9111	74.60
C-2	30"	618	0.9596	76.27
C-3	48"	612	0.7415	66.83
C-4	66"	612	0.6774	63.91
C-5	84"	610	0.8060	69.64
C-6	102"	605	0.7879	68.68
D-1	12"	609	0.8388	71.01
D-2	30"	608	0.7532	67.24
D-3	48"	606	0.7344	66.33
D-4	66"	603	0.6037	60.06
D-5	84"	602	0.7560	67.17
D-6	102"	598	0.8144	69.61
Average, (group mean)		612	0.8212	70.22
Average, (wt mean)		612	---	---
Maximum		628	1.0410	79.40
Minimum		598	0.6037	60.06
Standard Deviation		8	0.1041	4.52

Port A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	70.22
Velocity, [fpm]	4,213
ACFM	227,503
SCFM	110,446
DSCFM	109,678
lb/hr Air (dry)	502,221
lb/hr Air (wet)	504,405

Summary Weighted Avg Results	
Velocity, [fps]	70.20
Velocity, [fpm]	4,212
ACFM	227,453
SCFM	110,421
DSCFM	109,654
lb/hr Flue Gas (dry)	502,110
lb/hr Flue Gas (wet)	504,294

(1) Due to additional offset, distances are 3" higher than desired. Unequal areas at top and bottom of duct are accounted for in weighted average value results.

Table F-29

Traverse Data Calculated Results -- 2A Heat Pipe Flue Gas Inlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	4.92%	Overhead Ash	90.00%	Std. Conditions	
C	74.58%	C in Ash	2.27%	T, deg F	60
H	4.83%			P, in. Hg	29.92
N	1.55%	Amb Air DB, deg F	56		
S	2.00%	Amb Air WB, deg F	52		
O	4.21%	Humd, lb/lb BD Air	0.00728		
Ash	7.91%				
Total	100.00%				
		No. Points	20		
		Duct Width	14.5 ft	Bar., " Hg	29.49
Date	05/16/96	Duct Height	5.5 ft	Static, " H2O	-3.79
Time	18:30-19:30	Duct Area	79.75 Sq ft		
Tube I.D.	S-53	Avg % O2	5.22	% H2O	6.58
C-Factor	0.808	Avg % CO2	13.72	Dry MW	30.42
Operator(s)	RLO/FUZ	Avg % N2	81.06	Wet MW	29.61

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	8-1/4"	605	0.2710	39.89	5.0	14.0	8	0.1
A-2	24-3/4"	606	0.3267	43.84	5.4	13.6	8	0.1
A-3	41-1/4"	604	0.3054	42.35	5.4	13.6	7	0.1
A-4	57-3/4"	593	0.2881	40.94	6.0	13.1	6	0.1
B-1	8-1/4"	594	0.2745	39.92	4.3	14.5	9	0.1
B-2	24-3/4"	595	0.3928	47.79	4.6	14.3	9	0.1
B-3	41-1/4"	595	0.3623	45.92	5.3	13.7	8	0.1
B-4	57-3/4"	592	0.3516	45.20	5.9	13.1	5	0.1
C-1	8-1/4"	594	0.2825	40.51	4.6	14.3	10	0.1
C-2	24-3/4"	593	0.3995	48.15	4.7	14.2	10	0.1
C-3	41-1/4"	591	0.3489	44.96	4.8	14.1	10	0.1
C-4	57-3/4"	591	0.3693	46.27	5.2	13.8	10	0.1
D-1	8-1/4"	611	0.2742	40.24	5.0	14.0	12	0.1
D-2	24-3/4"	606	0.3864	47.68	5.4	13.6	11	0.1
D-3	41-1/4"	599	0.3545	45.51	5.2	13.8	10	0.1
D-4	57-3/4"	596	0.3594	45.76	5.4	13.6	10	0.1
E-1	8-1/4"	613	0.2700	39.99	5.4	13.6	12	0.1
E-2	24-3/4"	607	0.3231	43.63	5.7	13.3	12	0.1
E-3	41-1/4"	599	0.3117	42.68	5.4	13.6	10	0.1
E-5	57-3/4"	595	0.3113	42.58	5.7	13.3	11	0.1
Average, (group mean)		599	0.3282	43.69	5.2	13.7	9	0.10
Average, (wt mean)		599	---	---	5.2	13.7	9	0.10
Maximum		613	0.3995	48.15	6.0	14.5	12	0.10
Minimum		591	0.2700	39.89	4.3	13.1	5	0.10
Standard Deviation		7	0.0421	2.75	0.4	0.4	2	0.00

Port A = South, E = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	43.69
Velocity, [fpm]	2,621
ACFM	209,052
SCFM	100,238
DSCFM	93,641
Ex Air Free	70,252
lb/hr Flue Gas (dry)	450,279
lb/hr Flue Gas (wet)	469,063

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	43.69
Velocity, [fpm]	2,621
ACFM	209,052
SCFM	100,238
DSCFM	93,641
Ex Air Free	70,252
lb/hr Flue Gas (dry)	450,278
lb/hr Flue Gas (wet)	469,063

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Table F-30

Traverse Data Calculated Results -- 2A Heat Pipe Flue Gas Outlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	4.92%	Overhead Ash	90.00%	Std. Conditions	
C	74.58%	C in Ash	2.27%	T, deg F	60
H	4.83%			P, in. Hg	29.92
N	1.55%	Amb Air DB, deg F	56		
S	2.00%	Amb Air WB, deg F	52		
O	4.21%	Humd, lb/lb BD Air	0.00728		
Ash	7.91%				
Total	100.00%				
		No. Of Points	24		
		Duct Width	34.0 ft	Bar., " Hg	29.49
Date	05/16/96	Duct Depth	2.5 ft	Static, " H2O	-6.12
Time	18:35-19:20	Duct Area	85.00 Sq ft		
Tube I.D.	S-52	Avg % O2	6.01	% H20	6.32
C-Factor	0.798	Avg % CO2	13.03	Dry MW	30.34
Operator(s)	MSD/GLC	Avg % N2	80.95	Wet MW	29.56

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	7-1/2"	271	0.3633	37.94	6.0	13.1	2	0.2
A-2	22-1/2"	272	0.2828	33.49	5.9	13.1	2	0.2
B-1	7-1/2"	271	0.2493	31.42	6.0	13.1	4	0.2
B-2	22-1/2"	272	0.2798	33.31	6.0	13.1	3	0.2
C-1	7-1/2"	270	0.3593	37.70	6.0	13.1	4	0.1
C-2	22-1/2"	269	0.3140	35.23	6.2	12.9	4	0.1
D-1	7-1/2"	271	0.3318	36.25	6.0	13.1	4	0.1
D-2	22-1/2"	269	0.2840	33.49	6.0	13.1	4	0.1
E-1	7-1/2"	271	0.2662	32.47	6.0	13.1	4	0.1
E-2	22-1/2"	271	0.2810	33.36	6.0	13.1	4	0.1
F-1	7-1/2"	268	0.3370	36.46	5.9	13.1	5	0.1
F-2	22-1/2"	271	0.2627	32.26	6.1	13.0	5	0.1
G-1	7-1/2"	269	0.1583	25.01	6.1	13.0	2	0.3
G-2	22-1/2"	269	0.1445	23.89	6.1	13.0	1	0.3
H-1	7-1/2"	271	0.1785	26.59	6.0	13.1	2	0.3
H-2	22-1/2"	270	0.1959	27.84	6.1	13.0	2	0.3
I-1	7-1/2"	273	0.2181	29.43	6.0	13.1	2	0.3
I-2	22-1/2"	273	0.2174	29.39	6.0	13.1	2	0.3
J-1	7-1/2"	277	0.2320	30.44	6.0	13.1	3	0.4
J-2	22-1/2"	276	0.2228	29.81	6.0	13.1	2	0.4
K-1	7-1/2"	279	0.2318	30.47	6.0	13.1	4	0.3
K-2	22-1/2"	278	0.2196	29.65	6.0	13.1	4	0.3
L-1	7-1/2"	280	0.2331	30.57	6.0	13.1	5	0.3
L-2	22-1/2"	277	0.2255	30.01	6.0	13.1	5	0.4
Average, (group mean)		272	0.2537	31.52	6.0	13.0	3	0.2
Average, (wt mean)		272	---	---	6.0	13.0	3	0.22
Maximum		280	0.3633	37.94	6.2	13.1	5	0.4
Minimum		268	0.1445	23.89	5.9	12.9	1	0.1
Standard Deviation		3	0.0578	3.62	0.1	0.1	1	0.1

Port A = North, L = South

ary Straight Avg'd Data	
Velocity, [fps]	31.52
Velocity, [fpm]	1,891
ACFM	160,757
SCFM	110,803
DSCFM	103,799
Ex Air Free	73,928
lb/hr Flue Gas (dry)	497,827
lb/hr Flue Gas (wet)	517,772

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	31.52
Velocity, [fpm]	1,891
ACFM	160,757
SCFM	110,803
DSCFM	103,800
Ex Air Free	73,928
lb/hr Flue Gas (dry)	497,828
lb/hr Flue Gas (wet)	517,772

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Table F-31

Traverse Data Calculated Results -- 2A Heat Pipe Primary Flue Gas Out Duct
NYSEG Milliken Station

Coal Composition					
Moisture	4.92%	Overhead Ash	90.00%	**Std. Conditions**	
C	74.58%	C in Ash	2.27%	T, deg F	60
H	4.83%			P, In. Hg	29.92
N	1.55%	Amb Air DB, deg F	56		
S	2.00%	Amb Air WB, deg F	52		
O	4.21%	Humd, lb/lb BD Air	0.00728		
Ash	7.91%				
Total	100.00%				

		No. Of Points	14	Bar., " Hg	29.49
Date	05/16/96	Duct Width	17.92 ft	Static, " H2O	-5.55
Time	19:45-20:20	Duct Height	3.28 ft		
Tube I.D.	S-52	Duct Area	58.79 Sq ft	% H2O	6.03
C-Factor	0.798	Avg % O2	6.90	Dry MW	30.26
Operator(s)	MSD/GLC	Avg % CO2	12.26	Wet MW	29.52
		Avg % N2	80.84		

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	9-7/8"	247	0.0178	8.26	7.20	12.0	0	0.8
A-2	29-9/16"	253	0.0132	7.14	6.70	12.5	1	0.5
B-1	9-7/8"	248	0.0241	9.62	6.80	12.4	13	0.3
B-2	29-9/16"	251	0.0088	5.82	5.80	13.2	24	0.2
C-1	9-7/8"	247	0.0122	6.84	7.10	12.1	28	0.3
C-2	29-9/16"	256	0.0127	7.02	7.40	11.9	39	0.2
D-1	9-7/8"	249	0.0266	10.10	6.20	12.9	49	0.5
D-2	29-9/16"	247	0.0055	4.59	7.50	11.8	62	0.2
E-1	9-7/8"	248	0.0309	10.89	7.10	12.1	64	0.1
E-2	29-9/16"	259	0.0176	8.28	6.30	12.8	80	0.3
F-1	9-7/8"	250	0.0250	9.81	6.70	12.5	63	0.3
F-2	29-9/16"	255	0.0277	10.36	7.30	11.9	78	0.2
G-1	9-7/8"	247	0.0278	10.32	7.30	11.9	64	0.4
G-2	29-9/16"	251	0.0095	6.05	7.20	12.0	83	0.3
Average, (group mean)		250	0.0185	8.22	6.90	12.26	46.29	0.33
Average, (wt mean)		250	---	---	6.90	12.26	47	0.33
Maximum		259	0.0309	10.89	7.50	13.20	83.00	0.80
Minimum		247	0.0055	4.59	5.80	11.75	0.00	0.10
Standard Deviation		4	0.0081	1.93	0.49	0.42	27.82	0.17

Port A = South, G = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	8.22
Velocity, [fpm]	493
ACFM	29,001
SCFM	20,636
DSCFM	19,391
Ex Air Free	12,991
lb/hr Flue Gas (dry)	92,730
lb/hr Flue Gas (wet)	96,275

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	8.20
Velocity, [fpm]	492
ACFM	28,923
SCFM	20,581
DSCFM	19,339
Ex Air Free	12,957
lb/hr Flue Gas (dry)	92,483
lb/hr Flue Gas (wet)	96,018

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Table F-33

Traverse Data Calculated Results -- 2A Heat Pipe Primary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	56
Amb Air WB, deg F	52
Humd, lb/lb BD Air	0.00728

Std. Conditions

T, deg F	**60**
P, in. Hg	**29.92**

Bar., " Hg	**29.49**
Static, " H20	**50.27**

Date	05/16/96	No. Points	20
Time	19:45-20:10	Duct Dia	47.5 inches
Tube I.D.	S-49	Duct Area	12.31 Sq ft
C-Factor	0.806	Avg % O2	21.0
Operator(s)	RLO/FUZ	Avg % N2	79.0

% H20	**1.16**
Dry MW	**28.97**
Wet MW	**28.84**

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	1-3/16"	534	0.1480	27.01
A-2	3-7/8"	535	0.1586	27.98
A-3	6-15/16"	535	0.1871	30.39
A-4	10-3/4"	535	0.1883	30.48
A-5	16-1/4"	536	0.2019	31.58
A-6	31-1/4"	536	0.1575	27.89
A-7	36-3/4"	536	0.1572	27.87
A-8	40-9/16"	535	0.1376	26.06
A-9	43-5/8"	534	0.1229	24.61
A-10	46-5/16"	533	0.1107	23.35
B-1	1-3/16"	533	0.1423	26.47
B-2	3-7/8"	534	0.1591	28.01
B-3	6-15/16"	534	0.1688	28.85
B-4	10-3/4"	534	0.1761	29.46
B-5	16-1/4"	534	0.1890	30.52
B-6	31-1/4"	534	0.1504	27.23
B-7	36-3/4"	534	0.1386	26.14
B-8	40-9/16"	533	0.1318	25.48
B-9	43-5/8"	532	0.1129	23.57
B-10	46-5/16"	531	0.0975	21.89
Average, (group mean)		534	0.1518	27.24
Average, (wt mean)		534	---	---
Maximum		536	0.2019	31.58
Minimum		531	0.0975	21.89
Standard Deviation		1	0.0277	2.55

Ports A = South, B = East

Summary Straight Avg'd Results	
Velocity, [fps]	27.24
Velocity, [fpm]	1,634
ACFM	20,114
SCFM	11,668
DSCFM	11,533
lb/hr Air (dry)	52,810
lb/hr Air (wet)	53,195

Summary Weighted Avg Results	
Velocity, [fps]	**27.24**
Velocity, [fpm]	**1,634**
ACFM	**20,114**
SCFM	**11,668**
DSCFM	**11,533**
lb/hr Flue Gas (dry)	**52,810**
lb/hr Flue Gas (wet)	**53,195**

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Table F-35

Traverse Data Calculated Results -- 2A Heat Pipe Secondary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	56
Amb Air WB, deg F	52
Humd, lb/lb BD Air	0.00728

Std. Conditions

T, deg F	**60**
P, in. Hg	**29.92**

		No. Points	24	**Bar., " Hg**	**29.49**
Date	05/16/96	Duct Width	6.0 ft	**Static, " H20**	**1.24**
Time	18:39-19:19	Duct Depth	9.0 ft		
Tube I.D.	S-54	Duct Area	54.00 Sq ft	**% " H20**	**1.16**
C-Factor	0.816	Avg % O2	21.0	**Dry MW**	**28.97**
Operator(s)	JAW/LLA	Avg % N2	79.0	**Wet MW**	**28.84**

PORT/ POINT	DISTANCE Fr Bottom (1)	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	12"	557	0.2672	39.36
A-2	30"	555	0.3072	42.17
A-3	48"	554	0.2966	41.41
A-4	66"	551	0.2458	37.65
A-5	84"	549	0.1376	28.14
A-6	102"	547	0.3030	41.71
B-1	12"	564	0.3437	44.80
B-2	30"	564	0.3595	45.82
B-3	48"	562	0.2950	41.47
B-4	66"	561	0.2665	39.39
B-5	84"	558	0.2834	40.55
B-6	102"	551	0.2594	38.67
C-1	12"	562	0.3514	45.24
C-2	30"	567	0.3659	46.30
C-3	48"	568	0.2847	40.85
C-4	66"	570	0.2696	39.79
C-5	84"	569	0.3238	43.59
C-6	102"	566	0.3653	46.24
D-1	12"	554	0.2643	39.09
D-2	30"	565	0.3438	44.83
D-3	48"	570	0.2813	40.64
D-4	66"	571	0.2890	41.23
D-5	84"	572	0.2745	40.20
D-6	102"	572	0.3932	48.10
Average, (group mean)		562	0.2988	41.55
Average, (wt mean)		562	---	---
Maximum		572	0.3932	48.10
Minimum		547	0.1376	28.14
Standard Deviation		8	0.0520	3.93

Port A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	41.55
Velocity, [fpm]	2,493
ACFM	134,625
SCFM	67,726
DSCFM	66,942
lb/hr Air (dry)	306,531
lb/hr Air (wet)	308,763

Summary Weighted Avg Results	
Velocity, [fps]	**41.51**
Velocity, [fpm]	**2,490**
ACFM	**134,485**
SCFM	**67,656**
DSCFM	**66,873**
lb/hr Flue Gas (dry)	**306,212**
lb/hr Flue Gas (wet)	**308,442**

(1) Due to additional offset, distances are 3" higher than desired. **Unequal areas at top and** bottom of duct are accounted for in weighted average value results.

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Table F-36

Traverse Data Calculated Results -- 2B Heat Pipe Flue Gas Inlet Duct
NYSEG Milliken Station

Coal Composition	
Moisture	4.92%
C	74.58%
H	4.83%
N	1.55%
S	2.00%
O	4.21%
Ash	7.91%
Total	100.00%

Overhead Ash	90.00%
C in Ash	2.27%
Amb Air DB, deg F	54
Amb Air WB, deg F	52
Humd, lb/lb BD Air	0.00773

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

Date	05/16/96
Time	21:40-22:20
Tube I.D.	S-53
C-Factor	0.808
Operator(s)	RLO/FUZ

No. Points	20
Duct Width	14.5 ft
Duct Height	5.5 ft
Duct Area	79.75 Sq ft
Avg % O2	6.12
Avg % CO2	12.93
Avg % N2	80.95

Bar., " Hg	29.48
Static, " H2O	-3.77
% H2O	6.35
Dry MW	30.33
Wet MW	29.55

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	8-1/4"	604	0.2357	37.24	6.2	12.9	0	0.1
A-2	24-3/4"	601	0.2986	41.84	5.8	13.2	1	0.1
A-3	41-1/4"	600	0.2848	40.84	5.8	13.2	1	0.2
A-4	57-3/4"	600	0.2682	39.63	5.8	13.2	2	0.1
B-1	8-1/4"	600	0.2408	37.56	6.1	13.0	0	0.1
B-2	24-3/4"	598	0.3471	45.05	5.9	13.1	0	0.1
B-3	41-1/4"	598	0.3148	42.90	5.9	13.1	0	0.2
B-4	57-3/4"	601	0.2817	40.64	5.8	13.2	0	0.3
C-1	8-1/4"	593	0.2617	39.03	6.0	13.1	0	0.1
C-2	24-3/4"	593	0.3206	43.19	6.0	13.1	0	0.1
C-3	41-1/4"	594	0.3057	42.19	5.7	13.3	0	0.1
C-4	57-3/4"	599	0.2940	41.48	5.8	13.2	0	0.2
D-1	8-1/4"	607	0.2448	38.00	6.2	12.9	1	0.1
D-2	24-3/4"	608	0.3265	44.05	6.2	12.9	1	0.1
D-3	41-1/4"	607	0.3160	43.18	6.4	12.7	1	0.1
D-4	57-3/4"	605	0.3068	42.51	6.3	12.8	0	0.1
E-1	8-1/4"	625	0.1463	29.64	6.7	12.5	3	0.1
E-2	24-3/4"	626	0.2259	36.84	6.5	12.6	3	0.1
E-3	41-1/4"	615	0.2797	40.79	6.6	12.5	2	0.1
E-4	57-3/4"	596	0.2820	40.64	6.9	12.3	1	0.1
Average, (group mean)		**604**	**0.2792**	**40.36**	**6.1**	**12.9**	**1**	**0.13**
Average, (wt mean)		**603**	**---**	**---**	**6.1**	**12.9**	**1**	**0.13**
Maximum		**626**	**0.3471**	**45.05**	**6.9**	**13.3**	**3**	**0.30**
Minimum		**593**	**0.1463**	**29.64**	**5.7**	**12.3**	**0**	**0.10**
Standard Deviation		**9**	**0.0441**	**3.34**	**0.3**	**0.3**	**1**	**0.05**

Port A = South, E = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	40.36
Velocity, [fpm]	2,422
ACFM	193,136
SCFM	92,201
DSCFM	86,348
Ex Air Free	61,076
lb/hr Flue Gas (dry)	413,963
lb/hr Flue Gas (wet)	430,628

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	40.36
Velocity, [fpm]	2,422
ACFM	193,136
SCFM	92,200
DSCFM	86,348
Ex Air Free	61,076
lb/hr Flue Gas (dry)	413,962
lb/hr Flue Gas (wet)	430,627

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Table F-37

Traverse Data Calculated Results -- 2B Heat Pipe Flue Gas Outlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	4.92%	Overhead Ash	90.00%	**Std. Conditions**	
C	74.58%	C in Ash	2.27%	**T, deg F**	**60**
H	4.83%			**P, in. Hg**	**29.92**
N	1.55%	Amb Air DB, deg F	54		
S	2.00%	Amb Air WB, deg F	52		
O	4.21%	Humd, lb/lb BD Air	0.00773		
Ash	7.91%				
Total	100.00%				
		No. Of Points	24		
		Duct Width	34.0 ft	**Bar., " Hg**	**29.48**
Date	05/16/96	Duct Depth	2.5 ft	**Static, " H2O**	**-6.80**
Time	21:45-22:30	Duct Area	85.00 Sq ft		
Tube I.D.	S-52	Avg % O2	6.45	**% H20**	**6.24**
C-Factor	0.798	Avg % CO2	12.65	**Dry MW**	**30.30**
Operator(s)	MSD/GLC	Avg % N2	80.91	**Wet MW**	**29.53**

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1 (1)	7-1/2"	257	0.1262	22.15	6.4	12.7	43	0.1
A-2 (1)	22-1/2"	257	0.1125	20.91	6.3	12.8	57	0.1
B-1	7-1/2"	257	0.1262	22.15	6.4	12.7	43	0.1
B-2	22-1/2"	257	0.1125	20.91	6.3	12.8	57	0.1
C-1	7-1/2"	256	0.1537	24.43	6.3	12.8	50	0.1
C-2	22-1/2"	256	0.1504	24.16	6.2	12.9	30	0.1
D-1	7-1/2"	254	0.2386	30.39	6.2	12.9	22	0.2
D-2	22-1/2"	255	0.2330	30.05	6.3	12.8	30	0.2
E-1	7-1/2"	253	0.2013	27.89	6.4	12.7	42	0.1
E-2	22-1/2"	253	0.2007	27.85	6.1	13.0	55	0.1
F-1	7-1/2"	252	0.1500	24.07	6.7	12.5	50	0.1
F-2	22-1/2"	252	0.1934	27.33	6.6	12.5	49	0.1
G-1	7-1/2"	253	0.1133	20.94	6.8	12.4	64	0.0
G-2	22-1/2"	252	0.1148	21.06	6.8	12.4	67	0.0
H-1	7-1/2"	254	0.3062	34.43	6.3	12.8	33	0.0
H-2	22-1/2"	255	0.3064	34.46	6.4	12.7	57	0.0
I-1	7-1/2"	256	0.3765	38.23	6.3	12.8	37	0.0
I-2	22-1/2"	254	0.3178	35.08	6.7	12.5	49	0.0
J-1	7-1/2"	254	0.2636	31.94	6.4	12.7	87	0.0
J-2	22-1/2"	253	0.2801	32.91	6.4	12.7	102	0.0
K-1	7-1/2"	249	0.2529	31.19	6.7	12.5	89	0.0
K-2	22-1/2"	251	0.2938	33.66	6.5	12.6	104	0.0
L-1	7-1/2"	247	0.2047	28.02	6.7	12.5	110	0.0
L-2	22-1/2"	249	0.1558	24.48	6.6	12.5	124	0.0
Average, (group mean)		253	0.2077	27.86	6.5	12.6	60	0.1
Average, (wt mean)		253	---	---	6.4	12.6	61	0.05
Maximum		257	0.3765	38.23	6.8	13.0	124	0.2
Minimum		247	0.1125	20.91	6.1	12.4	22	0.0
Standard Deviation		3	0.0766	5.21	0.2	0.2	27	0.1

Port A = North, L = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	27.86
Velocity, [fpm]	1,672
ACFM	142,091
SCFM	100,581
DSCFM	94,301
Ex Air Free	65,220
lb/hr Flue Gas (dry)	451,614
lb/hr Flue Gas (wet)	469,497

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	**27.86**
Velocity, [fpm]	**1,672**
ACFM	**142,091**
SCFM	**100,581**
DSCFM	**94,301**
Ex Air Free	**65,220**
lb/hr Flue Gas (dry)	**451,615**
lb/hr Flue Gas (wet)	**469,498**

(1) No Port at Location Due to Structural Steel Support. Used Values For Port "B".

Table F-38

Traverse Data Calculated Results -- 2B Heat Pipe Primary Flue Gas Out Duct
NYSEG Milliken Station

Coal Composition	
Moisture	4.92%
C	74.58%
H	4.83%
N	1.55%
S	2.00%
O	4.21%
Ash	7.91%
Total	100.00%

Overhead Ash	90.00%
C in Ash	2.27%
Amb Air DB, deg F	54
Amb Air WB, deg F	52
Humd, lb/lb BD Air	0.00773

Std. Conditions	
T, deg F	60
P, In. Hg	29.92

Date	05/16/96
Time	20:45-21:15
Tube I.D.	S-52
C-Factor	0.798
Operator(s)	MSD/GLC

No. Of Points	14
Duct Width	17.92 ft
Duct Height	3.28 ft
Duct Area	58.79 Sq ft
Avg % O2	8.61
Avg % CO2	10.77
Avg % N2	80.63

Bar., " Hg	29.51
Static, " H2O	-5.26
% H2O	5.53
Dry MW	30.08
Wet MW	29.42

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	9-7/8"	229	0.0145	7.37	9.3	10.2	40	0.9
A-2	29-9/16"	233	0.0239	9.48	8.8	10.6	55	0.9
B-1	9-7/8"	230	0.0121	6.73	8.5	10.9	60	0.6
B-2	29-9/16"	235	0.0088	5.76	8.1	11.2	80	0.1
C-1	9-7/8"	231	0.0111	6.45	8.4	11.0	85	0.4
C-2	29-9/16"	233	0.0052	4.42	8.6	10.8	90	0.4
D-1	9-7/8"	227	0.0042	3.96	8.2	11.1	92	0.4
D-2	29-9/16"	233	0.0064	4.91	8.4	11.0	113	0.4
E-1	9-7/8"	226	0.0093	5.89	8.6	10.8	90	0.4
E-2	29-9/16"	236	0.0095	5.99	7.9	11.3	123	0.4
F-1	9-7/8"	232	0.0234	9.38	9.4	10.1	102	0.4
F-2	29-9/16"	239	0.0115	6.60	8.3	11.1	121	0.4
G-1	9-7/8"	227	0.0175	8.08	8.7	10.7	71	0.6
G-2	29-9/16"	237	0.0023	2.95	8.1	11.2	102	0.6
Average, (group mean)		232	0.0114	6.28	8.52	10.84	87.43	0.49
Average, (wt mean)		232	---	---	8.6	10.8	85	0.52
Maximum		239	0.0239	9.48	9.40	11.30	123.00	0.90
Minimum		226	0.0023	2.95	7.90	10.05	40.00	0.10
SDEV		4	0.0063	1.83	0.42	0.36	23.74	0.21

Port A = North, G = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	6.28
Velocity, [fpm]	377
ACFM	22,166
SCFM	16,224
DSCFM	15,327
Ex Air Free	9,016
lb/hr Flue Gas (dry)	72,880
lb/hr Flue Gas (wet)	75,435

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	6.29
Velocity, [fpm]	377
ACFM	22,183
SCFM	16,237
DSCFM	15,339
Ex Air Free	9,023
lb/hr Flue Gas (dry)	72,938
lb/hr Flue Gas (wet)	75,495

Table F-39

Traverse Data Calculated Results -- 2B Heat Pipe Primary Air Inlet Duct
NYSEG Milliken Station

Amb Air DB, deg F 56
Amb Air WB, deg F 52
Humd, lb/lb BD Air 0.00773

Std. Conditions
T, deg F 60
P, in. Hg 29.92

Date 05/16/96
Time 20:53-21:18
Tube I.D. S-50
C-Factor 0.789
Operator(s) JAW/LLA

No. Points 12
Duct Width 17.5 ft
Duct Depth 3.28 ft
Duct Area 57.42 Sq ft
Avg % O2 21.0
Avg % N2 79.0

Bar., " Hg 29.51
Static, " H20 52.02

% H20 1.23
Dry MW 28.97
Wet MW 28.84

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	9-7/8"	115	0.1080	17.14
A-2	29-9/16"	116	0.0263	8.46
B-1	9-7/8"	115	0.0438	10.92
B-2	29-9/16"	116	0.0099	5.19
C-1	9-7/8"	115	0.0295	8.96
C-2	29-9/16"	115	0.0100	5.22
D-1	9-7/8"	115	0.0194	7.26
D-2	29-9/16"	115	0.0111	5.50
E-1	9-7/8"	115	0.0033	3.00
E-2	29-9/16"	115	0.0077	4.58
F-1	9-7/8"	115	-0.0028	-2.76
F-2	29-9/16"	115	0.0000	0.00
Average, (group mean)		115	0.0222	6.12
Average, (wt mean)		115	---	---
Maximum		116	0.1080	17.14
Minimum		115	-0.0028	-2.76
Standard Deviation		0	0.0289	4.91

Ports A = South, F = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	6.12
Velocity, [fpm]	367
ACFM	21,092
SCFM	21,249
DSCFM	20,988
lb/hr Air (dry)	96,107
lb/hr Air (wet)	96,850

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	6.12
Velocity, [fpm]	367
ACFM	21,092
SCFM	21,249
DSCFM	20,988
lb/hr Flue Gas (dry)	96,105
lb/hr Flue Gas (wet)	96,848

Table F-40

Traverse Data Calculated Results -- 2B Heat Pipe Primary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	56
Amb Air WB, deg F	52
Humd, lb/lb BD Air	0.00728

Std. Conditions

T, deg F	**60**
P, in. Hg	**29.92**
Bar., " Hg	**29.51**
Static, " H20	**50.23**
% H20	**1.16**
Dry MW	**28.97**
Wet MW	**28.84**

Date	05/16/96	No. Of Points	20
Time	20:50-21:05	Duct Dia	47.5 inches
Tube I.D.	S-49	Duct Area	12.31 Sq ft
C-Factor	0.806	Avg % O2	21.0
Operator(s)	RLO/FUZ	Avg % N2	79.0

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	1-3/16"	537	0.1083	23.13
A-2	3-7/8"	538	0.1237	24.74
A-3	6-15/16"	538	0.1420	26.50
A-4	10-3/4"	539	0.1440	26.70
A-5	16-1/4"	539	0.1454	26.83
A-6	31-1/4"	540	0.1089	23.23
A-7	36-3/4"	540	0.0971	21.94
A-8	40-9/16"	540	0.0956	21.77
A-9	43-5/8"	539	0.0855	20.58
A-10	46-5/16"	538	0.0795	19.83
B-1	1-3/16"	536	0.1094	23.24
B-2	3-7/8"	537	0.1330	25.64
B-3	6-15/16"	537	0.1542	27.61
B-4	10-3/4"	538	0.1736	29.31
B-5	16-1/4"	538	0.1684	28.86
B-6	31-1/4"	538	0.1410	26.41
B-7	36-3/4"	538	0.1134	23.69
B-8	40-9/16"	538	0.1116	23.50
B-9	43-5/8"	537	0.1062	22.91
B-10	46-5/16"	537	0.0896	21.04
Average, (group mean)		538	0.1215	24.37
Average, (wt mean)		538	---	---
Maximum		540	0.1736	29.31
Minimum		536	0.0795	19.83
Standard Deviation		1	0.0267	2.68

Ports A = North, B = East

Summary Straight Avg'd Results	
Velocity, [fps]	24.37
Velocity, [fpm]	1,462
ACFM	17,996
SCFM	10,404
DSCFM	10,283
lb/hr Air (dry)	47,088
lb/hr Air (wet)	47,431

Summary Weighted Avg Results	
Velocity, [fps]	**24.37**
Velocity, [fpm]	**1,462**
ACFM	**17,996**
SCFM	**10,404**
DSCFM	**10,283**
lb/hr Flue Gas (dry)	**47,088**
lb/hr Flue Gas (wet)	**47,431**

Table F-41

Traverse Data Calculated Results -- 2B Heat Pipe Secondary Air By-Pass Duct
NYSEG Milliken Station

Amb Air DB, deg F 56
Amb Air WB, deg F 52
Humd, lb/lb BD Air 0.00728

Std. Conditions
T, deg F 60
P, in. Hg 29.92

No. Of Point 8
Duct Width 17.5 ft
Duct Depth 2.09 ft
Duct Area 36.64 Sq ft
Avg % O2 21.0
Avg % N2 79.0

Date 5/16/96
Time 16:45 hrs
Tube I.D. S-53
C-Factor 0.808
Operator(s) RLO/FUZ

Bar., " Hg 29.51
Static, " H2 2.10

% H20 1.16
Dry MW 28.97
Wet MW 28.84

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	6-5/16"	141	0.0000	0.00
A-2	18-7/8"	147	0.0000	0.00
B-1	6-5/16"	117	-0.0004	-1.13
B-2	18-7/8"	123	-0.0002	-0.81
C-1	6-5/16"	177	0.0007	1.58
C-2	18-7/8"	171	0.0000	0.00
D-1	6-5/16"	199	-0.0001	-0.61
D-2	18-7/8"	205	0.0000	0.00
Average, (group mean)		160	-0.0000	-0.12
Average, (wt mean)		152	---	---
Maximum		205	0.0007	1.58
Minimum		117	-0.0004	-1.13
Standard Deviation		31	0.0003	0.76

Ports A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	-0.12
Velocity, [fpm]	-7
ACFM	(267)
SCFM	(225)
DSCFM	(222)
lb/hr Air (dry)	(1,017)
lb/hr Air (wet)	(1,024)

Summary Weighted Avg Results	
Velocity, [fps]	-0.12
Velocity, [fpm]	-7
ACFM	(267)
SCFM	(254)
DSCFM	(251)
lb/hr Flue Gas (dry)	(1,150)
lb/hr Flue Gas (wet)	(1,158)

Table F-42

Traverse Data Calculated Results -- 2B Heat Pipe Secondary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F 56
Amb Air WB, deg F 52
Humd, lb/lb BD Air 0.00728

Std. Conditions
T, deg F **60**
P, in. Hg **29.92**

No. Of Points 24
Duct Width 6.0 ft
Duct Depth 9.0 ft
Duct Area 54.00 Sq ft
Avg % O2 21.0
Avg % N2 79.0

Bar., " Hg **29.48**
Static, " H20 **1.18**

% " H20 **1.16**
Dry MW **28.97**
Wet MW **28.84**

Date 05/16/96
Time 21:46-22:29
Tube I.D. S-54
C-Factor 0.816
Operator(s) JAW/LLA

PORT/ POINT	DISTANCE Fr Bottom (1)	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	12"	547	0.3162	42.61
A-2	30"	561	0.3119	42.63
A-3	48"	567	0.2663	39.51
A-4	66"	570	0.2801	40.57
A-5	84"	571	0.3026	42.18
A-6	102"	570	0.3657	46.37
B-1	12"	559	0.3482	44.99
B-2	30"	566	0.3189	43.20
B-3	48"	567	0.2741	40.07
B-4	66"	570	0.2674	39.63
B-5	84"	570	0.3274	43.86
B-6	102"	567	0.3640	46.18
C-1	12"	560	0.3498	45.11
C-2	30"	561	0.3673	46.26
C-3	48"	560	0.2773	40.16
C-4	66"	561	0.2558	38.61
C-5	84"	559	0.3015	41.87
C-6	102"	552	0.2873	40.73
D-1	12"	548	0.3219	43.03
D-2	30"	546	0.2942	41.10
D-3	48"	546	0.2823	40.25
D-4	66"	546	0.2161	35.21
D-5	84"	544	0.2647	38.94
D-6	102"	542	0.2863	40.45
Average, (group mean)		559	0.3020	41.81
Average, (wt mean)		559	---	---
Maximum		571	0.3673	46.37
Minimum		542	0.2161	35.21
Standard Deviation		10	0.0378	2.70

Port A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	41.81
Velocity, [fpm]	2,509
ACFM	135,477
SCFM	68,335
DSCFM	67,545
lb/hr Air (dry)	309,289
lb/hr Air (wet)	311,540

Summary Weighted Avg Results	
Velocity, [fps]	**41.83**
Velocity, [fpm]	**2,510**
ACFM	**135,522**
SCFM	**68,358**
DSCFM	**67,567**
lb/hr Flue Gas (dry)	**309,393**
lb/hr Flue Gas (wet)	**311,645**

Table F-43

Traverse Data Calculated Results -- 2A Heat Pipe Flue Gas Outlet Duct
NYSEG Milliken Station

Coal Composition	
Moisture	4.92%
C	74.58%
H	4.83%
N	1.55%
S	2.00%
O	4.21%
Ash	7.91%
Total	100.00%

Overhead Ash	90.00%
C in Ash	4.86%
Amb Air DB, deg F	56
Amb Air WB, deg F	52
Humd, lb/lb BD Air	0.00728

Std. Conditions

T, deg F	60
P, in. Hg	29.92

Date	05/17/96
Time	08:30-09:30
Tube I.D.	S-51
C-Factor	0.798
Operator(s)	JAW/RLO

No. Of Points	24
Duct Width	34.0 ft
Duct Depth	2.5 ft
Duct Area	85.00 Sq ft
Avg % O2	3.30
Avg % CO2	15.40
Avg % N2	81.30

Bar., " Hg	29.48
Static, " H2O	-13.89
% H20	7.22
Dry MW	30.61
Wet MW	29.70

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	7-1/2"	280	0.6589	51.82	3.3	15.4	0	0.0
A-2	22-1/2"	281	0.7986	57.08	3.3	15.4	0	0.0
B-1	7-1/2"	280	0.5964	49.29	3.3	15.4	0	0.0
B-2	22-1/2"	281	0.6051	49.67	3.3	15.4	0	0.0
C-1	7-1/2"	279	0.7490	55.20	3.3	15.4	0	0.0
C-2	22-1/2"	280	0.8002	57.10	3.3	15.4	0	0.0
D-1	7-1/2"	280	0.6866	52.89	3.3	15.4	0	0.0
D-2	22-1/2"	281	0.7295	54.55	3.3	15.4	0	0.0
E-1	7-1/2"	282	0.6404	51.14	3.3	15.4	0	0.0
E-2	22-1/2"	283	0.6386	51.09	3.3	15.4	0	0.0
F-1	7-1/2"	282	0.5611	47.87	3.3	15.4	0	0.0
F-2	22-1/2"	283	0.7025	53.58	3.3	15.4	0	0.0
G-1	7-1/2"	280	0.3252	36.40	3.3	15.4	0	0.0
G-2	22-1/2"	282	0.4210	41.46	3.3	15.4	0	0.0
H-1	7-1/2"	281	0.4324	42.00	3.3	15.4	0	0.0
H-2	22-1/2"	282	0.4330	42.05	3.3	15.4	0	0.0
I-1	7-1/2"	282	0.4917	44.82	3.3	15.4	0	0.0
I-2	22-1/2"	282	0.4708	43.86	3.3	15.4	0	0.0
J-1	7-1/2"	283	0.5423	47.10	3.3	15.4	0	0.0
J-2	22-1/2"	284	0.5325	46.70	3.3	15.4	0	0.0
K-1	7-1/2"	282	0.5310	46.57	3.3	15.4	0	0.0
K-2	22-1/2"	284	0.6011	49.61	3.3	15.4	0	0.0
L-1	7-1/2"	282	0.5087	45.57	3.3	15.4	0	0.0
L-2	22-1/2"	284	0.5060	45.52	3.3	15.4	0	0.0
Average, (group mean)		282	0.5818	48.46	3.3	15.4	0	0.0
Average, (wt mean)		282	---	---	3.3	15.4	0	0.00
Maximum		284	0.8002	57.10	3.3	15.4	0	0.0
Minimum		279	0.3252	36.40	3.3	15.4	0	0.0
Standard Deviation		1	0.1222	5.18	0.0	0.0	0	0.0

Port A = North, L = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	48.46
Velocity, [fpm]	2,907
ACFM	247,129
SCFM	164,804
DSCFM	152,909
Ex Air Free	128,766
lb/hr Flue Gas (dry)	739,905
lb/hr Flue Gas (wet)	773,777

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	48.46
Velocity, [fpm]	2,907
ACFM	247,129
SCFM	164,804
DSCFM	152,909
Ex Air Free	128,766
lb/hr Flue Gas (dry)	739,905
lb/hr Flue Gas (wet)	773,777

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Table F-44

Traverse Data Calculated Results -- 2B Heat Pipe Flue Gas Outlet Duct
NYSEG Milliken Station

Coal Composition

Moisture	4.92%	Overhead Ash	90.00%	Std. Conditions	
C	74.56%	C in Ash	4.86%	T, deg F	60
H	4.83%			P, in. Hg	29.92
N	1.55%	Amb Air DB, deg F	56		
S	2.00%	Amb Air WB, deg F	52		
O	4.23%	Humd, lb/lb BD Air	0.00728		
Ash	7.91%				
Total	100.00%				
		No. Of Points	24		
		Duct Width	34.0 ft	Bar., " Hg	29.48
Date	05/17/96	Duct Depth	2.5 ft	Static, " H2O	-13.95
Time	08:30-09:20	Duct Area	85.00 Sq ft		
Tube I.D.	S-52	Avg % O2	3.30	% H20	7.22
C-Factor	0.798	Avg % CO2	15.40	Dry MW	30.61
Operator(s)	GLC/LLA	Avg % N2	81.30	Wet MW	29.70

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1 (1)	7-1/2"	278	0.3477	37.58	3.3	15.4	0	0.0
A-2 (1)	22-1/2"	278	0.3163	35.85	3.3	15.4	0	0.0
B-1	7-1/2"	278	0.3477	37.58	3.3	15.4	0	0.0
B-2	22-1/2"	278	0.3163	35.85	3.3	15.4	0	0.0
C-1	7-1/2"	280	0.4419	42.43	3.3	15.4	0	0.0
C-2	22-1/2"	279	0.4590	43.21	3.3	15.4	0	0.0
D-1	7-1/2"	281	0.6331	50.82	3.3	15.4	0	0.0
D-2	22-1/2"	281	0.6474	51.39	3.3	15.4	0	0.0
E-1	7-1/2"	283	0.5638	48.02	3.3	15.4	0	0.0
E-2	22-1/2"	282	0.5643	48.01	3.3	15.4	0	0.0
F-1	7-1/2"	284	0.4389	42.40	3.3	15.4	0	0.0
F-2	22-1/2"	284	0.5556	47.70	3.3	15.4	0	0.0
G-1	7-1/2"	283	0.3500	37.84	3.3	15.4	0	0.0
G-2	22-1/2"	282	0.3083	35.49	3.3	15.4	0	0.0
H-1	7-1/2"	281	0.9035	60.71	3.3	15.4	0	0.0
H-2	22-1/2"	281	0.8744	59.72	3.3	15.4	0	0.0
I-1	7-1/2"	281	1.0830	66.47	3.3	15.4	0	0.0
I-2	22-1/2"	282	0.9347	61.79	3.3	15.4	0	0.0
J-1	7-1/2"	284	0.7350	54.87	3.3	15.4	0	0.0
J-2	22-1/2"	284	0.8184	57.90	3.3	15.4	0	0.0
K-1	7-1/2"	288	0.6442	51.50	3.3	15.4	0	0.0
K-2	22-1/2"	288	0.7890	57.00	3.3	15.4	0	0.0
L-1	7-1/2"	289	0.5863	49.17	3.3	15.4	0	0.0
L-2	22-1/2"	286	0.4438	42.75	3.3	15.4	0	0.0
Average, (group mean)		282	0.5876	48.17	3.3	15.4	0	0.0
Average, (wt mean)		283	---	---	3.3	15.4	0	0.00
Maximum		289	1.0830	66.47	3.3	15.4	0	0.0
Minimum		278	0.3083	35.49	3.3	15.4	0	0.0
Standard Deviation		3	0.2191	9.07	0.0	0.0	0	0.0

Port A = North, L = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	48.17
Velocity, [fpm]	2,890
ACFM	245,658
SCFM	163,608
DSCFM	151,797
Ex Air Free	127,829
lb/hr Flue Gas (dry)	734,523
lb/hr Flue Gas (wet)	768,157

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	48.17
Velocity, [fpm]	2,890
ACFM	245,658
SCFM	163,608
DSCFM	151,797
Ex Air Free	127,829
lb/hr Flue Gas (dry)	734,523
lb/hr Flue Gas (wet)	768,157

(1) No Port at Location Due to Structural Steel Support. Used Values For Port "B".

APPENDIX G

HEAT PIPE PRESSURE DROP DATA

Table G-1
Milliken Heat Pipe Performance Test 1
Heat Pipe Pressure Differentials By Section, in. WC

"A" Side Test

Date 05/14/96

	2A Heat Pipe				2B Heat Pipe			
Time	Primary Air	Secondary Air	Primary Flue Gas	Secondary Flue Gas	Primary Air	Secondary Air	Primary Flue Gas	Secondary Flue Gas
08:10	4.10	3.95	3.60	3.60	4.95	3.60	3.15	3.25
10:08	4.35	4.35	3.70	3.70	4.50	4.00	3.25	3.35
11:06	4.15	4.30	3.65	3.65	4.25	3.95	3.20	3.30
12:20	4.10	4.30	3.65	3.65	4.20	4.00	3.20	3.30
12:35	4.05	4.30	3.70	3.65	4.20	3.95	3.15	3.25
12:50	3.95	4.30	3.65	3.65	4.10	4.00	3.15	3.25
13:10	3.85	4.45	3.70	3.75	4.00	4.00	3.25	3.35
13:30	3.90	4.45	3.70	3.70	4.05	4.15	3.30	3.45
13:50	3.85	4.50	3.75	3.70	4.00	4.15	3.35	3.45
14:15	3.85	4.55	3.75	3.75	4.00	4.25	3.35	3.45
14:30	3.80	4.55	3.75	3.75	4.00	4.25	3.35	3.50
14:50	3.80	4.45	3.70	3.75	3.95	4.10	3.35	3.40
"B" Side Test								
16:00	3.60	4.60	3.80	3.80	3.80	4.30	3.35	3.55
16:20	3.55	4.60	3.80	3.80	3.85	4.30	3.40	3.50
16:30	3.60	4.55	3.80	3.85	3.85	4.25	3.45	3.50
17:30	3.55	4.55	3.80	3.80	3.80	4.25	3.35	3.45
17:50	3.55	4.55	3.80	3.75	3.75	4.25	3.35	3.45
18:05	3.50	4.50	3.80	3.80	3.70	4.20	3.40	3.40

Table G-2
Milliken Heat Pipe Performance Test 2
Heat Pipe Pressure Differentials By Section, in. WC

"B" Side Test

Date 05/15/96

	2A Heat Pipe				2B Heat Pipe			
Time	**Primary Air**	**Secondary Air**	**Primary Flue Gas**	**Secondary Flue Gas**	**Primary Air**	**Secondary Air**	**Primary Flue Gas**	**Secondary Flue Gas**
10:45	3.90	4.35	3.75	3.85	4.00	4.05	3.40	3.50
11:40	3.70	4.25	3.70	3.70	3.85	3.95	3.25	3.35
12:00	3.65	4.25	3.75	3.70	3.80	3.95	3.25	3.35
12:20	3.75	4.35	3.75	3.75	3.90	4.00	3.30	3.40
12:40	3.75	4.35	3.75	3.75	3.95	4.00	3.35	3.40
13:00	3.75	4.30	3.75	3.75	3.90	4.00	3.30	3.40
13:20	3.75	4.35	3.75	3.75	3.90	4.00	3.35	3.40
13:40	3.70	4.30	3.75	3.75	3.80	4.00	3.30	3.35
14:00	3.65	4.35	3.75	3.75	3.75	4.00	3.30	3.45
14:20	3.65	4.40	3.75	3.75	3.80	4.10	3.35	3.45
14:40	3.60	4.40	3.80	3.80	3.80	4.10	3.35	3.45
"A" Side Test								
15:20	3.70	4.50	3.80	3.80	3.80	4.20	3.50	3.60
16:00	3.65	4.35	3.75	3.75	3.75	4.00	3.30	3.40
16:20	3.60	4.30	3.75	3.70	3.75	3.95	3.30	3.35
16:40	3.65	4.30	3.75	3.75	3.80	4.00	3.25	3.35
17:00	3.60	4.35	3.75	3.75	3.85	4.00	3.30	3.40

Table G-3
Milliken Heat Pipe Performance Test 3
Heat Pipe Pressure Differentials By Section, in. WC

"A" Side Test

Date 05/16/96

	2A Heat Pipe				2B Heat Pipe			
Time	Primary Air	Secondary Air	Primary Flue Gas	Secondary Flue Gas	Primary Air	Secondary Air	Primary Flue Gas	Secondary Flue Gas
18:40	1.85	1.95	1.80	1.85	1.75	1.75	1.60	1.65
19:00	1.90	1.90	1.80	1.85	1.75	1.70	1.55	1.60
19:20	1.95	1.95	1.80	1.85	1.80	1.70	1.60	1.65
19:40	2.00	1.95	1.75	1.85	1.85	1.75	1.60	1.65
20:00	1.95	1.90	1.75	1.85	1.85	1.75	1.55	1.65
20:20	2.00	1.95	1.75	1.85	1.85	1.75	1.60	1.65
"B" Side Test								
21:00	1.95	1.95	1.65	1.85	1.85	1.75	1.60	1.65
21:20	2.00	1.95	1.70	1.85	1.85	1.75	1.60	1.65
21:40	2.00	1.95	1.85	1.80	1.85	1.75	1.60	1.65
22:00	2.00	1.95	1.80	1.85	1.85	1.75	1.60	1.70
22:20	2.00	1.95	1.85	1.90	1.85	1.75	1.65	1.70
22:40	1.95	2.00	1.80	1.85	1.80	1.75	1.65	1.70

File: DPLOGS.WB2 06/27/96 13:55:17

APPENDIX H

SOOTBLOWER PURGE AIR DATA

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Table H-1
Sootblower Ambient Air Purges
2A Heat Pipe

Amb Air DB, deg F 56
Amb Air WB, deg F 52
Humd, lb/lb BD Air 0.00728

Std. Conditions
T, deg F 60
P, in. Hg 29.92

Bar., " Hg 29.52
Static, " H20 0.00

Date 05/16/96
Time 14:35-16:12
Tube I.D. Direct Impact
C-Factor 0.80 (1)
Operator(s) MSD/DCM

No. Of Valves 16
Duct Dia. (2) 2.0 inches
Duct Area 0.3491 Sq ft
% O2 21.0
% N2 79.0

% H20 1.16
Dry MW 28.97
Wet MW 28.84

Valve On Sootblower #	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
AHB11	1"	89	0.0697	14.50
AHB12	1"	89	0.0725	14.79
AHB13	1"	89	0.1058	17.86
AHB14	1"	89	0.0766	15.20
AHB21	1"	89	0.0828	15.80
AHB22	1"	89	0.0848	15.99
AHB23	1"	89	0.0879	16.28
AHB24	1"	89	0.0832	15.84
AHB31	1"	89	0.0575	13.17
AHB32	1"	89	0.0757	15.11
AHB33	1"	89	0.0886	16.34
AHB34	1"	89	0.0710	14.63
AHB41	1"	89	0.0634	13.83
AHB42	1"	89	0.0729	14.83
AHB43	1"	89	0.0741	14.95
AHB44	1"	89	0.0702	14.55
Average, (group mean)		89	0.077	15.23
Average, (wt mean)		89	---	---
Maximum		89	0.106	17.86
Minimum		89	0.058	13.17
Standard Deviation		0	0.011	1.08

Purge Air Totals	
Velocity, [fps]	15.23
Velocity, [fpm]	914
ACFM	319
SCFM	298
DSCFM	295
lb/hr Air (dry)	1,349
lb/hr Air (wet)	1,359

(1) Adjusted For Calculation of Approximate Average Velocity (i.e. 1.0 x 0.80)
(2) All Purge Air Drawn Through A 2" ID x 5' Long Measuring Tube.

Table H-2
Sootblower Ambient Air Purges
2B Heat Pipe

Amb Air DB, deg F 56
Amb Air WB, deg F 52
Humd, lb/lb BD Air 0.00728

Std. Conditions
T, deg F 60
P, in. Hg 29.92

Bar., " Hg 29.52
Static, " H20 0.00

% H20 1.16
Dry MW 28.97
Wet MW 28.84

Date	05/16/96	No. of Valves	16
Time	14:35-16:12	Duct Dia. (2)	2.0 inches
Tube I.D.	Direct Impact	Duct Area	0.3491 Sq ft
C-Factor	0.80 (1)	% O2	21.0
Operator(s)	MSD/DCM	% N2	79.0

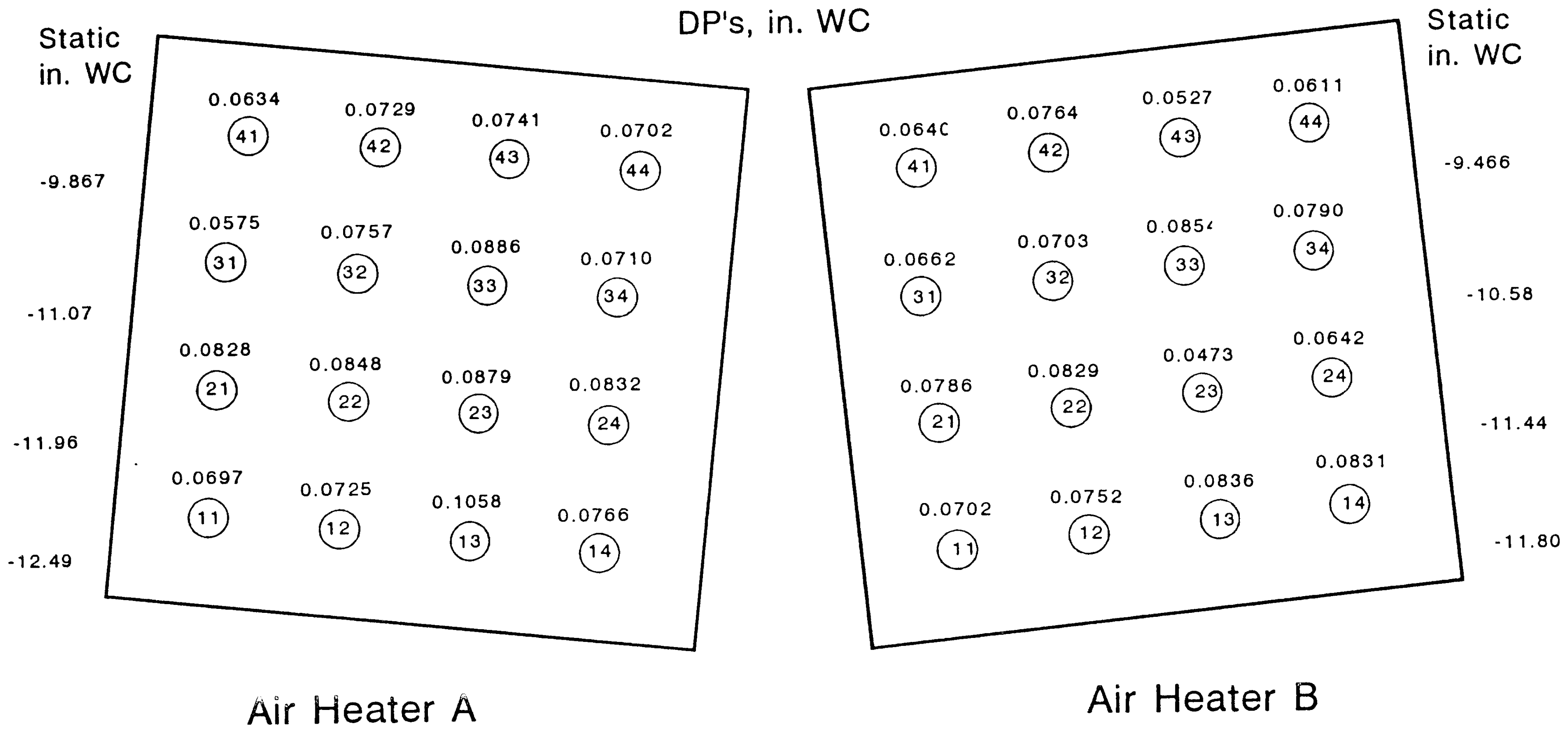
Valves On Sootblower #	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
AHB11	1"	89	0.0702	14.55
AHB12	1"	89	0.0752	15.06
AHB13	1"	89	0.0836	15.88
AHB14	1"	89	0.0831	15.83
AHB21	1"	89	0.0786	15.39
AHB22	1"	89	0.0829	15.81
AHB23	1"	89	0.0473	11.94
AHB24	1"	89	0.0642	13.91
AHB31	1"	89	0.0662	14.13
AHB32	1"	89	0.0703	14.56
AHB33	1"	89	0.0854	16.05
AHB34	1"	89	0.0790	15.43
AHB41	1"	89	0.0640	13.89
AHB42	1"	89	0.0764	15.18
AHB43	1"	89	0.0527	12.61
AHB44	1"	89	0.0611	13.57
Average, (group mean)		89	0.071	14.61
Average, (wt mean)		89	---	---
Maximum		89	0.085	16.05
Minimum		89	0.047	11.94
Standard Deviation		0	0.011	1.17

Purge Air Totals	
Velocity, [fps]	14.61
Velocity, [fpm]	877
ACFM	306
SCFM	286
DSCFM	283
lb/hr Air (dry)	1,294
lb/hr Air (wet)	1,304

(1) Adjusted For Calculation of Approximate Average Velocity (i.e. 1.0 x 0.80)
(2) All Purge Air Drawn Through A 2" ID x 5' Long Measuring Tube.

Figure H-1

Sootblower Purge Air Data Velocity Heads In 2" Dia. Air Flow Measureing Tube -- High Load Test



Baro 29.52" Hg

APPENDIX I

HEAT PIPE PERFORMANCE CALCULATIONS

PROGRAM CALCULATES AIR HEATER PERFORMANCE FROM TEST DATA

After Entering Data Into Blocked Areas Calculate Results Using Macro \C
Print Results Using Macro \P

Description	**Unit 2A Test 1 – 5/14/96 12:20-14:50 hrs**

Coal and Ash Data

AFC = As Fired Coal

Use ASME Mol Weights? 1=Y 0=Alt	1

	Coal Comp Wt % Dry	Wt % Wet
Moisture		6.43
C	78.66	73.60
H	5.19	4.86
N	1.63	1.53
S	2.00	1.87
O	4.62	4.32
Ash	7.90	7.39
HHV	13,994	100.00

Fly Ash Overhead	90.00%
Carbon in Refuse, %	2.89
lbs C in Refuse/lb AFC (1)	0.0021
C Burned/lb AFC	0.7340

Gas Stream Data

Flue Gas In

Ht Pipe Inlet Temp, deg F	675

	Mol %	
COMPOUND	Dry	Wet
CO2	15.050%	14.01%
CO	0.000%	0.00%
N2	81.240%	75.61%
O2	3.710%	3.45%
H2O	0.00%	6.92%
TOTAL	100.00%	100.00%

Amb Air Temp, deg F	96
Amb Air Moisture, lb/lb BD Air	0.00422
Downstream Leak Temp, deg F	148
Downstream Leak Moisture, lb/lb BD Air	0.00422
Downstream Leak Rate, lb/hr	4800
Primary Air (PA) Inlet Temp (Tpai), deg F	111
Primary Air Outlet Temp (Tpao), deg F	593
Secondary Air (SA) Inlet Temp (Tsai), deg F	89
Sec Air With Bypass Outlet Temp (Tsao), deg F	612
Primary Flue Gas Outlet Temp (Tpgo), deg F	294
Total Mols Dry Flue Gas In/lb AFC	0.4099
Total lbs Dry Flue Gas In/lb AFC (WG'14)	12.5321
Atomizing Steam (Wz), lbs/lb AFC	0.00
Steam From Ash Pit (Wm), lbs/lb AFC	0.00
Flue Gas H2O (WmGi), lbs/lb AFC	0.5494
H2O in Flue Gas, Mols/lb AFC	0.0305
Flue Gas Moisture, vol %	6.924%
Flue Gas MW	29.70
Flue Gas MW (dry)	30.57

(1) Assumption: Bottom Ash Carbon Concentration is 1/3 That of Overhead Ash.

Flue Gas Out

Ht. Pipe Outlet Temp, deg F	295	
	Mol %	
COMPOUND	Dry	Wet
CO2	14.620%	13.63%
CO	0.000%	0.00%
N2	81.170%	75.69%
O2	4.210%	3.93%
H2O	0.00%	6.76%
TOTAL	100.00%	100.00%

Mols Dry Flue Gas/lb AFC	0.4220
lbs Dry Flue Gas/lb AFC (WG'15)	12.8802
Flue Gas H2O (WmGo), lbs/lb AFC	0.5509
H2O in Flue Gas, Mols/lb AFC	0.0306
Total Flue Gas Out, lbs/hr	767218
Flue Gas Moisture, vol %	6.756%
Flue Gas MW (wet)	29.68
Flue Gas MW (dry)	30.52
Total Air Leak, wt % (AL)	**2.67**

Boiler Load, MW	149.04		
Heat Rate, Btu/KWh	9,594		
As Fired Coal Rate, Tons/hr	54.60		
lbs/hr (Wfe)	109,200		
Flow Split to Heat Pipe	52.31%	lb/hr	
Primary Air Fan Flow, lbs/lb AFC	2.1351	121,965	(3)
Primary Air (PA) Out Heat Pipe, Wpa, lbs/lb AFC	1.3291	75,924	
Cppa, Btu/mol-F (Tpao to Tpai)	7.1518		
Cppa, Btu/lb-F	0.2475		
Primary Air Bypass (PABP), lbs/lb AFC	0.8060	46,041	
Wet Flue Gas In (WF14), lbs/lb AFC	13.0815	747,247	
Cpfg, Btu/mol-F (Tfgi to Tfgo)	7.7765		
Cpfg, Btu/lb-F	0.2618		
Sootblower At Wall Air Leaks, lbs/lb AFC	0.2656	15,170	
Cpal, Btu/mol-F (Tsai to Tfgo)	7.0234		
Cpal, Btu/lb-F	0.2431		
Downstream Air Leak Rate, lbs/lb AFC	0.0840	4,800	
Cpal, Btu/mol-F (Tdsi to Tfgo)	7.0452		
Cpal, Btu/lb-F	0.2438		
SA+Bypass Rate (SA+SABP), lbs/lb AFC	8.7041	497,202	<<Ht Bal Calc
Cpsa, Btu/mol-F (Tsai to Tsao)	7.1502		
Cpsa, Btu/lb-F	0.2474		
Secondary Air Bypass (SAPB), lbs/lb AFC	0.0000	0	
Cpsabp, Btu/mol-F (Tsai to Tsao)	7.1502		
Cpsabp, Btu/lb-F	0.2474		
PA+PABP+SA+SABP+Coal, lbs/lb AFC (2)	11.7654	672,067	(3)
Calc'd Air Leakage into Boiler, lbs/lb AFC	1.3161	75,180	10.06% (3)

(2) Does Not Include Leaks Into Boiler

(3) Not Required For Performance Calculations

	CONDITIONS		
	DESIGN	ACTUAL	
Flow Rates to Heat Pipe, lb/hr			
Primary Air	62,500	75,924	
Secondary Air (No Bypass)	562,500	497,202	
Flue Gas	750,000	747,247	
Temperatures, deg F			
Primary Air In	80.0	111.0	
Primary Air Out	644.0	593.0	
2nd Air in	80.0	88.7	
2nd Air Out With Bypass	616.0	612.0	
2nd Air Out Without Bypass		612.0	
Avg Air In, (TA8)	80.0	91.7	
Avg Air Out, (TA9)	618.8	609.5	<<(Ex SA Bypass)
Flue Gas In, (TG14)	680.0	675.0	
Flue Gas Out, (TG15)	253.0	295.0	
FG Out No Leak, (TG15NL)		299.9	
Primary Air Duty, MMBtu/hr		9.057	
Sootblower Wall Leak Duty, MMBtu/hr		0.724	
Primary Flue Gas Duty, MMBtu/hr		9.782	
Primary Flue Gas Rate, lb/hr		98066	
Primary Flue Gas Rate, lb/lb AFC		1.7168	
Primary Flue Gas Outlet Temp NL, deg F		323.0	
Secondary Flue Gas Rate, lb/hr		649182	
Secondary Flue Gas Rate, lb/lb AFC		11.3647	
Secondary Flue Gas Outlet Temp, deg F		296.2	

Pressure Drops, in. wc	**Design**	**Measured**
Primary Air, (DP8_9)	5.35	3.91
Secondary Air, (DP8_9)	5.35	4.43
Flue Gas, (DP14_15)		
Primary Flue Gas	3.65	3.71
Secondary Flue Gas	3.65	3.71

Pressure Drops Corrected for Deviation From Design Flow and Design Temp

Gas Side (DPs(14-15), in. wc (4)	**3.59**	
Pressure Drop is	**-0.06**	in. wc Less Than Design
Air Side (DPs(8-9), in. wc		
Primary Air Section	**2.68**	
Pressure Drop is	**-2.67**	in. wc Less Than Design
Secondary Air Section	**5.65**	
Pressure Drop is	**0.30**	in. wc Greater Than Design

(4) Average In/Out Flue Gas Flow Used In Calculation.

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Correction Calculations For Heat Pipe -- Design Condition Results

		Curve 1	Curve 2 (Ea Limited)	
Flue Gas Inlet Temp, deg F	TG14D	680.00	680.00	
Pri Air (PA) Inlet Temp, deg F	TA8D	80.00	80.00	
Sec Air (SA) Inlet Temp, deg F	T'A8D	80.00	80.00	
PA Outlet, deg F	Tpa9D	649.75	649.75	
SA Outlet, deg F	Tsa9D	617.20	617.20	
Pri Flue Gas (PFG) Outlet, deg F	TPFG15D	309.66	309.66	
Sec Flue Gas (SFG) Outlet, deg	TSFG15D	243.92	243.92	
PFG Rate, Mlb/hr	WPFGD	182.70	182.70	
SFG Rate, Mlb/hr	WSFGD	1317.30	1317.30	
Combined Outlet T, deg F		251.93	251.93	
PA Side Effectiveness	Ea	0.9496	0.9492	<Curve 2 Limit
PA X-Ratio	X Design	0.6500	0.6500	
PA fg	fpgD	1.0001	1.0001	
PA fx	fpxD	0.9991	0.9987	
	Eg	0.6172	0.6170	
Calculated TPFG Out, deg F	TPFG15D	309.66	309.81	
SA Side Effectiveness	Ea	0.8953	0.9300	<Curve 2 Limit
SA X-Ratio (Design)	X Design	0.8118	0.8118	
SA fg	fsgD	1.0004	1.0004	
SA fx	fsxD	1.0001	1.0388	
	Eg	0.7268	0.7549	
Calculated TSFG Out, deg F	TSFG15D	243.91	227.04	
Combined Outlet T, deg F		251.92	237.12	

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Correction Calculations For Heat Pipe -- Operating Condition Results

Ambient Temp, deg F	Tamb	96.00
Sootblower Wall Air Leak, wt % PFG	Al	15.47
Cpa (Tpfg15-Tamb), Btu/lb-F	CpA	0.2411
Cpg (Tpfgnl15-Tpg15), Btu/lb-F	CpG	0.2547
Flue Gas Inlet Temp, deg F	TG14	675.00
PA Inlet Temp, deg F	TA8	111.00
SA Inlet Temp, deg F	T'A8	88.70
PA Outlet Temp, deg F	Tpa9	593.00
SA Outlet Temp (No Bypass), deg F	Tsa9	612.00
PFG Outlet Temp, deg F	TPG15	294.00
PFG Outlet Temp (No Leak), deg F	TPFG15NL	323.00
SFG Outlet Temp, deg F	TSFG15	296.22
PFG Rate, Mlb/hr	WPFG	98.07
SFG Rate, Mlb/hr	WSFG	649.18
Sootblower Wall Air Leak Into PFG, Mlb/hr	WAL1	15.17
Constant, Al/100*CpA/CpG*(TPG15-Tamb)		29.00
PA Side Effectiveness	Epa	0.8546
SA Side Effectiveness	Esa	0.8925
X-Ratios	Xp	0.7303
	Xs	0.7238
PA Eg	Epg	0.6241
SA Eg	Esg	0.6461

Correction Factors	**Pri Flue Gas**		**Sec Flue Gas**	
	fpg	0.9954	fsg	1.0016
	fpgD	1.0001	fsgD	1.0004
	fpx	1.0876	fsx	0.9265
	fpxD	0.9991	fsxD	1.0001
	TPFG15D	309.66	TSFG15D	243.91
Performance	TPFG15	268.84	TSFG15	279.70

Primary Flue Gas Corrections For Differences From:	
Design Entering Air Temperature, TPFG15DA, deg F	273.06
Design Entering Flue Gas Temperature, TPFG15DG, deg F	295.62
Design X-Ratio (No Leak), TPFG15DX, deg F	326.78
Air Leak Correction, deg F	29.00
Design Flue Gas Flow Rate, TPFG15DGR, deg F	292.27
Secondary Flue Gas Corrections for Differences From:	
Design Entering Air Temperature, TSFG15DA, deg F	290.60
Design Entering Flue Gas Temperature, TSFG15DG, deg F	297.99
Design X-Ratio, TSFG15DX, deg F	264.15
Design Flue Gas Flow Rate, TSFG15DGR, deg F	296.77
PFG Totally Corrected Outlet Temp, deg F	334.73
SFG Totally Corrected Outlet Temp, deg F	260.85
Avg FG Outlet Totally Corrected T, TG15_Total, deg F	**270.55**

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AVERAGE HEAT CAPACITY CALCULATIONS

Calculation of Primary, Secondary, and Air Leak Heat Capacities Over Inlet to Outlet Temperature Ranges

Cp for Primary Air From Tpai to Tpao

Humidity, lb H2O/lb DB Air 0.00422

	deg F	deg R	deg K	deg C
T1 =	111	571	317	44
T2 =	593	1053	585	312
T2 - T1 =	482	482	268	268

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.33%	7.1436	7.095
H2O	0.67%	8.3519	0.056
TOTAL	100.00%	Avg Cp	7.152
Mol Wt.	28.90	Btu/lb-F	0.2475

Cp Secondary Air From Tsai to Tsao

0.00422

deg F	deg R	deg K	deg C
88.7	548.7	305	32
612	1072	596	322
523.3	523.3	291	291

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	7.1421	7.094
0.67%	8.3499	0.056
100.00%	Avg Cp	7.150
28.90	Btu/lb-F	0.2474

Cp Air Leak From Tamb to Tfgo

Humidity, lb H2O/lb DB Air 0.00422

	deg F	deg R	deg K	deg C
T1 =	96	556	309	36
T2 =	295	755	419	146
T2 - T1 =	199	199	111	111

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.33%	7.0159	6.969
H2O	0.67%	8.1307	0.055
TOTAL	100.00%	Avg Cp	7.023
Mol Wt.	28.90	Btu/lb-F	0.2431

Cp Downstream Leak From Tdsi to Tfgo

0.00422

deg F	deg R	deg K	deg C
148	608	338	64
295	755	419	146
147	147	82	82

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	7.0375	6.990
0.67%	8.1668	0.055
100.00%	Avg Cp	7.045
28.90	Btu/lb-F	0.2438

Secondary Air Outlet Temperature Correction For Bypass Flow

Cp for Secondary Air From Tsai to Tsao'

	deg F	deg R	deg K	deg C
T1 =	88.7	548.7	305	32
T2 =	612.0	1072.0	596	322
T2 - T1 =	523.3	523.3	291	291

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.33%	7.1421	7.094
H2O	0.67%	8.3499	0.056
TOTAL	100.00%	Avg Cp	7.150
		Btu/lb-F	0.2474

Corrected Tsao', deg F **612.0**

Cp for Secondary Air From Tsao to Tsao'

deg F	deg R	deg K	deg C
612.0	1072.0	596	322
612.0	1072.0	596	322
0.0	0.0	0	0

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	7.3521	7.303
0.67%	8.7250	0.059
100.00%	Avg Cp	7.361
	Btu/lb-F	0.2548

Calculation of Average Air Inlet Temperature

Cp of Primary Air Between Tpai and Taia (TA8)

	deg F	deg R	deg K	deg C
T1 =	111.0	571.0	317	44
T2 =	91.7	551.7	306	33
T2 - T1 =	-19.3	-19.3	-11	-11

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.33%	6.9372	6.890
H2O	0.67%	8.0002	0.054
TOTAL	100.00%	Avg Cp	6.944
		Btu/lb-F	0.2403

Avg Air In Temp, Taia (TA8) **91.7**

Cp of Secondary Air Between Tsai and Taia (TA8)

deg F	deg R	deg K	deg C
88.7	548.7	305	32
91.7	551.7	306	33
3.0	3.0	2	2

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	6.9278	6.881
0.67%	7.9848	0.054
100.00%	Avg Cp	6.935
	Btu/lb-F	0.2400

Calculation of Average Air Outlet Temperature

Cp of Primary Air Between Tpao and Taoa (TA9)

	deg F	deg R	deg K	deg C
T1 =	593.0	1053.0	585	312
T2 =	609.5	1069.5	594	321
T2 - T1 =	16.5	16.5	9	9

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.33%	7.3437	7.294
H2O	0.67%	8.7092	0.059
TOTAL	100.00%	Avg Cp	7.353
		Btu/lb-F	0.2545

Avg Air Out Temp, Taoa (TA9) **609.5**

Cp of Secondary Air Between Tsao and Taoa (TA9)

deg F	deg R	deg K	deg C
612.0	1072.0	596	322
609.5	1069.5	594	321
-2.5	-2.5	-1	-1

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	7.3511	7.302
0.67%	8.7231	0.059
100.00%	Avg Cp	7.360
	Btu/lb-F	0.2547

Cp of Air Between Taia and Taoa (TA8 to TA9)

deg F	deg R	deg K	deg C
91.7	551.7	306	33
609.5	1069.5	594	321
517.8	517.8	288	288

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	7.1423	7.094
0.67%	8.3502	0.056
100.00%	Avg Cp	7.150
	Btu/lb-F	0.2475

Calculation of Flue Gas Outlet Temp for No Leak Case

Cp for Outlet Flue Gas Between Tfgo (TG15) and Tfgonl (TG15NL) – No Leak Case

	deg F	deg R	deg K	deg C
T1 =	295.0	755	419	146
T2 =	299.9	759.9	422	149
T2 - T1 =	4.9	4.9	3	3

	Mol %		Cpi Btu/mol-F	Cpi*MF Btu/mol-F
COMPOUND	Dry	Wet		
CO2	15.050%	14.008%	9.9610	1.395
CO	0.000%	0.000%	7.0859	0.000
N2	81.240%	75.615%	7.0498	5.331
O2	3.710%	3.453%	7.2899	0.252
H2O	0.000%	6.924%	8.2731	0.573
TOTAL	100.000%	100.000%	Avg Cp	7.551
			Btu/lb-F	0.2542

FG Out Temp, (TG15NL) **299.9**

Cp of Air Leak Between Tsai to Tfgo (TG15)

deg F	deg R	deg K	deg C
88.7	548.7	305	32
295.0	755.0	419	146
206.3	206.3	115	115

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	7.0128	6.966
0.67%	8.1256	0.055
100.00%	Avg Cp	7.020
	Btu/lb-F	0.2429

Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgo (TG15)
No Leak Case

	deg F	deg R	deg K	deg C
T1 =	675.0	1135	631	357
T2 =	295.0	755.0	419	146
T2 - T1 =	-380.0	-380.0	-211	-211

	Mol %		Cpi Btu/mol-F	Cpi*MF Btu/mol-F
COMPOUND	Dry	Wet		
CO2	15.050%	14.008%	10.6816	1.496
CO	0.000%	0.000%	7.2394	0.000
N2	81.240%	75.615%	7.1800	5.429
O2	3.710%	3.453%	7.5187	0.260
H2O	0.000%	6.924%	8.5415	0.591
TOTAL	100.000%	100.000%	Avg Cp	7.776
			Btu/lb-F	0.2618

Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgonl (TG15NL)--No Leak Case

deg F	deg R	deg K	deg C
675.0	1135	631	357
299.9	759.9	422	149
-375.1	-375.1	-208	-208

Mol %		Cpi Btu/mol-F	Cpi*MF Btu/mol-F
Dry	Wet		
15.050%	14.008%	10.6911	1.498
0.000%	0.000%	7.2414	0.000
81.240%	75.615%	7.1817	5.430
3.710%	3.453%	7.5217	0.260
0.000%	6.924%	8.5450	0.592
100.000%	100.000%	Avg Cp	7.779
		Btu/lb-F	0.2619

PROGRAM CALCULATES AIR HEATER PERFORMANCE FROM TEST DATA

After Entering Data Into Blocked Areas Calculate Results Using Macro \C
Prints Results Using Macro \P

Description Unit 2B Test 1 – 5/14/96 16:00-19:00 hrs

Coal and Ash Data

AFC = As Fired Coal

Use ASME Mol Weights? 1=Y 0=Alt 1

	Coal Comp Wt % Dry	Wt % Wet
Moisture		6.43
C	78.66	73.60
H	5.19	4.86
N	1.63	1.53
S	2.00	1.87
O	4.62	4.32
Ash	7.90	7.39
HHV	13,994	100.00

Fly Ash Overhead	90.00%
Carbon in Refuse, %	2.89
lbs C in Refuse/lb AFC (1)	0.0021
C Burned/lb AFC	0.7340

Gas Stream Data

Flue Gas In

Ht Pipe Inlet Temp, deg F 678

	Mol %	
COMPOUND	Dry	Wet
CO2	13.740%	12.86%
CO	0.000%	0.00%
N2	81.050%	75.85%
O2	5.210%	4.88%
H2O	0.00%	6.41%
TOTAL	100.00%	100.00%

Amb Air Temp, deg F	96
Amb Air Moisture, lb/lb BD Air	0.00422
Downstream Leak Temp, deg F	148
Downstream Leak Moisture, lb/lb BD Air	0.00422
Downstream Leak Rate, lb/hr	0
Primary Air (PA) Inlet Temp (Tpai), deg F	109
Primary Air Outlet Temp (Tpao), deg F	592
Secondary Air (SA) Inlet Temp (Tsai), deg F	89
Sec Air With Bypass Outlet Temp (Tsao), deg F	612
Primary Flue Gas Outlet Temp (Tpgo), deg F	268
Total Mols Dry Flue Gas In/lb AFC	0.4490
Total lbs Dry Flue Gas In/lb AFC (WG'14)	13.6597
Atomizing Steam (Wz), lbs/lb AFC	0.00
Steam From Ash Pit (Wm), lbs/lb AFC	0.00
Flue Gas H2O (WmGi), lbs/lb AFC	0.5542
H2O in Flue Gas, Mols/lb AFC	0.0308
Flue Gas Moisture, vol %	6.411%
Flue Gas MW	29.63
Flue Gas MW (dry)	30.42

(1) Assumption: Bottom Ash Carbon Concentration is 1/3 That of Overhead Ash.

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Flue Gas Out

Ht. Pipe Outlet Temp, deg F: 281

COMPOUND	Mol % Dry	Mol % Wet
CO2	14.330%	13.38%
CO	0.000%	0.00%
N2	81.170%	75.78%
O2	4.500%	4.20%
H2O	0.00%	6.64%
TOTAL	100.00%	100.00%

Mols Dry Flue Gas/lb AFC	0.4305
lbs Dry Flue Gas/lb AFC (WG'15)	13.1260
Flue Gas H2O (WmGo), lbs/lb AFC	0.5519
H2O in Flue Gas, Mols/lb AFC	0.0306
Total Flue Gas Out, lbs/hr	712311
Flue Gas Moisture, vol %	6.643%
Flue Gas MW (wet)	29.66
Flue Gas MW (dry)	30.49

Total Air Leak, wt % (AL) **-3.77**

Boiler Load, MW	150.52		
Heat Rate, Btu/KWh	9,500		
As Fired Coal Rate, Tons/hr	54.60		
lbs/hr (Wfe)	109,200		
Flow Split to Heat Pipe	47.69%	lb/hr	
Primary Air Fan Flow, lbs/lb AFC	2.4822	129,266	(3)
Primary Air (PA) Out Heat Pipe, Wpa, lbs/lb AFC	1.4280	74,368	
Cppa, Btu/mol-F (Tpao to Tpai)	7.1505		
Cppa, Btu/lb-F	0.2475		
Primary Air Bypass (PABP), lbs/lb AFC	1.0542	54,898	
Wet Flue Gas In (WF14), lbs/lb AFC	14.2139	740,224	
Cpfg, Btu/mol-F (Tfgi to Tfgo)	7.7275		
Cpfg, Btu/lb-F	0.2608		
Sootblower At Wall Air Leaks, lbs/lb AFC	-0.5360	(27,913)	Warning DS Leak Too High
Cpal, Btu/mol-F (Tsai to Tfgo)	7.0176		
Cpal, Btu/lb-F	0.2429		
Downstream Air Leak Rate, lbs/lb AFC	0.0000	0	
Cpal, Btu/mol-F (Tdsi to Tfgo)	7.0393		
Cpal, Btu/lb-F	0.2436		
SA+Bypass Rate (SA+SABP), lbs/lb AFC	10.2400	533,273	<<Ht Bal Calc
Cpsa, Btu/mol-F (Tsai to Tsao)	7.1503		
Cpsa, Btu/lb-F	0.2474		
Secondary Air Bypass (SAPB), lbs/lb AFC	0.0000	0	
Cpsabp, Btu/mol-F (Tsai to Tsao)	7.1503		
Cpsabp, Btu/lb-F	0.2474		
PA+PABP+SA+SABP+Coal, lbs/lb AFC (2)	13.6483	710,767	(3)
Calc'd Air Leakage into Boiler, lbs/lb AFC	0.5656	29,457	3.98% (3)

(2) Does Not Include Leaks Into Boiler

(3) Not Required For Performance Calculations

	CONDITIONS	
	DESIGN	ACTUAL
Flow Rates to Heat Pipe, lb/hr		
Primary Air	62,500	74,368
Secondary Air (No Bypass)	562,500	533,273
Flue Gas	750,000	740,224
Temperatures, deg F		
Primary Air In	80.0	109.0
Primary Air Out	644.0	592.0
2nd Air in	80.0	89.0
2nd Air Out With Bypass	616.0	612.0
2nd Air Out Without Bypass		612.0
Avg Air In, (TA8)	80.0	91.4
Avg Air Out, (TA9)	618.8	609.6 <<(Ex SA Bypass)
Flue Gas In, (TG14)	680.0	678.0
Flue Gas Out, (TG15)	253.0	281.0
FG Out No Leak, (TG15NL)		274.0
Primary Air Duty, MMBtu/hr		8.889
Sootblower Wall Leak Duty, MMBtu/hr		-1.156
Primary Flue Gas Duty, MMBtu/hr		7.733
Primary Flue Gas Rate, lb/hr		72377
Primary Flue Gas Rate, lb/lb AFC		1.3898
Primary Flue Gas Outlet Temp NL, deg F		204.4
Secondary Flue Gas Rate, lb/hr		667847
Secondary Flue Gas Rate, lb/lb AFC		12.8241
Secondary Flue Gas Outlet Temp, deg F		281.9

Pressure Drops, in. wc	Design	Measured
Primary Air, (DP8_9)	5.35	3.79
Secondary Air, (DP8_9)	5.35	4.26
Flue Gas, (DP14_15)		
Primary Flue Gas	3.65	3.38
Secondary Flue Gas	3.65	3.48

Pressure Drops Corrected for Deviation From Design Flow and Design Temp

Gas Side (DPs(14-15), in. wc (4)	**3.66**	
Pressure Drop is	**0.01**	in. wc Greater Than Design
Air Side (DPs(8-9), in. wc		
Primary Air Section	**2.71**	
Pressure Drop is	**-2.64**	in. wc Less Than Design
Secondary Air Section	**4.73**	
Pressure Drop is	**-0.62**	in. wc Less Than Design

(4) Average In/Out Flue Gas Flow Used In Calculation.

Correction Calculations For Heat Pipe -- Design Condition Results

		Curve 1	Curve 2 (Ea Limited)	
Flue Gas Inlet Temp, deg F	TG14D	680.00	680.00	
Pri Air (PA) Inlet Temp, deg F	TA8D	80.00	80.00	
Sec Air (SA) Inlet Temp, deg F	T'A8D	80.00	80.00	
PA Outlet, deg F	Tpa9D	649.75	649.75	
SA Outlet, deg F	Tsa9D	617.20	617.20	
Pri Flue Gas (PFG) Outlet, deg F	TPFG15D	309.66	309.66	
Sec Flue Gas (SFG) Outlet, deg	TSFG15D	243.92	243.92	
PFG Rate, Mlb/hr	WPFGD	182.70	182.70	
SFG Rate, Mlb/hr	WSFGD	1317.30	1317.30	
Combined Outlet T, deg F		251.93	251.93	
PA Side Effectiveness	Ea	0.9496	0.9492	<Curve 2 Limit
PA X-Ratio	X Design	0.6500	0.6500	
PA fg	fpgD	1.0001	1.0001	
PA fx	fpxD	0.9991	0.9987	
	Eg	0.6172	0.6170	
Calculated TPFG Out, deg F	TPFG15D	309.66	309.81	
SA Side Effectiveness	Ea	0.8953	0.9300	<Curve 2 Limit
SA X-Ratio (Design)	X Design	0.8118	0.8118	
SA fg	fsgD	1.0004	1.0004	
SA fx	fsxD	1.0001	1.0388	
	Eg	0.7268	0.7549	
Calculated TSFG Out, deg F	TSFG15D	243.91	227.04	
Combined Outlet T, deg F		251.92	237.12	

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Correction Calculations For Heat Pipe -- Operating Condition Results

Ambient Temp, deg F	Tamb	96.00
Sootblower Wall Air Leak, wt % PFG	Al	-38.57
Cpa (Tpfg15-Tamb), Btu/lb-F	CpA	0.2408
Cpg (Tpfgnl15-Tpg15), Btu/lb-F	CpG	0.2511
Flue Gas Inlet Temp, deg F	TG14	678.00
PA Inlet Temp, deg F	TA8	109.00
SA Inlet Temp, deg F	T'A8	88.97
PA Outlet Temp, deg F	Tpa9	592.00
SA Outlet Temp (No Bypass), deg F	Tsa9	612.00
PFG Outlet Temp, deg F	TPG15	268.00
PFG Outlet Temp (No Leak), deg F	TPFG15NL	204.40
SFG Outlet Temp, deg F	TSFG15	281.88
PFG Rate, Mlb/hr	WPFG	72.38
SFG Rate, Mlb/hr	WSFG	667.8
Sootblower Wall Air Leak Into PFG, Mlb/hr	WAL1	-27.9
Constant, Al/100*CpA/CpG*(TPG15-Tamb)		-63.60
PA Side Effectiveness	Epa	0.8489
SA Side Effectiveness	Esa	0.8880
X-Ratios	Xp	0.9805
	Xs	0.7573
PA Eg	Epg	0.8323
SA Eg	Esg	0.6725

Correction Factors	**Pri Flue Gas**		**Sec Flue Gas**	
	fpg	1.0133	fsg	0.9991
	fpgD	1.0001	fsgD	1.0004
	fpx	1.2791	fsx	0.9561
	fpxD	0.9991	fsxD	1.0001
	TPFG15D	309.66	TSFG15D	243.91
Performance	TPFG15	286.04	TSFG15	269.22

Primary Flue Gas Corrections For Differences From:	
Design Entering Air Temperature, TPFG15DA, deg F	247.10
Design Entering Flue Gas Temperature, TPFG15DG, deg F	268.56
Design X-Ratio (No Leak), TPFG15DX, deg F	371.76
Air Leak Correction, deg F	-63.60
Design Flue Gas Flow Rate, TPFG15DGR, deg F	272.90

Secondary Flue Gas Corrections for Differences From:	
Design Entering Air Temperature, TSFG15DA, deg F	275.85
Design Entering Flue Gas Temperature, TSFG15DG, deg F	282.54
Design X-Ratio, TSFG15DX, deg F	262.70
Design Flue Gas Flow Rate, TSFG15DGR, deg F	281.35

PFG Totally Corrected Outlet Temp, deg F	292.72
SFG Totally Corrected Outlet Temp, deg F	256.79
Avg FG Outlet Totally Corrected T, TG15_Total, deg F	**260.30**

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AVERAGE HEAT CAPACITY CALCULATIONS

Calculation of Primary, Secondary, and Air Leak Heat Capacities Over Inlet to Outlet Temperature Ranges

Cp for Primary Air From Tpai to Tpao

Humidity, lb H2O/lb DB Air 0.00422

	deg F	deg R	deg K	deg C
T1 =	109	569	316	43
T2 =	592	1052	584	311
T2 - T1 =	483	483	268	268

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.33%	7.1424	7.094
H2O	0.67%	8.3498	0.056
TOTAL	100.00%	Avg Cp	7.151
Mol Wt.	28.90	Btu/lb-F	0.2475

Cp Secondary Air From Tsai to Tsao

0.00422

deg F	deg R	deg K	deg C
88.97	548.97	305	32
612	1072	596	322
523.03	523.03	291	291

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	7.1422	7.094
0.67%	8.3501	0.056
100.00%	Avg Cp	7.150
28.90	Btu/lb-F	0.2474

Cp Air Leak From Tamb to Tfgo

Humidity, lb H2O/lb DB Air 0.00422

	deg F	deg R	deg K	deg C
T1 =	96	556	309	36
T2 =	281	741	412	138
T2 - T1 =	185	185	103	103

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.33%	7.0101	6.963
H2O	0.67%	8.1209	0.055
TOTAL	100.00%	Avg Cp	7.018
Mol Wt.	28.90	Btu/lb-F	0.2429

Cp Downstream Leak From Tdsi to Tfgo

0.00422

deg F	deg R	deg K	deg C
148	608	338	64
281	741	412	138
133	133	74	74

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	7.0318	6.984
0.67%	8.1570	0.055
100.00%	Avg Cp	7.039
28.90	Btu/lb-F	0.2436

Secondary Air Outlet Temperature Correction For Bypass Flow

Cp for Secondary Air From Tsai to Tsao'

	deg F	deg R	deg K	deg C
T1 =	89.0	549.0	305	32
T2 =	612.0	1072.0	596	322
T2 - T1 =	523.0	523.0	291	291

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.33%	7.1422	7.094
H2O	0.67%	8.3501	0.056
TOTAL	100.00%	Avg Cp	7.150
		Btu/lb-F	0.2474

Corrected Tsao', deg F **612.0**

Cp for Secondary Air From Tsao to Tsao'

deg F	deg R	deg K	deg C
612.0	1072.0	596	322
612.0	1072.0	596	322
0.0	0.0	0	0

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	7.3521	7.303
0.67%	8.7250	0.059
100.00%	Avg Cp	7.361
	Btu/lb-F	0.2548

Calculation of Average Air Inlet Temperature

Cp of Primary Air Between Tpai and Taia (TA8)

	deg F	deg R	deg K	deg C
T1 =	109.0	569.0	316	43
T2 =	91.4	551.4	306	33
T2 - T1 =	-17.6	-17.6	-10	-10

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.33%	6.9363	6.890
H2O	0.67%	7.9986	0.054
TOTAL	100.00%	Avg Cp	6.943
		Btu/lb-F	0.2403

Avg Air In Temp, Taia (TA8) **91.4**

Cp of Secondary Air Between Tsai and Taia (TA8)

deg F	deg R	deg K	deg C
89.0	549.0	305	32
91.4	551.4	306	33
2.5	2.5	1	1

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	6.9278	6.881
0.67%	7.9849	0.054
100.00%	Avg Cp	6.935
	Btu/lb-F	0.2400

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Calculation of Average Air Outlet Temperature

Cp of Primary Air Between Tpao and Taoa (TA9)

	deg F	deg R	deg K	deg C
T1 =	592.0	1052.0	584	311
T2 =	609.6	1069.6	594	321
T2 - T1 =	17.6	17.6	10	10

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.33%	7.3433	7.294
H2O	0.67%	8.7085	0.059
TOTAL	100.00%	Avg Cp	7.353
		Btu/lb-F	0.2544

Avg Air Out Temp, Taoa (TA9) **609.6**

Cp of Secondary Air Between Tsao and Taoa (TA9)

deg F	deg R	deg K	deg C
612.0	1072.0	596	322
609.6	1069.6	594	321
-2.4	-2.4	-1	-1

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	7.3511	7.302
0.67%	8.7232	0.059
100.00%	Avg Cp	7.360
	Btu/lb-F	0.2547

Cp of Air Between Taia and Taoa (TA8 to TA9)

deg F	deg R	deg K	deg C
91.4	551.4	306	33
609.6	1069.6	594	321
518.1	518.1	288	288

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	7.1422	7.094
0.67%	8.3501	0.056
100.00%	Avg Cp	7.150
	Btu/lb-F	0.2474

Calculation of Flue Gas Outlet Temp for No Leak Case

Cp for Outlet Flue Gas Between Tfgo (TG15) and Tfgonl (TG15NL) -- No Leak Case

	deg F	deg R	deg K	deg C
T1 =	281.0	741	412	138
T2 =	274.0	734.0	408	134
T2 - T1 =	-7.0	-7.0	-4	-4

	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	13.740%	12.859%	9.8785	1.270
CO	0.000%	0.000%	7.0693	0.000
N2	81.050%	75.853%	7.0360	5.337
O2	5.210%	4.876%	7.2640	0.354
H2O	0.000%	6.411%	8.2451	0.529
TOTAL	100.000%	100.000%	Avg Cp	7.490
			Btu/lb-F	0.2528

FG Out Temp, (TG15NL) **274.0**

Cp of Air Leak Between Tsai to Tfgo (TG15)

deg F	deg R	deg K	deg C
89.0	549.0	305	32
281.0	741.0	412	138
192.0	192.0	107	107

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	7.0071	6.960
0.67%	8.1160	0.055
100.00%	Avg Cp	7.015
	Btu/lb-F	0.2428

Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgo (TG15)
No Leak Case

	deg F	deg R	deg K	deg C
T1 =	678.0	1138	632	359
T2 =	281.0	741.0	412	138
T2 - T1 =	-397.0	-397.0	-221	-221

	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	13.740%	12.859%	10.6600	1.371
CO	0.000%	0.000%	7.2348	0.000
N2	81.050%	75.853%	7.1762	5.443
O2	5.210%	4.876%	7.5119	0.366
H2O	0.000%	6.411%	8.5337	0.547
TOTAL	100.000%	100.000%	Avg Cp	7.728
			Btu/lb-F	0.2608

Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgonl (TG15NL)--No Leak Case

deg F	deg R	deg K	deg C
678.0	1138	632	359
274.0	734.0	408	134
-404.0	-404.0	-224	-224

Mol %		Cpi	Cpi*MF
Dry	Wet	Btu/mol-F	Btu/mol-F
13.740%	12.859%	10.6466	1.369
0.000%	0.000%	7.2320	0.000
81.050%	75.853%	7.1737	5.442
5.210%	4.876%	7.5076	0.366
0.000%	6.411%	8.5287	0.547
100.000%	100.000%	Avg Cp	7.723
		Btu/lb-F	0.2607

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Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgo (TPFG15)

	deg F	deg R	deg K	deg C
T1 =	678.0	1138	632	359
T2 =	268.0	728.0	404	131
T2 - T1 =	-410.0	-410.0	-228	-228

	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	13.740%	12.859%	10.6348	1.368
CO	0.000%	0.000%	7.2295	0.000
N2	81.050%	75.853%	7.1716	5.440
O2	5.210%	4.876%	7.5039	0.366
H2O	0.000%	6.411%	8.5244	0.547
TOTAL	100.000%	100.000%	Avg Cp	7.720
			Btu/lb-F	0.2606

Cp for Sootblower Air Leak From Tamb to Tpfgo

Humidity, lb H2O/lb DB Air	0.00422			
	deg F	deg R	deg K	deg C
T1 =	96	556	309	36
T2 =	268	728	404	131
T2 - T1 =	172	172	96	96

		Cpi	Cpi*MF
COMPOUND	Mol %	Btu/mol-F	Btu/mol-F
AIR	99.33%	7.0047	6.957
H2O	0.67%	0.0000	0.000
TOTAL	100.00%	Avg Cp	6.957
Mol Wt.	28.90	Btu/lb-F	0.2408

Calculation of Secondary Flue Gas Outlet Temperature

Cp for Secondary Flue Gas Between Tsfgo (TSFG15) and Tfgo (TG15)

	deg F	deg R	deg K	deg C
T1 =	281.9	741.9	412	139
T2 =	281.0	741.0	412	138
T2 - T1 =	-0.9	-0.9	-0	-0

	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	13.740%	12.859%	9.8948	1.272
CO	0.000%	0.000%	7.0726	0.000
N2	81.050%	75.853%	7.0387	5.339
O2	5.210%	4.876%	7.2691	0.354
H2O	0.000%	6.411%	8.2506	0.529
TOTAL	100.000%	100.000%	Avg Cp	7.495
			Btu/lb-F	0.2530

SFG Out Temp, (TSFG15) **281.9**

Cp for Secondary Flue Gas Between Tfgi (TG14) and Tsfgo (TSFG15)

	deg F	deg R	deg K	deg C
T1 =	678.0	1138.0	632	359
T2 =	281.9	741.9	412	139
T2 - T1 =	-396.1	-396.1	-220	-220

	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	13.740%	12.859%	10.6617	1.371
CO	0.000%	0.000%	7.2352	0.000
N2	81.050%	75.853%	7.1765	5.444
O2	5.210%	4.876%	7.5124	0.366
H2O	0.000%	6.411%	8.5343	0.547
TOTAL	100.000%	100.000%	Avg Cp	7.728
			Btu/lb-F	0.2609

SFG T Out Alt Calc, (TSFG15) **281.8**

Cp for Primary Flue Gas Between Tpfgo (TPFG15) and Tpfgonl (TPFG15NL)

deg F	deg R	deg K	deg C
268.0	728	404	131
204.4	664.4	369	96
-63.6	-63.6	-35	-35

Mol %		Cpi	Cpi*MF
Dry	Wet	Btu/mol-F	Btu/mol-F
13.740%	12.859%	9.7043	1.248
0.000%	0.000%	7.0346	0.000
81.050%	75.853%	7.0073	5.315
5.210%	4.876%	7.2096	0.352
0.000%	6.411%	8.1872	0.525
100.000%	100.000%	Avg Cp	7.440
		Btu/lb-F	0.2511

PFG Out Temp, (TPFG15NL) **204.40**

Cp for Sootblower Air Leak From Tpfgo (TPFG15) to Tfgo (TG15)

0.00422			
deg F	deg R	deg K	deg C
268	728	404	131
281	741	412	138
13	13	7	7

	Cpi	Cpi*MF
Mol %	Btu/mol-F	Btu/mol-F
99.33%	7.0814	7.034
0.67%	0.0000	0.000
100.00%	Avg Cp	7.034
28.90	Btu/lb-F	0.2434

Cp for Primary Flue Gas Between Tfgo (TG15) and Tpfgo (TPFG15)

deg F	deg R	deg K	deg C
281.0	741	412	138
268.0	728.0	404	131
-13.0	-13.0	-7	-7

0		Cpi	Cpi*MF
0	Wet	Btu/mol-F	Btu/mol-F
13.740%	12.859%	9.8659	1.269
0.000%	0.000%	7.0668	0.000
81.050%	75.853%	7.0339	5.335
5.210%	4.876%	7.2601	0.354
0.000%	6.411%	8.2408	0.528
100.000%	100.000%	Avg Cp	7.486
		Btu/lb-F	0.2527

Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgonl (TPFG15NL)

deg F	deg R	deg K	deg C
678.0	1138	632	359
204.4	664.4	369	96
-473.6	-473.6	-263	-263

0		Cpi	Cpi*MF
0	Wet	Btu/mol-F	Btu/mol-F
13.740%	12.859%	10.5099	1.351
0.000%	0.000%	7.2033	0.000
81.050%	75.853%	7.1496	5.423
5.210%	4.876%	7.4644	0.364
0.000%	6.411%	8.4791	0.544
100.000%	100.000%	Avg Cp	7.682
		Btu/lb-F	0.2593

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PROGRAM CALCULATES AIR HEATER PERFORMANCE FROM TEST DATA
After Entering Data Into Blocked Areas Calculate Results Using Macro \C
Print Results Using Macro \P

Description Unit 2B 5/14/96 16:00-19:00 hrs 1.36% Assumed Leak

Coal and Ash Data

AFC = As Fired Coal

Use ASME Mol Weights? 1=Y 0=Alt 1

	Coal Comp Wt % Dry	Wt % Wet
Moisture		6.43
C	78.66	73.60
H	5.19	4.86
N	1.63	1.53
S	2.00	1.87
O	4.62	4.32
Ash	7.90	7.39
HHV	13,994	100.00

Fly Ash Overhead	90.00%
Carbon in Refuse, %	2.89
lbs C in Refuse/lb AFC (1)	0.0021
C Burned/lb AFC	0.7340

Gas Stream Data

Flue Gas In

Ht Pipe Inlet Temp, deg F 678

COMPOUND	Mol % Dry	Mol % Wet
CO2	14.545%	13.57%
CO	0.000%	0.00%
N2	81.165%	75.70%
O2	4.290%	4.00%
H2O	0.00%	6.73%
TOTAL	100.00%	100.00%

Amb Air Temp, deg F	96
Amb Air Moisture, lb/lb BD Air	0.00422
Downstream Leak Temp, deg F	148
Downstream Leak Moisture, lb/lb BD Air	0.00422
Downstream Leak Rate, lb/hr	0
Primary Air (PA) Inlet Temp (Tpai), deg F	109
Primary Air Outlet Temp (Tpao), deg F	592
Secondary Air (SA) Inlet Temp (Tsai), deg F	89
Sec Air With Bypass Outlet Temp (Tsao), deg F	612
Primary Flue Gas Outlet Temp (Tpgo), deg F	268
Total Mols Dry Flue Gas In/lb AFC	0.4242
Total lbs Dry Flue Gas In/lb AFC (WG'14)	12.9428
Atomizing Steam (Wz), lbs/lb AFC	0.00
Steam From Ash Pit (Wm), lbs/lb AFC	0.00
Flue Gas H2O (WmGi), lbs/lb AFC	0.5511
H2O in Flue Gas, Mols/lb AFC	0.0306
Flue Gas Moisture, vol %	6.727%
Flue Gas MW	29.67
Flue Gas MW (dry)	30.51

(1) Assumption: Bottom Ash Carbon Concentration is 1/3 That of Overhead Ash.

Flue Gas Out

Ht. Pipe Outlet Temp, deg F 281

COMPOUND	Mol % Dry	Mol % Wet
CO2	14.330%	13.38%
CO	0.000%	0.00%
N2	81.170%	75.78%
O2	4.500%	4.20%
H2O	0.00%	6.64%
TOTAL	100.00%	100.00%

Mols Dry Flue Gas/lb AFC	0.4305
lbs Dry Flue Gas/lb AFC (WG'15)	13.1260
Flue Gas H2O (WmGo), lbs/lb AFC	0.5519
H2O in Flue Gas, Mols/lb AFC	0.0306
Total Flue Gas Out, lbs/hr	712311
Flue Gas Moisture, vol %	6.643%
Flue Gas MW (wet)	29.66
Flue Gas MW (dry)	30.49
Total Air Leak, wt % (AL)	**1.36**

		lb/hr	
Boiler Load, MW	150.52		
Heat Rate, Btu/KWh	9,500		
As Fired Coal Rate, Tons/hr	54.60		
lbs/hr (Wfe)	109,200		
Flow Split to Heat Pipe	47.69%		
Primary Air Fan Flow, lbs/lb AFC	2.4822	129,266	(3)
Primary Air (PA) Out Heat Pipe, Wpa, lbs/lb AFC	1.4280	74,368	
Cppa, Btu/mol-F (Tpao to Tpai)	7.1505		
Cppa, Btu/lb-F	0.2475		
Primary Air Bypass (PABP), lbs/lb AFC	1.0542	54,898	
Wet Flue Gas In (WF14), lbs/lb AFC	13.4939	702,731	
Cpfg, Btu/mol-F (Tfgi to Tfgo)	7.7535		
Cpfg, Btu/lb-F	0.2613		
Sootblower At Wall Air Leaks, lbs/lb AFC	0.1840	9,580	
Cpal, Btu/mol-F (Tsai to Tfgo)	7.0176		
Cpal, Btu/lb-F	0.2429		
Downstream Air Leak Rate, lbs/lb AFC	0.0000	0	
Cpal, Btu/mol-F (Tdsi to Tfgo)	7.0393		
Cpal, Btu/lb-F	0.2436		
SA+Bypass Rate (SA+SABP), lbs/lb AFC	9.4338	491,290	<<Ht Bal Calc
Cpsa, Btu/mol-F (Tsai to Tsao)	7.1503		
Cpsa, Btu/lb-F	0.2474		
Secondary Air Bypass (SAPB), lbs/lb AFC	0.0000	0	
Cpsabp, Btu/mol-F (Tsai to Tsao)	7.1503		
Cpsabp, Btu/lb-F	0.2474		
PA+PABP+SA+SABP+Coal, lbs/lb AFC (2)	12.8421	668,784	(3)
Calc'd Air Leakage into Boiler, lbs/lb AFC	0.6519	33,947	4.83% (3)

(2) Does Not Include Leaks Into Boiler

(3) Not Required For Performance Calculations

	CONDITIONS	
	DESIGN	ACTUAL
Flow Rates to Heat Pipe, lb/hr		
Primary Air	62,500	74,368
Secondary Air (No Bypass)	562,500	491,290
Flue Gas	750,000	702,731
Temperatures, deg F		
Primary Air In	80.0	109.0
Primary Air Out	644.0	592.0
2nd Air in	80.0	89.0
2nd Air Out With Bypass	616.0	612.0
2nd Air Out Without Bypass		612.0
Avg Air In, (TA8)	80.0	91.6
Avg Air Out, (TA9)	618.8	609.4 <<(Ex SA Bypass)
Flue Gas In, (TG14)	680.0	678.0
Flue Gas Out, (TG15)	253.0	281.0
FG Out No Leak, (TG15NL)		283.5
Primary Air Duty, MMBtu/hr		8.889
Sootblower Wall Leak Duty, MMBtu/hr		0.397
Primary Flue Gas Duty, MMBtu/hr		9.285
Primary Flue Gas Rate, lb/hr		86756
Primary Flue Gas Rate, lb/lb AFC		1.6659
Primary Flue Gas Outlet Temp NL, deg F		286.1
Secondary Flue Gas Rate, lb/hr		615974
Secondary Flue Gas Rate, lb/lb AFC		11.8280
Secondary Flue Gas Outlet Temp, deg F		283.0

Pressure Drops, in. wc	Design	Measured
Primary Air, (DP8_9)	5.35	3.79
Secondary Air, (DP8_9)	5.35	4.26
Flue Gas, (DP14_15)		
Primary Flue Gas	3.65	3.38
Secondary Flue Gas	3.65	3.48

Pressure Drops Corrected for Deviation From Design Flow and Design Temp

Gas Side (DPs(14-15), in. wc (4)	**3.86**	
Pressure Drop is	**0.21**	in. wc Greater Than Design
Air Side (DPs(8-9), in. wc		
Primary Air Section	**2.71**	
Pressure Drop is	**-2.64**	in. wc Less Than Design
Secondary Air Section	**5.57**	
Pressure Drop is	**0.22**	in. wc Greater Than Design

(4) Average In/Out Flue Gas Flow Used In Calculation.

Correction Calculations For Heat Pipe -- Design Condition Results

		Curve 1	Curve 2 (Ea Limited)	
Flue Gas Inlet Temp, deg F	TG14D	680.00	680.00	
Pri Air (PA) Inlet Temp, deg F	TA8D	80.00	80.00	
Sec Air (SA) Inlet Temp, deg F	T'A8D	80.00	80.00	
PA Outlet, deg F	Tpa9D	649.75	649.75	
SA Outlet, deg F	Tsa9D	617.20	617.20	
Pri Flue Gas (PFG) Outlet, deg F	TPFG15D	309.66	309.66	
Sec Flue Gas (SFG) Outlet, deg	TSFG15D	243.92	243.92	
PFG Rate, Mlb/hr	WPFGD	182.70	182.70	
SFG Rate, Mlb/hr	WSFGD	1317.30	1317.30	
Combined Outlet T, deg F		251.93	251.93	
PA Side Effectiveness	Ea	0.9496	0.9492	<Curve 2 Limit
PA X-Ratio	X Design	0.6500	0.6500	
PA fg	fpgD	1.0001	1.0001	
PA fx	fpxD	0.9991	0.9987	
	Eg	0.6172	0.6170	
Calculated TPFG Out, deg F	TPFG15D	309.66	309.81	
SA Side Effectiveness	Ea	0.8953	0.9300	<Curve 2 Limit
SA X-Ratio (Design)	X Design	0.8118	0.8118	
SA fg	fsgD	1.0004	1.0004	
SA fx	fsxD	1.0001	1.0388	
	Eg	0.7268	0.7549	
Calculated TSFG Out, deg F	TSFG15D	243.91	227.04	
Combined Outlet T, deg F		251.92	237.12	

Correction Calculations For Heat Pipe -- Operating Condition Results

Ambient Temp, deg F	Tamb	96.00
Sootblower Wall Air Leak, wt % PFG	Al	11.04
Cpa (Tpfg15-Tamb), Btu/lb-F	CpA	0.2408
Cpg (Tpfgnl15-Tpg15), Btu/lb-F	CpG	0.2531
Flue Gas Inlet Temp, deg F	TG14	678.00
PA Inlet Temp, deg F	TA8	109.00
SA Inlet Temp, deg F	T'A8	89.00
PA Outlet Temp, deg F	Tpa9	592.00
SA Outlet Temp (No Bypass), deg F	Tsa9	612.00
PFG Outlet Temp, deg F	TPG15	268.00
PFG Outlet Temp (No Leak), deg F	TPFG15NL	286.07
SFG Outlet Temp, deg F	TSFG15	283.02
PFG Rate, Mlb/hr	WPFG	86.76
SFG Rate, Mlb/hr	WSFG	615.97
Sootblower Wall Air Leak Into PFG, Mlb/hr	WAL1	9.58
Constant, Al/100*CpA/CpG*(TPG15-Tamb)		18.07
PA Side Effectiveness	Epa	0.8489
SA Side Effectiveness	Esa	0.8879
X-Ratios	Xp	0.8115
	Xs	0.7552
PA Eg	Epg	0.6888
SA Eg	Esg	0.6706

Correction Factors

		Pri Flue Gas		**Sec Flue Gas**
	fpg	1.0033	fsg	1.0061
	fpgD	1.0001	fsgD	1.0004
	fpx	1.1637	fsx	0.9543
	fpxD	0.9991	fsxD	1.0001
	TPFG15D	309.66	TSFG15D	243.91
Performance	TPFG15	249.58	TSFG15	267.17

Primary Flue Gas Corrections For Differences From:	
Design Entering Air Temperature, TPFG15DA, deg F	247.10
Design Entering Flue Gas Temperature, TPFG15DG, deg F	268.56
Design X-Ratio (No Leak), TPFG15DX, deg F	328.98
Air Leak Correction, deg F	18.07
Design Flue Gas Flow Rate, TPFG15DGR, deg F	269.19
Secondary Flue Gas Corrections for Differences From:	
Design Entering Air Temperature, TSFG15DA, deg F	276.99
Design Entering Flue Gas Temperature, TSFG15DG, deg F	283.68
Design X-Ratio, TSFG15DX, deg F	263.05
Design Flue Gas Flow Rate, TSFG15DGR, deg F	285.53
PFG Totally Corrected Outlet Temp, deg F	327.90
SFG Totally Corrected Outlet Temp, deg F	260.17
Avg FG Outlet Totally Corrected T, TG15_Total, deg F	**268.53**

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AVERAGE HEAT CAPACITY CALCULATIONS

Calculation of Primary, Secondary, and Air Leak Heat Capacities Over Inlet to Outlet Temperature Ranges

Cp for Primary Air From Tpai to Tpao — Cp Secondary Air From Tsai to Tsao

Humidity, lb H2O/lb DB Air 0.00422 — 0.00422

	deg F	deg R	deg K	deg C	deg F	deg R	deg K	deg C
T1 =	109	569	316	43	89	549	305	32
T2 =	592	1052	584	311	612	1072	596	322
T2 - T1 =	483	483	268	268	523	523	291	291

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.33%	7.1424	7.094	99.33%	7.1422	7.094
H2O	0.67%	8.3498	0.056	0.67%	8.3501	0.056
TOTAL	100.00%	Avg Cp	7.151	100.00%	Avg Cp	7.150
Mol Wt.	28.90	Btu/lb-F	0.2475	28.90	Btu/lb-F	0.2474

Cp Air Leak From Tamb to Tfgo — Cp Downstream Leak From Tdsi to Tfgo

Humidity, lb H2O/lb DB Air 0.00422 — 0.00422

	deg F	deg R	deg K	deg C	deg F	deg R	deg K	deg C
T1 =	96	556	309	36	148	608	338	64
T2 =	281	741	412	138	281	741	412	138
T2 - T1 =	185	185	103	103	133	133	74	74

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.33%	7.0101	6.963	99.33%	7.0318	6.984
H2O	0.67%	8.1209	0.055	0.67%	8.1570	0.055
TOTAL	100.00%	Avg Cp	7.018	100.00%	Avg Cp	7.039
Mol Wt.	28.90	Btu/lb-F	0.2429	28.90	Btu/lb-F	0.2436

Secondary Air Outlet Temperature Correction For Bypass Flow

Cp for Secondary Air From Tsai to Tsao' — Cp for Secondary Air From Tsao to Tsao'

	deg F	deg R	deg K	deg C	deg F	deg R	deg K	deg C
T1 =	89.0	549.0	305	32	612.0	1072.0	596	322
T2 =	612.0	1072.0	596	322	612.0	1072.0	596	322
T2 - T1 =	523.0	523.0	291	291	0.0	0.0	0	0

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.33%	7.1422	7.094	99.33%	7.3521	7.303
H2O	0.67%	8.3501	0.056	0.67%	8.7250	0.059
TOTAL	100.00%	Avg Cp	7.150	100.00%	Avg Cp	7.361
		Btu/lb-F	0.2474		Btu/lb-F	0.2548

Corrected Tsao', deg F **612.0**

Calculation of Average Air Inlet Temperature

Cp of Primary Air Between Tpai and Taia (TA8) — Cp of Secondary Air Between Tsai and Taia (TA8)

	deg F	deg R	deg K	deg C	deg F	deg R	deg K	deg C
T1 =	109.0	569.0	316	43	89.0	549.0	305	32
T2 =	91.6	551.6	306	33	91.6	551.6	306	33
T2 - T1 =	-17.4	-17.4	-10	-10	2.6	2.6	1	1

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.33%	6.9363	6.890	99.33%	6.9279	6.881
H2O	0.67%	7.9988	0.054	0.67%	7.9850	0.054
TOTAL	100.00%	Avg Cp	6.944	100.00%	Avg Cp	6.935
		Btu/lb-F	0.2403		Btu/lb-F	0.2400

Avg Air In Temp, Taia (TA8) **91.6**

Calculation of Average Air Outlet Temperature

Cp of Primary Air Between Tpao and Taoa (TA9)

	deg F	deg R	deg K	deg C
T1 =	592.0	1052.0	584	311
T2 =	609.4	1069.4	594	321
T2 - T1 =	17.4	17.4	10	10

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.33%	7.3432	7.294
H_2O	0.67%	8.7084	0.059
TOTAL	100.00%	Avg Cp	7.352
		Btu/lb-F	0.2544

Avg Air Out Temp, Taoa (TA9) **609.4**

Calculation of Flue Gas Outlet Temp for No Leak Case

Cp for Outlet Flue Gas Between Tfgo (TG15) and Tfgonl (TG15NL) -- No Leak Case

	deg F	deg R	deg K	deg C
T1 =	281.0	741	412	138
T2 =	283.5	743.5	413	140
T2 - T1 =	2.5	2.5	1	1

	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO_2	14.545%	13.567%	9.8981	1.343
CO	0.000%	0.000%	7.0733	0.000
N_2	81.165%	75.705%	7.0393	5.329
O_2	4.290%	4.001%	7.2702	0.291
H_2O	0.000%	6.727%	8.2517	0.555
TOTAL	100.000%	100.000%	Avg Cp	7.518
			Btu/lb-F	0.2534

FG Out Temp, (TG15NL) **283.5**

Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgo (TG15)
No Leak Case

	deg F	deg R	deg K	deg C
T1 =	678.0	1138	632	359
T2 =	281.0	741.0	412	138
T2 - T1 =	-397.0	-397.0	-221	-221

	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO_2	14.545%	13.567%	10.6600	1.446
CO	0.000%	0.000%	7.2348	0.000
N_2	81.165%	75.705%	7.1762	5.433
O_2	4.290%	4.001%	7.5119	0.301
H_2O	0.000%	6.727%	8.5337	0.574
TOTAL	100.000%	100.000%	Avg Cp	7.754
			Btu/lb-F	0.2613

Cp of Secondary Air Between Tsao and Taoa (TA9)

deg F	deg R	deg K	deg C
612.0	1072.0	596	322
609.4	1069.4	594	321
-2.6	-2.6	-1	-1

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	7.3511	7.302
0.67%	8.7230	0.059
100.00%	Avg Cp	7.360
	Btu/lb-F	0.2547

Cp of Air Between Taia and Taoa (TA8 to TA9)

deg F	deg R	deg K	deg C
91.6	551.6	306	33
609.4	1069.4	594	321
517.7	517.7	288	288

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	7.1422	7.094
0.67%	8.3501	0.056
100.00%	Avg Cp	7.150
	Btu/lb-F	0.2474

Cp of Air Leak Between Tsai to Tfgo (TG15)

deg F	deg R	deg K	deg C
89.0	549.0	305	32
281.0	741.0	412	138
192.0	192.0	107	107

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.33%	7.0071	6.960
0.67%	8.1161	0.055
100.00%	Avg Cp	7.015
	Btu/lb-F	0.2428

Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgonl (TG15NL)--No Leak Case

deg F	deg R	deg K	deg C
678.0	1138	632	359
283.5	743.5	413	140
-394.5	-394.5	-219	-219

Mol %		Cpi	Cpi*MF
Dry	Wet	Btu/mol-F	Btu/mol-F
14.545%	13.567%	10.6649	1.447
0.000%	0.000%	7.2359	0.000
81.165%	75.705%	7.1770	5.433
4.290%	4.001%	7.5134	0.301
0.000%	6.727%	8.5355	0.574
100.000%	100.000%	Avg Cp	7.755
		Btu/lb-F	0.2614

Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgo (TPFG15)

	deg F	deg R	deg K	deg C
T1 =	678.0	1138	632	359
T2 =	268.0	728.0	404	131
T2 - T1 =	-410.0	-410.0	-228	-228
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	14.545%	13.567%	10.6348	1.443
CO	0.000%	0.000%	7.2295	0.000
N2	81.165%	75.705%	7.1716	5.429
O2	4.290%	4.001%	7.5039	0.300
H2O	0.000%	6.727%	8.5244	0.573
TOTAL	100.000%	100.000%	Avg Cp	7.746
			Btu/lb-F	0.2610

Cp for Sootblower Air Leak From Tamb to Tpfgo

Humidity, lb H2O/lb DB Air	0.00422			
	deg F	deg R	deg K	deg C
T1 =	96	556	309	36
T2 =	268	728	404	131
T2 - T1 =	172	172	96	96
			Cpi	Cpi*MF
COMPOUND	Mol %		Btu/mol-F	Btu/mol-F
AIR	99.33%		7.0047	6.957
H2O	0.67%		0.0000	0.000
TOTAL	100.00%		Avg Cp	6.957
Mol Wt.	28.90		Btu/lb-F	0.2408

Calculation of Secondary Flue Gas Outlet Temperature

Cp for Secondary Flue Gas Between Tsfgo (TSFG15) and Tfgo (TG15)

	deg F	deg R	deg K	deg C
T1 =	283.0	743.0	413	139
T2 =	281.0	741.0	412	138
T2 - T1 =	-2.0	-2.0	-1	-1
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	14.545%	13.567%	9.8971	1.343
CO	0.000%	0.000%	7.0731	0.000
N2	81.165%	75.705%	7.0391	5.329
O2	4.290%	4.001%	7.2699	0.291
H2O	0.000%	6.727%	8.2514	0.555
TOTAL	100.000%	100.000%	Avg Cp	7.518
			Btu/lb-F	0.2534

SFG Out Temp, (TSFG15) **283.0**

Cp for Secondary Flue Gas Between Tfgi (TG14) and Tsfgo (TSFG15)

	deg F	deg R	deg K	deg C
T1 =	678.0	1138.0	632	359
T2 =	283.0	743.0	413	139
T2 - T1 =	-395.0	-395.0	-219	-219
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	14.545%	13.567%	10.6639	1.447
CO	0.000%	0.000%	7.2357	0.000
N2	81.165%	75.705%	7.1769	5.433
O2	4.290%	4.001%	7.5131	0.301
H2O	0.000%	6.727%	8.5351	0.574
TOTAL	100.000%	100.000%	Avg Cp	7.755
			Btu/lb-F	0.2613

SFG T Out Alt Calc, (TSFG15) **283.0**

Cp for Primary Flue Gas Between Tpfgo (TPFG15) and Tpfgonl (TPFG15NL)

deg F	deg R	deg K	deg C
268.0	728	404	131
286.1	746.1	414	141
18.1	18.1	10	10
Mol %		Cpi	Cpi*MF
Dry	Wet	Btu/mol-F	Btu/mol-F
14.545%	13.567%	9.8764	1.340
0.000%	0.000%	7.0689	0.000
81.165%	75.705%	7.0357	5.326
4.290%	4.001%	7.2634	0.291
0.000%	6.727%	8.2444	0.555
100.000%	100.000%	Avg Cp	7.511
		Btu/lb-F	0.2531

PFG Out Temp, (TPFG15NL) **286.07**

Cp for Sootblower Air Leak From Tpfgo (TPFG15) to Tfgo (TG15)

0.00422			
deg F	deg R	deg K	deg C
268	728	404	131
281	741	412	138
13	13	7	7
		Cpi	Cpi*MF
Mol %		Btu/mol-F	Btu/mol-F
99.33%		7.0814	7.034
0.67%		0.0000	0.000
100.00%		Avg Cp	7.034
28.90		Btu/lb-F	0.2434

Cp for Primary Flue Gas Between Tfgo (TG15) and Tpfgo (TPFG15)

deg F	deg R	deg K	deg C
281.0	741	412	138
268.0	728.0	404	131
-13.0	-13.0	-7	-7
0		Cpi	Cpi*MF
0	Wet	Btu/mol-F	Btu/mol-F
14.545%	13.567%	9.8659	1.338
0.000%	0.000%	7.0668	0.000
81.165%	75.705%	7.0339	5.325
4.290%	4.001%	7.2601	0.291
0.000%	6.727%	8.2408	0.554
100.000%	100.000%	Avg Cp	7.508
		Btu/lb-F	0.2530

Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgonl (TPFG15NL)

deg F	deg R	deg K	deg C
678.0	1138	632	359
286.1	746.1	414	141
-391.9	-391.9	-218	-218
0		Cpi	Cpi*MF
0	Wet	Btu/mol-F	Btu/mol-F
14.545%	13.567%	10.6698	1.448
0.000%	0.000%	7.2369	0.000
81.165%	75.705%	7.1779	5.434
4.290%	4.001%	7.5150	0.301
0.000%	6.727%	8.5373	0.574
100.000%	100.000%	Avg Cp	7.757
		Btu/lb-F	0.2614

PROGRAM CALCULATES AIR HEATER PERFORMANCE FROM TEST DATA
After Entering Data Into Blocked Areas Calculate Results Using Macro \C
Print Results Using Macro \P

Description Unit 2A Test 2 - 5/15/96 14:50-17:00 hrs

Coal and Ash Data

AFC = As Fired Coal

Use ASME Mol Weights? 1=Y 0=Alt 1

	Coal Comp Wt % Dry	Wt % Wet
Moisture		7.94
C	78.55	72.31
H	5.11	4.70
N	1.62	1.49
S	2.04	1.88
O	4.34	4.00
Ash	8.34	7.68
HHV	13,914	100.00

Fly Ash Overhead	90.00%
Carbon in Refuse, %	1.89
lbs C in Refuse/lb AFC (1)	0.0014
C Burned/lb AFC	0.7218

Gas Stream Data

Flue Gas In

Ht Pipe Inlet Temp, deg F 677

COMPOUND	Mol % Dry	Mol % Wet
CO2	15.070%	14.01%
CO	0.001%	0.00%
N2	81.249%	75.54%
O2	3.680%	3.42%
H2O	0.00%	7.03%
TOTAL	100.00%	100.00%

Amb Air Temp, deg F	95
Amb Air Moisture, lb/lb BD Air	0.0041
Downstream Leak Temp, deg F	148
Downstream Leak Moisture, lb/lb BD Air	0.0041
Downstream Leak Rate, lb/hr	4800
Primary Air (PA) Inlet Temp (Tpai), deg F	116
Primary Air Outlet Temp (Tpao), deg F	605
Secondary Air (SA) Inlet Temp (Tsai), deg F	95
Sec Air With Bypass Outlet Temp (Tsao), deg F	619
Primary Flue Gas Outlet Temp (Tpgo), deg F	304
Total Mols Dry Flue Gas In/lb AFC	0.4026
Total lbs Dry Flue Gas In/lb AFC (WG'14)	12.3101
Atomizing Steam (Wz), lbs/lb AFC	0.00
Steam From Ash Pit (Wm), lbs/lb AFC	0.00
Flue Gas H2O (WmGi), lbs/lb AFC	0.5486
H2O in Flue Gas, Mols/lb AFC	0.0305
Flue Gas Moisture, vol %	7.031%
Flue Gas MW	29.69
Flue Gas MW (dry)	30.57

(1) Assumption: Bottom Ash Carbon Concentration is 1/3 That of Overhead Ash.

Flue Gas Out

Ht. Pipe Outlet Temp, deg F	302	
	Mol %	
COMPOUND	Dry	Wet
CO2	14.370%	13.40%
CO	0.000%	0.00%
N2	81.120%	75.64%
O2	4.510%	4.21%
H2O	0.00%	6.75%
TOTAL	100.00%	100.00%

Mols Dry Flue Gas/lb AFC	0.4223
lbs Dry Flue Gas/lb AFC (WG'15)	12.8770
Flue Gas H2O (WmGo), lbs/lb AFC	0.5509
H2O in Flue Gas, Mols/lb AFC	0.0306
Total Flue Gas Out, lbs/hr	774806
Flue Gas Moisture, vol %	6.752%
Flue Gas MW (wet)	29.65
Flue Gas MW (dry)	30.49
Total Air Leak, wt % (AL)	**4.43**

Boiler Load, MW	147.22		
Heat Rate, Btu/KWh	9,501		
As Fired Coal Rate, Tons/hr	54.60		
lbs/hr (Wfe)	109,200		
Flow Split to Heat Pipe	52.84%	lb/hr	
Primary Air Fan Flow, lbs/lb AFC	2.1413	123,553	(3)
Primary Air (PA) Out Heat Pipe, Wpa, lbs/lb AFC	1.2763	73,646	
Cppa, Btu/mol-F (Tpao to Tpai)	7.1584		
Cppa, Btu/lb-F	0.2477		
Primary Air Bypass (PABP), lbs/lb AFC	0.8649	49,907	
Wet Flue Gas In (WF14), lbs/lb AFC	12.8587	741,965	
Cpfg, Btu/mol-F (Tfgi to Tfgo)	7.7833		
Cpfg, Btu/lb-F	0.2622		
Sootblower At Wall Air Leaks, lbs/lb AFC	0.4860	28,041	
Cpal, Btu/mol-F (Tsai to Tfgo)	7.0257		
Cpal, Btu/lb-F	0.2431		
Downstream Air Leak Rate, lbs/lb AFC	0.0832	4,800	
Cpal, Btu/mol-F (Tdsi to Tfgo)	7.0478		
Cpal, Btu/lb-F	0.2439		
SA+Bypass Rate (SA+SABP), lbs/lb AFC	8.3387	481,154	<<Ht Bal Calc
Cpsa, Btu/mol-F (Tsai to Tsao)	7.1554		
Cpsa, Btu/lb-F	0.2476		
Secondary Air Bypass (SAPB), lbs/lb AFC	0.0000	0	
Cpsabp, Btu/mol-F (Tsai to Tsao)	7.1554		
Cpsabp, Btu/lb-F	0.2476		
PA+PABP+SA+SABP+Coal, lbs/lb AFC (2)	11.4032	657,978	(3)
Calc'd Air Leakage into Boiler, lbs/lb AFC	1.4555	83,987	11.32% (3)

(2) Does Not Include Leaks Into Boiler

(3) Not Required For Performance Calculations

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	CONDITIONS		
	DESIGN	ACTUAL	
Flow Rates to Heat Pipe, lb/hr			
Primary Air	62,500	73,646	
Secondary Air (No Bypass)	562,500	481,154	
Flue Gas	750,000	741,965	
Temperatures, deg F			
Primary Air In	80.0	116.0	
Primary Air Out	644.0	605.0	
2nd Air in	80.0	95.0	
2nd Air Out With Bypass	616.0	619.0	
2nd Air Out Without Bypass		619.0	
Avg Air In, (TA8)	80.0	97.8	
Avg Air Out, (TA9)	618.8	617.1	<<(Ex SA Bypass)
Flue Gas In, (TG14)	680.0	677.0	
Flue Gas Out, (TG15)	253.0	302.0	
FG Out No Leak, (TG15NL)		310.4	
Primary Air Duty, MMBtu/hr		8.921	
Sootblower Wall Leak Duty, MMBtu/hr		1.414	
Primary Flue Gas Duty, MMBtu/hr		10.335	
Primary Flue Gas Rate, lb/hr		105678	
Primary Flue Gas Rate, lb/lb AFC		1.8315	
Primary Flue Gas Outlet Temp NL, deg F		356.3	
Secondary Flue Gas Rate, lb/hr		636288	
Secondary Flue Gas Rate, lb/lb AFC		11.0273	
Secondary Flue Gas Outlet Temp, deg F		302.7	

Pressure Drops, in. wc	**Design**	**Measured**
Primary Air, (DP8_9)	5.35	3.64
Secondary Air, (DP8_9)	5.35	4.36
Flue Gas, (DP14_15)		
Primary Flue Gas	3.65	3.76
Secondary Flue Gas	3.65	3.76

Pressure Drops Corrected for Deviation From Design Flow and Design Temp

Gas Side (DPs(14-15), in. wc (4)	**3.61**	
Pressure Drop is	**-0.04**	in. wc Less Than Design
Air Side (DPs(8-9), in. wc		
Primary Air Section	**2.63**	
Pressure Drop is	**-2.72**	in. wc Less Than Design
Secondary Air Section	**5.89**	
Pressure Drop is	**0.54**	in. wc Greater Than Design

(4) Average In/Out Flue Gas Flow Used In Calculation.

Correction Calculations For Heat Pipe -- Design Condition Results

		Curve 1	Curve 2 (Ea Limited)	
Flue Gas Inlet Temp, deg F	TG14D	680.00	680.00	
Pri Air (PA) Inlet Temp, deg F	TA8D	80.00	80.00	
Sec Air (SA) Inlet Temp, deg F	T'A8D	80.00	80.00	
PA Outlet, deg F	Tpa9D	649.75	649.75	
SA Outlet, deg F	Tsa9D	617.20	617.20	
Pri Flue Gas (PFG) Outlet, deg F	TPFG15D	309.66	309.66	
Sec Flue Gas (SFG) Outlet, deg	TSFG15D	243.92	243.92	
PFG Rate, Mlb/hr	WPFGD	182.70	182.70	
SFG Rate, Mlb/hr	WSFGD	1317.30	1317.30	
Combined Outlet T, deg F		251.93	251.93	
PA Side Effectiveness	Ea	0.9496	0.9492	<Curve 2 Limit
PA X-Ratio	X Design	0.6500	0.6500	
PA fg	fpgD	1.0001	1.0001	
PA fx	fpxD	0.9991	0.9987	
	Eg	0.6172	0.6170	
Calculated TPFG Out, deg F	TPFG15D	309.66	309.81	
SA Side Effectiveness	Ea	0.8953	0.9300	<Curve 2 Limit
SA X-Ratio (Design)	X Design	0.8118	0.8118	
SA fg	fsgD	1.0004	1.0004	
SA fx	fsxD	1.0001	1.0388	
	Eg	0.7268	0.7549	
Calculated TSFG Out, deg F	TSFG15D	243.91	227.04	
Combined Outlet T, deg F		251.92	237.12	

Correction Calculations For Heat Pipe -- Operating Condition Results

Ambient Temp, deg F	Tamb	95.00
Sootblower Wall Air Leak, wt % PFG	Al	26.53
Cpa (Tpfg15-Tamb), Btu/lb-F	CpA	0.2413
Cpg (Tpfgnl15-Tpg15), Btu/lb-F	CpG	0.2557
Flue Gas Inlet Temp, deg F	TG14	677.00
PA Inlet Temp, deg F	TA8	116.00
SA Inlet Temp, deg F	T'A8	95.00
PA Outlet Temp, deg F	Tpa9	605.00
SA Outlet Temp (No Bypass), deg F	Tsa9	619.00
PFG Outlet Temp, deg F	TPG15	304.00
PFG Outlet Temp (No Leak), deg F	TPFG15NL	356.33
SFG Outlet Temp, deg F	TSFG15	302.70
PFG Rate, Mlb/hr	WPFG	105.68
SFG Rate, Mlb/hr	WSFG	636.29
Sootblower Wall Air Leak Into PFG, Mlb/hr	WAL1	28.04
Constant, Al/100*CpA/CpG*(TPG15-Tamb)		52.33
PA Side Effectiveness	Epa	0.8717
SA Side Effectiveness	Esa	0.9003
X-Ratios	Xp	0.6558
	Xs	0.7143
PA Eg	Epg	0.5716
SA Eg	Esg	0.6431

Correction Factors		**Pri Flue Gas**		**Sec Flue Gas**
	fpg	0.9901	fsg	1.0034
	fpgD	1.0001	fsgD	1.0004
	fpx	1.0059	fsx	0.9178
	fpxD	0.9991	fsxD	1.0001
	TPFG15D	309.66	TSFG15D	243.91
Performance	TPFG15	279.53	TSFG15	287.62

Primary Flue Gas Corrections For Differences From:	
Design Entering Air Temperature, TPFG15DA, deg F	280.06
Design Entering Flue Gas Temperature, TPFG15DG, deg F	305.01
Design X-Ratio (No Leak), TPFG15DX, deg F	306.51
Air Leak Correction, deg F	52.33
Design Flue Gas Flow Rate, TPFG15DGR, deg F	300.30

Secondary Flue Gas Corrections for Differences From:	
Design Entering Air Temperature, TSFG15DA, deg F	293.05
Design Entering Flue Gas Temperature, TSFG15DG, deg F	303.77
Design X-Ratio, TSFG15DX, deg F	266.82
Design Flue Gas Flow Rate, TSFG15DGR, deg F	304.01

PFG Totally Corrected Outlet Temp, deg F	332.22
SFG Totally Corrected Outlet Temp, deg F	259.56
Avg FG Outlet Totally Corrected T, TG15_Total, deg F	**269.91**

AVERAGE HEAT CAPACITY CALCULATIONS

Calculation of Primary, Secondary, and Air Leak Heat Capacities Over Inlet to Outlet Temperature Ranges

Cp for Primary Air From Tpai to Tpao

Humidity, lb H2O/lb DB Air 0.0041

	deg F	deg R	deg K	deg C
T1 =	116	576	320	47
T2 =	605	1065	592	318
T2 - T1 =	489	489	272	272

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.35%	7.1505	7.104
H2O	0.65%	8.3640	0.055
TOTAL	100.00%	Avg Cp	7.158
Mol Wt.	28.90	Btu/lb-F	0.2477

Cp Secondary Air From Tsai to Tsao

0.0041

deg F	deg R	deg K	deg C
95	555	308	35
619	1079	599	326
524	524	291	291

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.35%	7.1475	7.101
0.65%	8.3593	0.055
100.00%	Avg Cp	7.155
28.90	Btu/lb-F	0.2476

Cp Air Leak From Tamb to Tfgo

Humidity, lb H2O/lb DB Air 0.0041

	deg F	deg R	deg K	deg C
T1 =	95	555	308	35
T2 =	302	762	423	150
T2 - T1 =	207	207	115	115

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.35%	7.0183	6.972
H2O	0.65%	8.1349	0.053
TOTAL	100.00%	Avg Cp	7.026
Mol Wt.	28.90	Btu/lb-F	0.2431

Cp Downstream Leak From Tdsi to Tfgo

0.0041

deg F	deg R	deg K	deg C
148	608	338	64
302	762	423	150
154	154	86	86

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.35%	7.0404	6.994
0.65%	8.1717	0.054
100.00%	Avg Cp	7.048
28.90	Btu/lb-F	0.2439

Secondary Air Outlet Temperature Correction For Bypass Flow

Cp for Secondary Air From Tsai to Tsao'

	deg F	deg R	deg K	deg C
T1 =	95.0	555.0	308	35
T2 =	619.0	1079.0	599	326
T2 - T1 =	524.0	524.0	291	291

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.35%	7.1475	7.101
H2O	0.65%	8.3593	0.055
TOTAL	100.00%	Avg Cp	7.155
		Btu/lb-F	0.2476

Corrected Tsao', deg F **619.0**

Cp for Secondary Air From Tsao to Tsao'

deg F	deg R	deg K	deg C
619.0	1079.0	599	326
619.0	1079.0	599	326
0.0	0.0	0	0

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.35%	7.3576	7.309
0.65%	8.7352	0.057
100.00%	Avg Cp	7.367
	Btu/lb-F	0.2549

Calculation of Average Air Inlet Temperature

Cp of Primary Air Between Tpai and Taia (TA8)

	deg F	deg R	deg K	deg C
T1 =	116.0	576.0	320	47
T2 =	97.8	557.8	310	37
T2 - T1 =	-18.2	-18.2	-10	-10

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.35%	6.9419	6.896
H2O	0.65%	8.0078	0.052
TOTAL	100.00%	Avg Cp	6.949
		Btu/lb-F	0.2405

Avg Air In Temp, Taia (TA8) **97.8**

Cp of Secondary Air Between Tsai and Taia (TA8)

deg F	deg R	deg K	deg C
95.0	555.0	308	35
97.8	557.8	310	37
2.8	2.8	2	2

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.35%	6.9330	6.888
0.65%	7.9934	0.052
100.00%	Avg Cp	6.940
	Btu/lb-F	0.2402

Calculation of Average Air Outlet Temperature

Cp of Primary Air Between Tpao and Taoa (TA9)

	deg F	deg R	deg K	deg C
T1 =	605.0	1065.0	592	318
T2 =	617.1	1077.1	598	325
T2 - T1 =	12.1	12.1	7	7

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.35%	7.3514	7.303
H2O	0.65%	8.7236	0.057
TOTAL	100.00%	Avg Cp	7.360
		Btu/lb-F	0.2547

Avg Air Out Temp, Taoa (TA9) **617.1**

Cp of Secondary Air Between Tsao and Taoa (TA9)

deg F	deg R	deg K	deg C
619.0	1079.0	599	326
617.1	1077.1	598	325
-1.9	-1.9	-1	-1

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.35%	7.3568	7.309
0.65%	8.7339	0.057
100.00%	Avg Cp	7.366
	Btu/lb-F	0.2549

Cp of Air Between Taia and Taoa (TA8 to TA9)

deg F	deg R	deg K	deg C
97.8	557.8	310	37
617.1	1077.1	598	325
519.4	519.4	289	289

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.35%	7.1479	7.101
0.65%	8.3600	0.055
100.00%	Avg Cp	7.156
	Btu/lb-F	0.2476

Calculation of Flue Gas Outlet Temp for No Leak Case

Cp for Outlet Flue Gas Between Tfgo (TG15) and Tfgonl (TG15NL) -- No Leak Case

	deg F	deg R	deg K	deg C
T1 =	302.0	762	423	150
T2 =	310.4	770.4	428	155
T2 - T1 =	8.4	8.4	5	5

	Mol %			
COMPOUND	Dry	Wet	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
CO2	15.070%	14.010%	9.9969	1.401
CO	0.001%	0.001%	7.0932	0.000
N2	81.249%	75.537%	7.0559	5.330
O2	3.680%	3.421%	7.3012	0.250
H2O	0.000%	7.031%	8.2855	0.583
TOTAL	100.000%	100.000%	Avg Cp	7.563
			Btu/lb-F	0.2547

FG Out Temp, (TG15NL) **310.4**

Cp of Air Leak Between Tsai to Tfgo (TG15)

deg F	deg R	deg K	deg C
95.0	555.0	308	35
302.0	762.0	423	150
207.0	207.0	115	115

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.35%	7.0183	6.972
0.65%	8.1349	0.053
100.00%	Avg Cp	7.026
	Btu/lb-F	0.2431

Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgo (TG15)
No Leak Case

	deg F	deg R	deg K	deg C
T1 =	677.0	1137	632	358
T2 =	302.0	762.0	423	150
T2 - T1 =	-375.0	-375.0	-208	-208

	Mol %			
COMPOUND	Dry	Wet	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
CO2	15.070%	14.010%	10.6986	1.499
CO	0.001%	0.001%	7.2430	0.000
N2	81.249%	75.537%	7.1831	5.426
O2	3.680%	3.421%	7.5241	0.257
H2O	0.000%	7.031%	8.5480	0.601
TOTAL	100.000%	100.000%	Avg Cp	7.783
			Btu/lb-F	0.2622

Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgonl (TG15NL)--No Leak Case

deg F	deg R	deg K	deg C
677.0	1137	632	358
310.4	770.4	428	155
-366.6	-366.6	-204	-204

Mol %			
Dry	Wet	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
15.070%	14.010%	10.7148	1.501
0.001%	0.001%	7.2465	0.000
81.249%	75.537%	7.1860	5.428
3.680%	3.421%	7.5293	0.258
0.000%	7.031%	8.5540	0.601
100.000%	100.000%	Avg Cp	7.788
		Btu/lb-F	0.2623

Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgo (TPFG15)

	deg F	deg R	deg K	deg C
T1 =	677.0	1137	632	358
T2 =	304.0	764.0	424	151
T2 - T1 =	-373.0	-373.0	-207	-207
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	15.070%	14.010%	10.7025	1.499
CO	0.001%	0.001%	7.2439	0.000
N2	81.249%	75.537%	7.1838	5.426
O2	3.680%	3.421%	7.5254	0.257
H2O	0.000%	7.031%	8.5494	0.601
TOTAL	100.000%	100.000%	Avg Cp	7.784
			Btu/lb-F	0.2622

Cp for Sootblower Air Leak From Tamb to Tpfgo

Humidity, lb H2O/lb DB Air 0.0041

	deg F	deg R	deg K	deg C
T1 =	95	555	308	35
T2 =	304	764	424	151
T2 - T1 =	209	209	116	116
			Cpi	Cpi*MF
COMPOUND	Mol %		Btu/mol-F	Btu/mol-F
AIR	99.35%		7.0192	6.973
H2O	0.65%		0.0000	0.000
TOTAL	100.00%		Avg Cp	6.973
Mol Wt.	28.90		Btu/lb-F	0.2413

Calculation of Secondary Flue Gas Outlet Temperature

Cp for Secondary Flue Gas Between Tsfgo (TSFG15) and Tfgo (TG15)

	deg F	deg R	deg K	deg C
T1 =	302.7	762.7	424	150
T2 =	302.0	762.0	423	150
T2 - T1 =	-0.7	-0.7	-0	-0
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	15.070%	14.010%	9.9811	1.398
CO	0.001%	0.001%	7.0900	0.000
N2	81.249%	75.537%	7.0532	5.328
O2	3.680%	3.421%	7.2962	0.250
H2O	0.000%	7.031%	8.2800	0.582
TOTAL	100.000%	100.000%	Avg Cp	7.558
			Btu/lb-F	0.2546

SFG Out Temp, (TSFG15) **302.7**

Cp for Secondary Flue Gas Between Tfgi (TG14) and Tsfgo (TSFG15)

	deg F	deg R	deg K	deg C
T1 =	677.0	1137.0	632	358
T2 =	302.7	762.7	424	150
T2 - T1 =	-374.3	-374.3	-208	-208
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	15.070%	14.010%	10.7000	1.499
CO	0.001%	0.001%	7.2433	0.000
N2	81.249%	75.537%	7.1833	5.426
O2	3.680%	3.421%	7.5246	0.257
H2O	0.000%	7.031%	8.5485	0.601
TOTAL	100.000%	100.000%	Avg Cp	7.784
			Btu/lb-F	0.2622

SFG T Out Alt Calc, (TSFG15) **302.8**

Cp for Primary Flue Gas Between Tpfgo (TPFG15) and Tpfgonl (TPFG15NL)

deg F	deg R	deg K	deg C
304.0	764	424	151
356.3	816.3	454	180
52.3	52.3	29	29
Mol %		Cpi	Cpi*MF
Dry	Wet	Btu/mol-F	Btu/mol-F
15.070%	14.010%	10.0943	1.414
0.001%	0.001%	7.1131	0.000
81.249%	75.537%	7.0725	5.342
3.680%	3.421%	7.3318	0.251
0.000%	7.031%	8.3193	0.585
100.000%	100.000%	Avg Cp	7.592
		Btu/lb-F	0.2557

PFG Out Temp, (TPFG15NL) **356.33**

Cp for Sootblower Air Leak From Tpfgo (TPFG15) to Tfgo (TG15)

0.0041			
deg F	deg R	deg K	deg C
304	764	424	151
302	762	423	150
-2	-2	-1	-1
		Cpi	Cpi*MF
Mol %		Btu/mol-F	Btu/mol-F
99.35%		7.1048	7.058
0.65%		0.0000	0.000
100.00%		Avg Cp	7.058
28.90		Btu/lb-F	0.2442

Cp for Primary Flue Gas Between Tfgo (TG15) and Tpfgo (TPFG15)

deg F	deg R	deg K	deg C
302.0	762	423	150
304.0	764.0	424	151
2.0	2.0	1	1
0		Cpi	Cpi*MF
0	Wet	Btu/mol-F	Btu/mol-F
15.070%	14.010%	9.9838	1.399
0.001%	0.001%	7.0906	0.000
81.249%	75.537%	7.0537	5.328
3.680%	3.421%	7.2971	0.250
0.000%	7.031%	8.2809	0.582
100.000%	100.000%	Avg Cp	7.559
		Btu/lb-F	0.2546

Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgonl (TPFG15NL)

deg F	deg R	deg K	deg C
677.0	1137	632	358
356.3	816.3	454	180
-320.7	-320.7	-178	-178
0		Cpi	Cpi*MF
0	Wet	Btu/mol-F	Btu/mol-F
15.070%	14.010%	10.8017	1.513
0.001%	0.001%	7.2652	0.000
81.249%	75.537%	7.2019	5.440
3.680%	3.421%	7.5569	0.259
0.000%	7.031%	8.5869	0.604
100.000%	100.000%	Avg Cp	7.816
		Btu/lb-F	0.2632

PROGRAM CALCULATES AIR HEATER PERFORMANCE FROM TEST DATA

After Entering Data Into Blocked Areas Calculate Results Using Macro \C
Print Results Using Macro \P

Description Unit 2B Test 2 – 5/15/96 12:00-14:45 hrs

Coal and Ash Data

AFC = As Fired Coal

Use ASME Mol Weights? 1=Y 0=Alt 1

	Coal Comp Wt % Dry	Wt % Wet
Moisture		7.94
C	78.55	72.31
H	5.11	4.70
N	1.62	1.49
S	2.04	1.88
O	4.34	4.00
Ash	8.34	7.68
HHV	13,914	100.00

Fly Ash Overhead	90.00%
Carbon in Refuse, %	1.89
lbs C in Refuse/lb AFC (1)	0.0014
C Burned/lb AFC	0.7218

Gas Stream Data

Flue Gas In

Ht Pipe Inlet Temp, deg F 671

	Mol %	
COMPOUND	Dry	Wet
CO2	14.360%	13.39%
CO	0.001%	0.00%
N2	81.149%	75.64%
O2	4.490%	4.19%
H2O	0.00%	6.78%
TOTAL	100.00%	100.00%

Amb Air Temp, deg F	95
Amb Air Moisture, lb/lb BD Air	0.00435
Downstream Leak Temp, deg F	148
Downstream Leak Moisture, lb/lb BD Air	0.00435
Downstream Leak Rate, lb/hr	0
Primary Air (PA) Inlet Temp (Tpai), deg F	116
Primary Air Outlet Temp (Tpao), deg F	590
Secondary Air (SA) Inlet Temp (Tsai), deg F	94
Sec Air With Bypass Outlet Temp (Tsao), deg F	612
Primary Flue Gas Outlet Temp (Tpgo), deg F	269
Total Mols Dry Flue Gas In/lb AFC	0.4225
Total lbs Dry Flue Gas In/lb AFC (WG'14)	12.8841
Atomizing Steam (Wz), lbs/lb AFC	0.00
Steam From Ash Pit (Wm), lbs/lb AFC	0.00
Flue Gas H2O (WmGi), lbs/lb AFC	0.5541
H2O in Flue Gas, Mols/lb AFC	0.0308
Flue Gas Moisture, vol %	6.784%
Flue Gas MW	29.65
Flue Gas MW (dry)	30.49

(1) Assumption: Bottom Ash Carbon Concentration is 1/3 That of Overhead Ash.

Flue Gas Out

Ht. Pipe Outlet Temp, deg F 279

	Mol %	
COMPOUND	Dry	Wet
CO2	14.150%	13.20%
CO	0.000%	0.00%
N2	81.110%	75.68%
O2	4.740%	4.42%
H2O	0.00%	6.70%
TOTAL	100.00%	100.00%

Mols Dry Flue Gas/lb AFC	0.4288
lbs Dry Flue Gas/lb AFC (WG'15)	13.0659
Flue Gas H2O (WmGo), lbs/lb AFC	0.5548
H2O in Flue Gas, Mols/lb AFC	0.0308
Total Flue Gas Out, lbs/hr	701449
Flue Gas Moisture, vol %	6.700%
Flue Gas MW (wet)	29.63
Flue Gas MW (dry)	30.47
Total Air Leak, wt % (AL)	**1.36**

Boiler Load, MW	147.22		
Heat Rate, Btu/KWh	9,501		
As Fired Coal Rate, Tons/hr	54.60		
lbs/hr (Wfe)	109,200		
Flow Split to Heat Pipe	47.16%	lb/hr	
Primary Air Fan Flow, lbs/lb AFC	2.5066	129,089	(3)
Primary Air (PA) Out Heat Pipe, Wpa, lbs/lb AFC	1.4263	73,451	
Cppa, Btu/mol-F (Tpao to Tpai)	7.1529		
Cppa, Btu/lb-F	0.2476		
Primary Air Bypass (PABP), lbs/lb AFC	1.0804	55,638	
Wet Flue Gas In (WF14), lbs/lb AFC	13.4382	692,050	
Cpfg, Btu/mol-F (Tfgi to Tfgo)	7.7434		
Cpfg, Btu/lb-F	0.2612		
Sootblower At Wall Air Leaks, lbs/lb AFC	0.1825	9,398	
Cpal, Btu/mol-F (Tsai to Tfgo)	7.0165		
Cpal, Btu/lb-F	0.2428		
Downstream Air Leak Rate, lbs/lb AFC	0.0000	0	
Cpal, Btu/mol-F (Tdsi to Tfgo)	7.0387		
Cpal, Btu/lb-F	0.2436		
SA+Bypass Rate (SA+SABP), lbs/lb AFC	9.3617	482,114	<<Ht Bal Calc
Cpsa, Btu/mol-F (Tsai to Tsao)	7.1526		
Cpsa, Btu/lb-F	0.2475		
Secondary Air Bypass (SAPB), lbs/lb AFC	0.0000	0	
Cpsabp, Btu/mol-F (Tsai to Tsao)	7.1526		
Cpsabp, Btu/lb-F	0.2475		
PA+PABP+SA+SABP+Coal, lbs/lb AFC (2)	12.7915	658,747	(3)
Calc'd Air Leakage into Boiler, lbs/lb AFC	0.6467	33,303	4.81% (3)

(2) Does Not Include Leaks Into Boiler

(3) Not Required For Performance Calculations

	CONDITIONS		
	DESIGN	ACTUAL	
Flow Rates to Heat Pipe, lb/hr			
Primary Air	62,500	73,451	
Secondary Air (No Bypass)	562,500	482,114	
Flue Gas	750,000	692,050	
Temperatures, deg F			
Primary Air In	80.0	116.0	
Primary Air Out	644.0	590.0	
2nd Air in	80.0	94.0	
2nd Air Out With Bypass	616.0	612.0	
2nd Air Out Without Bypass		612.0	
Avg Air In, (TA8)	80.0	96.9	
Avg Air Out, (TA9)	618.8	609.1	<<(Ex SA Bypass)
Flue Gas In, (TG14)	680.0	671.0	
Flue Gas Out, (TG15)	253.0	279.0	
FG Out No Leak, (TG15NL)		281.4	
Primary Air Duty, MMBtu/hr		8.619	
Sootblower Wall Leak Duty, MMBtu/hr		0.394	
Primary Flue Gas Duty, MMBtu/hr		9.013	
Primary Flue Gas Rate, lb/hr		85897	
Primary Flue Gas Rate, lb/lb AFC		1.6679	
Primary Flue Gas Outlet Temp NL, deg F		287.1	
Secondary Flue Gas Rate, lb/hr		606154	
Secondary Flue Gas Rate, lb/lb AFC		11.7703	
Secondary Flue Gas Outlet Temp, deg F		280.6	

Pressure Drops, in. wc	Design	Measured
Primary Air, (DP8_9)	5.35	3.84
Secondary Air, (DP8_9)	5.35	4.02
Flue Gas, (DP14_15)		
Primary Flue Gas	3.65	3.32
Secondary Flue Gas	3.65	3.41

Pressure Drops Corrected for Deviation From Design Flow and Design Temp

Gas Side (DPs(14-15), in. wc (4)	**3.92**	
Pressure Drop is	**0.27**	in. wc Greater Than Design
Air Side (DPs(8-9), in. wc		
Primary Air Section	**2.81**	
Pressure Drop is	**-2.54**	in. wc Less Than Design
Secondary Air Section	**5.44**	
Pressure Drop is	**0.09**	in. wc Greater Than Design

(4) Average In/Out Flue Gas Flow Used In Calculation.

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Correction Calculations For Heat Pipe -- Design Condition Results

		Curve 1	Curve 2 (Ea Limited)	
Flue Gas Inlet Temp, deg F	TG14D	680.00	680.00	
Pri Air (PA) Inlet Temp, deg F	TA8D	80.00	80.00	
Sec Air (SA) Inlet Temp, deg F	T'A8D	80.00	80.00	
PA Outlet, deg F	Tpa9D	649.75	649.75	
SA Outlet, deg F	Tsa9D	617.20	617.20	
Pri Flue Gas (PFG) Outlet, deg F	TPFG15D	309.66	309.66	
Sec Flue Gas (SFG) Outlet, deg	TSFG15D	243.92	243.92	
PFG Rate, Mlb/hr	WPFGD	182.70	182.70	
SFG Rate, Mlb/hr	WSFGD	1317.30	1317.30	
Combined Outlet T, deg F		251.93	251.93	
PA Side Effectiveness	Ea	0.9496	0.9492	<Curve 2 Limit
PA X-Ratio	X Design	0.6500	0.6500	
PA fg (fpgD)	fpgD	1.0001	1.0001	
PA fx (fpxD)	fpxD	0.9991	0.9987	
	Eg	0.6172	0.6170	
Calculated TPFG Out, deg F	TPFG15D	309.66	309.81	
SA Side Effectiveness	Ea	0.8953	0.9300	<Curve 2 Limit
SA X-Ratio (Design)	X Design	0.8118	0.8118	
SA fg	fsgD	1.0004	1.0004	
SA fx	fsxD	1.0001	1.0388	
	Eg	0.7268	0.7549	
Calculated TSFG Out, deg F	TSFG15D	243.91	227.04	
Combined Outlet T, deg F		251.92	237.12	

Correction Calculations For Heat Pipe -- Operating Condition Results

Ambient Temp, deg F	Tamb	95.00
Sootblower Wall Air Leak, wt % PFG	Al	10.94
Cpa (Tpfg15-Tamb), Btu/lb-F	CpA	0.2407
Cpg (Tpfgnl15-Tpg15), Btu/lb-F	CpG	0.2533
Flue Gas Inlet Temp, deg F	TG14	671.00
PA Inlet Temp, deg F	TA8	116.00
SA Inlet Temp, deg F	T'A8	94.00
PA Outlet Temp, deg F	Tpa9	590.00
SA Outlet Temp (No Bypass), deg F	Tsa9	612.00
PFG Outlet Temp, deg F	TPG15	269.00
PFG Outlet Temp (No Leak), deg F	TPFG15NL	287.09
SFG Outlet Temp, deg F	TSFG15	280.56
PFG Rate, Mlb/hr	WPFG	85.90
SFG Rate, Mlb/hr	WSFG	606.17
Sootblower Wall Air Leak Into PFG, Mlb/hr	WAL1	9.39
Constant, Al/100*CpA/CpG*(TPG15-Tamb)		18.09
PA Side Effectiveness	Epa	0.8541
SA Side Effectiveness	Esa	0.8977
X-Ratios	Xp	0.8099
	Xs	0.7537
PA Eg	Epg	0.6917
SA Eg	Esg	0.6767

Correction Factors		**Pri Flue Gas**	**Sec Flue Gas**	
	fpg	1.0039	fsg	1.0074
	fpgD	1.0001	fsgD	1.0004
	fpx	1.1624	fsx	0.9530
	fpxD	0.9991	fsxD	1.0001
	TPFG15D	309.66	TSFG15D	243.91
Performance	TPFG15	252.87	TSFG15	268.55

Primary Flue Gas Corrections For Differences From:

Design Entering Air Temperature, TPFG15DA, deg F	242.92
Design Entering Flue Gas Temperature, TPFG15DG, deg F	271.48
Design X-Ratio (No Leak), TPFG15DX, deg F	329.50
Air Leak Correction, deg F	18.09
Design Flue Gas Flow Rate, TPFG15DGR, deg F	270.41

Secondary Flue Gas Corrections for Differences From:

Design Entering Air Temperature, TSFG15DA, deg F	271.09
Design Entering Flue Gas Temperature, TSFG15DG, deg F	283.47
Design X-Ratio, TSFG15DX, deg F	260.03
Design Flue Gas Flow Rate, TSFG15DGR, deg F	283.64

PFG Totally Corrected Outlet Temp, deg F	325.40
SFG Totally Corrected Outlet Temp, deg F	256.55
Avg FG Outlet Totally Corrected T, TG15_Total, deg F	**265.09**

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AVERAGE HEAT CAPACITY CALCULATIONS

Calculation of Primary, Secondary, and Air Leak Heat Capacities Over Inlet to Outlet Temperature Ranges

Cp for Primary Air From Tpai to Tpao

Humidity, lb H2O/lb DB Air 0.00435

	deg F	deg R	deg K	deg C
T1 =	116	576	320	47
T2 =	590	1050	583	310
T2 - T1 =	474	474	263	263

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.31%	7.1445	7.095
H2O	0.69%	8.3533	0.058
TOTAL	100.00%	Avg Cp	7.153
Mol Wt.	28.89	Btu/lb-F	0.2476

Cp Secondary Air From Tsai to Tsao

0.00435

	deg F	deg R	deg K	deg C
	94	554	308	34
	612	1072	596	322
	518	518	288	288

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.31%	7.1442	7.095
0.69%	8.3536	0.058
100.00%	Avg Cp	7.153
28.89	Btu/lb-F	0.2475

Cp Air Leak From Tamb to Tfgo

Humidity, lb H2O/lb DB Air 0.00435

	deg F	deg R	deg K	deg C
T1 =	95	555	308	35
T2 =	279	739	411	137
T2 - T1 =	184	184	102	102

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.31%	7.0088	6.960
H2O	0.69%	8.1188	0.056
TOTAL	100.00%	Avg Cp	7.017
Mol Wt.	28.89	Btu/lb-F	0.2428

Cp Downstream Leak From Tdsi to Tfgo

0.00435

	deg F	deg R	deg K	deg C
	148	608	338	64
	279	739	411	137
	131	131	73	73

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.31%	7.0309	6.982
0.69%	8.1556	0.057
100.00%	Avg Cp	7.039
28.89	Btu/lb-F	0.2436

Secondary Air Outlet Temperature Correction For Bypass Flow

Cp for Secondary Air From Tsai to Tsao'

	deg F	deg R	deg K	deg C
T1 =	94.0	554.0	308	34
T2 =	612.0	1072.0	596	322
T2 - T1 =	518.0	518.0	288	288

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.31%	7.1442	7.095
H2O	0.69%	8.3536	0.058
TOTAL	100.00%	Avg Cp	7.153
		Btu/lb-F	0.2475

Corrected Tsao', deg F **612.0**

Cp for Secondary Air From Tsao to Tsao'

	deg F	deg R	deg K	deg C
	612.0	1072.0	596	322
	612.0	1072.0	596	322
	0.0	0.0	0	0

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.31%	7.3521	7.301
0.69%	8.7250	0.061
100.00%	Avg Cp	7.362
	Btu/lb-F	0.2548

Calculation of Average Air Inlet Temperature

Cp of Primary Air Between Tpai and Taia (TA8)

	deg F	deg R	deg K	deg C
T1 =	116.0	576.0	320	47
T2 =	96.9	556.9	309	36
T2 - T1 =	-19.1	-19.1	-11	-11

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	99.31%	6.9415	6.893
H2O	0.69%	8.0072	0.056
TOTAL	100.00%	Avg Cp	6.949
		Btu/lb-F	0.2405

Avg Air In Temp, Taia (TA8) **96.9**

Cp of Secondary Air Between Tsai and Taia (TA8)

	deg F	deg R	deg K	deg C
	94.0	554.0	308	34
	96.9	556.9	309	36
	2.9	2.9	2	2

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
99.31%	6.9322	6.884
0.69%	7.9921	0.056
100.00%	Avg Cp	6.940
	Btu/lb-F	0.2402

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Calculation of Average Air Outlet Temperature

Cp of Primary Air Between Tpao and Taoa (TA9)

	deg F	deg R	deg K	deg C
T1 =	590.0	1050.0	583	310
T2 =	609.1	1069.1	594	321
T2 - T1 =	19.1	19.1	11	11
			Cpi	Cpi*MF
COMPOUND	Mol %		Btu/mol-F	Btu/mol-F
AIR	99.31%		7.3423	7.291
H2O	0.69%		8.7067	0.060
TOTAL	100.00%		Avg Cp	7.352
			Btu/lb-F	0.2544

Avg Air Out Temp, Taoa (TA9) **609.1**

Cp of Secondary Air Between Tsao and Taoa (TA9)

deg F	deg R	deg K	deg C
612.0	1072.0	596	322
609.1	1069.1	594	321
-2.9	-2.9	-2	-2
		Cpi	Cpi*MF
Mol %		Btu/mol-F	Btu/mol-F
99.31%		7.3510	7.300
0.69%		8.7228	0.061
100.00%		Avg Cp	7.360
		Btu/lb-F	0.2547

Cp of Air Between Taia and Taoa (TA8 to TA9)

deg F	deg R	deg K	deg C
96.9	556.9	309	36
609.1	1069.1	594	321
512.2	512.2	285	285
		Cpi	Cpi*MF
Mol %		Btu/mol-F	Btu/mol-F
99.31%		7.1443	7.095
0.69%		8.3536	0.058
100.00%		Avg Cp	7.153
		Btu/lb-F	0.2475

Calculation of Flue Gas Outlet Temp for No Leak Case

Cp for Outlet Flue Gas Between Tfgo (TG15) and Tfgonl (TG15NL) – No Leak Case

	deg F	deg R	deg K	deg C
T1 =	279.0	739	411	137
T2 =	281.4	741.4	412	139
T2 - T1 =	2.4	2.4	1	1
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	14.360%	13.386%	9.8896	1.324
CO	0.001%	0.001%	7.0715	0.000
N2	81.149%	75.644%	7.0379	5.324
O2	4.490%	4.185%	7.2675	0.304
H2O	0.000%	6.784%	8.2489	0.560
TOTAL	100.000%	100.000%	Avg Cp	7.511
			Btu/lb-F	0.2534

FG Out Temp, (TG15NL) **281.4**

Cp of Air Leak Between Tsai to Tfgo (TG15)

deg F	deg R	deg K	deg C
94.0	554.0	308	34
279.0	739.0	411	137
185.0	185.0	103	103
		Cpi	Cpi*MF
Mol %		Btu/mol-F	Btu/mol-F
99.31%		7.0084	6.960
0.69%		8.1181	0.056
100.00%		Avg Cp	7.016
		Btu/lb-F	0.2428

Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgo (TG15)
No Leak Case

	deg F	deg R	deg K	deg C
T1 =	671.0	1131	628	355
T2 =	279.0	739.0	411	137
T2 - T1 =	-392.0	-392.0	-218	-218
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	14.360%	13.386%	10.6436	1.425
CO	0.001%	0.001%	7.2312	0.000
N2	81.149%	75.644%	7.1730	5.426
O2	4.490%	4.185%	7.5066	0.314
H2O	0.000%	6.784%	8.5272	0.579
TOTAL	100.000%	100.000%	Avg Cp	7.743
			Btu/lb-F	0.2612

Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgonl (TG15NL)--No Leak Case

deg F	deg R	deg K	deg C
671.0	1131	628	355
281.4	741.4	412	139
-389.6	-389.6	-216	-216
Mol %		Cpi	Cpi*MF
Dry	Wet	Btu/mol-F	Btu/mol-F
14.360%	13.386%	10.6483	1.425
0.001%	0.001%	7.2322	0.000
81.149%	75.644%	7.1739	5.427
4.490%	4.185%	7.5081	0.314
0.000%	6.784%	8.5289	0.579
100.000%	100.000%	Avg Cp	7.745
		Btu/lb-F	0.2613

Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgo (TPFG15)

	deg F	deg R	deg K	deg C
T1 =	671.0	1131	628	355
T2 =	269.0	729.0	405	132
T2 - T1 =	-402.0	-402.0	-223	-223

	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	14.360%	13.386%	10.6242	1.422
CO	0.001%	0.001%	7.2271	0.000
N2	81.149%	75.644%	7.1696	5.423
O2	4.490%	4.185%	7.5005	0.314
H2O	0.000%	6.784%	8.5200	0.578
TOTAL	100.000%	100.000%	Avg Cp	7.737
			Btu/lb-F	0.2610

Cp for Sootblower Air Leak From Tamb to Tpfgo

Humidity, lb H2O/lb DB Air	0.00435			
	deg F	deg R	deg K	deg C
T1 =	95	555	308	35
T2 =	269	729	405	132
T2 - T1 =	174	174	97	97

		Cpi	Cpi*MF
COMPOUND	Mol %	Btu/mol-F	Btu/mol-F
AIR	99.31%	7.0047	6.956
H2O	0.69%	0.0000	0.000
TOTAL	100.00%	Avg Cp	6.956
Mol Wt.	28.89	Btu/lb-F	0.2407

Calculation of Secondary Flue Gas Outlet Temperature

Cp for Secondary Flue Gas Between Tsfgo (TSFG15) and Tfgo (TG15)

	deg F	deg R	deg K	deg C
T1 =	280.6	740.6	411	138
T2 =	279.0	739.0	411	137
T2 - T1 =	-1.6	-1.6	-1	-1

	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	14.360%	13.386%	9.8879	1.324
CO	0.001%	0.001%	7.0712	0.000
N2	81.149%	75.644%	7.0376	5.323
O2	4.490%	4.185%	7.2670	0.304
H2O	0.000%	6.784%	8.2483	0.560
TOTAL	100.000%	100.000%	Avg Cp	7.511
			Btu/lb-F	0.2534

SFG Out Temp, (TSFG15) **280.6**

Cp for Secondary Flue Gas Between Tfgi (TG14) and Tsfgo (TSFG15)

	deg F	deg R	deg K	deg C
T1 =	671.0	1131.0	628	355
T2 =	280.6	740.6	411	138
T2 - T1 =	-390.4	-390.4	-217	-217

	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	14.360%	13.386%	10.6466	1.425
CO	0.001%	0.001%	7.2319	0.000
N2	81.149%	75.644%	7.1736	5.426
O2	4.490%	4.185%	7.5076	0.314
H2O	0.000%	6.784%	8.5283	0.579
TOTAL	100.000%	100.000%	Avg Cp	7.744
			Btu/lb-F	0.2612

SFG T Out Alt Calc, (TSFG15) **280.6**

Cp for Primary Flue Gas Between Tpfgo (TPFG15) and Tpfgonl (TPFG15NL)

deg F	deg R	deg K	deg C
269.0	729	405	132
287.1	747.1	415	142
18.1	18.1	10	10
Mol %		Cpi	Cpi*MF
Dry	Wet	Btu/mol-F	Btu/mol-F
14.360%	13.386%	9.8806	1.323
0.001%	0.001%	7.0697	0.000
81.149%	75.644%	7.0364	5.323
4.490%	4.185%	7.2647	0.304
0.000%	6.784%	8.2458	0.559
100.000%	100.000%	Avg Cp	7.509
		Btu/lb-F	0.2533

PFG Out Temp, (TPFG15NL) **287.10**

Cp for Sootblower Air Leak From Tpfgo (TPFG15) to Tfgo (TG15)

0.00435			
deg F	deg R	deg K	deg C
269	729	405	132
279	739	411	137
10	10	6	6
		Cpi	Cpi*MF
Mol %		Btu/mol-F	Btu/mol-F
99.31%		7.0810	7.032
0.69%		0.0000	0.000
100.00%		Avg Cp	7.032
28.89		Btu/lb-F	0.2434

Cp for Primary Flue Gas Between Tfgo (TG15) and Tpfgo (TPFG15)

deg F	deg R	deg K	deg C
279.0	739	411	137
269.0	729.0	405	132
-10.0	-10.0	-6	-6
0		Cpi	Cpi*MF
0	Wet	Btu/mol-F	Btu/mol-F
14.360%	13.386%	9.8638	1.320
0.001%	0.001%	7.0664	0.000
81.149%	75.644%	7.0336	5.320
4.490%	4.185%	7.2594	0.304
0.000%	6.784%	8.2401	0.559
100.000%	100.000%	Avg Cp	7.504
		Btu/lb-F	0.2531

Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgonl (TPFG15NL)

deg F	deg R	deg K	deg C
671.0	1131	628	355
287.1	747.1	415	142
-383.9	-383.9	-213	-213
0		Cpi	Cpi*MF
0	Wet	Btu/mol-F	Btu/mol-F
14.360%	13.386%	10.6593	1.427
0.001%	0.001%	7.2345	0.000
81.149%	75.644%	7.1758	5.428
4.490%	4.185%	7.5116	0.314
0.000%	6.784%	8.5329	0.579
100.000%	100.000%	Avg Cp	7.748
		Btu/lb-F	0.2614

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PROGRAM CALCULATES AIR HEATER PERFORMANCE FROM TEST DATA
After Entering Data Into Blocked Areas Calculate Results Using Macro \C
Print Results Using Macro \P

Description	**Unit 2A Test 3 – 5/16/96 18:39-20:30 hrs**

Coal and Ash Data

AFC = As Fired Coal

Use ASME Mol Weights? 1=Y 0=Alt	1

	Coal Comp Wt % Dry	Wt % Wet
Moisture		4.92
C	78.44	74.58
H	5.08	4.83
N	1.63	1.55
S	2.10	2.00
O	4.43	4.21
Ash	8.32	7.91
HHV	13,912	100.00

Fly Ash Overhead	90.00%
Carbon in Refuse, %	2.27
lbs C in Refuse/lb AFC (1)	0.0017
C Burned/lb AFC	0.7441

Gas Stream Data

Flue Gas In

Ht Pipe Inlet Temp, deg F	599

COMPOUND	Mol % Dry	Mol % Wet
CO2	13.720%	12.82%
CO	0.001%	0.00%
N2	81.059%	75.73%
O2	5.220%	4.88%
H2O	0.00%	6.58%
TOTAL	100.00%	100.00%

Amb Air Temp, deg F	95
Amb Air Moisture, lb/lb BD Air	0.00728
Downstream Leak Temp, deg F	148
Downstream Leak Moisture, lb/lb BD Air	0.00728
Downstream Leak Rate, lb/hr	4800
Primary Air (PA) Inlet Temp (Tpai), deg F	112
Primary Air Outlet Temp (Tpao), deg F	534
Secondary Air (SA) Inlet Temp (Tsai), deg F	92
Sec Air With Bypass Outlet Temp (Tsao), deg F	562
Primary Flue Gas Outlet Temp (Tpgo), deg F	250
Total Mols Dry Flue Gas In/lb AFC	0.4561
Total lbs Dry Flue Gas In/lb AFC (WG'14)	13.8733
Atomizing Steam (Wz), lbs/lb AFC	0.00
Steam From Ash Pit (Wm), lbs/lb AFC	0.00
Flue Gas H2O (WmGi), lbs/lb AFC	0.5788
H2O in Flue Gas, Mols/lb AFC	0.0321
Flue Gas Moisture, vol %	6.580%
Flue Gas MW	29.60
Flue Gas MW (dry)	30.42

(1) Assumption: Bottom Ash Carbon Concentration is 1/3 That of Overhead Ash.

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Flue Gas Out

Ht. Pipe Outlet Temp, deg F	272	
	Mol %	
COMPOUND	Dry	Wet
CO2	13.030%	12.21%
CO	0.000%	0.00%
N2	80.960%	75.84%
O2	6.010%	5.63%
H2O	0.00%	6.32%
TOTAL	100.00%	100.00%

Mols Dry Flue Gas/lb AFC	0.4803
lbs Dry Flue Gas/lb AFC (WG'15)	14.5707
Flue Gas H2O (WmGo), lbs/lb AFC	0.5839
H2O in Flue Gas, Mols/lb AFC	0.0324
Total Flue Gas Out, lbs/hr	506015
Flue Gas Moisture, vol %	6.321%
Flue Gas MW (wet)	29.56
Flue Gas MW (dry)	30.34
Total Air Leak, wt % (AL)	**4.86**

Boiler Load, MW	79.55		
Heat Rate, Btu/KWh	10,376		
As Fired Coal Rate, Tons/hr	31.20		
lbs/hr (Wfe)	62,400		
Flow Split to Heat Pipe	53.51%	lb/hr	
Primary Air Fan Flow, lbs/lb AFC	2.5840	86,282	(3)
Primary Air (PA) Out Heat Pipe, Wpa, lbs/lb AFC	1.5931	53,195	
Cppa, Btu/mol-F (Tpao to Tpai)	7.1340		
Cppa, Btu/lb-F	0.2473		
Primary Air Bypass (PABP), lbs/lb AFC	0.9909	33,087	
Wet Flue Gas In (WF14), lbs/lb AFC	14.4521	482,559	
Cpfg, Btu/mol-F (Tfgi to Tfgo)	7.6779		
Cpfg, Btu/lb-F	0.2594		
Sootblower At Wall Air Leaks, lbs/lb AFC	0.5587	18,656	
Cpal, Btu/mol-F (Tsai to Tfgo)	7.0187		
Cpal, Btu/lb-F	0.2433		
Downstream Air Leak Rate, lbs/lb AFC	0.1438	4,800	
Cpal, Btu/mol-F (Tdsi to Tfgo)	7.0410		
Cpal, Btu/lb-F	0.2441		
SA+Bypass Rate (SA+SABP), lbs/lb AFC	8.8709	296,202	<<Ht Bal Calc
Cpsa, Btu/mol-F (Tsai to Tsao)	7.1372		
Cpsa, Btu/lb-F	0.2474		
Secondary Air Bypass (SAPB), lbs/lb AFC	0.0000	0	
Cpsabp, Btu/mol-F (Tsai to Tsao)	7.1372		
Cpsabp, Btu/lb-F	0.2474		
PA+PABP+SA+SABP+Coal, lbs/lb AFC (2)	12.3759	413,233	(3)
Calc'd Air Leakage into Boiler, lbs/lb AFC	2.0763	69,327	14.37% (3)

(2) Does Not Include Leaks Into Boiler

(3) Not Required For Performance Calculations

	CONDITIONS	
	DESIGN	ACTUAL
Flow Rates to Heat Pipe, lb/hr		
Primary Air	62,500	53,195
Secondary Air (No Bypass)	562,500	296,202
Flue Gas	750,000	482,559
Temperatures, deg F		
Primary Air In	80.0	112.0
Primary Air Out	644.0	534.0
2nd Air in	80.0	92.3
2nd Air Out With Bypass	616.0	562.0
2nd Air Out Without Bypass		562.0
Avg Air In, (TA8)	80.0	95.3
Avg Air Out, (TA9)	618.8	557.7 <<(Ex SA Bypass)
Flue Gas In, (TG14)	680.0	599.0
Flue Gas Out, (TG15)	253.0	272.0
FG Out No Leak, (TG15NL)		279.9
Primary Air Duty, MMBtu/hr		5.552
Sootblower Wall Leak Duty, MMBtu/hr		0.693
Primary Flue Gas Duty, MMBtu/hr		6.246
Primary Flue Gas Rate, lb/hr		69115
Primary Flue Gas Rate, lb/lb AFC		2.0699
Primary Flue Gas Outlet Temp NL, deg F		289.7
Secondary Flue Gas Rate, lb/hr		413444
Secondary Flue Gas Rate, lb/lb AFC		12.3822
Secondary Flue Gas Outlet Temp, deg F		278.0

Pressure Drops, in. wc	Design	Measured
Primary Air, (DP8_9)	5.35	1.94
Secondary Air, (DP8_9)	5.35	1.93
Flue Gas, (DP14_15)		
Primary Flue Gas	3.65	1.78
Secondary Flue Gas	3.65	1.85

Pressure Drops Corrected for Deviation From Design Flow and Design Temp

Gas Side (DPs(14-15), in. wc (4)	**4.45**	
Pressure Drop is	**0.80**	in. wc Greater Than Design
Air Side (DPs(8-9), in. wc		
Primary Air Section	**2.81**	
Pressure Drop is	**-2.54**	in. wc Less Than Design
Secondary Air Section	**7.14**	
Pressure Drop is	**1.79**	in. wc Greater Than Design

(4) Average In/Out Flue Gas Flow Used In Calculation.

Correction Calculations For Heat Pipe -- Design Condition Results

		Curve 1	Curve 2 (Ea Limited)	
Flue Gas Inlet Temp, deg F	TG14D	680.00	680.00	
Pri Air (PA) Inlet Temp, deg F	TA8D	80.00	80.00	
Sec Air (SA) Inlet Temp, deg F	T'A8D	80.00	80.00	
PA Outlet, deg F	Tpa9D	649.75	649.75	
SA Outlet, deg F	Tsa9D	617.20	617.20	
Pri Flue Gas (PFG) Outlet, deg F	TPFG15D	309.66	309.66	
Sec Flue Gas (SFG) Outlet, deg	TSFG15D	243.92	243.92	
PFG Rate, Mlb/hr	WPFGD	182.70	182.70	
SFG Rate, Mlb/hr	WSFGD	1317.30	1317.30	
Combined Outlet T, deg F		251.93	251.93	
PA Side Effectiveness	Ea	0.9496	0.9492	<Curve 2 Limit
PA X-Ratio	X Design	0.6500	0.6500	
PA fg	fpgD	1.0001	1.0001	
PA fx	fpxD	0.9991	0.9987	
	Eg	0.6172	0.6170	
Calculated TPFG Out, deg F	TPFG15D	309.66	309.81	
SA Side Effectiveness	Ea	0.8953	0.9300	<Curve 2 Limit
SA X-Ratio (Design)	X Design	0.8118	0.8118	
SA fg	fsgD	1.0004	1.0004	
SA fx	fsxD	1.0001	1.0388	
	Eg	0.7268	0.7549	
Calculated TSFG Out, deg F	TSFG15D	243.91	227.04	
Combined Outlet T, deg F		251.92	237.12	

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Correction Calculations For Heat Pipe -- Operating Condition Results

Ambient Temp, deg F	Tamb	95.00
Sootblower Wall Air Leak, wt % PFG	Al	26.99
Cpa (Tpfg15-Tamb), Btu/lb-F	CpA	0.2398
Cpg (Tpfgnl15-Tpg15), Btu/lb-F	CpG	0.2527
Flue Gas Inlet Temp, deg F	TG14	599.00
PA Inlet Temp, deg F	TA8	112.00
SA Inlet Temp, deg F	T'A8	92.30
PA Outlet Temp, deg F	Tpa9	534.00
SA Outlet Temp (No Bypass), deg F	Tsa9	562.00
PFG Outlet Temp, deg F	TPG15	250.00
PFG Outlet Temp (No Leak), deg F	TPFG15NL	289.69
SFG Outlet Temp, deg F	TSFG15	278.01
PFG Rate, Mlb/hr	WPFG	69.11
SFG Rate, Mlb/hr	WSFG	413.44
Sootblower Wall Air Leak Into PFG, Mlb/hr	WAL1	18.66
Constant, Al/100*CpA/CpG*(TPG15-Tamb)		39.69
PA Side Effectiveness	Epa	0.8665
SA Side Effectiveness	Esa	0.9270
X-Ratios	Xp	0.7330
	Xs	0.6834
PA Eg	Epg	0.6351
SA Eg	Esg	0.6335

Correction Factors		**Pri Flue Gas**		**Sec Flue Gas**
	fpg	1.0156	fsg	1.0333
	fpgD	1.0001	fsgD	1.0004
	fpx	1.0903	fsx	0.8884
	fpxD	0.9991	fsxD	1.0001
	TPFG15D	309.66	TSFG15D	243.91
Performance	TPFG15	226.20	TSFG15	261.07

Primary Flue Gas Corrections For Differences From:	
Design Entering Air Temperature, TPFG15DA, deg F	227.07
Design Entering Flue Gas Temperature, TPFG15DG, deg F	272.95
Design X-Ratio (No Leak), TPFG15DX, deg F	283.79
Air Leak correction, deg F	39.69
Design Flue Gas Flow Rate, TPFG15DGR, deg F	255.74

Secondary Flue Gas Corrections for Differences From:	
Design Entering Air Temperature, TSFG15DA, deg F	270.22
Design Entering Flue Gas Temperature, TSFG15DG, deg F	307.70
Design X-Ratio, TSFG15DX, deg F	229.30
Design Flue Gas Flow Rate, TSFG15DGR, deg F	292.39

PFG Totally Corrected Outlet Temp, deg F	329.24
SFG Totally Corrected Outlet Temp, deg F	265.58
Avg FG Outlet Totally Corrected T, TG15_Total, deg F	**274.69**

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AVERAGE HEAT CAPACITY CALCULATIONS

Calculation of Primary, Secondary, and Air Leak Heat Capacities Over Inlet to Outlet Temperature Ranges

Cp for Primary Air From Tpai to Tpao

Humidity, lb H2O/lb DB Air 0.00728

	deg F	deg R	deg K	deg C
T1 =	112	572	318	44
T2 =	534	994	552	279
T2 - T1 =	422	422	234	234

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	98.84%	7.1203	7.038
H2O	1.16%	8.3105	0.096
TOTAL	100.00%	Avg Cp	7.134
Mol Wt.	28.84	Btu/lb-F	0.2473

Cp Secondary Air From Tsai to Tsao

0.00728

	deg F	deg R	deg K	deg C
T1 =	92.3	552.3	307	34
T2 =	562	1022	568	294
T2 - T1 =	469.7	469.7	261	261

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
98.84%	7.1234	7.041
1.16%	8.3167	0.096
100.00%	Avg Cp	7.137
28.84	Btu/lb-F	0.2474

Cp Air Leak From Tamb to Tfgo

Humidity, lb H2O/lb DB Air 0.00728

	deg F	deg R	deg K	deg C
T1 =	95	555	308	35
T2 =	272	732	407	133
T2 - T1 =	177	177	98	98

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	98.84%	7.0059	6.925
H2O	1.16%	8.1139	0.094
TOTAL	100.00%	Avg Cp	7.019
Mol Wt.	28.84	Btu/lb-F	0.2433

Cp Downstream Leak From Tdsi to Tfgo

0.00728

	deg F	deg R	deg K	deg C
T1 =	148	608	338	64
T2 =	272	732	407	133
T2 - T1 =	124	124	69	69

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
98.84%	7.0280	6.947
1.16%	8.1507	0.094
100.00%	Avg Cp	7.041
28.84	Btu/lb-F	0.2441

Secondary Air Outlet Temperature Correction For Bypass Flow

Cp for Secondary Air From Tsai to Tsao'

	deg F	deg R	deg K	deg C
T1 =	92.3	552.3	307	34
T2 =	562.0	1022.0	568	294
T2 - T1 =	469.7	469.7	261	261

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	98.84%	7.1234	7.041
H2O	1.16%	8.3167	0.096
TOTAL	100.00%	Avg Cp	7.137
		Btu/lb-F	0.2474

Corrected Tsao', deg F **562.0**

Cp for Secondary Air From Tsao to Tsao'

	deg F	deg R	deg K	deg C
T1 =	562.0	1022.0	568	294
T2 =	562.0	1022.0	568	294
T2 - T1 =	0.0	0.0	0	0

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
98.84%	7.3129	7.228
1.16%	8.6520	0.100
100.00%	Avg Cp	7.328
	Btu/lb-F	0.2541

Calculation of Average Air Inlet Temperature

Cp of Primary Air Between Tpai and Taia (TA8)

	deg F	deg R	deg K	deg C
T1 =	112.0	572.0	318	44
T2 =	95.3	555.3	309	35
T2 - T1 =	-16.7	-16.7	-9	-9

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	98.84%	6.9392	6.859
H2O	1.16%	8.0033	0.093
TOTAL	100.00%	Avg Cp	6.951
		Btu/lb-F	0.2410

Avg Air In Temp, Taia (TA8) **95.3**

Cp of Secondary Air Between Tsai and Taia (TA8)

	deg F	deg R	deg K	deg C
T1 =	92.3	552.3	307	34
T2 =	95.3	555.3	309	35
T2 - T1 =	3.0	3.0	2	2

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
98.84%	6.9308	6.851
1.16%	7.9898	0.092
100.00%	Avg Cp	6.943
	Btu/lb-F	0.2407

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Calculation of Average Air Outlet Temperature

Cp of Primary Air Between Tpao and Taoa (TA9)

	deg F	deg R	deg K	deg C
T1 =	534.0	994.0	552	279
T2 =	557.7	1017.7	565	292
T2 - T1 =	23.7	23.7	13	13
			Cpi	Cpi*MF
COMPOUND	Mol %		Btu/mol-F	Btu/mol-F
AIR	98.84%		7.3001	7.216
H2O	1.16%		8.6285	0.100
TOTAL	100.00%		Avg Cp	7.316
			Btu/lb-F	0.2536

Avg Air Out Temp, Taoa (TA9) **557.7**

Cp of Secondary Air Between Tsao and Taoa (TA9)

deg F	deg R	deg K	deg C
562.0	1022.0	568	294
557.7	1017.7	565	292
-4.3	-4.3	-2	-2
		Cpi	Cpi*MF
Mol %		Btu/mol-F	Btu/mol-F
98.84%		7.3112	7.227
1.16%		8.6489	0.100
100.00%		Avg Cp	7.327
		Btu/lb-F	0.2540

Cp of Air Between Taia and Taoa (TA8 to TA9)

deg F	deg R	deg K	deg C
95.3	555.3	309	35
557.7	1017.7	565	292
462.4	462.4	257	257
		Cpi	Cpi*MF
Mol %		Btu/mol-F	Btu/mol-F
98.84%		7.1229	7.041
1.16%		8.3157	0.096
100.00%		Avg Cp	7.137
		Btu/lb-F	0.2474

Calculation of Flue Gas Outlet Temp for No Leak Case

Cp for Outlet Flue Gas Between Tfgo (TG15) and Tfgonl (TG15NL) -- No Leak Case

	deg F	deg R	deg K	deg C
T1 =	272.0	732	407	133
T2 =	279.9	739.9	411	138
T2 - T1 =	7.9	7.9	4	4
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	13.720%	12.817%	9.8718	1.265
CO	0.001%	0.001%	7.0680	0.000
N2	81.059%	75.725%	7.0349	5.327
O2	5.220%	4.877%	7.2620	0.354
H2O	0.000%	6.580%	8.2429	0.542
TOTAL	100.000%	100.000%	Avg Cp	7.489
			Btu/lb-F	0.2530

FG Out Temp, (TG15NL) **279.9**

Cp of Air Leak Between Tsai to Tfgo (TG15)

deg F	deg R	deg K	deg C
92.3	552.3	307	34
272.0	732.0	407	133
179.7	179.7	100	100
		Cpi	Cpi*MF
Mol %		Btu/mol-F	Btu/mol-F
98.84%		7.0048	6.924
1.16%		8.1121	0.094
100.00%		Avg Cp	7.018
		Btu/lb-F	0.2433

Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgo (TG15)
No Leak Case

	deg F	deg R	deg K	deg C
T1 =	599.0	1059	588	315
T2 =	272.0	732.0	407	133
T2 - T1 =	-327.0	-327.0	-182	-182
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	13.720%	12.817%	10.4989	1.346
CO	0.001%	0.001%	7.1993	0.000
N2	81.059%	75.725%	7.1456	5.411
O2	5.220%	4.877%	7.4603	0.364
H2O	0.000%	6.580%	8.4701	0.557
TOTAL	100.000%	100.000%	Avg Cp	7.678
			Btu/lb-F	0.2594

Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgonl (TG15NL)--No Leak Case

deg F	deg R	deg K	deg C
599.0	1059	588	315
279.9	739.9	411	138
-319.1	-319.1	-177	-177
Mol %		Cpi	Cpi*MF
Dry	Wet	Btu/mol-F	Btu/mol-F
13.720%	12.817%	10.5143	1.348
0.001%	0.001%	7.2025	0.000
81.059%	75.725%	7.1484	5.413
5.220%	4.877%	7.4651	0.364
0.000%	6.580%	8.4757	0.558
100.000%	100.000%	Avg Cp	7.683
		Btu/lb-F	0.2595

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Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgo (TPFG15)

	deg F	deg R	deg K	deg C
T1 =	599.0	1059	588	315
T2 =	250.0	710.0	394	121
T2 - T1 =	-349.0	-349.0	-194	-194
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	13.720%	12.817%	10.4554	1.340
CO	0.001%	0.001%	7.1902	0.000
N2	81.059%	75.725%	7.1380	5.405
O2	5.220%	4.877%	7.4465	0.363
H2O	0.000%	6.580%	8.4544	0.556
TOTAL	100.000%	100.000%	Avg Cp	7.665
			Btu/lb-F	0.2589

Cp for Sootblower Air Leak From Tamb to Tpfgo

Humidity, lb H2O/lb DB Air 0.00728

	deg F	deg R	deg K	deg C
T1 =	95	555	308	35
T2 =	250	710	394	121
T2 - T1 =	155	155	86	86
			Cpi	Cpi*MF
COMPOUND	Mol %		Btu/mol-F	Btu/mol-F
AIR	98.84%		6.9968	6.916
H2O	1.16%		0.0000	0.000
TOTAL	100.00%		Avg Cp	6.916
Mol Wt.	28.84		Btu/lb-F	0.2398

Calculation of Secondary Flue Gas Outlet Temperature

Cp for Secondary Flue Gas Between Tsfgo (TSFG15) and Tfgo (TG15)

	deg F	deg R	deg K	deg C
T1 =	278.0	738.0	410	137
T2 =	272.0	732.0	407	133
T2 - T1 =	-6.0	-6.0	-3	-3
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	13.720%	12.817%	9.8680	1.265
CO	0.001%	0.001%	7.0672	0.000
N2	81.059%	75.725%	7.0343	5.327
O2	5.220%	4.877%	7.2608	0.354
H2O	0.000%	6.580%	8.2415	0.542
TOTAL	100.000%	100.000%	Avg Cp	7.488
			Btu/lb-F	0.2530

SFG Out Temp, (TSFG15) **278.0**

Cp for Secondary Flue Gas Between Tfgi (TG14) and Tsfgo (TSFG15)

	deg F	deg R	deg K	deg C
T1 =	599.0	1059.0	588	315
T2 =	278.0	738.0	410	137
T2 - T1 =	-321.0	-321.0	-178	-178
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	13.720%	12.817%	10.5107	1.347
CO	0.001%	0.001%	7.2018	0.000
N2	81.059%	75.725%	7.1477	5.413
O2	5.220%	4.877%	7.4640	0.364
H2O	0.000%	6.580%	8.4744	0.558
TOTAL	100.000%	100.000%	Avg Cp	7.681
			Btu/lb-F	0.2595

SFG T Out Alt Calc, (TSFG15) **278.1**

Cp for Primary Flue Gas Between Tpfgo (TPFG15) and Tpfgonl (TPFG15NL)

deg F	deg R	deg K	deg C
250.0	710	394	121
289.7	749.7	416	143
39.7	39.7	22	22
Mol %		Cpi	Cpi*MF
Dry	Wet	Btu/mol-F	Btu/mol-F
13.720%	12.817%	9.8463	1.262
0.001%	0.001%	7.0629	0.000
81.059%	75.725%	7.0307	5.324
5.220%	4.877%	7.2540	0.354
0.000%	6.580%	8.2343	0.542
100.000%	100.000%	Avg Cp	7.482
		Btu/lb-F	0.2527

PFG Out Temp, (TPFG15NL) **289.69**

Cp for Sootblower Air Leak From Tpfgo (TPFG15) to Tfgo (TG15)

0.00728

deg F	deg R	deg K	deg C
250	710	394	121
272	732	407	133
22	22	12	12
		Cpi	Cpi*MF
Mol %		Btu/mol-F	Btu/mol-F
98.84%		7.0703	6.988
1.16%		0.0000	0.000
100.00%		Avg Cp	6.988
28.84		Btu/lb-F	0.2423

Cp for Primary Flue Gas Between Tfgo (TG15) and Tpfgo (TPFG15)

deg F	deg R	deg K	deg C
272.0	732	407	133
250.0	710.0	394	121
-22.0	-22.0	-12	-12
0		Cpi	Cpi*MF
0	Wet	Btu/mol-F	Btu/mol-F
13.720%	12.817%	9.8094	1.257
0.001%	0.001%	7.0555	0.000
81.059%	75.725%	7.0245	5.319
5.220%	4.877%	7.2424	0.353
0.000%	6.580%	8.2219	0.541
100.000%	100.000%	Avg Cp	7.471
		Btu/lb-F	0.2524

Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgonl (TPFG15NL)

deg F	deg R	deg K	deg C
599.0	1059	588	315
289.7	749.7	416	143
-309.3	-309.3	-172	-172
0		Cpi	Cpi*MF
0	Wet	Btu/mol-F	Btu/mol-F
13.720%	12.817%	10.5335	1.350
0.001%	0.001%	7.2066	0.000
81.059%	75.725%	7.1518	5.416
5.220%	4.877%	7.4712	0.364
0.000%	6.580%	8.4827	0.558
100.000%	100.000%	Avg Cp	7.688
		Btu/lb-F	0.2597

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PROGRAM CALCULATES AIR HEATER PERFORMANCE FROM TEST DATA
After Entering Data Into Blocked Areas Calculate Results Using Alt C
Alt P Prints Results

Description Unit 2B Test 3 – 5/16/96 20:45-22:30 hrs

Coal and Ash Data

AFC = As Fired Coal

Use ASME Mol Weights? 1=Y 0=Alt 1

	Coal Comp Wt % Dry	Wt % Wet
Moisture		4.92
C	78.44	74.58
H	5.08	4.83
N	1.63	1.55
S	2.10	2.00
O	4.43	4.21
Ash	8.32	7.91
HHV	13,912	100.00

Fly Ash Overhead	90.00%
Carbon in Refuse, %	2.27
lbs C in Refuse/lb AFC (1)	0.0017
C Burned/lb AFC	0.7441

Gas Stream Data

Flue Gas In

Ht Pipe Inlet Temp, deg F 603

COMPOUND	Mol % Dry	Mol % Wet
CO2	12.930%	12.11%
CO	0.000%	0.00%
N2	80.950%	75.81%
O2	6.120%	5.73%
H2O	0.00%	6.35%
TOTAL	100.00%	100.00%

Amb Air Temp, deg F	95
Amb Air Moisture, lb/lb BD Air	0.00773
Downstream Leak Temp, deg F	148
Downstream Leak Moisture, lb/lb BD Air	0.00773
Downstream Leak Rate, lb/hr	0
Primary Air (PA) Inlet Temp (Tpai), deg F	115
Primary Air Outlet Temp (Tpao), deg F	538
Secondary Air (SA) Inlet Temp (Tsai), deg F	92
Sec Air With Bypass Outlet Temp (Tsao), deg F	559
Primary Flue Gas Outlet Temp (Tpgo), deg F	232
Total Mols Dry Flue Gas In/lb AFC	0.4840
Total lbs Dry Flue Gas In/lb AFC (WG'14)	14.6780
Atomizing Steam (Wz), lbs/lb AFC	0.00
Steam From Ash Pit (Wm), lbs/lb AFC	0.00
Flue Gas H2O (WmGi), lbs/lb AFC	0.5911
H2O in Flue Gas, Mols/lb AFC	0.0328
Flue Gas Moisture, vol %	6.348%
Flue Gas MW	29.55
Flue Gas MW (dry)	30.33

(1) Assumption: Bottom Ash Carbon Concentration is 1/3 That of Overhead Ash.

Flue Gas Out

Ht. Pipe Outlet Temp, deg F	253

	Mol %	
COMPOUND	Dry	Wet
CO2	12.650%	11.86%
CO	0.006%	0.01%
N2	80.894%	75.84%
O2	6.450%	6.05%
H2O	0.00%	6.25%
TOTAL	100.00%	100.00%

Mols Dry Flue Gas/lb AFC	0.4945
lbs Dry Flue Gas/lb AFC (WG'15)	14.9803
Flue Gas H2O (WmGo), lbs/lb AFC	0.5934
H2O in Flue Gas, Mols/lb AFC	0.0329
Total Flue Gas Out, lbs/hr	451860
Flue Gas Moisture, vol %	6.245%
Flue Gas MW (wet)	29.53
Flue Gas MW (dry)	30.30

Total Air Leak, wt % (AL)	**1.99**

		lb/hr		
Boiler Load, MW	80.07			
Heat Rate, Btu/KWh	10,310			
As Fired Coal Rate, Tons/hr	31.21			
lbs/hr (Wfe)	62,410			
Flow Split to Heat Pipe	46.49%			
Primary Air Fan Flow, lbs/lb AFC	2.8334	82,209		(3)
Primary Air (PA) Out Heat Pipe, Wpa, lbs/lb AFC	1.6347	47,431		
Cppa, Btu/mol-F (Tpao to Tpai)	7.1377			
Cppa, Btu/lb-F	0.2475			
Primary Air Bypass (PABP), lbs/lb AFC	1.1986	34,778		
Wet Flue Gas In (WF14), lbs/lb AFC	15.2691	443,023		
Cpfg, Btu/mol-F (Tfgi to Tfgo)	7.6450			
Cpfg, Btu/lb-F	0.2587			
Sootblower At Wall Air Leaks, lbs/lb AFC	0.3046	8,837		
Cpal, Btu/mol-F (Tsai to Tfgo)	7.0116			
Cpal, Btu/lb-F	0.2432			
Downstream Air Leak Rate, lbs/lb AFC	0.0000	0		
Cpal, Btu/mol-F (Tdsi to Tfgo)	7.0339			
Cpal, Btu/lb-F	0.2439			
SA+Bypass Rate (SA+SABP), lbs/lb AFC	10.3729	300,964	<<Ht Bal Calc	
Cpsa, Btu/mol-F (Tsai to Tsao)	7.1366			
Cpsa, Btu/lb-F	0.2475			
Secondary Air Bypass (SAPB), lbs/lb AFC	0.0000	0		
Cpsabp, Btu/mol-F (Tsai to Tsao)	7.1366			
Cpsabp, Btu/lb-F	0.2475			
PA+PABP+SA+SABP+Coal, lbs/lb AFC (2)	14.1272	409,892		(3)
Calc'd Air Leakage into Boiler, lbs/lb AFC	1.1419	33,131	7.48%	(3)

(2) Does Not Include Leaks Into Boiler

(3) Not Required For Performance Calculations

	CONDITIONS		
	DESIGN	ACTUAL	
Flow Rates to Heat Pipe, lb/hr			
Primary Air	62,500	47,431	
Secondary Air (No Bypass)	562,500	300,964	
Flue Gas	750,000	443,023	
Temperatures, deg F			
Primary Air In	80.0	115.0	
Primary Air Out	644.0	538.0	
2nd Air in	80.0	91.6	
2nd Air Out With Bypass	616.0	559.0	
2nd Air Out Without Bypass		559.0	
Avg Air In, (TA8)	80.0	94.8	
Avg Air Out, (TA9)	618.8	556.1	<<(Ex SA Bypass)
Flue Gas In, (TG14)	680.0	603.0	
Flue Gas Out, (TG15)	253.0	253.0	
FG Out No Leak, (TG15NL)		256.1	
Primary Air Duty, MMBtu/hr		4.966	
Sootblower Wall Leak Duty, MMBtu/hr		0.290	
Primary Flue Gas Duty, MMBtu/hr		5.256	
Primary Flue Gas Rate, lb/hr		54843	
Primary Flue Gas Rate, lb/lb AFC		1.8902	
Primary Flue Gas Outlet Temp NL, deg F		253.0	
Secondary Flue Gas Rate, lb/hr		388180	
Secondary Flue Gas Rate, lb/lb AFC		13.3789	
Secondary Flue Gas Outlet Temp, deg F		256.4	

Pressure Drops, in. wc	**Design**	**Measured**
Primary Air, (DP8_9)	5.35	1.84
Secondary Air, (DP8_9)	5.35	1.75
Flue Gas, (DP14_15)		
Primary Flue Gas	3.65	1.62
Secondary Flue Gas	3.65	1.68

Pressure Drops Corrected for Deviation From Design Flow and Design Temp

Gas Side (DPs(14-15), in. wc (4)	**4.92**	
Pressure Drop is	**1.27**	in. wc Greater Than Design
Air Side (DPs(8-9), in. wc		
Primary Air Section	**3.34**	
Pressure Drop is	**-2.01**	in. wc Less Than Design
Secondary Air Section	**6.29**	
Pressure Drop is	**0.94**	in. wc Greater Than Design

(4) Average In/Out Flue Gas Flow Used In Calculation.

Correction Calculations For Heat Pipe -- Design Condition Results

		Curve 1	Curve 2 (Ea Limited)	
Flue Gas Inlet Temp, deg F	TG14D	680.00	680.00	
Pri Air (PA) Inlet Temp, deg F	TA8D	80.00	80.00	
Sec Air (SA) Inlet Temp, deg F	T'A8D	80.00	80.00	
PA Outlet, deg F	Tpa9D	649.75	649.75	
SA Outlet, deg F	Tsa9D	617.20	617.20	
Pri Flue Gas (PFG) Outlet, deg F	TPFG15D	309.66	309.66	
Sec Flue Gas (SFG) Outlet, deg	TSFG15D	243.92	243.92	
PFG Rate, Mlb/hr	WPFGD	182.70	182.70	
SFG Rate, Mlb/hr	WSFGD	1317.30	1317.30	
Combined Outlet T, deg F		251.93	251.93	
PA Side Effectiveness	Ea	0.9496	0.9492	<Curve 2 Limit
PA X-Ratio	X Design	0.6500	0.6500	
PA fg	fpgD	1.0001	1.0001	
PA fx	fpxD	0.9991	0.9987	
	Eg	0.6172	0.6170	
Calculated TPFG Out, deg F	TPFG15D	309.66	309.81	
SA Side Effectiveness	Ea	0.8953	0.9300	<Curve 2 Limit
SA X-Ratio (Design)	X Design	0.8118	0.8118	
SA fg	fsgD	1.0004	1.0004	
SA fx	fsxD	1.0001	1.0388	
	Eg	0.7268	0.7549	
Calculated TSFG Out, deg F	TSFG15D	243.91	227.04	
Combined Outlet T, deg F		251.92	237.12	

Correction Calculations For Heat Pipe -- Operating Condition Results

Ambient Temp, deg F	Tamb	95.00
Sootblower Wall Air Leak, wt % PFG	Al	16.11
Cpa (Tpfg15-Tamb), Btu/lb-F	CpA	0.2394
Cpg (Tpfgnl15-Tpg15), Btu/lb-F	CpG	0.2514
Flue Gas Inlet Temp, deg F	TG14	603.00
PA Inlet Temp, deg F	TA8	115.00
SA Inlet Temp, deg F	T'A8	91.60
PA Outlet Temp, deg F	Tpa9	538.00
SA Outlet Temp (No Bypass), deg F	Tsa9	559.00
PFG Outlet Temp, deg F	TPG15	232.00
PFG Outlet Temp (No Leak), deg F	TPFG15NL	253.02
SFG Outlet Temp, deg F	TSFG15	256.42
PFG Rate, Mlb/hr	WPFG	54.84
SFG Rate, Mlb/hr	WSFG	388.18
Sootblower Wall Air Leak Into PFG, Mlb/hr	WAL1	8.84
Constant, Al/100*CpA/CpG*(TPG15-Tamb)		21.02
PA Side Effectiveness	Epa	0.8668
SA Side Effectiveness	Esa	0.9140
X-Ratios	Xp	0.8274
	Xs	0.7415
PA Eg	Epg	0.7172
SA Eg	Esg	0.6777

Correction Factors		**Pri Flue Gas**		**Sec Flue Gas**
	fpg	1.0256	fsg	1.0367
	fpgD	1.0001	fsgD	1.0004
	fpx	1.1770	fsx	0.9424
	fpxD	0.9991	fsxD	1.0001
	TPFG15D	309.66	TSFG15D	243.91
Performance	TPFG15	218.11	TSFG15	240.02

Primary Flue Gas Corrections For Differences From:

Design Entering Air Temperature, TPFG15DA, deg F	205.39
Design Entering Flue Gas Temperature, TPFG15DG, deg F	250.46
Design X-Ratio (No Leak), TPFG15DX, deg F	297.93
Air Leak Correction, deg F	21.02
Design Flue Gas Flow Rate, TPFG15DGR, deg F	241.43

Secondary Flue Gas Corrections for Differences From:

Design Entering Air Temperature, TSFG15DA, deg F	248.56
Design Entering Flue Gas Temperature, TSFG15DG, deg F	281.24
Design X-Ratio, TSFG15DX, deg F	231.25
Design Flue Gas Flow Rate, TSFG15DGR, deg F	272.28

PFG Totally Corrected Outlet Temp, deg F	320.23
SFG Totally Corrected Outlet Temp, deg F	264.06

Avg FG Outlet Totally Corrected T, TG15_Total, deg F	**271.02**

AVERAGE HEAT CAPACITY CALCULATIONS

Calculation of Primary, Secondary, and Air Leak Heat Capacities Over Inlet to Outlet Temperature Ranges

Cp for Primary Air From Tpai to Tpao

Humidity, lb H2O/lb DB Air 0.00773

	deg F	deg R	deg K	deg C
T1 =	115	575	319	46
T2 =	538	998	554	281
T2 - T1 =	423	423	235	235

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	98.77%	7.1231	7.036
H2O	1.23%	8.3154	0.102
TOTAL	100.00%	Avg Cp	7.138
Mol Wt.	28.84	Btu/lb-F	0.2475

Cp Secondary Air From Tsai to Tsao

0.00773

	deg F	deg R	deg K	deg C
T1 =	91.6	551.6	306	33
T2 =	559	1019	566	293
T2 - T1 =	467.4	467.4	260	260

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	98.77%	7.1219	7.034
H2O	1.23%	8.3140	0.102
TOTAL	100.00%	Avg Cp	7.137
Mol Wt.	28.84	Btu/lb-F	0.2475

Cp Air Leak From Tamb to Tfgo

Humidity, lb H2O/lb DB Air 0.00773

	deg F	deg R	deg K	deg C
T1 =	95	555	308	35
T2 =	253	713	396	123
T2 - T1 =	158	158	88	88

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	98.77%	6.9980	6.912
H2O	1.23%	8.1007	0.099
TOTAL	100.00%	Avg Cp	7.012
Mol Wt.	28.84	Btu/lb-F	0.2432

Cp Downstream Leak From Tdsi to Tfgo

0.00773

	deg F	deg R	deg K	deg C
T1 =	148	608	338	64
T2 =	253	713	396	123
T2 - T1 =	105	105	58	58

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	98.77%	7.0202	6.934
H2O	1.23%	8.1374	0.100
TOTAL	100.00%	Avg Cp	7.034
Mol Wt.	28.84	Btu/lb-F	0.2439

Secondary Air Outlet Temperature Correction For Bypass Flow

Cp for Secondary Air From Tsai to Tsao'

	deg F	deg R	deg K	deg C
T1 =	91.6	551.6	306	33
T2 =	559.0	1019.0	566	293
T2 - T1 =	467.4	467.4	260	260

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	98.77%	7.1219	7.034
H2O	1.23%	8.3140	0.102
TOTAL	100.00%	Avg Cp	7.137
		Btu/lb-F	0.2475

Corrected Tsao', deg F **559.0**

Cp for Secondary Air From Tsao to Tsao'

	deg F	deg R	deg K	deg C
T1 =	559.0	1019.0	566	293
T2 =	559.0	1019.0	566	293
T2 - T1 =	0.0	0.0	0	0

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	98.77%	7.3105	7.221
H2O	1.23%	8.6476	0.106
TOTAL	100.00%	Avg Cp	7.327
		Btu/lb-F	0.2541

Calculation of Average Air Inlet Temperature

Cp of Primary Air Between Tpai and Taia (TA8)

	deg F	deg R	deg K	deg C
T1 =	115.0	575.0	319	46
T2 =	94.8	554.8	308	35
T2 - T1 =	-20.2	-20.2	-11	-11

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	98.77%	6.9402	6.855
H2O	1.23%	8.0051	0.098
TOTAL	100.00%	Avg Cp	6.953
		Btu/lb-F	0.2411

Avg Air In Temp, Taia (TA8) **94.8**

Cp of Secondary Air Between Tsai and Taia (TA8)

	deg F	deg R	deg K	deg C
T1 =	91.6	551.6	306	33
T2 =	94.8	554.8	308	35
T2 - T1 =	3.2	3.2	2	2

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	98.77%	6.9303	6.845
H2O	1.23%	7.9890	0.098
TOTAL	100.00%	Avg Cp	6.943
		Btu/lb-F	0.2408

Calculation of Average Air Outlet Temperature

Cp of Primary Air Between Tpao and Taoa (TA9)

	deg F	deg R	deg K	deg C
T1 =	538.0	998.0	554	281
T2 =	556.1	1016.1	565	291
T2 - T1 =	18.1	18.1	10	10

COMPOUND	Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
AIR	98.77%	7.3011	7.211
H2O	1.23%	8.6303	0.106
TOTAL	100.00%	Avg Cp	7.317
		Btu/lb-F	0.2538

Avg Air Out Temp, Taoa (TA9) **556.1**

Calculation of Flue Gas Outlet Temp for No Leak Case

Cp for Outlet Flue Gas Between Tfgo (TG15) and Tfgonl (TG15NL) -- No Leak Case

	deg F	deg R	deg K	deg C
T1 =	253.0	713	396	123
T2 =	256.1	716.1	398	125
T2 - T1 =	3.1	3.1	2	2

	Mol %			
COMPOUND	Dry	Wet	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
CO2	12.930%	12.109%	9.7823	1.185
CO	0.000%	0.000%	7.0501	0.000
N2	80.950%	75.811%	7.0201	5.322
O2	6.120%	5.731%	7.2340	0.415
H2O	0.000%	6.348%	8.2128	0.521
TOTAL	100.000%	100.000%	Avg Cp	7.443
			Btu/lb-F	0.2519

FG Out Temp, (TG15NL) **256.1**

Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgo (TG15)
No Leak Case

	deg F	deg R	deg K	deg C
T1 =	603.0	1063	591	317
T2 =	253.0	713.0	396	123
T2 - T1 =	-350.0	-350.0	-194	-194

	Mol %			
COMPOUND	Dry	Wet	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
CO2	12.930%	12.109%	10.4687	1.268
CO	0.000%	0.000%	7.1931	0.000
N2	80.950%	75.811%	7.1404	5.413
O2	6.120%	5.731%	7.4508	0.427
H2O	0.000%	6.348%	8.4594	0.537
TOTAL	100.000%	100.000%	Avg Cp	7.645
			Btu/lb-F	0.2587

Cp of Secondary Air Between Tsao and Taoa (TA9)

deg F	deg R	deg K	deg C
559.0	1019.0	566	293
556.1	1016.1	565	291
-2.9	-2.9	-2	-2

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
98.77%	7.3094	7.220
1.23%	8.6455	0.106
100.00%	Avg Cp	7.326
	Btu/lb-F	0.2541

Cp of Air Between Taia and Taoa (TA8 to TA9)

deg F	deg R	deg K	deg C
94.8	554.8	308	35
556.1	1016.1	565	291
461.4	461.4	256	256

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
98.77%	7.1221	7.035
1.23%	8.3142	0.102
100.00%	Avg Cp	7.137
	Btu/lb-F	0.2475

Cp of Air Leak Between Tsai to Tfgo (TG15)

deg F	deg R	deg K	deg C
91.6	551.6	306	33
253.0	713.0	396	123
161.4	161.4	90	90

Mol %	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
98.77%	6.9966	6.911
1.23%	8.0983	0.099
100.00%	Avg Cp	7.010
	Btu/lb-F	0.2431

Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgonl (TG15NL)--No Leak Case

deg F	deg R	deg K	deg C
603.0	1063	591	317
256.1	716.1	398	125
-346.9	-346.9	-193	-193

Mol %			
Dry	Wet	Cpi Btu/mol-F	Cpi*MF Btu/mol-F
12.930%	12.109%	10.4749	1.268
0.000%	0.000%	7.1944	0.000
80.950%	75.811%	7.1415	5.414
6.120%	5.731%	7.4527	0.427
0.000%	6.348%	8.4617	0.537
100.000%	100.000%	Avg Cp	7.647
		Btu/lb-F	0.2588

Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgo (TPFG15)

	deg F	deg R	deg K	deg C
T1 =	603.0	1063	591	317
T2 =	232.0	692.0	384	111
T2 - T1 =	-371.0	-371.0	-206	-206
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	12.930%	12.109%	10.4270	1.263
CO	0.000%	0.000%	7.1844	0.000
N2	80.950%	75.811%	7.1331	5.408
O2	6.120%	5.731%	7.4376	0.426
H2O	0.000%	6.348%	8.4445	0.536
TOTAL	100.000%	100.000%	Avg Cp	7.633
			Btu/lb-F	0.2583

Cp for Sootblower Air Leak From Tamb to Tpfgo

	deg F	deg R	deg K	deg C
Humidity, lb H2O/lb DB Air	0.00773			
T1 =	95	555	308	35
T2 =	232	692	384	111
T2 - T1 =	137	137	76	76
			Cpi	Cpi*MF
COMPOUND	Mol %		Btu/mol-F	Btu/mol-F
AIR	98.77%		6.9893	6.903
H2O	1.23%		0.0000	0.000
TOTAL	100.00%		Avg Cp	6.903
Mol Wt.	28.84		Btu/lb-F	0.2394

Calculation of Secondary Flue Gas Outlet Temperature

Cp for Secondary Flue Gas Between Tsfgo (TSFG15) and Tfgo (TG15)

	deg F	deg R	deg K	deg C
T1 =	256.4	716.4	398	125
T2 =	253.0	713.0	396	123
T2 - T1 =	-3.4	-3.4	-2	-2
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	12.930%	12.109%	9.7829	1.185
CO	0.000%	0.000%	7.0502	0.000
N2	80.950%	75.811%	7.0202	5.322
O2	6.120%	5.731%	7.2342	0.415
H2O	0.000%	6.348%	8.2131	0.521
TOTAL	100.000%	100.000%	Avg Cp	7.443
			Btu/lb-F	0.2519

SFG Out Temp, (TSFG15) **256.4**

Cp for Secondary Flue Gas Between Tfgi (TG14) and Tsfgo (TSFG15)

	deg F	deg R	deg K	deg C
T1 =	603.0	1063.0	591	317
T2 =	256.4	716.4	398	125
T2 - T1 =	-346.6	-346.6	-193	-193
	Mol %		Cpi	Cpi*MF
COMPOUND	Dry	Wet	Btu/mol-F	Btu/mol-F
CO2	12.930%	12.109%	10.4755	1.268
CO	0.000%	0.000%	7.1945	0.000
N2	80.950%	75.811%	7.1416	5.414
O2	6.120%	5.731%	7.4529	0.427
H2O	0.000%	6.348%	8.4619	0.537
TOTAL	100.000%	100.000%	Avg Cp	7.647
			Btu/lb-F	0.2588

SFG T Out Alt Calc, (TSFG15) **256.5**

Cp for Primary Flue Gas Between Tpfgo (TPFG15) and Tpfgonl (TPFG15NL)

deg F	deg R	deg K	deg C
232.0	692	384	111
253.0	713.0	396	123
21.0	21.0	12	12
Mol %		Cpi	Cpi*MF
Dry	Wet	Btu/mol-F	Btu/mol-F
12.930%	12.109%	9.7314	1.178
0.000%	0.000%	7.0400	0.000
80.950%	75.811%	7.0117	5.316
6.120%	5.731%	7.2181	0.414
0.000%	6.348%	8.1960	0.520
100.000%	100.000%	Avg Cp	7.428
		Btu/lb-F	0.2514

PFG Out Temp, (TPFG15NL) **253.02**

Cp for Sootblower Air Leak From Tpfgo (TPFG15) to Tfgo (TG15)

deg F	deg R	deg K	deg C
0.00773			
232	692	384	111
253	713	396	123
21	21	12	12
		Cpi	Cpi*MF
Mol %		Btu/mol-F	Btu/mol-F
98.77%		7.0550	6.968
1.23%		0.0000	0.000
100.00%		Avg Cp	6.968
28.84		Btu/lb-F	0.2417

Cp for Primary Flue Gas Between Tfgo (TG15) and Tpfgo (TPFG15)

deg F	deg R	deg K	deg C
253.0	713	396	123
232.0	692.0	384	111
-21.0	-21.0	-12	-12
0		Cpi	Cpi*MF
0	Wet	Btu/mol-F	Btu/mol-F
12.930%	12.109%	9.7313	1.178
0.000%	0.000%	7.0400	0.000
80.950%	75.811%	7.0117	5.316
6.120%	5.731%	7.2180	0.414
0.000%	6.348%	8.1960	0.520
100.000%	100.000%	Avg Cp	7.428
		Btu/lb-F	0.2514

Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgonl (TPFG15NL)

deg F	deg R	deg K	deg C
603.0	1063	591	317
253.0	713.0	396	123
-350.0	-350.0	-194	-194
0		Cpi	Cpi*MF
0	Wet	Btu/mol-F	Btu/mol-F
12.930%	12.109%	10.4688	1.268
0.000%	0.000%	7.1931	0.000
80.950%	75.811%	7.1404	5.413
6.120%	5.731%	7.4508	0.427
0.000%	6.348%	8.4595	0.537
100.000%	100.000%	Avg Cp	7.645
		Btu/lb-F	0.2587

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MILLIKEN CLEAN COAL TECHNOLOGY DEMONSTRATION PROJECT

HEAT PIPE PERFORMANCE TEST RESULTS INTERIM REPORT NO. 2

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February 1997

ACKNOWLEDGMENTS

The contributions of the following New York State Electric & Gas Corporation personnel are gratefully acknowledged: Mr. Paul Southard for allowing access to the plant site and insuring that the heat pipes were in a clean testable condition; Mr. Burt Marker for overall test program review; Mr. Dave Stafford for coordinating plant operations to achieve stable test periods; Mr. Al Vought for computer data logger programing support; and Mr. Jerry Goodenough for assistance in flue gas flow split balancing between heat pipes.

The author would also like to thank ABB API representatives Mr. Wayne Counterman, for assistance with heat pipe inspections and Mr. Michael Chen for performance test monitoring.

Finally, the following CONSOL test team members are acknowledged for their assistance in obtaining the manual field test data: Mr. L. L. Anthony, Mr. G. L. Cairns, Mr. R. E. Douglas, Mr. M. L. Fenger, Mr. W. L. Mizwa, Mr. D. R. Stacy, and Mr. R. O. Scandrol.

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LIST OF ABBREVIATIONS

ABB API	Asea Brown Boveri Air Preheater Inc.
ACFM	Actual Cubic Feet Per Minute
ASTM	American Society for Testing and Materials
Avg	Average
BD	Bone Dry
Btu	British Thermal Unit
C-Factor	Pitot Tube Flow Coefficient
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CONSOL R&D	CONSOL Inc., Research & Development
Cp	Specific Heat
°F	Degrees Fahrenheit
°R	Degrees Rankine
DB	Dry Bulb
DP	Differential Pressure
DSCFM	Dry Standard Cubic Feet Per Minute
EPA	Environmental Protection Agency
ESP	Electrostatic Precipitator
ext	Extension
FD	Forced Draft
FG	Flue Gas
FGD	Flue Gas Desulfurization
fpm	Feet per Minute
fps	Feet per Second
ft or ‘	Feet
ft^3	Cubic Feet
H_2O	Water
hr	Hour
ID	Inside Diameter
ID	Induced Draft (when referring to a fan)
in or “	Inches
in WC	Inches Water Column
lb/hr	Pounds per Hour
min.	Minute
MM	Million
MW	Mole Weight
MW_{net}	Net Megawatts
N_2	Nitrogen
NIST	National Institute of Standards and Technology
NYSEG	New York State Electric & Gas Corporation
O_2	Oxygen
OD	Outside Diameter

LIST OF ABBREVIATIONS (Cont.)

P	Pressure
PA	Primary Air
PFG	Primary Flue Gas
ppm	Parts per Million
ppmv	Parts per Million by Volume
PTC	Performance Test Code
PVC	Poly Vinyl Chloride
SA	Secondary Air
SO_2	Sulfur Dioxide
spgr	Specific Gravity
Sq ft	Square Feet
SCFM	Standard Cubic Feet per Minute
SS	Stainless Steel
Temp	Temperature
TC or T/C	Thermocouple
Vol	Volume
WB	Wet Bulb
wt	Weight

/000

ABSTRACT

As part of the Clean Coal Technology IV demonstration project at the NYSEG Milliken Station, the Unit 2 Ljungstrom® air heaters were replaced with two heat pipe air heaters. Detailed performance tests of the new heat pipe air heaters were conducted in May 1996 and in November 1996. Prior to both tests, the heat pipes were washed to remove cold-end deposits. The tests were used to establish the heat pipe thermal performance for comparison with guaranteed thermal performance, air side and gas side pressure drops, and air leakages. This report documents the results of the November 1996 testing.

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HEAT PIPE PERFORMANCE TEST RESULTS

INTRODUCTION

The Ljungstrom air heaters on Milliken Station Unit 2 were replaced with two heat pipe air heaters designed and fabricated by ABB Air Preheater Inc. of Wellsville, New York. In this report, the parallel air heaters are designated as "2A" and "2B." The air heater installation was part of the CCT-IV demonstration program to evaluate the feasibility of the heat pipe air heater design to improve boiler heat rate and reduce air leakage into the system.

Two detailed performance tests were conducted on the Milliken heat pipe air heaters by NYSEG and CONSOL R&D. The first tests were conducted between May 13-16,[1] 1996 and the second set between November 6-8, 1996. This report documents the results of the second performance test. For each heat pipe, duplicate tests were conducted while the boiler maintained full load (147-148 MW_{net}). The test objectives were to: (1) determine the amount of air infiltration to each heat pipe, (2) determine the air and flue gas side full load pressure drops, and (3) determine the thermal performance as measured by the totally corrected flue gas outlet temperature. The totally corrected flue gas outlet temperature is a calculated temperature corrected for differences between actual and design operating conditions. The testing was done in general accordance with the procedures specified in the *ASME Performance Test Codes for Air Heaters, PTC 4.3* and as outlined in the heat pipe performance test plan.[2,3]

Milliken Unit 2 was shut down in October for heat pipe washing to remove flyash deposits from the cold-end tubes, and to inspect the FGD absorber. Following the washing operations, both heat pipes were inspected by NYSEG, ABB API, and CONSOL R&D. The inspection showed that the heat pipes were clean and that the water washing effectively removed the cold-end deposits.

ABB API observed the November performance tests which were conducted approximately three weeks after the boiler was brought back on line. To eliminate the possibility of the Infrasonic cleaner operation affecting the results, the device was taken out of service when the 2A heat pipe was tested. This was done at ABB API request and is the only major plant operating difference between the May and November tests.

SUMMARY

The test results show:

1. Air infiltration remains low for both heat pipes. The unaccounted for, full boiler load air in-leakage rates ranged between 2.2 to 2.4 wt percent of the inlet flue gas flow to the 2A heat pipe and 1.1 to 2.1 wt percent to the 2B heat pipe. Air infiltration at sootblower wall penetrations is probably responsible for most of the measured leak.

2. The flue gas side pressure drops for both heat pipes met the design guarantee of 3.65 in. WC maximum. The 2A heat pipe gas side pressure loss, corrected for deviation from design flow and temperature, is 0.2 in.WC less than the design loss. For the 2B heat pipe, the corrected pressure loss ranged from 0.05 in.WC greater than design, to 0.19 in. WC less than design.

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3. Primary air side pressure drops met the design guarantee of 3.6 in. WC maximum. The primary air side pressure drops were 0.51 to 0.99 in.WC less than the design allowance for the 2A heat pipe and 0.16 to 0.46 in.WC less than the design allowance for the 2B heat pipe.

4. The secondary air side pressure drops met the design limit of 5.35 in. WC maximum for both units. The totally corrected pressure loss was 0.05 to 0.12 in. WC less than design for the 2A heat pipe, and 0.03 to 0.32 in.WC less than design for the 2B heat pipe.

5. Both the November and May test results show the thermal performance of the 2B heat pipe to be slightly better than that of the 2A heat pipe. For the November testing, the full load, fully-corrected flue gas outlet temperature was 268°F to 269°F (15°F to 16°F greater than design) for the 2B heat pipe and 273°F to 276°F (20°F to 23°F greater than design) for the 2A heat pipe.

RECOMMENDATIONS

Future Testing

The overall thermal performance of both heat pipes appears to have declined slightly between the May and November test periods. Comparing tests with complete data sets for full load operations, i.e., May 15 with November 7 and 8, shows an average 4°F increase in the totally corrected flue gas outlet temperature. The temperature changes are small and may be due to test condition variations. However, if the performance decline is real, it may be due to degradation or loss of heat transfer working fluids. Additional testing at 12 month intervals is recommended to determine if the performance is gradually declining.

EQUIPMENT DESCRIPTION

The Unit 2 boiler is equipped with two identical heat pipe air heaters which are each located in separate parallel ducts between the boiler economizer outlet and the electrostatic precipitators. The heat pipes are mirror image units and are designed to preheat both the primary and secondary air streams. Figure 1 shows the major streams associated with each heat pipe with the exception that an Infrasonic cleaner is installed only on the 2A heat pipe. At the heat pipe inlet, the total flue gas flow splits into primary flue gas and a secondary flue gas streams. These streams then heat the primary air and secondary air streams, respectively. Flow to the primary flue gas side is controlled by an internal damper. By restricting the primary flue gas flow, this damper is used to prevent primary air tube overheating. For performance tests, the damper was held in the full-open position.

Because the heat pipe modules are a seal welded construction, there should not be air leakage from the primary air or secondary air sections into the flue gas sections. Since the flue gas side of the heat pipes operates under nominally a 10-15 in. WC vacuum, the measured air leaks are due to ambient air infiltration through various heat pipe shell accesses. Figure 1 shows the main sources of air infiltration which are:

1. Sootblower lance air purges. These purges prevent fly ash lay down inside the sootblowers when the units are out of service (i.e., between sootblowing periods).

2. Miscellaneous leaks at manway doors, sample ports, and at sootblower wall penetrations.

3. The Infrasonic cleaner motive air.

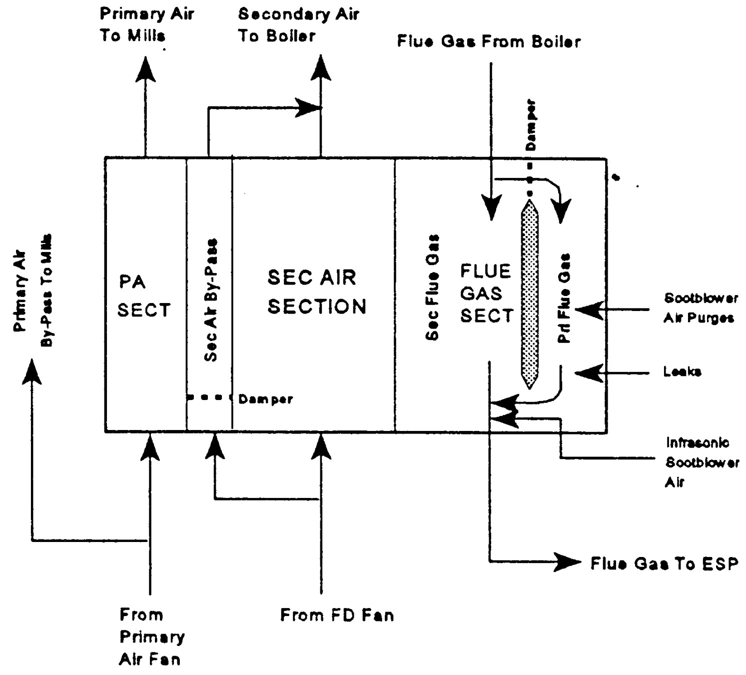

Figure 1
Heat Pipe Process Flows

The Infrasonic cleaner, which uses approximately 4,800 lb/hr of low pressure air to generate low frequency sound for heat pipe cleaning, was shut down during the 2A heat pipe tests at the request of ABB API. Shutting off the device eliminated this source of air leakage into the heat pipe.

As shown in Figure 1, each heat pipe has an integral secondary air bypass which is located between the primary and secondary air sections. The secondary air bypass damper can be used to control the air flow around the heating section. These dampers are normally in a closed position and were closed for the performance tests. Closing the dampers assures that maximum air flow is maintained through the heat pipes to achieve the lowest flue gas outlet temperatures.

TEST PROCEDURES AND RESULTS

Testing was completed over a three-day period. Each heat pipe was tested separately. The testing was preformed in general accordance with the procedures outlined in the ASME Performance Test Code for Air Heaters, ASME PTC 4.3, and as detailed in the heat pipe test plan. On Day 1, the test teams assembled at the site, team orientation was conducted, test equipment was set up and checked out. Two tests (i.e., one complete testof each heat pipe per day) were conducted on Days 2 and 3 while the boiler maintained full-load (nominally 147-148 MW_{net}). Before each test, the flue gas flow balance between heat pipes was checked and adjusted to approximately a 50/50 split. After completing the tests on Day 3, the test equipment was removed from the plant site.

Data Collection

Data was collected in the same fashion as for the May performance test.[1] Before testing began, CONSOL R&D personnel measured the air flow in the secondary air bypass ducts. Pitot tube (S-Type) traverses of the bypass ducts were completed using high accuracy electronic manometers (0.0001 in. WC resolution). The ABB API representative performed a similar check using a hot wire anneometer. For all tests, both flow measuring techniques indicated that the secondary air bypass dampers were tightly closed and that there was no flow or only a very slight leakage in the bypass ducts (see Tables F-7, F-14, F-21 and F-28)(1).

On each test day, the boiler operation was set to full load and stabilized. During the stabilization period, plant operations initiated the heat pipe sootblower cycle to insure the units were operating at peak efficiency. Before the first test on November 7, all 16 sootblowers on each heat pipe were activated during the sootblow. The sootblower cycle took approximately four hours and was completed by 12:30 p.m. Heat pipe testing began 10 minutes later. On November 8, plant operators blew only the bottom two rows of sootblowers to clean the cold-end sections of each heat pipe. This was standard operating practice since the top sections of the heat pipes do not foul during normal operation. Sootblowing was completed at 7:13 a.m. Heat pipe testing began at 10:15 a.m. Not sootblowing the heat pipe top sections on the second test day did not affect the measured thermal performance since the November 7 and 8 test results were very similar.

After the boiler load, economizer oxygen level, coal feed rate and flue gas inlet temperatures stabalized, heat pipe testing began. Each heat pipe was tested separately. Simultaneous traverse data were collected for three streams at a time. The stream groupings were selected to minimize the effect of possible small changes in operating conditions during the test period on the measured performance. The stream groupings were either: flue gas in, flue gas out, and secondary air out, or primary air in, primary air out, and primary flue gas out. By simultaneously collecting flue gas inlet and outlet data, the accuracy of the air leak determinations was maximized. Collecting the primary air outlet and primary flue gas outlet data simultaneously maximizes the accuracy of estimating the primary flue gas flow through heat balance calculation for each heat pipe. After obtaining the first group of simultaneous measurements, the sampling teams moved to new positions and collected the second group data. This same procedure was repeated on the second heat pipe.

Each heat pipe has a close coupled forced draft (FD) fan which discharges directly into the heat pipe secondary air section. By prior agreement between NYSEG and ABB API, the secondary air inlet temperatures were obtained by averaging the readings of special, calibrated thermocouples (TCs) which were installed at the FD fan outlets. The special TCs were positioned at the centers of equal ductwork flow areas, four per FD fan, and the readings recorded on a strip chart. This provided accurate average temperature measurement. Typically, the maximum absolute deviation among the four thermocouples was 2-3 °F.

The performance test code requires that the air heater inlet and outlet flue gas flow rates be calculated based on coal rate, coal composition and gas composition. Coal rates (15 minute average values) were obtained from the plant computer records for the test periods. Coal samples were obtained by NYSEG plant operators using the coal feeder automatic samplers. Multi 3-4 lb samples were taken over the

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(1)Numbering convention -- Tables and figures found in Appendices A-I are identified with the appendix letter preceding the sequence number.

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course of each test to obtain a 50 to 70 lb composite sample. The composite samples were riffled to 25 lb samples for analysis. Coal sampling logs are presented in Table A-1 with analyses in Table A-2.

Fly ash samples were collected during each test period using the procedures proposed in the test plan. The samples were obtained with a cyclone/filter bag ash sampler device at the fly ash silo. Typically, every one-and-a half to two hours, the boiler and ESP fly ash hoppers are emptied and the ash conveyed to the fly ash silo. The ash sampler allows continuous withdrawal of a sample from the pneumatically conveyed fly ash over the ash dumping period. A three-to-five gallon fly ash sample was obtained for each test. Ash analyses are presented with the coal analyses in Table A-2.

Operational Stability

Figures 2a-2f, and 3a-3f show the plant and heat pipe operating stability during the two high load performance tests. The time spans in the figures include three to five hours for system line out and the test periods. Computer logged data were used to generate the 15-minute average values presented in the figures. Test average values and standard deviations are presented in Table 1 for each operating variable shown in the figures.

The results in Table 1 demonstrate good control of all important operating variables during both test periods. The most stable operating conditions were achieved for the first test period on November 7. Because of heavy rains and a wetter coal feedstock, plant operation was somewhat less stable for the November 8 test period (see Table 1 for changes in standard deviations). For both test periods, however, the variations in 15-minute averaged values were well within the test plan proposed target limits of less than:

±3% for boiler load
±0.3% (absolute) for economizer outlet oxygen
±5% for coal feed rate
±10°F for flue gas inlet temperature change.

The lower stability for the second test period does not appear to have significantly affected the performance results. The thermal performances of the heat pipes determined by fully correcting the flue gas outlet temperatures (discussed in a following section) were essentially the same for the November 7 and 8 tests. The November 8 corrected flue gas outlet temperatures were 3°F higher for the 2A heat pipe and 1°F lower for the 2B heat pipe than the November 7 results.

Air Leakage Determination

The results of the air leak rate determinations are presented in Table 2. The air leakage into each heat pipe was determined in accordance with the ASME PTC 4.3 Test Code procedures. Total leakage is the difference between the flue gas outlet and inlet flow rates. Table 2 includes the total air leakage, measured leakages, and unaccounted leakage. The unaccounted air leakage is total leakage minus specific leaks which are known or are directly measured such as the continuous ambient air purges to the sootblower lances.

The measured air leakages are low for both heat pipes. Total air leakage was between 2.4 to 2.5 wt. percent of the inlet flue gas flow rates for the 2A heat pipe and 1.2 to 2.2 wt percent for the 2B heat pipe. Unaccounted air leakage rates were 0.1 to 0.2 wt. percent lower for both heat pipes. The low leakages show that the heat pipes are tightly constructed. Since the heat pipe modules are seal welded together, the air leakage is not due to internal leaks between the air and flue gas sides. Rather, leakages

Figure 2a
Coal Rate & Economizer O2 -- Test 1

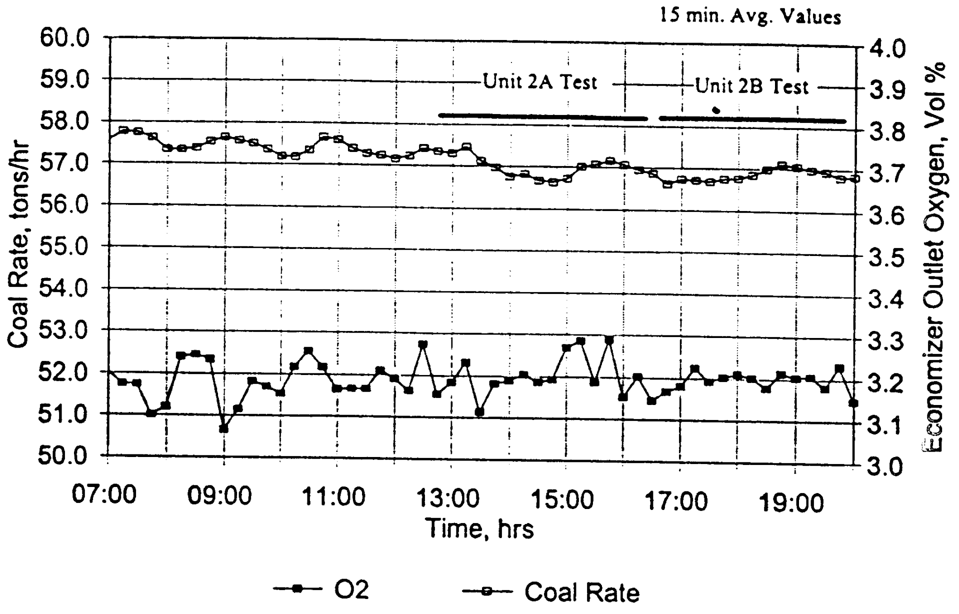

Figure 2b
Pri. & Sec. Air Flows -- Test 1

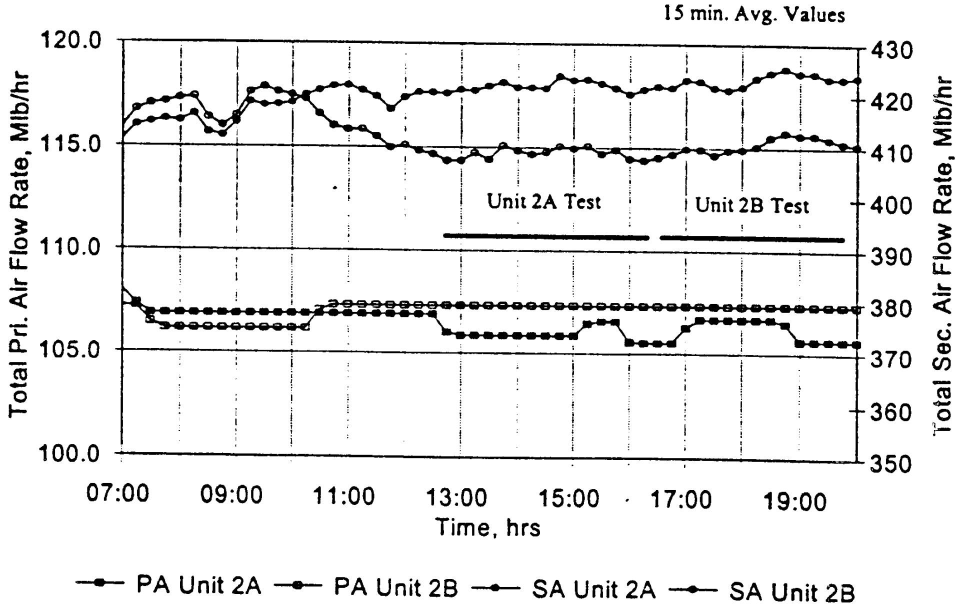

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Figure 2c
Flue Gas Inlet Temperatures -- Test 1

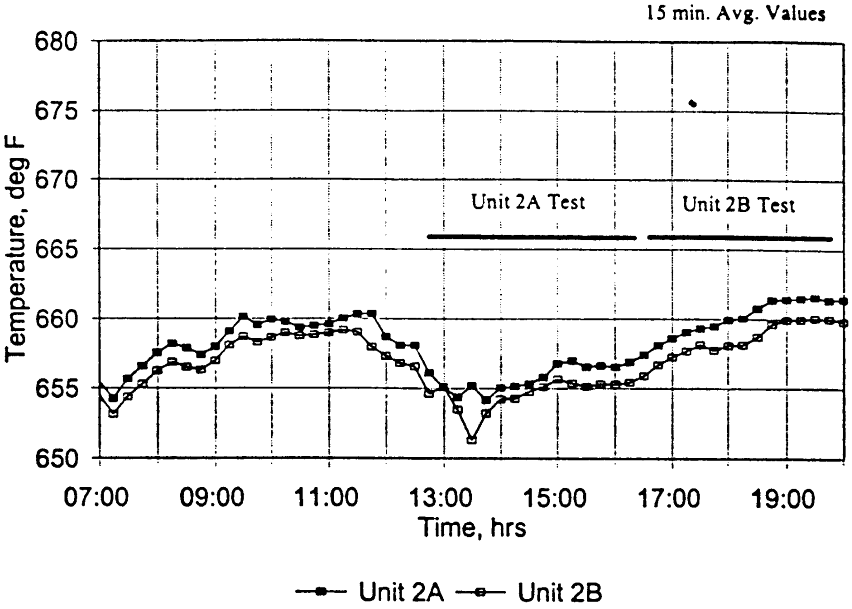

Figure 2d
Flue Gas Outlet Temperatures -- Test 1

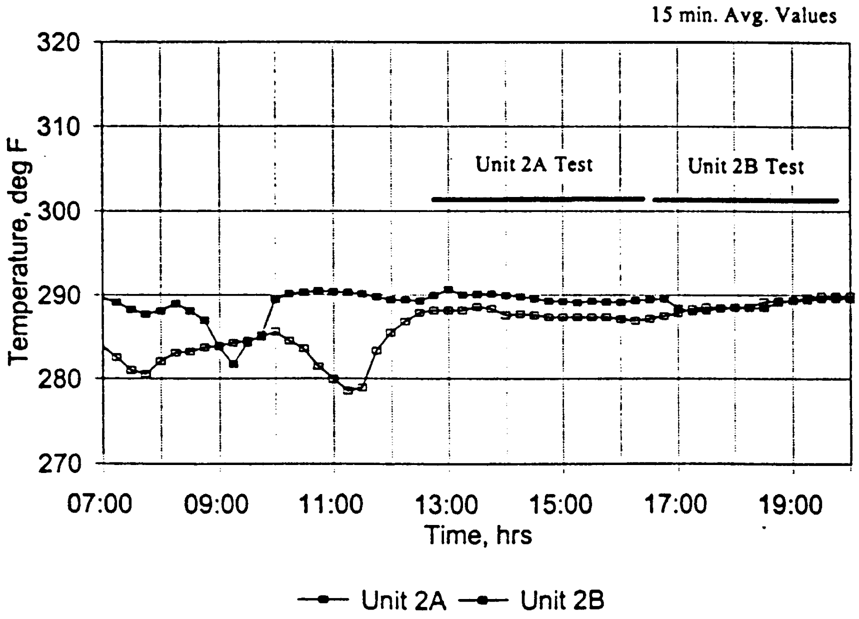

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Figure 2e
Pri. & Sec. Air Inlet Temps -- Test 1

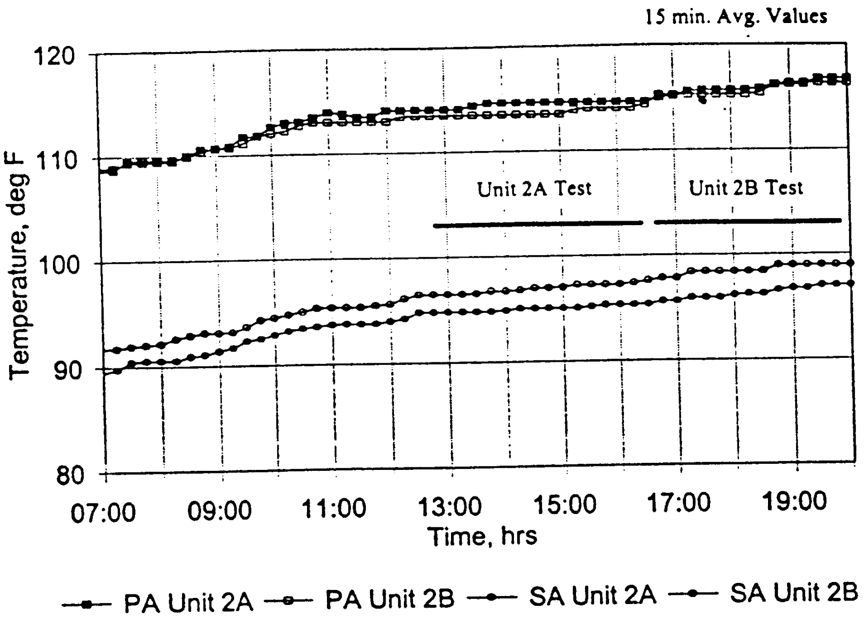

Figure 2f
Pri. & Sec. Air Outlet Temps -- Test 1

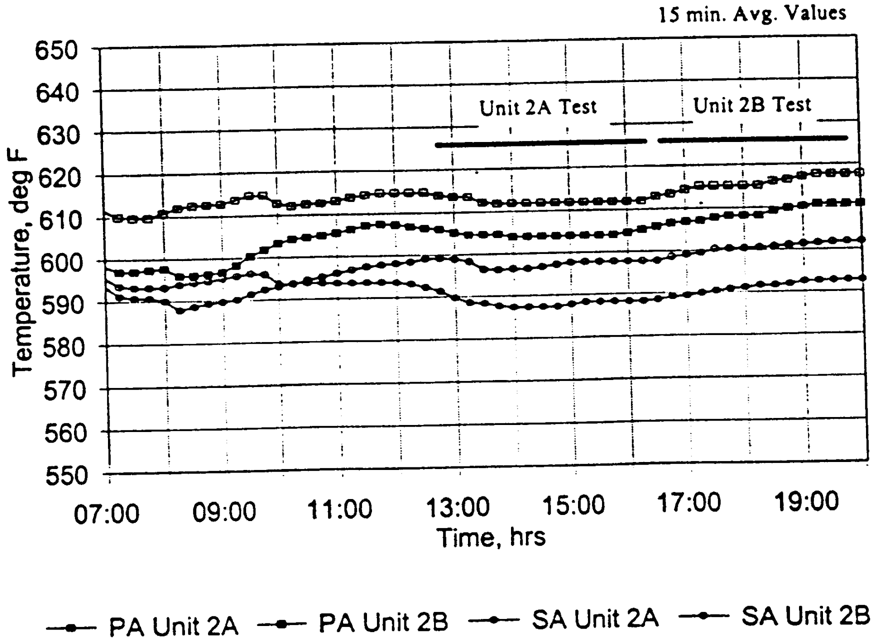

Figure 3a
Coal Rate & Economizer O2 -- Test 2

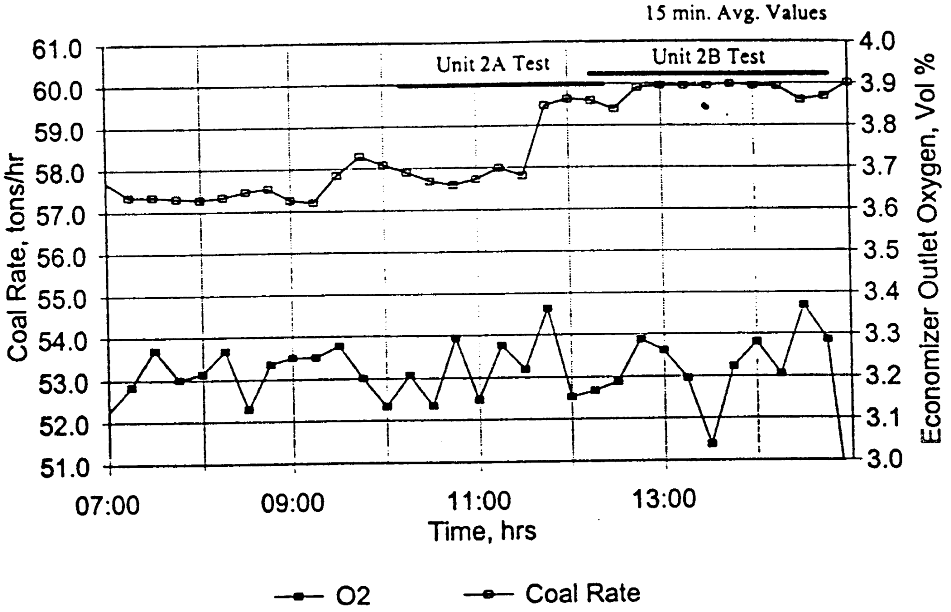

Figure 3b
Pri. & Sec. Air Flows -- Test 2

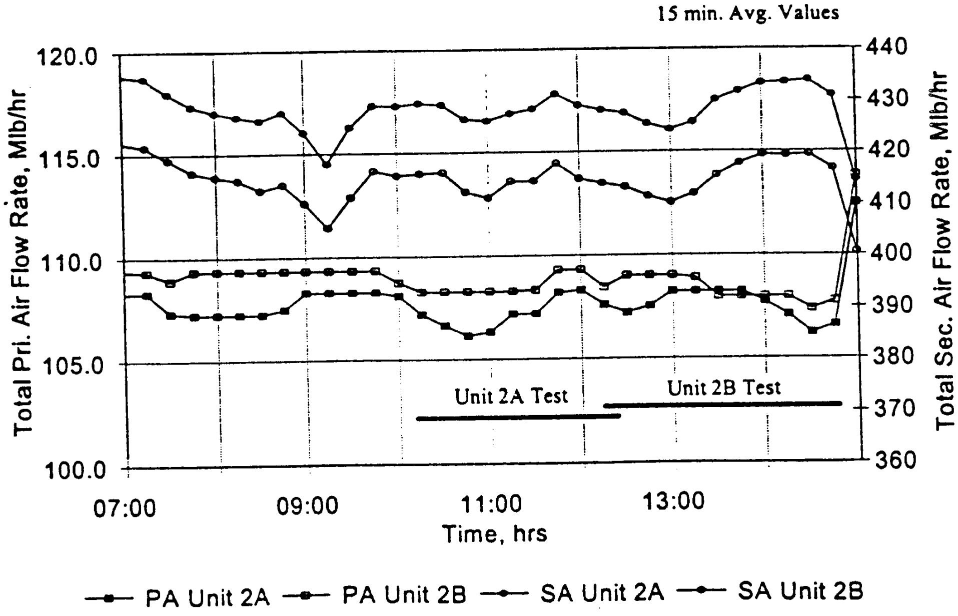

Figure 3c
Flue Gas Inlet Temperatures -- Test 2

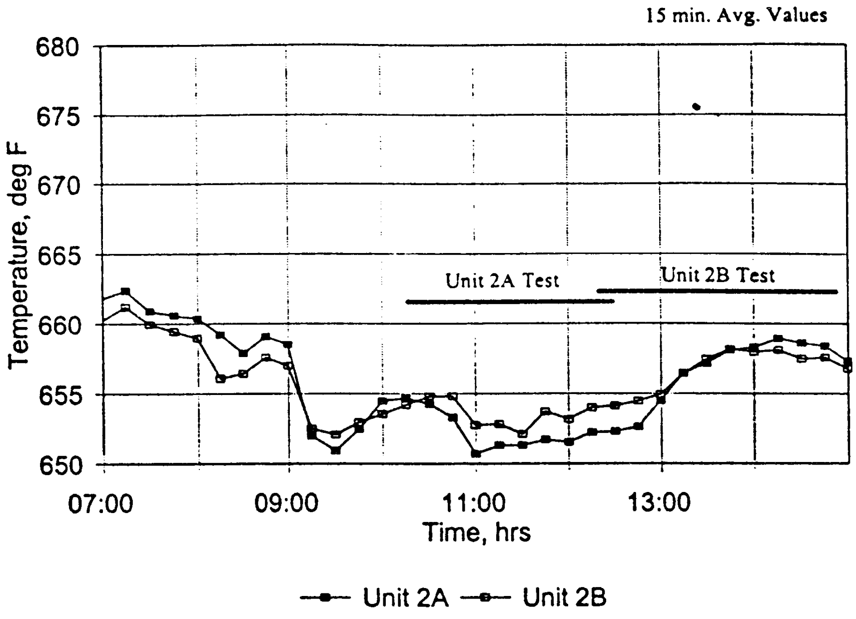

Figure 3d
Flue Gas Outlet Temperatures -- Test 2

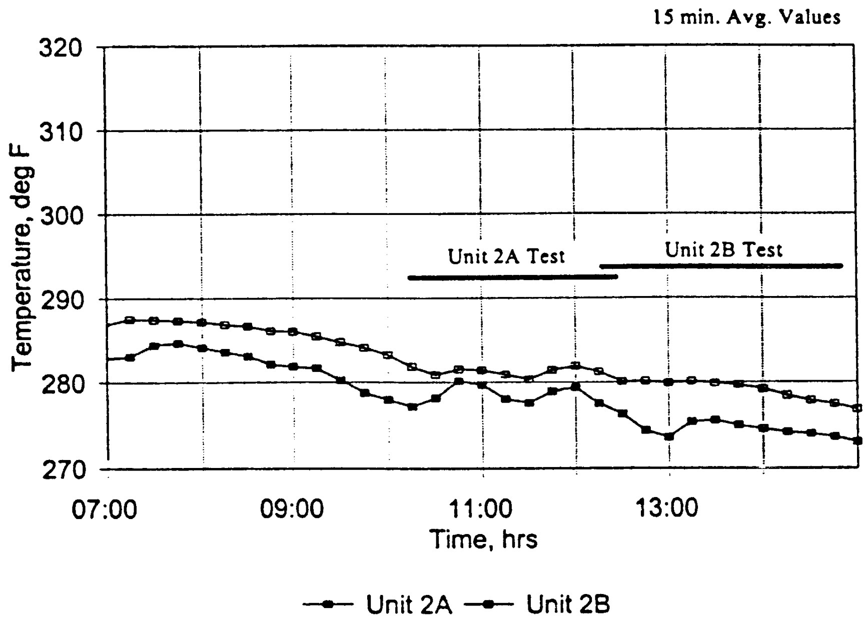

Figure 3e
Pri. & Sec. Air Inlet Temps -- Test 2

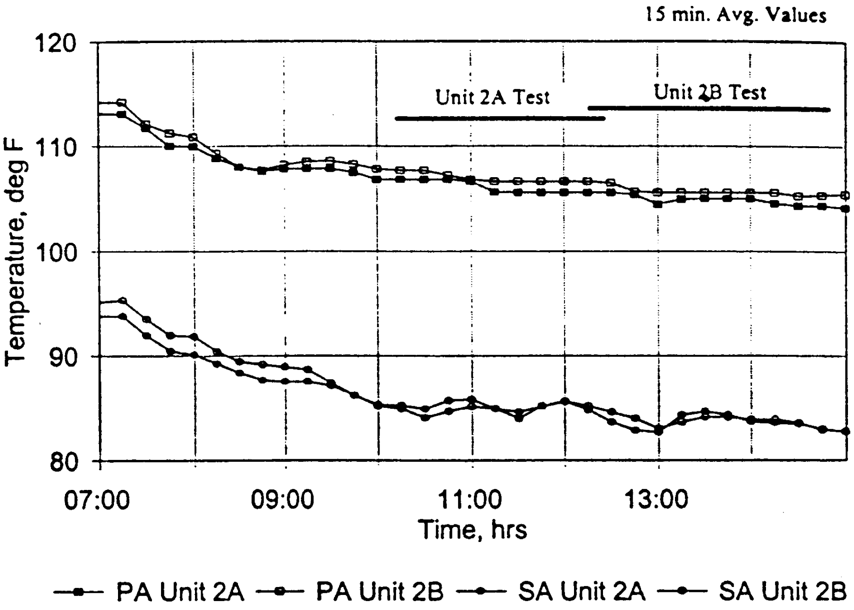

Figure 3f
Pri. & Sec. Air Outlet Temps -- Test 2

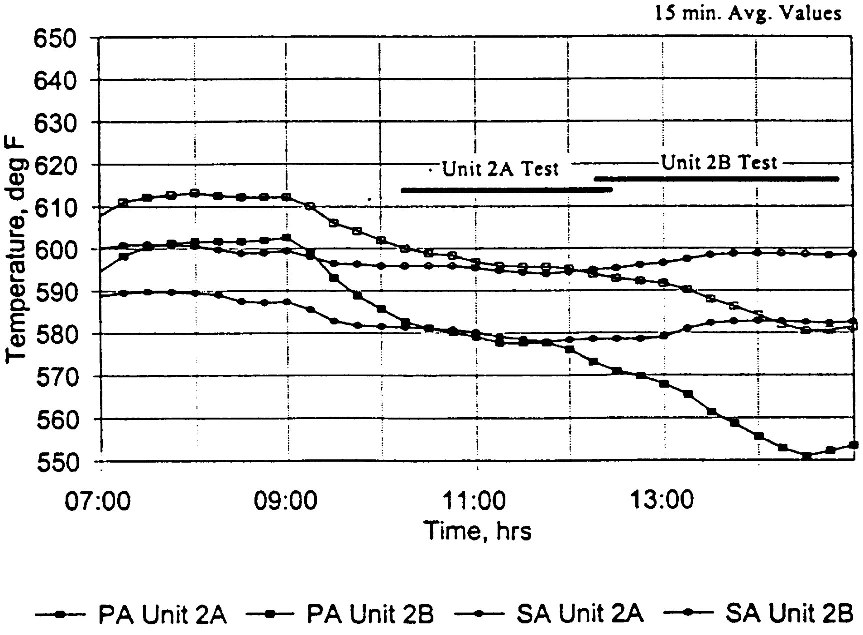

Table 1

Operating Conditions Summary

Computer Logged Data

Unit	2A		2B	
Date	11/7/96		11/7/96	
Test Period	12:40 - 16:22 Hrs		16:30 - 19:38 Hrs	
	Average	Std Dev	Average	Std Dev
Coal Rate, tons/hr	57.0	0.25	56.9	0.15
Load, MWnet	146.9	0.34	146.8	0.26
O_2 at Economizer, Vol %	3.20	0.05	3.20	0.02
Total Pri Air Flow, Mlb/hr	106.0	0.32	107.3	0.00
Total Sec Air Flow, Mlb/hr	421.7	0.98	410.5	1.61
Flue Gas Inlet Temp, °F	655.8	0.93	658.4	1.34
Flue Gas Out Temp, °F	289.6	0.48	288.7	0.87
Pri Air Inlet Temp, °F	114.5	0.22	115.5	0.61
Sec Air Inlet Temp, °F	95.0	0.21	98.5	0.47
Pri Air Outlet Temp, °F	604.5	0.60	615.7	1.48
Sec Air Outlet Temp, °F	588.3	1.08	600.4	1.22
Date	11/8/96		11/8/96	
Test Period	10:15 - 12:28 Hrs		12:15 - 14:50 Hrs	
	Average	Std Dev	Average	Std Dev
Coal Rate, tons/hr	58.5	0.91	59.8	0.20
Load, MWnet	147.8	0.80	147.8	0.91
O_2 at Economizer, Vol %	3.22	0.07	3.23	0.09
Total Pri Air Flow, Mlb/hr	107.2	0.71	108.3	0.58
Total Sec Air Flow, Mlb/hr	428.3	1.55	415.2	3.38
Flue Gas Inlet Temp, °F	652.3	1.33	656.4	1.69
Flue Gas Out Temp, °F	278.4	1.19	279.5	1.10
Pri Air Inlet Temp, °F	106.1	0.61	105.7	0.43
Sec Air Inlet Temp, °F	85.1	0.63	83.9	0.65
Pri Air Outlet Temp, °F	577.7	3.53	587.5	5.06
Sec Air Outlet Temp, °F	579.4	1.28	597.5	1.47

Table 2

Performance Summary -- Air Leakages

Unit	2A		2B	
Date	11/7/96	11/8/96	11/7/96	11/8/96
Time	12:40-16:22	10:15-12:28	16:25-19:38	12:15-14:50
Boiler Load, MW net	146.9	147.8	146.8	147.8
Flue Gas Rate In, lb/hr	748,050	755,560	738,720	778,040
Flue Gas Rate Out, lb/hr	767,090	773,820	747,660	795,380
Total Air Leakage, lb/hr	19,040	18,260	8,900	17,340
Measured Air Leaks, lb/hr				
Infrasonic cleaner Air Rate, lb/hr	Off	Off	NA	NA
Sootblower Purge Air Rate, lb/hr	1,340	1,340	1,360	1,360
Unaccounted Air Leak, lb/hr	17,700	16,920	7,580	15,980
Total Air Leakage, % Inlet FG Flow	**2.5**	**2.4**	**1.2**	**2.2**
Unaccounted Air Leak, % Inlet Flow	**2.4**	**2.2**	**1.0**	**2.1**

are likely due to ambient air infiltration through sootblower wall seals. Additional, potential leak sites are: heat pipe manway doors, sample ports, and duct expansion joints.

As requested by ABB API, the Infrasonic cleaner was shut down when the 2A heat pipe was tested. This eliminated the Infrasonic cleaner as a source of extraneous air.

The 16 high pressure air sootblowers on each heat pipe are equipped with check valves to allow a small amount of ambient air to be drawn through the sootblower lances when the units are out of service. The air purges prevent fly ash laydown in the lances. These purges were measured once during the tests (see Appendix H). The purge rates were only 1,340 lb/hr for the 2A heat pipe and 1,360 lb/hr for the 2B heat pipe; rates which were essentially the same as measured during the May 1996 performance tests.

Heat Pipe Pressure Drops

The heat pipes were designed to have maximum, full load, clean condition pressure drops not exceeding:

3.65 In. WC for the flue gas side,
3.60 In. WC for the primary air side, and
5.35 In. WC for the secondary air side.

The November test pressure drops are summarized in Table 3. For each heat pipe section, the measured and design values are presented for flue gas or air side flow rates, temperatures and pressure drops. To compare the measured pressure drops with the design values, the measured pressure drops must be corrected for differences between actual and design gas or air flow rates and temperatures. The following equation, based on the PTC 4.3 Test Code, was used:

$$DP_{corr} = DP_M \left(\frac{W_D^2(T_{DI}+T_{DO})}{W_M^2(T_{MI}+T_{MO})} \right) \qquad (1)$$

Where:

DP_{corr} = *Corrected Pressure Drop, in. WC*

DP_M = *Measured Pressure Drop , in. WC*

T_{DI} = *Design Inlet Temperature, °R*

T_{DO} = *Design Outlet Temperature, °R*

T_{MI} = *Measured Inlet Temperature, °R*

T_{MO} = *Measured Outlet Temperature, °R*

W_D = *Design Gas Or Air Flow Rate, lb/hr*

W_M = *Measured Gas Or Air Flow Rate, lb/hr*

Table 3 includes all data required to calculate the corrected pressure drops and the totally corrected values. Differences between the corrected and the design pressure drops are presented in the table. If the corrected pressure drop is less than the design, the heat pipe meets the design guarantee for pressure drop performance. Test results indicate that the heat pipe pressure drop performance meets design guarantees for all sections of both heat pipes. Corrected pressure drops were all lower than design values for the 2A heat pipe for both high load tests. The same is true for the 2B heat pipe except for the first test period; when the corrected pressure drop across the flue gas side exceeded the design value by an insignificant 0.05 In.WC.

Manually read, U-tube manometers were used to measure total pressure drops across the flue gas, primary air, and secondary air tube banks. The manometers were connected to specially installed pressure taps to insure that the measured pressure drops would be across the heat pipe modules and not include losses for ductwork. The manometer readings are presented in Appendix G.

Thermal Performance

Heat balances around each heat pipe and net flue gas side duties are presented in Table 4 for the two high load tests conducted in November 1996. The heat balances show that the total heat removed from the flue gas streams equals the energy absorbed by the primary and secondary air streams plus the energy lost to the air leaks. The useful energy recovered is the total heat transferred to the primary and secondary air streams. This energy is recycled back to the boiler. For completeness, the results include the net flue gas duties which match the respective primary and secondary air side duties.

Table 3
Performance Summary -- Heat Pipe Pressure Drops

Unit		**2A**		**2B**	
Date		11/7/96	11/8/96	11/7/96	11/8/96
Time		12:40-16:22	10:15-12:28	16:30-19:38	12:15-14:50
Boiler Load, MW net		146.9	147.8	146.8	147.8
Flue Gas Section					
Design Flue Gas Rate, lb/hr	750,000				
Design Pressure Drop, In. WC	3.65				
Design Inlet Temp, °F	680				
Design Outlet Temp, °F	253				
Flue Gas Rate In, lb/hr		748,100	755,600	738,700	778,000
Flue Gas Rate Out, lb/hr		767,100	773,800	747,700	795,400
Avg Flue Gas Rate, lb/hr		757,600	764,700	743,200	786,700
Flue Gas Temp In, °F		659	658	663	661
Flue Gas Temp Out,°F		289	278	294	283
Measured DP, in. WC		3.55	3.58	3.68	3.83
Totally Corrected DP, In. WC		**3.45**	**3.44**	**3.70**	**3.46**
Corrected - Design DP, In. WC		-0.20	-0.21	0.05	-0.19
Primary Air Section					
Design Air Rate, lb/hr	62,500				
Design Pressure Drop, In. WC	3.60				
Design Inlet Temp, °F	80				
Design Outlet Temp, °F	644				
Average Air Rate, lb/hr		58,790	73,450	53,590	68,710
Air Temp In, °F		115	106	115	107
Air Temp Out, °F		604	576	614	592
Measured DP, in. WC		2.73	3.51	2.54	3.74
Totally Corrected DP, In. WC		**3.09**	**2.61**	**3.44**	**3.14**
Corrected - Design DP, In. WC		-0.51	-0.99	-0.16	-0.46
Secondary Air Section					
Design Air Rate, lb/hr	562,500				
Design Pressure Drop, In. WC	5.35				
Design Inlet Temp, °F	80				
Design Outlet Temp, °F	616				
Average Air Rate, lb/hr		531,100	539,700	516,300	535,400
Air Temp In, °F		94	85	94	83
Air Temp Out, °F		584	578	596	595
Measured DP, in. WC		4.67	4.72	4.47	4.51
Totally Corrected DP, In. WC		**5.30**	**5.23**	**5.32**	**5.03**
Corrected - Design DP, In. WC		-0.05	-0.12	-0.03	-0.32

10/16

Table 4
Performance Summary -- Heat Balances and Duties

Unit	A		B	
Date	11/7/96	11/8/96	11/7/96	11/8/96
Boiler Load, MW net	146.9	147.8	146.8	147.8
Inputs				
Flue Gas Rate In, lb/hr	748,100	755,600	738,700	778,000
Temperature In, °F	659	658	663	661
Temperature Out With Air Leak, °F	289	278	294	283
Cp, Btu/lb-°F	0.2628	0.2621	0.2625	0.2619
Overall Duty, MM Btu/hr	**72.73**	**75.26**	**71.55**	**77.03**
Outputs				
Primary Air Rate, lb/hr	58,790	73,450	53,590	68,710
Temperature In, °F	115	106	115	107
Temperature Out, °F	604	576	614	592
Cp, Btu/lb-F	0.2491	0.2481	0.2492	0.2483
Duty, MM Btu/hr	7.16	8.56	6.66	8.27
Secondary Air Rate, lb/hr	531,100	539,700	516,400	535,400
Temperature In, °F	94	85.4	94	83
Temperature Out, °F	584	578	596	595
Cp, Btu/lb-°F	0.2485	0.2478	0.2486	0.2479
Duty, MM Btu/hr	64.67	65.88	64.46	67.96
Air Leak Rate, lb/hr	19,000	18,200	8,900	17,400
Temperature In, °F	95	95	95	95
Temperature Out, °F	289	278	294	283
Cp, Btu/lb-°F	0.2443	0.2437	0.2443	0.2437
Duty, MM Btu/hr	0.90	0.81	0.43	0.80
Downstream Air Input Rate, lb/hr (1)	0	0	NA	NA
Temperature In, °F				
Temperature Out, °F				
Cp, Btu/lb-°F				
Duty, MM Btu/hr	0.00	0.00	0.00	0.00
Overall Duty, MM Btu/hr	**72.73**	**75.26**	**71.55**	**77.03**
Net Flue Gas Side Duties				
Primary Flue Gas Rate In, lb/hr	92,980	97,000	80,490	91,570
Temperature In, °F	659	658	663	661
Temperature Out No Leak, °F	368	322	349	317
Cp, Btu/lb-°F	0.2644	0.2630	0.2636	0.2626
Duty, MM Btu/hr	7.16	8.57	6.66	8.27
Secondary Flue Gas Rate In, lb/hr	655,100	658,600	658,200	686,400
Temperature In, °F	659	658	663	661
Temperature Out No Leak, °F	283	276	290	283
Cp, Btu/lb-°F	0.2626	0.2621	0.2624	0.2619
Duty, MM Btu/hr	64.68	65.89	64.46	67.96
Net Energy Recovery, % of Fuel Input	**4.99**	**5.17**	**4.96**	**5.18**

(1) Infrasonic Cleaner Air Flow -- Unit Was Shutdown For Tests.

For a clean well balanced system, each heat pipe recovers about 5% of the energy in the feed coal. The total energy recovery is about 10%. For the November 7 performance test, energy recoveries were 4.99% and 4.96% for the 2A and 2B heat pipes, respectively. Heat recoveries were slightly higher for the duplicate test on November 8. Heat recovery was 5.17% in the 2A heat pipe and 5.18% in the 2B heat pipe. These higher recoveries were due to higher flue gas and air flow rates, and to lower flue gas outlet and lower air inlet temperatures on the second day of testing.

To determine if the measured performance meets the design, the PTC 4.3 Test Code requires that the corrected flue gas outlet temperature be compared to the design. Design performance is achieved if the totally corrected temperature equals or is less than the design flue gas outlet temperature. Temperature corrections are made for differences between design and actual flue gas inlet temperature, air inlet temperature, X-ratio, and flue gas flow rate. Procedures for calculating the corrections are presented in the PTC 4.3 Test Code and in an uncertainty analysis.[4]

Table 5 presents the results of the performance evaluations and shows all temperature corrections for differences from design bases. The reported results were taken from a Quattro® Pro for Windows® spreadsheet program which was developed to evaluate the heat pipe performances. The detailed program results for all test cases are presented in Appendix I. Boxed cells in the printouts are user input values obtained from the performance test data.

Since each heat pipe heats both primary air and secondary air streams, the calculation method treats each heat pipe as two heat exchangers. Corrected temperatures are calculated for the primary flue gas/air sections and for the secondary flue gas/air sections. These temperatures are then combined by heat balance to obtain the final totally corrected outlet temperature for each heat pipe (see uncertainty analysis).

The performance summary results (Table 5) show that the totally corrected flue gas outlet temperature for the 2A heat pipe exceeded the design by 20°F to 23°F for the high load performance tests. For the 2B heat pipe, the corrected outlet temperature exceeded the design by 15°F to 16°F. Like the May test results, these results show that, in an unfouled condition, the thermal performance of the 2B heat pipe is slightly better than that of the 2A heat pipe.

Comparing the May and November thermal performance results indicates that there may be a slight decline in the thermal performance of both heat pipes. The May test results show a 17°F to 18°F approach to the design temperature for the 2A heat pipe and a 12°F approach for the 2B heat pipe at full boiler load conditions(2). Based on current results, there is a 3°F to 6°F increase in the approach to design outlet temperature for the 2A heat pipe and a 3°F to 4°F increase for the 2B heat pipe. While these changes are small, they may signal an ongoing performance decline which may be due to loss of heat transfer fluids or degradation of the fluids. Additional testing of the heat pipes at 12 month intervals appears to be warranted to determine if the performance declines are real or if the changes are due to variations in test conditions and data collection.

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(2) The 12°F approach for the 2B heat pipe is for the May 15 test for which the data set is complete.

Table 5

Performance Summary -- Totally Corrected Flue Gas Outlet Temperatures

Unit	**A**		**B**	
Date	11/7/96	11/8/96	11/7/96	11/8/96
Time	12:40-16:22	10:15-12:28	16:25-19:38	12:15-14:50
Boiler Load, MW net	146.9	147.8	146.8	147.8
Primary Flue Gas Section				
Primary Flue Gas Flow, lb/hr	92,980	97,000	80,490	91,570
Measured Outlet Temp, °F	324	288	325	283
Temperature Corrections For Differences From:				
Design Entering Air Temp, °F	302	271	303	265
Design Entering Flue Gas Temp, °F	332	295	332	289
Design X-Ratio, °F	299	315	316	308
Design Flue Gas Flow Rate, °F	324	287	328	283
Air Leak Correction, °F	44	34	24	34
Totally Corrected Outlet Temp, °F	**329**	**337**	**327**	**329**
Secondary Flue Gas Section				
Secondary Flue Gas Flow, lb/hr	655,100	658,600	658,200	686,500
Outlet Temp (Ht Bal), °F	283	276	290	283
Temperature Corrections for Differences From:				
Design Entering Air Temp, °F	274	273	281	281
Design Entering Flue Gas Temp, °F	290	284	296	290
Design X-Ratio, °F	268	264	265	257
Design Flue Gas Flow Rate, °F	283	276	290	281
Totally Corrected Outlet Temp, °F	**265**	**267**	**262**	**260**
Totally Corrected Temperatures				
Combined Flue Gas Outlet, °F	**273**	**276**	**269**	**268**
Design Flue Gas Outlet Temp, °F	253	253	253	253
Outlet Temp Approach To Design, °F	**20**	**23**	**16**	**15**

Data Handling and Quality Control

A. Temperature Measurement. All TCs used for gas or air measurements were calibrated and the handheld temperature potentiometers were factory calibrated, NIST traceable units.

In the May tests, exposed junction, unsheathed TCs were used in the pitot probes. For the November tests, the TCs were replaced with grounded, sheathed TCs. Grounded, sheathed TCs have the following advantages:

- Superior quality control with machined junctions,
- Ability to seal the TC-probe attachment via Swagelok® fitting,
- Extended TC life,
- Contamination-free junctions eliminating calibration shifts,
- Ease of replacement.

The response times of ungrounded and grounded sheathed TCs were compared to the originally used 20 ga., exposed junction TCs. The ungrounded TC lagged the exposed junction TC by about 15 seconds while the response curves were identical for the grounded, sheathed and exposed junction TCs. Based on these results, new and spare grounded sheathed TCs were purchased for all pitot probes.

The calibration data for the new TCs are presented in Tables B-1 to B-4. The differences between the measured TC reading and a traceable reference TC are plotted against measured readings in Figures B-1 and B-2. These data were correlated by least squares linear fit. The measured heat pipe test temperatures were corrected using Equation 2.

$$T_{act} = T_M + a + bT_M \qquad \textbf{(2)}$$

Where:

T_{act} = *Actual Temperature, °F*

T_M = *Measured Temperature, °F*

a & b = *Correlation Constants For Difference Correction*

The correlation coefficients for the TCs used and the spares are presented in Table B-5.

Before the May performance tests, special calibrated TCs were installed at the outlets of the secondary air fans (heat pipe inlets). These TCs (four per FD fan outlet) were left in place and used for the November tests. Calibrations for the TCs can be found in the May performance test report.[1] The secondary air fan outlet temperatures, recorded at 15-minute intervals during the November test periods, are presented in Tables B-6 and B-7. Both the as-measured or uncorrected, and corrected temperatures are shown. The four TC averaged corrected temperatures are plotted in Figure B-3 for the test periods. The figure shows that the secondary air inlet temperatures were essentially stable and changed less than 2°F during any heat pipe test.

B. Pitot Tube Calibrations. Flue gas and air duct velocity traverses were conducted using the EPA Method 2 procedure. The traverse data were used to calculate weighted average gas and air temperatures, and gas compositions. All pitot tubes were calibrated before and after testing. Since the post test calibrations showed no significant changes from the pre-test values, the pre-test calibration coefficients were used. Pitot tube coefficients are summarized in Table C-1 and the complete data set is included as Tables C-2 and C-3.

Shortridge Instruments Inc.AirData Multimeters were used to measure the pitot tube differential pressures. These units are highly accurate electronic manometers and can measure differential pressures to 0.0001 in. WC. The same instruments used for the May tests were used for November testing.

C. Gas Composition Determinations. Teledyne Max 5 combustion gas analyzers were used to measure flue gas oxygen, CO, and percent combustibles. The units were rebuilt by the manufacturer's local Pittsburgh representative prior to the November test program. Before the tests began, the gas analyzers were calibrated against air and an oxygen calibration gas (3.57% O_2, 100 ppm CO, 0.52% CH_4, bal N_2). To eliminate drift due to ambient temperature changes, the instruments were recalibrated on air by the sampling teams several times at each traverse location as data were collected.

The CO_2 concentrations were not directly measured. Instead, the oxygen and CO levels were measured with the Max 5 analyzers and a fuel line plot was used to obtain the CO_2 concentrations. The fuel line plot shown in Figure D-1 was constructed using detailed analyses of a few gas samples taken at various locations and times throughout the test periods. The standard procedure for developing the fuel line plot was to collect gas samples in Tedlar® bags and then to analyze the samples on site by Orsat. Because of equipment problems, the on site Orsat analyses had to be abandoned. To over come the analysis problem, the gas samples were taken back to the CONSOL lab in Library, Pa. and analyzed by gas chromatography. The results are presented in Table D-1.

Figure D-2 presents a parity plot of the Max 5 electronic analyzer oxygen measurements versus the gas chromatograph measurements. The data shows excellent agreement. The average difference between the two measurement methods was 0.143% O_2 with a standard deviation of 0.248%. Agreement between the two measurement methods is good considering the time difference between when the gas analyzer analysis was obtained (i.e., when the bags were filled) and the time of the chromatograph measurements (i.e., two to three days later).

D. Temperature and Velocity Traverse Data. Flue gas and air duct traverse data sheets are provided in Appendix E. The data sheets contain the raw field data for temperatures, velocity heads, and gas compositions. The calculation sheets are presented in Appendix F. These sheets show: the thermocouple calibration corrected temperatures, simple and weighted average temperatures, simple and weighted average gas compositions and mass flow rates. As noted in the May performance test, there is generally no significant difference between the simple and weighted average values for temperature and gas compositions. Unless specified, weighted averages were always used in performance evaluations.

Except for the primary air outlet flows, the performance calculations do not use air and flue gas flow rates based on pitot velocity head measurements. This is because the Performance Test Code requires that the overall flue gas rates be calculated from the measured fuel feed rate, and the fuel and flue gas compositions. The secondary air rate is calculated by heat balance. The velocity head based mass flow rates are provided in this report for completeness and as a check of the Code calculation flow rates. A comparison summary is provided in Table 6. The results show good agreement between the calculated inlet and outlet flue gas rates and the inlet and outlet rates determined by pitot measurements. The pitot traverse flow rates averaged 4.9% less, 3.7% greater, and 2.8% greater than the calculated rates for the flue gas inlet, flue gas outlet, and secondary air outlet rates, respectively. These results, like the results for the May tests, indicate that the data are consistent and accurate.

The primary air inlet and outlet rates based on pitot measurements are also shown in Table 6. The two flow rates do not agree well. The inlet rate is typically twice the outlet rate. The outlet flow is considered to be correct since the pitot measurement location is ideal for accurate flow determination. The inlet primary air pitot ports meet code layout requirements for weighted average temperature determination. However the location is not ideal for accurate flow measurement; measured pressure heads are very low because the duct area is large and there is insufficient straight run ahead of the sampling location for flow straightening. This is not a concern for the performance evaluations. Gross errors in the primary air inlet flow measurement have no affect on the weighted average temperatures used for the performance calculations since the temperature variation in the duct was always less than 4°F.

E. Heat Pipe Pressure Drop Data. During the tests, U-tube manometers were connected to special taps across the heat pipe tube banks. For each heat pipe the manometers were used to measure the drops across the primary air, secondary air, primary flue gas, and secondary flue gas sections. Manometer fluids were either water or 0.826 spgr. red oil depending upon the instrument requirements. The data are provided in Appendix G, Tables G-1 and G-2. An explanation of these data is provided in the previous section, Heat Pipe Pressure Drops.

Table 6

Performance Summary -- Gas And Air Rate Comparisons

Unit	A		B	
Date	11/7/96	11/8/96	11/7/96	11/8/96
Time	12:40-16:22	10:15-12:28	16:25-19:38	12:15-14:50
Boiler Load, MW net	146.9	147.8	146.8	147.8
Flue Gas Rate In, lb/hr				
Calculated	748,100	755,600	738,700	778,000
Pitot	717,200	719,100	710,200	724,500
Pitot/Calc	0.959	0.952	0.961	0.931
Flue Gas Rate Out, lb/hr				
Calculated	767,100	773,800	747,700	795,400
Pitot	813,900	802,300	793,500	787,400
Pitot/Calc	1.061	1.037	1.061	0.990
Secondary Air Rate Out, lb/hr				
Calculated	531,100	539,700	516,400	535,400
Pitot	545,800	552,700	536,700	546,700
Pitot/Calc	1.028	1.024	1.040	1.021
Primary Air Rates, lb/hr				
Inlet Pitot (1)	114,500	140,990	106,500	142,990
Outlet Pitot	58,800	73,450	53,590	68,710
In/Out	1.95	1.92	1.99	2.08

(1) Inlet Primary Air Rate Is Unreliable Due To Large Duct Size And Low Measured

For the November test, ABB API requested data on module-to-module pressure drops after the October water washing and during or just after the performance testing. The data are presented here. A schematic of the pressure tap layout for the 2A heat pipe is shown in Figure 4. There are 10 pressure taps on the east wall of the heat pipe. Tap 1 is in the gas space above the primary flue gas section damper. Tap 2 is in the gas space just below this damper. Taps 3A and 3B are in the sootblower lane below the first heat pipe tube bank module; taps 4A and 4B are below the second tube bank module; taps 5A and 5B are below the third tube bank module, and taps 6A and 6B are below the forth tube bank module. On the north wall, there is a set of 14 pressure taps for measuring the pressure drops across the bottom three heat tube bank modules. Figure 4 shows only 12 taps since two taps are being used for local instrumentation.

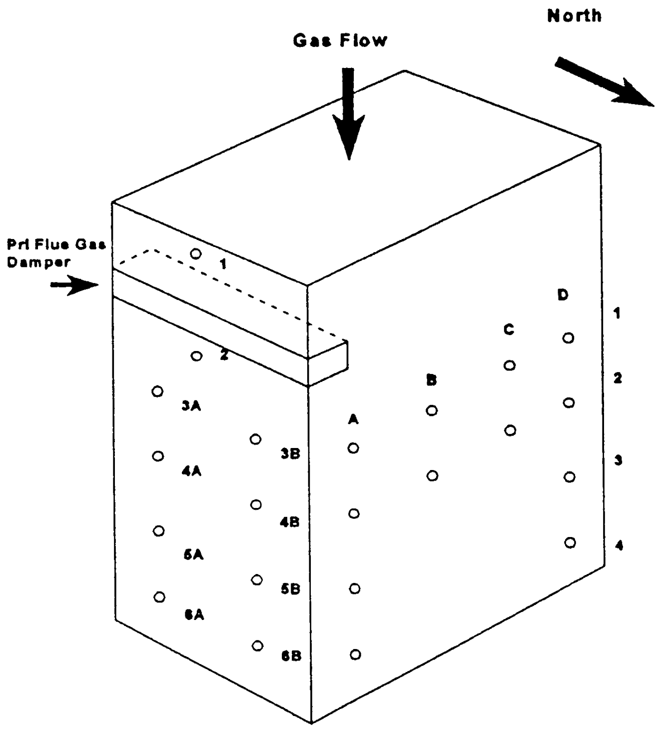

Figure 4

Flue Gas Side DP Taps – 2A Heat Pipe
(2B Unit is Mirror Image)

The combined tap arrangement allows for complete pressure profile determination. The module-to-module pressure drops can be determined parallel with the tubes along the north-south direction and also across the tube banks in the east-west direction. The pressure tap arrangement for the 2B heat pipe is a mirror image of the 2A tap arrangement with north-south taps on the east wall of the flue gas section and east-west taps on the south wall.

A complete set of pressure drop measurements was obtained on October 22, four days after the heat pipes were back online at full load, following the water washing. A similar set of measurements was obtained on November 8. Differential pressures were measured rather than static pressures to eliminate manual subtraction and improve accuracy. The high accuracy electronic manometers, used for velocity traverse measurements, were used to obtain the pressure drop profile data. Measured pressure drops are presented in Table G-3 and corrected to common basis pressure drops are shown in Table G-4. The results are summarized in Table 7.

For both heat pipes, the corrected pressure drops show little change between the clean and performance test conditions. This is true for the east-west and north-south pressure tap results; indicating that there was very little fouling of the heat pipes between the time the units were washed and the performance tests conducted. The data set does indicate that some fouling likely occurred between the two measurement periods. The performance period average total pressure drops are consistently 3 to 6% higher than the clean condition results. Additionally, the increased pressure drops are mainly associated with the bottom, cold-end modules. This is consistent with past experience that fouling mainly occurs in the cold-end modules. The current data set is limited but appears to be consistent with little or no change in pressure drop across the top tube banks and a small increase across the bottom tube banks.

F. Sootblower Lance Air Purges. Sixteen high pressure air sootblowers were installed on each heat pipe. As explained in the previous performance report,[1] at each sootblower location there are two sources of air leak into the flue gas. Leaks occur through spring-loaded sootblower lance shaft seals and through the sootblower lance purge valves. The individual shaft seal leaks were not directly measured because of the difficulty and expense of obtaining these data. The shaft seal leaks, therefore, remain a large, but undetermined portion of the total air leak which is calculated from the difference between the flue gas outlet and inlet flow rates.

The amount of air leak for sootblower lance air purges is easily measured. These leaks were measured by placing a two-inch ID by five foot long PVC pipe over each sootblower purge air check valve. The maximum velocity at the center of the pipe was measured using a miniature, direct-impact pitot tube. The miniature pitot was inserted through the side of the PVC pipe, two feet from the inlet end. This provided sufficient straight run both ahead and behind the measurement point for proper flow straightening. Velocity head measurements were obtained and the maximum pipe velocity calculated. To estimate the air flow, the average velocity through the pipe was taken to be 0.8 times the maximum velocity.[5]

Leak data are presented in Appendix H. For the November test, the sootblower lance purge air leakages were 1,343 lb/hr and 1,361 lb/hr for the 2A and 2B heat pipes, respectively. These leak rates are essentially the same as were measured during the May performance test.

Table 7
Heat Pipe Module-To-Module Pressure Drops Corrected to Common Basis

Condition		Clean	Performance	
Taps		East/West	East/West	
Date		10/22/96	11/8/96	
Time		12:10-12:50	17:30-18:10	

2A Heat Pipe	Levels	Avg Pressure Drops, in. WC		Change In Avg Value
Top	1-2	1.10	1.12	1.58%
	2-3	0.90	0.92	1.69%
Bottom	3-4	0.82	0.92	11.96%
	Total	2.83	2.98	5.29%

2B Heat Pipe	Levels	Avg Pressure Drops, in. WC		Change In Avg Value
Top	1-2	1.16	1.20	3.15%
	2-3	1.00	1.00	-0.31%
Bottom	3-4	0.85	0.97	14.46%
	Total	3.01	3.19	5.97%

Condition		Clean	Performance	
Taps		North/South	North/South	
Date		10/22/96	11/8/96	
Time		17:00-18:15	18:15-19:00	

2A Heat Pipe	Levels	Avg Pressure Drops, in. WC		Change In Avg Value
Top	1-2	0.65		
	2-3		0.70	8.13%
	3-4	1.04	1.04	-0.05%
	4-5	0.95	0.91	-5.13%
Bottom	5-6	0.68	0.78	14.19%
	Total	3.32	3.42	3.00%

2B Heat Pipe	Levels	Avg Pressure Drops, in. WC		Change In Avg Value
Top	1-2			
	2-3	0.771	0.79	1.93%
	3-4	1.155	1.17	1.46%
	4-5	0.983	1.02	3.38%
Bottom	5-6	0.797	0.93	16.34%
	Total	3.706	3.90	5.26%

Basis: 160 MW gross load, 680 °F Flue Gas Inlet, 253 °F Flue Gas Outlet.

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REFERENCES

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2. *Air Heaters, Supplement to Performance Test Code for Steam Generating Units, PTC 4.1*, ASME Performance Test Codes, ASME PTC 4.3, The American Society of Mechanical Engineers, New York, 1968.

3. McCoy, D. C., "Heat Pipe Performance Evaluation And Acceptance Testing," CONSOL Report to NYSEG, New York State Electric & Gas Corporation, Binghamton, New York, April 1996.

4. Maskew, J. T., "Milliken Station Heat Pipe Air Heater Performance Uncertainty Analysis of 'Totally Corrected Gas Temperature Leaving The Air Heater,'" CONSOL Report to NYSEG, New York State Electric & Gas Corporation, Binghamton, New York, April 1996.

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APPENDIX A

COAL SAMPLING LOGS
COAL AND ASH ANALYSES

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Table A-1

Coal Sampling Log Sheet

Plant/Mine Milliken Unit 2 Date 11/7/96

Clean Coal					
Top Size, in	5/8		2		6
Minumum Increments	15		15		15
Minimum Wt, lb	2		6		15
Raw Coal					
Top Size, in	5/8		2		6
Minumum Increments	35		35		35
Minimum Wt, lb	2		6		15

Increment	Time	Location	Weight, lb	Stored	Sampler
1	1235	2A1	4.2	Consol Can	M.E.O. / F.O.S.
2	1255	2B2	3.3	✓	M.E.O / F.O.S.
3	1315	2B4	4.0		M.E.O. / F.O.S.
4	1336	2A1	4.2		M.E.O. / F.O.S.
5	1355	2B2	3.3		M.E.O. / F.O.S.
6	1415	2B4	40		M.E.O. / F.O.S.
7	1435	2A1	4.2		M.E.O. / F.O.S.
8	1455	2B2	3.3		M.E.O. / F.O.S.
9	1516	2B4	4.0		M.E.O. / F.O.S.
10	1536	2A1	4.2		M.E.O. / F.O.S.
11	1556	2B2	3.3		MEO / FOS
12	1616	2B4	4.0		MEO / FOS
13	1636	2A1	4.2		MEO / FOS
14	1705	2B2	3.3		MEO / FOS
15	1735	2B4	4.0		MEO / FOS
16	1805	2A1	4.2		MEO / FOS
17	1835	2B2	3.3		MEO / FOS
18	1905	2B4	4.0		MEO / FS
19	1935	2A1	4.2		MEO / FS
20					

B test

Increment Storage YES

Final Weight (Approximate) 73 lbs

Field Preparation RIFFLED

Final Sample Wt ~25 lbs

Sample ID MILLIKEN UNIT 2 COAL 1235 - 1935 11/7/96

Checked by LLA

Table A-1 (Continued)

Coal Sampling Log Sheet

Plant/Mine MILLIKEN UNIT 2 Date 11/8/96

Clean Coal					
Top Size, in	5/8		2		6
Minumum Increments	15		15		15
Minimum Wt, lb	2		6		15
Raw Coal					
Top Size, in	5/8		2		6
Minumum Increments	35		35		35
Minimum Wt, lb	2		6		15

Increment	Time	Location	Weight, lb	Stored	Sampler
1	1020	2A1	3.8	Censol Can	M.E.O. / F.D.W.
2	1040	2B2	4.5		M.E.O / F.D.W.
3	1055	2B4	4.4		M.E.O. / F.D.W.
4	1116	2A1	3.8		M.E.O / F.D.W.
5	1138	2B2	4.5		M.E.O / F.D.W.
6	1155	2B4	4.4		M.E.O / F.D.W.
7	1235	2A1	3.8		M.E.O / F.D.W.
8	1255	2B2	4.5		M.E.O. / F.D.W.
9	1315	2B4	4.4	✓	M.E.O. / F.D.W.
10	1336	2A1	3.8		M.E.O / F.D.W.
11	1400	2B2	4.5		M.E.O / F.D.W.
12	1420	2B4	4.4		M.E.O / F.D.W.
13					
14					
15					
16					
17					
18					
19					
20					

Increment Storage YES

Final Weight (Approximate) 51 lbs

Field Preparation RIFFLED

Final Sample Wt ~25 lbs

Sample ID MILLIKEN UNIT 2 COAL 11/8/96

Checked by LLA

Table A-2
Coal and Fly Ash Analyses

	Coal Analysis		Fly Ash Analysis	
Date	11/7/96	11/8/96	11/7/96	11/8/96
As Received Moisture, wt %	5.90	7.58	0.01	0.09
PROXIMATE, wt % (Dry)				
Volatile Matter	37.85	38.20		
Fixed Carbon	51.25	50.62		
Ash	10.90	11.18		
Total	100.00	100.00		
ULTIMATE (Dry)				
Carbon	74.95	75.02	1.37	3.19
Hydrogen	5.14	5.07	0.01	0.02
Nitrogen	1.47	1.45	<0.01	<0.01
Sulfur	3.08	3.04	0.53	0.68
Oxygen (by diff)	4.46	4.24	-0.12	0.24
Ash	10.90	11.18	98.21	95.87
Total	100.00	100.00	100.00	100.00
Higher Heating Value				
Dry, Btu/lb	13,412	13,315		
Moist/Ash Free, Btu/lb	15,053	14,991		

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APPENDIX B

THERMOCOUPLE CALIBRATION INFORMATION SECONDARY AIR FAN TEMPERATURES

Table B-1

PCS

PITTSBURGH CONTROL SYSTEMS, INC.

601 MAYER STREET · BRIDGEVILLE, PA 15017 · 412/220-9371 · FAX 412/220-9375

Report Of Calibration

Date OCTOBER 29, 1996

Certification Test of THERMOCOUPLES

Type 'K'

Part No. CK6S16044G-00-RST-SB(317)006MP

Calibration for CONSOL INC.

Serial No. SEE BELOW

Inventory No. 033980

Test No. 1386/7-2172

Temp. 69°F Humid 37%

PERFORMED BY: THOMAS L. RUGGLES

T/C	TARGET		TEST	TEMP		STD	TEMP		DEV.
NUMBER	TEMP		MV	EQUIV		MV	EQUIV		
44-1	100°F		1.480	98.2°F		0.221	100°F		-1.8°F
	300°F		6.057	298.4°F		1.022	300°F		-1.6°F
	500°F		10.537	499.0°F		1.963	500°F		-1.0°F
	700°F		15.146	698.6°F		2.985	700°F		-1.4°F
44-2	100°F		1.482	98.3°F		0.221	100°F		-1.7°F
	300°F		6.059	298.5°F		1.022	300°F		-1.5°F
	500°F		10.539	499.1°F		1.963	500°F		-0.9°F
	700°F		15.150	698.8°F		2.985	700°F		-1.2°F
44-3	100°F		1.482	98.3°F		0.221	100°F		-1.7°F
	300°F		6.059	198.5°F		1.022	300°F		-1.5°F
	500°F		10.539	499.1°F		1.963	500°F		-0.9°F
	700°F		15.148	698.7°F		2.985	700°F		-1.3°F

This calibration is traceable to NIST. NO. 256676 (REFERENCE THERMOCOUPLE)

CALIBRAITON UNIT: LINDBERG CALIBRATING FURNACE MODEL NO. 55667 S/N 919006

Thomas Ruggles

Head Metrologist

Table B-2

PCS
PITTSBURGH CONTROL SYSTEMS, INC.
601 MAYER STREET · BRIDGEVILLE, PA 15017 · 412/220-9371 · FAX 412/220-9375

Report Of Calibration

Date OCTOBER 29, 1996

Certification Test of THERMOCOUPLES
Type 'K'
Part No. CK6S16066G-00-RST-SB(317)006MP
Calibration for CONSOL INC.

Serial No. SEE BELOW
Inventory No. 033980
Test No. 1386/7-2172
Temp. 69°F Humid 37%
PERFORMED BY: THOMAS L. RUGGLES

T/C NUMBER	TARGET TEMP.		TEST MV	TEMP EQUIV		STD MV	TEMP EQUIV		DEV.
66-4	100°F		1.502	99.2°F		0.221	100°F		-0.8°F
	300°F		6.077	299.3°F		1.022	300°F		-0.7°F
	500°F		10.562	500.1°F		1.963	500°F		+0.1°F
	700°F		15.167	699.5°F		2.985	700°F		-0.5°F
66-5	100°F		1.494	98.8°F		0.221	100°F		-1.2°F
	300°F		6.068	298.9°F		1.022	300°F		-1.1°F
	500°F		10.537	499.0°F		1.963	500°F		-1.0°F
	700°F		15.148	698.7°F		2.985	700°F		-1.3°F

This calibration is traceable to NIST. NO. 256676 (REFERENCE THERMOCOUPLE)
CALIBRATION UNIT: LINDBERG CALIBRATING FURNACE MODEL NO. 55667 S/N 919006

Thomas
Head Metrologist

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Table B-3

PCS **PITTSBURGH CONTROL SYSTEMS, INC.**
601 MAYER STREET · BRIDGEVILLE, PA 15017 · 412/220-9371 · FAX 412/220-9375

Report Of Calibration

Date OCTOBER 29, 1996

Certification Test of THERMOCOUPLES

Type 'K'

Part No. CK6S16120G-00-RST-SB(317)006MP

Calibration for CONSOL INC.

Serial No. SEE BELOW

Inventory No. 033980

Test No. 1386/7-2172

Temp. 69°F Humid 37%

PERFORMED BY: THOMAS L. RUGGLES

T/C	TARGET		TEST	TEMP		STD	TEMP		DEV.
NUMBER	TEMP		MV	EQUIV		MV	EQUIV		
140-6 ~~120-6~~	100°F		1.492	98.7°F		0.221	100°F		-1.3°F
	300°F		6.068	298.9°F		1.022	300°F		-1.1°F
	500°F		10.556	499.8°F		1.963	500°F		-0.2°F
	700°F		15.16 5	699.4°F		2.985	700°F		-0.6°F
120-7	100°F		1.498	99.0°F		0.221	100°F		-1.0°F
	300°F		6.072	2~~1~~99.1°F		1.022	300°F		-0.9°F
	500°F		10.558	499.9°F		1.963	500°F		-0.1°F
	700°F		15.169	699.6°F		2.985	700°F		-0.4°F

This calibration is traceable to NIST. NO. 256676 (REFERENCE THERMOCOOUPLE)

CALIBRAITON UNIT: LINDBERG CALIBRATING FURNACE MODEL NO. 55667 S/N 919006

Thomas

Head Metrologist

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Table B-4

PCS
PITTSBURGH CONTROL SYSTEMS, INC.
601 MAYER STREET · BRIDGEVILLE, PA 15017 · 412/220-9371 · FAX 412/220-9375

Report Of Calibration

Date OCTOBER 29, 1996

Certification Test of THERMOCOUPLES
Type 'K'
Part No. CK6S16140G-00-RST-SB(317)006MP
Calibration for CONSOL INC.

Serial No. SEE BELOW
Inventory No. 033980
Test No. 1386/7-2172
Temp. 69°F Humid 37%
PERFORMED BY: THOMAS L. RUGGLES

T/C	TARGET		TEST	TEMP		STD	TEMP		DEV.
NUMBER	TEMP		MV	EQUIV		MV	EQUIV		
120-8 ~~140-8~~	100°F		1.491	98.7°F		0.221	100°F		-1.3°F
	300°F		6.066	298.8°F		1.022	300°F		-1.2°F
	500°F		10.542	499.2°F		1.963	500°F		-0.8°F
	700°F		15.153	698.9°F		2.985	700°F		-1.1°F
140-9	100°F		1.480	98.2°F		0.221	100°F		-1.8°F
	300°F		6.057	298.4°F		1.022	300°F		-1.6°F
	500°F		10.537	499.0°F		1.963	500°F		-1.0°F
	700°F		15.148	698.7°F		2.985	700°F		-1.3°F

This calibration is traceable to NIST. NO. 256676 (REFERENCE THERMOCOUPLE)
CALIBRAITON UNIT: LINDBERG CALIBRATING FURNACE MODEL NO. 55667 S/N 919006

Head Metrologist

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Table B-5
Calibration Correlation Coefficients
Grounded Sheathed Thermocouples

Pitot Probe TC's

TC #	a	b
44-1	1.80875	-0.00090
44-2	1.74346	-0.00105
44-3	1.70884	-0.00090
66-4	0.81499	-0.00085
66-5	1.11021	0.00010
140-6	1.39848	-0.00150
120-7	1.11895	-0.00130
120-8	1.29953	-0.00050
140-9	1.84336	-0.00105

$T_a = T_m + (a + bT_m)$

Where:

Ta = Actual Temperature, °F

Tm = Measured Temperature, °F

a, b = Correction Correlation Constants

TABLE B-6
Secondary Air Fan Outlet Temperatures (Heat Pipe Inlet) -- Test 1

	Uncorrected Recorder Readings, °F								Corrected Recorder Readings, °F							
Date	11/7/96															
	Unit 2A Thermocouples				Unit 2B Thermocouples				Unit 2A Thermocouples				Unit 2B Thermocouples			
Time	TC-1	TC-2	TC-3	TC-4	TC-5	TC-6	TC-7	TC-8	TC-1	TC-2	TC-3	TC-4	TC-5	TC-6	TC-7	TC-8
12:37	94.8	93.8	93.4	96.5	94.2	93.3	91.1	92.0	93.5	92.4	92.2	95.1	92.8	91.6	90.5	91.1
12:52	94.8	93.8	93.8	96.3	94.5	93.4	91.3	92.0	93.5	92.4	92.6	94.8	93.1	91.7	90.6	91.2
13:07	94.9	93.8	93.6	96.4	94.3	93.0	91.2	91.9	93.6	92.4	92.4	94.9	92.9	91.3	90.5	91.1
13:22	95.1	94.0	93.8	96.9	95.0	93.8	91.6	92.4	93.8	92.7	92.6	95.4	93.6	92.1	90.9	91.6
13:37	95.2	94.1	93.8	97.0	94.7	93.7	91.8	92.6	93.9	92.7	92.6	95.5	93.3	92.0	91.2	91.7
13:52	95.4	94.2	94.1	97.1	95.0	93.8	91.6	92.5	94.1	92.8	92.9	95.7	93.6	92.1	90.9	91.6
14:07	95.3	94.1	93.9	97.1	95.0	94.1	91.8	92.7	94.0	92.7	92.7	95.7	93.6	92.4	91.2	91.8
14:22	95.2	94.0	94.0	96.8	94.8	93.9	91.7	92.6	93.9	92.6	92.7	95.3	93.4	92.2	91.0	91.8
14:37	95.1	94.2	94.3	96.6	95.0	94.1	91.6	92.6	93.8	92.8	93.1	95.2	93.6	92.3	91.0	91.8
14:54	95.5	94.3	94.2	97.2	95.3	94.1	92.0	93.0	94.2	92.9	93.0	95.7	93.9	92.4	91.3	92.2
15:09	95.3	94.3	94.3	97.2	95.3	94.4	91.8	92.7	94.0	92.9	93.1	95.7	93.9	92.7	91.1	91.9
15:24	95.4	94.4	94.3	97.1	95.3	94.2	92.0	92.7	94.1	93.0	93.1	95.6	93.9	92.5	91.3	91.8
15:39	95.5	94.2	94.5	97.1	95.0	94.2	91.8	92.7	94.2	92.9	93.2	95.7	93.6	92.4	91.1	91.9
15:54	95.5	94.4	94.4	97.1	95.2	94.0	91.8	92.7	94.2	93.0	93.2	95.6	93.8	92.2	91.1	91.8
16:09	95.7	94.8	94.6	97.6	95.5	94.5	92.2	93.1	94.4	93.4	93.3	96.2	94.1	92.7	91.5	92.2
16:24	95.7	94.7	94.8	97.5	95.6	94.6	92.6	93.3	94.4	93.3	93.6	96.0	94.2	92.8	91.9	92.5
Average Temps			95.1	Unit 2A			93.3	Unit 2B			**93.8**	**Unit 2A**			92.2	Unit 2B
16:39	96.2	95.3	95.2	97.7	96.2	94.9	92.9	93.7	94.9	93.9	94.0	96.2	94.8	93.2	92.2	92.8
16:54	96.1	95.2	95.2	97.6	96.2	95.1	93.0	93.8	94.8	93.8	94.0	96.1	94.8	93.4	92.3	93.0
17:09	96.6	95.4	95.4	98.0	96.3	95.5	93.2	94.0	95.3	94.0	94.2	96.5	94.9	93.8	92.5	93.1
17:24	96.2	95.4	95.4	97.9	96.4	95.2	92.9	93.7	94.9	94.0	94.2	96.4	95.0	93.5	92.3	92.9
17:39	96.3	95.3	95.4	97.9	96.3	95.1	93.0	93.6	95.0	93.9	94.2	96.5	94.9	93.4	92.3	92.8
17:54	96.2	95.1	95.1	98.0	96.3	94.9	92.8	93.4	94.9	93.7	93.8	96.5	94.9	93.2	92.1	92.6
18:09	96.4	95.4	95.2	98.2	96.6	95.4	93.2	93.9	95.1	94.0	94.0	96.7	95.2	93.7	92.6	93.1
18:24	96.6	95.7	95.4	98.3	96.7	95.6	93.3	94.0	95.3	94.3	94.2	96.8	95.3	93.8	92.6	93.1
18:39	97.1	96.0	95.7	98.6	97.2	95.9	93.6	94.6	95.8	94.6	94.5	97.1	95.8	94.2	93.0	93.8
18:54	97.0	96.0	95.9	98.6	97.2	96.2	93.6	94.6	95.7	94.6	94.7	97.1	95.8	94.5	93.0	93.7
19:09	97.4	96.3	96.1	98.9	97.3	96.1	93.7	94.7	96.1	94.9	94.9	97.5	95.9	94.4	93.1	93.9
19:24	97.1	96.1	96.0	98.7	97.3	96.0	93.8	94.8	95.8	94.7	94.8	97.2	95.9	94.3	93.1	94.0
19:39	97.2	96.2	95.8	98.9	97.5	96.0	93.6	94.9	95.9	94.8	94.6	97.4	96.1	94.2	93.0	94.0
Average Temps			96.5	Unit 2A			94.9	Unit 2B			95.2	Unit 2A			**93.8**	**Unit 2B**

TABLE B-7

Secondary Air Fan Outlet Temperatures (Heat Pipe Inlet) -- Test 2

Date 11/8/96

	Uncorrected Recorder Readings, °F								Corrected Recorder Readings, °F							
	Unit 2A Thermocouples				**Unit 2B Thermocouples**				**Unit 2A Thermocouples**				**Unit 2B Thermocouples**			
Time	TC-1	TC-2	TC-3	TC-4	TC-5	TC-6	TC-7	TC-8	TC-1	TC-2	TC-3	TC-4	TC-5	TC-6	TC-7	TC-8
10:08	87.6	86.7	86.4	88.8	86.2	86.8	84.0	84.3	86.3	85.3	85.2	87.4	84.8	85.2	83.3	83.5
10:23	86.9	86.0	85.7	88.4	86.0	86.3	84.0	84.2	85.6	84.6	84.4	87.0	84.6	84.7	83.3	83.3
10:38	86.7	85.8	85.4	88.0	85.8	86.2	83.8	84.0	85.4	84.4	84.2	86.6	84.4	84.5	83.1	83.1
10:53	86.8	85.8	85.6	88.0	85.7	86.3	83.6	83.7	85.5	84.4	84.3	86.6	84.3	84.7	82.8	82.8
11:08	86.2	85.1	84.9	87.5	85.2	85.4	83.1	83.2	84.9	83.7	83.7	86.1	83.8	83.8	82.4	82.4
11:23	85.8	85.1	84.8	87.3	85.0	85.3	83.1	83.1	84.5	83.7	83.6	85.9	83.7	83.7	82.4	82.3
11:38	86.2	85.0	85.1	87.4	85.9	85.7	83.4	84.0	84.9	83.7	83.9	86.0	84.5	84.1	82.7	83.1
11:53	85.9	85.0	85.2	87.3	85.5	85.4	83.2	83.7	84.6	83.6	83.9	85.9	84.2	83.8	82.5	82.8
12:08	85.8	84.6	84.7	86.9	85.3	85.1	83.0	83.5	84.5	83.2	83.5	85.5	84.0	83.5	82.3	82.6
12:23	85.7	84.6	84.6	86.9	85.5	85.3	83.1	83.5	84.4	83.2	83.4	85.5	84.1	83.7	82.4	82.6
12:38	85.4	84.7	84.6	86.7	85.2	85.0	82.9	83.3	84.1	83.3	83.3	85.3	83.8	83.4	82.2	82.5
Average Temps			86.1	Unit 2A			84.6	Unit 2B			**84.7**	**Unit 2A**			83.4	Unit 2B
12:23	85.7	84.6	84.6	86.9	85.5	85.3	83.1	83.5	84.4	83.2	83.4	85.5	84.1	83.7	82.4	82.6
12:38	85.4	84.7	84.6	86.7	85.2	85.0	82.9	83.3	84.1	83.3	83.3	85.3	83.8	83.4	82.2	82.5
12:53	85.5	84.7	84.6	86.8	85.1	84.8	82.9	83.4	84.2	83.3	83.3	85.4	83.7	83.2	82.2	82.5
13:08	85.5	84.8	84.9	86.7	85.4	85.3	82.9	83.5	84.2	83.5	83.7	85.3	84.0	83.7	82.2	82.6
13:23	85.6	85.0	85.2	86.9	85.7	85.2	83.3	83.8	84.3	83.6	84.0	85.5	84.4	83.6	82.6	82.9
13:38	85.9	84.9	85.2	86.9	85.8	85.0	83.2	83.8	84.6	83.6	83.9	85.5	84.4	83.4	82.4	82.9
13:53	85.7	85.1	85.3	86.9	85.4	85.0	83.2	83.7	84.4	83.8	84.0	85.5	84.0	83.4	82.5	82.8
14:08	85.9	84.9	85.2	86.8	85.9	85.3	83.5	84.1	84.6	83.6	84.0	85.4	84.5	83.7	82.8	83.2
14:23	85.5	84.8	84.8	86.7	85.7	85.5	83.3	83.9	84.2	83.4	83.6	85.3	84.3	83.9	82.6	83.1
14:38	85.1	84.4	84.3	86.4	85.2	85.0	83.0	83.7	83.8	83.0	83.0	85.0	83.8	83.4	82.3	82.8
14:53	85.2	84.5	84.2	86.4	85.5	85.2	83.3	83.5	83.9	83.1	83.0	85.0	84.1	83.5	82.6	82.7
Average Temps			85.5	Unit 2A			84.4	Unit 2B			84.1	Unit 2A			**83.2**	**Unit 2B**

1040

Figure B-1
Thermocouple Calibration Temperature differences For Sheathed TCs -- Milliken Heat Pipe Tests

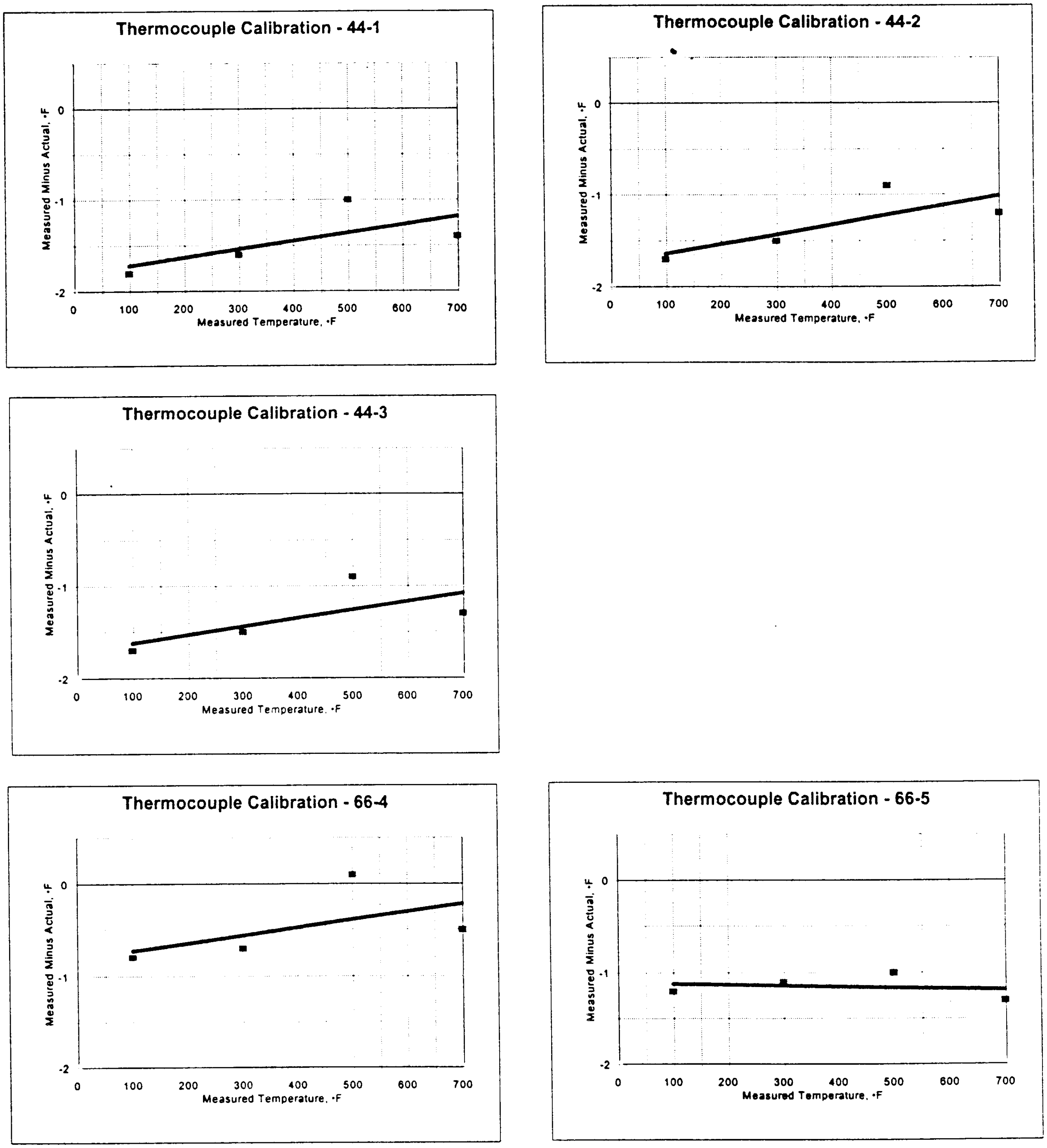


Figure B-2
Thermocouple Calibration Temperature differences For Sheathed TCs -- Milliken Heat Pipe Tests

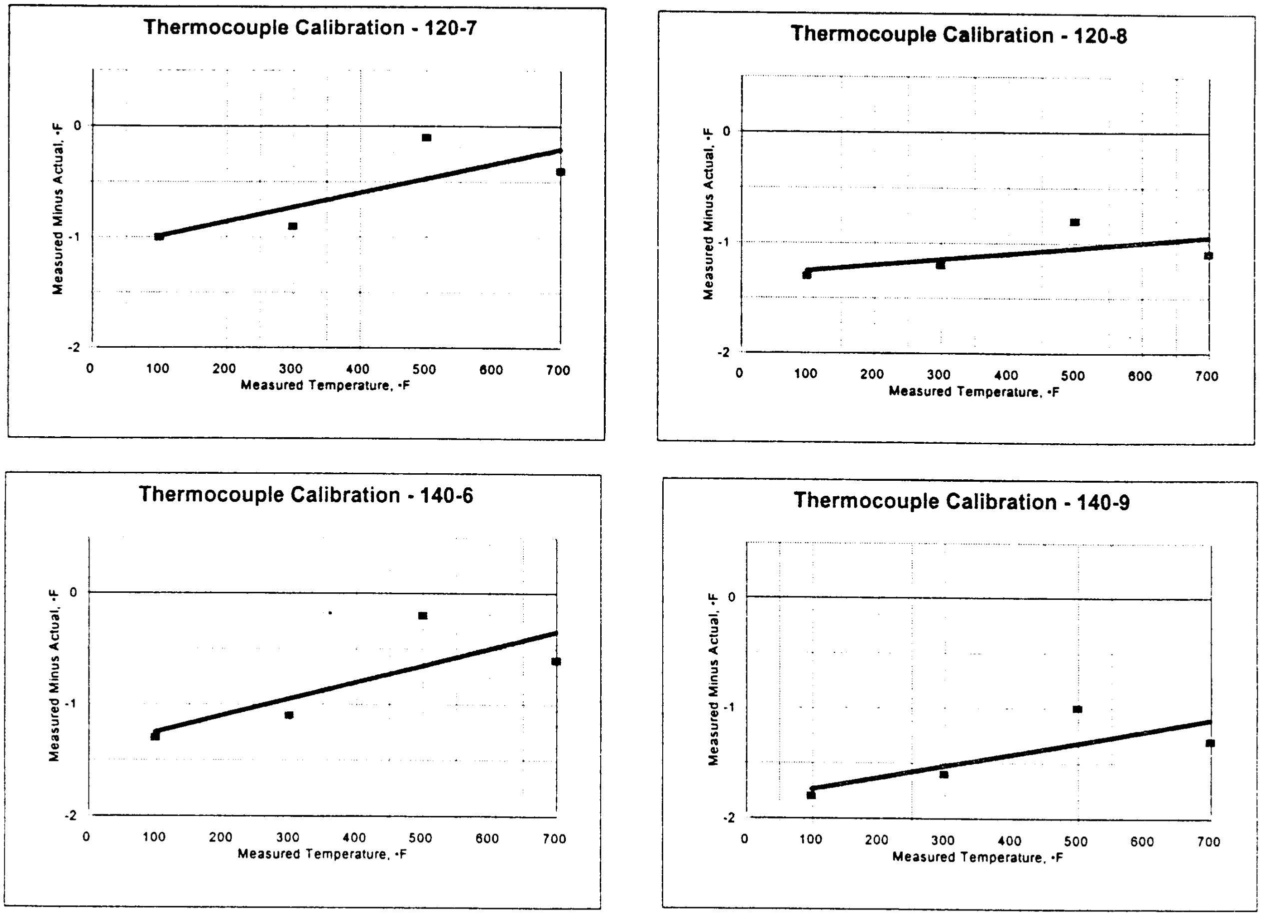
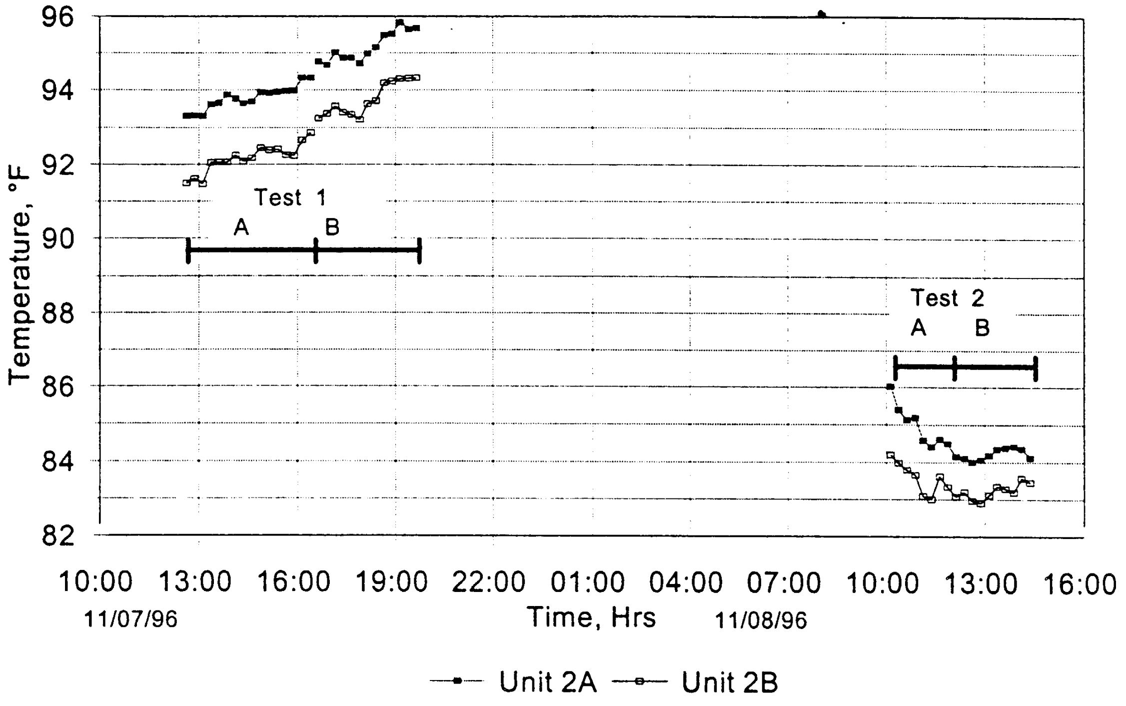


Figure B-3

Secondary Air Fan Outlet (Heat Pipe Inlet) Temps

15 Min. Interval Readings -- Chessell Recorder



APPENDIX C

PITOT TUBE CALIBRATIONS

Table C-1
Pitot Calibration C-Factor Summary

	C-Factor Pre-Test		C-Factor Post-Test		% Change	
Pitot ID	**A Side**	**B Side**	**A Side**	**B Side**	**A Side**	**B Side**
S-49	0.802	0.796	0.795	0.792	-0.873	-0.503
S-50	0.810	0.802	0.797	0.792	-1.605	-1.247
S-51	0.822	0.823	0.815	0.814	-0.852	-1.094
S-52	0.813	0.809	0.822	0.821	1.107	1.483
S-53	0.816	0.813	0.811	0.809	-0.613	-0.492
S-54	0.806	0.811	0.808	0.806	0.248	-0.617

Note "A" side is normally faced into flow.

1045

Table C-2
Pre-Test Pitot Tube Calibrations

PITOT TUBE ID NUMBER- S-49
PITOT TUBE DESCRIPTION- 5', 1" OD, SS
DATE CALIBRATED- 6/3/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.19	0.27	0.813	0.813	0.000	28
	2		0.19	0.27	0.813			
	3		0.19	0.27	0.813			
LOW	1	B	0.19	0.28	0.799	0.804	0.006	28
	2		0.19	0.27	0.813			
	3		0.19	0.28	0.799			
MEDIUM	1	A	0.42	0.67	0.791	0.794	0.004	43
	2		0.42	0.67	0.791			
	3		0.43	0.67	0.800			
MEDIUM	1	B	0.42	0.67	0.791	0.794	0.004	43
	2		0.43	0.67	0.800			
	3		0.42	0.67	0.791			
HIGH	1	A	0.89	1.38	0.798	0.798	0.000	62
	2		0.89	1.38	0.798			
	3		0.89	1.38	0.798			
HIGH	1	B	0.88	1.37	0.797	0.798	0.001	61
	2		0.88	1.36	0.800			
	3		0.88	1.37	0.797			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.802	0.008
B	0.798	0.004

[illegible]

PITOT TUBE CALIBRATIONS

PITOT TUBE ID NUMBER- S-50
PITOT TUBE DESCRIPTION- 5', 1" OD, SS
DATE CALIBRATED- 6/3/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.16	0.25	0.810	0.799	0.007	26
	2		0.16	0.26	0.794			
	3		0.16	0.26	0.794			
LOW	1	B	0.16	0.26	0.794	0.789	0.007	26
	2		0.16	0.26	0.794			
	3		0.16	0.27	0.779			
MEDIUM	1	A	0.46	0.69	0.808	0.805	0.004	44
	2		0.46	0.69	0.808			
	3		0.45	0.69	0.799			
MEDIUM	1	B	0.45	0.69	0.799	0.801	0.003	44
	2		0.45	0.68	0.805			
	3		0.45	0.69	0.799			
HIGH	1	A	0.88	1.26	0.824	0.826	0.002	61
	2		0.89	1.27	0.825			
	3		0.89	1.26	0.828			
HIGH	1	B	0.89	1.30	0.816	0.816	0.002	61
	2		0.88	1.29	0.814			
	3		0.89	1.29	0.819			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.810	0.010
B	0.802	0.009

[illegible]

MSD

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Signed	Date	Signed	Date
		MSD	6-14-9

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Table C-2 (Continued)
Pre-Test Pitot Tube Calibrations

PITOT TUBE ID NUMBER- S-51
PITOT TUBE DESCRIPTION- 42", 1" OD, SS
DATE CALIBRATED- 6/3/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.17	0.25	0.834	0.823	0.007	27
	2		0.17	0.26	0.818			
	3		0.17	0.26	0.818			
LOW	1	B	0.17	0.26	0.818	0.815	0.003	27
	2		0.17	0.26	0.818			
	3		0.16	0.25	0.810			
MEDIUM	1	A	0.45	0.66	0.817	0.816	0.001	43
	2		0.44	0.65	0.815			
	3		0.44	0.65	0.815			
MEDIUM	1	B	0.45	0.65	0.824	0.821	0.004	44
	2		0.45	0.65	0.824			
	3		0.44	0.65	0.815			
HIGH	1	A	0.88	1.25	0.827	0.827	0.001	61
	2		0.88	1.25	0.827			
	3		0.89	1.26	0.828			
HIGH	1	B	0.89	1.24	0.835	0.832	0.002	61
	2		0.88	1.24	0.830			
	3		0.88	1.24	0.830			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.822	0.004
B	0.823	0.006

[illegible]

PITOT TUBE CALIBRATIONS

PITOT TUBE ID NUMBER- S-52
PITOT TUBE DESCRIPTION- 42", 1" OD, SS
DATE CALIBRATED- 6/3/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.19	0.28	0.805	0.805	0.000	28
	2		0.19	0.28	0.805			
	3		0.19	0.28	0.805			
LOW	1	B	0.19	0.29	0.791	0.795	0.006	28
	2		0.19	0.28	0.805			
	3		0.19	0.29	0.791			
MEDIUM	1	A	0.44	0.65	0.810	0.809	0.003	43
	2		0.44	0.66	0.804			
	3		0.45	0.66	0.813			
MEDIUM	1	B	0.44	0.65	0.815	0.812	0.003	43
	2		0.44	0.66	0.806			
	3		0.44	0.65	0.815			
HIGH	1	A	0.88	1.26	0.824	0.826	0.001	61
	2		0.88	1.25	0.827			
	3		0.88	1.25	0.827			
HIGH	1	B	0.89	1.29	0.819	0.818	0.001	61
	2		0.88	1.28	0.817			
	3		0.88	1.28	0.817			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.813	0.006
B	0.809	0.009

[illegible]

MSD

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Read and Understood By

Signed ____________ Date ____________

Signed MSD Date 6-14-96

Table C-2 (Continued)
Pre-Test Pitot Tube Calibrations

PITOT TUBE ID NUMBER- S-53
PITOT TUBE DESCRIPTION- 10', 1" OD, SS
DATE CALIBRATED- 6/3/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.21	0.32	0.816	0.810	0.009	30
	2		0.20	0.32	0.797			
	3		0.21	0.32	0.816			
LOW	1	B	0.20	0.31	0.810	0.805	0.006	29
	2		0.20	0.32	0.797			
	3		0.20	0.31	0.810			
MEDIUM	1	A	0.44	0.67	0.809	0.810	0.003	43
	2		0.44	0.66	0.815			
	3		0.43	0.66	0.806			
MEDIUM	1	B	0.43	0.66	0.803	0.810	0.005	43
	2		0.43	0.65	0.809			
	3		0.44	0.65	0.818			
HIGH	1	A	0.88	1.24	0.830	0.828	0.001	61
	2		0.88	1.25	0.827			
	3		0.88	1.25	0.827			
HIGH	1	B	0.88	1.26	0.824	0.824	0.001	61
	2		0.89	1.27	0.825			
	3		0.88	1.26	0.824			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.816	0.008
B	0.813	0.007

[illegible]

PITOT TUBE CALIBRATIONS

PITOT TUBE ID NUMBER- S-54
PITOT TUBE DESCRIPTION- 11', 1" OD, SS
DATE CALIBRATED- 6/3/96
CALIBRATED BY- OJB,FLL

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.18	0.28	0.810	0.805	0.003	27
	2		0.17	0.27	0.802			
	3		0.17	0.27	0.802			
LOW	1	B	0.17	0.27	0.802	0.813	0.007	27
	2		0.17	0.26	0.818			
	3		0.17	0.26	0.818			
MEDIUM	1	A	0.43	0.66	0.806	0.804	0.001	43
	2		0.42	0.65	0.803			
	3		0.42	0.65	0.803			
MEDIUM	1	B	0.42	0.64	0.802	0.802	0.000	42
	2		0.42	0.64	0.802			
	3		0.42	0.64	0.802			
HIGH	1	A	0.85	1.27	0.810	0.809	0.001	60
	2		0.85	1.27	0.810			
	3		0.84	1.26	0.808			
HIGH	1	B	0.85	1.25	0.816	0.817	0.001	60
	2		0.85	1.25	0.816			
	3		0.85	1.24	0.820			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.806	0.002
B	0.811	0.006

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Read and Understood By

Signed	Date	Signed	Date
		MSD	6-14-9

Table C-3
Post-Test Pitot Tube Calibrations

PITOT TUBE ID NUMBER- S-49
PITOT TUBE DESCRIPTION- 5', 1" OD, SS
DATE CALIBRATED- 12/12/96
CALIBRATED BY- OJB,LLA

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.18	0.26	0.806	0.798	0.005	27
	2		0.17	0.26	0.794			
	3		0.17	0.26	0.794			
LOW	1	B	0.17	0.25	0.798	0.795	0.004	26
	2		0.17	0.25	0.798			
	3		0.16	0.24	0.789			
MEDIUM	1	A	0.39	0.60	0.798	0.800	0.003	41
	2		0.39	0.60	0.798			
	3		0.39	0.59	0.805			
MEDIUM	1	B	0.39	0.60	0.798	0.799	0.002	41
	2		0.39	0.60	0.798			
	3		0.40	0.61	0.802			
HIGH	1	A	0.89	1.40	0.789	0.787	0.002	61
	2		0.88	1.40	0.785			
	3		0.88	1.39	0.788			
HIGH	1	B	0.89	1.44	0.781	0.781	0.001	62
	2		0.88	1.43	0.780			
	3		0.89	1.44	0.781			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.795	0.005
B	0.792	0.007

PITOT TUBE ID NUMBER- S-50
PITOT TUBE DESCRIPTION- 5', 1" OD, SS
DATE CALIBRATED- 12/12/96
CALIBRATED BY- OJB,LLA

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.18	0.28	0.794	0.791	0.004	27
	2		0.17	0.27	0.786			
	3		0.18	0.28	0.794			
LOW	1	B	0.18	0.29	0.787	0.787	0.000	28
	2		0.18	0.29	0.787			
	3		0.18	0.29	0.787			
MEDIUM	1	A	0.41	0.64	0.792	0.799	0.004	42
	2		0.42	0.64	0.802			
	3		0.42	0.64	0.802			
MEDIUM	1	B	0.41	0.63	0.799	0.798	0.004	42
	2		0.41	0.64	0.792			
	3		0.42	0.64	0.802			
HIGH	1	A	0.88	1.34	0.801	0.801	0.000	61
	2		0.88	1.34	0.801			
	3		0.89	1.35	0.800			
HIGH	1	B	0.88	1.38	0.791	0.792	0.002	61
	2		0.89	1.38	0.795			
	3		0.89	1.39	0.790			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.797	0.004
B	0.792	0.004

Table C-3 (Continued)
Post-Test Pitot Tube Calibrations

PITOT TUBE ID NUMBER– S-51
PITOT TUBE DESCRIPTION– 42", 1" OD, SS
DATE CALIBRATED– 12/12/96
CALIBRATED BY– OJB,LLA

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.18	0.27	0.808	0.808	0.000	28
	2		0.18	0.27	0.808			
	3		0.18	0.27	0.808			
LOW	1	B	0.18	0.27	0.808	0.808	0.000	28
	2		0.18	0.27	0.808			
	3		0.18	0.27	0.808			
MEDIUM	1	A	0.41	0.60	0.818	0.823	0.004	42
	2		0.42	0.60	0.828			
	3		0.42	0.61	0.821			
MEDIUM	1	B	0.41	0.60	0.818	0.819	0.001	42
	2		0.42	0.61	0.821			
	3		0.41	0.60	0.818			
HIGH	1	A	0.88	1.30	0.815	0.815	0.000	61
	2		0.88	1.30	0.815			
	3		0.88	1.30	0.815			
HIGH	1	B	0.88	1.30	0.815	0.815	0.001	61
	2		0.88	1.30	0.815			
	3		0.89	1.31	0.816			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.815	0.005
B	0.814	0.004

PITOT TUBE ID NUMBER– S-52
PITOT TUBE DESCRIPTION– 42", 1" OD, SS
DATE CALIBRATED– 12/12/96
CALIBRATED BY– OJB,LLA

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.19	0.29	0.817	0.817	0.000	29
	2		0.19	0.29	0.817			
	3		0.19	0.29	0.817			
LOW	1	B	0.18	0.28	0.810	0.819	0.008	28
	2		0.19	0.28	0.832			
	3		0.19	0.29	0.817			
MEDIUM	1	A	0.40	0.58	0.822	0.817	0.003	41
	2		0.40	0.59	0.815			
	3		0.40	0.59	0.815			
MEDIUM	1	B	0.40	0.60	0.808	0.815	0.005	41
	2		0.40	0.58	0.822			
	3		0.40	0.59	0.815			
HIGH	1	A	0.88	1.24	0.830	0.830	0.000	61
	2		0.88	1.24	0.830			
	3		0.88	1.24	0.830			
HIGH	1	B	0.88	1.25	0.827	0.829	0.002	61
	2		0.89	1.25	0.832			
	3		0.89	1.26	0.828			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.822	0.006
B	0.821	0.005

Table C-3 (Continued)
Post-Test Pitot Tube Calibrations

PITOT TUBE ID NUMBER- S-53
PITOT TUBE DESCRIPTION- 10', 1" OD, SS
DATE CALIBRATED- 12/12/96
CALIBRATED BY- OJB,LLA

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.19	0.28	0.816	0.813	0.013	28
	2		0.19	0.27	0.830			
	3		0.18	0.28	0.794			
LOW	1	B	0.18	0.27	0.808	0.808	0.000	28
	2		0.18	0.27	0.808			
	3		0.18	0.27	0.808			
MEDIUM	1	A	0.40	0.61	0.802	0.805	0.004	41
	2		0.41	0.61	0.812			
	3		0.40	0.61	0.802			
MEDIUM	1	B	0.40	0.60	0.808	0.807	0.002	41
	2		0.39	0.59	0.805			
	3		0.40	0.60	0.808			
HIGH	1	A	0.87	1.29	0.813	0.814	0.001	61
	2		0.87	1.29	0.813			
	3		0.88	1.30	0.815			
HIGH	1	B	0.87	1.29	0.813	0.812	0.002	61
	2		0.87	1.30	0.810			
	3		0.88	1.30	0.815			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.811	0.004
B	0.809	0.002

PITOT TUBE ID NUMBER- S-54
PITOT TUBE DESCRIPTION- 11', 1" OD, SS
DATE CALIBRATED- 12/12/96
CALIBRATED BY- OJB,LLA

VELOCITY RANGE	SAMPLE NUMBER	SIDE	STANDARD READINGS [" of H20]	S-TUBE READINGS [" of H20]	INDIVIDUAL C FACTOR	AVG OF INDIVIDUAL C FACTOR	DEVIATION	APPROX VELOCITY [FT/SEC]
LOW	1	A	0.18	0.29	0.795	0.800	0.006	28
	2		0.18	0.29	0.795			
	3		0.18	0.28	0.810			
LOW	1	B	0.18	0.29	0.795	0.795	0.000	28
	2		0.18	0.29	0.795			
	3		0.18	0.29	0.795			
MEDIUM	1	A	0.43	0.65	0.805	0.807	0.001	43
	2		0.44	0.66	0.808			
	3		0.44	0.66	0.808			
MEDIUM	1	B	0.43	0.64	0.811	0.810	0.001	43
	2		0.43	0.64	0.811			
	3		0.42	0.63	0.808			
HIGH	1	A	0.87	1.28	0.815	0.817	0.001	61
	2		0.87	1.28	0.815			
	3		0.87	1.27	0.819			
HIGH	1	B	0.87	1.29	0.811	0.811	0.001	61
	2		0.88	1.30	0.812			
	3		0.87	1.29	0.811			

AVERAGE CALCULATIONS OVER ENTIRE VELOCITY RANGES

SIDE	C-FACTOR	DEVIATION
A	0.808	0.006
B	0.806	0.007

APPENDIX D

GAS ANALYSES
FUEL LINE PLOT

Table D-1
Gas Analyses

			Gas Chromatagraph Analyses						Analyzer
			CO2	CO	O2 + Ar	N2 (1)	O2 (2)		O2
Location	**Date**	**Time**	%	ppm	%	%	%		%
Flue Gas To 2A Heat Pipe	11/7/96	13:37	14.48	<10	5.18	80.34	4.21		NA
Flue Gas From 2A Heat Pipe	11/7/96	13:45	14.67	<10	5.22	80.11	4.25		NA
Flue Gas From 2B Heat Pipe - Port I-2	11/7/96	19:05	13.71	<10	6.17	80.12	5.20		4.8
Flue Gas From 2A Heat Pipe - Port D-1	11/8/96	10:58	14.50	<10	5.42	80.08	4.46		4.1
Flue Gas To 2A Heat Pipe - Port D-2	11/8/96	11:08	15.52	<10	4.18	80.30	3.21		3.0
Flue Gas From 2A Heat Pipe - Port B-2	11/8/96	11:17	14.55	17	5.34	80.11	4.37		4.4
Pri Flue Gas From 2A Heat Pipe - Port A-1	11/8/96	11:53	12.35	<10	7.73	79.92	6.77		6.6
Flue Gas To 2B Heat Pipe - Port D-2	11/8/96	14:41	14.19	<10	5.61	80.20	4.64		4.9

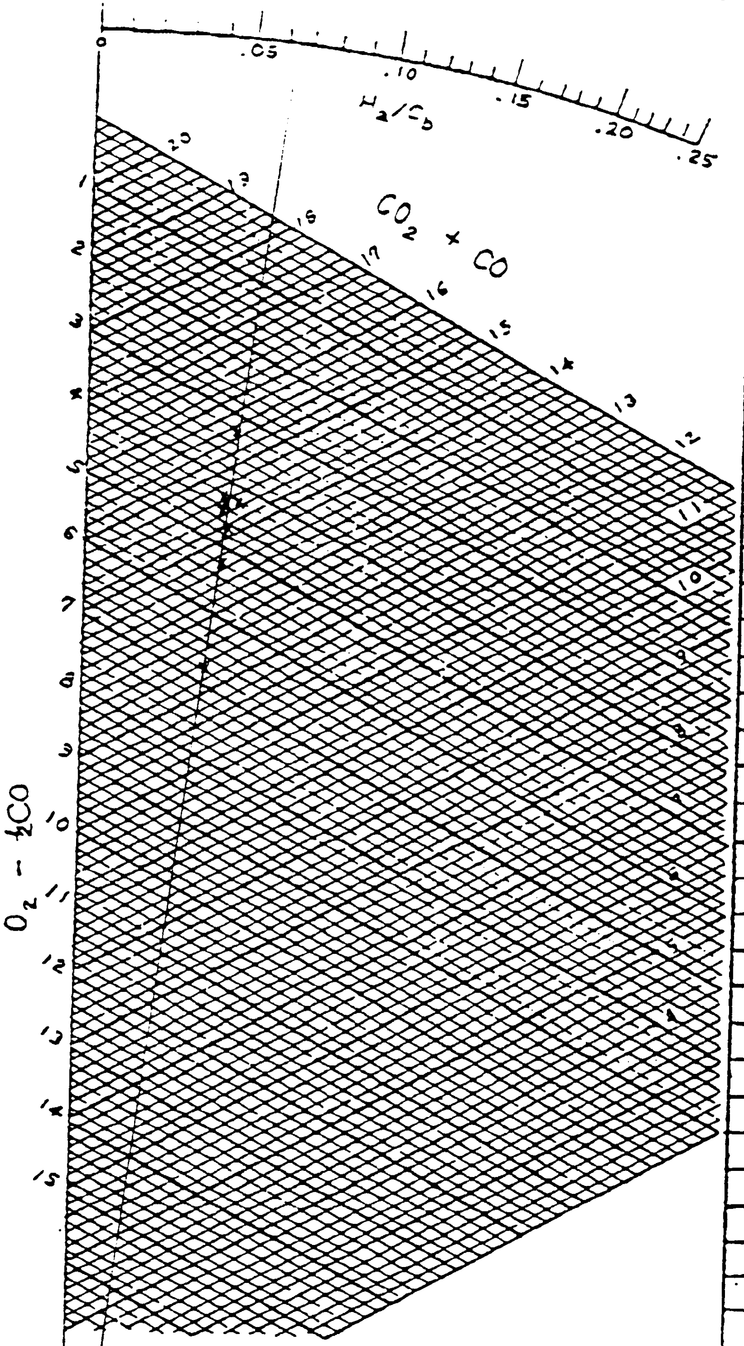
(1) 100 - CO2 - (O2 + Ar)

(2) (O2 + Ar) - N2*0.94/78.03

NA - Not Available

1053

Figure D-1
Dry Flue Gas Volumetric Combustion Chart



$\Sigma V\sqrt{VF}$ = ________

$\Sigma V\sqrt{VF} \times CO_2$ = ________

WTD. CO_2 = ________

ST. CO_2 = ________

PIVOT POINT

LOC	$V\sqrt{F}$	CO_2	$+O_2$	O_2	LOC	$V\sqrt{F}$	CO_2+O_2		O_2

SUBJECT

FILE NO.

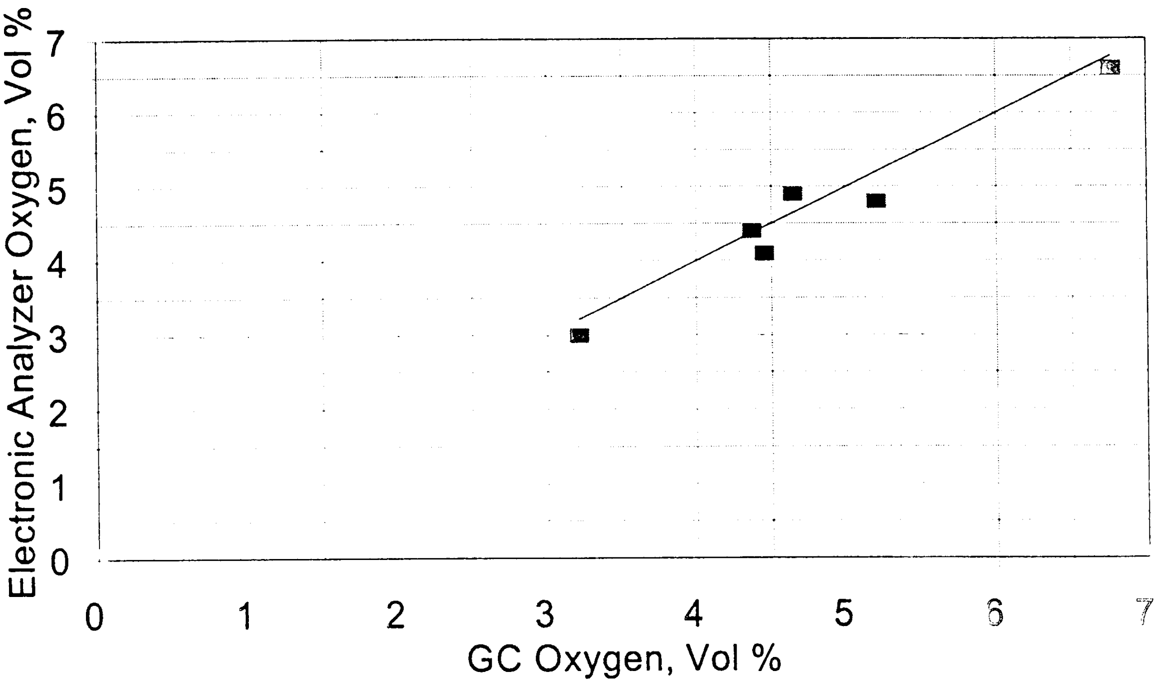
BY

DATE

TEST NO.

Figure D-2

Comparison - Gas Analyzer Versus GC Oxygen



1055

APPENDIX E

FIELD DATA -- PITOT TRAVERSE DATA SHEETS, BAROMETRIC PRESSURES, WET/DRY BULBS

1056

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Flue Gas Inlet - (Rectangular Duct)

Location	A	A or B Duct			
Date	11/7/96			Bar., " Hg	•29.37
Time Begin	12:40	End	13:56	Static, " H2O	-9.602
Tube I.D.	S-53	No. Points	20	Amb Air DB, deg F	
C-Factor	0.816	Duct Width	14.5 ft	Amb Air WB, deg F	
Operator(s)	ROS/WLM	Duct Height	5.5 ft	Humd, lb/lb BD Air	
		Duct Area	79.75 Sq ft		

PORT/ POINT	DISTANCE " From Wall	✓ TEMP Deg-F	✓ DELTA P [" H2O]	✓ % O2	% CO2	✓ CO ppmv	✓ %COMB.	
A-1	8-1/4"	680	0.5965	3.9		10	0.0	* O2 Cal
A-2	24-3/4"	680	0.7132	4.0		10	0.0	
A-3	41-1/4"	675	0.6822	5.0		7	0.0	
A-4	57-3/4"	667	.7238	5.2		10	0.0	
B-1	8-1/4"	649	.6655	3.3		25	0.0	
B-2	24-3/4"	652	.9157	3.5		23	0.0	
B-3	41-1/4"	660	.8490	4.1		27	0.0	
B-4	57-3/4"	664	.9341	4.7		28	0.0	
C-1	8-1/4"	64[illegible]	.6900	2.3		39	0.1	* Cal O2 20.9
C-2	24-3/4"	641	1.054	2.7		48	.1	** Static -9.602
C-3	41-1/4"	641	.9131	3.4		57	.1	
C-4	57-3/4"	645	.9468	4.1		57	.1	
D-1	8-1/4"	669	.6800	2.9		70	0	
D-2	24-3/4"	663	.8669	3.2		73	0	
D-3	41-1/4"	646	.9105	4.1		56	0	
D-4	57-3/4"	651	.9015	4.8		71	0	
E-1	8-1/4"	688	.6526	3.4		72	0	* O2 Cal
E-2	24-3/4"	673	.8068	3.5		86	.1	
E-3	41-1/4"	656	.[illegible]9	3.7		83	.1	
E-5	57-3/4"	653		3.8		83	.1	

Port A = South, E = North

.7931
.8631

Sampling Notes:

Wall = duct btm

File FGITPL.WQ2

05-Nov-96

Method 2 QA/QC Checklist

Plant: Milliken
Date: 11/7/96
Start Time: 12:40 PM Stop Time: 13:56
Unit ID: 2 Duct ID: A
Testers: Roy Scandrol, Lee Mizwa

Pitot ID 10' probe Cp 0.816 Calibration Date 6/96

Pitot Opening Checked? Yes By Whom? DCM Condition? Good

Leak Check of System? Yes By Whom? RoS Condition? Good

Dp Gauge ID S/N M94349 Static Pressure Gauge ID S/N M94349

TC ID [illegible] 7 Handheld TC Readout ID 1

Barometer ID 8623

Leak Check of Gas Sampling System? Yes By Whom? LS Condition? Good

Gas Meter ID [illegible] ORSAT Bag ID F4 N 11/7/96 13:37

QA/QC Check List:

Proper sampling points identified? RoS
Pitot orientation properly marked? RoS
Reference point for pitot depth marked? RoS
Pitot leak check? RoS
Gas sampling system leak check? RLm
Gas Meter Calibrated? DCM
Safety equipment utilized? RoS
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? Yes
Proper probe orientation while traversing? Yes
Process at steady state prior to testing? Yes

1058

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Flue Gas Outlet - (Rectangular Duct)

29.38" BAROMETER
" DP CELL #

Location [✓ A] or B Duct
Date 11/7/96
Time Begin 1245 End 2:02
Bar., " Hg 29.6
Static, " H2O .
Tube I.D. 551
C-Factor 0,822
Operator(s) GLC
DRS
No. Points 24
Duct Width 34 ft
Duct Height 2.5 ft
Duct Area 85.00 Sq ft
Amb Air DB, deg F 113°F
Amb Air WB, deg F
Humd, lb/lb BD Air

288 ,6119 4.4 320 ,3

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	7-1/2"	~~286~~	~~.5~~	~~4.8~~		~~6~~	~~.2~~
A-2	22-1/2"	290	.8192	4.6		276	.3
B-1	7-1/2"	288	.5960	4.3		378	.2
B-2	22-1/2"	288	.6778	4.3		378	.2
C-1	7-1/2"	287	.8301	3.9		368	.2
C-2	22-1/2"	286	.7547	4.0		369	.3
D-1	7-1/2"	287	.8116	4.2		314	.3
D-2	22-1/2"	287	.7529	4.1		318	.3
E-1	7-1/2"	288	.6705	4.2		303	.3
E-2	22-1/2"	289	.7996	4.3		298	.3
F-1	7-1/2"	289	.7157	4.0		261	.3
F-2	22-1/2"	289	.5856	3.9		280	.2
G-1	7-1/2"	290	.4154	4.3		290	.3
G-2	22-1/2"	289	.3332	4.1		185	.3
H-1	7-1/2"	289	.4368	3.9		260	.3
H-2	22-1/2"	288	.4643	4.0		265	.2
I-1	7-1/2"	286	.4749	4.4		175	.1
I-2	22-1/2"	286	.5498	4.3		203	.1
J-1	7-1/2"	286	.5518	4.5		126	.5
J-2	22-1/2"	286	.6343	4.5		144	.5
K-1	7-1/2"	287	.7906	4.5		86	.5
K-2	22-1/2"	286	.5473	4.5		104	.5
L-1	7-1/2"	286	.5246	4.5		11	.2
L-2	22-1/2"	284	.5255	4.6		42	.3

O2 CAL ✓
STATIC = -14.27
STATIC : 14.01"
-14.12" STATIC
O2 CAL ✓

START

Port A = North, L = South

Sampling Notes:

File: FGOTPL.WQ2 05-Nov-96

1059

Method 2 QA/QC Checklist

Plant: Millikan
Date: 11/7/96
Start Time: 12:45 Stop Time: 14:02
Unit ID: 1 Duct ID:
Testers: GLC/DRS

Pitot ID 551 Cp 0.822 Calibration Date 6/96

Pitot Opening Checked? ✓ By Whom? GLC Condition? OK

Leak Check of System? ✓ By Whom? GLC/DRS Condition? OK

Dp Gauge ID M89172 Static Pressure Gauge ID M89172

TC ID 44-1 Handheld TC Readout ID #4

Barometer ID

Leak Check of Gas Sampling System? ✓ By Whom? DRS Condition? Good

Gas Meter ID 118844 ORSAT Bag ID Tg OUT 11/7/96 B

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

1060

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Flue Gas Outlet - (Rectangular Duct)

Location [✓ A] or B Duct
Date 11/7/96
Time Begin 15:30 End 16:22

2932 BAROMETER & DP CELL #
Bar., " Hg 29.6
*Static, " H2O -12.65

Tube I.D. S-52
No. Points 14
C-Factor 0.813
Duct Width 17.92 ft
Operator(s) GLC/DRS
Duct Height 3.28 ft
Duct Area 58.79 Sq ft

Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	9-7/8"	318	.0426	5.7		229	.2
A-2	29-9/16"	325	.0120	4.4		301	.3
B-1	9-7/8"	321	.0395	4.9		290	.3
B-2	29-9/16"	331	.0206	3.8		358	.4
C-1	9-7/8"	319	.0186	5.0		332	.2
C-2	29-9/16"	329	.0200	4.2		370	.6
D-1	9-7/8"	319	.0183	4.6		390	.3
D-2	29-9/16"	329	.0082	3.6		428	.4
E-1	9-7/8"	318	.0470	5.0		420	.7
E-2	29-9/16"	334	.0311	3.8		470	.4
F-1	9-7/8"	318	.0453	4.4		380	.2
F-2	29-9/16"	335	.0248	3.4		420	.2
G-1	9-7/8"	317	.0572	6.3		365	.1
G-2	29-9/16"	317	.0069	5.4		407	.1

O₂ CAL ✓

ORSAT + O₂ CAL

STATIC

O₂ CAL

Port A = South, L = North

Sampling Notes:

28 25
~~29~~ 9/16
9 14/16
10 11

1061

Method 2 QA/QC Checklist

Plant: MILLIKEN
Date: 11/7/96
Start Time: 15:30 Stop Time: 16:22
Unit ID: 2 Duct ID:
Testers: GLC/DRS

Pitot ID S-52 Cp 0.813 Calibration Date 6/96

Pitot Opening Checked? ✓ By Whom? GL Condition? ok

Leak Check of System? ✓ By Whom? GLC Condition? ok

Dp Gauge ID M89172 Static Pressure Gauge ID

TC ID 44-2 Handheld TC Readout ID #4

Barometer ID

Leak Check of Gas Sampling System? ✓ By Whom? GLC Condition? ok

Gas Meter ID 118844 ORSAT Bag ID A SIDE PFG 11/7/96 16:05

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓ ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

1062

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Inlet - (Rectangular Duct)

Location A A or B Duct
Date 11/7/96
Time Begin 15:10 End 15 59

Bar., " Hg 29.32
Static, " H2O 55.5

Tube I.D. S-50 No. Points 12
C-Factor 0.810 Duct Widt 17.5 ft
Operator(s) ROS/WLM Duct Heig 3.28 ft
Duct Area 57.42 Sq ft

Amb Air DB, deg F ______
Amb Air WB, deg F ______
Humd, lb/lb BD Air ______

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]	
A-1	9-7/8"	116	~~.092~~	.0027
A-2	29-9/16"	116	.0033	
B-1	9-7/8"	115	.0207	
B-2	29-9/16"	115	.0120	
C-1	9-7/8"	114	.0285	* STATIC 55.50
C-2	29-9/16"	115	.0121	
D-1	9-7/8"	115	.0147	
D-2	29-9/16"	116	.0056	
E-1	9-7/8"	114	.0373	
E-2	29-9/16"	117	~~[illegible]~~	.0122
F-1	9-7/8"	113	.1026	
F-2	29-9/16"	115	.0258	

Port A = South, F = North

Sampling Notes:

Method 2 QA/QC Checklist

Plant: Milliken
Date: 11/7/96
Start Time: 15:10 Stop Time: 15:59
Unit ID: 2A Duct ID: A
Testers: Roy Scandrol, Lee Mizura

Pitot ID 5-50 Cp 0.810 Calibration Date 6/96

Pitot Opening Checked? Yes By Whom? Roy Condition? Good

Leak Check of System? Yes By Whom? Roy Condition? Good

Dp Gauge ID M94349 Static Pressure Gauge ID M94349

TC ID 4 Handheld TC Readout ID 2

Barometer ID ________

Leak Check of Gas Sampling System? N/A By Whom? _____ Condition? _____

Gas Meter ID N/A ORSAT Bag ID ________

QA/QC Check List:

Proper sampling points identified? Yes
Pitot orientation properly marked? Yes
Reference point for pitot depth marked? Yes
Pitot leak check? Yes
Gas sampling system leak check? ~~Yes~~ N/A
Gas Meter Calibrated? N/A
Safety equipment utilized? Yes
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? Yes
Proper probe orientation while traversing? Yes
Process at steady state prior to testing? Yes

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Outlet - (Circular Duct)

Location A A or B Duct
Date 11-7-96
Time Begin 1507 End ______

Tube I.D. 48' 3-19 No. Points 20
C-Factor 0.802
Operator(s) Bch/LEN Duct Dia. 47.5 inches
Duct Are 12.31 Sq ft

Bar., " Hg 29.34
Static, " H2O 51.58" ; 51.65"
Amb Air DB, deg F ______
Amb Air WB, deg F ______
Humd, lb/lb BD Air ______

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	1-3/16"	~~600~~ 600	0.1964
A-2	3-7/8"	601	0.2412
A-3	6-15/16"	601	0.2519
A-4	10-3/4"	602	0.2741
A-5	16-1/4"	603	0.2507
A-6	31-1/4"	604	0.2271
A-7	36-3/4"	604	0.1952
A-8	40-9/16"	603	0.1789
A-9	43-5/8"	602	0.1630
A-10	46-5/16"	600	0.1368
B-1	1-3/16"	602	0.1879
B-2	3-7/8"	603	0.2333
B-3	6-15/16"	604	0.2201
B-4	10-3/4"	605	0.2432
B-5	16-1/4"	605	0.2448
B-6	31-1/4"	605	0.1930
B-7	36-3/4"	605	0.1730
B-8	40-9/16"	603	0.1676
B-9	43-5/8"	601	0.1412
B-10	46-5/16"	598	0.1159

South Port

Back wall

East Port

SOUTH

Flow Down

EAST

Port A = South or North, B = East

Sampling Notes:

Before Leak Check OK.

Pitot Ports OK, but should be polished up.

File PAOTPL.WQ2 05-Nov-96

1065

Method 2 QA/QC Checklist

Plant: MILLIKEN
Date: 11-7-96
Start Time: 15:07 Stop Time:
Unit ID: 2A Duct ID:
Testers: LEN & Bob

Pitot ID S-49 Cp 0.802 Calibration Date 6/96

Pitot Opening Checked? Rsd By Whom? Red Condition? RSd/Good

Leak Check of System? RSD By Whom? RSD Condition? OK

Dp Gauge ID 120676 CONSEC.# M87129 SER.# Static Pressure Gauge ID NA

TC ID 66-5 Handheld TC Readout ID SEVEN

Barometer ID NA

Leak Check of Gas Sampling System? ~~OK~~ NA By Whom? ~~Len/Bob~~ Condition?

Gas Meter ID NA ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? YES
Pitot orientation properly marked? YES
Reference point for pitot depth marked? YES
Pitot leak check? OK
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

1066

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Secondary Air Outlet - (Rectangular Duct)

Location A A or B Duct
Date 11-7-96
Time Begin 1244 End 1315

29.38 BAROMETER
Bar., " Hg 29.0 " Hg DP CELL
Static, " H2O

Tube I.D. S-54 No. Points 24
C-Factor 0.806 Duct Widt 6.0 ft
Operator(s) B. Klein Duct Heig 9.0 ft
Duct Area 54.00 Sq ft

Amb Air DB, deg F 100+
Amb Air WB, deg F
Humd, lb/lb BD Air

ttom
f
Duct

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	9"	577	0.7645
A-2	27"	575	0.8292
A-3	45"	573	0.8557
A-4	63"	570	0.9363
A-5	81"	564	0.9135
A-6	99"	557	0.9031
B-1	9"	582	0.9329
B-2	27"	584	0.9219
B-3	45"	585	0.8552
B-4	63"	585	0.9536
B-5	81"	576	1.148
B-6	99"	566	0.8516
C-1	9"	576	0.9605
C-2	27"	585	1.059
C-3	45"	591	0.9877
C-4	63"	596	1.106
C-5	81"	598	1.230
C-6	99"	593	1.053
D-1	9"	569	0.9128
D-2	27"	580	0.8641
D-3	45"	589	0.8835
D-4	63"	595	1.146
D-5	81"	600	1.132
D-6	99"	600	1.249

Port A = South, D = North

South

← Flow

Static = 3.657"

NORTH

Sampling Notes:

Method 2 QA/QC Checklist

Plant: MILLIKEN
Date: 11-7-96
Start Time: 12:44
Stop Time: 13:15
Unit ID: 2A
Duct ID: A Secondary
Testers: Len & Bob

Pitot ID 554
Cp 0.806
Calibration Date 6/96

Pitot Opening Checked? RSD
By Whom? Red
Condition? RSD

Leak Check of System? Red
By Whom? Red
Condition? Red

Dp Gauge ID 120676
Static Pressure Gauge ID ____

TC ID 14/0-9
Handheld TC Readout ID SEVEN

Barometer ID ____

Leak Check of Gas Sampling System? N/A
By Whom? ____
Condition? ____

Gas Meter ID NA
ORSAT Bag ID NA

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? OK – Before and after TEST
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? OK
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

1068

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Secondary Air Bypass - (Rectangular Duct)

Location [✓ A] or B Duct
Date 11/07/96
Time Begin 9:05 End 9:28
Tube I.D. 5-53
No. Points ~~8~~ 6
C-Factor 0.816
Duct Widt 17.5 ft
Operator(s) GLC/WLM
Duct Heig 2.09 ft
Duct Area 36.64 Sq ft

29.48 BAROMETER
Bar., " Hg 29.5 DP CELL
Static, " H2O 5.562
Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	6-5/16"		
A-2	18-7/8"		
B-1	6-5/16"	-.0002	240
B-2	18-7/8"	268	-.0001
C-1	6-5/16"	240	.0000
C-2	18-7/8"	275	.0000
D-1	6-5/16"	238	.0000
D-2	18-7/8"	284	.0000

N/A

→ STATIC 5.562"

STATIC 5.464

Port A = South, D = North

Sampling Notes:

File: SA-BPTPL.WQ2

05-Nov-96

Method 2 QA/QC Checklist

Plant: Milliken
Date: 11/7/96
Start Time: 9:05 Stop Time: 9:28
Unit ID: 2A Duct ID: A-2nd Air Bypass
Testers: GLC/WLM

Pitot ID S-53 (10') Cp 0.816 Calibration Date 6/96

Pitot Opening Checked? YES By Whom? GLC Condition? GOOD

Leak Check of System? YES By Whom? GLC Condition? GOOD

Dp Gauge ID M94349 Static Pressure Gauge ID SAME

TC ID #7 Handheld TC Readout ID #1

Barometer ID ________

Leak Check of Gas Sampling System? ~~Y~~N/A By Whom? ____ Condition? ____

Gas Meter ID ____ ORSAT Bag ID ________

QA/QC Check List:

Proper sampling points identified? YES
Pitot orientation properly marked? YES
Reference point for pitot depth marked? YES
Pitot leak check? YES
Gas sampling system leak check? YES
Gas Meter Calibrated? N/A
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? YES

1070

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Flue Gas Inlet - (Rectangular Duct)

Location Milliken A or [✓ B] Duct

Date 11/7/96

Time Begin ~~E:18~~ 18:18 End 19:18

Tube I.D. 5-53

C-Factor 0.816

Operator(s) ROS/WLM

No. Points 20

Duct Width 14.5 ft

Duct Height 5.5 ft

Duct Area 79.75 Sq ft

Bar., " Hg 29.30

Static, " H2O -9.734

Amb Air DB, deg F

Amb Air WB, deg F

Humd, lb/lb BD Air

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.	
A-1	8-1/4"	665	.6677	4.1		8	0	O2 cal
A-2	24-3/4"	658	.8174	4.1		26	0	
A-3	41-1/4"	653	.8155	4.0		38	0	
A-4	57-3/4"	654	.7345	4.1		46	0	
B-1	8-1/4"	658	.7743	4.5		70	0	
B-2	24-3/4"	651	.9983	4.3		83	0	
B-3	41-1/4"	649	.9225	4.3		66	0	
B-4	57-3/4"	655	.8719	4.4		60	0	
C-1	8-1/4"	658	.7094	4.6		~~72~~ 118	0	*O2 cal
C-2	24-3/4"	657	.9669	4.5		115	0	
C-3	41-1/4"	648	.8781	5.0		96	0	*static
C-4	57-3/4"	650	.9311	5.1		72	0	-9.734
D-1	8-1/4"	662	.7043	4.3		51	.1	
D-2	24-3/4"	669	.8693	4.8		125	0	*[illegible]
D-3	41-1/4"	671	.9458	5.1		123	0	
D-4	57-3/4"	667	.9255	5.3		108	0	
E-1	8-1/4"	697	.3645	4.9		64	.2	
E-2	24-3/4"	698	.5910	5.0		53	.1	*O2 cal
E-3	41-1/4"	690	.7640	5.4		58	.2	
E-5	57-3/4"	668	.8633	5.8		48	.1	

Port A = South, E = North

Sampling Notes:

Wall = btm of duct

Method 2 QA/QC Checklist

Plant: Millikan
Date: 11/7/96
Start Time: 18:18 Stop Time: 19:18
Unit ID: 2 B Duct ID: B
Testers: Roy Scandrl , Lee Mizuy

Pitot ID 10 ft probe S-53 Cp 0.816 Calibration Date 6/96

Pitot Opening Checked? ft Yes By Whom? Roy Condition? Good

Leak Check of System? Yes By Whom? Roy Condition?______

Dp Gauge ID M 94349 Static Pressure Gauge ID M 94349

TC ID 7 Handheld TC Readout ID 1

Barometer ID ______

Leak Check of Gas Sampling System? Yes By Whom? Roy Condition?______

Gas Meter ID N/A ORSAT Bag ID ______

QA/QC Check List:

Unit B - O_2

Proper sampling points identified? Yes
Pitot orientation properly marked? Yes
Reference point for pitot depth marked? Yes
Pitot leak check? Yes
Gas sampling system leak check? Yes
Gas Meter Calibrated? N/A
Safety equipment utilized? Yes
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? Yes
Proper probe orientation while traversing? Yes
Process at steady state prior to testing? Yes

1072

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Flue Gas Outlet - (Rectangular Duct)

Location A or [✓ B Duct]
Date 11/7/96
Time Begin 1835 End 1938

Tube I.D. S-52 No. Points 24
C-Factor 0.813 Duct Width 34 ft
Operator(s) GLL/DES Duct Height 2.5 ft
Duct Area 85.00 Sq ft

29.29 BAROMETER
Bar., " Hg 29.5 DP CELL
Static, " H2O
Amb Air DB, deg F 98
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	7-1/2"						
A-2	22-1/2"						
B-1	7-1/2"	291	.3464	5.1		295	.2
B-2	22-1/2"	291	.3990	5.2		594	.3
C-1	7-1/2"	292	.4318	5.1		611	.2
C-2	22-1/2"	291	.4857	5.0		604	.2
D-1	7-1/2"	292	.6809	5.1		607	.4
D-2	22-1/2"	291	.6977	4.8		620	.4
E-1	7-1/2"	293	.5731	5.0		581	.3
E-2	22-1/2"	292	.5992	5.0		585	.3
F-1	7-1/2"	292	.4604	5.1		556	.3
F-2	22-1/2"	293	.5724	5.1		569	.3
G-1	7-1/2"	292	.3454	5.0		545	.2
G-2	22-1/2"	292	.2932	4.9		553	.2
H-1	7-1/2"	293	.8625	4.9		528	.1
H-2	22-1/2"	293	.9350	4.8		540	.1
I-1	7-1/2"	293	.9653	4.9		455	.1
I-2	22-1/2"	293	.9337	4.8		495	.1
J-1	7-1/2"	293	.6742	4.8		409	.2
J-2	22-1/2"	292	.8086	4.6		438	.1
K-1	7-1/2"	293	.8494	4.8		372	.3
K-2	22-1/2"	293	.8786	4.8		390	.2
L-1	7-1/2"	293	.7467	4.9		242	.1
L-2	22-1/2"	293	.5879	5.0		304	.2

STATIC = -14.40
(21.1) O2CAL

STATIC = -14.62

ORSAT/O2 CAL
STATIC = -14.92
20.3 O2CAL ✓

4.9

Port A = North, L = South

.5879

START

Sampling Notes:

File: FGOTPL.WQ2

05-Nov-96

Method 2 QA/QC Checklist

Plant: Milliken
Date: 11/7/96
Start Time: 1835 Stop Time: 1938
Unit ID: 2B Duct ID:
Testers: GLC/DRS

Pitot ID S-52 Cp 0.813 Calibration Date 6/96

Pitot Opening Checked? ✓ By Whom? GLC Condition? GOOD

Leak Check of System? ✓ By Whom? GLC Condition? ✓

Dp Gauge ID M8917R Static Pressure Gauge ID

TC ID #2 (44-2) Handheld TC Readout ID #4

Barometer ID

Leak Check of Gas Sampling System? ✓ By Whom? GC Condition? OK – (Remove

LINE FILTER WAS PLUGGE

Gas Meter ID 118844 ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Primary Flue Gas Outlet - (Rectangular Duct)

Location A or [✓ B Duct]

Date 11/7/96

Time Begin 1710 End 1741

29.32 BAROMETER

Bar., " Hg 29.6 DP. CELL

Static, " H2O -12.85

Tube I.D. S-52

C-Factor 0.813

Operator(s) GLC/DRS

No. Points 14

Duct Width 17.92 ft

Duct Height 3.28 ft

Duct Area 58.79 Sq ft

Amb Air DB, deg F

Amb Air WB, deg F

Humd, lb/lb BD Air

PORT/ POINT	DISTANCE " From Wall	TEMP Deg F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.	
A-1	9-7/8"	321	.0467	7.6		276	.2	
A-2	29-9/16"	324	.0028	7.0		328	.2	
B-1	9-7/8"	330	.0381	6.2		350	.3	
B-2	29-9/16"	324	.0162	6.1		325	.4	
C-1	9-7/8"	311	.0285	5.8		339	.4	STATIC -12.85
C-2	29-9/16"	326	.0095	4.7		390	.5	O2 CAL OK
D-1	9-7/8"	325	.0331	4.9		374	.2	
* D-2	29-9/16"	322	.0078	6.8		300	.1	
* E-1	9-7/8"	319	.0220	6.5		301	.2	
E-2	29-9/16"	327	.0210	5.7		347	.3	
F-1	9-7/8"	327	-.0085	6.2		330	.3	
F-2	29-9/16"	332	.0287	5.3		360	.3	
G-1	9-7/8"	315	.0302	7.6		290	.2	
G-2	29-9/16"	331	.0361	6.1		327	.2	

Port A = South, L = North

Sampling Notes:

PORT A O2's were Double checked w/ 2nd Probe . . .
SAME O2 LEVELS were OBSERVED.
SUSPECT LEAKage AROUND SOOTBLOWERS ABOVE PORT.

* MANWAY ABOVE PORTS D+E Could RESULT IN Slight LEAKage
re. High O2 readings
(FLUCTUATING)

05-Nov-96

File: PFGOTPL.WQ2

1075

Method 2 QA/QC Checklist

Plant: MILLIKEN
Date: 11/7/96
Start Time: 17:10 Stop Time: 17:47
Unit ID: 2B Duct ID:
Testers: GLC/DRS

Pitot ID S-52 Cp 0.813 Calibration Date 6/96

Pitot Opening Checked? ✓ By Whom? GLC Condition? ok

Leak Check of System? ✓ By Whom? GLC Condition? ok

Dp Gauge ID M89172 Static Pressure Gauge ID

TC ID #2 Handheld TC Readout ID #4

Barometer ID

Leak Check of Gas Sampling System? ✓ By Whom? GLC Condition? ok

Gas Meter ID ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified?
Pitot orientation properly marked?
Reference point for pitot depth marked?
Pitot leak check?
Gas sampling system leak check?
Gas Meter Calibrated?
Safety equipment utilized?
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port?
Proper probe orientation while traversing?
Process at steady state prior to testing?

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Inlet - (Rectangular Duct)

Location B A or B Duct
Date 11-7-96
Time Begin 16:25 End 17:03

Bar., " Hg 29.32
Static, " H2O 54.93

Tube I.D. 5-50 No. Points 12
C-Factor 0.810 Duct Widt 17.5 ft
Operator(s) RDS/WLM Duct Heig 3.28 ft
Duct Area 57.42 Sq ft

Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	9-7/8"	115	.0327
A-2	29-9/16"	117	.0058
B-1	9-7/8"	114	.0184
B-2	29-9/16"	115	.0062
C-1	9-7/8"	114	.0876
C-2	29-9/16"	114	.0049
D-1	9-7/8"	113	.0481
D-2	29-9/16"	114	.0015
E-1	9-7/8"	114	.0197
E-2	29-9/16"	114	.0186
F-1	9-7/8"	114	.0015
F-2	29-9/16"	115	.0094

* STATIC

Port A = South, F = North

Sampling Notes:

File PAITPL.WQ2

05-Nov-96

1077

Method 2 QA/QC Checklist

Plant: Milliken
Date: 11-7-96
Start Time: 16:25 Stop Time: 17:03
Unit ID: 2B Duct ID: B
Testers: Roy Scandrel, Lee Mizua

Pitot ID 5-50 Cp 0.810 Calibration Date 6/96

Pitot Opening Checked? Yes By Whom? RS Condition? ______

Leak Check of System? Yes By Whom? RS Condition? ______

Dp Gauge ID M94349 Static Pressure Gauge ID M94349

TC ID 4 Handheld TC Readout ID 1

Barometer ID ______

Leak Check of Gas Sampling System? N/A By Whom? ______ Condition? ______

Gas Meter ID ______ ORSAT Bag ID ______

QA/QC Check List:

Proper sampling points identified? Yes
Pitot orientation properly marked? Yes
Reference point for pitot depth marked? Yes
Pitot leak check? Yes
Gas sampling system leak check? N/A
Gas Meter Calibrated? N/A
Safety equipment utilized? Yes
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? Yes
Proper probe orientation while traversing? Yes
Process at steady state prior to testing? Yes

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Outlet - (Circular Duct)

Location B A or B Duct
Date 11-7-96
Time Begin 1630 End 1710
Tube I.D. S-49 No. Points 20
C-Factor 0.802
Operator(s) Bob/KEN Duct Dia. 47.5 inches
Duct Are 12.31 Sq ft

Bar., " Hg 29.32
Static, " H2O 51.57" & 51.68"
Amb Air DB, deg F 100+
Amb Air WB, deg F
Humd, lb/lb BD Air

Back wall

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	1-3/16"	610	0.1778
A-2	3-7/8"	612	0.2263
A-3	6-15/16"	612	0.2298
A-4	10-3/4"	613	0.2109
A-5	16-1/4"	614	0.2207
A-6	31-1/4"	615	0.1760
A-7	36-3/4"	615	0.1651
A-8	40-9/16"	614	0.1453
A-9	43-5/8"	613	0.1318
A-10	46-5/16"	609	0.0927
B-1	1-3/16"	612	0.1891
B-2	3-7/8"	613	0.1972
B-3	6-15/16"	614	0.2139
B-4	10-3/4"	614	0.2194
B-5	16-1/4"	615	0.2044
B-6	31-1/4"	615	0.1495
B-7	36-3/4"	615	0.1393
B-8	40-9/16"	614	0.1258
B-9	43-5/8"	611	0.1164
B-10	46-5/16"	609	0.0818

North

Flow down

N

East

EAST

Port A = South or North, B = East

Sampling Notes:

LEAK Check & OK Before & After ✓

1079

Method 2 QA/QC Checklist

Plant: MILLIKEN
Date: 11-7-96
Start Time: 16:30 Stop Time: 17:10
Unit ID: 2B Duct ID:
Testers: LEN + BOB

Pitot ID 5-49 Cp 0.802 Calibration Date 6/96

Pitot Opening Checked? ✓ By Whom? RKD Condition? OK

Leak Check of System? ✓ By Whom? RKD Condition? OK

Dp Gauge ID 120676 Static Pressure Gauge ID NA

TC ID 66-5 Handheld TC Readout ID SEVEN

Barometer ID

Leak Check of Gas Sampling System? NA By Whom? Condition?

Gas Meter ID ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? YES
Pitot orientation properly marked? YES
Reference point for pitot depth marked? YES
Pitot leak check? OK
Gas sampling system leak check? NA
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

1080

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Secondary Air Outlet - (Rectangular Duct)

Location B A or B Duct
Date 11-7-96
Time Begin 1825 End 1910

Bar., " Hg 29.30
Static, " H2O 3.623" ; 3.778

Tube I.D. S-54
C-Factor 0.806
Operator(s) Bohlken

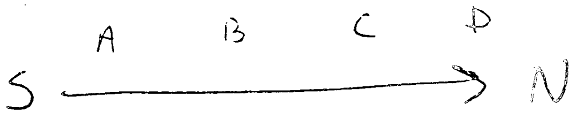
No. Points 24
Duct Widt 6.0 ft
Duct Heig 9.0 ft
Duct Area 54.00 Sq ft

Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

Bottom

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	9"	576	0.8607
A-2	27"	591	0.7080
A-3	45"	602	0.8601
A-4	63"	607	1.190
A-5	81"	609	1.234
A-6	99"	608	1.123
B-1	9"	593	0.8954
B-2	27"	600	0.7763
B-3	45"	605	0.8148
B-4	63"	609	1.077
B-5	81"	610	1.276
B-6	99"	604	1.124
C-1	9"	597	0.9330
C-2	27"	601	0.9329
C-3	45"	600	0.5149
C-4	63"	600	0.9784
C-5	81"	592	1.194
C-6	99"	579	0.9024
D-1	9"	584	0.8592
D-2	27"	586	0.6713
D-3	45"	585	0.7854
D-4	63"	578	1.038
D-5	81"	574	1.133
D-6	99"	569	0.8528

Port A = South, D = North



Sampling Notes:

LEAK Check @ START ✓

Slight Nick on Low Side Port

File: SAOTPL.WQ2

05-Nov-96

Method 2 QA/QC Checklist

Plant: MILLIKEN
Date: 11-7-96
Start Time: 18:25 Stop Time: 19:10
Unit ID: 23 Duct ID:
Testers: Bob/LEN

Pitot ID S-54 Cp 0.806 Calibration Date 6/96

Pitot Opening Checked? By Whom? RED Condition? Low Side has nick

Leak Check of System? ✓ By Whom? RED Condition? ✓

Dp Gauge ID 120676 Static Pressure Gauge ID

TC ID 140-9 Handheld TC Readout ID SEVEN

Barometer ID

Leak Check of Gas Sampling System? ✓ By Whom? RSD Condition? 0"

Gas Meter ID ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? NA
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

1082

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Secondary Air Bypass - (Rectangular Duct)

Location ________ A or [✓ B Duct]
Date 11/7/96
Time Begin 9:35 End 10:06

29.48 BAROMETER
Bar., " Hg 29.6 D.R CELL
Static, " H2O 5.507

Tube I.D. 553
C-Factor 0.816
Operator(s) GLC/WLM
No. Points 8
Duct Widt 17.5 ft
Duct Heig 2.09 ft
Duct Area 36.64 Sq ft

Amb Air DB, deg F ________
Amb Air WB, deg F ________
Humd, lb/lb BD Air ________

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	6-5/16"	254	.0000
A-2	18-7/8"	311	.0000
B-1	6-5/16"	245	.0000
B-2	18-7/8"	307	.0000
C-1	6-5/16"	215	.0000
C-2	18-7/8"	290	-.0001
D-1	6-5/16"	269	.0000
D-2	18-7/8"	314	.0000

STATIC = 5.507"

STATIC = 5.562

Port A = South, D = North

Sampling Notes:

File: SA-BPTPL.WQ2

05-Nov-96

1083

Method 2 QA/QC Checklist

Plant: Milliken
Date: 11/7/96
Start Time: 9:35 Stop Time: 10:06
Unit ID: 2B Duct ID:
Testers: GLC/WLM

Pitot ID S53 Cp 0.816 Calibration Date 6/96

Pitot Opening Checked? ✓ By Whom? GLC Condition? Good

Leak Check of System? ✓ By Whom? GLC Condition? ✓

Dp Gauge ID M94349 Static Pressure Gauge ID SAME

TC ID #7 Handheld TC Readout ID #1

Barometer ID

Leak Check of Gas Sampling System? By Whom? Condition?

Gas Meter ID ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? N/A
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

1084

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Flue Gas Inlet - (Rectangular Duct)

B-O₂ Anal
O₂ + CO Cal. @
8:30 AM
span gas

Location A A or B Duct
Date 11/8/96
Time Begin 10:16 End 11:21
Bar., " Hg 29.13
Static, " H2O -9.688

Tube I.D. 5-53
C-Factor 0.816
Operator(s) ROS/WLM
No. Points 20
Duct Width 14.5 ft
Duct Height 5.5 ft
Duct Area 79.75 Sq ft
Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

	PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.	
	A-1	8-1/4"	677	.6324	4.5		411	.3	O₂ cal OK
	A-2	24-3/4"	680	.7598	5.0		390	.3	
	A-3	41-1/4"	672	.6720	6.0		307	.3	
	A-4	57-3/4"	665	.7202	6.2		256	.3	
	B-1	8-1/4"	648	.6730	3.6		505	.4	}
	B-2	24-3/4"	652	.9443	4.2		377	.4	}
	B-3	41-1/4"	660	.8524	4.9		500	.4	}*
	B-4	57-3/4"	662	1.007	5.8		458	.4	}
	C-1	8-1/4"	641	.7173	2.9		597	.3	** O₂ Cal 20.9
ΔΔ	C-2	24-3/4"	639	1.043	3.4		580	.4	Δ- static -9.688
	C-3	41-1/4"	638	.8772	4.0		546	.3	
	C-4	57-3/4"	640	.9175	4.8		489	.1	*
	D-1	8-1/4"	662	.6787	2.7		579	.6	*
ΔΔΔ	D-2	24-3/4"	660	.9905	3.0		583	.1	
↓ 11:08	D-3	41-1/4"	650	.9218	4.0		633	.2	
	D-4	57-3/4"	646	.8975	5.2		460	.1	
	E-1	8-1/4"	684	.6201	3.0		596	.4	O₂ Cal/□
	E-2	24-3/4"	672	.8559	3.3		586	.5	*
	E-3	41-1/4"	655	.7956	3.7		700	.6	
	E-5	57-3/4"	650	.8942	4.7		657	.2	

Port A = South, E = North

Sampling Notes:

Wall = btm of duct

* % Comb rotometer bouncing

ΔΔ - orsat ~~[illegible]~~ 10:56 #1
ΔΔΔ - ~~orsat~~ #2

File FGITPL.WQ2 05-Nov-96

** 20.9 O₂
0 CO
.3 % Comb
} Prior to Cal

□ - 21% O₂
5 CO

Method 2 QA/QC Checklist

Plant: Milliken
Date: 11/8/96
Start Time: 10:15 Stop Time: 11:22
Unit ID: Unit 2A Duct ID: A
Testers: Roy Scandrol, Lee Mizwa

Pitot ID 10' probe Cp 0.816 Calibration Date 6/96

Pitot Opening Checked? Yes By Whom? RJS Condition? Good

Leak Check of System? Yes By Whom? RJS Condition? Good

Dp Gauge ID M 94349 Static Pressure Gauge ID M 94349

TC ID ~~one~~ 8 Handheld TC Readout ID one

Barometer ID 8623

Leak Check of Gas Sampling System? Yes By Whom? RJS Condition? Good

Gas Meter ID ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? Yes
Pitot orientation properly marked? Yes
Reference point for pitot depth marked? Yes
Pitot leak check? Yes
Gas sampling system leak check? Yes
Gas Meter Calibrated? N/A
Safety equipment utilized? Yes
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? Yes
Proper probe orientation while traversing? Yes
Process at steady state prior to testing? Yes

1086

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Flue Gas Outlet - (Rectangular Duct)

Location [✓ A] or B Duct
Date 11-8-96
Time Begin 1015 End 1120

29.13 BAROMETER
Bar., " Hg 29.1 DP CELL
Static, " H2O

Tube I.D. 552 No. Points 24
C-Factor 0.813 Duct Width 34 ft
Operator(s) GCC Duct Height 2.5 ft
DRS Duct Area 85.00 Sq ft

Amb Air DB, deg F 1100 F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	7-1/2"	277	.8471	4.6		486	.1
A-2	22-1/2"	277	.6602	4.4		486	.1
B-1	7-1/2"	276	.6103	4.3		389	.1
B-2	22-1/2"	276	.6106	4.4		400	.1
C-1	7-1/2"	275	.8562	4.4		373	.1
C-2	22-1/2"	275	.7970	4.2		399	.1
D-1	7-1/2"	276	.7974	4.1		457	.1
D-2	22-1/2"	276	.7241	4.3		355	.1
E-1	7-1/2"	276	.6788	4.4		408	.1
E-2	22-1/2"	276	.7286	4.3		428	.1
F-1	7-1/2"	277	.7716	4.3		377	.1
F-2	22-1/2"	277	.6035	4.4		385	.1
G-1	7-1/2"	277	.4307	4.8		335	0
G-2	22-1/2"	277	.3314	5.0		350	0
H-1	7-1/2"	277	.4410	4.8		300	0
H-2	22-1/2"	276	.4752	5.0		315	0
I-1	7-1/2"	276	.4948	5.0		270	0
I-2	22-1/2"	276	.5223	5.0		273	0
J-1	7-1/2"	278	.5677	5.2		269	0
J-2	22-1/2"	278	.5877	5.2		317	0
K-1	7-1/2"	278	.5279	5.5		260	.1
K-2	22-1/2"	278	.5328	5.2		285	.1
L-1	7-1/2"	277	.4937	5.1		175	.2
L-2	22-1/2"	276	.5326	5.0		225	.2

ORSAT/1115 O2 CHECK 2

STATIC = -14.80

ORSAT BAG 1058
O2 CHECK (20.9)

O2 CAL (21.2)

STATIC = -14.35

STATIC = -14.53

O2 CAL - OK (20.9)

START

Port A = North, L = South

Sampling Notes:

File: FGOTPL WQ2 05-Nov-96

Method 2 QA/QC Checklist

Plant: Millikan
Date: 11/8/96
Start Time: 10:15 Stop Time: 11:20
Unit ID: 2A Duct ID:
Testers: GLC/DRS

Pitot ID 552 Cp 0.813 Calibration Date 6/96

Pitot Opening Checked? ✓ By Whom? DRS Condition? OK

Leak Check of System? ✓ By Whom? DRS Condition? OK

Dp Gauge ID MB7129 Static Pressure Gauge ID Same

TC ID #2 Handheld TC Readout ID #7

Barometer ID

Leak Check of Gas Sampling System? ✓ By Whom? DRS Condition? Good

Gas Meter ID 148645 ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Primary Flue Gas Outlet - (Rectangular Duct)

Location [✓ A] or B Duct

Date 11-8-96

Time Begin 1148 End 1228

29.16 BAROMETER

Bar., " Hg 29.0 DP CELL

Static, " H2O

Tube I.D. 5-52

No. Points 14

C-Factor 0.813

Duct Width 17.92 ft

Operator(s) GLC/DRS

Duct Height 3.28 ft

Duct Area 58.79 Sq ft

Amb Air DB, deg F 90°F

Amb Air WB, deg F

Humd, lb/lb BD Air

START

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	9-7/8"	288	.0459	6.6		430	.2
A-2	29-9/16"	292	.0133	5.9		420	.1
B-1	9-7/8"	286	.0301	6.8		407	.1
B-2	29-9/16"	293	.0218	5.2		468	.1
C-1	9-7/8"	279	.0180	6.3		433	.1
C-2	29-9/16"	289	.0232	5.5		485	.1
D-1	9-7/8"	283	.0251	5.5		470	.1
D-2	29-9/16"	288	.0077	4.4		530	.1
E-1	9-7/8"	285	.0532	5.2		485	.1
E-2	29-9/16"	293	.0278	4.0		565	.1
F-1	9-7/8"	285	.0376	4.5		570	.1
F-2	29-9/16"	293	.0236	4.0		623	.1
G-1	9-7/8"	278	.0504	6.3		495	.1
G-2	29-9/16"	278	.0044	5.7		572	.1

ORSAT 1153
(20.5) O2 CAL

STATIC = -12.72
(20.4) O2 CAL

STATIC = -12.8

O2 CHECK (20.8

Port A = South, L = North

Sampling Notes:

File: PFGOTPL.WQ2

05-Nov-96

Method 2 QA/QC Checklist

Plant: Milliken
Date: 11/8/96
Start Time: 1148
Stop Time: 12:28
Unit ID: 2A
Duct ID:
Testers: GLC/DRS

Pitot ID S-52
Cp 0.813
Calibration Date 6/96

Pitot Opening Checked? ✓ By Whom? GLC Condition? Good

Leak Check of System? ✓ By Whom? DRS Condition? Good

Dp Gauge ID M87129
Static Pressure Gauge ID SAME

TC ID #2
Handheld TC Readout ID #7

Barometer ID —

Leak Check of Gas Sampling System? ✓ By Whom? DRS Condition? GOOD

Gas Meter ID 148645
ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓ - WET COAL

1090

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Inlet - (Rectangular Duct)

Location A A or B Duct
Date 11/8/96
Time Begin 11:40 End 12:10

Bar., " Hg 29.16 BAROMETER.
Static, " H2O 56.53

Tube I.D. S-50
C-Factor 0.810
Operator(s) ROS/WLM

No. Points 12
Duct Widt 17.5 ft
Duct Heig 3.28 ft
Duct Area 57.42 Sq ft

Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	9-7/8"	106	
A-2	29-9/16"	~~.0077~~	.0077
B-1	9-7/8"	105	.~~1443~~
B-2	29-9/16"	106	.0332
C-1	9-7/8"	105	.0479
C-2	29-9/16"	106	.0294
D-1	9-7/8"	105	.0347
D-2	29-9/16"	107	.0121
E-1	9-7/8"	105	.0380
E-2	29-9/16"	107	~~.0050~~
F-1	9-7/8"	105	.1120
F-2	29-9/16"	106	.0349

.0033
105
.0222
* - static + 56.53
.0106

Port A = South, F = North

Sampling Notes:

Wall = back wall

File PAITPL.WQ2 05-Nov-96

Method 2 QA/QC Checklist

Plant: Milliken
Date: 11/8/96
Start Time: 11:40 Stop Time: 12:10
Unit ID: 2A Duct ID: A
Testers: Lee Mizha, Roy Scandrol

Pitot ID 5-50 Cp 0.810 Calibration Date 6/96

Pitot Opening Checked? Yes By Whom? Roy Condition? Good

Leak Check of System? Yes By Whom? Lee Condition? Good

Dp Gauge ID M94349 Static Pressure Gauge ID M94349

TC ID 4 Handheld TC Readout ID 1

Barometer ID

Leak Check of Gas Sampling System? N/A By Whom? – Condition? –

Gas Meter ID N/A ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? Yes
Pitot orientation properly marked? Yes
Reference point for pitot depth marked? Yes
Pitot leak check? Yes
Gas sampling system leak check? Yes
Gas Meter Calibrated? N/A
Safety equipment utilized? Yes
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? Yes
Proper probe orientation while traversing? Yes
Process at steady state prior to testing? Yes

1092

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Outlet - (Circular Duct)

Location A A or B Duct
Date 11-8-96
Time Begin 1145 End 1210
Bar., " Hg 29.16
Static, " H2O 51.92 51.99

Tube I.D. S-49 No. Points 20
C-Factor 0.802
Operator(s) Len/Bos Duct Dia. 47.5 inches
Duct Are 12.31 Sq ft
Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

back wall

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	1-3/16"	574	0.3132
A-2	3-7/8"	576	0.3515
A-3	6-15/16"	577	0.3351
A-4	10-3/4"	578	0.3537
A-5	16-1/4"	578	0.3837
A-6	31-1/4"	579	0.3226
A-7	36-3/4"	579	0.2922
A-8	40-9/16"	578	0.2687
A-9	43-5/8"	575	0.2318
A-10	46-5/16"	573	0.1724
B-1	1-3/16"	571	0.2978
B-2	3-7/8"	572	0.3693
B-3	6-15/16"	573	0.3613
B-4	10-3/4"	573	0.4050
B-5	16-1/4"	574	0.4050
B-6	31-1/4"	574	0.3119
B-7	36-3/4"	574	0.3414
B-8	40-9/16"	573	0.2560
B-9	43-5/8"	572	0.2230
B-10	46-5/16"	571	0.1905

South

East

South (A)

East (B)

Port A = South or North, B = East

Sampling Notes:

Leak Check @ Start
Tips Good
TC-66-5
Probe S-49

File PAOTPL.WQ2 05-Nov-96

Method 2 QA/QC Checklist

Plant: MILLIKEN
Date: 11-8-96
Start Time: 11:45 Stop Time: 12:10
Unit ID: 2A Duct ID: ____
Testers: BAH & LEN

Pitot ID S-49 Cp 0.802 Calibration Date 6/96

Pitot Opening Checked? ✓ By Whom? RCJ Condition? ok

Leak Check of System? ✓ By Whom? RSJ Condition? ok

Dp Gauge ID ____ Static Pressure Gauge ID ____

TC ID ____ Handheld TC Readout ID #4

Barometer ID ____

Leak Check of Gas Sampling System? N/A By Whom? ____ Condition? ____

Gas Meter ID ____ ORSAT Bag ID ____

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

1094

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Secondary Air Outlet - (Rectangular Duct)

Location A A or B Duct
Date 11-3-96
Time Begin 1015 End 1102

Tube I.D. 5-54 No. Points 24
C-Factor 0.806 Duct Widt 6.0 ft
Operator(s) [illegible] Duct Heig 9.0 ft
Duct Area 54.00 Sq ft

Bar., " Hg 29.12 ~~29.3" Hg @ 0830 HRS~~
Static, " H2O 3.783" H2O & 3.616" H2O
Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

S

Flow ←

V

N

Bottom →

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	9"	570	0.7935
A-2	27"	570	0.8544
A-3	45"	566	0.8351
A-4	63"	564	0.9969
A-5	81"	558	0.9216
A-6	99"	551	0.9191
B-1	9"	576	1.017
B-2	27"	577	1.000
B-3	45"	579	0.9169
B-4	63"	582	1.046
B-5	81"	574	1.165
B-6	99"	561	0.8586
C-1	9"	572	0.9873
C-2	27"	579	1.039
C-3	45"	585	0.8765
C-4	63"	590	1.124
C-5	81"	593	1.260
C-6	99"	588	1.111
D-1	9"	563	0.8790
D-2	27"	573	0.8761
D-3	45"	583	0.9969
D-4	63"	590	1.212
D-5	81"	595	1.192
D-6	99"	596	1.293

Port A = South, D = North

Sampling Notes:

Leak checked @ start ✓ @ end ✓
Ports as before - Low Seal N.CK (small)
Probe 5-54 Manometer "0" Check ✓
TC 140-9
Pyro = FOUR

1095

Method 2 QA/QC Checklist

Plant: MILLIKEN

Date: 11-8-96

Start Time: 10:15 Stop Time: 11:00

Unit ID: 2A Duct ID:

Testers: BM & LEN

Pitot ID 5-54 Cp 0.806 Calibration Date 6/96

Pitot Opening Checked? ✓ By Whom? RSD Condition? OK

Leak Check of System? ✓ By Whom? RJD Condition? OK

Dp Gauge ID______ Static Pressure Gauge ID ______

TC ID______ Handheld TC Readout ID H

Barometer ID ______

Leak Check of Gas Sampling System? NA By Whom?______ Condition?______

Gas Meter ID______ ORSAT Bag ID ______

QA/QC Check List:

Proper sampling points identified? ✓

Pitot orientation properly marked? ✓

Reference point for pitot depth marked? ✓

Pitot leak check? ✓

Gas sampling system leak check? ✓

Gas Meter Calibrated? ✓

Safety equipment utilized? ✓

(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)

Tight seal around probe entry port? ✓

Proper probe orientation while traversing? ✓

Process at steady state prior to testing? ✓

1096

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Secondary Air Bypass - (Rectangular Duct)

29.12" BAROMETER

Location [✓ A] or B Duct
Date 11/8/96
Time Begin ~~[illegible]~~ 825 End 843
Bar., " Hg 29.2"
Static, " H2O 5.564"

Tube I.D. S-53
C-Factor 0.816
Operator(s) GLC/WLM
No. Points ~~8~~ 6
Duct Widt 17.5 ft
Duct Heig 2.09 ft
Duct Area 36.64 Sq ft
Amb Air DB, deg F 93 F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	6-5/16"		
A-2	18-7/8"		
B-1	6-5/16"	235	.0002
B-2	18-7/8"	238	.0001
C-1	6-5/16"	218	.0002
C-2	18-7/8"	227	.0002
D-1	6-5/16"	215	.0001
D-2	18-7/8"	223	.0001

STATIC = 5.564"

Port A = South, D = North

Sampling Notes:

~~TO~~ TC #7 WAS FOUND TO BE OPEN ... REPLACED w/TC #8.

File: SA-BPTPL.WQ2

05-Nov-96

Method 2 QA/QC Checklist

Plant: Millikan
Date: 11/8/96
Start Time: 08:25 Stop Time: 08:43
Unit ID: 2A Duct ID:
Testers: GLC/WLM

Pitot ID S-53 Cp 0.816 Calibration Date 6/96

Pitot Opening Checked? ✓ By Whom? GLC Condition? GOOD

Leak Check of System? ✓ By Whom? WLM Condition? GOOD

Dp Gauge ID MB7129 Static Pressure Gauge ID SAME

TC ID #8 Handheld TC Readout ID #1

Barometer ID —

Leak Check of Gas Sampling System? N/A By Whom? Condition?

Gas Meter ID N/A ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check?
Gas Meter Calibrated?
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

1098

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Flue Gas Inlet - (Rectangular Duct)

Location B A or B Duct
Date 11/8/96
Time Begin 14:05 End 14:48
Bar., " Hg 29.12
Static, " H2O -10.16

Tube I.D. S-53
C-Factor 0.816
Operator(s) ROS/WLM
No. Points 20
Duct Width 14.5 ft
Duct Height 5.5 ft
Duct Area 79.75 Sq ft
Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	8-1/4"	668	~~.40~~ .7359	4.2		556	.1
A-2	24-3/4"	662	.7964	4.3		600	.2
A-3	41-1/4"	656	.8357	4.4		565	.2
A-4	57-3/4"	656	.9073	4.7		490	.2
B-1	8-1/4"	657	.8367	4.1		570	.3
B-2	24-3/4"	649	1.068	4.1		570	.2
B-3	41-1/4"	648	.9673	4.4		580	.2
B-4	57-3/4"	654	.9063	4.9		540	.2
C-1	8-1/4"	653	.7399	4.6		675	.1
C-2	24-3/4"	648	.9164	4.6		668	.2
C-3	41-1/4"	644	.9279	4.85		650	.1
C-4	57-3/4"	647	.9619	5.1		525	.1
D-1	8-1/4"	658	.7147	4.8		606	.2
D-2	24-3/4"	666	.9609	4.9		703	.4
D-3	41-1/4"	667	.9921	5.1		676	.4
D-4	57-3/4"	662	.9252	5.6		551	.3
E-1	8-1/4"	694	.4262	5.0		629	.4
E-2	24-3/4"	693	.5950	5.2		610	.2
E-3	41-1/4"	686	.7622	5.6		589	.2
E-5	57-3/4"	664	.8706	5.9		500	.2

O2 Cal

— O2 Cal Δ
static -10.16

Δ Sorsat Sample + Recal O2

Port A = South, E = North

Sampling Notes:

Wall = btm of duct
• Recrossed A side pitot prior to [illegible]

Δ O2 - 20.1 20.9 after cal
CO - 2 0 - CO
% comb .3
Prior to recal

File FGITPL.WQ2 05-Nov-96

Method 2 QA/QC Checklist

Plant: Milliken
Date: 11/8/96
Start Time: 14:05 Stop Time: 14:48
Unit ID: 2B Duct ID: B
Testers: Lee Mizwa, R Scondrel

Pitot ID 10' probe Cp 0.816 Calibration Date 6/96

Pitot Opening Checked? Yes By Whom? RJ / 10cm Condition? ~~[illegible]~~

Leak Check of System? Yes By Whom? RJ Condition? Good

Dp Gauge ID M94349 Static Pressure Gauge ID M94349

TC ID 8 Handheld TC Readout ID 1

Barometer ID

Leak Check of Gas Sampling System? Yes By Whom? RJ Condition? Good

Gas Meter ID ORSAT Bag ID

Redressed A-side Previous tests OK

QA/QC Check List:

Proper sampling points identified? Yes
Pitot orientation properly marked? Yes
Reference point for pitot depth marked? Yes
Pitot leak check? Yes
Gas sampling system leak check? Yes
Gas Meter Calibrated? N/A
Safety equipment utilized? Yes
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? Yes
Proper probe orientation while traversing? Yes
Process at steady state prior to testing? Yes

1100

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Flue Gas Outlet - (Rectangular Duct)

Location ______ A or [✓ B] Duct
Date 11-8-96
Time Begin 1402 End 1450
Bar., " Hg 29.1
Static, " H2O ______

Tube I.D. 5-52
No. Points 24
Amb Air DB, deg F 87°F
C-Factor 0.813
Duct Width 34 ft
Amb Air WB, deg F ______
Operator(s) GLC/DRS
Duct Height 2.5 ft
Humd, lb/lb BD Air ______
Duct Area 85.00 Sq ft

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	7-1/2"						
A-2	22-1/2"						
B-1	7-1/2"	284	.2822	4.7		720	.1
B-2	22-1/2"	283	.3152	4.2		768	.1
C-1	7-1/2"	286	.4580	5.5		605	.1
C-2	22-1/2"	285	.4934	5.4		676	.1
D-1	7-1/2"	284	.6608	5.3		660	6
D-2	22-1/2"	284	.6848	5.3		677	0
E-1	7-1/2"	280	.6003	5.4		630	.1
E-2	22-1/2"	281	.5969	5.2		645	0
F-1	7-1/2"	280	.4592	5.4		600	0
F-2	22-1/2"	279	.5738	5.4		625	0
G-1	7-1/2"	280	.3660	5.3		605	0
G-2	22-1/2"	280	.2473	5.4		620	0
H-1	7-1/2"	281	.8959	5.4		585	0
H-2	22-1/2"	282	.9307	5.2		605	0
I-1	7-1/2"	282	1.078	5.2		585	0
I-2	22-1/2"	281	.9691	5.4		590	0
J-1	7-1/2"	281	.7029	5.2		531	0
J-2	22-1/2"	280	.8532	5.2		573	0
K-1	7-1/2"	279	.8312	5.2		574	.2
K-2	22-1/2"	280	.9143	5.2		574	.2
L-1	7-1/2"	278	.7010	5.4		513	.3
L-2	22-1/2"	279	.4881	5.2		540	.3

O2 CAL (21.1) ✓
STATIC = -14.99
(21.1) O2 CAL ✓
STATIC = -15.14
STATIC = -15.16
O2 CAL (20.4) ✓

START

Port A = North, L = South

Sampling Notes:

Method 2 QA/QC Checklist

Plant: Milliken
Date: 11-8-96
Start Time: 14:02 Stop Time: 14:50
Unit ID: 2B Duct ID:
Testers: GLC/DRS

Pitot ID S-52 Cp 0.813 Calibration Date 6/96

Pitot Opening Checked? ✓ By Whom? GLC Condition? Good

Leak Check of System? ✓ By Whom? DRS Condition? GOOD

Dp Gauge ID M87129 Static Pressure Gauge ID SAME

TC ID #2 Handheld TC Readout ID #7

Barometer ID

Leak Check of Gas Sampling System? ✓ By Whom? GLC Condition? Good

Gas Meter ID 148645 ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

1102

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Flue Gas Outlet - (Rectangular Duct)

Location ______ A or [✓ B Duct]
Date 11-8-96
Time Begin 1240 End 1311
Bar., " Hg 29.1
Static, " H2O -12.87

Tube I.D. 5-52
No. Points 14
C-Factor 0.813
Duct Width 17.92 ft
Operator(s) GLC/DRS
Duct Height 3.28 ft
Duct Area 58.79 Sq ft
Amb Air DB, deg F 90°F
Amb Air WB, deg F ______
Humd, lb/lb BD Air ______

START

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	9-7/8"	286	,0448	7.3		290	.1
A-2	29-9/16"	288	,0011	6.8		345	.1
B-1	9-7/8"	288	.0378	6,1		372	.1
B-2	29-9/16"	282	.0088	6.1		377	.1
C-1	9-7/8"	277	.0322	6.1		318	.5
C-2	29-9/16"	286	.0119	5.2		413	.4
D-1	9-7/8"	278	.0154	5.3		317	.3
* D-2	29-9/16"	257	.0020	7.6		337	.2
E-1	9-7/8"	272	.0216	6.4		485	.2
E-2	29-9/16"	283	.0086	5,4		560	.1
F-1	9-7/8"	281	.0394	7.4		445	.1
F-2	29-9/16"	291	.0359	5.2		568	.1
G-1	9-7/8"	273	.0368	7.6		455	.2
G-2	29-9/16"	283	.0360	6.2		547	.1

STATIC = -12.8
O_2 CHECK (20.
→ ORSAT ★
STATIC: -12,
(20.8) O_2 CAL ✓

Port A = South, L = North

Sampling Notes:

* FLUCTUATING O_2'S (BENEATH MANWAY)

★ ORSAT @ E-1 / 1315 → $O_{2\ START}$ = 6.7% O_2

$O_{2\ END}$ = 6.7% O_2 / 1319

Method 2 QA/QC Checklist

Plant: MILLIKEN
Date: 11/8/96
Start Time: 1240 Stop Time: 13:11
Unit ID: 2B Duct ID:
Testers: GLC/DRS

Pitot ID S-52 Cp 0.813 Calibration Date 6/96

Pitot Opening Checked? By Whom? Condition?

Leak Check of System? By Whom? Condition?

Dp Gauge ID #M87129 Static Pressure Gauge ID Same

TC ID #2 Handheld TC Readout ID #7

Barometer ID

Leak Check of Gas Sampling System? By Whom? Condition?

Gas Meter ID ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

1104

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Inlet - (Rectangular Duct)

Location B A or B Duct
Date 11/8/96
Time Begin 12:18 End 12:52
Bar., " Hg 29,18
Static, " H2O 56,02

Tube I.D. S-50
C-Factor 0.810
Operator(s) ROS/WLM
No. Points 12
Duct Widt 17.5 ft
Duct Heig 3.28 ft
Duct Area 57.42 Sq ft
Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]	
A-1	9-7/8"	106	.0494	
A-2	29-9/16"	108	.0073	
B-1	9-7/8"	106	.0376	
B-2	29-9/16"	107	.0089	
C-1	9-7/8"	105	.0758	
C-2	29-9/16"	106	.0176	* STATIC
D-1	9-7/8"	106	.0730	
D-2	29-9/16"	106	.0169	
E-1	9-7/8"	105	.0374	
E-2	29-9/16"	106	.0272	
F-1	9-7/8"	106	~~[illegible]~~	.0130
F-2	29-9/16"	106	.0183	

Port A = South, F = North

Sampling Notes:

wall = back wall

File PAITPL.WQ2

05-Nov-96

Method 2 QA/QC Checklist

Plant: Milliken
Date: 11/8/96
Start Time: 12:18
Stop Time: 12:52
Unit ID: 2B
Duct ID: B
Testers: Lee Mizuna, Roy Scanland

Pitot ID 5-50 Cp 0.810 Calibration Date 6/96

Pitot Opening Checked? Yes By Whom? RWS Condition? Good

Leak Check of System? Yes By Whom? RWS Condition? Good

Dp Gauge ID M94349 Static Pressure Gauge ID M94349

TC ID 4 Handheld TC Readout ID 1

Barometer ID

Leak Check of Gas Sampling System? N/A By Whom? - Condition? -

Gas Meter ID N/A ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? Yes
Pitot orientation properly marked? Yes
Reference point for pitot depth marked? Yes
Pitot leak check? Yes
Gas sampling system leak check? Yes
Gas Meter Calibrated? N/A
Safety equipment utilized? Yes
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? Yes
Proper probe orientation while traversing? Yes
Process at steady state prior to testing? Yes

1106

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Primary Air Outlet - (Circular Duct)

Location E A or B Duct
Date 11-8-96
Time Begin 1215 End 1255

Bar., " Hg 29.18
Static, " H2O 51.66 51.51

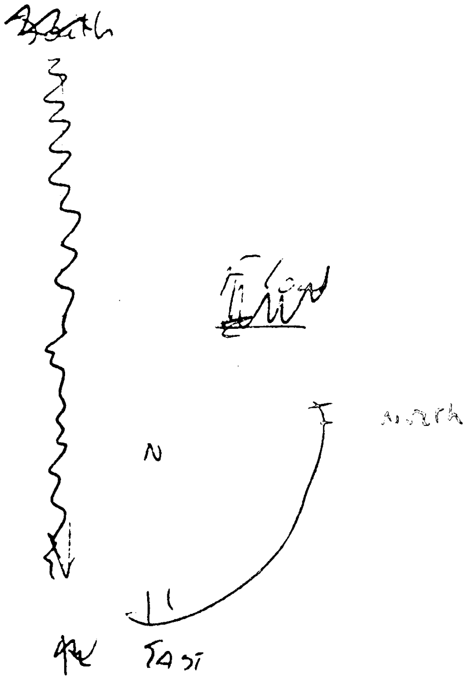
Tube I.D. S-49 No. Points 20
C-Factor 0.802
Operator(s) Len/B.b Duct Dia. 47.5 inches
Duct Are 12.31 Sq ft

Amb Air DB, deg F
Amb Air WB, deg F
Humd, lb/lb BD Air

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	1-3/16"	589	0.3013
A-2	3-7/8"	590	0.3434
A-3	6-15/16"	591	0.3692
A-4	10-3/4"	591	0.3597
A-5	16-1/4"	592	0.3508
A-6	31-1/4"	593	0.2883
A-7	36-3/4"	593	0.2051
A-8	40-9/16"	593	0.2361
A-9	43-5/8"	591	0.2063
A-10	46-5/16"	590	0.1566
B-1	1-3/16"	589	0.2864
B-2	3-7/8"	589	0.3387
B-3	6-15/16"	590	0.3258
B-4	10-3/4"	591	0.3500
B-5	16-1/4"	591	0.3293
B-6	31-1/4"	592	0.2541
B-7	36-3/4"	591	0.2219
B-8	40-9/16"	590	0.2022
B-9	43-5/8"	589	0.1753
B-10	46-5/16"	588	0.1385

NORTH

EAST



Port A = South or North, B = East

Sampling Notes:

Drive ~~S-54~~ S-49 Leak Chck OK Before & After

TC ~~14-9~~ 66-5 TIPS OK

Pyro = Fair

Method 2 QA/QC Checklist

Plant: MILLIKEN
Date: 11/8/96
Start Time: 12:15 Stop Time: 12:55
Unit ID: 2B Duct ID:
Testers: LEN/BOB

Pitot ID J-49 Cp 0.802 Calibration Date 6/96

Pitot Opening Checked? ✓ By Whom? RJD Condition? o/k

Leak Check of System? ✓ By Whom? RJD Condition? ok

Dp Gauge ID Static Pressure Gauge ID

TC ID 66-5 Handheld TC Readout ID 4

Barometer ID

Leak Check of Gas Sampling System? NA By Whom? Condition?

Gas Meter ID ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

11 08

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Secondary Air Outlet - (Rectangular Duct)

Location B A or B Duct
Date 11-8-96
Time Begin [illegible] 1405 HRS End 1440
Tube I.D. S-54 No. Points 24
C-Factor 0.806 Duct Widt 6.0 ft
Operator(s) ______ Duct Heig 9.0 ft
Duct Area 54.00 Sq ft

Bar., " Hg 29.12
Static, " H2O 3.503 ? 3.826
Amb Air DB, deg F ______
Amb Air WB, deg F ______
Humd, lb/lb BD Air ______

5

Bottm

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	9"	569	0.9557
A-2	27"	587	0.7562
A-3	45"	601	0.9261
A-4	63"	606	1.253
A-5	81"	609	1.282
A-6	99"	608	1.144
B-1	9"	590	0.9761
B-2	27"	599	0.7940
B-3	45"	605	0.8475
B-4	63"	609	1.093
B-5	81"	610	1.286
B-6	99"	603	1.085
C-1	9"	596	0.9851
C-2	27"	600	0.9850
C-3	45"	601	0.8691
C-4	63"	601	1.064
C-5	81"	592	1.193
C-6	99"	577	0.9578
D-1	9"	586	0.8679
D-2	27"	585	0.7047
D-3	45"	585	0.7994
D-4	63"	576	1.048
D-5	81"	573	1.176
D-6	99"	568	0.8678

← Flow

V
N

Port A = South, D = North

Sampling Notes:

TIPS OK
Probe S-54 LEAK Check @ START
TC 140-9
Pyro = FOUR

File: SAOTPL.WQ2

05-Nov-96

Method 2 QA/QC Checklist

Plant: MILLIKEN
Date: 11/8/96
Start Time: 14:05 Stop Time: 14:40
Unit ID: 2B Duct ID:
Testers: Bob, Len

Pitot ID 5-54 Cp 0.806 Calibration Date 6/96

Pitot Opening Checked? ✓ By Whom? RSO Condition? ok

Leak Check of System? ✓ By Whom? RSO Condition? ok

Dp Gauge ID Static Pressure Gauge ID

TC ID 140-9 Handheld TC Readout ID 4

Barometer ID

Leak Check of Gas Sampling System? NA By Whom? Condition?

Gas Meter ID ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Secondary Air Bypass - (Rectangular Duct)

Location A or [✓ B] Duct

Date 11/8/96

Time Begin 935 End 956

Bar., " Hg 29.1

Static, " H2O 5.509"

Tube I.D. 553

C-Factor 0.816

Operator(s) GLC/WLM

No. Points 8

Duct Width 17.5 ft

Duct Height 2.09 ft

Duct Area 36.64 Sq ft

Amb Air DB, deg F

Amb Air WB, deg F

Humd, lb/lb BD Air

N

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	6-5/16"	124	.0000
A-2	18-7/8"	133	.0000
B-1	6-5/16"	106	.0027
B-2	18-7/8"	119	-.0004
C-1	6-5/16"	110	.0012
C-2	18-7/8"	130	-.0004
D-1	6-5/16"	163	.0000
D-2	18-7/8"	163	.0001

STATIC = 5.569"

START

Port A = South, D = North

Sampling Notes:

RETEST of DUCT B After DAMPER WAS MANUALLY CLOSED.

1111

Method 2 QA/QC Checklist

Plant: MILLIKEN
Date: 11/8/96
Start Time: 935 Stop Time: 956
Unit ID: 2B Duct ID:
Testers: GLC/WLM

Pitot ID S-53 Cp 0.816 Calibration Date 6/96

Pitot Opening Checked? ✓ By Whom? GLC Condition? OK

Leak Check of System? ✓ By Whom? GLC Condition? OK

Dp Gauge ID Static Pressure Gauge ID

TC ID #8 Handheld TC Readout ID #1

Barometer ID

Leak Check of Gas Sampling System? By Whom? Condition?

Gas Meter ID ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

Milliken Station Heat Pipe Performance Testing
Barometer and Dry/Wet Bulb Readings
Pitot Traverse Data Inputs

"A" Side Test 1

Date 11/7/96

Time	Barometer " Hg	Dry Bulb °F	Wet Bulb °F	Moisture lb/lb BD Air
09:45	29.48			
12:30	29.41			
13:00	29.38			
13:20	29.38			
13:40	29.36			
14:00	29.36			
14:20	29.34			
14:40	29.32	76	65	0.01086
15:00	29.34			
15:20	29.32			
15:40	29.32	77	65	0.01055

"B" Side Test 1

16:40	29.32	77	65	0.01055
17:20	29.32			
18:01	29.32			
18:44	29.31	77	65	0.01055
19:01	29.30			
19:20	29.28			
19:41	29.28			

"A" Side Test 2

Date 11/8/96

Time	Barometer " Hg	Dry Bulb °F	Wet Bulb °F	Moisture lb/lb BD Air
09:20	29.12	76	62	0.00879
10:20	29.12			
10:40	29.12	75	61	0.00842
11:20	29.16			
11:40	29.14			
12:00	29.16			
12:20	29.18	74	60	0.00833

"B" Side Test 2

12:20	29.18			
13:40	29.12			
14:00	29.12	75	60	0.00808

APPENDIX F

TRAVERSE DATA CALCULATED RESULTS

Table F-1

Traverse Data Calculated Results -- 2A Heat Pipe Flue Gas Inlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	5.90%	Overhead Ash	90.00%	Std. Conditions	
C	70.53%	C in Ash	1.37%	T, deg F	60
H	4.84%			P, in. Hg	29.92
N	1.38%	Amb Air DB, deg F	76		
S	2.90%	Amb Air WB, deg F	65		
O	4.20%	Humd, lb/lb BD Air	0.01082		
Ash	10.26%				
Total	100.00%				
		No. Of Points	20		
		Duct Width	14.5 ft	Bar., " Hg	29.37
Date	11/7/96	Duct Height	5.5 ft	Static, " H2O	-9.60
Time	12:40-13:56	Duct Area	79.75 Sq ft		
Tube I.D.	S-53		3.78	Avg % H2O	7.96
C-Factor	0.816		14.99	Dry MW	30.57
Operator(s)	ROS/WLM		81.23	Wet MW	29.57

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	8-1/4"	680	0.5965	62.49	3.9	14.9	10	0.0
A-2	24-3/4"	681	0.7132	68.37	4.0	14.8	10	0.0
A-3	41-1/4"	675	0.6822	66.75	5.0	13.9	7	0.0
A-4	57-3/4"	667	0.7238	68.52	5.2	13.7	10	0.0
B-1	8-1/4"	649	0.6655	65.07	3.3	15.4	25	0.0
B-2	24-3/4"	652	0.9157	76.45	3.5	15.2	23	0.0
B-3	41-1/4"	660	0.8490	73.91	4.1	14.7	27	0.0
B-4	57-3/4"	664	0.9341	77.70	4.7	14.2	28	0.0
C-1	8-1/4"	642	0.6900	66.00	2.3	16.3	39	0.1
C-2	24-3/4"	641	1.0540	81.56	2.7	15.9	48	0.1
C-3	41-1/4"	641	0.9131	75.96	3.4	15.3	57	0.1
C-4	57-3/4"	645	0.9468	77.53	4.1	14.7	57	0.1
D-1	8-1/4"	664	0.6800	66.20	2.9	15.8	70	0.0
D-2	24-3/4"	663	0.9669	78.92	3.2	15.5	73	0.0
D-3	41-1/4"	646	0.9105	76.06	4.1	14.7	56	0.0
D-4	57-3/4"	651	0.9015	75.90	4.8	14.1	71	0.0
E-1	8-1/4"	688	0.6526	65.57	3.4	15.3	72	0.0
E-2	24-3/4"	673	0.8068	72.43	3.5	15.2	86	0.1
E-3	41-1/4"	656	0.7931	71.29	3.7	15.1	83	0.1
E-4	57-3/4"	653	0.8631	74.27	3.8	15.0	83	0.1
Average, (group mean)		660	0.8129	72.05	3.8	15.0	47	0.04
Average, (wt mean)		659	---	---	3.8	15.0	47	0.04
Maximum		688	1.0540	81.56	5.2	16.3	86	0.10
Minimum		641	0.5965	62.49	2.3	13.7	7	0.00
Standard Deviation		14	0.1262	5.39	0.7	0.6	27	0.05

Port A = South, E = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	72.05
Velocity, [fpm]	4,323
ACFM	344,747
SCFM	153,466
DSCFM	141,257
Ex Air Free	115,703
lb/hr Flue Gas (dry)	682,477
lb/hr Flue Gas (wet)	717,245

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	72.05
Velocity, [fpm]	4,323
ACFM	344,747
SCFM	153,466
DSCFM	141,256
Ex Air Free	115,703
lb/hr Flue Gas (dry)	682,474
lb/hr Flue Gas (wet)	717,242

1115

Table F-2
Traverse Data Calculated Results -- 2A Heat Pipe Flue Gas Outlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	5.90%	Overhead Ash	90.00%	Std. Conditions	
C	70.53%	C in Ash	1.37%	T, deg F	60
H	4.84%			P, in. Hg	29.92
N	1.38%	Amb Air DB, deg F	76		
S	2.90%	Amb Air WB, deg F	65		
O	4.20%	Humd, lb/lb BD Air	0.01082		
Ash	10.26%				
Total	100.00%				
		No. Of Points	24		
		Duct Width	34.0 ft	Bar., " Hg	29.38
Date	11/7/96	Duct Depth	2.5 ft	Static, " H2O	-14.13
Time	12:45-14:02	Duct Area	85.00 Sq ft		
Tube I.D.	S-51	Avg % O2	4.26	% H20	7.80
C-Factor	0.822	Avg % CO2	14.56	Dry MW	30.52
Operator(s)	GLC/DRS	Avg % N2	81.15	Wet MW	29.54

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	7-1/2"	290	0.6119	52.02	4.4	14.4	320	0.3
A-2	22-1/2"	292	0.8192	60.28	4.6	14.3	276	0.3
B-1	7-1/2"	290	0.5960	51.34	4.3	14.5	378	0.2
B-2	22-1/2"	290	0.6778	54.75	4.3	14.5	378	0.2
C-1	7-1/2"	289	0.8301	60.53	3.9	14.9	368	0.2
C-2	22-1/2"	288	0.7547	57.68	4.0	14.8	369	0.3
D-1	7-1/2"	289	0.8116	59.86	4.2	14.6	314	0.3
D-2	22-1/2"	289	0.7529	57.65	4.1	14.7	318	0.3
E-1	7-1/2"	290	0.6705	54.44	4.2	14.6	303	0.3
E-2	22-1/2"	291	0.7996	59.50	4.3	14.5	298	0.3
F-1	7-1/2"	291	0.7157	56.28	4.0	14.8	261	0.3
F-2	22-1/2"	291	0.5856	50.90	3.9	14.9	280	0.2
G-1	7-1/2"	292	0.4154	42.91	4.3	14.5	290	0.3
G-2	22-1/2"	291	0.3332	38.40	4.1	14.7	185	0.3
H-1	7-1/2"	291	0.4368	43.96	3.9	14.9	260	0.3
H-2	22-1/2"	290	0.4643	45.30	4.0	14.8	265	0.2
I-1	7-1/2"	288	0.4749	45.76	4.4	14.4	175	0.1
I-2	22-1/2"	288	0.5498	49.24	4.3	14.5	203	0.1
J-1	7-1/2"	288	0.5518	49.33	4.5	14.4	126	0.5
J-2	22-1/2"	288	0.6343	52.89	4.5	14.4	144	0.5
K-1	7-1/2"	289	0.7906	59.09	4.5	14.4	86	0.5
K-2	22-1/2"	288	0.5473	49.13	4.5	14.4	104	0.5
L-1	7-1/2"	288	0.5246	48.10	4.5	14.4	11	0.2
L-2	22-1/2"	286	0.5255	48.08	4.6	14.3	42	0.3
Average, (group mean)		289	0.6198	51.98	4.3	14.6	240	0.3
Average, (wt mean)		289	---	---	4.3	14.6	244	0.29
Maximum		292	0.8301	60.53	4.6	14.9	378	0.5
Minimum		286	0.3332	38.40	3.9	14.3	11	0.1
Standard Deviation		1	0.1400	6.05	0.2	0.2	106	0.1

Port A = North, L = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	51.98
Velocity, [fpm]	3,119
ACFM	265,078
SCFM	174,301
DSCFM	160,710
Ex Air Free	127,930
lb/hr Flue Gas (dry)	775,232
lb/hr Flue Gas (wet)	813,935

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	51.98
Velocity, [fpm]	3,119
ACFM	265,078
SCFM	174,301
DSCFM	160,710
Ex Air Free	127,930
lb/hr Flue Gas (dry)	775,232
lb/hr Flue Gas (wet)	813,936

Table F-3

Traverse Data Calculated Results -- 2A Heat Pipe Primary Flue Gas Out Duct
NYSEG Milliken Station

Coal Composition					
Moisture	5.90%	Overhead Ash	90.00%	Std. Conditions	
C	70.53%	C in Ash	1.37%	T, deg F	60
H	4.84%			P, in. Hg	29.92
N	1.38%	Amb Air DB, deg F	77		
S	2.90%	Amb Air WB, deg F	65		
O	4.20%	Humd, lb/lb BD Air	0.01055		
Ash	10.26%				
Total	100.00%				

		No. Of Points	14	Bar., " Hg	29.32
Date	11/7/96	Duct Width	17.92 ft	Static, " H2O	-12.65
Time	15:30-16:22	Duct Height	3.28 ft		
Tube I.D.	S-52	Duct Area	58.79 Sq ft	% H2O	7.61
C-Factor	0.813	Avg % O2	4.70	Dry MW	30.47
Operator(s)	GLC/DRS	Avg % CO2	14.18	Wet MW	29.53
		Avg % N2	81.08		

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	9-7/8"	319	0.0426	13.84	5.7	13.3	229	0.2
A-2	29-9/16"	326	0.0120	7.37	4.4	14.4	301	0.3
B-1	9-7/8"	322	0.0395	13.35	4.9	14.0	290	0.3
B-2	29-9/16"	332	0.0206	9.69	3.8	15.0	358	0.4
C-1	9-7/8"	320	0.0186	9.15	5.0	13.9	332	0.2
C-2	29-9/16"	330	0.0200	9.54	4.2	14.6	370	0.6
D-1	9-7/8"	320	0.0183	9.07	4.6	14.3	390	0.3
D-2	29-9/16"	330	0.0082	6.11	3.6	15.1	428	0.4
E-1	9-7/8"	319	0.0470	14.53	5.0	13.9	420	0.7
E-2	29-9/16"	335	0.0311	11.93	3.8	15.0	470	0.4
F-1	9-7/8"	319	0.0453	14.26	4.4	14.4	380	0.2
F-2	29-9/16"	336	0.0248	10.66	3.4	15.3	420	0.2
G-1	9-7/8"	318	0.0572	16.04	6.2	12.9	365	0.1
G-2	29-9/16"	318	0.0069	5.57	5.4	13.6	407	0.1
Average, (group mean)		325	0.0280	10.79	4.6	14.3	369	0.31
Average, (wt mean)		324	---	---	4.7	14.2	365	0.31
Maximum		336	0.0572	16.04	6.2	15.3	470	0.70
Minimum		318	0.0069	5.57	3.4	12.9	229	0.10
Standard Deviation		6	0.0153	3.16	0.8	0.7	61	0.17

Port A = South, G = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	10.79
Velocity, [fpm]	648
ACFM	38,075
SCFM	23,950
DSCFM	22,127
Ex Air Free	17,147
lb/hr Flue Gas (dry)	106,582
lb/hr Flue Gas (wet)	111,773

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	10.77
Velocity, [fpm]	646
ACFM	37,990
SCFM	23,898
DSCFM	22,079
Ex Air Free	17,109
lb/hr Flue Gas (dry)	106,348
lb/hr Flue Gas (wet)	111,528

Table F-4

Traverse Data Calculated Results -- 2A Heat Pipe Primary Air Inlet Duct
NYSEG Milliken Station

Amb Air DB, deg F 77
Amb Air WB, deg F 65
Humd, lb/lb BD Air 0.01055

Std. Conditions
T, deg F 60
P, in. Hg 29.92

Date 11/7/96
Time 15:10-15:59
Tube I.D. S-50
C-Factor 0.810
Operator(s) ROS/WLM

No. Of Points 12
Duct Width 17.5 ft
Duct Depth 3.28 ft
Duct Area 57.42 Sq ft
Avg % O2 21.0
Avg % N2 79.0

Bar., " Hg 29.32
Static, " H20 55.5

% H20 1.67
Dry MW 28.97
Wet MW 28.79

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	9-7/8"	117	0.0027	2.79
A-2	29-9/16"	117	0.0033	3.08
B-1	9-7/8"	116	0.0207	7.71
B-2	29-9/16"	116	0.0120	5.87
C-1	9-7/8"	115	0.0285	9.04
C-2	29-9/16"	116	0.0121	5.89
D-1	9-7/8"	116	0.0147	6.50
D-2	29-9/16"	117	0.0056	4.01
E-1	9-7/8"	115	0.0373	10.34
E-2	29-9/16"	118	0.0122	5.93
F-1	9-7/8"	114	0.1026	17.13
F-2	29-9/16"	116	0.0258	8.61
Average, (group mean)		116	0.0231	7.24
Average, (wt mean)		115	---	---
Maximum		118	0.1026	17.13
Minimum		114	0.0027	2.79
Standard Deviation		1	0.0260	3.72

Ports A = South, F = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	7.24
Velocity, [fpm]	434
ACFM	24,945
SCFM	25,170
DSCFM	24,750
lb/hr Air (dry)	113,333
lb/hr Air (wet)	114,529

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	7.24
Velocity, [fpm]	434
ACFM	24,945
SCFM	25,170
DSCFM	24,750
lb/hr Flue Gas (dry)	113,333
lb/hr Flue Gas (wet)	114,529

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Table F-5

Traverse Data Calculated Results -- 2A Heat Pipe Primary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F 77
Amb Air WB, deg F 65
Humd, lb/lb BD Air 0.01055

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

Bar., " Hg 29.34
Static, " H20 51.62

Date 11/7/96
Time 15:07
Tube I.D. S-49
C-Factor 0.802
Operator(s) RED/LLA

No. Of Points 20
Duct Dia 47.5 inches
Duct Area 12.31 Sq ft
Avg % O2 21.0
Avg % N2 79.0

% H20 1.67
Dry MW 28.97
Wet MW 28.79

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	1-3/16"	601	0.1964	32.04
A-2	3-7/8"	602	0.2412	35.53
A-3	6-15/16"	602	0.2519	36.31
A-4	10-3/4"	603	0.2741	37.89
A-5	16-1/4"	604	0.2507	36.25
A-6	31-1/4"	605	0.2271	34.52
A-7	36-3/4"	605	0.1952	32.01
A-8	40-9/16"	604	0.1789	30.63
A-9	43-5/8"	603	0.1630	29.22
A-10	46-5/16"	601	0.1368	26.74
B-1	1-3/16"	603	0.1879	31.37
B-2	3-7/8"	604	0.2333	34.97
B-3	6-15/16"	605	0.2201	33.99
B-4	10-3/4"	606	0.2432	35.74
B-5	16-1/4"	606	0.2448	35.86
B-6	31-1/4"	606	0.1930	31.84
B-7	36-3/4"	606	0.1730	30.14
B-8	40-9/16"	604	0.1676	29.64
B-9	43-5/8"	602	0.1412	27.18
B-10	46-5/16"	599	0.1159	24.59
Average, (group mean)		604	0.2018	32.32
Average, (wt mean)		604	---	---
Maximum		606	0.2741	37.89
Minimum		599	0.1159	24.59
Standard Deviation		2	0.0429	3.57

Ports A = South, B = East

Summary Straight Avg'd Results	
Velocity, [fps]	32.32
Velocity, [fpm]	1,939
ACFM	23,866
SCFM	12,921
DSCFM	12,705
lb/hr Air (dry)	58,177
lb/hr Air (wet)	58,791

Summary Weighted Avg Results	
Velocity, [fps]	32.32
Velocity, [fpm]	1,939
ACFM	23,866
SCFM	12,921
DSCFM	12,705
lb/hr Flue Gas (dry)	58,177
lb/hr Flue Gas (wet)	58,791

Table F-6

Traverse Data Calculated Results -- 2A Heat Pipe Secondary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F 76
Amb Air WB, deg F 65
Humd, lb/lb BD Air 0.01082

Std. Conditions
T, deg F 60
P, in. Hg 29.92

Date 11/7/96
Time 12:44-13:15
Tube I.D. S-54
C-Factor 0.806
Operator(s) RED/LLA

No. Of Points 24
Duct Width 6.0 ft
Duct Depth 9.0 ft
Duct Area 54.00 Sq ft
Avg % O2 21.0
Avg % N2 79.0

Bar., " Hg 29.38
Static, " H20 3.66
% " H20 1.71
Dry MW 28.97
Wet MW 28.78

PORT/ POINT	DISTANCE Fr Bottom (1)	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	9"	578	0.7645	66.45
A-2	27"	576	0.8292	69.13
A-3	45"	574	0.8557	70.16
A-4	63"	571	0.9363	73.29
A-5	81"	565	0.9135	72.18
A-6	99"	558	0.9031	71.52
B-1	9"	583	0.9329	73.58
B-2	27"	585	0.9219	73.21
B-3	45"	586	0.8552	70.55
B-4	63"	586	0.9536	74.49
B-5	81"	577	1.1480	81.38
B-6	99"	567	0.8516	69.76
C-1	9"	577	0.9605	74.44
C-2	27"	586	1.0590	78.50
C-3	45"	592	0.8877	72.08
C-4	63"	597	1.1060	80.65
C-5	81"	599	1.2300	85.13
C-6	99"	594	1.0530	78.58
D-1	9"	570	0.9128	72.32
D-2	27"	581	0.8641	70.74
D-3	45"	590	0.8835	71.84
D-4	63"	596	1.1460	82.05
D-5	81"	601	1.1320	81.74
D-6	99"	601	1.2490	85.86
Average, (group mean)		583	0.9729	74.99
Average, (wt mean)		584	---	---
Maximum		601	1.2490	85.86
Minimum		558	0.7645	66.45
Standard Deviation		12	0.1309	5.26

Port A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	74.99
Velocity, [fpm]	4,499
ACFM	242,951
SCFM	119,963
DSCFM	117,912
lb/hr Air (dry)	539,922
lb/hr Air (wet)	545,764

Summary Weighted Avg Results	
Velocity, [fps]	74.99
Velocity, [fpm]	4,499
ACFM	242,951
SCFM	119,963
DSCFM	117,912
lb/hr Flue Gas (dry)	539,922
lb/hr Flue Gas (wet)	545,764

Table F-7

Traverse Data Calculaed Results -- 2A Heat Pipe Secondary Air By-Pass Duct
NYSEG Milliken Station

Amb Air DB, deg F	76
Amb Air WB, deg F	65
Humd, lb/lb BD Air	0.01076

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

		No. Points	8	Bar., " Hg	29.48
Date	11/7/96	Duct Width	17.5 ft	Static, " H2C	5.56
Time	09:05-9:28	Duct Depth	2.09 ft		
Tube I.D.	S-53	Duct Area	36.64 Sq ft	% H20	1.70
C-Factor	0.816	% O2	21.0	Dry MW	28.97
Operator(s)	GLC/WLM	% N2	79.0	Wet MW	28.78

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	6-5/16"	241	0.0000	0.00
A-2	18-7/8"	269	0.0000	0.00
B-1	6-5/16"	241	-0.0002	-0.89
B-2	18-7/8"	269	-0.0001	-0.64
C-1	6-5/16"	241	0.0000	0.00
C-2	18-7/8"	276	0.0000	0.00
D-1	6-5/16"	239	0.0000	0.00
D-2	18-7/8"	285	0.0000	0.00
Average, (group mean)		257	-0.0000	-0.19
Average, (wt mean)		252	---	---
Maximum		285	0.0000	0.00
Minimum		239	-0.0002	-0.89
SDEV		18	0.0001	0.34

Ports A = South, D = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	-0.19
Velocity, [fpm]	-11
ACFM	-421
SCFM	-307
DSCFM	-302
lb/hr Air (dry)	-1382
lb/hr Air (wet)	-1397

Data Summary Wt'd Avg Data	
Velocity, [fps]	-0.19
Velocity, [fpm]	-11
ACFM	-421
SCFM	-307
DSCFM	-302
lb/hr Flue Gas (dry)	-1382
lb/hr Flue Gas (wet)	-1397

Table F-8

Traverse Data Calculated Results -- 2B Heat Pipe Flue Gas Inlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	5.90%	**Overhead Ash**	90.00%	**Std. Conditions**	
C	70.53%	**C in Ash**	1.37%	**T, deg F**	60
H	4.84%			**P, in. Hg**	29.92
N	1.38%	**Amb Air DB, deg F**	77		
S	2.90%	**Amb Air WB, deg F**	65		
O	4.20%	**Humd, lb/lb BD Air**	0.01055		
Ash	10.26%				
Total	100.00%				
		No. Of Points	20		
		Duct Width	14.5 ft	**Bar., " Hg**	29.30
Date	11/7/96	**Duct Height**	5.5 ft	**Static, " H2O**	-9.73
Time	18:18-19:18	**Duct Area**	79.75 Sq ft		
Tube I.D.	S-53		4.68	**Avg % H2O**	7.61
C-Factor	0.816		14.20	**Dry MW**	30.48
Operator(s)	ROS/WLM		81.11	**Wet MW**	29.53

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	8-1/4"	665	0.6679	65.79	4.1	14.7	8	0.0
A-2	24-3/4"	658	0.8174	72.55	4.1	14.7	26	0.0
A-3	41-1/4"	653	0.8155	72.30	4.0	14.8	38	0.0
A-4	57-3/4"	654	0.7895	71.18	4.1	14.7	46	0.0
B-1	8-1/4"	658	0.7743	70.64	4.5	14.4	70	0.0
B-2	24-3/4"	651	0.9983	79.95	4.3	14.5	83	0.0
B-3	41-1/4"	649	0.9225	76.78	4.3	14.5	66	0.0
B-4	57-3/4"	655	0.8219	72.67	4.4	14.4	68	0.0
C-1	8-1/4"	658	0.7094	67.62	4.6	14.3	115	0.0
C-2	24-3/4"	654	0.9669	78.80	4.5	14.4	115	0.0
C-3	41-1/4"	648	0.8781	74.92	5.0	13.9	96	0.0
C-4	57-3/4"	650	0.9311	77.22	5.1	13.8	72	0.0
D-1	8-1/4"	662	0.7043	67.48	4.3	14.5	51	0.1
D-2	24-3/4"	669	0.8693	75.24	4.8	14.1	125	0.0
D-3	41-1/4"	671	0.9458	78.57	5.1	13.8	113	0.0
D-4	57-3/4"	667	0.9255	77.59	5.3	13.7	108	0.0
E-1	8-1/4"	697	0.3645	49.32	4.9	14.0	64	0.2
E-2	24-3/4"	698	0.5910	62.83	5.0	13.9	53	0.1
E-3	41-1/4"	690	0.7640	71.22	5.4	13.6	58	0.2
E-4	57-3/4"	668	0.8633	75.00	5.8	13.2	49	0.1
Average, (group mean)		**664**	**0.8060**	**71.88**	**4.7**	**14.2**	**71**	**0.04**
Average, (wt mean)		**663**	**---**	**---**	**4.7**	**14.2**	**72**	**0.03**
Maximum		**698**	**0.9983**	**79.95**	**5.8**	**14.8**	**125**	**0.20**
Minimum		**648**	**0.3645**	**49.32**	**4.0**	**13.2**	**8**	**0.00**
Standard Deviation		**15**	**0.1452**	**6.86**	**0.5**	**0.4**	**32**	**0.07**

Port A = South, E = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	**71.88**
Velocity, [fpm]	**4,313**
ACFM	**343,964**
SCFM	**152,170**
DSCFM	**140,590**
Ex Air Free	**109,102**
lb/hr Flue Gas (dry)	**677,245**
lb/hr Flue Gas (wet)	**710,219**

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	**71.88**
Velocity, [fpm]	**4,313**
ACFM	**343,964**
SCFM	**152,169**
DSCFM	**140,590**
Ex Air Free	**109,102**
lb/hr Flue Gas (dry)	**677,242**
lb/hr Flue Gas (wet)	**710,216**

Table F-9

Traverse Data Calculated Results -- 2B Heat Pipe Flue Gas Outlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	5.90%	Overhead Ash	90.00%	Std. Conditions	
C	70.53%	C in Ash	1.37%	T, deg F	60
H	4.84%			P, in. Hg	29.92
N	1.38%	Amb Air DB, deg F	77		
S	2.90%	Amb Air WB, deg F	65		
O	4.20%	Humd, lb/lb BD Air	0.01055		
Ash	10.26%				
Total	100.00%				
		No. Of Points	24		
		Duct Width	34.0 ft	Bar., " Hg	29.29
Date	11/7/96	Duct Depth	2.5 ft	Static, " H2O	-14.65
Time	18:35-19:38	Duct Area	85.00 Sq ft		
Tube I.D.	S-52	Avg % O2	4.94	% H20	7.54
C-Factor	0.813	Avg % CO2	13.97	Dry MW	30.45
Operator(s)	DRS/GLC	Avg % N2	81.04	Wet MW	29.51

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1 (1)	7-1/2"	292	0.3464	38.89	5.1	13.8	295	0.0
A-2 (1)	22-1/2"	292	0.3990	41.75	5.2	13.7	594	0.3
B-1	7-1/2"	292	0.3464	38.89	5.1	13.8	295	0.0
B-2	22-1/2"	292	0.3990	41.75	5.2	13.7	594	0.3
C-1	7-1/2"	293	0.4318	43.46	5.1	13.8	611	0.2
C-2	22-1/2"	292	0.4857	46.05	5.0	13.9	604	0.2
D-1	7-1/2"	293	0.6809	54.57	5.1	13.8	607	0.4
D-2	22-1/2"	292	0.6977	55.19	4.8	14.1	620	0.4
E-1	7-1/2"	294	0.5731	50.09	5.0	13.9	581	0.3
E-2	22-1/2"	293	0.5992	51.19	5.0	13.9	585	0.3
F-1	7-1/2"	293	0.4604	44.87	5.1	13.8	556	0.3
F-2	22-1/2"	294	0.5724	50.07	5.1	13.8	569	0.3
G-1	7-1/2"	293	0.3454	38.86	5.0	13.9	545	0.2
G-2	22-1/2"	293	0.2932	35.80	4.9	14.0	553	0.2
H-1	7-1/2"	294	0.8625	61.45	4.9	14.0	528	0.1
H-2	22-1/2"	294	0.9350	63.97	4.8	14.1	540	0.1
I-1	7-1/2"	294	0.9653	65.00	4.9	14.0	455	0.1
I-2	22-1/2"	294	0.9337	63.92	4.8	14.1	495	0.1
J-1	7-1/2"	294	0.6742	54.32	4.8	14.1	409	0.2
J-2	22-1/2"	293	0.8086	59.44	4.6	14.3	438	0.1
K-1	7-1/2"	294	0.8494	60.97	4.8	14.1	372	0.3
K-2	22-1/2"	294	0.8786	62.01	4.8	14.1	390	0.2
L-1	7-1/2"	294	0.7467	57.16	4.9	14.0	242	0.1
L-2	22-1/2"	294	0.5879	50.73	5.0	13.9	304	0.2
Average, (group mean)		**294**	**0.6197**	**51.27**	**5.0**	**14.0**	**491**	**0.2**
Average, (wt mean)		**294**	**---**	**---**	**4.9**	**14.0**	**488**	**0.20**
Maximum		**294**	**0.9653**	**65.00**	**5.2**	**14.3**	**620**	**0.4**
Minimum		**292**	**0.2932**	**35.80**	**4.6**	**13.7**	**242**	**0.0**
Standard Deviation		**1**	**0.2115**	**9.07**	**0.1**	**0.1**	**116**	**0.1**

Port A = North, L = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	51.27
Velocity, [fpm]	3,076
ACFM	261,457
SCFM	170,097
DSCFM	157,279
Ex Air Free	120,104
lb/hr Flue Gas (dry)	756,991
lb/hr Flue Gas (wet)	793,491

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	51.27
Velocity, [fpm]	3,076
ACFM	261,457
SCFM	170,097
DSCFM	157,279
Ex Air Free	120,104
lb/hr Flue Gas (dry)	756,991
lb/hr Flue Gas (wet)	793,491

(1) No Port at Location Due to Structural Steel Support. Used Values For Port "B".

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Table F-10

Traverse Data Calculated Results -- 2B Heat Pipe Primary Flue Gas Out Duct
NYSEG Milliken Station

Coal Composition

Moisture	5.90%
C	70.53%
H	4.84%
N	1.38%
S	2.90%
O	4.20%
Ash	10.26%
Total	100.00%

Overhead Ash	90.00%
C in Ash	1.37%
Amb Air DB, deg F	77
Amb Air WB, deg F	65
Humd, lb/lb BD Air	0.01055

Std. Conditions

T, deg F	60
P, in. Hg	29.92

Date	11/7/96
Time	17:10-17:47
Tube I.D.	S-52
C-Factor	0.813
Operator(s)	GLC/DRS

No. Of Points	14	
Duct Width	17.92	ft
Duct Height	3.28	ft
Duct Area	58.79	Sq ft
Avg % O2	6.19	
Avg % CO2	12.87	
Avg % N2	80.90	

Bar., " Hg	29.32
Static, " H2O	-12.85
% H2O	7.09
Dry MW	30.32
Wet MW	29.45

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	9-7/8"	320	0.0467	14.53	7.6	11.6	276	0.2
A-2	29-9/16"	325	0.0028	3.57	7.0	12.2	328	0.2
B-1	9-7/8"	331	0.0387	13.31	6.2	12.9	350	0.3
B-2	29-9/16"	325	0.0162	8.58	6.1	13.0	325	0.4
C-1	9-7/8"	312	0.0285	11.28	5.8	13.2	339	0.4
C-2	29-9/16"	327	0.0095	6.57	4.7	14.2	390	0.5
D-1	9-7/8"	326	0.0331	12.25	4.9	14.0	374	0.2
D-2	29-9/16"	323	0.0078	5.95	6.8	12.3	300	0.1
E-1	9-7/8"	320	0.0220	9.97	6.5	12.6	301	0.2
E-2	29-9/16"	328	0.0210	9.78	5.7	13.3	347	0.3
F-1	9-7/8"	328	-0.0085	-6.22	6.2	12.9	330	0.3
F-2	29-9/16"	333	0.0287	11.46	5.3	13.7	360	0.3
G-1	9-7/8"	316	0.0302	11.66	7.6	11.6	290	0.2
G-2	29-9/16"	332	0.0361	12.86	6.1	13.0	327	0.2
Average, (group mean)		325	0.0223	8.97	6.2	12.9	331	0.27
Average, (wt mean)		325	---	---	6.2	12.9	330	0.27
Maximum		333	0.0467	14.53	7.6	14.2	390	0.50
Minimum		312	-0.0085	-6.22	4.7	11.6	276	0.10
Standard Deviation		6	0.0148	5.15	0.9	0.7	31	0.10

Port A = South, G = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	8.97
Velocity, [fpm]	538
ACFM	31,627
SCFM	19,869
DSCFM	18,459
Ex Air Free	12,988
lb/hr Flue Gas (dry)	88,477
lb/hr Flue Gas (wet)	92,491

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	9.00
Velocity, [fpm]	540
ACFM	31,730
SCFM	19,943
DSCFM	18,528
Ex Air Free	13,036
lb/hr Flue Gas (dry)	88,808
lb/hr Flue Gas (wet)	92,836

Table F-11

Traverse Data Calculated Results -- 2B Heat Pipe Primary Air Inlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	77	Std. Conditions	
Amb Air WB, deg F	65	T, deg F	60
Humd, lb/lb BD Air	0.01055	P, in. Hg	29.92

Date	11/7/96	No. Of Points	12		Bar., " Hg	29.32
Time	16:25-17:03	Duct Width	17.5	ft	Static, " H20	54.93
Tube I.D.	S-50	Duct Depth	3.28	ft		
C-Factor	0.810	Duct Area	57.42	Sq ft	% H20	1.67
Operator(s)	ROS/WLM	Avg % O2	21.0		Dry MW	28.97
		Avg % N2	79.0		Wet MW	28.79

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	9-7/8"	116	0.0327	9.69
A-2	29-9/16"	118	0.0058	4.09
B-1	9-7/8"	115	0.0189	7.36
B-2	29-9/16"	116	0.0062	4.22
C-1	9-7/8"	115	0.0876	15.85
C-2	29-9/16"	115	0.0049	3.75
D-1	9-7/8"	114	0.0481	11.74
D-2 (1)	29-9/16"	115	0.0015	2.07
E-1	9-7/8"	115	0.0197	7.52
E-2	29-9/16"	115	0.0186	7.30
F-1	9-7/8"	115	0.0015	2.07
F-2	29-9/16"	116	0.0094	5.20
Average, (group mean)		115	0.0212	6.74
Average, (wt mean)		115	—	—
Maximum		118	0.0876	15.85
Minimum		114	0.0015	2.07
Standard Deviation		1	0.0240	3.94

Ports A = South, F = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	6.74
Velocity, [fpm]	404
ACFM	23,220
SCFM	23,416
DSCFM	23,026
lb/hr Air (dry)	105,436
lb/hr Air (wet)	106,548

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	6.74
Velocity, [fpm]	404
ACFM	23,220
SCFM	23,416
DSCFM	23,026
lb/hr Flue Gas (dry)	105,436
lb/hr Flue Gas (wet)	106,548

Table F-12

Traverse Data Calculated Results -- 2B Heat Pipe Primary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F 77
Amb Air WB, deg F 65
Humd, lb/lb BD Air 0.01055

Std. Conditions
T, deg F 60
P, in. Hg 29.92

Bar., " Hg 29.32
Static, " H20 51.61

Date 11/7/96
Time 16:30-17:10
Tube I.D. S-49
C-Factor 0.802
Operator(s) RED/LLA

No. Of Points 20
Duct Dia 47.5 inches
Duct Area 12.31 Sq ft
Avg % O2 21.0
Avg % N2 79.0

% H20 1.67
Dry MW 28.97
Wet MW 28.79

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	1-3/16"	611	0.1778	30.64
A-2	3-7/8"	613	0.2263	34.60
A-3	6-15/16"	613	0.2298	34.87
A-4	10-3/4"	614	0.2109	33.42
A-5	16-1/4"	615	0.2207	34.20
A-6	31-1/4"	616	0.1760	30.56
A-7	36-3/4"	616	0.1651	29.60
A-8	40-9/16"	615	0.1453	27.75
A-9	43-5/8"	614	0.1318	26.42
A-10	46-5/16"	610	0.0927	22.11
B-1	1-3/16"	613	0.1891	31.63
B-2	3-7/8"	614	0.1972	32.31
B-3	6-15/16"	615	0.2139	33.67
B-4	10-3/4"	615	0.2194	34.10
B-5	16-1/4"	616	0.2044	32.93
B-6	31-1/4"	616	0.1485	28.07
B-7	36-3/4"	616	0.1393	27.18
B-8	40-9/16"	615	0.1258	25.82
B-9	43-5/8"	612	0.1164	24.80
B-10	46-5/16"	610	0.0818	20.77
Average, (group mean)		614	0.1706	29.77
Average, (wt mean)		614	---	---
Maximum		616	0.2298	34.87
Minimum		610	0.0818	20.77
Standard Deviation		2	0.0446	4.14

Ports A = South, B = East

Summary Straight Avg'd Results	
Velocity, [fps]	29.77
Velocity, [fpm]	1,786
ACFM	21,983
SCFM	11,779
DSCFM	11,582
lb/hr Air (dry)	53,035
lb/hr Air (wet)	53,594

Summary Weighted Avg Results	
Velocity, [fps]	29.77
Velocity, [fpm]	1,786
ACFM	21,983
SCFM	11,779
DSCFM	11,582
lb/hr Flue Gas (dry)	53,035
lb/hr Flue Gas (wet)	53,594

Table F-13

Traverse Data Calculated Results -- 2B Heat Pipe Secondary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F 77
Amb Air WB, deg F 65
Humd, lb/lb BD Air 0.01055

Std. Conditions
T, deg F 60
P, in. Hg 29.92

No. Of Points 24
Duct Width 6.0 ft
Duct Depth 9.0 ft
Duct Area 54.00 Sq ft
Avg % O2 21.0
Avg % N2 79.0

Date 11/7/96
Time 18:25-19:10
Tube I.D. S-54
C-Factor 0.806
Operator(s) RED/LLA

Bar., " Hg 29.30
Static, " H20 3.70
% " H20 1.67
Dry MW 28.97
Wet MW 28.79

PORT/ POINT	DISTANCE Fr Bottom (1)	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	9"	577	0.8607	70.56
A-2	27"	592	0.7080	64.45
A-3	45"	603	0.8601	71.41
A-4	63"	608	1.1900	84.19
A-5	81"	610	1.2340	85.82
A-6	99"	609	1.1230	81.83
B-1	9"	594	0.8954	72.55
B-2	27"	601	0.7763	67.78
B-3	45"	606	0.8148	69.60
B-4	63"	610	1.0770	80.17
B-5	81"	611	1.2760	87.31
B-6	99"	605	1.1290	81.89
C-1	9"	598	0.9330	74.20
C-2	27"	602	0.9324	74.32
C-3	45"	601	0.8149	69.44
C-4	63"	601	0.9784	76.09
C-5	81"	593	1.1940	83.74
C-6	99"	580	0.9024	72.35
D-1	9"	590	0.8092	68.84
D-2	27"	587	0.6713	62.61
D-3	45"	586	0.7804	67.48
D-4	63"	579	1.0380	77.56
D-5	81"	575	1.1330	80.88
D-6	99"	570	0.8528	70.00
Average, (group mean)		**596**	**0.9577**	**74.79**
Average, (wt mean)		**596**	**---**	**---**
Maximum		**611**	**1.2760**	**87.31**
Minimum		**570**	**0.6713**	**62.61**
Standard Deviation		**12**	**0.1715**	**6.88**

Port A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	74.79
Velocity, [fpm]	4,488
ACFM	242,336
SCFM	117,944
DSCFM	115,977
lb/hr Air (dry)	531,062
lb/hr Air (wet)	536,665

Summary Weighted Avg Results	
Velocity, [fps]	74.79
Velocity, [fpm]	4,488
ACFM	242,336
SCFM	117,944
DSCFM	115,977
lb/hr Flue Gas (dry)	531,062
lb/hr Flue Gas (wet)	536,665

Table F-14

Traverse Data Calculaed Results -- 2B Heat Pipe Secondary Air By-Pass Duct
NYSEG Milliken Station

Amb Air DB, deg F 76
Amb Air WB, deg F 65
Humd, lb/lb BD Air 0.01076

Std. Conditions
T, deg F 60
P, in. Hg 29.92

No. Points 8
Date 11/7/96
Duct Width 17.5 ft
Time 09:35-10:06
Duct Depth 2.09 ft
Tube I.D. S-53
Duct Area 36.64 Sq ft
C-Factor 0.816
% O2 21.0
Operator(s) GLC/WLM
% N2 79.0

Bar., " Hg 29.48
Static, " H2C 5.53
% H20 1.70
Dry MW 28.97
Wet MW 28.78

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	6-5/16"	125	0.0000	0.00
A-2	18-7/8"	134	0.0000	0.00
B-1	6-5/16"	107	0.0000	0.00
B-2	18-7/8"	120	0.0000	0.00
C-1	6-5/16"	111	0.0000	0.00
C-2	18-7/8"	131	-0.0001	-0.58
D-1	6-5/16"	164	0.0000	0.00
D-2	18-7/8"	164	0.0000	0.00
Average, (group mean)		132	-0.0000	-0.07
Average, (wt mean)		131	---	---
Maximum		164	0.0000	0.00
Minimum		107	-0.0001	-0.58
SDEV		20	0.0000	0.19

Ports A = South, D = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	-0.07
Velocity, [fpm]	-4
ACFM	-159
SCFM	-140
DSCFM	-137
lb/hr Air (dry)	-629
lb/hr Air (wet)	-635

Data Summary Wt'd Avg Data	
Velocity, [fps]	-0.07
Velocity, [fpm]	-4
ACFM	-159
SCFM	-140
DSCFM	-137
lb/hr Flue Gas (dry)	-629
lb/hr Flue Gas (wet)	-635

Table F-15

Traverse Data Calculated Results -- 2A Heat Pipe Flue Gas Inlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	7.58%	**Overhead Ash**	90.00%	**Std. Conditions**	
C	69.33%	**C in Ash**	3.19%	**T, deg F**	60
H	4.69%			**P, in. Hg**	29.92
N	1.34%	**Amb Air DB, deg F**	76		
S	2.81%	**Amb Air WB, deg F**	62		
O	3.92%	**Humd, lb/lb BD Air**	0.00879		
Ash	10.33%				
Total	100.00%				
		No. Of Points	20		
		Duct Width	14.5 ft	**Bar., " Hg**	29.13
Date	11/8/96	**Duct Height**	5.5 ft	**Static, " H2O**	-9.69
Time	10:16-11:21	**Duct Area**	79.75 Sq ft		
Tube I.D.	S-53		4.25	**Avg % H2O**	7.68
C-Factor	0.816		14.57	**Dry MW**	30.52
Operator(s)	ROS/WLM		81.12	**Wet MW**	29.56

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	8-1/4"	678	0.6324	64.59	4.5	14.4	411	0.3
A-2	24-3/4"	681	0.7598	70.92	5.0	13.9	390	0.3
A-3	41-1/4"	673	0.6720	66.51	6.0	13.0	307	0.3
A-4	57-3/4"	666	0.7202	68.65	6.2	12.9	256	0.3
B-1	8-1/4"	649	0.6730	65.73	3.6	15.1	505	0.4
B-2	24-3/4"	653	0.9443	78.03	4.2	14.6	377	0.4
B-3	41-1/4"	661	0.8524	74.45	4.9	14.0	500	0.4
B-4	57-3/4"	663	1.0070	81.05	5.8	13.2	458	0.4
C-1	8-1/4"	642	0.7173	67.61	2.9	15.8	597	0.3
C-2	24-3/4"	640	1.0430	81.48	3.4	15.3	580	0.4
C-3	41-1/4"	639	0.8772	74.73	4.0	14.8	546	0.3
C-4	57-3/4"	641	0.9175	76.54	4.8	14.1	484	0.1
D-1	8-1/4"	663	0.6787	66.38	2.7	15.9	579	0.6
D-2	24-3/4"	662	0.9905	80.17	3.0	15.7	583	0.1
D-3	41-1/4"	651	0.9218	77.02	4.0	14.8	633	0.2
D-4	57-3/4"	647	0.8975	75.93	5.2	13.7	460	0.1
E-1	8-1/4"	685	0.6201	64.08	3.0	15.7	596	0.4
E-2	24-3/4"	673	0.8559	74.91	3.3	15.4	586	0.5
E-3	41-1/4"	656	0.7956	71.70	3.7	15.1	700	0.6
E-4	57-3/4"	651	0.8942	75.91	4.7	14.2	657	0.2
Average, (group mean)		**659**	**0.8235**	**72.82**	**4.2**	**14.6**	**510**	**0.33**
Average, (wt mean)		**658**	**---**	**---**	**4.3**	**14.6**	**512**	**0.33**
Maximum		**685**	**1.0430**	**81.48**	**6.2**	**15.9**	**700**	**0.60**
Minimum		**639**	**0.6201**	**64.08**	**2.7**	**12.9**	**256**	**0.10**
Standard Deviation		**14**	**0.1283**	**5.53**	**1.0**	**0.9**	**115**	**0.14**

Port A = South, E = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	**72.82**
Velocity, [fpm]	**4,369**
ACFM	**348,440**
SCFM	**153,923**
DSCFM	**142,101**
Ex Air Free	**113,175**
lb/hr Flue Gas (dry)	**685,486**
lb/hr Flue Gas (wet)	**719,151**

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	**72.82**
Velocity, [fpm]	**4,369**
ACFM	**348,440**
SCFM	**153,922**
DSCFM	**142,101**
Ex Air Free	**113,175**
lb/hr Flue Gas (dry)	**685,485**
lb/hr Flue Gas (wet)	**719,149**

Table F-16

Traverse Data Calculated Results -- 2A Heat Pipe Flue Gas Outlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	7.58%	Overhead Ash	90.00%	Std. Conditions	
C	69.33%	C in Ash	3.19%	T, deg F	60
H	4.69%			P, in. Hg	29.92
N	1.34%	Amb Air DB, deg F	78		
S	2.81%	Amb Air WB, deg F	62		
O	3.92%	Humd, lb/lb BD Air	0.00879		
Ash	10.33%				
Total	100.00%				
		No. Of Points	24		
		Duct Width	34.0 ft	Bar., " Hg	29.13
Date	11/8/96	Duct Depth	2.5 ft	Static, " H2O	-14.56
Time	10:15-11:20	Duct Area	85.00 Sq ft		
Tube I.D.	S-52	Avg % O2	4.67	% H20	7.53
C-Factor	0.813	Avg % CO2	14.21	Dry MW	30.48
Operator(s)	GLC/DRS	Avg % N2	81.09	Wet MW	29.54

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	7-1/2"	278	0.8471	60.38	4.6	14.3	486	.1
A-2	22-1/2"	278	0.6602	53.30	4.4	14.4	486	.1
B-1	7-1/2"	277	0.6103	51.20	4.3	14.5	389	.1
B-2	22-1/2"	277	0.6706	53.68	4.4	14.4	400	.1
C-1	7-1/2"	276	0.8562	60.61	4.4	14.4	373	.1
C-2	22-1/2"	276	0.7970	58.47	4.2	14.6	399	.1
D-1	7-1/2"	277	0.7974	58.52	4.1	14.7	457	.1
D-2	22-1/2"	277	0.7241	55.77	4.3	14.5	355	.1
E-1	7-1/2"	277	0.6788	54.01	4.4	14.4	408	.1
E-2	22-1/2"	277	0.7286	55.95	4.3	14.5	428	.1
F-1	7-1/2"	278	0.7916	58.34	4.3	14.5	377	.1
F-2	22-1/2"	278	0.6035	50.96	4.4	14.4	385	.1
G-1	7-1/2"	278	0.4307	43.06	4.8	14.1	335	0.0
G-2	22-1/2"	278	0.3314	37.78	5.0	13.9	350	0.0
H-1	7-1/2"	278	0.4410	43.57	4.8	14.1	300	0.0
H-2	22-1/2"	277	0.4752	45.21	5.0	13.9	315	0.0
I-1	7-1/2"	277	0.4948	46.13	5.0	13.9	270	0.0
I-2	22-1/2"	277	0.5223	47.39	5.0	13.9	273	0.0
J-1	7-1/2"	279	0.5677	49.49	5.2	13.7	289	0.0
J-2	22-1/2"	279	0.5877	50.35	5.2	13.7	317	0.0
K-1	7-1/2"	279	0.5279	47.73	5.5	13.5	260	0.1
K-2	22-1/2"	279	0.5328	47.94	5.2	13.7	285	0.1
L-1	7-1/2"	278	0.4937	46.11	5.1	13.8	175	0.2
L-2	22-1/2"	277	0.5326	47.86	5.0	13.9	225	0.2
Average, (group mean)		**278**	**0.6126**	**50.99**	**4.7**	**14.2**	**332**	**0.0**
Average, (wt mean)		**278**	**---**	**---**	**4.7**	**14.2**	**335**	**0.02**
Maximum		**279**	**0.8562**	**60.61**	**5.5**	**14.7**	**486**	**0.2**
Minimum		**276**	**0.3314**	**37.78**	**4.1**	**13.5**	**0**	**0.0**
Standard Deviation		**1**	**0.1399**	**5.90**	**0.4**	**0.3**	**104**	**0.1**

Port A = North, L = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	50.99
Velocity, [fpm]	3,060
ACFM	260,059
SCFM	171,841
DSCFM	158,909
Ex Air Free	123,384
lb/hr Flue Gas (dry)	765,513
lb/hr Flue Gas (wet)	802,338

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	50.99
Velocity, [fpm]	3,060
ACFM	260,059
SCFM	171,841
DSCFM	158,909
Ex Air Free	123,384
lb/hr Flue Gas (dry)	765,512
lb/hr Flue Gas (wet)	802,337

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Table F-17

Traverse Data Calculated Results -- 2A Heat Pipe Primary Flue Gas Out Duct
NYSEG Milliken Station

Coal Composition					
Moisture	7.58%	Overhead Ash	90.00%	Std. Conditions	
C	69.33%	C in Ash	3.19%	T, deg F	60
H	4.69%			P, in. Hg	29.92
N	1.34%	Amb Air DB, deg F	75		
S	2.81%	Amb Air WB, deg F	61		
O	3.92%	Humd, lb/lb BD Air	0.00842		
Ash	10.33%				
Total	100.00%				

		No. Of Points	14	Bar., " Hg	29.16
Date	11/8/96	Duct Width	17.92 ft	Static, " H2O	-12.78
Time	11:48-12:28	Duct Height	3.28 ft		
Tube I.D.	S-52	Duct Area	58.79 Sq ft	% H2O	7.19
C-Factor	0.813	Avg % O2	5.47	Dry MW	30.40
Operator(s)	GLC/DRS	Avg % CO2	13.50	Wet MW	29.51
		Avg % N2	80.98		

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	9-7/8"	289	0.0459	14.14	6.6	12.5	430	0.2
A-2	29-9/16"	293	0.0133	7.63	5.9	13.1	420	0.1
B-1	9-7/8"	287	0.0301	11.44	6.8	12.3	407	0.1
B-2	29-9/16"	294	0.0218	9.77	5.2	13.7	468	0.1
C-1	9-7/8"	280	0.0180	8.80	6.3	12.8	433	0.1
C-2	29-9/16"	290	0.0232	10.05	5.5	13.5	485	0.1
D-1	9-7/8"	284	0.0251	10.41	5.5	13.5	470	0.1
D-2	29-9/16"	289	0.0077	5.78	4.4	14.4	530	0.1
E-1	9-7/8"	286	0.0532	15.18	5.2	13.7	485	0.1
E-2	29-9/16"	294	0.0278	11.02	4.0	14.8	565	0.1
F-1	9-7/8"	286	0.0376	12.75	4.5	14.4	570	0.1
F-2	29-9/16"	294	0.0236	10.15	4.0	14.8	623	0.1
G-1	9-7/8"	279	0.0504	14.72	6.3	12.8	495	0.1
G-2	29-9/16"	279	0.0044	4.35	5.7	13.3	572	0.1
Average, (group mean)		288	0.0273	10.44	5.4	13.5	497	0.11
Average, (wt mean)		288	---	---	5.5	13.5	493	0.11
Maximum		294	0.0532	15.18	6.8	14.8	623	0.20
Minimum		279	0.0044	4.35	4.0	12.3	407	0.10
Standard Deviation		5	0.0144	3.06	0.9	0.8	64	0.03

Port A = South, G = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	10.44
Velocity, [fpm]	626
ACFM	36,831
SCFM	24,156
DSCFM	22,418
Ex Air Free	16,550
lb/hr Flue Gas (dry)	107,708
lb/hr Flue Gas (wet)	112,657

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	10.43
Velocity, [fpm]	626
ACFM	36,783
SCFM	24,124
DSCFM	22,388
Ex Air Free	16,528
lb/hr Flue Gas (dry)	107,565
lb/hr Flue Gas (wet)	112,508

Table F-18

Traverse Data Calculated Results -- 2A Heat Pipe Primary Air Inlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	75		**Std. Conditions**	
Amb Air WB, deg F	61		T, deg F	60
Humd, lb/lb BD Air	0.00842		P, In. Hg	29.92

Date	11/8/96	No. Of Points	12		Bar., " Hg	29.16
Time	11:40-12:10	Duct Width	17.5	ft	Static, " H20	56.53
Tube I.D.	S-50	Duct Depth	3.28	ft		
C-Factor	0.810	Duct Area	57.42	Sq ft	% H20	1.34
Operator(s)	ROS/WLM	Avg % O2	21.0		Dry MW	28.97
		Avg % N2	79.0		Wet MW	28.82

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	9-7/8"	107	0.0033	3.06
A-2	29-9/16"	106	0.0077	4.66
B-1	9-7/8"	106	0.0222	7.92
B-2	29-9/16"	107	0.0332	9.69
C-1	9-7/8"	106	0.0479	11.63
C-2	29-9/16"	107	0.0294	9.12
D-1	9-7/8"	106	0.0347	9.90
D-2	29-9/16"	108	0.0121	5.86
E-1	9-7/8"	106	0.0380	10.36
E-2	29-9/16"	108	0.0106	5.48
F-1	9-7/8"	106	0.1120	17.78
F-2	29-9/16"	107	0.0349	9.94
Average, (group mean)		106	0.0322	8.78
Average, (wt mean)		106	---	---
Maximum		108	0.1120	17.78
Minimum		106	0.0033	3.06
Standard Deviation		1	0.0275	3.71

Ports A = South, F = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	8.78
Velocity, [fpm]	527
ACFM	30,259
SCFM	30,946
DSCFM	30,532
lb/hr Air (dry)	139,809
lb/hr Air (wet)	140,986

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	8.78
Velocity, [fpm]	527
ACFM	30,259
SCFM	30,946
DSCFM	30,532
lb/hr Flue Gas (dry)	139,809
lb/hr Flue Gas (wet)	140,986

Table F-19

Traverse Data Calculated Results -- 2A Heat Pipe Primary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	75
Amb Air WB, deg F	61
Humd, lb/lb BD Air	0.00842

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

Bar., " Hg	29.16
Static, " H20	51.96

Date	11/8/96	No. Of Points	20
Time	11:45-12:10	Duct Dia	47.5 inches
Tube I.D.	S-49	Duct Area	12.31 Sq ft
C-Factor	0.802	Avg % O2	21.0
Operator(s)	RED/LLA	Avg % N2	79.0

% H20	1.34
Dry MW	28.97
Wet MW	28.82

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	1-3/16"	575	0.3132	40.03
A-2	3-7/8"	577	0.3515	42.45
A-3	6-15/16"	578	0.3351	41.47
A-4	10-3/4"	579	0.3537	42.63
A-5	16-1/4"	579	0.3837	44.40
A-6	31-1/4"	580	0.3226	40.73
A-7	36-3/4"	580	0.2922	38.76
A-8	40-9/16"	579	0.2687	37.15
A-9	43-5/8"	576	0.2318	34.46
A-10	46-5/16"	574	0.1724	29.69
B-1	1-3/16"	572	0.2978	38.98
B-2	3-7/8"	573	0.3693	43.43
B-3	6-15/16"	574	0.3843	44.33
B-4	10-3/4"	574	0.4050	45.50
B-5	16-1/4"	575	0.4050	45.53
B-6	31-1/4"	575	0.3119	39.95
B-7	36-3/4"	575	0.2914	38.62
B-8	40-9/16"	574	0.2560	36.18
B-9	43-5/8"	573	0.2230	33.75
B-10	46-5/16"	572	0.1905	31.18
Average, (group mean)		576	0.3080	39.46
Average, (wt mean)		576	---	---
Maximum		580	0.4050	45.53
Minimum		572	0.1724	29.69
Standard Deviation		3	0.0668	4.48

Ports A = South, B = East

Summary Straight Avg'd Results	
Velocity, [fps]	39.46
Velocity, [fpm]	2,368
ACFM	29,136
SCFM	16,122
DSCFM	15,907
lb/hr Air (dry)	72,838
lb/hr Air (wet)	73,451

Summary Weighted Avg Results	
Velocity, [fps]	39.46
Velocity, [fpm]	2,368
ACFM	29,136
SCFM	16,122
DSCFM	15,907
lb/hr Flue Gas (dry)	72,838
lb/hr Flue Gas (wet)	73,451

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Table F-20

Traverse Data Calculated Results -- 2A Heat Pipe Secondary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F 75
Amb Air WB, deg F 61
Humd, lb/lb BD Air 0.00842

Std. Conditions
T, deg F 60
P, In. Hg 29.92

No. Of Points 24
Duct Width 6.0 ft
Duct Depth 9.0 ft
Duct Area 54.00 Sq ft
Avg % O2 21.0
Avg % N2 79.0

Date 11/8/96
Time 10:15-11:00
Tube I.D. S-54
C-Factor 0.806
Operator(s) RED/LLA

Bar., " Hg 29.12
Static, " H20 3.70
% " H20 1.34
Dry MW 28.97
Wet MW 28.82

PORT/ POINT	DISTANCE Fr Bottom (1)	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	9"	571	0.7933	67.70
A-2	27"	571	0.8544	70.26
A-3	45"	567	0.8351	69.33
A-4	63"	565	0.8969	71.78
A-5	81"	559	0.9216	72.55
A-6	99"	552	0.9181	72.16
B-1	9"	577	1.0170	76.88
B-2	27"	578	1.0000	76.27
B-3	45"	580	0.9189	73.18
B-4	63"	583	1.0460	78.19
B-5	81"	575	1.1650	82.20
B-6	99"	562	0.8586	70.13
C-1	9"	573	0.9873	75.60
C-2	27"	580	1.0590	78.56
C-3	45"	586	0.8965	72.49
C-4	63"	591	1.1240	81.37
C-5	81"	594	1.2600	86.27
C-6	99"	589	1.1110	80.82
D-1	9"	564	0.8790	71.02
D-2	27"	574	0.8761	71.25
D-3	45"	584	0 8969	72.44
D-4	63"	591	1.2120	84.49
D-5	81"	596	1.1920	83.99
D-6	99"	597	1.2930	87.52
Average, (group mean)		578	1.0005	76.10
Average, (wt mean)		578	---	---
Maximum		597	1.2930	87.52
Minimum		552	0.7933	67.70
Standard Deviation		12	0.1427	5.71

Port A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	76.10
Velocity, [fpm]	4,566
ACFM	246,572
SCFM	121,315
DSCFM	119,695
lb/hr Air (dry)	548,086
lb/hr Air (wet)	552,699

Summary Weighted Avg Results	
Velocity, [fps]	76.10
Velocity, [fpm]	4,566
ACFM	246,572
SCFM	121,315
DSCFM	119,695
lb/hr Flue Gas (dry)	548,086
lb/hr Flue Gas (wet)	552,699

Table F-21

Traverse Data Calculaed Results -- 2A Heat Pipe Secondary Air By-Pass Duct
NYSEG Milliken Station

Amb Air DB, deg F 76
Amb Air WB, deg F 62
Humd, lb/lb BD Air 0.00879

Std. Conditions
T, deg F 60
P, in. Hg 29.92

Date 11/8/96
Time 08:25-08:43
Tube I.D. S-53
C-Factor 0.816
Operator(s) GLC/WLM

No. Points 8
Duct Width 17.5 ft
Duct Depth 2.09 ft
Duct Area 36.64 Sq ft
% O2 21.0
% N2 79.0

Bar., " Hg 29.12
Static, " H2C 5.56

% H20 1.39
Dry MW 28.97
Wet MW 28.82

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	6-5/16"	236	0.0000	0.00
A-2	18-7/8"	236	0.0000	0.00
B-1	6-5/16"	236	0.0002	0.89
B-2	18-7/8"	239	0.0001	0.63
C-1	6-5/16"	219	0.0002	0.88
C-2	18-7/8"	228	0.0002	0.89
D-1	6-5/16"	216	0.0001	0.62
D-2	18-7/8"	224	0.0001	0.63
Average, (group mean)		229	0.0001	0.57
Average, (wt mean)		227	---	---
Maximum		239	0.0002	0.89
Minimum		216	0.0000	0.00
SDEV		8	0.0001	0.35

Ports A = South, D = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	0.57
Velocity, [fpm]	34
ACFM	1248
SCFM	932
DSCFM	919
lb/hr Air (dry)	4207
lb/hr Air (wet)	4244

Data Summary Wt'd Avg Data	
Velocity, [fps]	0.57
Velocity, [fpm]	34
ACFM	1248
SCFM	932
DSCFM	919
lb/hr Flue Gas (dry)	4207
lb/hr Flue Gas (wet)	4244

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Table F-22

Traverse Data Calculated Results -- 2B Heat Pipe Flue Gas Inlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	7.58%	Overhead Ash	90.00%	Std. Conditions	
C	69.33%	C in Ash	3.19%	T, deg F	60
H	4.69%			P, in. Hg	29.92
N	1.34%	Amb Air DB, deg F	75		
S	2.81%	Amb Air WB, deg F	60		
O	3.92%	Humd, lb/lb BD Air	0.00808		
Ash	10.33%				
Total	100.00%				
		No. Of Points	20		
		Duct Width	14.5 ft	Bar., " Hg	29.12
Date	11/8/96	Duct Height	5.5 ft	Static, " H2O	-10.16
Time	14:05-14:48	Duct Area	79.75 Sq ft		
Tube I.D.	S-53		4.81	Avg % H2O	7.39
C-Factor	0.816		14.08	Dry MW	30.46
Operator(s)	ROS/WLM		81.05	Wet MW	29.54

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	8-1/4"	669	0.7359	69.42	4.2	14.6	556	0.1
A-2	24-3/4"	663	0.7964	72.04	4.3	14.5	600	0.2
A-3	41-1/4"	657	0.8357	73.60	4.4	14.4	565	0.2
A-4	57-3/4"	657	0.9073	76.70	4.7	14.2	490	0.2
B-1	8-1/4"	658	0.8367	73.66	4.1	14.7	570	0.3
B-2	24-3/4"	650	1.0680	82.92	4.1	14.7	570	0.2
B-3	41-1/4"	649	0.9673	78.90	4.4	14.4	580	0.2
B-4	57-3/4"	655	0.9063	76.61	4.9	14.0	540	0.2
C-1	8-1/4"	654	0.7399	69.18	4.6	14.3	675	0.1
C-2	24-3/4"	649	0.9164	76.81	4.6	14.3	668	0.2
C-3	41-1/4"	645	0.9279	77.17	4.9	14.0	650	0.1
C-4	57-3/4"	648	0.9619	78.69	5.1	13.8	525	0.1
D-1	8-1/4"	659	0.7147	68.15	4.8	14.1	606	0.2
D-2	24-3/4"	667	0.9609	79.31	4.9	14.0	703	0.4
D-3	41-1/4"	668	0.9921	80.64	5.1	13.8	676	0.4
D-4	57-3/4"	663	0.9252	77.73	5.6	13.4	551	0.3
E-1	8-1/4"	695	0.4262	53.48	5.0	13.9	629	0.4
E-2	24-3/4"	694	0.5950	63.17	5.2	13.7	610	0.2
E-3	41-1/4"	687	0.7622	71.30	5.6	13.4	589	0.2
E-4	57-3/4"	665	0.8706	75.48	5.9	13.1	500	0.2
Average, (group mean)		663	0.8423	73.75	4.8	14.1	593	0.22
Average, (wt mean)		661	---	---	4.8	14.1	592	0.22
Maximum		695	1.0680	82.92	5.9	14.7	703	0.40
Minimum		645	0.4262	53.48	4.1	13.1	490	0.10
Standard Deviation		14	0.1461	6.61	0.5	0.4	58	0.09

Port A = South, E = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	73.75
Velocity, [fpm]	4,425
ACFM	352,881
SCFM	155,156
DSCFM	143,697
Ex Air Free	110,611
lb/hr Flue Gas (dry)	691,913
lb/hr Flue Gas (wet)	724,544

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	73.75
Velocity, [fpm]	4,425
ACFM	352,881
SCFM	155,156
DSCFM	143,697
Ex Air Free	110,610
lb/hr Flue Gas (dry)	691,910
lb/hr Flue Gas (wet)	724,541

Table F-23

Traverse Data Calculated Results -- 2B Heat Pipe Flue Gas Outlet Duct
NYSEG Milliken Station

Coal Composition	
Moisture	7.58%
C	69.33%
H	4.69%
N	1.34%
S	2.81%
O	3.92%
Ash	10.33%
Total	100.00%

Overhead Ash	90.00%
C in Ash	3.19%
Amb Air DB, deg F	75
Amb Air WB, deg F	60
Humd, lb/lb BD Air	0.00808

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

Date	11/8/96
Time	14:02-14:50
Tube I.D.	S-52
C-Factor	0.813
Operator(s)	DRS/GLC

No. Of Points	24
Duct Width	34.0 ft
Duct Depth	2.5 ft
Duct Area	85.00 Sq ft
Avg % O2	5.20
Avg % CO2	13.74
Avg % N2	81.00

Bar., " Hg	29.12
Static, " H2O	-15.10
% H20	7.25
Dry MW	30.42
Wet MW	29.52

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1 (1)	7-1/2"	285	0.2822	35.05	4.7	14.2	720	0.1
A-2 (1)	22-1/2"	284	0.3152	37.00	4.2	14.6	768	0.1
B-1	7-1/2"	285	0.2822	35.05	4.7	14.2	720	0.1
B-2	22-1/2"	284	0.3152	37.00	4.2	14.6	768	0.1
C-1	7-1/2"	287	0.4580	44.74	5.5	13.5	605	0.1
C-2	22-1/2"	286	0.4934	46.40	5.4	13.6	676	0.1
D-1	7-1/2"	285	0.6608	53.66	5.3	13.7	660	0.0
D-2	22-1/2"	285	0.6848	54.62	5.3	13.7	677	0.0
E-1	7-1/2"	281	0.6003	51.01	5.4	13.6	630	0.1
E-2	22-1/2"	282	0.5969	50.89	5.2	13.7	645	0.0
F-1	7-1/2"	281	0.4592	44.61	5.4	13.6	600	0.0
F-2	22-1/2"	280	0.5738	49.84	5.4	13.6	625	0.0
G-1	7-1/2"	281	0.3660	39.82	5.3	13.7	605	0.0
G-2	22-1/2"	281	0.2473	32.74	5.4	13.6	620	0.0
H-1	7-1/2"	282	0.8959	62.35	5.4	13.6	585	0.0
H-2	22-1/2"	283	0.9307	63.59	5.2	13.7	605	0.0
I-1	7-1/2"	283	1.0780	68.43	5.2	13.7	585	0.0
I-2	22-1/2"	282	0.9691	64.85	5.4	13.6	590	0.0
J-1	7-1/2"	282	0.7029	55.22	5.2	13.7	531	0.0
J-2	22-1/2"	281	0.8532	60.80	5.2	13.7	573	0.0
K-1	7-1/2"	280	0.8312	59.97	5.2	13.7	574	0.2
K-2	22-1/2"	281	0.9143	62.94	5.2	13.7	574	0.2
L-1	7-1/2"	279	0.7010	55.04	5.4	13.6	513	0.3
L-2	22-1/2"	280	0.4881	45.95	5.2	13.7	540	0.3
Average, (group mean)		283	0.6125	50.48	5.2	13.8	625	0.0
Average, (wt mean)		283	---	---	5.2	13.7	616	0.07
Maximum		287	1.0780	68.43	5.5	14.6	768	0.3
Minimum		279	0.2473	32.74	4.2	13.5	513	0.0
Standard Deviation		2	0.2427	10.48	0.3	0.3	67	0.1

Port A = North, L = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	50.48
Velocity, [fpm]	3,029
ACFM	257,456
SCFM	168,718
DSCFM	156,490
Ex Air Free	117,547
lb/hr Flue Gas (dry)	752,542
lb/hr Flue Gas (wet)	787,365

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	50.48
Velocity, [fpm]	3,029
ACFM	257,456
SCFM	168,718
DSCFM	156,490
Ex Air Free	117,547
lb/hr Flue Gas (dry)	752,542
lb/hr Flue Gas (wet)	787,365

(1) No Port at Location Due to Structural Steel Support. Used Values For Port "B".

Table F-24

Traverse Data Calculated Results -- 2B Heat Pipe Primary Flue Gas Out Duct
NYSEG Milliken Station

Coal Composition					
Moisture	7.58%	Overhead Ash	90.00%	Std. Conditions	
C	69.33%	C in Ash	2.89%	T, deg F	60
H	4.69%			P, in. Hg	29.92
N	1.34%	Amb Air DB, deg F	74		
S	2.81%	Amb Air WB, deg F	60		
O	3.92%	Humd, lb/lb BD Air	0.00833		
Ash	10.33%				
Total	100.00%				
		No. Of Points	14	Bar., " Hg	29.12
Date	11/8/96	Duct Width	17.92 ft	Static, " H2O	-12.87
Time	12:40-13:11	Duct Height	3.28 ft		
Tube I.D.	S-52	Duct Area	58.79 Sq ft	% H2O	6.86
C-Factor	0.813	Avg % O2	6.37	Dry MW	30.31
Operator(s)	GLC/DRS	Avg % CO2	12.72	Wet MW	29.46
		Avg % N2	80.87		

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	9-7/8"	287	0.0448	13.97	7.3	11.9	290	0.1
A-2	29-9/16"	289	0.0011	2.19	6.8	12.3	345	0.1
B-1	9-7/8"	289	0.0378	12.84	6.1	13.0	372	0.1
B-2	29-9/16"	283	0.0088	6.17	6.1	13.0	377	0.1
C-1	9-7/8"	278	0.0322	11.76	6.1	13.0	318	0.5
C-2	29-9/16"	287	0.0119	7.19	5.2	13.7	413	0.4
D-1	9-7/8"	279	0.0154	8.13	5.3	13.7	317	0.3
D-2	29-9/16"	258	0.0020	2.89	7.6	11.6	337	0.2
E-1	9-7/8"	273	0.0216	9.60	6.4	12.7	485	0.2
E-2	29-9/16"	284	0.0086	6.10	5.4	13.6	560	0.1
F-1	9-7/8"	282	0.0394	13.06	7.4	11.8	445	0.1
F-2	29-9/16"	292	0.0359	12.53	5.2	13.7	568	0.1
G-1	9-7/8"	274	0.0368	12.56	7.6	11.6	455	0.2
G-2	29-9/16"	284	0.0360	12.49	6.2	12.9	547	0.1
Average, (group mean)		282	0.0237	9.39	6.3	12.7	416	0.19
Average, (wt mean)		283	---	---	6.4	12.7	424	0.18
Maximum		292	0.0448	13.97	7.6	13.7	568	0.50
Minimum		258	0.0011	2.19	5.2	11.6	290	0.10
Standard Deviation		8	0.0148	3.81	0.9	0.7	92	0.12

Port A = South, G = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	9.39
Velocity, [fpm]	563
ACFM	33,127
SCFM	21,837
DSCFM	20,340
Ex Air Free	14,145
lb/hr Flue Gas (dry)	97,435
lb/hr Flue Gas (wet)	101,699

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	9.36
Velocity, [fpm]	561
ACFM	33,003
SCFM	21,755
DSCFM	20,263
Ex Air Free	14,092
lb/hr Flue Gas (dry)	97,069
lb/hr Flue Gas (wet)	101,317

Table F-25

Traverse Data Calculated Results -- 2B Heat Pipe Primary Air Inlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	75
Amb Air WB, deg F	61
Humd, lb/lb BD Air	0.00842

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

Date	11/8/96
Time	12:18-12:52
Tube I.D.	S-50
C-Factor	0.810
Operator(s)	ROS/WLM

No. Of Points	12	
Duct Width	17.5	ft
Duct Depth	3.28	ft
Duct Area	57.42	Sq ft
Avg % O2	21.0	
Avg % N2	79.0	

Bar., " Hg	29.18
Static, " H20	56.02
% H20	1.34
Dry MW	28.97
Wet MW	28.82

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	9-7/8"	107	0.0494	11.82
A-2	29-9/16"	109	0.0073	4.55
B-1	9-7/8"	107	0.0376	10.32
B-2	29-9/16"	108	0.0089	5.02
C-1	9-7/8"	106	0.0758	14.63
C-2	29-9/16"	107	0.0176	7.06
D-1	9-7/8"	107	0.0730	14.37
D-2 (1)	29-9/16"	107	0.0169	6.92
E-1	9-7/8"	106	0.0374	10.28
E-2	29-9/16"	107	0.0272	8.77
F-1	9-7/8"	107	0.0130	6.07
F-2	29-9/16"	107	0.0183	7.20
Average, (group mean)		107	0.0319	8.92
Average, (wt mean)		107	---	---
Maximum		109	0.0758	14.63
Minimum		106	0.0073	4.55
Standard Deviation		1	0.0226	3.26

Ports A = South, F = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	8.92
Velocity, [fpm]	535
ACFM	30,726
SCFM	31,385
DSCFM	30,966
lb/hr Air (dry)	141,794
lb/hr Air (wet)	142,987

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	8.92
Velocity, [fpm]	535
ACFM	30,726
SCFM	31,385
DSCFM	30,966
lb/hr Flue Gas (dry)	141,794
lb/hr Flue Gas (wet)	142,987

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Table F-26

Traverse Data Calculated Results -- 2B Heat Pipe Primary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	75
Amb Air WB, deg F	61
Humd, lb/lb BD Air	0.00842

Std. Conditions	
T, deg F	60
P, in. Hg	29.92
Bar., " Hg	29.18
Static, " H20	51.59
% H20	1.34
Dry MW	28.97
Wet MW	28.82

Date	11/8/96	No. Of Points	20
Time	12:15-12:55	Duct Dia	47.5 inches
Tube I.D.	S-49	Duct Area	12.31 Sq ft
C-Factor	0.802	Avg % O2	21.0
Operator(s)	RED/LLA	Avg % N2	79.0

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	1-3/16"	590	0.3013	39.55
A-2	3-7/8"	591	0.3434	42.25
A-3	6-15/16"	592	0.3692	43.83
A-4	10-3/4"	592	0.3599	43.27
A-5	16-1/4"	593	0.3508	42.74
A-6	31-1/4"	594	0.2883	38.77
A-7	36-3/4"	594	0.2651	37.17
A-8	40-9/16"	594	0.2361	35.08
A-9	43-5/8"	592	0.2063	32.76
A-10	46-5/16"	591	0.1566	28.53
B-1	1-3/16"	590	0.2862	38.55
B-2	3-7/8"	590	0.3387	41.94
B-3	6-15/16"	591	0.3258	41.15
B-4	10-3/4"	592	0.3560	43.04
B-5	16-1/4"	592	0.3293	41.39
B-6	31-1/4"	593	0.2541	36.38
B-7	36-3/4"	592	0.2219	33.98
B-8	40-9/16"	591	0.2022	32.42
B-9	43-5/8"	590	0.1753	30.17
B-10	46-5/16"	589	0.1385	26.80
Average, (group mean)		592	0.2753	37.49
Average, (wt mean)		592	---	---
Maximum		594	0.3692	43.83
Minimum		589	0.1385	26.80
Standard Deviation		1	0.0711	5.13

Ports A = South, B = East

Summary Straight Avg'd Results	
Velocity, [fps]	37.49
Velocity, [fpm]	2,249
ACFM	27,680
SCFM	15,081
DSCFM	14,880
lb/hr Air (dry)	68,135
lb/hr Air (wet)	68,709

Summary Weighted Avg Results	
Velocity, [fps]	37.49
Velocity, [fpm]	2,249
ACFM	27,680
SCFM	15,081
DSCFM	14,880
lb/hr Flue Gas (dry)	68,135
lb/hr Flue Gas (wet)	68,709

Table F-27

Traverse Data Calculated Results -- 2B Heat Pipe Secondary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F 75
Amb Air WB, deg F 60
Humd, lb/lb BD Air 0.00808

Std. Conditions
T, deg F 60
P, in. Hg 29.92

Date 11/8/96
Time 14:05-14:40
Tube I.D. S-54
C-Factor 0.806
Operator(s) RED/LLA

No. Of Points 24
Duct Width 6.0 ft
Duct Depth 9.0 ft
Duct Area 54.00 Sq ft
Avg % O2 21.0
Avg % N2 79.0

Bar., " Hg 29.12
Static, " H20 3.86
% " H20 1.28
Dry MW 28.97
Wet MW 28.83

PORT/ POINT	DISTANCE Fr Bottom (1)	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	9"	570	0.9557	74.27
A-2	27"	588	0.7562	66.64
A-3	45"	602	0.9261	74.24
A-4	63"	607	1.2530	86.55
A-5	81"	610	1.2860	87.81
A-6	99"	609	1.1480	82.92
B-1	9"	591	0.9761	75.82
B-2	27"	600	0.7940	68.67
B-3	45"	606	0.8475	71.15
B-4	63"	610	1.0930	80.95
B-5	81"	611	1.2860	87.85
B-6	99"	604	1.0850	80.43
C-1	9"	597	0.9851	76.38
C-2	27"	601	0.9850	76.52
C-3	45"	602	0.8699	71.95
C-4	63"	602	1.0640	79.57
C-5	81"	593	1.1930	83.90
C-6	99"	578	0.9578	74.64
D-1	9"	587	0.8679	71.36
D-2	27"	586	0.7047	64.27
D-3	45"	586	0.7894	68.02
D-4	63"	577	1.0480	78.04
D-5	81"	574	1.1760	82.55
D-6	99"	569	0.8648	70.62
Average, (group mean)		594	0.9963	76.46
Average, (wt mean)		595	---	---
Maximum		611	1.2860	87.85
Minimum		569	0.7047	64.27
Standard Deviation		13	0.1657	6.59

Port A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	76.46
Velocity, [fpm]	4,588
ACFM	247,741
SCFM	119,977
DSCFM	118,439
lb/hr Air (dry)	542,336
lb/hr Air (wet)	546,716

Summary Weighted Avg Results	
Velocity, [fps]	76.46
Velocity, [fpm]	4,588
ACFM	247,741
SCFM	119,977
DSCFM	118,439
lb/hr Flue Gas (dry)	542,336
lb/hr Flue Gas (wet)	546,716

Table F-28

Traverse Data Calculaed Results -- 2B Heat Pipe Secondary Air By-Pass Duct
NYSEG Milliken Station

Amb Air DB, deg F	76
Amb Air WB, deg F	62
Humd, lb/lb BD Air	0.00879

Std. Conditions

T, deg F	60
P, In. Hg	29.92

		No. Points	8	Bar., " Hg	29.12
Date	11/8/96	Duct Width	17.5 ft	Static, " H2C	5.09
Time	08:50	Duct Depth	2.09 ft		
Tube I.D.	S-53	Duct Area	36.64 Sq ft	% H20	1.39
C-Factor	0.816	% O2	21.0	Dry MW	28.97
Operator(s)	GLC/WLM	% N2	79.0	Wet MW	28.82

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	6-5/16"	125	0.0000	0.00
A-2	18-7/8"	134	0.0000	0.00
B-1	6-5/16"	107	0.0027	2.96
B-2	18-7/8"	120	-0.0004	-1.15
C-1	6-5/16"	111	0.0012	1.98
C-2	18-7/8"	131	-0.0004	-1.16
D-1	6-5/16"	164	0.0000	0.00
D-2	18-7/8"	164	0.0001	0.60
Average, (group mean)		132	0.0004	0.40
Average, (wt mean)		118	---	---
Maximum		164	0.0027	2.96
Minimum		107	-0.0004	-1.16
SDEV		20	0.0010	1.34

Ports A = South, D = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	0.40
Velocity, [fpm]	24
ACFM	886
SCFM	786
DSCFM	775
lb/hr Air (dry)	3549
lb/hr Air (wet)	3580

Data Summary Wt'd Avg Data	
Velocity, [fps]	0.40
Velocity, [fpm]	24
ACFM	886
SCFM	802
DSCFM	790
lb/hr Flue Gas (dry)	3619
lb/hr Flue Gas (wet)	3651

APPENDIX G

HEAT PIPE PRESSURE DROP DATA

Table G-1
Milliken Heat Pipe Performance Test 1
Heat Pipe Pressure Differentials By Section, in. WC

"A" Side Test

Date 11/7/96

	2A Heat Pipe				2B Heat Pipe			
Time	**Primary Air**	**Secondary Air**	**Primary Flue Gas**	**Secondary Flue Gas**	**Primary Air**	**Secondary Air**	**Primary Flue Gas**	**Secondary Flue Gas**
12:40	2.75	4.65	3.90	3.55	2.55	4.45	3.70	3.65
13:00	2.75	4.65	3.90	3.55	2.55	4.45	3.65	3.65
13:20	2.70	4.65	3.95	3.55	2.50	4.45	3.60	3.70
13:40	2.75	4.70	3.95	3.60	2.50	4.45	3.55	3.65
14:00	2.70	4.65	3.95	3.55	2.50	4.45	3.55	3.70
14:20	2.75	4.65	3.95	3.55	2.55	4.45	3.55	3.70
14:40	2.80	4.70	4.00	3.55	2.60	4.45	3.60	3.70
15:00	2.75	4.70	4.00	3.55	2.60	4.45	3.55	3.65
15:20	2.75	4.70	4.00	3.55	2.60	4.45	3.55	3.65
15:40	2.70	4.65	4.00	3.55	2.50	4.45	3.55	3.65
16:00	2.70	4.65	4.00	3.55	2.55	4.40	3.50	3.65
16:20	2.65	4.65	4.00	3.55	2.50	4.40	3.55	3.65
Average	**2.73**	**4.67**	**3.97**	**3.55**	**2.54**	**4.44**	**3.58**	**3.67**
"B" Side Test								
16:40	2.65	4.65	4.00	3.55	2.50	4.45	3.55	3.65
17:00	2.70	4.65	4.00	3.55	2.50	4.45	3.55	3.65
17:20	2.70	4.65	4.05	3.55	2.55	4.45	3.55	3.70
17:41	2.75	4.70	4.05	3.55	2.55	4.45	3.55	3.65
18:01	2.70	4.70	4.00	3.55	2.55	4.45	3.55	3.65
18:23	2.70	4.70	4.00	3.55	2.55	4.45	3.55	3.65
18:44	2.70	4.75	4.05	3.60	2.55	4.50	3.60	3.70
19:01	2.70	4.75	4.00	3.55	2.55	4.50	3.60	3.70
19:20	2.70	4.70	4.05	3.60	2.55	4.50	3.60	3.70
19:41	2.70	4.70	4.05	3.60	2.55	4.45	3.55	3.70
Average	**2.70**	**4.70**	**4.03**	**3.57**	**2.54**	**4.47**	**3.57**	**3.68**

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Table G-2
Milliken Heat Pipe Performance Test 2
Heat Pipe Pressure Differentials By Section, in. WC

"A" Side Test

Date 11/8/96

	2A Heat Pipe				2B Heat Pipe			
Time	Primary Air	Secondary Air	Primary Flue Gas	Secondary Flue Gas	Primary Air	Secondary Air	Primary Flue Gas	Secondary Flue Gas
10:20	3.45	4.75	3.50	3.60	3.20	4.50	3.70	3.80
10:40	3.40	4.65	3.50	3.60	3.20	4.45	3.70	3.80
11:00	3.40	4.70	3.50	3.55	3.20	4.50	3.70	3.80
11:20	3.35	4.75	3.50	3.55	3.10	4.50	3.65	3.80
11:40	3.50	4.75	3.60	3.60	3.25	4.55	3.75	3.85
12:00	3.75	4.75	3.55	3.60	3.50	4.55	3.75	3.85
12:20	3.70	4.70	3.50	3.55	3.50	4.45	3.70	3.80
Average	**3.51**	**4.72**	**3.52**	**3.58**	**3.28**	**4.50**	**3.71**	**3.81**
"B" Side Test								
12:20	3.70	4.70	3.50	3.55	3.50	4.45	3.70	3.80
12:40	3.70	4.70	3.50	3.55	3.45	4.45	3.70	3.80
13:00	3.90	4.60	3.50	3.55	3.60	4.35	3.65	3.70
13:27	4.10	4.80	3.60	3.65	3.80	4.55	3.75	3.90
13:40	4.20	4.85	3.60	3.65	3.90	4.60	3.75	3.90
14:00	4.30	4.85	3.60	3.65	4.00	4.60	3.75	3.85
14:20	4.10	4.85	3.60	3.65	3.85	4.55	3.75	3.85
14:40	4.10	4.80	3.60	3.65	3.80	4.55	3.70	3.85
Average	**4.01**	**4.77**	**3.56**	**3.61**	**3.74**	**4.51**	**3.72**	**3.83**

Table G-3
Milliken Heat Pipe Performance Test 3
Heat Pipe Pressure Differentials By Section, in. WC

"A" Side Test

Date 05/16/96

	2A Heat Pipe				2B Heat Pipe			
Time	**Primary Air**	**Secondary Air**	**Primary Flue Gas**	**Secondary Flue Gas**	**Primary Air**	**Secondary Air**	**Primary Flue Gas**	**Secondary Flue Gas**
18:40	1.85	1.95	1.80	1.85	1.75	1.75	1.60	1.65
19:00	1.90	1.90	1.80	1.85	1.75	1.70	1.55	1.60
19:20	1.95	1.95	1.80	1.85	1.80	1.70	1.60	1.65
19:40	2.00	1.95	1.75	1.85	1.85	1.75	1.60	1.65
20:00	1.95	1.90	1.75	1.85	1.85	1.75	1.55	1.65
20:20	2.00	1.95	1.75	1.85	1.85	1.75	1.60	1.65
"B" Side Test								
21:00	1.95	1.95	1.65	1.85	1.85	1.75	1.60	1.65
21:20	2.00	1.95	1.70	1.85	1.85	1.75	1.60	1.65
21:40	2.00	1.95	1.85	1.80	1.85	1.75	1.60	1.65
22:00	2.00	1.95	1.80	1.85	1.85	1.75	1.60	1.70
22:20	2.00	1.95	1.85	1.90	1.85	1.75	1.65	1.70
22:40	1.95	2.00	1.80	1.85	1.80	1.75	1.65	1.70

File: DPLOGS.WB2 06/27/96 13:55:17

Table G-3
Heat Pipe Module-To-Module Pressure Drops

Clean Condition Results

Date	10/22/96
Time	12:10-12:50
Load, MW Gross	161.6
Econ. O2, Vol %	3.24
FG Flow Split to 2A	51.49%

2A Heat Pipe – East/West Pressure Taps

Flue Gas Inlet T, °F	662
Flue Gas Outlet T, °F	282

		Pressure Drops, in. WC			
	Levels	A	B	C	D
Top	1-2	1.16	1.20	1.20	1.22
	2-3	0.94	0.93	1.02	1.04
Bottom	3-4	0.90	Taps In Use		0.89
	Total	3.01			3.14

2B Heat Pipe – East/West Pressure Taps

Flue Gas Inlet T, °F	662
Flue Gas Outlet T, °F	274

		Pressure Drops, in. WC			
	Levels	A	B	C	D
Top	1-2	1.13	1.13	1.14	1.07
	2-3	0.92	0.92	0.97	1.04
Bottom	3-4	0.78	Taps In Use		0.85
	Total	2.83			2.96

Performance Test Condition Results

Date	11/8/96
Time	17:30-18:10
Load, MW Gross	158.1
Econ. O2, Vol %	3.36
FG Flow Split to 2A	50.48%

2A Heat Pipe – East/West Pressure Taps

Flue Gas Inlet T, °F	653
Flue Gas Outlet T, °F	277

		Pressure Drops, in. WC			
	Levels	A	B	C	D
Top	1-2	1.12	1.08	1.13	1.11
	2-3	0.87	0.85	0.94	0.98
Bottom	3-4	0.93	Taps In Use		0.90
	Total	2.92			3.00

2B Heat Pipe – East/West Pressure Taps

Flue Gas Inlet T, °F	654
Flue Gas Outlet T, °F	284

		Pressure Drops, in. WC			
	Levels	A	B	C	D
Top	1-2	1.15	1.14	1.14	1.18
	2-3	0.94	0.91	0.98	1.00
Bottom	3-4	0.90	Taps In Use		0.96
	Total	2.99			3.13

Clean Condition Results

Date	10/22/96
Time	17:00-18:15
Load, MW Gross	159.5
Econ. O2, Vol %	3.23
FG Flow Split to 2A	51.49%

2A Heat Pipe – North/South Pressure Taps

Flue Gas Inlet T, °F	656
Flue Gas Outlet T, °F	276

		DP, In. WC	
	Levels	A	B
Top	1-2	0.68	0.69
	2-3		
	3-4	1.06	1.12
	4-5	1.00	1.02
Bottom	5-6	0.72	0.71
	Total	3.46	3.54

2B Heat Pipe – North/South Pressure Taps

Flue Gas Inlet T, °F	658
Flue Gas Outlet T, °F	275

		DP, In. WC		
	Levels	A	B	
Top	1-2			0.71
	2-3	0.71	0.73	
	3-4	1.07	1.09	
	4-5	0.92	0.92	
Bottom	5-6	0.75	0.74	
	Total	3.46	3.48	

Performance Test Condition Results

Date	11/8/96
Time	18:15-19:00
Load, MW Gross	159.4
Econ. O2, Vol %	3.31
FG Flow Split to 2A	50.48%

2A Heat Pipe – North/South Pressure Taps

Flue Gas Inlet T, °F	658
Flue Gas Outlet T, °F	280

		DP, In. WC	
	Levels	A	B
Top	1-2		
	2-3	0.71	0.71
	3-4	1.06	1.04
	4-5	0.92	0.92
Bottom	5-6	0.80	0.78
	Total	3.49	3.45

2B Heat Pipe – North/South Pressure Taps

Flue Gas Inlet T, °F	660
Flue Gas Outlet T, °F	286

		DP, In. WC	
	Levels	A	B
Top	1-2		
	2-3	0.77	0.77
	3-4	1.15	1.15
	4-5	1.00	0.99
Bottom	5-6	0.90	0.92
	Total	3.82	3.83

File HPFGDPS4 WB2 1/16/97

Table G-4
Heat Pipe Module-To-Module Pressure Drops
(Corrected to Common Basis)

Clean Condition Results

Date 10/22/96
Time 12:10-12:50

2A Heat Pipe

Corr Factor 0.919

		Pressure Drops, in. WC				
	Levels	A	B	C	D	Average
Top	1-2	1.07	1.10	1.11	1.12	1.10
	2-3	0.87	0.86	0.94	0.95	0.90
Bottom	3-4	0.83	Taps In Use		0.82	0.82
	Total	2.77			2.89	2.83

2B Heat Pipe

Corr Factor 1.040

		Pressure Drops, in. WC				
	Levels	A	B	C	D	Average
Top	1-2	1.18	1.18	1.19	1.11	1.16
	2-3	0.95	0.95	1.01	1.08	1.00
Bottom	3-4	0.81	Taps In Use		0.88	0.85
	Total	2.94			3.08	3.01

Performance Test Condition Results

Date 11/8/96
Time 17:30-18:10

2A Heat Pipe

Corr Factor 1.006

		Pressure Drops, in. WC				
	Levels	A	B	C	D	Average
Top	1-2	1.13	1.09	1.14	1.12	1.12
	2-3	0.88	0.86	0.95	0.99	0.92
Bottom	3-4	0.93	Taps In Use		0.91	0.92
	Total	2.94			3.02	2.98

2B Heat Pipe

Corr Factor 1.041

		Pressure Drops, in. WC				
	Levels	A	B	C	D	Average
Top	1-2	1.20	1.19	1.19	1.22	1.20
	2-3	0.98	0.95	1.02	1.04	1.00
Bottom	3-4	0.94	Taps In Use		1.00	0.97
	Total	3.12			3.26	3.19

Clean Condition Results

Date 10/22/96
Time 17:00-18:15

2A Heat Pipe

Corr Factor 0.949

		Pressure Drops, in. WC		
	Levels	A	B	Average
Top	1-2	0.64	0.65	0.65
	2-3			
	3-4	1.01	1.07	1.04
	4-5	0.94	0.96	0.95
Bottom	5-6	0.69	0.68	0.68
	Total	3.28	3.36	3.32

2B Heat Pipe

Corr Factor 1.069

		Pressure Drops, in. WC		
	Levels	A	B	Average
Top	1-2			
	2-3	0.76	0.78	0.77
	3-4	1.14	1.17	1.16
	4-5	0.98	0.98	0.98
Bottom	5-6	0.80	0.79	0.80
	Total	3.70	3.72	3.71

Performance Test Condition Results

Date 11/8/96
Time 18:15-19:00

2A Heat Pipe

Corr Factor 0.986

		Pressure Drops, in. WC		
	Levels	A	B	Average
Top	1-2			
	2-3	0.70	0.70	0.70
	3-4	1.05	1.02	1.04
	4-5	0.91	0.91	0.91
Bottom	5-6	0.79	0.77	0.78
	Total	3.44	3.40	3.42

2B Heat Pipe

Corr Factor 1.020

		Pressure Drops, in. WC		
	Levels	A	B	Average
Top	1-2			
	2-3	0.78	0.79	0.79
	3-4	1.17	1.17	1.17
	4-5	1.02	1.01	1.02
Bottom	5-6	0.92	0.93	0.93
	Total	3.90	3.90	3.90

Common Basis: 160 MW gross Boiler Load, 680°F Flue Gas Inlet, 253 °F Flue Gas Outlet.

APPENDIX H

SOOTBLOWER PURGE AIR DATA

Table H-1
Sootblower Ambient Air Purges
2A Heat Pipe

1148

Amb Air DB, deg F	75
Amb Air WB, deg F	60
Humd, lb/lb BD Air	0.00808

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

Bar., " Hg	29.12
Static, " H20	0.00
% H20	1.28
Dry MW	28.97
Wet MW	28.83

Date	11/8/96	No. Of Valves	16
Time	04:40 PM	Duct Dia. (2)	2.0 inches
Tube I.D.	Direct Impact	Duct Area	0.3491 Sq ft
C-Factor	0.80 (1)	% O2	21.0
Operator(s)	ROS/MLF/DRS/WLM	% N2	79.0

Valve On Sootblower #	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
AHA11	1"	72	0.0760	15.01
AHA12	1"	71	0.0708	14.47
AHA13	1"	71	0.0818	15.55
AHA14	1"	71	0.0853	15.88
AHA21	1"	71	0.0822	15.59
AHA22	1"	71	0.0720	14.59
AHA23	1"	71	0.0761	15.00
AHA24	1"	71	0.0767	15.06
AHA31	1"	71	0.0660	13.97
AHA32	1"	71	0.0728	14.67
AHA33	1"	71	0.0810	15.48
AHA34	1"	71	0.0641	13.77
AHA41	1"	84	0.0645	13.98
AHA42	1"	84	0.0754	15.12
AHA43	1"	84	0.0742	14.99
AHA44	1"	84	0.0688	14.44
Average, (group mean)		74	0.074	14.85
Average, (wt mean)		74	---	---
Maximum		84	0.085	15.88
Minimum		71	0.064	13.77
Standard Deviation		6	0.006	0.60

Purge Air Totals	
Velocity, [fps]	14.85
Velocity, [fpm]	891
ACFM	311
SCFM	295
DSCFM	291
lb/hr Air (dry)	1,332
lb/hr Air (wet)	1,343

(1) Adjusted For Calculation of Approximate Average Velocity (i.e. 1.0 x 0.80)

(2) All Purge Air Drawn Through A 2" ID x 5' Long Measuring Tube.

Table H-2
Sootblower Ambient Air Purges
2B Heat Pipe

Amb Air DB, deg F 75
Amb Air WB, deg F 60
Humd, lb/lb BD Air 0.00808

Std. Conditions
T, deg F 60
P, in. Hg 29.92

Bar., " Hg 29.12
Static, " H20 0.00

Date 11/8/96
Time 04:40 PM
Tube I.D. Direct Impact
C-Factor 0.80 (1)
Operator(s) ROS/MLF/DRS/WLM

No. of Valves 16
Duct Dia. (2) 2.0 inches
Duct Area 0.3491 Sq ft
% O2 21.0
% N2 79.0

% H20 1.28
Dry MW 28.97
Wet MW 28.83

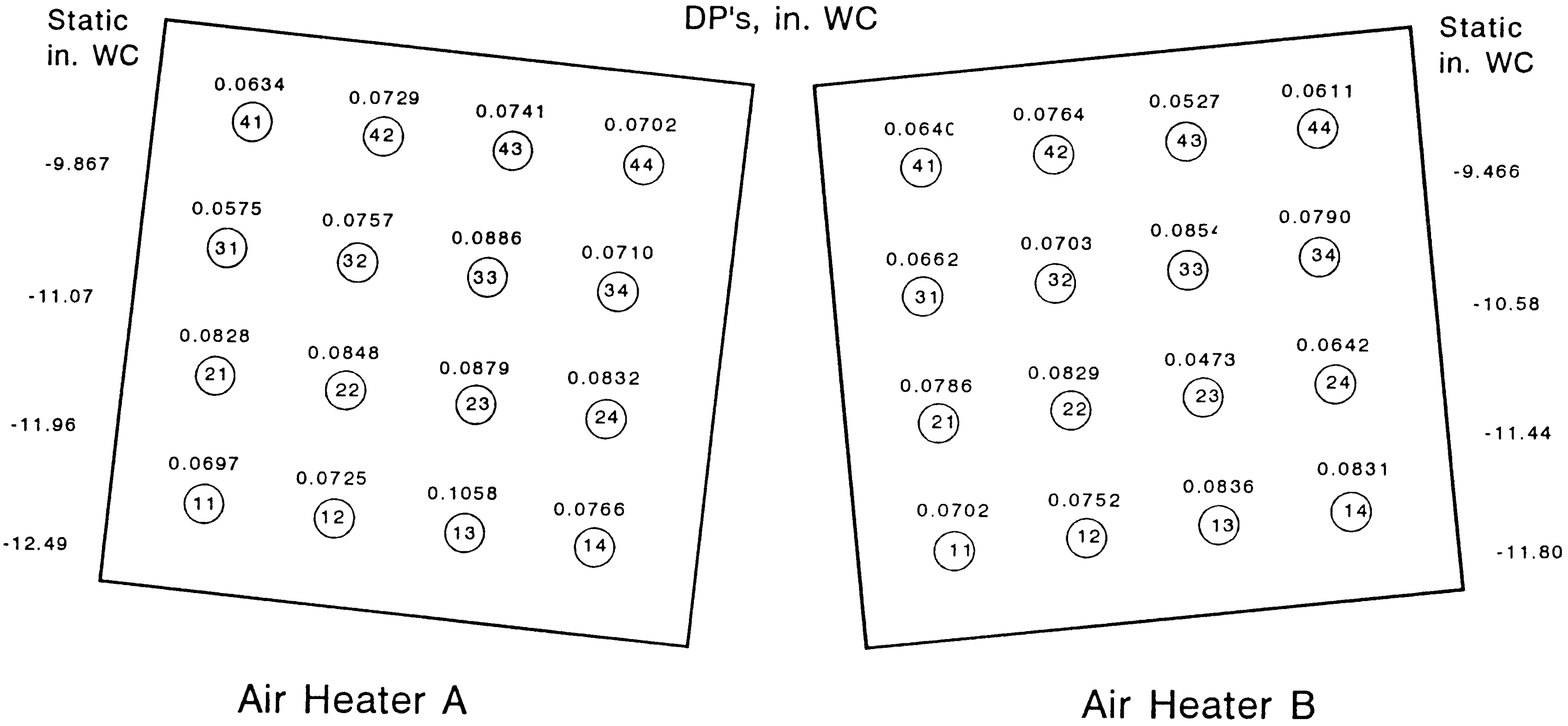
Valves On Sootblower #	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
AHB11	1"	71	0.0690	14.29
AHB12	1"	71	0.0775	15.14
AHB13	1"	71	0.0760	14.99
AHB14	1"	71	0.0834	15.71
AHB21	1"	71	0.1044	17.57
AHB22	1"	71	0.0885	16.18
AHB23	1"	71	0.0488	12.01
AHB24	1"	71	0.0694	14.33
AHB31	1"	71	0.0641	13.77
AHB32	1"	71	0.0773	15.12
AHB33	1"	71	0.0973	16.96
AHB34	1"	71	0.0771	15.10
AHB41	1"	84	0.0827	15.83
AHB42	1"	84	0.0889	16.41
AHB43	1"	84	0.0628	13.79
AHB44	1"	84	0.0606	13.55
Average, (group mean)		74	0.077	15.05
Average, (wt mean)		74	---	---
Maximum		84	0.104	17.57
Minimum		71	0.049	12.01
Standard Deviation		6	0.014	1.37

Purge Air Totals	
Velocity, [fps]	15.05
Velocity, [fpm]	903
ACFM	315
SCFM	299
DSCFM	295
lb/hr Air (dry)	1,350
lb/hr Air (wet)	1,361

(1) Adjusted For Calculation of Approximate Average Velocity (i.e. 1.0 x 0.80)
(2) All Purge Air Drawn Through A 2" ID x 5' Long Measuring Tube.

Figure H-1

Sootblower Purge Air Data
Velocity Heads In 2" Dia. Air Flow
Measureing Tube -- High Load Test



Baro 29.52" Hg

1150

APPENDIX I

HEAT PIPE PERFORMANCE CALCULATIONS

PROGRAM CALCULATES AIR HEATER PERFORMANCE FROM TEST DATA
After Entering Data Into Blocked Areas Calculate Results Using Macro \C
Print Results Using Macro \P

Description	**Unit 2A Test 1 – 11/07/96 12:40-16:22 hrs**

Coal and Ash Data

AFC = As Fired Coal

Use ASME Mol Weights? 1=Y 0=Alt		1
	Coal Comp Wt % Dry	Wt % Wet
Moisture		5.90
C	74.95	70.53
H	5.14	4.84
N	1.47	1.38
S	3.08	2.90
O	4.46	4.20
Ash	10.90	10.26
HHV	13,412	100.00

Fly Ash Overhead	90.00%
Carbon in Refuse, %	1.37
lbs C in Refuse/lb AFC (1)	0.0013
C Burned/lb AFC	0.7040

Gas Stream Data

Flue Gas In

Ht Pipe Inlet Temp, deg F 659

COMPOUND	Mol % Dry	Wet
CO2	14.990%	13.80%
CO	0.005%	0.00%
N2	81.225%	74.79%
O2	3.780%	3.48%
H2O	0.00%	7.92%
TOTAL	100.00%	100.00%

Amb Air Temp, deg F	95
Amb Air Moisture, lb/lb BD Air	0.01055
Downstream Leak Temp, deg F	148
Downstream Leak Moisture, lb/lb BD Air	0.01055
Downstream Leak Rate, lb/hr	0
Primary Air (PA) Inlet Temp (Tpai), deg F	115
Primary Air Outlet Temp (Tpao), deg F	604
Secondary Air (SA) Inlet Temp (Tsai), deg F	94
Sec Air With Bypass Outlet Temp (Tsao), deg F	584
Primary Flue Gas Outlet Temp (Tpgo), deg F	324
Total Mols Dry Flue Gas In/lb AFC	0.3969
Total lbs Dry Flue Gas In/lb AFC (WG'14)	12.1316
Atomizing Steam (Wz), lbs/lb AFC	0.00
Steam From Ash Pit (Wm), lbs/lb AFC	0.00
Flue Gas H2O (WmGi), lbs/lb AFC	0.6150
H2O in Flue Gas, Mols/lb AFC	0.0341
Flue Gas Moisture, vol %	7.919%
Flue Gas MW	29.57
Flue Gas MW (dry)	30.56

(1) Assumption: Bottom Ash Carbon Concentration is 1/3 That of Overhead Ash.

Flue Gas Out

Ht. Pipe Outlet Temp, deg F 289

	Mol %	
COMPOUND	Dry	Wet
CO2	14.560%	13.43%
CO	0.024%	0.02%
N2	81.156%	74.86%
O2	4.260%	3.93%
H2O	0.00%	7.76%
TOTAL	100.00%	100.00%

Mols Dry Flue Gas/lb AFC	0.4081
lbs Dry Flue Gas/lb AFC (WG'15)	12.4526
Flue Gas H2O (WmGo), lbs/lb AFC	0.6184
H2O in Flue Gas, Mols/lb AFC	0.0343
Total Flue Gas Out, lbs/hr	767089
Flue Gas Moisture, vol %	7.759%
Flue Gas MW (wet)	29.54
Flue Gas MW (dry)	30.51

Total Air Leak, wt % (AL) **2.55**

Boiler Load, MW	146.94			
Heat Rate, Btu/KWh	9,793			
As Fired Coal Rate, Tons/hr	57.01			
lbs/hr (Wfe)	114,020			
Flow Split to Heat Pipe	51.47%	lb/hr		
Primary Air Fan Flow, lbs/lb AFC	1.8057	105,970		(3)
Primary Air (PA) Out Heat Pipe, Wpa, lbs/lb AFC	1.0018	58,791		
Cppa, Btu/mol-F (Tpao to Tpai)	7.1699			
Cppa, Btu/lb-F	0.2491			
Primary Air Bypass (PABP), lbs/lb AFC	0.8039	47,179		
Wet Flue Gas In (WF14), lbs/lb AFC	12.7466	748,050		
Cpfg, Btu/mol-F (Tfgi to Tfgo)	7.7700			
Cpfg, Btu/lb-F	0.2628			
Sootblower At Wall Air Leaks, lbs/lb AFC	0.3244	19,039		
Cpal, Btu/mol-F (Tsai to Tfgo)	7.0315			
Cpal, Btu/lb-F	0.2443			
Downstream Air Leak Rate, lbs/lb AFC	0.0000	0		
Cpal, Btu/mol-F (Tdsi to Tfgo)	7.0539			
Cpal, Btu/lb-F	0.2450			
SA+Bypass Rate (SA+SABP), lbs/lb AFC	9.0499	531,106	<<Ht Bal Calc	
Cpsa, Btu/mol-F (Tsai to Tsao)	7.1530			
Cpsa, Btu/lb-F	0.2485			
Secondary Air Bypass (SAPB), lbs/lb AFC	0.0000	0		
Cpsabp, Btu/mol-F (Tsai to Tsao)	7.1530			
Cpsabp, Btu/lb-F	0.2485			
PA+PABP+SA+SABP+Coal, lbs/lb AFC (2)	11.7531	689,742		(3)
Calc'd Air Leakage into Boiler, lbs/lb AFC	0.9936	58,308	7.79%	(3)

(2) Does Not Include Leaks Into Boiler

(3) Not Required For Performance Calculations

	CONDITIONS		
	DESIGN	ACTUAL	
Flow Rates to Heat Pipe, lb/hr			
Primary Air	62,500	58,791	
Secondary Air (No Bypass)	562,500	531,106	
Flue Gas	750,000	748,050	
Temperatures, deg F			
Primary Air In	80.0	115.0	
Primary Air Out	644.0	604.0	
2nd Air in	80.0	94.0	
2nd Air Out With Bypass	616.0	584.0	
2nd Air Out Without Bypass		584.0	
Avg Air In, (TA8)	80.0	96.1	
Avg Air Out, (TA9)	618.8	586.0	<<(Ex SA Bypass)
Flue Gas In, (TG14)	680.0	659.0	
Flue Gas Out, (TG15)	253.0	289.0	
FG Out No Leak, (TG15NL)		293.7	
Primary Air Duty, MMBtu/hr		7.160	
Sootblower Wall Leak Duty, MMBtu/hr		1.047	
Primary Flue Gas Duty, MMBtu/hr		8.207	
Primary Flue Gas Rate, lb/hr		92981	
Primary Flue Gas Rate, lb/lb AFC		1.5844	
Primary Flue Gas Outlet Temp NL, deg F		367.7	
Secondary Flue Gas Rate, lb/hr		655069	
Secondary Flue Gas Rate, lb/lb AFC		11.1623	
Secondary Flue Gas Outlet Temp, deg F		283.0	

Pressure Drops, in. wc	**Design**	**Measured**
Primary Air, (DP8_9)	3.60	2.73
Secondary Air, (DP8_9)	5.35	4.67
Flue Gas, (DP14_15)		
Primary Flue Gas	3.65	3.97
Secondary Flue Gas	3.65	3.55

Pressure Drops Corrected for Deviation From Design Flow and Design Temp

Gas Side (DPs(14-15), in. wc (4)	**3.45**	
Pressure Drop is	**-0.20**	in. wc Less Than Design
Air Side (DPs(8-9), in. wc		
Primary Air Section	**3.09**	
Pressure Drop is	**-0.51**	in. wc Less Than Design
Secondary Air Section	**5.30**	
Pressure Drop is	**-0.05**	in. wc Less Than Design

(4) Average In/Out Flue Gas Flow Used In Calculation.

Correction Calculations For Heat Pipe -- Design Condition Results

		Curve 1	Curve 2 (Ea Limited)	
Flue Gas Inlet Temp, deg F	TG14D	680.00	680.00	
Pri Air (PA) Inlet Temp, deg F	TA8D	80.00	80.00	
Sec Air (SA) Inlet Temp, deg F	T'A8D	80.00	80.00	
PA Outlet, deg F	Tpa9D	649.75	649.75	
SA Outlet, deg F	Tsa9D	617.20	617.20	
Pri Flue Gas (PFG) Outlet, deg F	TPFG15D	309.66	309.66	
Sec Flue Gas (SFG) Outlet, deg F	TSFG15D	243.92	243.92	
PFG Rate, Mlb/hr	WPFGD	182.70	182.70	
SFG Rate, Mlb/hr	WSFGD	1317.30	1317.30	
Combined Outlet T, deg F		251.93	251.93	
PA Side Effectiveness	Ea	0.9496	0.9492	<Curve 2 Limit
PA X-Ratio	X Design	0.6500	0.6500	
PA fg	fpgD	1.0001	1.0001	
PA fx	fpxD	0.9991	0.9987	
	Eg	0.6172	0.6170	
Calculated TPFG Out, deg F	TPFG15D	309.66	309.81	
SA Side Effectiveness	Ea	0.8953	0.9300	<Curve 2 Limit
SA X-Ratio (Design)	X Design	0.8118	0.8118	
SA fg	fsgD	1.0004	1.0004	
SA fx	fsxD	1.0001	1.0388	
	Eg	0.7268	0.7549	
Calculated TSFG Out, deg F	TSFG15D	243.91	227.04	
Combined Outlet T, deg F		251.92	237.12	

Correction Calculations For Heat Pipe -- Operating Condition Results

Ambient Temp, deg F	Tamb	95.00
Sootblower Wall Air Leak, wt % PFG	Al	20.48
Cpa (Tpfg15-Tamb), Btu/lb-F	CpA	0.2400
Cpg (Tpfgnl15-Tpg15), Btu/lb-F	CpG	0.2576
Flue Gas Inlet Temp, deg F	TG14	659.00
PA Inlet Temp, deg F	TA8	115.00
SA Inlet Temp, deg F	T'A8	94.00
PA Outlet Temp, deg F	Tpa9	604.00
SA Outlet Temp (No Bypass), deg F	Tsa9	584.00
PFG Outlet Temp, deg F	TPG15	324.00
PFG Outlet Temp (No Leak), deg F	TPFG15NL	367.70
SFG Outlet Temp, deg F	TSFG15	283.05
PFG Rate, Mlb/hr	WPFG	92.98
SFG Rate, Mlb/hr	WSFG	655.07
Sootblower Wall Air Leak Into PFG, Mlb/hr	WAL1	19.04
Constant, Al/100*CpA/CpG*(TPG15-Tamb)		43.70
PA Side Effectiveness	Epa	0.8989
SA Side Effectiveness	Esa	0.8673
X-Ratios	Xp	0.5957
	Xs	0.7673
PA Eg	Epg	0.5355
SA Eg	Esg	0.6654

Correction Factors	**Pri Flue Gas**		**Sec Flue Gas**	
	fpg	0.9990	fsg	1.0009
	fpgD	1.0001	fsgD	1.0004
	fpx	0.9319	fsx	0.9645
	fpxD	0.9991	fsxD	1.0001
	TPFG15D	309.66	TSFG15D	243.91
Performance NL	TPFG15	346.18	TSFG15	262.78

Primary Flue Gas Corrections For Differences From:

Design Entering Air Temperature, TPFG15DA, deg F	302.45
Design Entering Flue Gas Temperature, TPFG15DG, deg F	332.07
Design X-Ratio (No Leak) TFG15DX, deg F	299.07
Air Leak Correction, deg F	43.70
Design Flue Gas Flow Rate, TPFG15DGR, deg F	323.58

Secondary Flue Gas Corrections for Differences From:

Design Entering Air Temperature, TSFG15DA, deg F	273.73
Design Entering Flue Gas Temperature, TSFG15DG, deg F	290.07
Design X-Ratio, TSFG15DX, deg F	267.52
Design Flue Gas Flow Rate, TSFG15DGR, deg F	283.26

PFG Totally Corrected Outlet Temp, deg F	328.86
SFG Totally Corrected Outlet Temp, deg F	265.44
Avg FG Outlet Totally Corrected T, TG15_Total, deg F	**273.32**

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Summary of Specific Heat Calculation Results

	T1 °F	T2 °F	Cp Btu/lb-°F
Calculation of Pri, Sec, and Air Leak Cps Over Inlet to Outlet Temp Ranges			
Cp for Primary Air From Tpai to Tpao	115.0	604.0	0.2491
Cp Secondary Air From Tsai to Tsao	94.0	584.0	0.2485
Cp Air Leak From Tamb to Tfgo	95.0	289.0	0.2443
Cp Downstream Leak From Tdsi to Tfgo	148.0	289.0	0.2450
Secondary Air Outlet Temperature Correction For Bypass Flow			
Cp for Secondary Air From Tsai to Tsao'	94.0	584.0	0.2485
Cp for Secondary Air From Tsao to Tsao'	584.0	584.0	0.2554
Calculation of Average Air Inlet Temperature			
Cp of Primary Air Between Tpai and Taia (TA8)	115.0	96.1	0.2417
Cp of Secondary Air Between Tsai and Taia (TA8)	94.0	96.1	0.2414
Calculation of Average Air Outlet Temperature			
Cp of Primary Air Between Tpao and Taoa (TA9)	604.0	586.0	0.2557
Cp of Secondary Air Between Tsao and Taoa (TA9)	584.0	586.0	0.2554
Cp of Air Between Taia and Taoa (TA8 to TA9)	96.1	586.0	0.2485
Calculation of Flue Gas Outlet Temp for No Leak Case (NL)			
Cp for Outlet Flue Gas Between Tfgo (TG15) and Tfgonl (TG15NL)	289.0	293.7	0.2553
Cp of Air Leak Between Tsai to Tfgo (TG15)	94.0	289.0	0.2442
Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgo (TG15)	659.0	289.0	0.2628
Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgonl (TG15NL)	659.0	293.7	0.2629
Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgo (TPFG15)	659.0	324.0	0.2635
Cp for Primary Flue Gas Between Tpfgo (TPFG15) and Tpfgonl (TPFG15NL)	324.0	367.7	0.2576
Cp for Sootblower Air Leak From Tamb to Tpfgo	95.0	324.0	0.2400
Cp for Sootblower Air Leak From Tpfgo (TPFG15) to Tfgo (TG15)	324.0	289.0	0.2428
Calculation of Secondary Flue Gas Outlet Temperature			
Cp for Secondary Flue Gas Between Tsfgo (TSFG15) and Tfgo (TG15)	283.0	289.0	0.2551
Cp for Primary Flue Gas Between Tfgo (TG15) and Tpfgo (TPFG15)	289.0	324.0	0.2559
Cp for Secondary Flue Gas Between Tfgi (TG14) and Tsfgo (TSFG15)	659.0	283.0	0.2626
Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgonl (TPFG15NL)	659.0	367.7	0.2644

Note -- air (a), average (a), ambient (amb), downstream (ds), flue gas (fg), in (i), out (o), no leak (nl), primary (p), secondary (s)
Numbers in variable names are consistant with Power Test Code, PTC 4.3, inlet/outlet stream numbering system.

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PROGRAM CALCULATES AIR HEATER PERFORMANCE FROM TEST DATA
After Entering Data Into Blocked Areas Calculate Results Using Macro \C
Print Results Using Macro \P

Description	**Unit 2B Test 1-- 11/07/96 16:25-19:38 hrs**

Coal and Ash Data

AFC = As Fired Coal

Use ASME Mol Weights? 1=Y 0=Alt	1

	Coal Comp Wt % Dry	Wt % Wet
Moisture		5.90
C	74.95	70.53
H	5.14	4.84
N	1.47	1.38
S	3.08	2.90
O	4.46	4.20
Ash	10.90	10.26
HHV	13,412	100.00

Fly Ash Overhead	90.00%
Carbon in Refuse, %	1.37
lbs C in Refuse/lb AFC (1)	0.0013
C Burned/lb AFC	0.7040

Gas Stream Data

Flue Gas In

Ht Pipe Inlet Temp, deg F	663

	Mol %	
COMPOUND	Dry	Wet
CO2	14.200%	13.12%
CO	0.007%	0.01%
N2	81.113%	74.94%
O2	4.680%	4.32%
H2O	0.00%	7.61%
TOTAL	100.00%	100.00%

Amb Air Temp, deg F	95
Amb Air Moisture, lb/lb BD Air	0.01055
Downstream Leak Temp, deg F	148
Downstream Leak Moisture, lb/lb BD Air	0.01055
Downstream Leak Rate, lb/hr	0
Primary Air (PA) Inlet Temp (Tpai), deg F	115
Primary Air Outlet Temp (Tpao), deg F	614
Secondary Air (SA) Inlet Temp (Tsai), deg F	94
Sec Air With Bypass Outlet Temp (Tsao), deg F	596
Primary Flue Gas Outlet Temp (Tpgo), deg F	325
Total Mols Dry Flue Gas In/lb AFC	0.4189
Total lbs Dry Flue Gas In/lb AFC (WG'14)	12.7662
Atomizing Steam (Wz), lbs/lb AFC	0.00
Steam From Ash Pit (Wm), lbs/lb AFC	0.00
Flue Gas H2O (WmGi), lbs/lb AFC	0.6217
H2O in Flue Gas, Mols/lb AFC	0.0345
Flue Gas Moisture, vol %	7.611%
Flue Gas MW	29.53
Flue Gas MW (dry)	30.47

(1) Assumption: Bottom Ash Carbon Concentration is 1/3 That of Overhead Ash.

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Flue Gas Out

Ht. Pipe Outlet Temp, deg F	294	
	Mol %	
COMPOUND	Dry	Wet
CO2	13.970%	12.92%
CO	0.049%	0.05%
N2	81.041%	74.93%
O2	4.940%	4.57%
H2O	0.00%	7.54%
TOTAL	100.00%	100.00%

Mols Dry Flue Gas/lb AFC	0.4246
lbs Dry Flue Gas/lb AFC (WG'15)	12.9265
Flue Gas H2O (WmGo), lbs/lb AFC	0.6234
H2O in Flue Gas, Mols/lb AFC	0.0346
Total Flue Gas Out, lbs/hr	747662
Flue Gas Moisture, vol %	7.536%
Flue Gas MW (wet)	29.51
Flue Gas MW (dry)	30.45
Total Air Leak, wt % (AL)	**1.21**

Boiler Load, MW	146.8			
Heat Rate, Btu/KWh	9,775			
As Fired Coal Rate, Tons/hr	56.85			
lbs/hr (Wfe)	113,700			
Flow Split to Heat Pipe	48.53%	lb/hr		
Primary Air Fan Flow, lbs/lb AFC	1.9451	107,330		(3)
Primary Air (PA) Out Heat Pipe, Wpa, lbs/lb AFC	0.9716	53,610		
Cppa, Btu/mol-F (Tpao to Tpai)	7.1740			
Cppa, Btu/lb-F	0.2492			
Primary Air Bypass (PABP), lbs/lb AFC	0.9736	53,720		
Wet Flue Gas In (WF14), lbs/lb AFC	13.3879	738,724		
Cpfg, Btu/mol-F (Tfgi to Tfgo)	7.7501			
Cpfg, Btu/lb-F	0.2625			
Sootblower At Wall Air Leaks, lbs/lb AFC	0.1620	8,938		
Cpal, Btu/mol-F (Tsai to Tfgo)	7.0336			
Cpal, Btu/lb-F	0.2443			
Downstream Air Leak Rate, lbs/lb AFC	0.0000	0		
Cpal, Btu/mol-F (Tdsi to Tfgo)	7.0560			
Cpal, Btu/lb-F	0.2451			
SA+Bypass Rate (SA+SABP), lbs/lb AFC	9.3577	516,346	<<Ht Bal Calc	
Cpsa, Btu/mol-F (Tsai to Tsao)	7.1579			
Cpsa, Btu/lb-F	0.2486			
Secondary Air Bypass (SAPB), lbs/lb AFC	0.0000	0		
Cpsabp, Btu/mol-F (Tsai to Tsao)	7.1579			
Cpsabp, Btu/lb-F	0.2486			
PA+PABP+SA+SABP+Coal, lbs/lb AFC (2)	12.2003	673,195		(3)
Calc'd Air Leakage into Boiler, lbs/lb AFC	1.1876	65,529	8.87%	(3)

(2) Does Not Include Leaks Into Boiler

(3) Not Required For Performance Calculations

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	CONDITIONS		
	DESIGN	ACTUAL	
Flow Rates to Heat Pipe, lb/hr			
Primary Air	62,500	53,610	
Secondary Air (No Bypass)	562,500	516,346	
Flue Gas	750,000	738,724	
Temperatures, deg F			
Primary Air In	80.0	115.0	
Primary Air Out	644.0	614.0	
2nd Air in	80.0	94.0	
2nd Air Out With Bypass	616.0	596.0	
2nd Air Out Without Bypass		596.0	
Avg Air In, (TA8)	80.0	96.0	
Avg Air Out, (TA9)	618.8	597.7	<<(Ex SA Bypass)
Flue Gas In, (TG14)	680.0	663.0	
Flue Gas Out, (TG15)	253.0	294.0	
FG Out No Leak, (TG15NL)		296.3	
Primary Air Duty, MMBtu/hr		6.667	
Sootblower Wall Leak Duty, MMBtu/hr		0.493	
Primary Flue Gas Duty, MMBtu/hr		7.160	
Primary Flue Gas Rate, lb/hr		80512	
Primary Flue Gas Rate, lb/lb AFC		1.4591	
Primary Flue Gas Outlet Temp NL, deg F		348.9	
Secondary Flue Gas Rate, lb/hr		658212	
Secondary Flue Gas Rate, lb/lb AFC		11.9287	
Secondary Flue Gas Outlet Temp, deg F		289.8	

Pressure Drops, in. wc	**Design**	**Measured**
Primary Air, (DP8_9)	3.60	2.54
Secondary Air, (DP8_9)	5.35	4.47
Flue Gas, (DP14_15)		
Primary Flue Gas	3.65	3.57
Secondary Flue Gas	3.65	3.68

Pressure Drops Corrected for Deviation From Design Flow and Design Temp

Gas Side (DPs(14-15), in. wc (4)	**3.70**	
Pressure Drop is	**0.05**	in. wc Greater Than Design
Air Side (DPs(8-9), in. wc		
Primary Air Section	**3.44**	
Pressure Drop is	**-0.16**	in. wc Less Than Design
Secondary Air Section	**5.32**	
Pressure Drop is	**-0.03**	in. wc Less Than Design

(4) Average In/Out Flue Gas Flow Used In Calculation.

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Correction Calculations For Heat Pipe -- Design Condition Results

		Curve 1	Curve 2 (Ea Limited)	
Flue Gas Inlet Temp, deg F	TG14D	680.00	680.00	
Pri Air (PA) Inlet Temp, deg F	TA8D	80.00	80.00	
Sec Air (SA) Inlet Temp, deg F	T'A8D	80.00	80.00	
PA Outlet, deg F	Tpa9D	649.75	649.75	
SA Outlet, deg F	Tsa9D	617.20	617.20	
Pri Flue Gas (PFG) Outlet, deg F	TPFG15D	309.66	309.66	
Sec Flue Gas (SFG) Outlet, deg F	TSFG15D	243.92	243.92	
PFG Rate, Mlb/hr	WPFGD	182.70	182.70	
SFG Rate, Mlb/hr	WSFGD	1317.30	1317.30	
Combined Outlet T, deg F		251.93	251.93	
PA Side Effectiveness	Ea	0.9496	0.9492	<Curve 2 Limit
PA X-Ratio	X Design	0.6500	0.6500	
PA fg	fpgD	1.0001	1.0001	
PA fx	fpxD	0.9991	0.9987	
	Eg	0.6172	0.6170	
Calculated TPFG Out, deg F	TPFG15D	309.66	309.81	
SA Side Effectiveness	Ea	0.8953	0.9300	<Curve 2 Limit
SA X-Ratio (Design)	X Design	0.8118	0.8118	
SA fg	fsgD	1.0004	1.0004	
SA fx	fsxD	1.0001	1.0388	
	Eg	0.7268	0.7549	
Calculated TSFG Out, deg F	TSFG15D	243.91	227.04	
Combined Outlet T, deg F		251.92	237.12	

Correction Calculations For Heat Pipe -- Operating Condition Results

Ambient Temp, deg F	Tamb	95.00
Sootblower Wall Air Leak, wt % PFG	Al	11.10
Cpa (Tpfg15-Tamb), Btu/lb-F	CpA	0.2401
Cpg (Tpfgnl15-Tpg15), Btu/lb-F	CpG	0.2568
Flue Gas Inlet Temp, deg F	TG14	663.00
PA Inlet Temp, deg F	TA8	115.00
SA Inlet Temp, deg F	T'A8	94.00
PA Outlet Temp, deg F	Tpa9	614.00
SA Outlet Temp (No Bypass), deg F	Tsa9	596.00
PFG Outlet Temp, deg F	TPG15	325.00
PFG Outlet Temp (No Leak), deg F	TPFG15NL	348.87
SFG Outlet Temp, deg F	TSFG15	289.80
PFG Rate, Mlb/hr	WPFG	80.51
SFG Rate, Mlb/hr	WSFG	658.21
Sootblower Wall Air Leak Into PFG, Mlb/hr	WAL1	8.94
Constant, Al/100*CpA/CpG*(TPG15-Tamb)		23.87
PA Side Effectiveness	Epa	0.9106
SA Side Effectiveness	Esa	0.8822
X-Ratios	Xp	0.6295
	Xs	0.7434
PA Eg	Epg	0.5732
SA Eg	Esg	0.6559

Correction Factors		**Pri Flue Gas**		**Sec Flue Gas**
	fpg	1.0077	fsg	1.0004
	fpgD	1.0001	fsgD	1.0004
	fpx	0.9745	fsx	0.9440
	fpxD	0.9991	fsxD	1.0001
	TPFG15D	309.66	TSFG15D	243.91
Performance	TPFG15	306.74	TSFG15	272.59

Primary Flue Gas Corrections For Differences From:	
Design Entering Air Temperature, TPFG15DA, deg F	303.41
Design Entering Flue Gas Temperature, TPFG15DG, deg F	331.51
Design X-Ratio (No Leak), TPFG15DX, deg F	315.86
Air Leak Correction, deg F	23.87
Design Flue Gas Flow Rate, TPFG15DGR, deg F	327.80
Secondary Flue Gas Corrections for Differences From:	
Design Entering Air Temperature, TSFG15DA, deg F	280.61
Design Entering Flue Gas Temperature, TSFG15DG, deg F	295.65
Design X-Ratio, TSFG15DX, deg F	265.36
Design Flue Gas Flow Rate, TSFG15DGR, deg F	289.82
PFG Totally Corrected Outlet Temp, deg F	327.45
SFG Totally Corrected Outlet Temp, deg F	262.06
Avg FG Outlet Totally Corrected T, TG15_Total, deg F	**269.18**

Summary of Specific Heat Calculation Results

	T1 °F	T2 °F	Cp Btu/lb-°F
Calculation of Pri, Sec, and Air Leak Cps Over Inlet to Outlet Temp Ranges			
Cp for Primary Air From Tpai to Tpao	115.0	614.0	0.2492
Cp Secondary Air From Tsai to Tsao	94.0	596.0	0.2486
Cp Air Leak From Tamb to Tfgo	95.0	294.0	0.2443
Cp Downstream Leak From Tdsi to Tfgo	148.0	294.0	0.2451
Secondary Air Outlet Temperature Correction For Bypass Flow			
Cp for Secondary Air From Tsai to Tsao'	94.0	596.0	0.2486
Cp for Secondary Air From Tsao to Tsao'	596.0	596.0	0.2557
Calculation of Average Air Inlet Temperature			
Cp of Primary Air Between Tpai and Taia (TA8)	115.0	96.0	0.2417
Cp of Secondary Air Between Tsai and Taia (TA8)	94.0	96.0	0.2414
Calculation of Average Air Outlet Temperature			
Cp of Primary Air Between Tpao and Taoa (TA9)	614.0	597.7	0.2560
Cp of Secondary Air Between Tsao and Taoa (TA9)	596.0	597.7	0.2558
Cp of Air Between Taia and Taoa (TA8 to TA9)	96.0	597.7	0.2487
Calculation of Flue Gas Outlet Temp for No Leak Case (NL)			
Cp for Outlet Flue Gas Between Tfgo (TG15) and Tfgonl (TG15NL)	294.0	296.3	0.2551
Cp of Air Leak Between Tsai to Tfgo (TG15)	94.0	294.0	0.2443
Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgo (TG15)	663.0	294.0	0.2625
Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgonl (TG15NL)	663.0	296.3	0.2625
Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgo (TPFG15)	663.0	325.0	0.2631
Cp for Primary Flue Gas Between Tpfgo (TPFG15) and Tpfgonl (TPFG15NL)	325.0	348.9	0.2568
Cp for Sootblower Air Leak From Tamb to Tpfgo	95.0	325.0	0.2401
Cp for Sootblower Air Leak From Tptgo (TPFG15) to Tfgo (TG15)	325.0	294.0	0.2429
Calculation of Secondary Flue Gas Outlet Temperature			
Cp for Secondary Flue Gas Between Tsfgo (TSFG15) and Tfgo (TG15)	289.8	294.0	0.2550
Cp for Primary Flue Gas Between Tfgo (TG15) and Tpfgo (TPFG15)	294.0	325.0	0.2557
Cp for Secondary Flue Gas Between Tfgi (TG14) and Tsfgo (TSFG15)	663.0	289.8	0.2624
Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgonl (TPFG15NL)	663.0	348.9	0.2636

Note -- air (a), average (a), ambient (amb), downstream (ds), flue gas (fg), in (i), out (o), no leak (nl), primary (p), secondary (s)
Numbers in variable names are consistant with Power Test Code, PTC 4.3, inlet/outlet stream numbering system.

PROGRAM CALCULATES AIR HEATER PERFORMANCE FROM TEST DATA

After Entering Data Into Blocked Areas Calculate Results Using Macro \C

Print Results Using Macro \P

Description Unit 2A Test 2– 11/08/96 10:15 -12:28 hrs

Coal and Ash Data

AFC = As Fired Coal

Use ASME Mol Weights? 1=Y 0=Alt 1

	Coal Comp Wt % Dry	Wt % Wet
Moisture		7.58
C	75.02	69.33
H	5.07	4.69
N	1.45	1.34
S	3.04	2.81
O	4.24	3.92
Ash	11.18	10.33
HHV	13,315	100.00

Fly Ash Overhead	90.00%
Carbon in Refuse, %	3.19
lbs C in Refuse/lb AFC (1)	0.0032
C Burned/lb AFC	0.6902

Gas Stream Data

Flue Gas In

Ht Pipe Inlet Temp, deg F 658

COMPOUND	Mol % Dry	Wet
CO2	14.570%	13.46%
CO	0.051%	0.05%
N2	81.129%	74.94%
O2	4.250%	3.93%
H2O	0.00%	7.62%
TOTAL	100.00%	100.00%

Amb Air Temp, deg F	95
Amb Air Moisture, lb/lb BD Air	0.00837
Downstream Leak Temp, deg F	148
Downstream Leak Moisture, lb/lb BD Air	0.00837
Downstream Leak Rate, lb/hr	0
Primary Air (PA) Inlet Temp (Tpai), deg F	106
Primary Air Outlet Temp (Tpao), deg F	576
Secondary Air (SA) Inlet Temp (Tsai), deg F	85
Sec Air With Bypass Outlet Temp (Tsao), deg F	578
Primary Flue Gas Outlet Temp (Tpgo), deg F	288
Total Mols Dry Flue Gas In/lb AFC	0.3990
Total lbs Dry Flue Gas In/lb AFC (WG'14)	12.1764
Atomizing Steam (Wz), lbs/lb AFC	0.00
Steam From Ash Pit (Wm), lbs/lb AFC	0.00
Flue Gas H2O (WmGi), lbs/lb AFC	0.5932
H2O in Flue Gas, Mols/lb AFC	0.0329
Flue Gas Moisture, vol %	7.623%
Flue Gas MW	29.56
Flue Gas MW (dry)	30.51

(1) Assumption: Bottom Ash Carbon Concentration is 1/3 That of Overhead Ash.

Flue Gas Out

Ht. Pipe Outlet Temp, deg F	278	
	Mol %	
COMPOUND	Dry	Wet
CO2	14.210%	13.15%
CO	0.034%	0.03%
N2	81.087%	75.03%
O2	4.670%	4.32%
H2O	0.00%	7.47%
TOTAL	100.00%	100.00%

Mols Dry Flue Gas/lb AFC	0.4096
lbs Dry Flue Gas/lb AFC (WG'15)	12.4825
Flue Gas H2O (WmGo), lbs/lb AFC	0.5957
H2O in Flue Gas, Mols/lb AFC	0.0331
Total Flue Gas Out, lbs/hr	773821
Flue Gas Moisture, vol %	7.470%
Flue Gas MW (wet)	29.54
Flue Gas MW (dry)	30.47
Total Air Leak, wt % (AL)	**2.42**

Boiler Load, MW	147.75		
Heat Rate, Btu/KWh	9,743		
As Fired Coal Rate, Tons/hr	58.49		
lbs/hr (Wfe)	116,980		
Flow Split to Heat Pipe	50.58%	lb/hr	
Primary Air Fan Flow, lbs/lb AFC	1.8119	107,210	(3)
Primary Air (PA) Out Heat Pipe, Wpa, lbs/lb AFC	1.2414	73,451	
Cppa, Btu/mol-F (Tpao to Tpai)	7.1507		
Cppa, Btu/lb-F	0.2481		
Primary Air Bypass (PABP), lbs/lb AFC	0.5706	33,759	
Wet Flue Gas In (WF14), lbs/lb AFC	12.7695	755,555	
Cpfg, Btu/mol-F (Tfgi to Tfgo)	7.7484		
Cpfg, Btu/lb-F	0.2621		
Sootblower At Wall Air Leaks, lbs/lb AFC	0.3087	18,267	
Cpal, Btu/mol-F (Tsai to Tfgo)	7.0231		
Cpal, Btu/lb-F	0.2437		
Downstream Air Leak Rate, lbs/lb AFC	0.0000	0	
Cpal, Btu/mol-F (Tdsi to Tfgo)	7.0455		
Cpal, Btu/lb-F	0.2444		
SA+Bypass Rate (SA+SABP), lbs/lb AFC	9.1206	539,650	<<Ht Bal Calc
Cpsa, Btu/mol-F (Tsai to Tsao)	7.1429		
Cpsa, Btu/lb-F	0.2478		
Secondary Air Bypass (SAPB), lbs/lb AFC	0.0000	0	
Cpsabp, Btu/mol-F (Tsai to Tsao)	7.1429		
Cpsabp, Btu/lb-F	0.2478		
PA+PABP+SA+SABP+Coal, lbs/lb AFC (2)	11.8292	699,915	(3)
Calc'd Air Leakage into Boiler, lbs/lb AFC	0.9404	55,640	7.36% (3)

(2) Does Not Include Leaks Into Boiler

(3) Not Required For Performance Calculations

	CONDITIONS		
	DESIGN	ACTUAL	
Flow Rates to Heat Pipe, lb/hr			
Primary Air	62,500	73,451	
Secondary Air (No Bypass)	562,500	539,650	
Flue Gas	750,000	755,555	
Temperatures, deg F			
Primary Air In	80.0	106.0	
Primary Air Out	644.0	576.0	
2nd Air in	80.0	85.4	
2nd Air Out With Bypass	616.0	578.0	
2nd Air Out Without Bypass		578.0	
Avg Air In, (TA8)	80.0	87.9	
Avg Air Out, (TA9)	618.8	577.8	<<(Ex SA Bypass)
Flue Gas In, (TG14)	680.0	658.0	
Flue Gas Out, (TG15)	253.0	278.0	
FG Out No Leak, (TG15NL)		282.5	
Primary Air Duty, MMBtu/hr		8.564	
Sootblower Wall Leak Duty, MMBtu/hr		0.846	
Primary Flue Gas Duty, MMBtu/hr		9.410	
Primary Flue Gas Rate, lb/hr		96960	
Primary Flue Gas Rate, lb/lb AFC		1.6387	
Primary Flue Gas Outlet Temp NL, deg F		322.2	
Secondary Flue Gas Rate, lb/hr		658595	
Secondary Flue Gas Rate, lb/lb AFC		11.1308	
Secondary Flue Gas Outlet Temp, deg F		276.3	

Pressure Drops, in. wc	**Design**	**Measured**
Primary Air, (DP8_9)	3.60	3.51
Secondary Air, (DP8_9)	5.35	4.72
Flue Gas, (DP14_15)		
Primary Flue Gas	3.65	3.52
Secondary Flue Gas	3.65	3.58

Pressure Drops Corrected for Deviation From Design Flow and Design Temp

Gas Side (DPs(14-15), in. wc (4)	**3.44**	
Pressure Drop is	**-0.21**	in. wc Less Than Design
Air Side (DPs(8-9), in. wc		
Primary Air Section	**2.61**	
Pressure Drop is	**-0.99**	in. wc Less Than Design
Secondary Air Section	**5.23**	
Pressure Drop is	**-0.12**	in. wc Less Than Design

(4) Average In/Out Flue Gas Flow Used In Calculation.

Correction Calculations For Heat Pipe -- Design Condition Results

		Curve 1	Curve 2 (Ea Limited)	
Flue Gas Inlet Temp, deg F	TG14D	680.00	680.00	
Pri Air (PA) Inlet Temp, deg F	TA8D	80.00	80.00	
Sec Air (SA) Inlet Temp, deg F	T'A8D	80.00	80.00	
PA Outlet, deg F	Tpa9D	649.75	649.75	
SA Outlet, deg F	Tsa9D	617.20	617.20	
Pri Flue Gas (PFG) Outlet, deg F	TPFG15D	309.66	309.66	
Sec Flue Gas (SFG) Outlet, deg F	TSFG15D	243.92	243.92	
PFG Rate, Mlb/hr	WPFGD	182.70	182.70	
SFG Rate, Mlb/hr	WSFGD	1317.30	1317.30	
Combined Outlet T, deg F		251.93	251.93	
PA Side Effectiveness	Ea	0.9496	0.9492	<Curve 2 Limit
PA X-Ratio	X Design	0.6500	0.6500	
PA fg	fpgD	1.0001	1.0001	
PA fx	fpxD	0.9991	0.9987	
	Eg	0.6172	0.6170	
Calculated TPFG Out, deg F	TPFG15D	309.66	309.81	
SA Side Effectiveness	Ea	0.8953	0.9300	<Curve 2 Limit
SA X-Ratio (Design)	X Design	0.8118	0.8118	
SA fg	fsgD	1.0004	1.0004	
SA fx	fsxD	1.0001	1.0388	
	Eg	0.7268	0.7549	
Calculated TSFG Out, deg F	TSFG15D	243.91	227.04	
Combined Outlet T, deg F		251.92	237.12	

Correction Calculations For Heat Pipe -- Operating Condition Results

Ambient Temp, deg F	Tamb	95.00
Sootblower Wall Air Leak, wt % PFG	Al	18.84
Cpa (Tpfg15-Tamb), Btu/lb-F	CpA	0.2401
Cpg (Tpfgnl15-Tpg15), Btu/lb-F	CpG	0.2555
Flue Gas Inlet Temp, deg F	TG14	658.00
PA Inlet Temp, deg F	TA8	106.00
SA Inlet Temp, deg F	T'A8	85.40
PA Outlet Temp, deg F	Tpa9	576.00
SA Outlet Temp (No Bypass), deg F	Tsa9	578.00
PFG Outlet Temp, deg F	TPG15	288.00
PFG Outlet Temp (No Leak), deg F	TPFG15NL	322.16
SFG Outlet Temp, deg F	TSFG15	276.26
PFG Rate, Mlb/hr	WPFG	96.96
SFG Rate, Mlb/hr	WSFG	658.59
Sootblower Wall Air Leak Into PFG, Mlb/hr	WAL1	18.27
Constant, Al/100*CpA/CpG*(TPG15-Tamb)		34.16
PA Side Effectiveness	Epa	0.8514
SA Side Effectiveness	Esa	0.8603
X-Ratios	Xp	0.7146
	Xs	0.7749
PA Eg	Epg	0.6084
SA Eg	Esg	0.6667

Correction Factors		**Pri Flue Gas**	**Sec Flue Gas**	
	fpg	0.9962	fsg	1.0004
	fpgD	1.0001	fsgD	1.0004
	fpx	1.0713	fsx	0.9709
	fpxD	0.9991	fsxD	1.0001
	TPFG15D	309.66	TSFG15D	243.91
Performance	TPFG15	259.95	TSFG15	253.98

Primary Flue Gas Corrections For Differences From:	
Design Entering Air Temperature, TPFG15DA, deg F	270.57
Design Entering Flue Gas Temperature, TPFG15DG, deg F	295.25
Design X-Ratio (No Leak), TPFG15DX, deg F	314.74
Air Leak Correction, deg F	34.16
Design Flue Gas Flow Rate, TPFG15DGR, deg F	286.55

Secondary Flue Gas Corrections for Differences From:	
Design Entering Air Temperature, TSFG15DA, deg F	272.66
Design Entering Flue Gas Temperature, TSFG15DG, deg F	283.59
Design X-Ratio, TSFG15DX, deg F	263.52
Design Flue Gas Flow Rate, TSFG15DGR, deg F	276.26

PFG Totally Corrected Outlet Temp, deg F	337.28
SFG Totally Corrected Outlet Temp, deg F	267.26
Avg FG Outlet Totally Corrected T, TG15_Total, deg F	**276.24**

Summary of Specific Heat Calculation Results

	T1 °F	T2 °F	Cp Btu/lb-°F
Calculation of Pri, Sec, and Air Leak Cps Over Inlet to Outlet Temp Ranges			
Cp for Primary Air From Tpai to Tpao	106.0	576.0	0.2481
Cp Secondary Air From Tsai to Tsao	85.4	578.0	0.2478
Cp Air Leak From Tamb to Tfgo	95.0	278.0	0.2437
Cp Downstream Leak From Tdsi to Tfgo	148.0	278.0	0.2444
Secondary Air Outlet Temperature Correction For Bypass Flow			
Cp for Secondary Air From Tsai to Tsao'	85.4	578.0	0.2478
Cp for Secondary Air From Tsao to Tsao'	578.0	578.0	0.2548
Calculation of Average Air Inlet Temperature			
Cp of Primary Air Between Tpai and Taia (TA8)	106.0	87.9	0.2410
Cp of Secondary Air Between Tsai and Taia (TA8)	85.4	87.9	0.2407
Calculation of Average Air Outlet Temperature			
Cp of Primary Air Between Tpao and Taoa (TA9)	576.0	577.8	0.2547
Cp of Secondary Air Between Tsao and Taoa (TA9)	578.0	577.8	0.2548
Cp of Air Between Taia and Taoa (TA8 to TA9)	87.9	577.8	0.2478
Calculation of Flue Gas Outlet Temp for No Leak Case (NL)			
Cp for Outlet Flue Gas Between Tfgo (TG15) and Tfgonl (TG15NL)	278.0	282.5	0.2545
Cp of Air Leak Between Tsai to Tfgo (TG15)	85.4	278.0	0.2435
Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgo (TG15)	658.0	278.0	0.2621
Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgonl (TG15NL)	658.0	282.5	0.2622
Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgo (TPFG15)	658.0	288.0	0.2623
Cp for Primary Flue Gas Between Tpfgo (TPFG15) and Tpfgonl (TPFG15NL)	288.0	322.2	0.2555
Cp for Sootblower Air Leak From Tamb to Tpfgo	95.0	288.0	0.2401
Cp for Sootblower Air Leak From Tpfgo (TPFG15) to Tfgo (TG15)	288.0	278.0	0.2426
Calculation of Secondary Flue Gas Outlet Temperature			
Cp for Secondary Flue Gas Between Tsfgo (TSFG15) and Tfgo (TG15)	276.3	278.0	0.2544
Cp for Primary Flue Gas Between Tfgo (TG15) and Tpfgo (TPFG15)	278.0	288.0	0.2546
Cp for Secondary Flue Gas Between Tfgi (TG14) and Tsfgo (TSFG15)	658.0	276.3	0.2621
Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgonl (TPFG15NL)	658.0	322.2	0.2630

Note -- air (a), average (a), ambient (amb), downstream (ds), flue gas (fg), in (i), out (o), no leak (nl), primary (p), secondary (s)
Numbers in variable names are consistant with Power Test Code, PTC 4.3, inlet/outlet stream numbering system.

PROGRAM CALCULATES AIR HEATER PERFORMANCE FROM TEST DATA
After Entering Data Into Blocked Areas Calculate Results Using Macro \C
Print Results Using Macro \P

Description	Unit 2B Test 2– 11/08/96 12:15-14:50 hrs

Coal and Ash Data

AFC = As Fired Coal

Use ASME Mol Weights? 1=Y 0=Alt	1

	Coal Comp Wt % Dry	Wt % Wet
Moisture		7.58
C	75.02	69.33
H	5.07	4.69
N	1.45	1.34
S	3.04	2.81
O	4.24	3.92
Ash	11.18	10.33
HHV	13,315	100.00

Fly Ash Overhead	90.00%
Carbon in Refuse, %	3.19
lbs C in Refuse/lb AFC (1)	0.0032
C Burned/lb AFC	0.6902

Gas Stream Data

Flue Gas In

Ht Pipe Inlet Temp, deg F	661

COMPOUND	Mol % Dry	Wet
CO2	14.080%	13.04%
CO	0.059%	0.05%
N2	81.051%	75.06%
O2	4.810%	4.45%
H2O	0.00%	7.39%
TOTAL	100.00%	100.00%

Amb Air Temp, deg F	95
Amb Air Moisture, lb/lb BD Air	0.00808
Downstream Leak Temp, deg F	148
Downstream Leak Moisture, lb/lb BD Air	0.00808
Downstream Leak Rate, lb/hr	0
Primary Air (PA) Inlet Temp (Tpai), deg F	107
Primary Air Outlet Temp (Tpao), deg F	592
Secondary Air (SA) Inlet Temp (Tsai), deg F	83
Sec Air With Bypass Outlet Temp (Tsao), deg F	595
Primary Flue Gas Outlet Temp (Tpgo), deg F	283.4
Total Mols Dry Flue Gas In/lb AFC	0.4126
Total lbs Dry Flue Gas In/lb AFC (WG'14)	12.5683
Atomizing Steam (Wz), lbs/lb AFC	0.00
Steam From Ash Pit (Wm), lbs/lb AFC	0.00
Flue Gas H2O (WmGi), lbs/lb AFC	0.5928
H2O in Flue Gas, Mols/lb AFC	0.0329
Flue Gas Moisture, vol %	7.386%
Flue Gas MW	29.54
Flue Gas MW (dry)	30.46

(1) Assumption: Bottom Ash Carbon Concentration is 1/3 That of Overhead Ash.

Flue Gas Out

Ht. Pipe Outlet Temp, deg F	283	
	Mol %	
COMPOUND	Dry	Wet
CO2	13.740%	12.74%
CO	0.062%	0.06%
N2	80.998%	75.13%
O2	5.200%	4.82%
H2O	0.00%	7.25%
TOTAL	100.00%	100.00%

Mols Dry Flue Gas/lb AFC	0.4227
lbs Dry Flue Gas/lb AFC (WG'15)	12.8593
Flue Gas H2O (WmGo), lbs/lb AFC	0.5952
H2O in Flue Gas, Mols/lb AFC	0.0330
Total Flue Gas Out, lbs/hr	795380
Flue Gas Moisture, vol %	7.249%
Flue Gas MW (wet)	29.52
Flue Gas MW (dry)	30.42

Total Air Leak, wt % (AL) **2.23**

Boiler Load, MW	147.84		
Heat Rate, Btu/KWh	9,957		
As Fired Coal Rate, Tons/hr	59.81		
lbs/hr (Wfe)	119,620		
Flow Split to Heat Pipe	49.42%	lb/hr	
Primary Air Fan Flow, lbs/lb AFC	1.8323	108,320	(3)
Primary Air (PA) Out Heat Pipe, Wpa, lbs/lb AFC	1.1623	68,709	
Cppa, Btu/mol-F (Tpao to Tpai)	7.1570		
Cppa, Btu/lb-F	0.2483		
Primary Air Bypass (PABP), lbs/lb AFC	0.6701	39,611	
Wet Flue Gas In (WF14), lbs/lb AFC	13.1612	778,038	
Cpfg, Btu/mol-F (Tfgi to Tfgo)	7.7371		
Cpfg, Btu/lb-F	0.2619		
Sootblower At Wall Air Leaks, lbs/lb AFC	0.2934	17,342	
Cpal, Btu/mol-F (Tsai to Tfgo)	7.0247		
Cpal, Btu/lb-F	0.2437		
Downstream Air Leak Rate, lbs/lb AFC	0.0000	0	
Cpal, Btu/mol-F (Tdsi to Tfgo)	7.0470		
Cpal, Btu/lb-F	0.2444		
SA+Bypass Rate (SA+SABP), lbs/lb AFC	9.0562	535,367	<<Ht Bal Calc
Cpsa, Btu/mol-F (Tsai to Tsao)	7.1483		
Cpsa, Btu/lb-F	0.2479		
Secondary Air Bypass (SAPB), lbs/lb AFC	0.0000	0	
Cpsabp, Btu/mol-F (Tsai to Tsao)	7.1483		
Cpsabp, Btu/lb-F	0.2479		
PA+PABP+SA+SABP+Coal, lbs/lb AFC (2)	11.7852	696,695	(3)
Calc'd Air Leakage into Boiler, lbs/lb AFC	1.3760	81,343	10.45% (3)

(2) Does Not Include Leaks Into Boiler

(3) Not Required For Performance Calculations

File: PER118B.WB2 2/5/97 10:56

	CONDITIONS		
	DESIGN	ACTUAL	
Flow Rates to Heat Pipe, lb/hr			
Primary Air	62,500	68,709	
Secondary Air (No Bypass)	562,500	535,367	
Flue Gas	750,000	778,038	
Temperatures, deg F			
Primary Air In	80.0	107.0	
Primary Air Out	644.0	592.0	
2nd Air in	80.0	83.0	
2nd Air Out With Bypass	616.0	595.0	
2nd Air Out Without Bypass		595.0	
Avg Air In, (TA8)	80.0	85.7	
Avg Air Out, (TA9)	618.8	594.7	<<(Ex SA Bypass)
Flue Gas In, (TG14)	680.0	661.0	
Flue Gas Out, (TG15)	253.0	283.0	
FG Out No Leak, (TG15NL)		287.3	
Primary Air Duty, MMBtu/hr		8.273	
Sootblower Wall Leak Duty, MMBtu/hr		0.784	
Primary Flue Gas Duty, MMBtu/hr		9.057	
Primary Flue Gas Rate, lb/hr		91572	
Primary Flue Gas Rate, lb/lb AFC		1.5490	
Primary Flue Gas Outlet Temp NL, deg F		317.0	
Secondary Flue Gas Rate, lb/hr		686465	
Secondary Flue Gas Rate, lb/lb AFC		11.6121	
Secondary Flue Gas Outlet Temp, deg F		282.9	

Pressure Drops, in. wc	**Design**	**Measured**
Primary Air, (DP8_9)	3.60	3.74
Secondary Air, (DP8_9)	5.35	4.51
Flue Gas, (DP14_15)		
Primary Flue Gas	3.65	3.72
Secondary Flue Gas	3.65	3.83

Pressure Drops Corrected for Deviation From Design Flow and Design Temp

Gas Side (DPs(14-15), in. wc (4)	**3.46**	
Pressure Drop is	**-0.19**	in. wc Less Than Design
Air Side (DPs(8-9), in. wc		
Primary Air Section	**3.14**	
Pressure Drop is	**-0.46**	in. wc Less Than Design
Secondary Air Section	**5.03**	
Pressure Drop is	**-0.32**	in. wc Less Than Design

(4) Average In/Out Flue Gas Flow Used In Calculation.

Correction Calculations For Heat Pipe -- Design Condition Results

		Curve 1	Curve 2 (Ea Limited)	
Flue Gas Inlet Temp, deg F	TG14D	680.00	680.00	
Pri Air (PA) Inlet Temp, deg F	TA8D	80.00	80.00	
Sec Air (SA) Inlet Temp, deg F	T'A8D	80.00	80.00	
PA Outlet, deg F	Tpa9D	649.75	649.75	
SA Outlet, deg F	Tsa9D	617.20	617.20	
Pri Flue Gas (PFG) Outlet, deg F	TPFG15D	309.66	309.66	
Sec Flue Gas (SFG) Outlet, deg F	TSFG15D	243.92	243.92	
PFG Rate, Mlb/hr	WPFGD	182.70	182.70	
SFG Rate, Mlb/hr	WSFGD	1317.30	1317.30	
Combined Outlet T, deg F		251.93	251.93	
PA Side Effectiveness	Ea	0.9496	0.9492	<Curve 2 Limit
PA X-Ratio	X Design	0.6500	0.6500	
PA fg	fpgD	1.0001	1.0001	
PA fx	fpxD	0.9991	0.9987	
	Eg	0.6172	0.6170	
Calculated TPFG Out, deg F	TPFG15D	309.66	309.81	
SA Side Effectiveness	Ea	0.8953	0.9300	<Curve 2 Limit
SA X-Ratio (Design)	X Design	0.8118	0.8118	
SA fg	fsgD	1.0004	1.0004	
SA fx	fsxD	1.0001	1.0388	
	Eg	0.7268	0.7549	
Calculated TSFG Out, deg F	TSFG15D	243.91	227.04	
Combined Outlet T, deg F		251.92	237.12	

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Correction Calculations For Heat Pipe -- Operating Condition Results

Ambient Temp, deg F	Tamb	95.00
Sootblower Wall Air Leak, wt % PFG	Al	18.94
Cpa (Tpfg15-Tamb), Btu/lb-F	CpA	0.2401
Cpg (Tpfgnl15-Tpg15), Btu/lb-F	CpG	0.2550
Flue Gas Inlet Temp, deg F	TG14	661.00
PA Inlet Temp, deg F	TA8	107.00
SA Inlet Temp, deg F	T'A8	83.00
PA Outlet Temp, deg F	Tpa9	592.00
SA Outlet Temp (No Bypass), deg F	Tsa9	595.00
PFG Outlet Temp, deg F	TPG15	283.40
PFG Outlet Temp (No Leak), deg F	TPFG15NL	316.98
SFG Outlet Temp, deg F	TSFG15	282.94
PFG Rate, Mlb/hr	WPFG	91.57
SFG Rate, Mlb/hr	WSFG	686.47
Sootblower Wall Air Leak Into PFG, Mlb/hr	WAL1	17.34
Constant, Al/100*CpA/CpG*(TPG15-Tamb)		33.58
PA Side Effectiveness	Epa	0.8755
SA Side Effectiveness	Esa	0.8858
X-Ratios	Xp	0.7093
	Xs	0.7384
PA Eg	Epg	0.6210
SA Eg	Esg	0.6541

Correction Factors		**Pri Flue Gas**		**Sec Flue Gas**
	fpg	1.0000	fsg	0.9966
	fpgD	1.0001	fsgD	1.0004
	fpx	1.0657	fsx	0.9396
	fpxD	0.9991	fsxD	1.0001
	TPFG15D	309.66	TSFG15D	243.91
Performance	TPFG15	262.73	TSFG15	267.77

Primary Flue Gas Corrections For Differences From:

Design Entering Air Temperature, TPFG15DA, deg F	265.00
Design Entering Flue Gas Temperature, TPFG15DG, deg F	289.45
Design X-Ratio (No Leak), TPFG15DX, deg F	308.09
Air Leak Correction, deg F	33.58
Design Flue Gas Flow Rate, TPFG15DGR, deg F	283.34

Secondary Flue Gas Corrections for Differences From:

Design Entering Air Temperature, TSFG15DA, deg F	280.97
Design Entering Flue Gas Temperature, TSFG15DG, deg F	289.51
Design X-Ratio, TSFG15DX, deg F	256.57
Design Flue Gas Flow Rate, TSFG15DGR, deg F	281.31

PFG Totally Corrected Outlet Temp, deg F	329.26
SFG Totally Corrected Outlet Temp, deg F	259.55

Avg FG Outlet Totally Corrected T, TG15_Total, deg F **267.76**

Summary of Specific Heat Calculation Results

	T1 °F	T2 °F	Cp Btu/lb-°F
Calculation of Pri, Sec, and Air Leak Cps Over Inlet to Outlet Temp Ranges			
Cp for Primary Air From Tpai to Tpao	107.0	592.0	0.2483
Cp Secondary Air From Tsai to Tsao	83.0	595.0	0.2479
Cp Air Leak From Tamb to Tfgo	95.0	283.0	0.2437
Cp Downstream Leak From Tdsi to Tfgo	148.0	283.0	0.2444
Secondary Air Outlet Temperature Correction For Bypass Flow			
Cp for Secondary Air From Tsai to Tsao'	83.0	595.0	0.2479
Cp for Secondary Air From Tsao to Tsao'	595.0	595.0	0.2552
Calculation of Average Air Inlet Temperature			
Cp of Primary Air Between Tpai and Taia (TA8)	107.0	85.7	0.2410
Cp of Secondary Air Between Tsai and Taia (TA8)	83.0	85.7	0.2406
Calculation of Average Air Outlet Temperature			
Cp of Primary Air Between Tpao and Taoa (TA9)	592.0	594.7	0.2551
Cp of Secondary Air Between Tsao and Taoa (TA9)	595.0	594.7	0.2552
Cp of Air Between Taia and Taoa (TA8 to TA9)	85.7	594.7	0.2480
Calculation of Flue Gas Outlet Temp for No Leak Case (NL)			
Cp for Outlet Flue Gas Between Tfgo (TG15) and Tfgonl (TG15NL)	283.0	287.3	0.2544
Cp of Air Leak Between Tsai to Tfgo (TG15)	83.0	283.0	0.2435
Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgo (TG15)	661.0	283.0	0.2619
Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgonl (TG15NL)	661.0	287.3	0.2620
Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgo (TPFG15)	661.0	283.4	0.2619
Cp for Primary Flue Gas Between Tpfgo (TPFG15) and Tpfgonl (TPFG15NL)	283.4	317.0	0.2550
Cp for Sootblower Air Leak From Tamb to Tpfgo	95.0	283.4	0.2401
Cp for Sootblower Air Leak From Tpfgo (TPFG15) to Tfgo (TG15)	283.4	283.0	0.2427
Calculation of Secondary Flue Gas Outlet Temperature			
Cp for Secondary Flue Gas Between Tsfgo (TSFG15) and Tfgo (TG15)	282.9	283.0	0.2543
Cp for Primary Flue Gas Between Tfgo (TG15) and Tpfgo (TPFG15)	283.0	283.4	0.2543
Cp for Secondary Flue Gas Between Tfgi (TG14) and Tsfgo (TSFG15)	661.0	282.9	0.2619
Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgonl (TPFG15NL)	661.0	317.0	0.2626

Note -- air (a), average (a), ambient (amb), downstream (ds), flue gas (fg), in (i), out (o), no leak (nl), primary (p), secondary (s)
Numbers in variable names are consistant with Power Test Code, PTC 4.3, inlet/outlet stream numbering system.

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MILLIKEN CLEAN COAL TECHNOLOGY DEMONSTRATION PROJECT

HEAT PIPE FOULED CONDITION TEST RESULTS
INTERIM REPORT NO. 3

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June 1997

ACKNOWLEDGMENTS

The author gratefully acknowledges and thanks the following New York State Electric & Gas Corporation personnel for their cooperation and assistance during the heat pipe testing: Mr. Paul Southard for hosting the testing at the Milliken Station; Mr. Burt Marker for overall test program review; and Mr. Dave Stafford for coordinating plant operations to achieve stable test periods.

The following CONSOL test team members are acknowledged for their assistance in obtaining the field test data: Mr. G. L. Cairns, Mr. W. L. Mizwa, and Mr. D. R. Stacy. Finally, Mr. R. O. Scandrol's assistance in coordinating the testing schedule with NYSEG is also acknowledged and appreciated.

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LIST OF ABBREVIATIONS

ABB API	Asea Brown Boveri Air Preheater Inc.
ACFM	Actual Cubic Feet Per Minute
ASTM	American Society for Testing and Materials
Avg	Average
BD	Bone Dry
Btu	British Thermal Unit
C-Factor	Pitot Tube Flow Coefficient
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COMB.	Combustibles
CONSOL R&D	CONSOL Inc., Research & Development Department
Cp	Specific Heat
°F	Degrees Fahrenheit
°R	Degrees Rankine
DB	Dry Bulb
DP	Differential Pressure
DSCFM	Dry Standard Cubic Feet Per Minute
EPA	Environmental Protection Agency
FD	Forced Draft
FG	Flue Gas
FGD	Flue Gas Desulfurization
fpm	Feet per Minute
fps	Feet per Second
ft or '	Feet
ft^3	Cubic Feet
H_2O	Water
hr	Hour
ID	Inside Diameter
ID	Induced Draft (when referring to a fan)
in or "	Inches
in WC	Inches Water Column
lb/hr	Pounds per Hour
min.	Minute
MM	Million
MW	Mole Weight
MW_{net}	Net Megawatts
N_2	Nitrogen
NIST	National Institute of Standards and Technology
NYSEG	New York State Electric & Gas Corporation
O_2	Oxygen
OD	Outside Diameter

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LIST OF ABBREVIATIONS (Cont.)

P	Pressure
PA	Primary Air
PFG	Primary Flue Gas
ppm	Parts per Million
ppmv	Parts per Million by Volume
PTC	Performance Test Code
SA	Secondary Air
SO_2	Sulfur Dioxide
spgr	Specific Gravity
Sq ft	Square Feet
SCFM	Standard Cubic Feet per Minute
Temp	Temperature
TC or T/C	Thermocouple
Vol	Volume
WB	Wet Bulb
wt	Weight

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ABSTRACT

Tests were conducted on the Milliken heat pipe air heaters to document the thermal performance decline after six months of operation following a water washing. This report presents the results of these tests. Flue gas side, cold-end fouling affected the thermal performance of both heat pipes. The performance declines are quantified by calculation of the totally corrected flue gas outlet temperature as specified in the ASME Performance Test Code for air heaters, PTC 4.3. The 2A heat pipe was affected the least with the totally corrected flue gas outlet temperature increasing to 283°F, or 30°F above the 253°F design value. For the 2B heat pipe, the totally corrected flue gas outlet temperature increased to 336°F, which is 83°F above the design temperature.

Fouling was also indicated by significant increases in the flue gas side outlet tube bank pressure drops. Full boiler load pressure drops for the bottom tube banks increased 189% and 469% above the clean condition values for the 2A and 2B heat pipes, respectively. The pressure drop increases occurred only across the coldest tube banks in each heat pipe. For all other tube banks, there was little or no increase in the pressure drop. As part of the Milliken Unit 2 shutdown, which occurred shortly after fouled condition testing ended, the heat pipe air heaters were again water washed to remove cold-end deposits. Heat pipe inspections confirmed that only the cold-end modules were fouled. The inspection observations, both before and after washing, are presented.

FOULED CONDITION HEAT PIPE PERFORMANCE

INTRODUCTION

During March 1996, the NYSEG Milliken Station Unit 2 boiler system was shut down for maintenance. The two heat pipe air heaters were water washed to remove cold-end deposits and a special low frequency sound device (infrasonic cleaner) was installed at the 2A heat pipe outlet. On April 3, the boiler was placed back in service.

Approximately six weeks after the boiler was on line, heat pipe performance tests were conducted with the heat pipes in clean condition. Little or no deterioration in the thermal performance of either heat pipe was observed over the first 13 weeks of operation. This conclusion is based on relatively constant log-mean temperature differences (LMTD), air side effectivenesses, heat transfer coefficients, and flue gas side pressure drops. Then the performance of both heat pipes, particularly the 2B heat pipe, began to decline. The LMTDs began to increase with corresponding declines in heat transfer coefficients and air side effectivenesses. Increases in flue gas side pressure drops indicated fouling in the cold-end heat pipe tube modules.

Before the Unit 2 boiler was again shut down on October 11, 1996 for inspection of the S-H-U scrubber and heat pipe cleaning, plans were made to conduct abbreviated fouled condition performance tests. These tests were conducted on October 7 and 8. The test measurements provide detailed data for assessing the performance decline at the end of the six-month period since the April 3 clean condition start-up. Additionally, the tests provided information to validate the computer logged data used in less rigorous calculation procedures to follow the day-to-day heat pipe operating performance trends.

Since the tests were not conducted to establish performance guarantees, test procedures as outlined in the test plan[1] were modified to reduce costs. A test crew of four people rather than nine was used, single rather than duplicate tests were conducted on each heat pipe, secondary air inlet temperatures were obtained from computer logs rather than from special field thermocouples, and flue gas compositions were estimated solely from oxygen gas analyzer measurements rather than in combination with Orsat spot check analyses,. Based on past experience, these changes were expected to have little or no effect on the test results.

The heat pipes were inspected in a fouled condition on October 13 by representatives of NYSEG, ABB API, and CONSOL, and again after washing on October 17. Based on the after-wash inspection, all parties agreed that both air heaters appeared to be clean and in an acceptable condition for performance testing. The Unit 2 boiler was brought back on line on October 18. On October 22, with the boiler at full load, module-to-module flue gas side pressure drops were measured to establish baseline operating conditions. Manual pitot traverses of the flue gas and secondary air outlet ducts were also done to confirm that the temperature profiles were typical of clean condition operations and that the heat pipes were operating normally. The results were positive and heat pipe performance tests were scheduled for November 7 and 8. This report covers only the heat pipe testing and inspections between October 7 and 22. A separate report was issued covering the November 7 and 8 clean condition performance tests.[2]

SUMMARY

Analysis of the fouled condition heat pipe test data shows significant declines in the thermal performance of both the 2A and 2B heat pipes. The thermal performance of the 2A heat pipe, as measured by the totally corrected flue gas outlet temperature, declined the least. For the 2A heat pipe, the totally corrected flue gas outlet temperature increased to 283°F. This is 30°F above the 253°F design outlet temperature and a 12-13°F increase since the May clean condition tests. For the 2B heat pipe, the totally corrected flue gas outlet temperature increased to 336°F. This is 83°F above design and a 71°F increase above the May 1996 results.

Based on manually measured module-to-module pressure drops and fouled condition inspections, the thermal performance decline is mainly due to flue gas side fouling in the cold-end tube banks. The fouling appears to be caused by sulfuric acid condensation which traps fly ash particles between the finned tubes, and the inability of the high pressure air sootblowers to remove the deposits. The deposits reduce cold-end tube bank heat transfer by plugging flow areas and insulating heat transfer surfaces. Plugging in the cold-end module also distorts the flue gas flow through the upper hot tube banks. This can further reduce the air heater performance.

The operation of the infrasonic cleaner appears to have provided some benefit in maintaining the thermal performance of the 2A heat pipe. The rise in the totally corrected flue gas outlet temperature was only 12-13°F for the 2A heat pipe compared to 71°F for the 2B heat pipe. Additionally, the change in flue gas side pressure drop (corrected to common basis) for the 2A unit was approximately one-third that of the 2B unit.

Good agreement was obtained between flue gas and air duct temperatures determined from simple averages of fixed thermocouple array readings with weighted average temperatures determined from manual, pitot probe traverse measurements. For the major streams, i.e., flue gas in, flue gas out, primary air out, and secondary air out, the two average temperature determination methods agreed within ± 5°F for the May 1996 clean condition tests and ± 11°F for the October 96 fouled condition tests. These results indicate that the heat pipe performance can be monitored reasonably well using the computer logged temperature array data.

Water washing of the heat pipes was effective in removing the cold-end deposits. This was confirmed both by visual inspection and pre-performance testing. The post-wash secondary air outlet duct temperature profiles at full boiler load were very similar to the clean condition profiles obtained in May. Additionally, post-wash pressure drop measurements established that the May clean condition pressure drops were restored. These results showed that both heat pipes were in a condition suitable for conducting detailed performance guarantee tests.

RECOMMENDATIONS

Flue-gas side fouling of the bottom cold-end tube modules is the primary operating problem for the heat pipe air heaters. During cleaning of the heat pipes, the NYSEG operators reported that the water-wash cleaning was greatly facilitated when the infrasonic cleaner was operated while water was sprayed through the heat pipes using the fixed nozzle arrays. Operation of the infrasonic cleaner improved the cleaning of both heat pipes apparently because of sound communication through the ductwork. To reduce cleaning time, consideration should be given to making combined operation of the infrasonic cleaner with water sprays in service a standard operating practice.

Improvement in on-line cleaning of the heat pipe cold-end modules is likely to be difficult and expensive. Potential improvements include:

1. Installation of an additional infrasonic cleaner on the 2B heat pipe to extend the time between water washings,
2. Replacing the staggered cold-end tube module with a design featuring in-line tubes and/or bare tubes to improve the effectiveness of the high pressure air sootblowing,
3. Horizontal splitting of the cold-end tube modules into two or more modules to reduce the tube row depth through which a sootblower must penetrate.

Further improvement in sootblower operation might be achieved if a way could be found to install the retractable sootblowers so that the travel is parallel with the tubes rather than perpendicular to the tubes. This would lessen the effect of the front tubes shielding deeper tubes from the sootblower air blast.

DISCUSSION

General

The layout of the 2A heat pipe is schematically shown in Figure 1. The figure shows the air and flue gas streams into and out of the heat pipe. The parallel 2B heat pipe has a similar layout but does not have an infrasonic cleaner. Each heat pipe treats approximately one-half of the flue gases from the Unit 2 boiler. The figure is presented hear to provide the reader a reference for identifying the process streams discussed throughout this report.

The thermal performance of the two heat pipes was determined in general accordance with the procedures outlined in the heat pipe test plan.[1] Since these tests were not being conducted to evaluate performance guarantees, adjustments in the testing procedures were made to reduce costs. The adjustments included: (1) the use of a minimum test crew (i.e., four people rather than nine), (2) single testing of each heat pipe rather than duplicate testing, (3) direct calculation of the fuel line plot for estimating flue gas CO_2 levels from the flue gas O_2, CO concentrations, coal analysis, and fly ash analysis rather than construction of the plot from Orsat gas analyses, and (4) reliance on the plant data logger for the heat pipe secondary air inlet temperatures rather than use of a field data logger to record special FD fan outlet temperature thermocouples.

The above changes are not expected to significantly impact the measured thermal performances. With respect to item 4, the field data logger used to record the special FD fan outlet thermocouple array temperatures had been removed following the May performance tests and not re-installed for the fouled condition tests. Since past measurements showed essentially no secondary air temperature gradient at the FD fan discharge, use of the plant data logged FD fan discharge temperatures was deemed to be adequate for these tests. Additionally, the problem experienced during the May testing with the plant data logger indicating a 10-12°F high temperature for the Unit 2B FD fan discharge had been corrected.

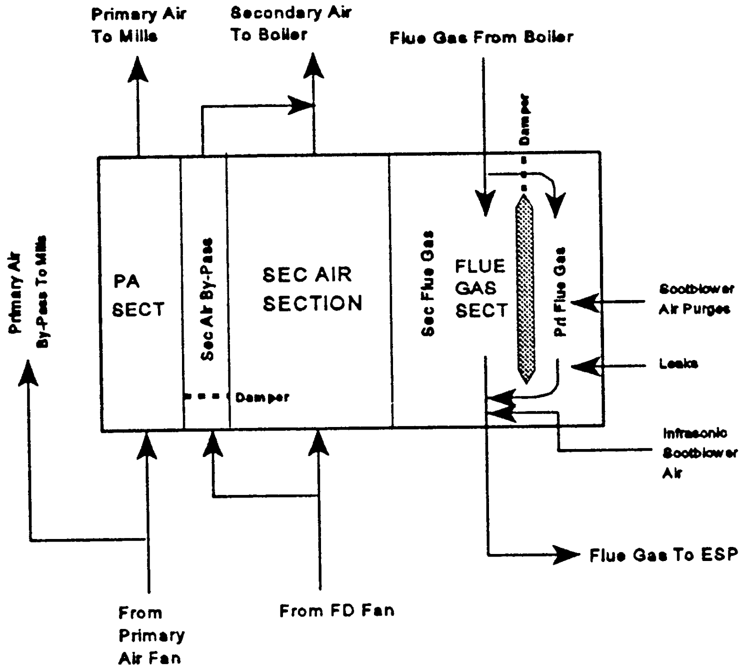


Figure 1
Heat Pipe Process Flows

System Stability

The boiler and heat pipe operations were stabilized with the boiler at high load (151-152 MW gross) before fouled condition performance tests were conducted. Data are presented in Figures 2a-2e and 3a-3e to show the stability of the plant operations. The plots show major process operating variables recorded at five minute intervals over the test period time spans on October 7 and 8, respectively. These data were obtained from plant computer logs and some results may differ from manually collected data taken for the performance testing due to differences in sampling locations and instrument calibration factors. This is not a concern since the data presented hear are only to show plant operating stability. The manually collected data are considered to be the most accurate and are used for the performance evaluations.

Figures 2a and 3a indicate that the boiler operations were well stabilized based on the coal feed rate and economizer oxygen levels. Although there are several spikes in the economizer oxygen levels, oxygen control was good and reasonably stable at about 3.3 % for both test periods. Figures 2b-2e and 3b-3e show good stability for the primary and secondary air fan flow rates, flue gas inlet and outlet temperatures, and the primary and secondary air inlet and outlet temperatures around the heat pipes. To better quantify the system stability, average values for the flow rates, gas compositions and temperatures shown in the figures are presented in Table 1 along with the standard deviations. The low standard deviations relative to the averages clearly indicate that most of the measured data values were very close to the average values.

Figure 2a
Coal Rate & Economizer O2
Oct 7, 1996

5 min. Interval Values

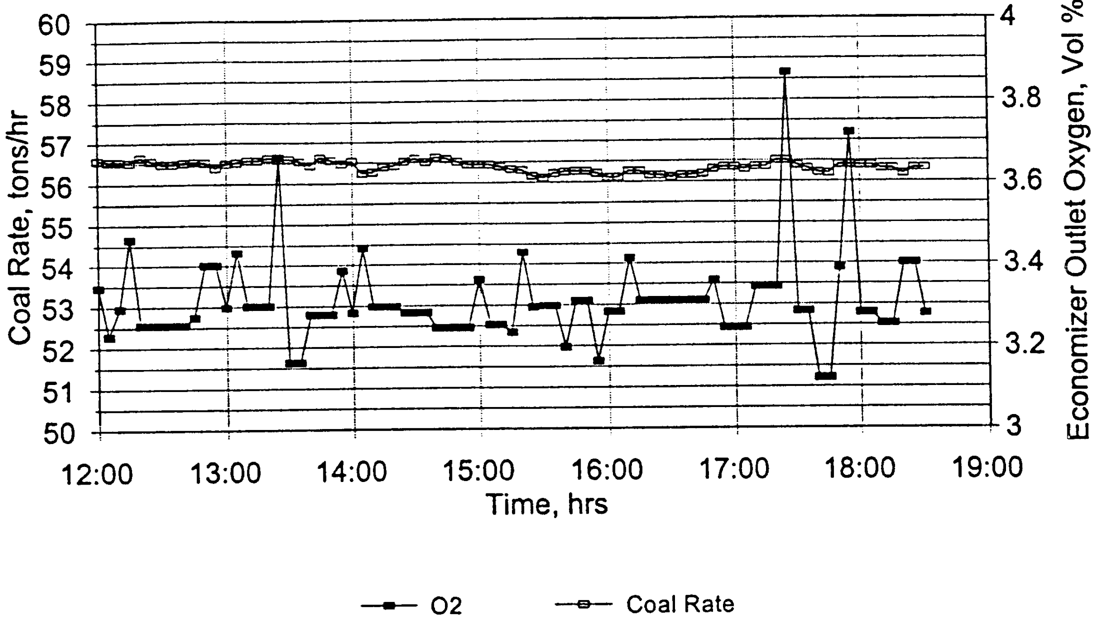
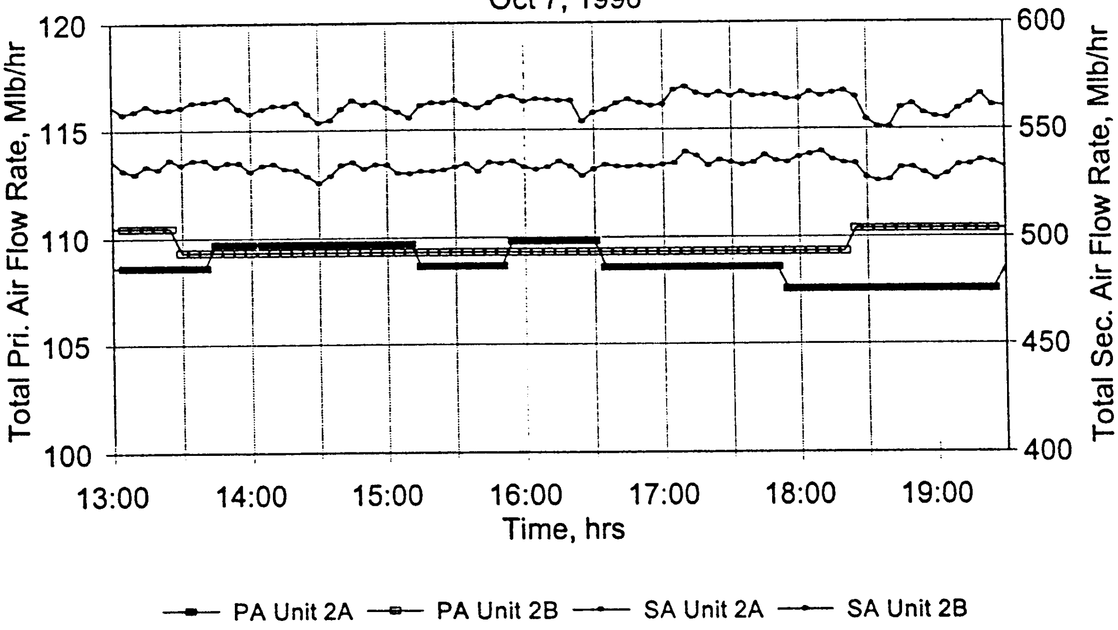


Figure 2b
Pri. & Sec. Air Flows
Oct 7, 1996

5 min. Interval Values



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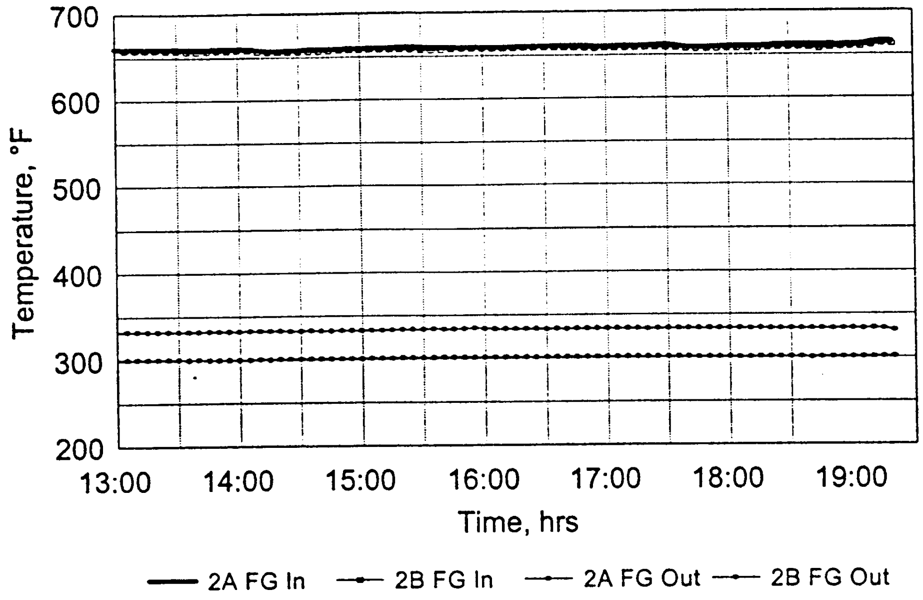


Figure 2c
Flue Gas Inlet/Outlet Temperatures
Oct 7, 1996

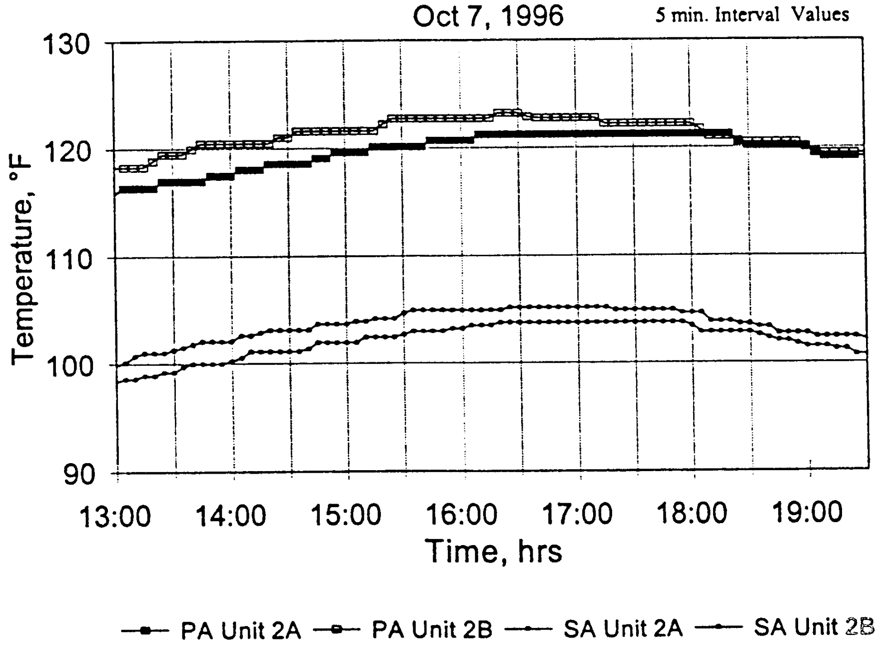


Figure 2d
Pri. & Sec. Air Inlet Temperatures
Oct 7, 1996

Figure 2e

Pri. & Sec. Air Outlet Temperatures

Oct 7, 1996

5 Min. Interval Values

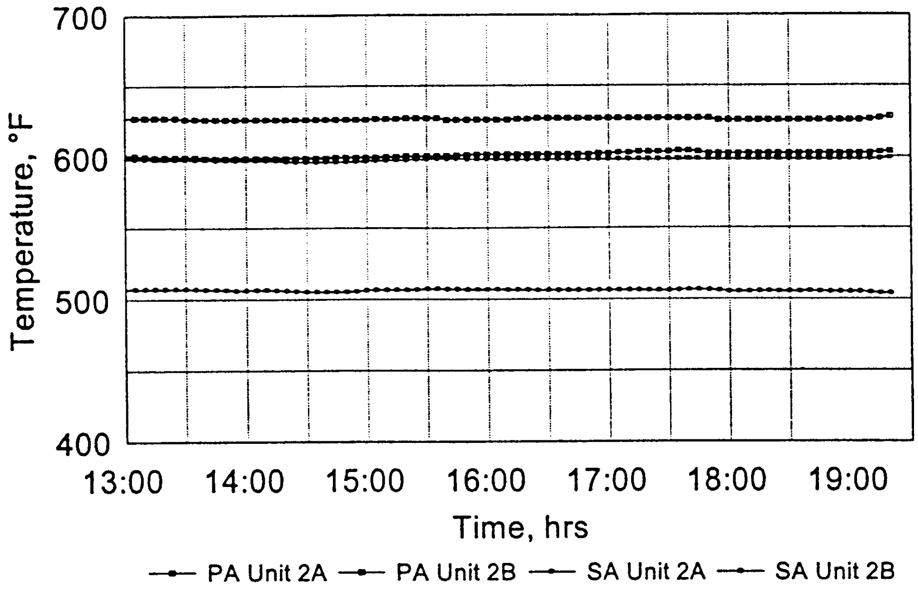


Figure 3a

Coal Rate & Economizer O2

Oct 8, 1996

5 min. Interval Values

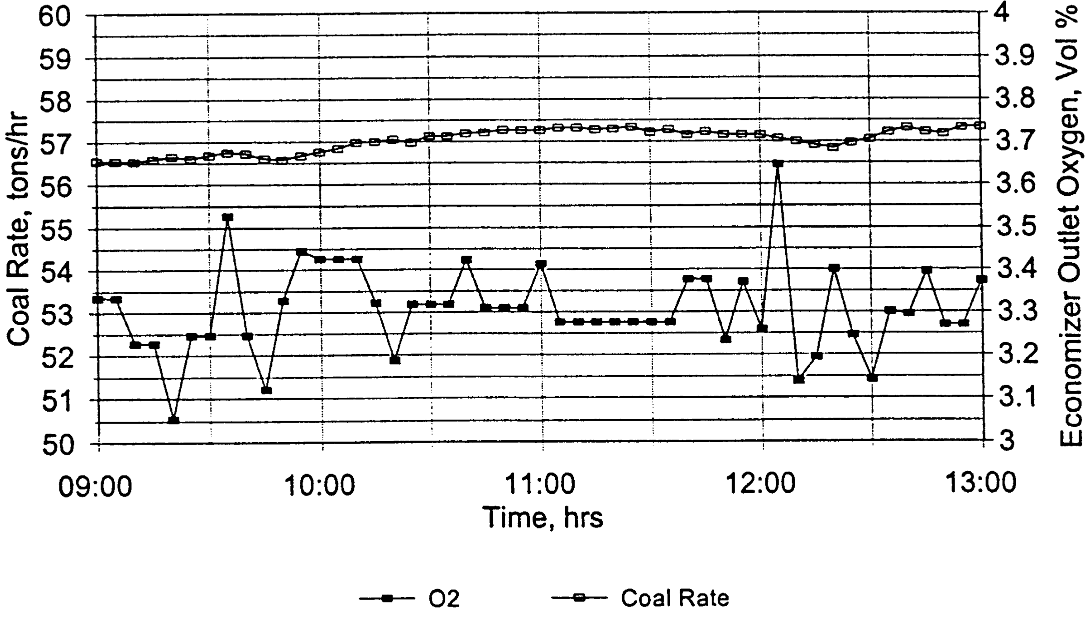


Figure 3b
Pri. & Sec. Air Flows
Oct 8, 1996

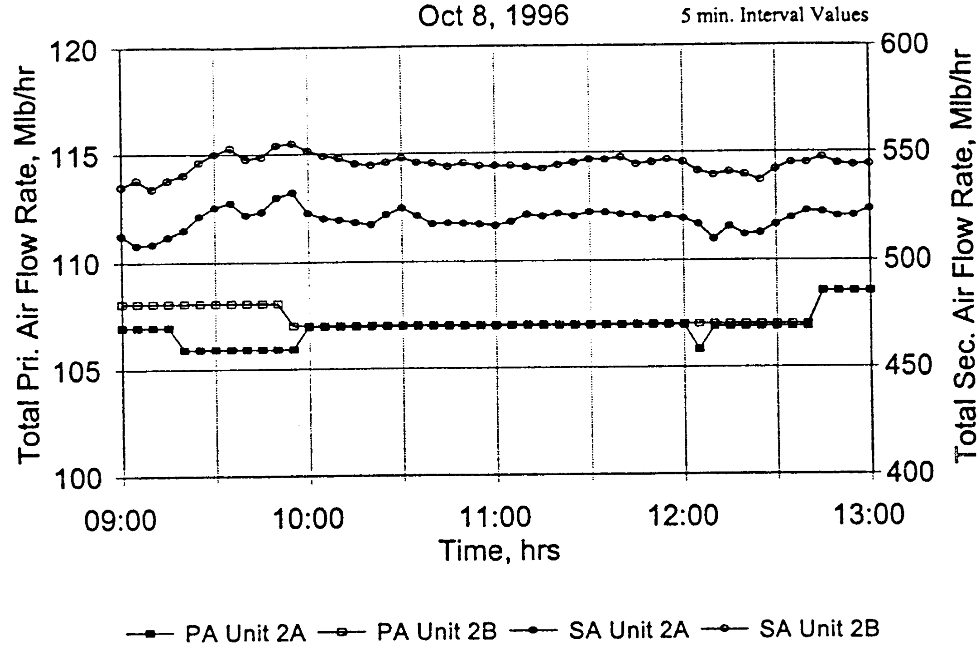


Figure 3c
Flue Gas Inlet/Outlet Temperatures
Oct 8, 1996

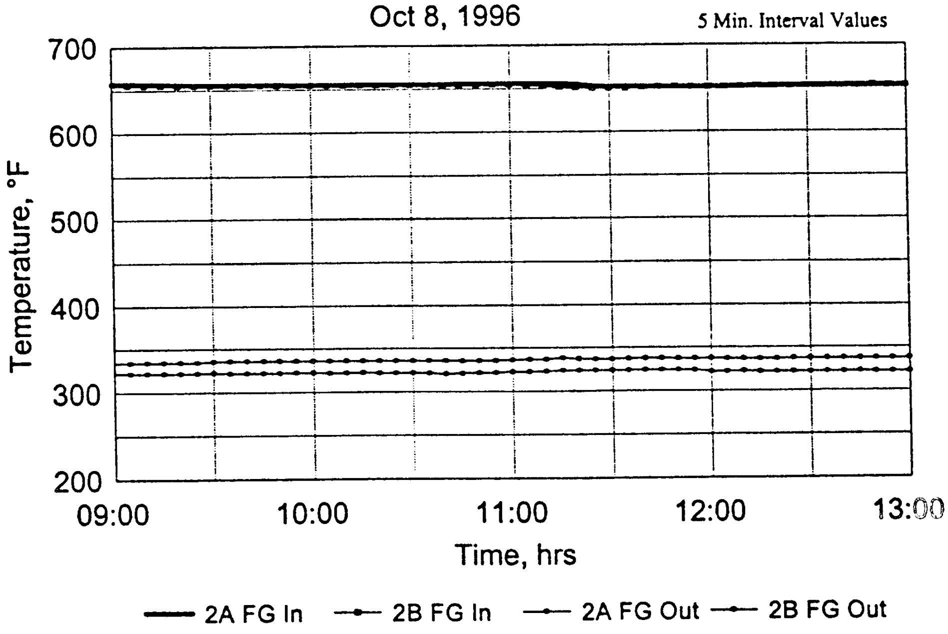


Figure 3d
Pri. & Sec. Air Inlet Temperatures
Oct 8, 1996

5 min. Interval Values

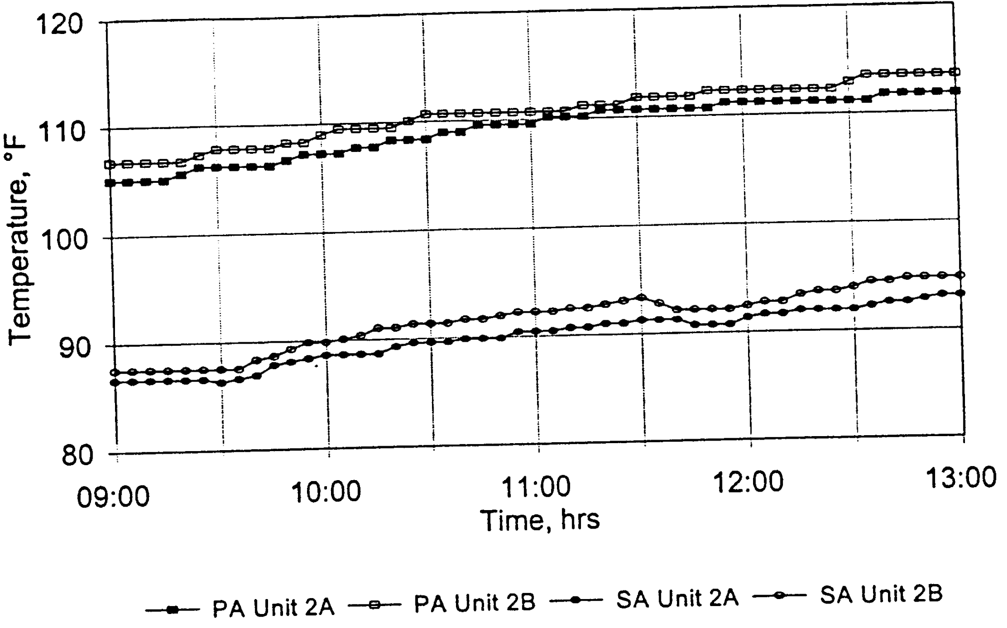


Figure 3e
Pri. & Sec. Air Outlet Temperatures
Oct 8, 1996

5 Min. Interval Values

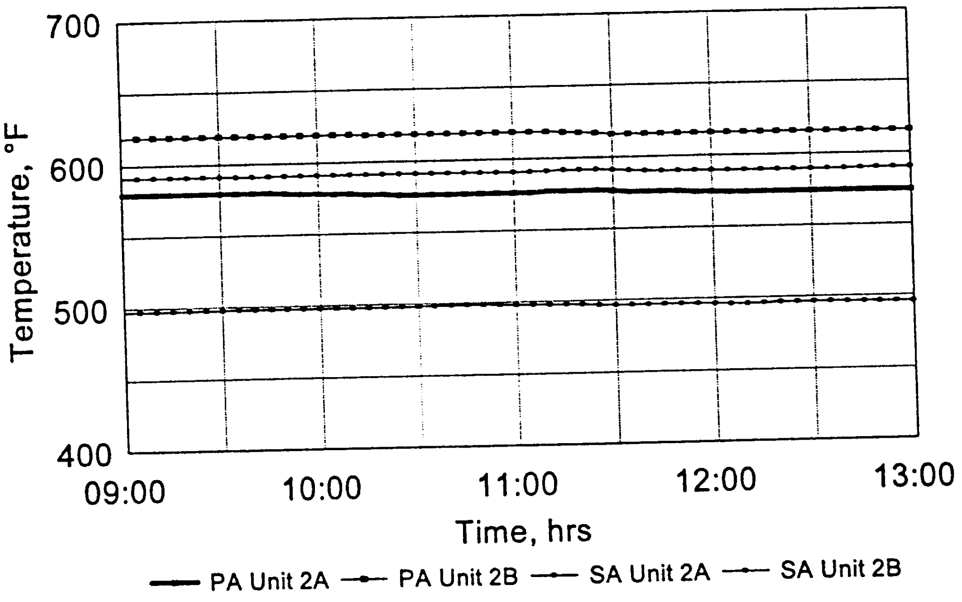


Table 1
Operating Conditions Summary
Computer Logged Data (5 min. Values)

Unit	2A			2B	
Date			10/7/96		
Test Period			13:10-19:30 hrs		
	Avg	Std. Dev		Avg	Std Dev
Coal Rate, tons/hr	**56.4**	**0.15**		56.4	0.15
O_2 at Economizer, Vol %	**3.31**	**0.11**		3.31	0.11
Total Pri Air Flow, Mlb/hr	**108.7**	**0.83**		109.6	0.45
Total Sec Air Flow, Mlb/hr	**533.1**	**2.96**		562.0	3.99
Flue Gas Inlet Temp, °F	**660.0**	**1.03**		657.3	0.80
Flue Gas Out Temp, °F	**333.3**	**0.81**		300.8	0.62
Pri Air Inlet Temp, °F	**119.8**	**1.50**		121.4	1.31
Sec Air Inlet Temp, °F	**102.2**	**1.47**		103.7	1.29
Pri Air Outlet Temp, °F	**601.2**	**1.43**		626.4	0.53
Sec Air Outlet Temp, °F	**598.2**	**0.70**		506.6	0.61
Date			10/8/96		
Test Period			09:00-12:40 hrs		
	Avg	Std. Dev		Avg	Std Dev
Coal Rate, tons/hr	57.0	0.27		**57.0**	**0.27**
O_2 at Economizer, Vol %	3.31	0.11		**3.31**	**0.11**
Total Pri Air Flow, Mlb/hr	106.8	0.42		**107.3**	**0.45**
Total Sec Air Flow, Mlb/hr	519.0	5.06		**544.8**	**4.61**
Flue Gas Inlet Temp, °F	655.8	1.48		**654.0**	**1.66**
Flue Gas Out Temp, °F	322.1	1.03		**335.5**	**1.43**
Pri Air Inlet Temp, °F	108.9	2.17		**110.3**	**2.04**
Sec Air Inlet Temp, °F	89.6	1.90		**91.2**	**2.17**
Pri Air Outlet Temp, °F	577.2	1.71		**617.7**	**1.39**
Sec Air Outlet Temp, °F	591.2	0.49		**497.4**	**0.81**

*** Bold numbers indicate heat pipe tested

Fouled Condition Thermal Performance

Summarized heat balances around each heat pipe are presented in Table 2. Although both heat pipes were fouled, the fouling affected the performance of the 2B heat pipe the most. The heat transfer in the 2B heat pipe was more than 10 MM Btu/hr less than that in the 2A unit (i.e., 57.3 MM Btu/hr versus 67.7 MM Btu/hr). Based on the clean condition performances obtained on May 14 and 15, the combined loss of heat transfer for the two heat pipes was about 14.1% (8.0% for 2A and 20.3% for 2B).[3] Most of the performance decline was associated with the operation of the secondary flue gas cooling sections.

To place all measured performances on a common basis, the totally corrected flue gas outlet temperatures were calculated as recommended by the Performance Test Code for air heaters (PTC 4.3). The detailed calculations were done according to procedures presented in the CONSOL uncertainty analysis[4] and are presented in Appendix F. The results of these calculations are summarized in Table 3.

Table 2
Performance Summary – Heat Balances and Duties

Unit	**2A**	**2B**
Date	10/7/96	10/8/96
Boiler Load, MW net	142.4	142.2
Inputs		
Flue Gas Rate In, lb/hr	744,900	674,100
Temperature In, °F	667	655
Temperature Out With Air Leak, °F	321	331
Cp, Btu/lb-°F	0.2628	0.2623
Overall Duty, MM Btu/hr	**67.73**	**57.29**
Outputs		
Primary Air Rate, lb/hr	56,430	59,310
Temperature In, °F	120	112
Temperature Out, °F	600	614
Cp, Btu/lb-°F	0.2482	0.2483
Duty, MM Btu/hr	6.72	7.39
Secondary Air Rate, lb/hr	498,200	500,900
Temperature In, °F	102	93
Temperature Out, °F	588	490
Cp, Btu/lb-°F	0.2478	0.2463
Duty, MM Btu/hr	60.00	48.98
Air Leak Rate, lb/hr	14,900	15,400
Temperature In, °F	97	87
Temperature Out, °F	321	331
Cp, Btu/lb-°F	0.2439	0.2439
Duty, MM Btu/hr	0.81	0.92
Downstream Air Leak Rate, lb/hr (1)	4,800	0
Temperature In, °F	148	---
Temperature Out, °F	321	---
Cp, Btu/lb-°F	0.2446	---
Duty, MM Btu/hr	0.20	0.00
Overall Duty, MM Btu/hr	**67.73**	**57.29**
Flue Gas Side Duties		
Primary Flue Gas Rate In, lb/hr	85,300	111,790
Temperature In, °F	667	655
Temperature Out No Leak, °F	368	404
Cp, Btu/lb-°F	0.2637	0.2637
Duty, MM Btu/hr	6.72	7.39
Secondary Flue Gas Rate In, lb/hr	659,600	562,300
Temperature In, °F	667	655
Temperature Out No Leak, °F	321	323
Cp, Btu/lb-°F	0.2628	0.2621
Duty, MM Btu/hr	60.00	48.98
Net Energy Recovery, % of Fuel	**4.65**	**4.02**

(1) Infrasonic Cleaner Air Flow

Table 4
Temperature Measurement Comparisons
Computer Logged Values with Manually Measurements

	2A Heat Pipe 5/15/96				2B Heat Pipe 5/15/96			
	Time	Computer °F	Manual °F	Diff (1) °F	Time	Computer °F	Manual °F	Diff (1) °F
Flue Gas In	16:05-17:00	677	677	0	12:00-12:50	669	671	2
Flue Gas Out	16:05-17:00	304	302	-2	12:00-12:40	279 (2)	279	0
Primary Air Out	14:50-15:00	603	605	2	14:00-14:25	590	590	0
Secondary Air Out	16:09-16:43	624 (2)	619	-5	12:00-13:02	612	612	0
	2A Heat Pipe 10/7/96				2B Heat Pipe 10/8/96			
Flue Gas In	13:14-14:17	661	667	6	09:08-09:46	654	655	1
Flue Gas Out	13:10-14:10	332	321	-11	09:00-10:00	334 (2)	331	-3
Primary Air Out	18:46-19:28	603	600	-3	10:32-11:20	619	614	-5
Secondary Air Out	17:00-17:45	598 (2)	588	-10	12:05-12:40	496	490	-6

No. of Pts In Averages	Traverse	TC Array
Flue Gas In	20	10
Flue Gas Out	24	6
Primary Air Out	20	2
Secondary Air Out	24	6

(1) Manual Minus Computer Value.
(2) One TC in Array Malfunctioning – Not Included in Average.

Immediately after completing the May heat pipe performance tests, module-to-module flue gas side differential pressures were measured for the bottom three modules of each heat pipe. The same measurements were again obtained during the fouled condition tests on October 8, and with the heat pipes in a clean condition on October 22. To reduce measurement error, differential pressure drops were measured rather that static pressures. High accuracy electronic manometers were used for the measurements. Each data point is an average of 10 or more signal samplings. The as-measured data are presented in Appendix G.

Table 5 presents a comparison of the results corrected to a common basis of 160 MW gross, and flue gas inlet/outlet temperatures of 680°F and 253°F, respectively. The results indicate a high amount of fouling in the bottom cold-end modules of both heat pipes. For the 2A heat pipe, the pressure drop over the bottom tube bank increased 189% above the average clean condition value, and in the 2B heat pipe the bottom module pressure drop increased 469% above the clean condition value. However, pressure drops across the tube modules above the bottom module remained essentially constant in the 2A heat pipe; indicating no fouling. The slight rise in the 2B heat pipe pressure drop for the tube module just above the bottom module indicates that fouling was beginning to carry up into the heat pipe because of the poor performance of the bottom module.

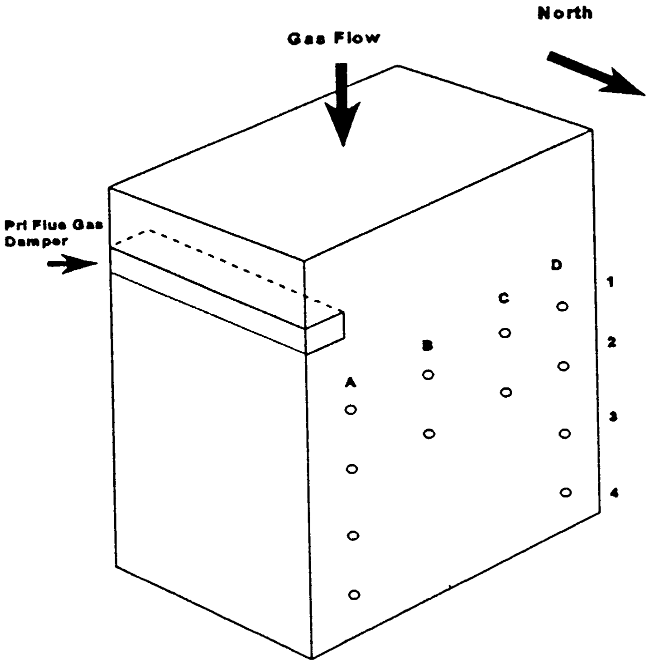


Figure 4

Flue Gas Side DP Taps -- 2A Heat Pipe
(2B Unit is Mirror Image)

The data also show that pressure drops for the two clean condition cases are essentially identical for the 2A heat pipe. This indicates similar levels of cleanliness. For the 2B unit, the slightly lower clean condition pressure drops obtained on October 22 versus the May 15 results may indicate a small improvement in overall cleanliness for the last heat pipe washing.

Cold-end fouling of power plant air heaters historically is caused by sulfuric acid condensation on metal surfaces which are below the acid dew point. Fly ash then forms a poultices with the acid which plugs gas passages. An analysis of deposits taken from the 2A heat pipe during the October 13 inspection indicates this is the cause. The deposits were high in sulfur (14.42 wt. %) and slightly enriched in alkali components and phosphorus (i.e., Na, K, Mg, and P) but otherwise had an elemental analysis similar to that expected for the bituminous coal burned (see Table A-2).

Heat Pipe Inspections

After the Unit 2 boiler was taken off line and the system cooled down, the flue gas sections of both heat pipes were inspected on October 13, 1996. Deposits were noted only in the bottom, cold-end modules

Table 5

Heat Pipe Module-To-Module Pressure Drops (Corrected to Common Basis)

Condition		Fouled	Clean	Clean	
Taps		East/West	East/West	East/West	DP Increase
Date		10/8/96	5/15/96	10/22/96	% Above Clean
Time		17:45-18:23	10:45-11:30	12:10-12:50	Condition
2A Heat Pipe	Levels	Avg Pressure Drops, in. WC			
Top	1-2	1.06	1.06	1.10	-2%
	2-3	0.88	0.89	0.90	-1%
Bottom	3-4	2.50	0.91	0.82	188%
	Total	4.42	2.86	2.83	
2B Heat Pipe	Levels				
Top	1-2	1.27	1.29	1.16	4%
	2-3	1.36	1.07	1.00	32%
Bottom	3-4	5.48	1.08	0.85	469%
	Total	8.10	3.44	3.01	

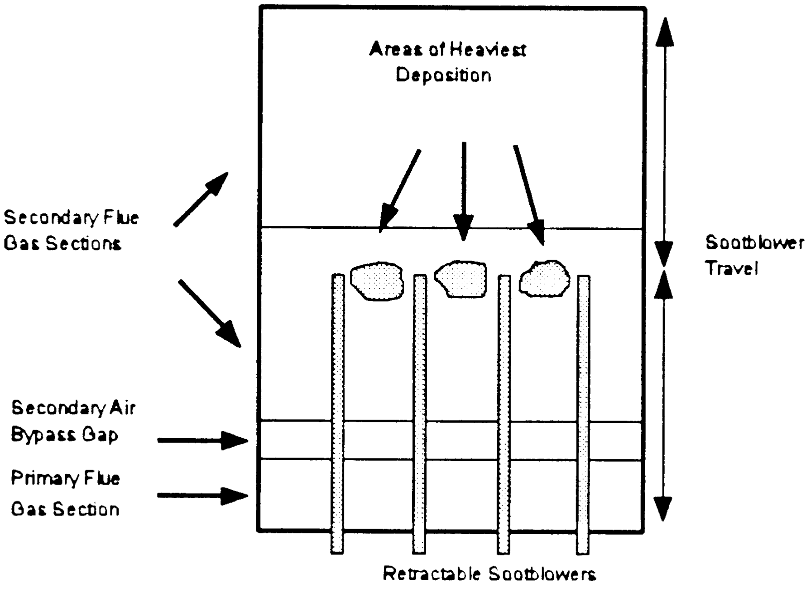
Basis: 160 MW gross load, 680 °F Flue Gas Inlet, 253 °F Flue Gas Outlet.

of the heat pipes. Except for a few areas in the 2A heat pipe, the top row tubes in the bottom modules of both heat pipes appeared to be relatively clean. As shown in Figure 5, these deposits were highly localized in relatively small areas between sootblowers. The deposits were on the leading edges of the tubes and fins as shown in Figure 6. In most other areas, the tubes appeared to be essentially deposit free as shown in Figure 7. The few top side deposits seem to be associated with the operation of the high pressure air sootblowers. The deposits may form due to tube cooling when the sootblowers begin operating; or there may be a small amount of condensate in the initial air surge which momentarily wets the tube surfaces when the sootblowers are activated. Because these deposits cover a very small area, they are not a major concern and are not responsible for the high pressure drops across the bottom cold-end modules.

The high module pressure drops are mainly due to deposit formation deeper in the cold-end modules. As the flue gases pass through these modules, the gases contact progressively colder tubes. At some point, sulfuric acid condenses out of the flue gases on to the cold tube surfaces; fly ash begins to stick to the surfaces, and deposits are formed. Figure 8 is a bottom side photograph of the cold-end tubes in the 2A heat pipe (i.e., flue gas outlet end of the bottom heat pipe module). The tubes in the 2B heat pipe

Figure 5

2A Heat Pipe Bottom Module Deposits -- Plan View Flue Gas Sections



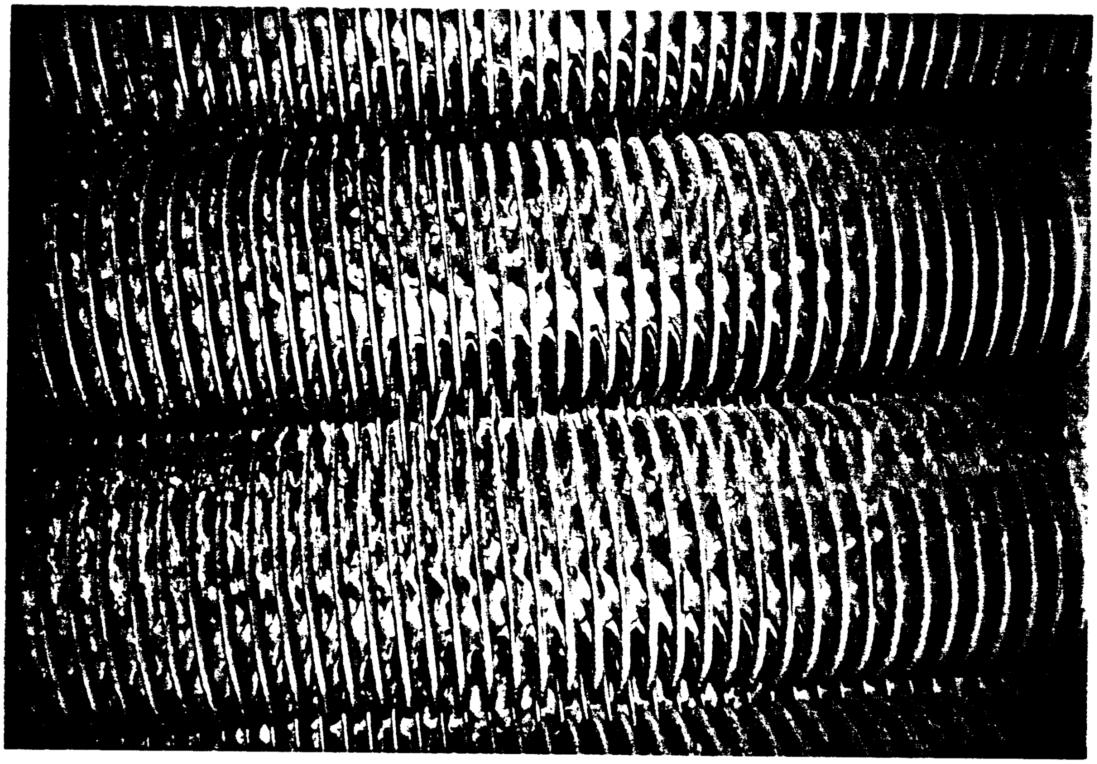


Figure 6. Localized Deposits On Inlet Tubes Of The Bottom Tube Module In The 2A Heat Pipe.

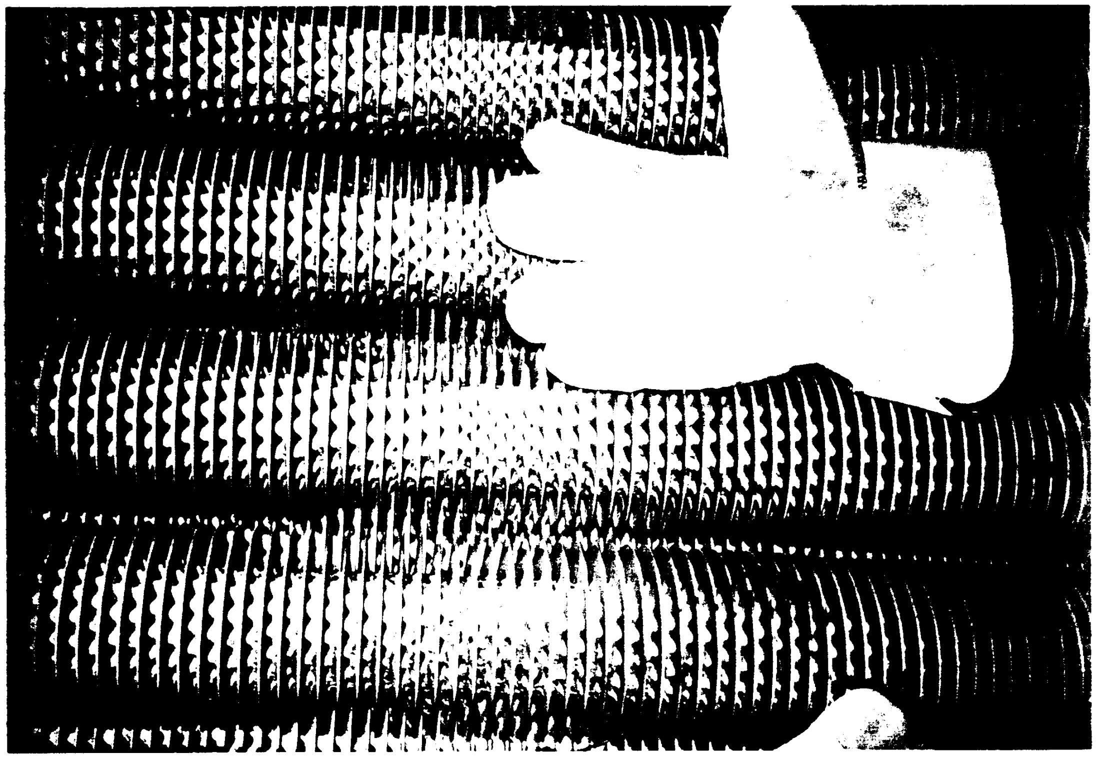


Figure 7. Relatively Clean Inlet Tubes Of The Bottom Tube Module In The 2A Heat Pipe.

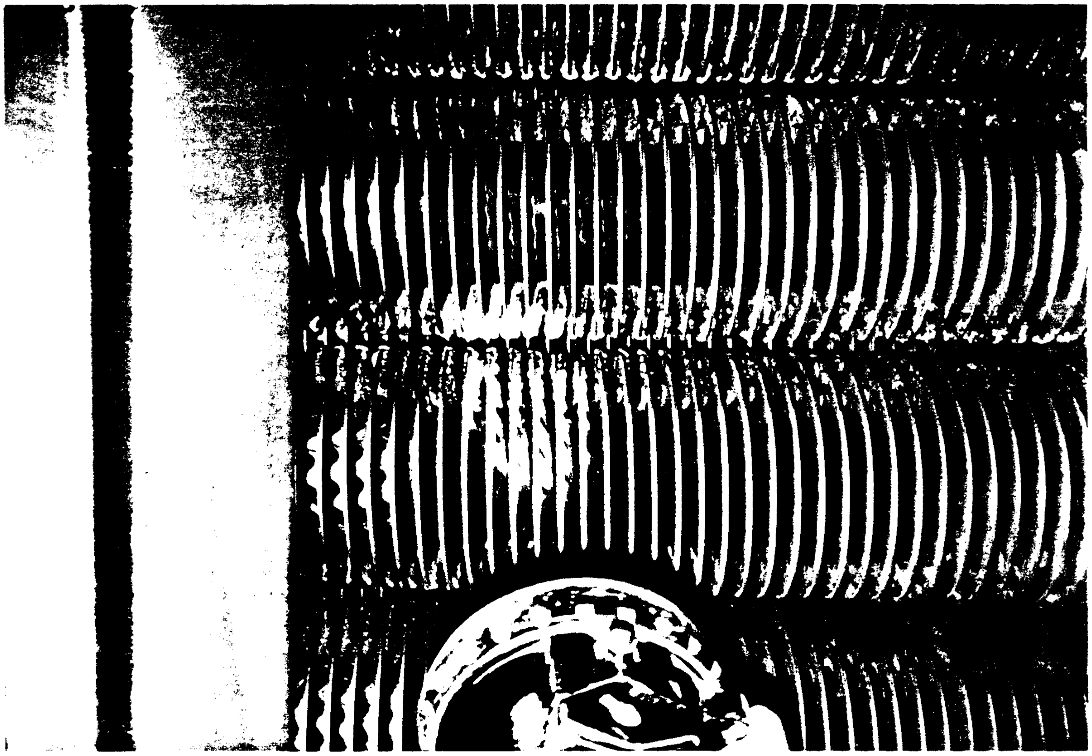


Figure 8. Outlet View Of Cold-End Module Showing Tube And Fin Deposits -- 2A Heat Pipe.

were in a similar condition. A large amount of deposit material can be seen between the tube fins. These deposits appeared to be more or less uniformly distributed in both heat pipes across the bottom side of the bottom tube module in the secondary flue gas sections.

Although the cold-end deposits were hard, they were effectively removed by a combination of deluge water washing using the nozzle equipped water spray headers inside the heat pipes and hand water lancing using 1/4" tubing lances attached to fire hoses. Plant operators reported that cleaning was facilitated when the infrasonic cleaner was operated during deluge washing.

On October 17, 1996, both heat pipes were inspected by representatives of NYSEG, ABB API, and CONSOL R&D. Both units were clean except for one small area (9" x 3') in the bottom module of the 2B heat pipe. This area was manually washed and found to be clean upon reinspection. The condition of the 2A heat pipe bottom module is shown in Figure 9. The photo shows that the tubes are free of deposits. Light from below can clearly be seen shining through this 8 row deep tube bank. The rust-colored surface is not a concern for these Cor-Ten A tubes and fins. The surface rusting was expected and is due to the water washing operations.

Following the inspections, all parties agreed that the heat pipes were clean and in an acceptable condition for performance testing. Performance tests were subsequently conducted in early November.

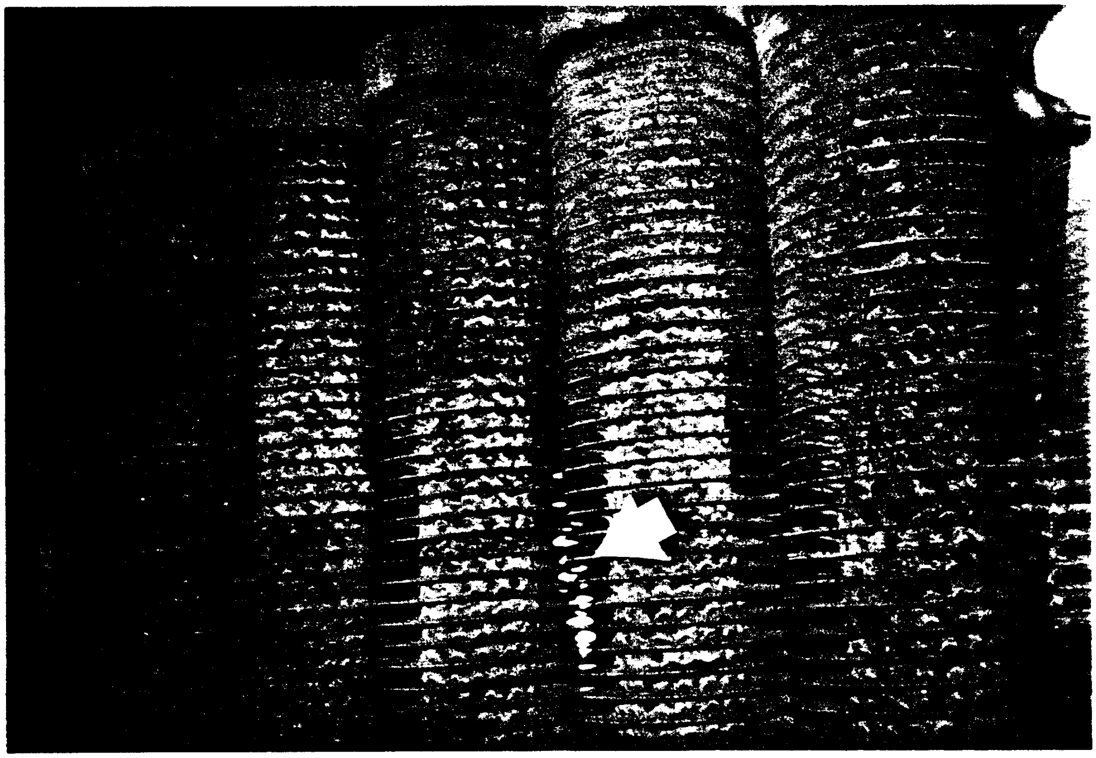


Figure 9. Top View Of Cleaned 2A Heat Pipe Bottom Module Showing Light Through Tubes.

Heat Pipe Checkout Prior to Clean Condition Performance Test

To insure that the heat pipes were operating properly prior to conducting a clean condition full-scale performance test, a pre-test system checkout was made on October 22, 1996. The temperature traverses were manually obtained for the secondary air and flue gas outlet ducts from both heat pipes and module-to-module pressure drops were measured. The data were then compared to similar data taken on May 15 and October 7 and 8. The pressure drop results have been previously discussed in the section on flue gas pressure drops. The temperature traverse data are presented in Figures 10 and 11 for the secondary air outlets and flue gas outlets, respectively.

Figure 10 shows that for the May 15 clean condition tests, the secondary air outlet temperature profiles for the heat pipes are essentially flat mirror images with small top-to-bottom duct temperature differences. The maximum-to-minimum temperature differences for the traverses were 26°F for the 2A heat pipe and 30°F for the 2B heat pipe. The fouled condition results obtained on October 7 and 8 show a significant divergence in the temperature profiles with temperature differences of 71°F for the 2A heat pipe and 315°F for the 2B heat pipe. The after washing, secondary air outlet temperatures obtained on October 22 were again mirror images with maximum-to-minimum temperature spreads approaching those for May 15. This indicates that the water washing was effective in removing the cold-end deposits and that the heat pipes were operating in the same fashion as in May.

The average secondary air outlet temperatures obtained on October 22 were somewhat lower than those for May 15. This does not necessarily mean that the heat pipes are operating less efficiently since the flue gas outlet temperatures (shown in Figure 10) were also lower. The lower average temperatures are most likely due to differences in operating conditions such as flue gas and air inlet temperatures and flow rates. To properly check the thermal performance, sufficient information must be obtained to calculate the totally corrected flue gas outlet temperatures. Testing to do this was scheduled for early November.

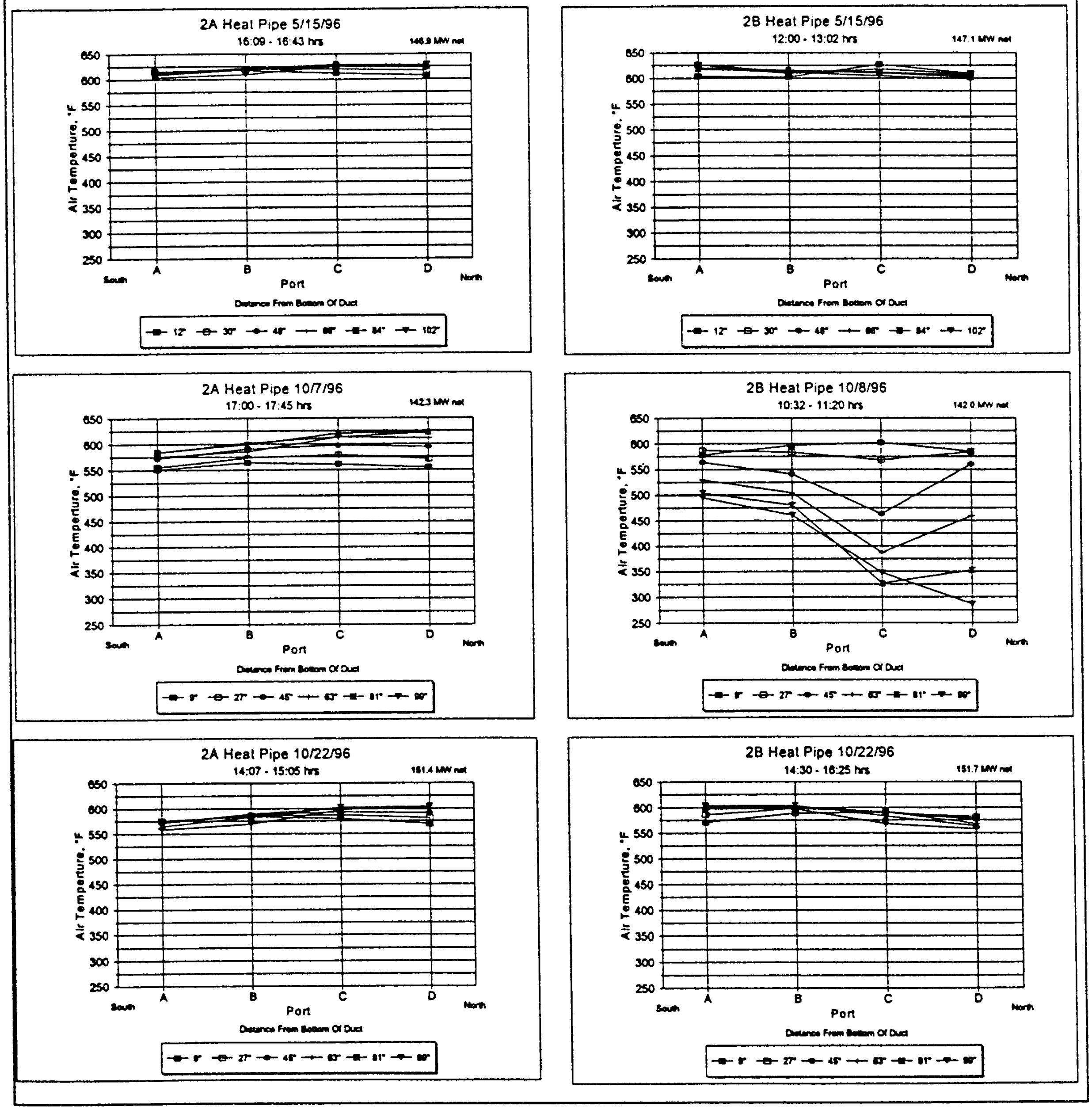
The outlet flue gas temperature profiles shown in Figure 11 tell much the same story as the secondary air outlet temperature profiles. The skewed profiles for October 7 and 8 indicate fouling and poor distribution of flue gas flow within the heat pipes. The May and October clean condition profiles are essentially flat for both heat pipes. This indicates that the October water washing was very effective in cleaning the air heaters and allowed reestablishment of uniform flue gas flows within the heat pipes.

Data Handling

The data collection and reduction was done in much the same fashion as reported for the May heat pipe performance tests.[3] However, since the heat pipes were fouled and not operating near design conditions, achieving extreme measurement accuracy was not considered to be as critical as for the clean condition performance tests. In the interest of reducing costs and simplifying data collection, some procedural adjustments were made. These changes are addressed in this section.

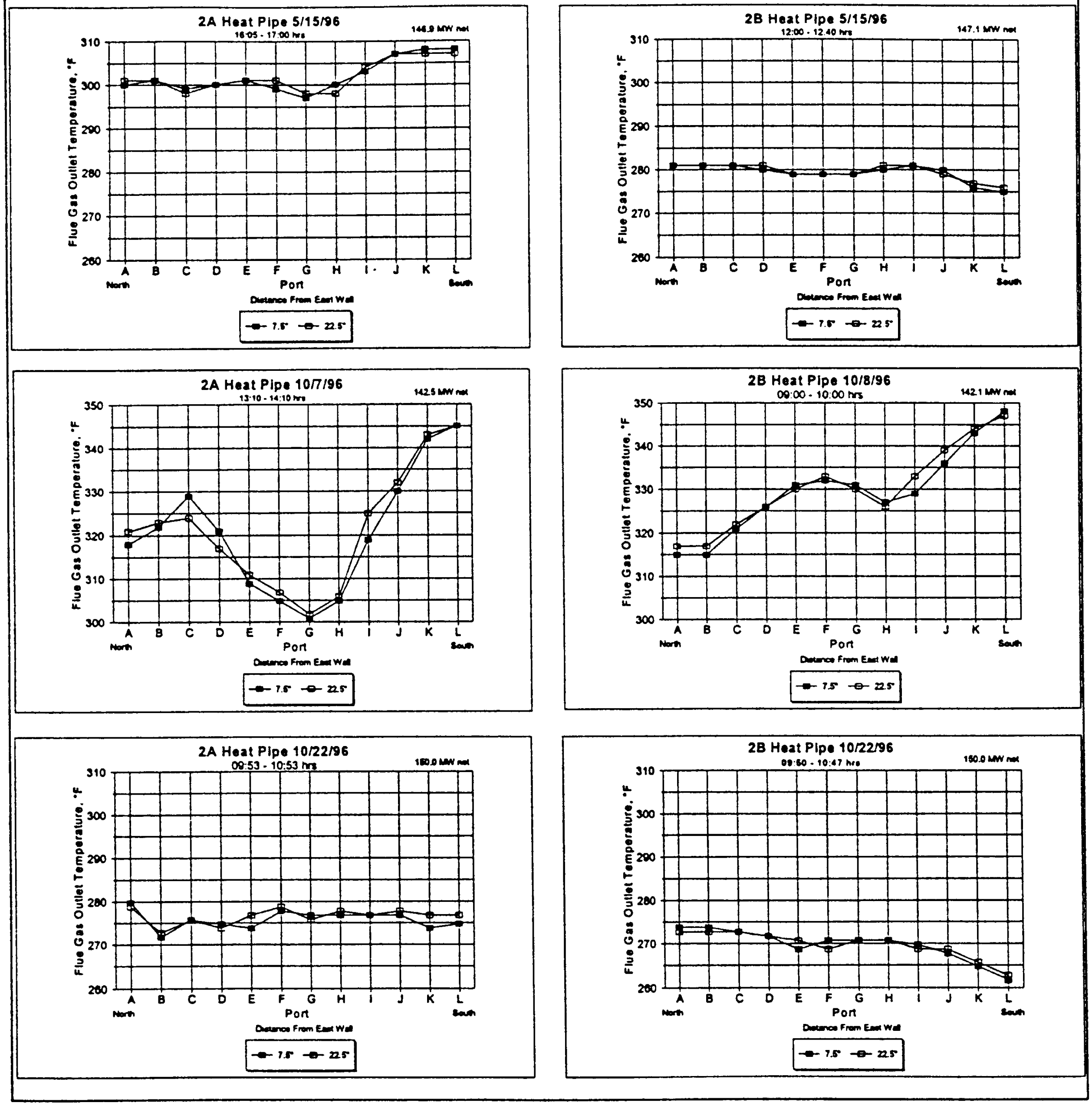
A. Test Crew Staffing. The major change in the testing was the use of a minimum crew of 4 people rather than typically 9 people to obtain the data. This greatly reduced data collection costs since duplicate testing was not done. However this also meant that only one heat pipe per day could be tested. To reduce the effect of operating condition changes on measured heat pipe performance, operators were instructed to establish the same boiler and air heater operating conditions on both test days. This was done to a great extent as illustrated by the Table 1 results. For the small changes in inlet operating

Figure 10
Heat Pipe Secondary Air Outlet Temperatures



1202

Figure 11
Heat Pipe Flue Gas Outlet Temperatures



1203

conditions shown, the heat pipe performance or thermal effectiveness will remain essentially constant and not have a major effect on the calculated thermal performance.

B. Coal Sampling. For clean condition performance testing, typically 15 to 20 coal samples are taken during a test period to obtain a composite sample. This was not done for the fouled condition testing; rather a single coal sample was taken during each test period by the NYSEG operators. The sample analyses are presented in appendix Table A-1, along with the fly ash analyses.

C. Temperature Measurements. All manual temperature traverses were obtained using the same calibrated thermocouples and temperature readout devices that were used for the May 1996 performance tests. The readings were all corrected based on calibrations as described in the previous performance report.[3] The only difference between the way the temperatures were obtained for the May and October tests was the use of the plant computer logged FD fan outlet temperatures for the secondary air temperatures to the heat pipes. During the May testing, the FD fan outlet temperatures were obtained from special calibrated thermocouples which were recorded with a local data logger. This data logger was removed following the May tests and was not reinstalled for the fouled condition tests. During the May tests, the plant computer logged FD fan outlet temperatures were typically within 1-2°F of the corrected values for the local data logger for the 2A heat pipe. Because of an instrumentation problem, this difference was much larger (10-12°F) for the 2B unit. Following the May testing, the plant instrumentation problem was corrected; so the use of plant data logger values was acceptable for the fouled condition testing.

D. Pitot Tube Calibrations. The same pitot tubes used during the May tests were again used for the fouled condition tests. The post test flow factors reported for the May testing were used for the October tests. The individual pitot tube calibration data can be found in Appendix C of the May test report.[3]

E. Gas Composition Determinations. For clean condition performance tests, the gas analyzers used for flue gas oxygen and CO measurement were calibrated on air and a low oxygen (3.57% O_2, 100 ppm CO) calibration gas. Orsat analyses were used as another check of the flue gas analyses and to construct a fuel line plot for estimating CO_2 levels from the measured O_2 and CO. For the fouled condition tests, the oxygen analyzers were calibrated on air only. This was considered acceptable since analyzer adjustment for low oxygen levels had not been necessary once the analyzers were calibrated on air. Additionally, the CO levels from the Milliken boilers are not high enough to have a noticeable impact on the flue gas mole weight, CO_2 level, or flue gas flow rate. Because the Orsat analyses were time-consuming, these also were not done. Rather, flue gas CO_2 levels were calculated from the flue gas O_2 and CO concentrations and the coal and fly ash analyses. A fuel line plot based on these calculations is presented Appendix B. The plot was used to estimate the CO_2 levels for the flue gas pitot traverses.

During the fouled condition performance testing, one problem arose with the 2A heat pipe flue gas inlet gas composition measurement. On the first day of testing, after the flue gas inlet and outlet duct traverses were completed, the inlet gas sampling train was found to have developed a small leak. The inlet O_2 was slightly higher than the measured outlet O_2; an impossible condition.

Rather than redo the flue gas inlet and outlet measurements, the decision was made to assume that the outlet flue gas composition was correct and to estimate the average inlet flue gas composition from the outlet composition and an assumed leak rate. This was justified based on the following considerations.

For guarantee performance calculations inlet flue gas compositions are used for three things: (1) determining air leakages, (2) calculating weighted average temperatures, and (3) determining the flue gas carbon split between heat pipes. Since measurement of air leakage was not a concern for the fouled condition tests, accurate measurement of the inlet O_2 was not essential. For the Milliken heat pipes, it has been found that the simple average and weighted average flue gas inlet and outlet temperatures are essentially the same. Normally, the difference between the simple and weighted average temperatures is between 0-2°F. So a slight error in the inlet oxygen levels has no significant affect on the weighted average temperature or the thermal performance calculations. An error in the inlet flue gas oxygen levels will have an effect on the calculated carbon split between the heat pipes. To overcome this problem, the outlet rather than the inlet flue gas compositions were used.

F. Temperature and Velocity Traverse Data. The field temperature and velocity data are presented in Appendix C with the calculated results in Appendix D. The calculated results are mainly used for determining weighted average temperatures which are then used in the thermal performance calculations.

G. Pressure Drop Data. Module-to-module pressure drops were measured during the fouled condition tests on October 8 and again on October 22 after the heat pipes had been washed and the unit placed back in service. All measurements were obtained with the same high accuracy electronic manometers which were also used for the pitot traverse measurements. The field data are presented in Appendix Table E-1. The data corrected to a common basis are provided in Table E-2.

REFERENCES

1. McCoy, D. C., “Heat Pipe Performance Evaluation And Acceptance Testing” CONSOL Report to NYSEG, New York State Electric & Gas Corporation, Binghamton, New York, April 1996.

2. McCoy, D. C. “Heat Pipe Performance Test Results—Interim Report No. 2,” CONSOL Report to NYSEG, New York State Electric & Gas Corporation, Binghamton, New York, February 1997.

3. McCoy, D. C., “Heat Pipe Performance Test Results—Interim Report, “CONSOL Report to NYSEG, New York State Electric & Gas Corporation, Binghamton, New York, September 1996.

4. Maskew, J. T., "Milliken Station Heat Pipe Air Heater Performance Uncertainty Analysis of ‘Totally Corrected Gas Temperature Leaving The Air Heater,’" CONSOL Report to NYSEG, New York State Electric & Gas Corporation, Binghamton, New York, April 1996.

1205

APPENDIX A

SOLIDS ANALYSES

Table A-1
Coal and Fly Ash Analyses

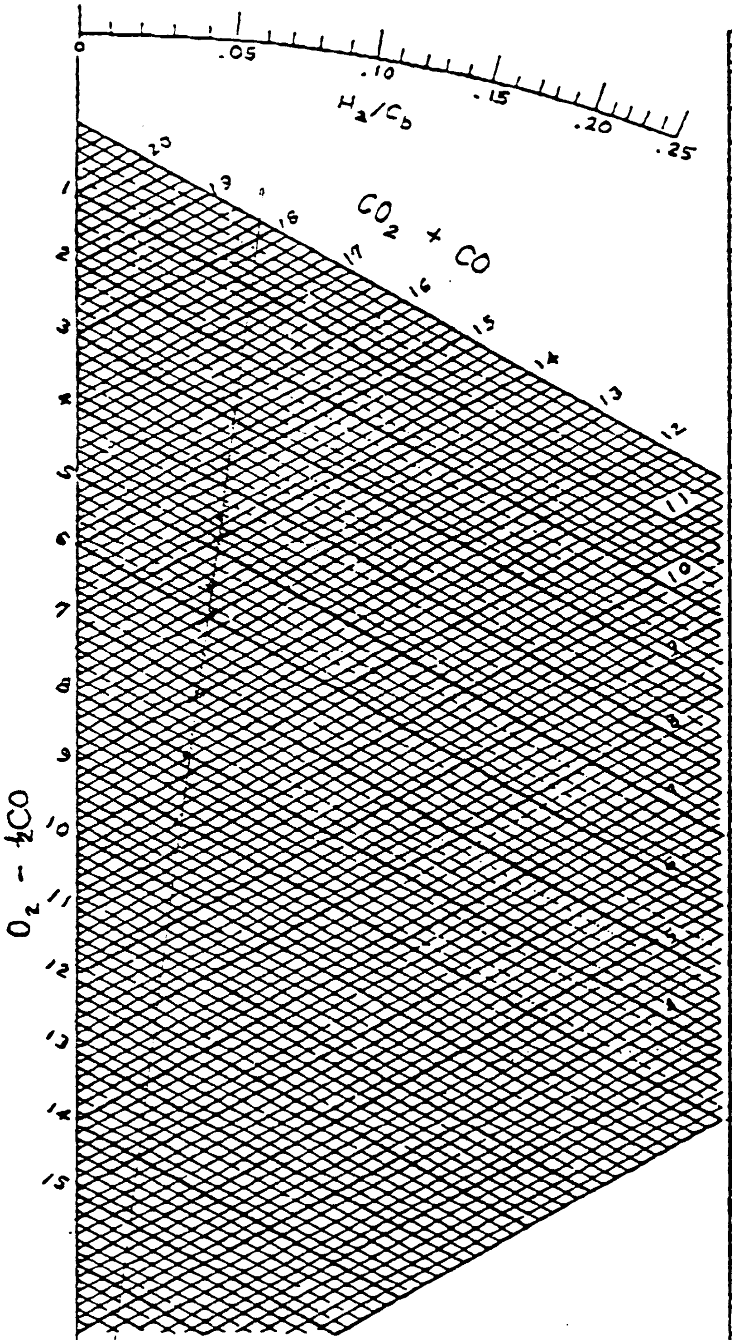
	Coal Analysis		Fly Ash Analysis	
Date	10/7/96	10/8/96	10/7/96	10/8/96
As Received Moisture, wt %	5.11	6.49	0.06	0.07
ULTIMATE (Dry)				
Carbon	74.69	73.14	2.25	1.61
Hydrogen	4.96	4.84	<0.01	0.01
Nitrogen	1.44	1.40	<0.01	<0.01
Sulfur	2.20	2.57	0.32	0.39
Oxygen (by diff)	4.81	4.93	1.06	0.96
Ash	11.90	13.12	96.37	97.03
Total	100.00	100.00	100.00	100.00
Higher Heating Value				
Dry, Btu/lb	13,358	13,117		
Moist/Ash Free, Btu/lb	15,162	15,098		

Table A-2
Coal and Fly Ash Analyses

	Coal Analysis		Fly Ash Analysis	
Date	11/7/96	11/8/96	11/7/96	11/8/96
As Received Moisture, wt %	5.90	7.58	0.01	0.09
PROXIMATE, wt % (Dry)				
Volatile Matter	37.85	38.20		
Fixed Carbon	51.25	50.62		
Ash	10.90	11.18		
Total	100.00	100.00		
ULTIMATE (Dry)				
Carbon	74.95	75.02	1.37	3.19
Hydrogen	5.14	5.07	0.01	0.02
Nitrogen	1.47	1.45	<0.01	<0.01
Sulfur	3.08	3.04	0.53	0.68
Oxygen (by diff)	4.46	4.24	-0.12	0.24
Ash	10.90	11.18	98.21	95.87
Total	100.00	100.00	100.00	100.00
Higher Heating Value				
Dry, Btu/lb	13,412	13,315		
Moist/Ash Free, Btu/lb	15,053	14,991		

APPENDIX B

FUEL LINE PLOT



$\Sigma\sqrt{VP}$ = ________

$\Sigma\sqrt{VP} \times CO_2$ = ________

WTD. CO_2 = ________

ST. CO_2 = ________

PIVOT POINT

LOG	$\sqrt{VP}$	CO_2	$+O_2$	O_2	LOG	$\sqrt{VP}$	CO_2	$+O_2$	O_2

SUBJECT [illegible]	FILE NO.
	BY
	DATE
	TEST NO.

1210

APPENDIX C

FIELD DATA -- PITOT TRAVERSE DATA SHEETS

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Flue Gas Inlet - (Rectangular Duct)

1211

Location [✓ A] or B Duct
Date 10/7/96
Time Begin 1314 End 14:17
Bar., " Hg 29.4
Static, " H2O -9.83

Tube I.D. S-5-3
C-Factor
Operator(s) WLM, DW
No. Points 20
Duct Width 14.5 ft
Duct Height 5.5 ft
Duct Area 79.75 Sq ft
Amb Air DB, deg F 66
Amb Air WB, deg F 54
Humd, lb/lb BD Air .0064

1,094

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	8-1/4"	0.7436	690	4.2		0	0.1
A-2	24-3/4"	0.8953	692	4.4		22.0	0.1
A-3	41-1/4"	0.7664	687	4.4		84	0.1
A-4	57-3/4"	0.4998	679	4.6		135	0.1
B-1	8-1/4"	0.7742	655	4.0		157	0.1
B-2	24-3/4"	1.099	659	4.0		178	0.1
B-3	41-1/4"	0.9715	667	4.2		210	0.1
B-4	57-3/4"	0.9597	671	4.4		100	0.4
C-1	8-1/4"	0.7852	651	4.1		130	0.1
C-2	24-3/4"	1.061	646	4.2		150	0.1
C-3	41-1/4"	0.9945	643	4.2		161	0.1
C-4	57-3/4"	1.035	647	4.4		169	0.1
D-1	8-1/4"	0.8174	675	4.3		199	0.1
D-2	24-3/4"	1.087	665	4.2		214	0.1
D-3	41-1/4"	1.022	653	4.4		220	0.1
D-4	57-3/4"	1.009	653	4.6		211	0.1
E-1	8-1/4"	0.7317	692	4.8		225	0.1
E-2	24-3/4"	0.9356	678	4.6		253	0.1
E-3	41-1/4"	0.8572	660	4.4		257	0.1
E-4	57-3/4"	0.9537	654	4.2		262	0.2

Port A = South, E = North

Sampling Notes:

Method 2 QA/QC Checklist

Plant:
Date: 10/7/96
Start Time: Stop Time:
Unit ID: Duct ID:
Testers:

Pitot ID Cp Calibration Date

Pitot Opening Checked? ✓ By Whom? DLW Condition? GOOD

Leak Check of System? ✓ By Whom? WLM/DLW Condition? ✓

Dp Gauge ID 120676 Static Pressure Gauge ID

TC ID 2-B Handheld TC Readout ID #1

Barometer ID

Leak Check of Gas Sampling System? ✓ By Whom? Condition? ✓

Gas Meter ID 118844 ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

1213

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Flue Gas Outlet - (Rectangular Duct)

[redacted] [redacted] [redacted] [redacted]

Location Milliken Heat Pipe [✓ A] or B Duct
Date 10/7/96
Time Begin ~~1235~~ 1310 End 1410
Tube I.D. S51
C-Factor
Operator(s) GLC DRS
No. Points 24
Duct Width 34 ft
Duct Height 2.5 ft
Duct Area 85.00 Sq ft
Bar., " Hg 29.9" Hg
Static, " H2O ~~[illegible]~~ -16"
Amb Air DB, deg F 100
Amb Air WB, deg F
Humd, lb/lb BD Air
OUTSIDE 66 54 0.0062
T/C #6C

PORT/ POINT	DISTANCE " From Wall Back	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	7-1/2"	317	.9842	3.5		249	.3
A-2	22-1/2"	320	.6407	3.4		227	.3
B-1	7-1/2"	321	.8431	3.4		218	.3
B-2	22-1/2"	322	.5542	3.4		230	.3
C-1	7-1/2"	328	1.164	3.5		211	.3
C-2	22-1/2"	323	.7581	3.6		219	.3
D-1	7-1/2"	320	.9653	3.6		187	.3
D-2	22-1/2"	316	.5781	3.7		196	.3
E-1	7-1/2"	308	.7954	3.8		164	.3
E-2	22-1/2"	310	.5108	3.9		172	.3
F-1	7-1/2"	304	.7242	3.7		164	.3
F-2	22-1/2"	306	.4012	3.7		172	.3
G-1	7-1/2"	300	.4646	3.7		143	.3
G-2	22-1/2"	301	.2282	3.8		152	.3
H-1	7-1/2"	304	.4921	3.6		125	.3
H-2	22-1/2"	305	.3476	3.6		135	.3
I-1	7-1/2"	318	.5394	3.6		98	.3
I-2	22-1/2"	324	.4629	3.5		108	.3
J-1	7-1/2"	329	.6779	3.5		78	.3
J-2	22-1/2"	331	.5012	3.6		85	.3
K-1	7-1/2"	341	.8341	3.5		58	.3%
K-2	22-1/2"	342	.4328 .6995	3.5 3.3		60	.2
L-1	7-1/2"	345	~~.7770~~	[illegible]	—	34	.2%
L-2	22-1/2"	344	0.4140	[illegible]35		43	.2%

Port A = South, L = North

Sampling Notes:

1214

Method 2 QA/QC Checklist

Plant:
Date:
Start Time: Stop Time:
Unit ID: Duct ID:
Testers:

Pitot ID Cp Calibration Date

Pitot Opening Checked? By Whom? Condition?

Leak Check of System? By Whom? Condition?

Dp Gauge ID 157512 Static Pressure Gauge ID

TC ID 6C Handheld TC Readout ID

Barometer ID

Leak Check of Gas Sampling System? By Whom? Condition?

Gas Meter ID ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified?
Pitot orientation properly marked?
Reference point for pitot depth marked?
Pitot leak check?
Gas sampling system leak check?
Gas Meter Calibrated?
Safety equipment utilized?
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port?
Proper probe orientation while traversing?
Process at steady state prior to testing?

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Primary Flue Gas Outlet - (Rectangular Duct)

1215

Location	A (A or B Duct)				
Date	10/7/96			Bar., " Hg	29.7
Time Begin	~~1600~~ 1630	End	1735	Static, " H2O	-15"
Tube I.D.	S51	No. Points	14	Amb Air DB, deg F	110
C-Factor	.822	Duct Width	17.92 ft	Amb Air WB, deg F	
Operator(s)	GLC DRS	Duct Height	3.28 ft	Humd, lb/lb BD Air	
		Duct Area	58.79 Sq ft		

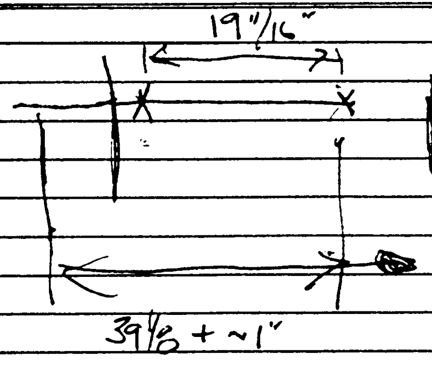
54

0.0262

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	9-7/8"	333	.0781	5.9		62	.1
A-2	~~29-9/16"~~	324	.0437	5.3		82	.1
B-1	9-7/8"	342	.0783	5.3		17	.1
B-2	~~29-9/16"~~	332	.0452	5.3		29	.2
C-1	9-7/8"	327	.0494	5.9		34	.1
C-2	~~29-9/16"~~	324	.0353	5.8		42	.2
D-1	9-7/8"	338	.0445	5.4		37	.1
D-2	~~29-9/16"~~	328	.04[illegible]	5.6		46	.2
E-1	9-7/8"	321	.0235	6.0		49	.2
E-2	~~29-9/16"~~	328	.0438	5.3		59	.2
F-1	9-7/8"	342	-.1099	4.6		43	.2
F-2	~~29-9/16"~~	330	.0133	5.3		45	.2
G-1	9-7/8"	[illegible] 333	[illegible]	[illegible] 5.8		[illegible] 56	[illegible] .2
G-2	~~29-9/16"~~	325	.0041	5.7		55	.2

Port A = South, L = North

Sampling Notes: ,0235



File: PFGOTPL.WQ2

09-May-96

U2"

40

49

9 7/8

39 1/8

49

29 7/8

3

1216

Method 2 QA/QC Checklist

Plant: ____________________
Date: ____________________
Start Time: ________________ Stop Time: ________________
Unit ID: ________________ Duct ID: ________________
Testers: ____

Pitot ID__________ Cp________ Calibration Date______________

Pitot Opening Checked?______ By Whom?_________ Condition?________

Leak Check of System?______ By Whom?_________ Condition?________

Dp Gauge ID 157512 Static Pressure Gauge ID ______________

TC ID 6C Handheld TC Readout ID ______________

Barometer ID __________

Leak Check of Gas Sampling System?______ By Whom?_____ Condition?______

Gas Meter ID______ ORSAT Bag ID ____________________

QA/QC Check List:

Proper sampling points identified? ______________
Pitot orientation properly marked? ______________
Reference point for pitot depth marked? ______________
Pitot leak check? ______________
Gas sampling system leak check? ______________
Gas Meter Calibrated? ______________
Safety equipment utilized? ______________
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ______________
Proper probe orientation while traversing? ______________
Process at steady state prior to testing? ______________

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Primary Air Outlet - (Circular Duct)

1217

Location [✓ A] or B Duct

Date 10/4/96

Time Begin 18:46 End 19:28

Tube I.D. 5-49 No. Points 20

C-Factor .802

Operator(s) GLC/DCW Duct Dia. 47.5 Inches

Duct Area 12.31 Sq ft

Bar., " Hg

Static, " H2O

Amb Air DB, deg F

Amb Air WB, deg F

Humd, lb/lb BD Air

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	1-3/16"	598	.1804
A-2	3-7/8"	597	.2179
A-3	6-15/16"	597	.2397
A-4	10-3/4"	597	.2540
A-5	16-1/4"	598	.2332
A-6	31-1/4"	598	.2051
A-7	36-3/4"	599	.1830
A-8	40-9/16"	599	.1679
A-9	43-5/8"	598	.1437
A-10	46-5/16"	596	.0846
B-1	1-3/16"	598	.1826
B-2	3-7/8"	598	.2172
B-3	6-15/16"	598	.2262
B-4	10-3/4"	597	.2343
B-5	16-1/4"	597	.2332
B-6	31-1/4"	598	.1780
B-7	36-3/4"	597	0.1613
B-8	40-9/16"	597	0.1490
B-9	43-5/8"	596	0.1350
B-10	46-5/16"	591	0.0885

In

51.3" STATIC.

Out

19:05 Hrs

Port A = South or North, B = East

Sampling Notes:

File PAOTPL.WQ2

09-May-96

1218

Method 2 QA/QC Checklist

Plant:
Date:
Start Time: Stop Time:
Unit ID: Duct ID:
Testers:

Pitot ID Cp Calibration Date

Pitot Opening Checked? By Whom? Condition?

Leak Check of System? By Whom? Condition?

Dp Gauge ID 157512 Static Pressure Gauge ID

TC ID 7B Handheld TC Readout ID

Barometer ID

Leak Check of Gas Sampling System? ✓ By Whom? GLC Condition?

Gas Meter ID ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked?
Reference point for pitot depth marked?
Pitot leak check?
Gas sampling system leak check?
Gas Meter Calibrated?
Safety equipment utilized?
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port?
Proper probe orientation while traversing?
Process at steady state prior to testing?

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Secondary Air Bypass - (Rectangular Duct)

1219

Location ______ [✓ A] or B Duct
Date 10/7/94
Time Begin 6:20pm End 6:25

Tube I.D. S-53
C-Factor ______
Operator(s) GC/DCW

No. Points 8
Duct Width 17.5 ft
Duct Height 2.09 ft
Duct Area 36.64 Sq ft

Bar., " Hg ______
Static, " H2O ______

Amb Air DB, deg F ______
Amb Air WB, deg F ______
Humd, lb/lb BD Air ______

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	6-5/16"		
A-2	18-7/8"		
B-1	6-5/16"	[illegible]	-.0001
B-2	18-7/8"	242	-.0002
C-1	6-5/16"		
C-2	18-7/8"		
D-1	6-5/16"		
D-2	18-7/8"		

235°F

Port A = South, D = North

Sampling Notes:

RUNNING OUT OF TIME. JUST CK'D 1 PORT - DAMPER IS CLOSED. READINN INDICATE NO FLOW.

WE CK'D 1 PORT ON 'B' UNIT. APPEARS THERE IS SMALL FLOW IN THAT BYPASS. ASK PLANT TO CK'D ON TIGHTNESS FOR TOMORROW'S TESTING.

File: SA-BPTPL.WQ2

09-May-96

1220

Method 2 QA/QC Checklist

Plant: ______________
Date: ______________
Start Time: ______________ Stop Time: ______________
Unit ID: ______________ Duct ID: ______________
Testers: ______________

Pitot ID__________ Cp________ Calibration Date__________

Pitot Opening Checked?______ By Whom?________ Condition?________

Leak Check of System?______ By Whom?________ Condition?________

Dp Gauge ID 157512 Static Pressure Gauge ID __________

TC ID 2B Handheld TC Readout ID __________

Barometer ID __________

Leak Check of Gas Sampling System?______ By Whom?_____ Condition?______

Gas Meter ID______ ORSAT Bag ID ______________

QA/QC Check List:

Proper sampling points identified? ______________
Pitot orientation properly marked? ______________
Reference point for pitot depth marked? ______________
Pitot leak check? ______________
Gas sampling system leak check? ______________
Gas Meter Calibrated? ______________
Safety equipment utilized? ______________
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ______________
Proper probe orientation while traversing? ______________
Process at steady state prior to testing? ______________

1221

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Secondary Air Outlet - (Rectangular Duct)

Location [✓ A] or B Duct
Date 10/7/96
Time Begin 17:00 **End** 17:45
Bar., " Hg ______
Static, " H2O ______

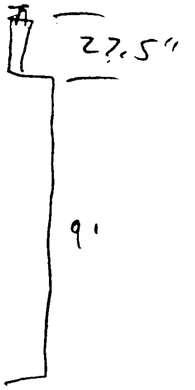
Tube I.D. S-54
C-Factor ______
Operator(s) WLM, DCM
No. Points 24
Duct Width 6.0 ft
Duct Height 9.0 ft
Duct Area 54.00 Sq ft
Amb Air DB, deg F 66 } outside
Amb Air WB, deg F 54 }
Humd, lb/lb BD Air .0062

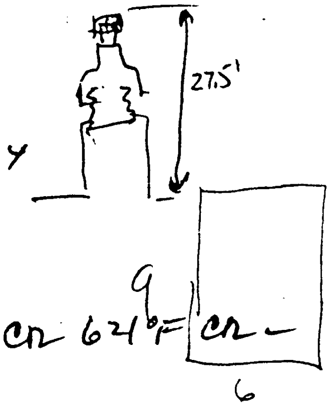
	PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]	
BOTTOM	A-1	9"	~~575~~	~~0.8122~~	550 0.7257
	A-2	27"	554	0.8046	18
	A-3	45"	571	0.7142	18
	A-4	63"	583	0.7568	18
	A-5	81"	583	0.8005	14
TOP	A-6	99"	575	0.8122	18 1200
	B-1	9"	563	0.8868	
	B-2	27"	572	0.8809	
	B-3	45"	589	0.8072	
	B-4	63"	601	0.8797	
	B-5	81"	598	0.9882	STATIC=+3.25"
	B-6	99"	584	0.7412	
	C-1	9"	560	0.8688	
	C-2	27"	578	0.9330	
	C-3	45"	596	0.8060	
	C-4	63"	612	0.9428	
	C-5	81"	619	1.144	
	C-6	99"	612	~~0.86~~	0.9804
	D-1	9"	553	0.8401	
	D-2	27"	570	0.8066	
	D-3	45"	593	.8315	
	D-4	63"	610	1.024	
	D-5	81"	621	0.9946	1.009 CR 624°F
	D-6	99"	620	1.1600	

Port A = South, D = North

27.5
108
135.5

2'-3.5"
9
11'-3.5"





10'-15.5"
9
10' 6.5'

12
9
108
27.5
135.5

Sampling Notes:

Method 2 QA/QC Checklist

Plant: ____________________
Date: 10/7/96
Start Time: 17:00 Stop Time: 17:45
Unit ID: ____________________ Duct ID: ____________________
Testers: WLM/DCW

Pitot ID__________ Cp________ Calibration Date__________

Pitot Opening Checked? ✓ By Whom? DCW Condition? Good

Leak Check of System? ✓ By Whom? WLM/DCW Condition? ✓ Good

Dp Gauge ID 120676 Static Pressure Gauge ID __________

TC ID 3A Handheld TC Readout ID #1

Barometer ID DP cell

Leak Check of Gas Sampling System? ✓ By Whom? WLM/DCW Condition? ✓

Gas Meter ID______ ORSAT Bag ID __________

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitôt depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? —
Gas Meter Calibrated? —
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Flue Gas Inlet - (Rectangular Duct)

1223.

Location ____ A or [✓ B] Duct
Date 10/8/76
Time Begin 0908 End 0946
Bar., " Hg 29.5
Static, " H2O -9.418

Tube I.D. S-53
No. Points 20
C-Factor 0.816
Duct Width 14.5 ft
Operator(s) WIM/DCM
Duct Height 5.5 ft
Duct Area 79.75 Sq ft

Amb Air DB, deg F ____
Amb Air WB, deg F ____
Humd, lb/lb BD Air ____

TC2B

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	8-1/4"	658	.5525	3.8		4	.2
A-2	24-3/4"	648	.7263	4.0		16	.2
A-3	41-1/4"	643	.7536	4.0		26	.2
A-4	57-3/4"	643	.6802	4.2		34	.1
B-1	8-1/4"	652	.5069	4.0		36	.1
B-2	24-3/4"	641	.8902	4.0		46	.1
B-3	41-1/4"	639	.8478	4.2		50	.1
B-4	57-3/4"	648	.6805	4.4		53	.1
C-1	8-1/4"	632	.6728	4.1		45	.1
C-2	24-3/4"	635	.8715	4.2		60	.1
C-3	41-1/4"	638	.7880	4.5		78	.1
C-4	57-3/4"	649	.7980	5.0		83	.1
D-1	8-1/4"	653	.6552	4.3		74	.1
D-2	24-3/4"	657	.8102	4.5		103	.1
D-3	41-1/4"	657	.8443	5.0		109	.1
D-4	57-3/4"	656	.8247	5.0		113	.1
E-1	8-1/4"	695	.4592	4.9		124	.1
E-2	24-3/4"	695	.4554	4.8		144	.1
E-3	41-1/4"	680	.6457	5.1		147	.1
E-4	57-3/4"	660	.8681	5.5		149	.1

~9.418

SOOTBLOW STARTED.

Port A = South, E = North

Sampling Notes:

1224

Method 2 QA/QC Checklist

Plant:
Date:
Start Time: Stop Time:
Unit ID: Duct ID:
Testers:

Pitot ID 5-53 Cp Calibration Date

Pitot Opening Checked? ✓ By Whom? Condition? G

Leak Check of System? ✓ By Whom? Condition? G

Dp Gauge ID 157512 Static Pressure Gauge ID

TC ID 2B Handheld TC Readout ID #1

Barometer ID

Leak Check of Gas Sampling System? By Whom? Condition?

Gas Meter ID 118844 ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified? ✓
Pitot orientation properly marked? ✓
Reference point for pitot depth marked? ✓
Pitot leak check? ✓
Gas sampling system leak check? ✓
Gas Meter Calibrated? ✓
Safety equipment utilized? ✓
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? ✓
Proper probe orientation while traversing? ✓
Process at steady state prior to testing? ✓

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Flue Gas Outlet - (Rectangular Duct)

1225

Location ______ [A or ✓ B] Duct

Date 10/8/96

Time Begin 0900 End 1000

Bar., " Hg 29.3" Hg

*Static, " H2O -17.0
CG

Tube I.D. S51

No. Points 24

C-Factor .822

Duct Width 34 ft

Operator(s) GLC
DRS

Duct Height 2.5 ft

Duct Area 85.00 Sq ft

Amb Air DB, deg F 95

Amb Air WB, deg F

Humd, lb/lb BD Air

T/C #6C
TI #3

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	7-1/2"						
A-2	22-1/2"						
B-1	7-1/2"	314	.3255	5.2		[redacted]	.1
B-2	22-1/2"	316	.3057	5.1		120	.1
C-1	7-1/2"	320	.4552	5.1		104	.1
C-2	22-1/2"	321	.4299	5.1		106	.1
D-1	7-1/2"	325	.6319	5.0		87	.1
D-2	22-1/2"	325	.6236	5.0		90	.1
E-1	7-1/2"	330	.5904	5.2		78	.1
E-2	22-1/2"	329	.5130	5.0		84	.1
F-1	7-1/2"	331	.4550	5.2		72	.1
F-2	22-1/2"	332	.5877	5.2		76	.1
G-1	7-1/2"	330	.3295	5.0		68	.1
G-2	22-1/2"	329	.2860	4.8		74	.1
H-1	7-1/2"	326	.8010	4.7		58	.1
H-2	22-1/2"	325	.8385	4.7		62	.1
I-1	7-1/2"	328	.8582	4.5		48	.1
I-2	22-1/2"	332	.8309	4.7		52	.1
J-1	7-1/2"	335	.6409	4.6		33	.1
J-2	22-1/2"	338	.6564	4.6		37	.1
K-1	7-1/2"	342	.7212	4.6		15	0
K-2	22-1/2"	343	.7063	4.7		22	.1
L-1	7-1/2"	347	0.5641	4.8		2	0
L-2	22-1/2"	346	.4589	4.7		2	0

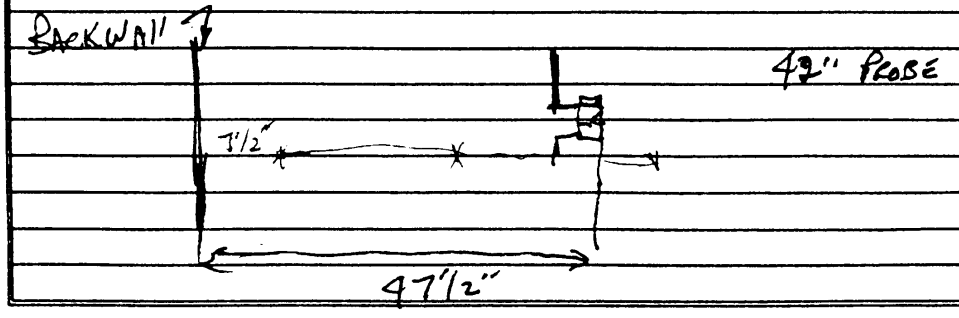
* Static

NORTH

SOUTH

Port A = [redacted], L = [redacted]
NORTH SOUTH

Sampling Notes:



c

1226

Method 2 QA/QC Checklist

Plant:
Date:
Start Time: Stop Time:
Unit ID: Duct ID:
Testers:

Pitot ID Cp Calibration Date

Pitot Opening Checked? By Whom? Condition?

Leak Check of System? By Whom? Condition?

Dp Gauge ID 120676 Static Pressure Gauge ID

TC ID 6C Handheld TC Readout ID #3

Barometer ID

Leak Check of Gas Sampling System? By Whom? Condition?

Gas Meter ID 154949 ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified?
Pitot orientation properly marked?
Reference point for pitot depth marked?
Pitot leak check?
Gas sampling system leak check?
Gas Meter Calibrated?
Safety equipment utilized?
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port?
Proper probe orientation while traversing?
Process at steady state prior to testing?

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack ~~Velocity~~, Gas Composition & Temperature ~~Traverse~~

Primary Flue Gas Outlet - (Rectangular Duct)

1227

Location ______ A or [✓ B] Duct
Date 10/8/96
Time Begin 1030 End 1105

Bar., " Hg 29.4"
Static, " H2O -15.65"
CD

Tube I.D. S51
C-Factor .822
Operator(s) GKC DPS

No. Points 14
Duct Width 17.92 ft
Duct Height 3.28 ft
Duct Area 58.79 Sq ft

Amb Air DB, deg F ______
Amb Air WB, deg F ______
Humd, lb/lb BD Air ______

PORT/ POINT	DISTANCE " From Wall	TEMP Deg-F	DELTA P [" H2O]	% O2	% CO2	CO ppmv	%COMB.
A-1	9-7/8"	.1033 ⟷ 360		6.8		132	.1
A-2	29-9/16"	360	.0002	5.8		167	.1
B-1	9-7/8"	369	.1284	5.5		159	.1
B-2	29-9/16"	361	.0314	6.3		180	.1
C-1	9-7/8"	363	.1246	6.2		129	.1
C-2	29-9/16"	367	.0830	4.9		190	.1
D-1	9-7/8"	366	.0385	4.4		213	.1
D-2	29-9/16"	364	.0195	5.2		225	.1
E-1	9-7/8"	360	.0956	6.3		183	.1
E-2	29-9/16"	370	.0769	5.4		216	.1
F-1	9-7/8"	372	.0775	4.6		162	.1
F-2	29-9/16"	368	.0305	4.7		228	.1
G-1	9-7/8"	356	-.0935	6.3		181	.1
G-2	29-9/16"	365	.0618	5.6		214	.1

STATIC * (D-1)

SOUTH

NORTH

Port A = South, L = North

Sampling Notes:

PORTS A → D : 39 1/8" PROBE INSERTION WAS POSSIBLE (i.e. 9 7/8" From Wall) AND G.

PORTS E+F : ~ 38 1/8 ONLY INSERT. POSSIBLE (i.e. 10 7/8" From Wall)

File: PFGOTPL.WQ2

09-May-96

Method 2 QA/QC Checklist

Plant: ____________
Date: ____________
Start Time: ____________ Stop Time: ____________
Unit ID: ____________ Duct ID: ____________
Testers: ____________

Pitot ID__________ Cp________ Calibration Date__________

Pitot Opening Checked?______ By Whom?________ Condition?________

Leak Check of System?______ By Whom?________ Condition?________

Dp Gauge ID 120676 Static Pressure Gauge ID __________

TC ID 6C Handheld TC Readout ID #3

Barometer ID __________

Leak Check of Gas Sampling System?______ By Whom?_____ Condition?______

Gas Meter ID 154949 ORSAT Bag ID __________

QA/QC Check List:

Proper sampling points identified? __________
Pitot orientation properly marked? __________
Reference point for pitot depth marked? __________
Pitot leak check? __________
Gas sampling system leak check? __________
Gas Meter Calibrated? __________
Safety equipment utilized? __________
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port? __________
Proper probe orientation while traversing? __________
Process at steady state prior to testing? __________

1229

NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Primary Air Outlet - (Circular Duct)

Location ________ A or [✓ B] Duct

Date 10/8/96

Time Begin 1205 End 1240

Tube I.D. 550 No. Points 20

C-Factor 0.810

Operator(s) QC Duct Dia. 47.5 inches

DCM Duct Area 12.31 Sq ft

Bar., " Hg 29.3"

* Static, " H2O +50.59" / + 50.51

Amb Air DB, deg F ________

Amb Air WB, deg F ________

Humd, lb/lb BD Air ________

TI #3

TE 5A

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]	
A-1	1-3/16"	613	.2039	
A-2	3-7/8"	613	.2752	
A-3	6-15/16"	613	.2491	
A-4	10-3/4"	612	.1985	
A-5	16-1/4"	612	.2972	
A-6	31-1/4"	612	.2201	
A-7	36-3/4"	612	.2037	
* A-8	40-9/16"	612	.1794	+50.59
A-9	43-5/8"	611	.1538	
A-10	46-5/16"	609	.1152	
B-1	1-3/16"	610	.2326	
B-2	3-7/8"	611	.2289	
B-3	6-15/16"	611	.2671	
B-4	10-3/4"	611	.2598	
* B-5	16-1/4"	611	.2536	+50.51"
B-6	31-1/4"	610	.1898	
B-7	36-3/4"	610	.1761	
B-8	40-9/16"	610	.1614	
B-9	43-5/8"	610	.1376	
B-10	46-5/16"	608	.0936	

Port A = South or North, B = East

Sampling Notes:

1230

Method 2 QA/QC Checklist

Plant: ____________________

Date: ____________________

Start Time: ______________ Stop Time: ______________

Unit ID: ______________ Duct ID: ______________

Testers: ____

Pitot ID __________ Cp ________ Calibration Date ______________

Pitot Opening Checked? ______ By Whom? ________ Condition? ________

Leak Check of System? ______ By Whom? ________ Condition? ________

Dp Gauge ID 120676 Static Pressure Gauge ID ______________

TC ID ______________ Handheld TC Readout ID ______________

Barometer ID __________

Leak Check of Gas Sampling System? ______ By Whom? _____ Condition? ______

Gas Meter ID ______ ORSAT Bag ID ____________________

QA/QC Check List:

Proper sampling points identified? ______________

Pitot orientation properly marked? ______________

Reference point for pitot depth marked? ______________

Pitot leak check? ______________

Gas sampling system leak check? ______________

Gas Meter Calibrated? ______________

Safety equipment utilized? ______________

(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)

Tight seal around probe entry port? ______________

Proper probe orientation while traversing? ______________

Process at steady state prior to testing? ______________

1231

NYSEG MILLIKEN STATION HEAT PIPE DATA
Stack Velocity, Gas Composition & Temperature Traverse
Secondary Air Bypass - (Rectangular Duct)

Location ______ A or [✓ B] Duct

Date 10/8/96

Time Begin 1130 End 1140

Bar., " Hg

* Static, " H2O 4.627"

Tube I.D. S53

No. Points 8

Amb Air DB, deg F

C-Factor .816

Duct Width 17.5 ft

Amb Air WB, deg F

Operator(s)

Duct Height 2.09 ft

Humd, lb/lb BD Air

Duct Area 36.64 Sq ft

TC - 2B

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	6-5/16"	283	.0000
A-2	18-7/8"	337	-.0001
* B-1	6-5/16"	279	-.0004
B-2	18-7/8"	328	-.0002
C-1	6-5/16"		
C-2	18-7/8"		
D-1	6-5/16"		
D-2	18-7/8"		

Port A = South, D = North

Sampling Notes:

DAMPER CLOSED. PITOT CHECK INDICATED NO FLOW CONDITION.
HIGH AIR TEMPERATURES IN DUCT ALSO INDICATE NO FLOW.

Method 2 QA/QC Checklist

Plant: ____________________

Date: ____________________

Start Time: ________________ Stop Time: ________________

Unit ID: ________________ Duct ID: ________________

Testers: ____

Pitot ID__________ Cp________ Calibration Date____________

Pitot Opening Checked?______ By Whom?__________ Condition?________

Leak Check of System?______ By Whom?__________ Condition?________

Dp Gauge ID 120676 Static Pressure Gauge ID ____________

TC ID____________ Handheld TC Readout ID ____________

Barometer ID ________

Leak Check of Gas Sampling System?______ By Whom?_____ Condition?______

Gas Meter ID______ ORSAT Bag ID ________________

QA/QC Check List:

Proper sampling points identified? ____________

Pitot orientation properly marked? ____________

Reference point for pitot depth marked? ____________

Pitot leak check? ____________

Gas sampling system leak check? ____________

Gas Meter Calibrated? ____________

Safety equipment utilized? ____________

(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)

Tight seal around probe entry port? ____________

Proper probe orientation while traversing? ____________

Process at steady state prior to testing? ____________

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NYSEG MILLIKEN STATION HEAT PIPE DATA

Stack Velocity, Gas Composition & Temperature Traverse

Secondary Air Outlet - (Rectangular Duct)

Location ______ A or [✓ B] Duct
Date 10/8/96
Time Begin 10:32 End 11:20
Bar., " Hg 29.5 "Hg.
Static, " H2O +3.195

Tube I.D. S-54
C-Factor .806
Operator(s) WLM/DGM
No. Points 24
Duct Width 6.0 ft
Duct Height 9.0 ft
Duct Area 54.00 Sq ft
Amb Air DB, deg F ______
Amb Air WB, deg F ______
Humd, lb/lb BD Air ______

TC 3A

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P [" H2O]
A-1	9"	577	.7529
A-2	27"	586	.6719
A-3	45"	563	.7502
A-4	63"	529	.9771
A-5	81"	503	1.018
A-6	99"	494	1.010
B-1	9"	595	.8439
B-2	27"	582	.6868
B-3	45"	540	0.7400
B-4	63"	503	.9025
B-5	81"	479	1.064
B-6	99"	459-460	0.9752
C-1	9"	601	0.8558
C-2	27"	567	0.7837
C-3	45"	462	0.6734
C-4	63"	386	0.8163
C-5	81"	326	0.9736
C-6	99"	347	.7675
D-1	9"	584	0.7572
D-2	27"	583	.7501
D-3	45"	559	.6748
D-4	63"	458	.6632
D-5	81"	352	.8309
D-6	99"	286	.9612

BOT (A-1)
TOP (A-6)
STATIC (B-3)
CR 325 .9720 (C-5)

Port A = South, D = North

Sampling Notes:

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1234

Method 2 QA/QC Checklist

Plant:
Date:
Start Time: Stop Time:
Unit ID: Duct ID:
Testers:

Pitot ID Cp Calibration Date

Pitot Opening Checked? By Whom? Condition?

Leak Check of System? By Whom? Condition?

Dp Gauge ID: 157512 Static Pressure Gauge ID

TC ID Handheld TC Readout ID #1

Barometer ID

Leak Check of Gas Sampling System? By Whom? Condition?

Gas Meter ID ORSAT Bag ID

QA/QC Check List:

Proper sampling points identified?
Pitot orientation properly marked?
Reference point for pitot depth marked?
Pitot leak check?
Gas sampling system leak check?
Gas Meter Calibrated?
Safety equipment utilized?
(Hot Gloves, Ear Protection, Eye Protection, Safety Harness, Radio)
Tight seal around probe entry port?
Proper probe orientation while traversing?
Process at steady state prior to testing?

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APPENDIX D

TRAVERSE DATA CALCULATED RESULTS

Table D-1

Traverse Data Calculated Results – 2A Heat Pipe Flue Gas Inlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	5.11%	Overhead Ash	90.00%	Std. Conditions	
C	70.87%	C in Ash	2.25%	T, deg F	60
H	4.71%			P, in. Hg	29.92
N	1.37%	Amb Air DB, deg F	66		
S	2.09%	Amb Air WB, deg F	54		
O	4.56%	Humd, lb/lb BD Air	0.0064		
Ash	11.29%				
Total	100.00%				
		No. Of Points	20		
		Duct Width	14.5 ft	Bar., " Hg	29.40
Date	10/7/96	Duct Height	5.5 ft	Static, " H2O	-9.83
Time	13:14-14:17	Duct Area	79.75 Sq ft		
Tube I.D.	S-53	Avg % O2	3.07	Avg % H2O	7.32
C-Factor	0.816	Avg % CO2	15.56	Dry MW	30.63
Operator(s)	WLM/DCM	Avg % N2	81.37	Wet MW	29.71

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	8-1/4"	692	0.7436	69.96	3.1	15.6	0	0.1
A-2	24-3/4"	694	0.8953	76.83	3.1	15.6	22	0.1
A-3	41-1/4"	689	0.7664	70.93	3.1	15.6	84	0.1
A-4	57-3/4"	680	0.8198	73.08	3.1	15.6	135	0.1
B-1	8-1/4"	657	0.7742	70.29	3.1	15.6	157	0.1
B-2	24-3/4"	661	1.0990	83.90	3.1	15.6	178	0.1
B-3	41-1/4"	669	0.9715	79.17	3.1	15.6	210	0.1
B-4	57-3/4"	673	0.9597	78.82	3.1	15.6	100	0.4
C-1	8-1/4"	653	0.7852	70.66	3.1	15.6	130	0.1
C-2	24-3/4"	648	1.0610	81.95	3.1	15.6	150	0.1
C-3	41-1/4"	645	0.9945	79.24	3.1	15.6	161	0.1
C-4	57-3/4"	649	1.0350	80.98	3.1	15.6	169	0.1
D-1	8-1/4"	677	0.8176	72.88	3.1	15.6	199	0.1
D-2	24-3/4"	667	1.0870	83.67	3.1	15.6	214	0.1
D-3	41-1/4"	655	1.0220	80.69	3.1	15.6	220	0.1
D-4	57-3/4"	655	1.0090	80.18	3.1	15.6	211	0.1
E-1	8-1/4"	694	0.7317	69.47	3.1	15.6	225	0.1
E-2	24-3/4"	680	0.9358	78.08	3.1	15.6	253	0.1
E-3	41-1/4"	662	0.8572	74.13	3.1	15.6	257	0.1
E-5	57-3/4"	656	0.9537	77.99	3.1	15.6	262	0.2
Average, (group mean)		668	0.9160	76.64	3.1	15.6	167	0.12
Average, (wt mean)		667	—	—	3.1	15.6	169	0.12
Maximum		694	1.0990	83.90		15.6	262	0.40
Minimum		645	0.7317	69.47	3.1	15.6	0	0.10
Standard Deviation		16	0.1177	4.68	0.0	0.0	71	0.07

Port A = South, E = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	76.64
Velocity, [fpm]	4,599
ACFM	366,744
SCFM	162,126
DSCFM	150,251
Ex Air Free	128,180
lb/hr Flue Gas (dry)	727,420
lb/hr Flue Gas (wet)	761,236

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	76.64
Velocity, [fpm]	4,599
ACFM	366,744
SCFM	162,126
DSCFM	150,251
Ex Air Free	128,181
lb/hr Flue Gas (dry)	727,421
lb/hr Flue Gas (wet)	761,237

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Table D-2

Traverse Data Calculated Results -- 2A Heat Pipe Flue Gas Outlet Duct
NYSEG Milliken Station

Coal Composition	
Moisture	5.11%
C	70.87%
H	4.71%
N	1.37%
S	2.09%
O	4.56%
Ash	11.29%
Total	100.00%

Overhead Ash	90.00%
C in Ash	2.25%
Amb Air DB, deg F	66
Amb Air WB, deg F	54
Humd, lb/lb BD Air	0.0062

Std. Conditions	
T, deg F	80
P, in. Hg	29.92

Date	10/7/96
Time	13:10-14:10
Tube I.D.	S-51
C-Factor	0.822
Operator(s)	GLC/DFS

No. Of Points	24
Duct Width	34.0 ft
Duct Depth	2.5 ft
Duct Area	85.00 Sq ft
Avg % O2	3.57
Avg % CO2	15.12
Avg % N2	81.31

Bar., " Hg	29.90
Static, " H2O	-16
% H20	7.14
Dry MW	30.58
Wet MW	29.68

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	7-1/2"	318	0.9842	66.59	3.5	15.2	249	0.3
A-2	22-1/2"	321	0.6407	53.82	3.4	15.3	227	0.3
B-1	7-1/2"	322	0.8431	61.78	3.4	15.3	218	0.3
B-2	22-1/2"	323	0.5542	50.12	3.4	15.3	230	0.3
C-1	7-1/2"	329	1.1640	72.93	3.5	15.2	211	0.3
C-2	22-1/2"	324	0.7581	58.67	3.6	15.1	219	0.3
D-1	7-1/2"	321	0.9653	66.08	3.7	15.0	187	0.3
D-2	22-1/2"	317	0.5781	51.01	3.7	15.0	196	0.3
E-1	7-1/2"	309	0.7954	59.52	3.8	14.9	164	0.3
E-2	22-1/2"	311	0.5108	47.77	3.9	14.8	172	0.3
F-1	7-1/2"	305	0.7242	56.64	3.7	15.0	164	0.3
F-2	22-1/2"	307	0.4012	42.22	3.7	15.0	172	0.3
G-1	7-1/2"	301	0.4646	45.25	3.7	15.0	143	0.3
G-2	22-1/2"	302	0.2282	31.74	3.8	14.9	152	0.3
H-1	7-1/2"	305	0.4921	46.69	3.6	15.1	125	0.3
H-2	22-1/2"	306	0.3476	39.27	3.6	15.1	135	0.3
I-1	7-1/2"	319	0.5394	49.33	3.6	15.1	98	0.3
I-2	22-1/2"	325	0.4629	45.87	3.5	15.2	108	0.3
J-1	7-1/2"	330	0.6779	55.68	3.5	15.2	78	0.3
J-2	22-1/2"	332	0.5012	47.95	3.6	15.1	85	0.3
K-1	7-1/2"	342	0.8341	62.24	3.5	15.2	58	0.3
K-2	22-1/2"	343	0.4328	44.86	3.5	15.2	60	0.2
L-1	7-1/2"	345	0.6995	57.09	3.3	15.4	34	0.2
L-2	22-1/2"	345	0.4140	43.92	3.3	15.4	43	0.2
Average, (group mean)		321	0.6256	52.38	3.6	15.1	147	0.3
Average, (wt mean)		321	—	—	3.6	15.1	151	0.29
Maximum		345	1.1640	72.93	3.9	15.4	249	0.3
Minimum		301	0.2282	31.74	3.3	14.8	34	0.2
Standard Deviation		14	0.2208	9.47	0.2	0.1	63	0.0

Port A = North, L = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	52.38
Velocity, [fpm]	3,143
ACFM	267,120
SCFM	170,657
DSCFM	158,480
Ex Air Free	131,407
lb/hr Flue Gas (dry)	766,024
lb/hr Flue Gas (wet)	800,701

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	52.38
Velocity, [fpm]	3,143
ACFM	267,120
SCFM	170,658
DSCFM	158,480
Ex Air Free	131,407
lb/hr Flue Gas (dry)	766,027
lb/hr Flue Gas (wet)	800,704

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Table D-3

Traverse Data Calculated Results -- 2A Heat Pipe Primary Flue Gas Out Duct
NYSEG Milliken Station

Coal Composition					
Moisture	5.11%	Overhead Ash	90.00%	Std. Conditions	
C	70.87%	C in Ash	2.25%	T, deg F	60
H	4.71%			P, in. Hg	29.92
N	1.37%	Amb Air DB, deg F	66		
S	2.09%	Amb Air WB, deg F	54		
O	4.56%	Humd, lb/lb BD Air	0.0064		
Ash	11.29%				
Total	100.00%				

		No. Of Points	14	Bar., " Hg	29.70
Date	10/7/96	Duct Width	17.92 ft	Static, " H2O	-15.00
Time	16:30-17:35	Duct Height	3.28 ft		
Tube I.D.	S-51	Duct Area	58.79 Sq ft	% H2O	6.44
C-Factor	0.822	Avg % O2	5.72	Dry MW	30.37
Operator(s)	GLC/DRS	Avg % CO2	13.26	Wet MW	29.57
		Avg % N2	81.02		

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	9-7/8"	334	0.0781	19.03	5.9	13.1	62	0.1
A-2	29-9/16"	325	0.0437	14.15	5.3	13.6	82	0.1
B-1	9-7/8"	343	0.0783	19.15	5.3	13.6	17	0.1
B-2	29-9/16"	333	0.0452	14.46	5.3	13.6	29	0.2
C-1	9-7/8"	328	0.0494	15.08	5.9	13.1	34	0.1
C-2	29-9/16"	325	0.0353	12.72	5.8	13.2	42	0.2
D-1	9-7/8"	339	0.0445	14.40	5.4	13.5	37	0.1
D-2	29-9/16"	329	0.0486	14.96	5.6	13.4	46	0.2
E-1	9-7/8"	322	0.0235	10.36	6.0	13.0	49	0.2
E-2	29-9/16"	329	0.0438	14.20	5.3	13.6	59	0.2
F-1	9-7/8"	343	-0.1099	-22.68	4.6	14.2	43	0.2
F-2	29-9/16"	331	0.0133	7.83	5.3	13.6	45	0.2
G-1	9-7/8"	334	0.0235	10.44	5.8	13.2	50	0.2
G-2	29-9/16"	326	0.0041	4.34	5.7	13.3	55	0.2
Average, (group mean)		331	0.0301	10.60	5.5	13.4	46	0.16
Average, (wt mean)		330	---	---	5.7	13.3	46	0.15
Maximum		343	0.0783	19.15	6.0	14.2	82	0.20
Minimum		322	-0.1099	-22.68	4.6	13.0	17	0.10
Standard Deviation		6	0.0438	9.99	0.4	0.3	15	0.05

Port A = South, G = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	10.60
Velocity, [fpm]	636
ACFM	37,401
SCFM	23,539
DSCFM	22,022
Ex Air Free	15,994
lb/hr Flue Gas (dry)	105,709
lb/hr Flue Gas (wet)	110,029

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	10.77
Velocity, [fpm]	646
ACFM	37,979
SCFM	23,900
DSCFM	22,360
Ex Air Free	16,239
lb/hr Flue Gas (dry)	107,328
lb/hr Flue Gas (wet)	111,714

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Table D-4

Traverse Data Calculated Results -- 2A Heat Pipe Primary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F 66
Amb Air WB, deg F 54
Humd, lb/lb BD Air 0.0064

Std. Conditions
T, deg F 60
P, in. Hg 29.92

Bar., " Hg 29.40
Static, " H20 51.3

Date 10/7/96
Time 18:46-19:28
Tube I.D. S-49
C-Factor 0.802
Operator(s) GLC/DCM

No. Of Points 20
Duct Dia 47.5 inches
Duct Area 12.31 Sq ft
Avg % O2 21.0
Avg % N2 79.0

% H20 1.01
Dry MW 28.97
Wet MW 28.86

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	1-3/16"	599	0.1804	30.63
A-2	3-7/8"	599	0.2179	33.66
A-3	6-15/16"	599	0.2397	35.31
A-4	10-3/4"	599	0.2540	36.34
A-5	16-1/4"	600	0.2332	34.84
A-6	31-1/4"	600	0.2051	32.67
A-7	36-3/4"	601	0.1830	30.88
A-8	40-9/16"	601	0.1679	29.58
A-9	43-5/8"	600	0.1437	27.35
A-10	46-5/16"	598	0.0846	20.97
B-1	1-3/16"	600	0.1826	30.83
B-2	3-7/8"	600	0.2172	33.62
B-3	6-15/16"	600	0.2262	34.31
B-4	10-3/4"	599	0.2343	34.91
B-5	16-1/4"	599	0.2332	34.82
B-6	31-1/4"	600	0.1780	30.44
B-7	36-3/4"	599	0.1613	28.96
B-8	40-9/16"	599	0.1490	27.84
B-9	43-5/8"	598	0.1350	26.48
B-10	46-5/16"	593	0.0885	21.39
Average, (group mean)		600	0.1857	30.79
Average, (wt mean)		600	---	---
Maximum		601	0.2540	36.34
Minimum		593	0.0846	20.97
Standard Deviation		2	0.0474	4.25

Ports A = South, B = East

Summary Straight Avg'd Results	
Velocity, [fps]	30.79
Velocity, [fpm]	1,848
ACFM	22,735
SCFM	12,371
DSCFM	12,245
lb/hr Air (dry)	56,071
lb/hr Air (wet)	56,429

Summary Weighted Avg Results	
Velocity, [fps]	30.79
Velocity, [fpm]	1,848
ACFM	22,735
SCFM	12,371
DSCFM	12,245
lb/hr Flue Gas (dry)	56,071
lb/hr Flue Gas (wet)	56,429

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Table D-5

Traverse Data Calculated Results -- 2A Heat Pipe Secondary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F 66
Amb Air WB, deg F 54
Humd, lb/lb BD Air 0.0064

Std. Conditions
T, deg F 60
P, in. Hg 29.92

Date 10/7/96
Time 17:00-17:45
Tube I.D. S-54
C-Factor 0.806
Operator(s) WLM/DCM

No. Of Points 24
Duct Width 6.0 ft
Duct Depth 9.0 ft
Duct Area 54.00 Sq ft
Avg % O2 21.0
Avg % N2 79.0

Bar., " Hg 29.40
Static, " H20 3.25

% " H20 1.01
Dry MW 28.97
Wet MW 28.86

PORT/ POINT	DISTANCE Fr Bottom	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	9"	551	0.7257	63.81
A-2	27"	555	0.8046	67.33
A-3	45"	572	0.7142	63.96
A-4	63"	584	0.7588	66.31
A-5	81"	584	0.8005	68.11
A-6	99	576	0.8122	68.34
B-1	9"	564	0.8888	71.07
B-2	27"	573	0.8809	71.07
B-3	45"	590	0.8072	68.59
B-4	63"	602	0.8797	72.01
B-5	81"	599	0.9882	76.22
B-6	99	585	0.7412	65.57
C-1	9"	561	0.8688	70.17
C-2	27"	579	0.9330	73.35
C-3	45"	597	0.8060	68.77
C-4	63"	613	0.9428	74.94
C-5	81"	620	1.1440	82.82
C-6	99	613	0.9804	76.42
D-1	9"	554	0.8401	68.76
D-2	27"	571	0.8066	67.94
D-3	45"	594	0.8315	69.75
D-4	63"	611	1.0240	78.02
D-5	81"	622	0.9916	77.17
D-6	99	621	1.1600	83.43
Average, (group mean)		587	0.8805	71.41
Average, (wt mean)		588	---	---
Maximum		622	1.1600	83.43
Minimum		551	0.7142	63.81
Standard Deviation		22	0.1176	5.26

Port A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	71.41
Velocity, [fpm]	4,285
ACFM	231,379
SCFM	113,715
DSCFM	112,561
lb/hr Air (dry)	515,421
lb/hr Air (wet)	518,707

Summary Weighted Avg Results	
Velocity, [fps]	71.41
Velocity, [fpm]	4,285
ACFM	231,379
SCFM	113,715
DSCFM	112,561
lb/hr Flue Gas (dry)	515,421
lb/hr Flue Gas (wet)	518,707

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Table D-6

Traverse Data Calculated Results -- 2B Heat Pipe Flue Gas Inlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	6.49%	Overhead Ash	90.00%	Std. Conditions	
C	68.39%	C in Ash	1.61%	T, deg F	60
H	4.53%			P, in. Hg	29.92
N	1.31%	Amb Air DB, deg F	66		
S	2.40%	Amb Air WB, deg F	54		
O	4.61%	Humd, lb/lb BD Air	0.0063		
Ash	12.27%				
Total	100.00%				
		No. Of Points	20		
		Duct Width	14.5 ft	Bar., " Hg	29.50
Date	10/8/96	Duct Height	5.5 ft	Static, " H2O	-9.42
Time	09:08-09:46	Duct Area	79.75 Sq ft		
Tube I.D.	S-53	Avg % O2	4.48	Avg % H2O	7.01
C-Factor	0.816	Avg % CO2	14.34	Dry MW	30.49
Operator(s)	WLM/DCM	Avg % N2	81.18	Wet MW	29.62

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	8-1/4"	660	0.5525	59.38	3.8	14.9	4	0.2
A-2	24-3/4"	650	0.7263	67.78	4.0	14.8	16	0.2
A-3	41-1/4"	645	0.7536	68.89	4.0	14.8	26	0.2
A-4	57-3/4"	645	0.6802	65.46	4.2	14.6	34	0.1
B-1	8-1/4"	654	0.5069	56.73	4.0	14.8	36	0.1
B-2	24-3/4"	643	0.8902	74.81	4.0	14.8	46	0.1
B-3	41-1/4"	641	0.8478	72.95	4.2	14.6	50	0.1
B-4	57-3/4"	650	0.6805	65.64	4.4	14.4	53	0.1
C-1	8-1/4"	634	0.6728	64.77	4.1	14.7	45	0.1
C-2	24-3/4"	637	0.8715	73.83	4.2	14.6	60	0.1
C-3	41-1/4"	640	0.7880	70.32	4.5	14.3	78	0.1
C-4	57-3/4"	651	0.7980	71.15	5.0	13.9	83	0.1
D-1	8-1/4"	655	0.6552	64.54	4.3	14.5	74	0.1
D-2	24-3/4"	659	0.8102	71.92	4.5	14.3	103	0.1
D-3	41-1/4"	659	0.8443	73.45	5.0	13.9	109	0.1
D-4	57-3/4"	658	0.8247	72.56	5.0	13.9	113	0.1
E-1	8-1/4"	697	0.4592	55.08	4.9	14.0	124	0.1
E-2	24-3/4"	697	0.4554	54.84	4.8	14.1	144	0.1
E-3	41-1/4"	682	0.6457	64.90	5.1	13.8	147	0.1
E-5	57-3/4"	662	0.8681	74.61	5.5	13.4	149	0.1
Average, (group mean)		656	0.7166	67.18	4.5	14.3	75	0.12
Average, (wt mean)		655	---	---	4.5	14.3	74	0.11
Maximum		697	0.8902	74.81	5.5	14.9	149	0.20
Minimum		634	0.4554	54.84	3.8	13.4	4	0.10
Standard Deviation		17	0.1347	6.33	0.5	0.4	44	0.04

Port A = South, E = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	67.18
Velocity, [fpm]	4,031
ACFM	321,453
SCFM	144,338
DSCFM	134,225
Ex Air Free	105,459
lb/hr Flue Gas (dry)	646,893
lb/hr Flue Gas (wet)	675,691

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	67.18
Velocity, [fpm]	4,031
ACFM	321,453
SCFM	144,337
DSCFM	134,224
Ex Air Free	105,458
lb/hr Flue Gas (dry)	646,889
lb/hr Flue Gas (wet)	675,687

Table D-7

Traverse Data Calculated Results -- 2B Heat Pipe Flue Gas Outlet Duct
NYSEG Milliken Station

Coal Composition					
Moisture	6.49%	**Overhead Ash**	90.00%	**Std. Conditions**	
C	68.39%	**C in Ash**	1.61%	**T, deg F**	60
H	4.53%			**P, in. Hg**	29.92
N	1.31%	**Amb Air DB, (**	66		
S	2.40%	**Amb Air WB, deg F**	54		
O	4.61%	**Humd, lb/lb BD Air**	0.0064		
Ash	12.27%				
Total	100.00%				
		No. Of Points	24		
		Duct Width	34.0 ft	**Bar., " Hg**	29.30
Date	10/8/96	**Duct Depth**	2.5 ft	**Static, " H2O**	-17
Time	09:00-10:00	**Duct Area**	85.00 Sq ft		
Tube I.D.	S-51	**Avg % O2**	4.88	**% H20**	6.88
C-Factor	0.822	**Avg % CO2**	13.99	**Dry MW**	30.45
Operator(s)	GLC/DFS	**Avg % N2**	81.13	**Wet MW**	29.60

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	7-1/2"	315	0.3255	38.74	5.2	13.7	115	0.1
A-2	22-1/2"	317	0.3057	37.59	5.1	13.8	120	0.1
B-1	7-1/2"	315	0.3255	38.74	5.2	13.7	115	0.1
B-2	22-1/2"	317	0.3057	37.59	5.1	13.8	120	0.1
C-1	7-1/2"	321	0.4552	45.99	5.1	13.8	104	0.1
C-2	22-1/2"	322	0.4299	44.72	5.1	13.8	106	0.1
D-1	7-1/2"	326	0.6319	54.36	5.0	13.9	87	0.1
D-2	22-1/2"	326	0.6236	54.00	5.0	13.9	90	0.1
E-1	7-1/2"	331	0.5904	52.72	5.2	13.7	78	0.1
E-2	22-1/2"	330	0.5130	49.10	5.0	13.9	84	0.1
F-1	7-1/2"	332	0.4550	46.31	5.2	13.7	72	0.1
F-2	22-1/2"	333	0.5877	52.66	5.2	13.7	76	0.1
G-1	7-1/2"	331	0.3295	39.38	5.0	13.9	68	0.1
G-2	22-1/2"	330	0.2860	36.65	4.8	14.1	74	0.1
H-1	7-1/2"	327	0.8010	61.22	4.7	14.1	58	0.1
H-2	22-1/2"	326	0.8385	62.60	4.7	14.1	62	0.1
I-1	7-1/2"	329	0.8582	63.44	4.5	14.3	48	0.1
I-2	22-1/2"	333	0.8309	62.59	4.7	14.1	52	0.1
J-1	7-1/2"	336	0.6409	55.07	4.6	14.2	33	0.1
J-2	22-1/2"	339	0.6564	55.84	4.6	14.2	37	0.1
K-1	7-1/2"	343	0.7212	58.67	4.6	14.2	15	0.0
K-2	22-1/2"	344	0.7063	58.11	4.7	14.2	22	0.1
L-1	7-1/2"	348	0.5641	52.06	4.8	14.1	2	0.0
L-2	22-1/2"	347	0.4589	46.92	4.7	14.2	2	0.0
Average, (group mean)		**330**	**0.5517**	**50.21**	**4.9**	**14.0**	**68**	**0.1**
Average, (wt mean)		**331**	**---**	**---**	**4.9**	**14.0**	**65**	**0.09**
Maximum		**348**	**0.8582**	**63.44**	**5.2**	**14.3**	**120**	**0.1**
Minimum		**315**	**0.2860**	**36.65**	**4.5**	**13.7**	**2**	**0.0**
Standard Deviation		**9**	**0.1814**	**8.65**	**0.2**	**0.2**	**36**	**0.0**

Port A = North, L = South

Data Summary Straight Avg'd Data	
Velocity, [fps]	50.21
Velocity, [fpm]	3,013
ACFM	256,076
SCFM	157,889
DSCFM	147,030
Ex Air Free	112,677
lb/hr Flue Gas (dry)	707,678
lb/hr Flue Gas (wet)	738,602

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	50.21
Velocity, [fpm]	3,013
ACFM	256,076
SCFM	157,909
DSCFM	147,048
Ex Air Free	112,691
lb/hr Flue Gas (dry)	707,765
lb/hr Flue Gas (wet)	738,692

Table D-8

Traverse Data Calculated Results -- 2B Heat Pipe Primary Flue Gas Out Duct
NYSEG Milliken Station

Coal Composition

Moisture	6.49%	Overhead Ash	90.00%	Std. Conditions	
C	68.39%	C in Ash	1.61%	T, deg F	60
H	4.53%			P, in. Hg	29.92
N	1.31%	Amb Air DB, deg F	66		
S	2.40%	Amb Air WB, deg F	54		
O	4.61%	Humd, lb/lb BD Air	0.0064		
Ash	12.27%				
Total	100.00%				

		No. Of Points	14	Bar., " Hg	29.40
Date	10/8/96	Duct Width	17.92 ft	Static, " H2O	-15.65
Time	10:30-11:05	Duct Height	3.28 ft		
Tube I.D.	S-51	Duct Area	58.79 Sq ft	% H2O	6.66
C-Factor	0.822	Avg % O2	5.50	Dry MW	30.39
Operator(s)	GLC/DRS	Avg % CO2	13.45	Wet MW	29.56
		Avg % N2	81.05		

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec	O2 Vol %	CO2 Vol %	CO ppmv	COMB %
A-1	9-7/8"	361	0.1033	22.42	6.8	12.3	132	0.1
A-2	29-9/16"	361	0.0002	0.99	5.8	13.2	167	0.1
B-1	9-7/8"	370	0.1284	25.10	5.5	13.4	159	0.1
B-2	29-9/16"	362	0.0314	12.36	6.3	12.8	180	0.1
C-1	9-7/8"	364	0.1246	24.65	6.2	12.8	129	0.1
C-2	29-9/16"	368	0.0830	20.15	4.9	14.0	190	0.1
D-1	9-7/8"	367	0.0385	13.71	4.4	14.4	213	0.1
D-2	29-9/16"	365	0.0195	9.75	5.2	13.7	225	0.1
E-1	9-7/8"	361	0.0956	21.56	6.3	12.8	183	0.1
E-2	29-9/16"	371	0.0769	19.44	5.4	13.5	216	0.1
F-1	9-7/8"	373	0.0775	19.52	4.6	14.2	162	0.1
F-2	29-9/16"	369	0.0305	12.22	4.7	14.1	228	0.1
G-1	9-7/8"	357	-0.0935	-21.27	6.3	12.8	181	0.1
G-2	29-9/16"	366	0.0618	17.38	5.6	13.4	214	0.1
Average, (group mean)		365	0.0556	14.14	5.6	13.4	184.2	0.10
Average, (wt mean)		368	---	---	5.5	13.4	178.8	0.10
Maximum		373	0.1284	25.10	6.8	14.4	228.0	0.10
Minimum		357	-0.0935	-21.27	4.4	12.3	129.0	0.10
Standard Deviation		4	0.0559	11.68	0.7	0.6	31.1	0.00

Port A = South, G = North

Data Summary Straight Avg'd Data	
Velocity, [fps]	14.14
Velocity, [fpm]	848
ACFM	49,882
SCFM	29,593
DSCFM	27,621
Ex Air Free	20,353
lb/hr Flue Gas (dry)	132,675
lb/hr Flue Gas (wet)	138,290

Data Summary Wt'd Avg Calculations	
Velocity, [fps]	14.11
Velocity, [fpm]	846
ACFM	49,761
SCFM	29,520
DSCFM	27,553
Ex Air Free	20,302
lb/hr Flue Gas (dry)	132,347
lb/hr Flue Gas (wet)	137,948

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Table D-9

Traverse Data Calculated Results -- 2B Heat Pipe Primary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	66
Amb Air WB, deg F	54
Humd, lb/lb BD Air	0.0064

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

Bar., " Hg	29.30
Static, " H20	50.55

Date	10/8/96
Time	12:05-12:40
Tube I.D.	S-50
C-Factor	0.81
Operator(s)	GLC/DCM

No. Of Points	20	
Duct Dia	47.5	inches
Duct Area	12.31	Sq ft
Avg % O2	21.0	
Avg % N2	79.0	

% H20	1.02
Dry MW	28.97
Wet MW	28.86

PORT/ POINT	DISTANCE From Wall	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	1-3/16"	616	0.2039	33.22
A-2	3-7/8"	616	0.2752	38.59
A-3	6-15/16"	616	0.2491	36.72
A-4	10-3/4"	615	0.1985	32.76
A-5	16-1/4"	615	0.2972	40.09
A-6	31-1/4"	615	0.2201	34.50
A-7	36-3/4"	615	0.2037	33.19
A-8	40-9/16"	615	0.1794	31.14
A-9	43-5/8"	614	0.1538	28.82
A-10	46-5/16"	612	0.1152	24.92
B-1	1-3/16"	613	0.2326	35.43
B-2	3-7/8"	614	0.2289	35.16
B-3	6-15/16"	614	0.2671	37.98
B-4	10-3/4"	614	0.2598	37.46
B-5	16-1/4"	614	0.2536	37.01
B-6	31-1/4"	613	0.1898	32.00
B-7	36-3/4"	613	0.1761	30.83
B-8	40-9/16"	613	0.1614	29.51
B-9	43-5/8"	613	0.1376	27.25
B-10	46-5/16"	611	0.0936	22.45
Average, (group mean)		614	0.2048	32.95
Average, (wt mean)		614	---	---
Maximum		616	0.2972	40.09
Minimum		611	0.0936	22.45
Standard Deviation		1	0.0536	4.57

Ports A = North, B = East

Summary Straight Avg'd Results	
Velocity, [fps]	32.95
Velocity, [fpm]	1,977
ACFM	24,330
SCFM	13,002
DSCFM	12,870
lb/hr Air (dry)	58,931
lb/hr Air (wet)	59,309

Summary Weighted Avg Results	
Velocity, [fps]	32.95
Velocity, [fpm]	1,977
ACFM	24,330
SCFM	13,002
DSCFM	12,870
lb/hr Flue Gas (dry)	58,931
lb/hr Flue Gas (wet)	59,309

Table D-10

Traverse Data Calculated Results -- 2B Heat Pipe Secondary Air Outlet Duct
NYSEG Milliken Station

Amb Air DB, deg F	66
Amb Air WB, deg F	54
Humd, lb/lb BD Air	0.0063

Std. Conditions	
T, deg F	60
P, in. Hg	29.92

Date	10/8/96
Time	10:32-11:20
Tube I.D.	S-54
C-Factor	0.806
Operator(s)	WLM/DCM

No. Of Points	24
Duct Width	6.0 ft
Duct Depth	9.0 ft
Duct Area	54.00 Sq ft
Avg % O2	21.0
Avg % N2	79.0

Bar., " Hg	29.50
Static, " H20	3.20
% " H20	1.01
Dry MW	28.97
Wet MW	28.86

PORT/ POINT	DISTANCE Fr Bottom	TEMP Deg-F	DELTA P " H2O	VEL Ft/Sec
A-1	9"	578	0.7529	65.76
A-2	27"	587	0.6719	62.39
A-3	45"	564	0.7502	65.19
A-4	63"	530	0.9771	73.15
A-5	81"	504	1.0180	73.68
A-6	99	495	1.0100	73.04
B-1	9"	596	0.8439	70.22
B-2	27"	583	0.6843	62.84
B-3	45"	541	0.7400	64.01
B-4	63"	504	0.9025	69.37
B-5	81"	480	1.0640	74.38
B-6	99	461	0.9752	70.48
C-1	9"	602	0.8558	70.91
C-2	27"	568	0.7837	66.76
C-3	45"	463	0.6734	58.63
C-4	63"	387	0.8163	61.83
C-5	81"	327	0.9736	65.09
C-6	99	348	0.7675	58.56
D-1	9"	585	0.7572	66.16
D-2	27"	584	0.7501	65.82
D-3	45"	560	0.6748	61.71
D-4	63"	459	0.6632	58.06
D-5	81"	353	0.8309	61.12
D-6	99	287	0.9612	63.00
Average, (group mean)		498	0.8291	65.92
Average, (wt mean)		490	---	---
Maximum		602	1.0640	74.38
Minimum		287	0.6632	58.06
Standard Deviation		93	0.1242	4.89

Port A = South, D = North

Summary Straight Avg'd Results	
Velocity, [fps]	65.92
Velocity, [fpm]	3,955
ACFM	213,595
SCFM	116,142
DSCFM	114,969
lb/hr Air (dry)	526,447
lb/hr Air (wet)	529,786

Summary Weighted Avg Results	
Velocity, [fps]	65.92
Velocity, [fpm]	3,955
ACFM	213,595
SCFM	116,142
DSCFM	114,969
lb/hr Flue Gas (dry)	526,447
lb/hr Flue Gas (wet)	529,786

APPENDIX E

HEAT PIPE PRESSURE DROP DATA

Table E-1
Heat Pipe Tube Bank Pressure Drop Data

Clean Condition Results

Date	5/15/96
Time	10:45-11:30
Load, MW Gross	157.9
Econ. O2, Vol %	3.31
FG Flow Split to 2A	52.84%

2A Heat Pipe -- East/West Pressure Taps

Flue Gas Inlet T, °F	675
Flue Gas Outlet T, °F	300

		Pressure Drops, in. WC			
	Levels	A	B	C	D
Top	1-2	1.10			1.16
	2-3	0.86			1.03
Bottom	3-4	1.03			0.91
	Total	2.99			3.10

2B Heat Pipe -- East/West Pressure Taps

Flue Gas Inlet T, °F	669
Flue Gas Outlet T, °F	279

		Pressure Drops, in. WC			
	Levels	A	B	C	D
Top	1-2	1.03			1.01
	2-3	0.83			0.87
Bottom	3-4	0.83			0.88
	Total	2.69			2.77

Fouled Condition Results

Date	10/8/96
Time	17:45-18:23
Load, MW Gross	151.7
Econ. O2, Vol %	3.34
FG Flow Split to 2A	53.81%

2A Heat Pipe -- East/West Pressure Taps

Flue Gas Inlet T, °F	653
Flue Gas Outlet T, °F	326

		Pressure Drops, in. WC			
	Levels	A	B	C	D
Top	1-2	0.92	0.94	1.34	1.34
	2-3	0.53	0.60	1.33	1.30
Bottom	3-4	3.26	Taps In Use		2.07
	Total	4.71			4.71

2B Heat Pipe -- East/West Pressure Taps

Flue Gas Inlet T, °F	652
Flue Gas Outlet T, °F	341

		Pressure Drops, in. WC			
	Levels	A	B	C	D
Top	1-2	1.76	1.71	0.32	0.24
	2-3	1.77	1.78	0.38	0.38
Bottom	3-4	2.42	Taps In Use		6.27
	Total	5.95			6.89

Clean Condition Results

Date	10/22/96
Time	12:10-12:50
Load, MW Gross	161.6
Econ. O2, Vol %	3.24
FG Flow Split to 2A	51.49%

2A Heat Pipe -- East/West Pressure Taps

Flue Gas Inlet T, °F	662
Flue Gas Outlet T, °F	282

		Pressure Drops, in. WC			
	Levels	A	B	C	D
Top	1-2	1.16	1.20	1.20	1.22
	2-3	0.94	0.93	1.02	1.04
Bottom	3-4	0.90	Taps In Use		0.89
	Total	3.01			3.14

2B Heat Pipe -- East/West Pressure Taps

Flue Gas Inlet T, °F	662
Flue Gas Outlet T, °F	274

		Pressure Drops, in. WC			
	Levels	A	B	C	D
Top	1-2	1.13	1.13	1.14	1.07
	2-3	0.92	0.92	0.97	1.04
Bottom	3-4	0.78	Taps In Use		0.85
	Total	2.83			2.96

Table E-2
Heat Pipe Module-To-Module Pressure Drops
(Corrected to Common Basis)

Clean Condition Results

Date 5/15/96
Time 10:45-11:30

2A Heat Pipe
Corr Factor 0.899

	Levels	A	B	C	D	Average
		Pressure Drops, in. WC				
Top	1-2	1.03			1.09	1.06
	2-3	0.81			0.96	0.89
Bottom	3-4	0.96	Taps In Use		0.86	0.91
	Total	2.80			2.91	2.86

2B Heat Pipe
Corr Factor 1.145

	Levels	A	B	C	D	Average
		Pressure Drops, in. WC				
Top	1-2	1.30			1.28	1.29
	2-3	1.04			1.10	1.07
Bottom	3-4	1.04	Taps In Use		1.12	1.08
	Total	3.39			3.50	3.44

Clean Condition Results

Date 10/8/96
Time 17:45-18:23

2A Heat Pipe
Corr Factor 0.937

	Levels	A	B	C	D	Average
		Pressure Drops, in. WC				
Top	1-2	0.86	0.88	1.25	1.25	1.06
	2-3	0.50	0.56	1.24	1.22	0.88
Bottom	3-4	3.05	Taps In Use		1.94	2.50
	Total	4.42			4.41	4.42

2B Heat Pipe
Corr Factor 1.263

	Levels	A	B	C	D	Average
		Pressure Drops, in. WC				
Top	1-2	2.23	2.16	0.40	0.30	1.27
	2-3	2.24	2.25	0.49	0.48	1.36
Bottom	3-4	3.05	Taps In Use		7.92	5.48
	Total	7.51			8.70	8.10

Performance Test Condition Results

Date 10/22/96
Time 12:10-12:50

2A Heat Pipe
Corr Factor 0.919

	Levels	A	B	C	D	Average
		Pressure Drops, in. WC				
Top	1-2	1.07	1.10	1.11	1.12	1.10
	2-3	0.87	0.86	0.94	0.95	0.90
Bottom	3-4	0.83	Taps In Use		0.82	0.82
	Total	2.77			2.89	2.83

2B Heat Pipe
Corr Factor 1.040

	Levels	A	B	C	D	Average
		Pressure Drops, in. WC				
Top	1-2	1.18	1.18	1.19	1.11	1.16
	2-3	0.95	0.95	1.01	1.08	1.00
Bottom	3-4	0.81	Taps In Use		0.88	0.85
	Total	2.94			3.08	3.01

Common Basis: 160 MW gross Boiler Load, 680°F Flue Gas Inlet, 253 °F Flue Gas Outlet.

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APPENDIX F

HEAT PIPE PERFORMANCE CALCULATIONS

12 50

PROGRAM CALCULATES AIR HEATER PERFORMANCE FROM TEST DATA

After Entering Data Into Blocked Areas Calculate Results Using Macro \C
Print Results Using Macro \P

Description	**Unit 2A Test – 10/07/96 13:10-19:28 hrs**

Coal and Ash Data

AFC = As Fired Coal

Use ASME Mol Weights? 1=Y 0=Alt 1

	Coal Comp Wt % Dry	Wt % Wet
Moisture		5.11
C	74.69	70.87
H	4.96	4.71
N	1.44	1.37
S	2.20	2.09
O	4.81	4.56
Ash	11.90	11.29
HHV	13,358	100.00

Fly Ash Overhead	90.00%
Carbon in Refuse, %	2.25
lbs C in Refuse/lb AFC (1)	0.0024
C Burned/lb AFC	0.7063

Gas Stream Data

Flue Gas In

Ht Pipe Inlet Temp, deg F 667

	Mol %	
COMPOUND	Dry	Wet
CO2	15.560%	14.42%
CO	0.017%	0.02%
N2	81.353%	75.39%
O2	3.070%	2.84%
H2O	0.00%	7.33%
TOTAL	100.00%	100.00%

Amb Air Temp, deg F	97
Amb Air Moisture, lb/lb BD Air	0.0064
Downstream Leak Temp, deg F	148
Downstream Leak Moisture, lb/lb BD Air	0.0064
Downstream Leak Rate, lb/hr	4800
Primary Air (PA) Inlet Temp (Tpai), deg F	120
Primary Air Outlet Temp (Tpao), deg F	600
Secondary Air (SA) Inlet Temp (Tsai), deg F	102
Sec Air With Bypass Outlet Temp (Tsao), deg F	588
Primary Flue Gas Outlet Temp (Tpgo), deg F	330
Total Mols Dry Flue Gas In/lb AFC	0.3817
Total lbs Dry Flue Gas In/lb AFC (WG'14)	11.6911
Atomizing Steam (Wz), lbs/lb AFC	0.00
Steam From Ash Pit (Wm), lbs/lb AFC	0.00
Flue Gas H2O (WmGi), lbs/lb AFC	0.5440
H2O in Flue Gas, Mols/lb AFC	0.0302
Flue Gas Moisture, vol %	7.331%
Flue Gas MW	29.70
Flue Gas MW (dry)	30.63

(1) Assumption: Bottom Ash Carbon Concentration is 1/3 That of Overhead Ash.

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Flue Gas Out

Ht. Pipe Outlet Temp, deg F	321	
	Mol %	
COMPOUND	Dry	Wet
CO2	15.120%	14.04%
CO	0.015%	0.01%
N2	81.295%	75.47%
02	3.570%	3.31%
H2O	0.00%	7.16%
TOTAL	100.00%	100.00%

Mols Dry Flue Gas/lb AFC	0.3929
lbs Dry Flue Gas/lb AFC (WG'15)	12.0126
Flue Gas H2O (WmGo), lbs/lb AFC	0.5461
H2O in Flue Gas, Mols/lb AFC	0.0303
Total Flue Gas Out, lbs/hr	764578
Flue Gas Moisture, vol %	7.163%
Flue Gas MW (wet)	29.68
Flue Gas MW (dry)	30.58
Total Air Leak, wt % (AL)	**2.64**

Boiler Load, MW	142.42		
Heat Rate, Btu/KWh	10,069		
As Fired Coal Rate, Tons/hr	56.57		
lbs/hr (Wfe)	113,140		
Flow Split to Heat Pipe	53.81%	lb/hr	
Primary Air Fan Flow, lbs/lb AFC	1.7851	108,680	(3)
Primary Air (PA) Out Heat Pipe, Wpa, lbs/lb AFC	0.9269	56,429	
Cppa, Btu/mol-F (Tpao to Tpai)	7.1625		
Cppa, Btu/lb-F	0.2482		
Primary Air Bypass (PABP), lbs/lb AFC	0.8583	52,251	
Wet Flue Gas In (WF14), lbs/lb AFC	12.2351	744,883	
Cpfg, Btu/mol-F (Tfgi to Tfgo)	7.8054		
Cpfg, Btu/lb-F	0.2628		
Sootblower At Wall Air Leaks, lbs/lb AFC	0.2447	14,895	
Cpal, Btu/mol-F (Tsai to Tfgo)	7.0385		
Cpal, Btu/lb-F	0.2439		
Downstream Air Leak Rate, lbs/lb AFC	0.0788	4,800	
Cpal, Btu/mol-F (Tdsi to Tfgo)	7.0598		
Cpal, Btu/lb-F	0.2446		
SA+Bypass Rate (SA+SABP), lbs/lb AFC	8.1830	498,188	<<Ht Bal Calc
Cpsa, Btu/mol-F (Tsai to Tsao)	7.1502		
Cpsa, Btu/lb-F	0.2478		
Secondary Air Bypass (SAPB), lbs/lb AFC	0.0000	0	
Cpsabp, Btu/mol-F (Tsai to Tsao)	7.1502		
Cpsabp, Btu/lb-F	0.2478		
PA+PABP+SA+SABP+Coal, lbs/lb AFC (2)	10.8552	660,874	(3)
Calc'd Air Leakage into Boiler, lbs/lb AFC	1.3799	84,008	11.23% (3)

(2) Does Not Include Leaks Into Boiler

(3) Not Required For Performance Calculations

	CONDITIONS		
	DESIGN	ACTUAL	
Flow Rates to Heat Pipe, lb/hr			
Primary Air	62,500	56,429	
Secondary Air (No Bypass)	562,500	498,188	
Flue Gas	750,000	744,883	
Temperatures, deg F			
Primary Air In	80.0	120.0	
Primary Air Out	644.0	600.0	
2nd Air in	80.0	102.0	
2nd Air Out With Bypass	616.0	588.0	
2nd Air Out Without Bypass		588.0	
Avg Air In, (TA8)	80.0	103.8	
Avg Air Out, (TA9)	618.8	589.2	<<(Ex SA Bypass)
Flue Gas In, (TG14)	680.0	667.0	
Flue Gas Out, (TG15)	253.0	321.0	
FG Out No Leak, (TG15NL)		326.2	
Primary Air Duty, MMBtu/hr		6.723	
Sootblower Wall Leak Duty, MMBtu/hr		0.837	
Primary Flue Gas Duty, MMBtu/hr		7.559	
Primary Flue Gas Rate, lb/hr		85300	
Primary Flue Gas Rate, lb/lb AFC		1.4011	
Primary Flue Gas Outlet Temp NL, deg F		368.2	
Secondary Flue Gas Rate, lb/hr		659582	
Secondary Flue Gas Rate, lb/lb AFC		10.8340	
Secondary Flue Gas Outlet Temp, deg F		320.8	

Pressure Drops, in. wc	**Design**	**Measured**
Primary Air, (DP8_9)	3.60	2.27
Secondary Air, (DP8_9)	5.35	3.98
Flue Gas, (DP14_15)		
Primary Flue Gas	3.65	6.10
Secondary Flue Gas	3.65	6.10

Pressure Drops Corrected for Deviation From Design Flow and Design Temp

Gas Side (DPs(14-15), in. wc (4)	**5.89**	
Pressure Drop is	**2.24**	in. wc Greater Than Design
Air Side (DPs(8-9), in. wc		
Primary Air Section	**2.79**	
Pressure Drop is	**-0.81**	in. wc Less Than Design
Secondary Air Section	**5.09**	
Pressure Drop is	**-0.26**	in. wc Less Than Design

(4) Average In/Out Flue Gas Flow Used In Calculation.

Correction Calculations For Heat Pipe -- Design Condition Results

		Curve 1	Curve 2 (Ea Limited)	
Flue Gas Inlet Temp, deg F	TG14D	680.00	680.00	
Pri Air (PA) Inlet Temp, deg F	TA8D	80.00	80.00	
Sec Air (SA) Inlet Temp, deg F	T'A8D	80.00	80.00	
PA Outlet, deg F	Tpa9D	649.75	649.75	
SA Outlet, deg F	Tsa9D	617.20	617.20	
Pri Flue Gas (PFG) Outlet, deg F	TPFG15D	309.66	309.66	
Sec Flue Gas (SFG) Outlet, deg F	TSFG15D	243.92	243.92	
PFG Rate, Mlb/hr	WPFGD	182.70	182.70	
SFG Rate, Mlb/hr	WSFGD	1317.30	1317.30	
Combined Outlet T, deg F		251.93	251.93	
PA Side Effectiveness	Ea	0.9496	0.9492	<Curve 2 Limit
PA X-Ratio	X Design	0.6500	0.6500	
PA fg	fpgD	1.0001	1.0001	
PA fx	fpxD	0.9991	0.9987	
	Eg	0.6172	0.6170	
Calculated TPFG Out, deg F	TPFG15D	309.66	309.81	
SA Side Effectiveness	Ea	0.8953	0.9300	<Curve 2 Limit
SA X-Ratio (Design)	X Design	0.8118	0.8118	
SA fg	fsgD	1.0004	1.0004	
SA fx	fsxD	1.0001	1.0388	
	Eg	0.7268	0.7549	
Calculated TSFG Out, deg F	TSFG15D	243.91	227.04	
Combined Outlet T, deg F		251.92	237.12	

Correction Calculations For Heat Pipe -- Operating Condition Results

Ambient Temp, deg F	Tamb	97.00
Sootblower Wall Air Leak, wt % PFG	Al	17.46
Cpa (Tpfg15-Tamb), Btu/lb-F	CpA	0.2411
Cpg (Tpfgnl15-Tpg15), Btu/lb-F	CpG	0.2569
Flue Gas Inlet Temp, deg F	TG14	667.00
PA Inlet Temp, deg F	TA8	120.00
SA Inlet Temp, deg F	T'A8	102.00
PA Outlet Temp, deg F	Tpa9	600.00
SA Outlet Temp (No Bypass), deg F	Tsa9	588.00
PFG Outlet Temp, deg F	TPG15	330.00
PFG Outlet Temp (No Leak), deg F	TPFG15NL	368.19
SFG Outlet Temp, deg F	TSFG15	320.85
PFG Rate, Mlb/hr	WPFG	85.30
SFG Rate, Mlb/hr	WSFG	659.58
Sootblower Wall Air Leak Into PFG, Mlb/hr	WAL1	14.90
Constant, Al/100*CpA/CpG*(TPG15-Tamb)		38.19
PA Side Effectiveness	Epa	0.8775
SA Side Effectiveness	Esa	0.8602
X-Ratios	Xp	0.6225
	Xs	0.7123
PA Eg	Epg	0.5463
SA Eg	Esg	0.6127

Correction Factors		**Pri Flue Gas**		**Sec Flue Gas**
	fpg	1.0043	fsg	1.0002
	fpgD	1.0001	fsgD	1.0004
	fpx	0.9658	fsx	0.9159
	fpxD	0.9991	fsxD	1.0001
	TPFG15D	309.66	TSFG15D	243.91
Performance NL	TPFG15	339.25	TSFG15	290.96

Primary Flue Gas Corrections For Differences From:	
Design Entering Air Temperature, TPFG15DA, deg F	305.36
Design Entering Flue Gas Temperature, TPFG15DG, deg F	334.99
Design X-Ratio (No Leak), TPFG15DX, deg F	317.66
Air Leak Correction, deg F	38.19
Design Flue Gas Flow Rate, TPFG15DGR, deg F	331.56
Secondary Flue Gas Corrections for Differences From:	
Design Entering Air Temperature, TSFG15DA, deg F	307.37
Design Entering Flue Gas Temperature, TSFG15DG, deg F	325.88
Design X-Ratio, TSFG15DX, deg F	284.13
Design Flue Gas Flow Rate, TSFG15DGR, deg F	320.79
PFG Totally Corrected Outlet Temp, deg F	337.76
SFG Totally Corrected Outlet Temp, deg F	275.64
Avg FG Outlet Totally Corrected T, TG15_Total, deg F	**282.75**

Summary of Specific Heat Calculation Results

	T1 °F	T2 °F	Cp Btu/lb-°F
Calculation of Pri, Sec, and Air Leak Cps Over Inlet to Outlet Temp Ranges			
Cp for Primary Air From Tpai to Tpao	120.0	600.0	0.2482
Cp Secondary Air From Tsai to Tsao	102.0	588.0	0.2478
Cp Air Leak From Tamb to Tfgo	97.0	321.0	0.2439
Cp Downstream Leak From Tdsi to Tfgo	148.0	321.0	0.2446
Secondary Air Outlet Temperature Correction For Bypass Flow			
Cp for Secondary Air From Tsai to Tsao'	102.0	588.0	0.2478
Cp for Secondary Air From Tsao to Tsao'	588.0	588.0	0.2546
Calculation of Average Air Inlet Temperature			
Cp of Primary Air Between Tpai and Taia (TA8)	120.0	103.8	0.2411
Cp of Secondary Air Between Tsai and Taia (TA8)	102.0	103.8	0.2408
Calculation of Average Air Outlet Temperature			
Cp of Primary Air Between Tpao and Taoa (TA9)	600.0	589.2	0.2548
Cp of Secondary Air Between Tsao and Taoa (TA9)	588.0	589.2	0.2546
Cp of Air Between Taia and Taoa (TA8 to TA9)	103.8	589.2	0.2478
Calculation of Flue Gas Outlet Temp for No Leak Case (NL)			
Cp for Outlet Flue Gas Between Tfgo (TG15) and Tfgonl (TG15NL)	321.0	326.2	0.2558
Cp of Air Leak Between Tsai to Tfgo (TG15)	102.0	321.0	0.2440
Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgo (TG15)	667.0	321.0	0.2628
Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgonl (TG15NL)	667.0	326.2	0.2629
Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgo (TPFG15)	667.0	330.0	0.2630
Cp for Primary Flue Gas Between Tpfgo (TPFG15) and Tpfgonl (TPFG15NL)	330.0	368.2	0.2569
Cp for Sootblower Air Leak From Tamb to Tpfgo	97.0	330.0	0.2411
Cp for Sootblower Air Leak From Tpfgo (TPFG15) to Tfgo (TG15)	330.0	321.0	0.2443
Calculation of Secondary Flue Gas Outlet Temperature			
Cp for Secondary Flue Gas Between Tsfgo (TSFG15) and Tfgo (TG15)	320.8	321.0	0.2557
Cp for Primary Flue Gas Between Tfgo (TG15) and Tpfgo (TPFG15)	321.0	330.0	0.2559
Cp for Secondary Flue Gas Between Tfgi (TG14) and Tsfgo (TSFG15)	667.0	320.8	0.2628
Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgonl (TPFG15NL)	667.0	368.2	0.2637

Note – air (a), average (a), ambient (amb), downstream (ds), flue gas (fg), in (i), out (o), no leak (nl), primary (p), secondary (s)
Numbers in variable names are consistant with Power Test Code, PTC 4.3, inlet/outlet stream numbering system.

1256

PROGRAM CALCULATES AIR HEATER PERFORMANCE FROM TEST DATA
After Entering Data Into Blocked Areas Calculate Results Using Macro \C
Print Results Using Macro \P

Description Unit 2B Test – 10/08/96 09:00-12:40 hrs

Coal and Ash Data

AFC = As Fired Coal

Use ASME Mol Weights? 1=Y 0=Alt 1

	Coal Comp	
	Wt % Dry	Wt % Wet
Moisture		6.49
C	73.14	68.39
H	4.84	4.53
N	1.40	1.31
S	2.57	2.40
O	4.93	4.61
Ash	13.12	12.27
HHV	13,117	100.00

Fly Ash Overhead	90.00%
Carbon in Refuse, %	1.61
lbs C in Refuse/lb AFC (1)	0.0019
C Burned/lb AFC	0.6821

Gas Stream Data

Flue Gas In

Ht Pipe Inlet Temp, deg F 655

	Mol %	
COMPOUND	Dry	Wet
CO2	14.340%	13.33%
CO	0.007%	0.01%
N2	81.173%	75.48%
O2	4.480%	4.17%
H2O	0.00%	7.02%
TOTAL	100.00%	100.00%

Amb Air Temp, deg F	87
Amb Air Moisture, lb/lb BD Air	0.0064
Downstream Leak Temp, deg F	148
Downstream Leak Moisture, lb/lb BD Air	0.0064
Downstream Leak Rate, lb/hr	0
Primary Air (PA) Inlet Temp (Tpai), deg F	112
Primary Air Outlet Temp (Tpao), deg F	614
Secondary Air (SA) Inlet Temp (Tsai), deg F	93
Sec Air With Bypass Outlet Temp (Tsao), deg F	490
Primary Flue Gas Outlet Temp (Tpgo), deg F	368
Total Mols Dry Flue Gas In/lb AFC	0.4011
Total lbs Dry Flue Gas In/lb AFC (WG'14)	12.2273
Atomizing Steam (Wz), lbs/lb AFC	0.00
Steam From Ash Pit (Wm), lbs/lb AFC	0.00
Flue Gas H2O (WmGi), lbs/lb AFC	0.5452
H2O in Flue Gas, Mols/lb AFC	0.0303
Flue Gas Moisture, vol %	7.016%
Flue Gas MW	29.61
Flue Gas MW (dry)	30.49

(1) Assumption: Bottom Ash Carbon Concentration is 1/3 That of Overhead Ash.

Flue Gas Out

Ht. Pipe Outlet Temp, deg F	331	
	Mol %	
COMPOUND	Dry	Wet
CO2	13.990%	13.03%
CO	0.007%	0.01%
N2	81.124%	75.54%
O2	4.880%	4.54%
H2O	0.00%	6.88%
TOTAL	100.00%	100.00%

Mols Dry Flue Gas/lb AFC	0.4111
lbs Dry Flue Gas/lb AFC (WG'15)	12.5173
Flue Gas H2O (WmGo), lbs/lb AFC	0.5470
H2O in Flue Gas, Mols/lb AFC	0.0304
Total Flue Gas Out, lbs/hr	689494
Flue Gas Moisture, vol %	6.878%
Flue Gas MW (wet)	29.59
Flue Gas MW (dry)	30.45

Total Air Leak, wt % (AL) **2.29**

Boiler Load, MW	142.18		
Heat Rate, Btu/KWh	9,857		
As Fired Coal Rate, Tons/hr	57.13		
lbs/hr (Wfe)	114,260		
Flow Split to Heat Pipe	46.19%	lb/hr	
Primary Air Fan Flow, lbs/lb AFC	2.0388	107,600	(3)
Primary Air (PA) Out Heat Pipe, Wpa, lbs/lb AFC	1.1238	59,309	
Cppa, Btu/mol-F (Tpao to Tpai)	7.1648		
Cppa, Btu/lb-F	0.2483		
Primary Air Bypass (PABP), lbs/lb AFC	0.9150	48,291	
Wet Flue Gas In (WF14), lbs/lb AFC	12.7724	674,087	
Cpfg, Btu/mol-F (Tfgi to Tfgo)	7.7664		
Cpfg, Btu/lb-F	0.2623		
Sootblower At Wall Air Leaks, lbs/lb AFC	0.2919	15,408	
Cpal, Btu/mol-F (Tsai to Tfgo)	7.0384		
Cpal, Btu/lb-F	0.2439		
Downstream Air Leak Rate, lbs/lb AFC	0.0000	0	
Cpal, Btu/mol-F (Tdsi to Tfgo)	7.0640		
Cpal, Btu/lb-F	0.2448		
SA+Bypass Rate (SA+SABP), lbs/lb AFC	9.4907	500,886	<<Ht Bal Calc
Cpsa, Btu/mol-F (Tsai to Tsao)	7.1065		
Cpsa, Btu/lb-F	0.2463		
Secondary Air Bypass (SAPB), lbs/lb AFC	0.0000	0	
Cpsabp, Btu/mol-F (Tsai to Tsao)	7.1065		
Cpsabp, Btu/lb-F	0.2463		
PA+PABP+SA+SABP+Coal, lbs/lb AFC (2)	12.4068	654,788	(3)
Calc'd Air Leakage into Boiler, lbs/lb AFC	0.3657	19,299	2.88% (3)

(2) Does Not Include Leaks Into Boiler

(3) Not Required For Performance Calculations

	CONDITIONS		
	DESIGN	ACTUAL	
Flow Rates to Heat Pipe, lb/hr			
Primary Air	62,500	59,309	
Secondary Air (No Bypass)	562,500	500,886	
Flue Gas	750,000	674,087	
Temperatures, deg F			
Primary Air In	80.0	112.0	
Primary Air Out	644.0	614.0	
2nd Air in	80.0	93.0	
2nd Air Out With Bypass	616.0	490.0	
2nd Air Out Without Bypass		490.0	
Avg Air In, (TA8)	80.0	95.0	
Avg Air Out, (TA9)	618.8	503.2	<<(Ex SA Bypass)
Flue Gas In, (TG14)	680.0	655.0	
Flue Gas Out, (TG15)	253.0	331.0	
FG Out No Leak, (TG15NL)		336.2	
Primary Air Duty, MMBtu/hr		7.392	
Sootblower Wall Leak Duty, MMBtu/hr		1.046	
Primary Flue Gas Duty, MMBtu/hr		8.438	
Primary Flue Gas Rate, lb/hr		111786	
Primary Flue Gas Rate, lb/lb AFC		2.1181	
Primary Flue Gas Outlet Temp NL, deg F		404.3	
Secondary Flue Gas Rate, lb/hr		562301	
Secondary Flue Gas Rate, lb/lb AFC		10.6543	
Secondary Flue Gas Outlet Temp, deg F		322.6	

Pressure Drops, in. wc	Design	Measured
Primary Air, (DP8_9)	3.60	2.18
Secondary Air, (DP8_9)	5.35	3.45
Flue Gas, (DP14_15)		
Primary Flue Gas	3.65	7.67
Secondary Flue Gas	3.65	7.67

Pressure Drops Corrected for Deviation From Design Flow and Design Temp

Gas Side (DPs(14-15), in. wc (4)	**9.02**	
Pressure Drop is	**5.37**	in. wc Greater Than Design
Air Side (DPs(8-9), in. wc		
Primary Air Section	**2.42**	
Pressure Drop is	**-1.18**	in. wc Less Than Design
Secondary Air Section	**4.68**	
Pressure Drop is	**-0.67**	in. wc Less Than Design

(4) Average In/Out Flue Gas Flow Used In Calculation.

Correction Calculations For Heat Pipe -- Design Condition Results

		Curve 1	Curve 2 (Ea Limited)	
Flue Gas Inlet Temp, deg F	TG14D	680.00	680.00	
Pri Air (PA) Inlet Temp, deg F	TA8D	80.00	80.00	
Sec Air (SA) Inlet Temp, deg F	T'A8D	80.00	80.00	
PA Outlet, deg F	Tpa9D	649.75	649.75	
SA Outlet, deg F	Tsa9D	617.20	617.20	
Pri Flue Gas (PFG) Outlet, deg F	TPFG15D	309.66	309.66	
Sec Flue Gas (SFG) Outlet, deg F	TSFG15D	243.92	243.92	
PFG Rate, Mlb/hr	WPFGD	182.70	182.70	
SFG Rate, Mlb/hr	WSFGD	1317.30	1317.30	
Combined Outlet T, deg F		251.93	251.93	
PA Side Effectiveness	Ea	0.9496	0.9492	<Curve 2 Limit
PA X-Ratio	X Design	0.6500	0.6500	
PA fg	fpgD	1.0001	1.0001	
PA fx	fpxD	0.9991	0.9987	
	Eg	0.6172	0.6170	
Calculated TPFG Out, deg F	TPFG15D	309.66	309.81	
SA Side Effectiveness	Ea	0.8953	0.9300	<Curve 2 Limit
SA X-Ratio (Design)	X Design	0.8118	0.8118	
SA fg	fsgD	1.0004	1.0004	
SA fx	fsxD	1.0001	1.0388	
	Eg	0.7268	0.7549	
Calculated TSFG Out, deg F	TSFG15D	243.91	227.04	
Combined Outlet T, deg F		251.92	237.12	

Correction Calculations For Heat Pipe -- Operating Condition Results

Ambient Temp, deg F	Tamb	87.00
Sootblower Wall Air Leak, wt % PFG	Al	13.78
Cpa (Tpfg15-Tamb), Btu/lb-F	CpA	0.2415
Cpg (Tpfgnl15-Tpg15), Btu/lb-F	CpG	0.2580
Flue Gas Inlet Temp, deg F	TG14	655.00
PA Inlet Temp, deg F	TA8	112.00
SA Inlet Temp, deg F	T'A8	92.98
PA Outlet Temp, deg F	Tpa9	614.00
SA Outlet Temp (No Bypass), deg F	Tsa9	490.00
PFG Outlet Temp, deg F	TPG15	368.00
PFG Outlet Temp (No Leak), deg F	TPFG15NL	404.25
SFG Outlet Temp, deg F	TSFG15	322.65
PFG Rate, Mlb/hr	WPFG	111.79
SFG Rate, Mlb/hr	WSFG	562.30
Sootblower Wall Air Leak Into PFG, Mlb/hr	WAL1	15.41
Constant, Al/100*CpA/CpG*(TPG15-Tamb)		36.25
PA Side Effectiveness	Epa	0.9245
SA Side Effectiveness	Esa	0.7064
X-Ratios	Xp	0.4995
	Xs	0.8371
PA Eg	Epg	0.4618
SA Eg	Esg	0.5914

Correction Factors		**Pri Flue Gas**		**Sec Flue Gas**
	fpg	0.9859	fsg	1.0133
	fpgD	1.0001	fsgD	1.0004
	fpx	0.7980	fsx	1.0189
	fpxD	0.9991	fsxD	1.0001
	TPFG15D	309.66	TSFG15D	243.91
Performance NL	TPFG15	391.14	TSFG15	233.44

Primary Flue Gas Corrections For Differences From:	
Design Entering Air Temperature, TPFG15DA, deg F	351.09
Design Entering Flue Gas Temperature, TPFG15DG, deg F	379.79
Design X-Ratio (No Leak), TPFG15DX, deg F	293.43
Air Leak Correction, deg F	36.25
Design Flue Gas Flow Rate, TPFG15DGR, deg F	362.72

Secondary Flue Gas Corrections for Differences From:	
Design Entering Air Temperature, TSFG15DA, deg F	314.97
Design Entering Flue Gas Temperature, TSFG15DG, deg F	332.86
Design X-Ratio, TSFG15DX, deg F	330.85
Design Flue Gas Flow Rate, TSFG15DGR, deg F	328.30
PFG Totally Corrected Outlet Temp, deg F	319.29
SFG Totally Corrected Outlet Temp, deg F	339.04
Avg FG Outlet Totally Corrected T, TG15_Total, deg F	**335.76**

Summary of Specific Heat Calculation Results

	T1 °F	T2 °F	Cp Btu/lb-°F
Calculation of Pri, Sec, and Air Leak Cps Over Inlet to Outlet Temp Ranges			
Cp for Primary Air From Tpai to Tpao	112.0	614.0	0.2483
Cp Secondary Air From Tsai to Tsao	93.0	490.0	0.2463
Cp Air Leak From Tamb to Tfgo	87.0	331.0	0.2439
Cp Downstream Leak From Tdsi to Tfgo	148.0	331.0	0.2448
Secondary Air Outlet Temperature Correction For Bypass Flow			
Cp for Secondary Air From Tsai to Tsao'	93.0	490.0	0.2463
Cp for Secondary Air From Tsao to Tsao'	490.0	490.0	0.2519
Calculation of Average Air Inlet Temperature			
Cp of Primary Air Between Tpai and Taia (TA8)	112.0	95.0	0.2408
Cp of Secondary Air Between Tsai and Taia (TA8)	93.0	95.0	0.2405
Calculation of Average Air Outlet Temperature			
Cp of Primary Air Between Tpao and Taoa (TA9)	614.0	503.2	0.2538
Cp of Secondary Air Between Tsao and Taoa (TA9)	490.0	503.2	0.2521
Cp of Air Between Taia and Taoa (TA8 to TA9)	95.0	503.2	0.2465
Calculation of Flue Gas Outlet Temp for No Leak Case (NL)			
Cp for Outlet Flue Gas Between Tfgo (TG15) and Tfgonl (TG15NL)	331.0	336.2	0.2559
Cp of Air Leak Between Tsai to Tfgo (TG15)	93.0	331.0	0.2440
Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgo (TG15)	655.0	331.0	0.2623
Cp for Inlet Flue Gas Between Tfgi (TG14) and Tfgonl (TG15NL)	655.0	336.2	0.2624
Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgo (TPFG15)	655.0	368.0	0.2630
Cp for Primary Flue Gas Between Tpfgo (TPFG15) and Tpfgonl (TPFG15NL)	368.0	404.3	0.2580
Cp for Sootblower Air Leak From Tamb to Tpfgo	87.0	368.0	0.2415
Cp for Sootblower Air Leak From Tpfgo (TPFG15) to Tfgo (TG15)	368.0	331.0	0.2450
Calculation of Secondary Flue Gas Outlet Temperature			
Cp for Secondary Flue Gas Between Tsfgo (TSFG15) and Tfgo (TG15)	322.6	331.0	0.2556
Cp for Primary Flue Gas Between Tfgo (TG15) and Tpfgo (TPFG15)	331.0	368.0	0.2566
Cp for Secondary Flue Gas Between Tfgi (TG14) and Tsfgc (TSFG15)	655.0	322.6	0.2621
Cp for Primary Flue Gas Between Tfgi (TG14) and Tpfgonl (TPFG15NL)	655.0	404.3	0.2637

Note -- air (a), average (a), ambient (amb), downstream (ds), flue gas (fg), in (i), out (o), no leak (nl), primary (p), secondary (s)
Numbers in variable names are consistant with Power Test Code, PTC 4.3, inlet/outlet stream numbering system.