Appendix 5.0-3

EVALUATION OF THE EFFECT OF MICRONIZED COAL INJECTION ON UNIT 1 ELECTROSTATIC PRECIPITATOR PERFORMANCE

MILLIKEN CLEAN COAL TECHNOLOGY DEMONSTRATION PROJECT

EVALUATION OF THE EFFECT OF MICRONIZED COAL INJECTION ON UNIT 1 ELECTROSTATIC PRECIPITATOR PERFORMANCE

INTERIM REPORT

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LIST OF ABBREVIATIONS

°F	Degrees Fahrenheit
°R	Degrees Rankine, Absolute Temperature
" Hg	Inches of Mercury
0% O_2	Value Calculated on Oxygen Free Basis
% ISO	Percent Isokinetic Sampling Rate
μm	Micrometers
A	Ampere(s)
ABS	Absolute
acfm	Actual Cubic Feet per Minute
ASTM	American Society for Testing and Materials
Amps	Amperes
An	Area of Sampling Nozzle, ft^2
Avg	Average
$BaCl_2$	Barium Chloride
C-Factor	Pitot Tube Calibration Factor
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CONSOL R&D	CONSOL Inc., Research & Development
Delta H	Dry Test Meter Orifice Calibration
dscf	Dry Standard Cubic Feet
dscfm	Dry Standard Cubic Feet per Minute
EPA	U. S. Environmental Protection Agency
ESP	Electrostatic Precipitator
F-Factor	Fuel Factor Relating Flue Gas Volume to Coal Composition
fpm	Feet per Minute
fps	Feet per Second
ft	Foot
ft^2	Square Foot
ft^3	Cubic Foot
gr	Grains
gr/dscf	Grains per Dry Standard Cubic Foot
H_2O	Water
H_2O_2	Hydrogen Peroxide
Hg	Mercury
h (hr)	Hour
kacfm	Actual Cubic Feet per Minute x 1000
kV	Kilovolts
kWh	Kilowatts per Hour
lb/lb-Mole	Pound(s) per Pound-Mole
lb/hr	Pound(s) per Hour
lb/MM Btu	Pound(s) per Million British Thermal Units of Heat Input
MACS	Miniature Acid Condensation System

LIST OF ABBREVIATIONS (Cont.)

mA	Milliamperes
min	Minute
mm	Millimeters
min	Minutes
MM Btu	Million British Thermal Units
MWe	Electrical Generation Station Power Rating, Megawatts–Electric
N_2	Nitrogen Gas
ND	Not Determined
NO_x	Nitrous Oxides, Stoichiometry Unknown
O_2	Oxygen Gas
PC	Pulverized Coal
PM	Particulate Matter, Particularly Apparent Solids Contained in Flue Gas
ppmv	Parts per Million, Volumetric Basis
PRSD	Percent Relative Standard Deviation
QA/QC	Quality Assurance / Quality Control
"S" Pitot	Stausscheibe or Reverse Type Pitot Tube
SCA	Specific Collection Area, i.e. ft^2 of ESP Plate Area per ft^3 of Flue Gas
SDEV	Standard Deviation
SO_2	Sulfur Dioxide
SO_3	Sulfur Trioxide
SO_x	Combined Sulfur Dioxide and Sulfur Trioxide
Std Dev	Standard Deviation
Std ft^3	Cubic Foot at Standard Conditions
Temp	Temperature
TC	Thermocouple
TR	Transformer–Rectifier
tph	Tons per Hour
V–I Curve	Voltage–Current Relationship, Especially in Reference to ESP
Vol	Volume
wt	Weight
Y-Factor	Dry Test Meter Volume Calibration

EPA METHODS

Method 1	Sample Point Selection
Method 2	Determination of Volumetric Gas Flow
Method 3	Determination of Gas Composition (ORSAT)
Method 4	Determination of Flue Gas Moisture
Method 6	Determination of SO_2 Emissions
Method 17	Determination of Particulate Matter (In–Stack Filter Method)

EXECUTIVE SUMMARY

The performance of an electrostatic precipitator (ESP) at a 160 MW_e pulverized coal-fired power plant firing a medium-sulfur, bituminous coal was evaluated in September 1998 during injection of micronized coal to reduce NO_x formation. No significant effect on the collection efficiency of the ESP was observed, but absolute particulate emissions did increase because of the higher ESP inlet loading. NYSEG had recently rebuilt the ESP to improve its effectiveness. New internals, new computer controlled transformer-rectifier sets, and an additional third field were installed. The plates have a 16-inch spacing. The micronized coal was injected in a reburn mode to reduce NO_x formation.

Although there were notable differences in the parameters that affect ESP performance between the initial baseline operation and the micronized coal reburn (MCR) case, the performance, as measured by removal efficiency, was similar. These results are specific for the wide-plate spacing retrofit of the Milliken ESP.

INTRODUCTION

NYSEG extensively modified the Milliken Station to accommodate a wet scrubber, flue gas desulfurization system. Modifications included upgrading the electrostatic precipitators (ESPs) on both units. The internals of the top portion of the ESPs were replaced using a wide plate spacing design by Belco Technologies Corp. New, computer controlled transformer-rectifier (TR) sets were also installed. The physical characteristics of the new ESPs are shown in the following table.

Precipitator Characteristics

Date Built	1993
Plate Spacing, inches	16
Plate Height, feet	30
Fields	3
Field Depth, feet, each	9
Gas Velocity, fps	3.7
SCA, ft^2/1,000 acfm gas @ full load	175

As shown, the plate spacing is sixteen inches and the SCA at full load is 175 ft^2 per 1,000 acfm of flue gas. Currently both Milliken Station units have identical ESPs. Each consists of two separate, parallel sections: a south, or "A", ESP and a north, or "B", ESP. Gas flow is evenly split between these sections dividing upstream of the air heaters and rejoining at the scrubber entrance. Each section has an additional divider wall that runs the length of the ESP box. The south and north sections are identical, parallel precipitators with three separate TR sets for each side. The two sections are enclosed in a single box. Design specifications for the ESPs built by Belco Technologies Corp. are tabulated in Appendix B of the Unit 2 Report.[1]

Data were obtained from two sources: a field test of the ESP performance conducted by CONSOL Research & Development and the Milliken Station data logger. Generally, the testing procedures used in this evaluation were the same as those used previously on Unit 2. Details of that testing procedure are published in *Unit 2 Electrostatic Precipitator Performance Test Results Before and After Modification.*[1] For the Unit 1 evaluation, detailed particulate sizes were not determined. This report provides the flue gas conditions and particle statistics as measured at the inlet and exit of both the north and south sides of the Unit 1 ESP. Appendix A contains a brief discussion of the sample port locations and general sampling procedure. It also lists the coal and ash analyses and the data from the performance testing. Gas flow rates, humidities, and temperatures measured during the field test are contained in Appendix B. The Milliken data logger provided general operating conditions and an indication of boiler and ESP operating stability during the field test. Averages of the operating parameters required are listed in Appendix B; selected instantaneous values will be presented later. An evaluation of the Unit 2 performance after modification was used as a baseline for this evaluation. The data for these earlier tests are listed along with the new, Unit 1 data in Appendices A and B.

The ESP field report discusses the test methods and results of duplicate testing of the Unit 1 ESP.[1] Inlet and exit data were obtained during the field testing for several parameters. The following parameters are included in this report:

Total particulate matter (PM)
Flue gas composition (O_2 and H_2O)
Volumetric flue gas flow rate
Flue gas temperature

Coal and ash samples were collected during the field test. The coal was analyzed as a single composite. The fly ash analyses were averaged.

One day of sampling was employed for the ESP. While the repeat trials were consistent, the performance appears to improve with time. As will be discussed, this may be the result of a system upset during the first test. The operating data for the boiler and individual TR sets are listed in Appendix B.

DISCUSSION OF THE RESULTS

Three sets of inlet and outlet particle data were collected during the study of the effect of firing micronized coal on the Unit 1 ESP performance. Since a baseline evaluation of this coal on the Unit 1 ESP performance was not conducted, the results are compared to a previous evaluation of the Unit 2 ESP at similar conditions. Since the units are similar, this should not present a problem. During the Unit 2 ESP test periods, samples were collected individually for each side of the ESP, rather than a single sample as in this test program. Tables A-1 and A-2 list the coal and ash analyses for these two evaluations. The ash analyses were not determined for the Unit 1 evaluation.

The Unit 2 data, October 17-20, 1995, represent periods of very stable boiler operation as shown in Figure 1 (middle and bottom plots). Operation was far less stable during the micronized coal tests on Unit 1, September 9, 1998 as shown in the top plot on this same figure. Unlike the previous test periods, NYSEG was unable to baseload the unit.

Similarly, the ESP secondary voltage and current readings are stable for the baseline Unit 2 operation, while those of the Unit 1 TR sets show wide fluctuations. Specifically at 9:00 a.m. on September 9, 1998 during the line-out period, the Unit 1 TR sets indicate a severe disturbance. After that, they are relatively stable. This is shown on Figures 2-7. ESP TR sets A1, A2, B2, B3, and to a lesser extent A3 show wide fluctuations from about 7:30 a.m. to 10:00 a.m. In general, energization levels are about the same for comparable ESP fields during the baseline and MCR tests.

Figure 8 also shows an upset as indicated by the opacity reading during the same period and again shortly after noon. This latter upset is in the midst of the first duct sampling period and probably led to increased in the particulate loadings.

Penetration will be used to evaluate differences in ESP performance. Total particulate concentrations into and out of the ESP were collected as part of the procedure for each trial. These measurements were used to calculate the penetration. Penetration is defined as:

$$\text{Penetration} = 100 - \text{Percent Removal}$$

or

$$\text{Penetration} = 100 - \left[\frac{\text{Concentration of Solids in Outlet}}{\text{Concentration of Solids in Inlet}}\right] \cdot 100$$

Since ESP performance, as indicated by percent removal, is constant for a given fly ash-size fraction, the penetration should be independent of micronized coal injection assuming that the size consist of the fly ash was the same for both determinations.

Figure 9 shows the penetration values for the baseline Unit 2 tests and the micronized coal test on Unit 1. The averages of the six baseline and of the three micronized tests are illustrated by the thick horizontal lines. While it appears that the penetration levels are higher for the micronized test, this is not a statistically valid conclusion. Statistically, there is no difference between the two averages. The dashed line at ~2.5% penetration shows the ~3 standard deviation error bar for the baseline tests. The Unit 1 average penetration (1.75%) is well below this, the 99% confidence interval limit. If test No. 1 for Unit 1 is omitted, the two averages are identical even though the carbon content of the fly ash is almost twice as high during the Unit 1 test. Thus, burning micronized coal in the boiler did not adversely affect the fly ash penetration for the Milliken ESP.

Particle size information was not requested for the Unit 1 evaluation. As a result, the penetration could not be modeled with sufficient accuracy and no attempt was made to do so. One would expect that the fly ash might have a finer size consist during the micronized coal tests, but the size consist was not measured. The loading was much higher as shown in Table 1. On a grains per dry standard cubic foot basis, the fly ash loading is 30% higher during the micronized coal tests. Even with a constant penetration, the absolute particulate emission increased by 30%.

Similarly the SO_3 levels were probably higher during the Unit 1 tests. Although SO_3 was not measured directly, some inferences can be made based on the SO_2 values, which were determined. Table 2 shows the average SO_2 loadings during the Unit 2 and Unit 1 testing periods. The SO_2 levels were more than 60% greater during the Unit 1 tests. Normally, it would be expected that the SO_3 levels would also be higher.

The higher SO_3 levels might compensate for the expected finer size consist during the Unit 1 evaluation. However, the required data were not obtained and this theory cannot be confirmed.

Additional observations may be made from the test data tables in the Appendices. ESP operating temperatures are similar in both tests. Carbon contents in the ash are higher for the MCR test (Table A-1). The solids loading is higher in the MCR test. When combined, these observations lead to the conclusion that they compensate for one another. The higher SO_2 (and probably SO_3) levels in the MCR test would lower the resistivity as would the higher carbon content. The lower resistivity would normally increase the removal efficiency. The finer particle size, expected due to the addition of the micronized coal above the normal fuel feed point, would reduce ESP efficiency. Overall it appears these effects compensated for each other resulting in no significant change in penetration.

CONCLUSIONS

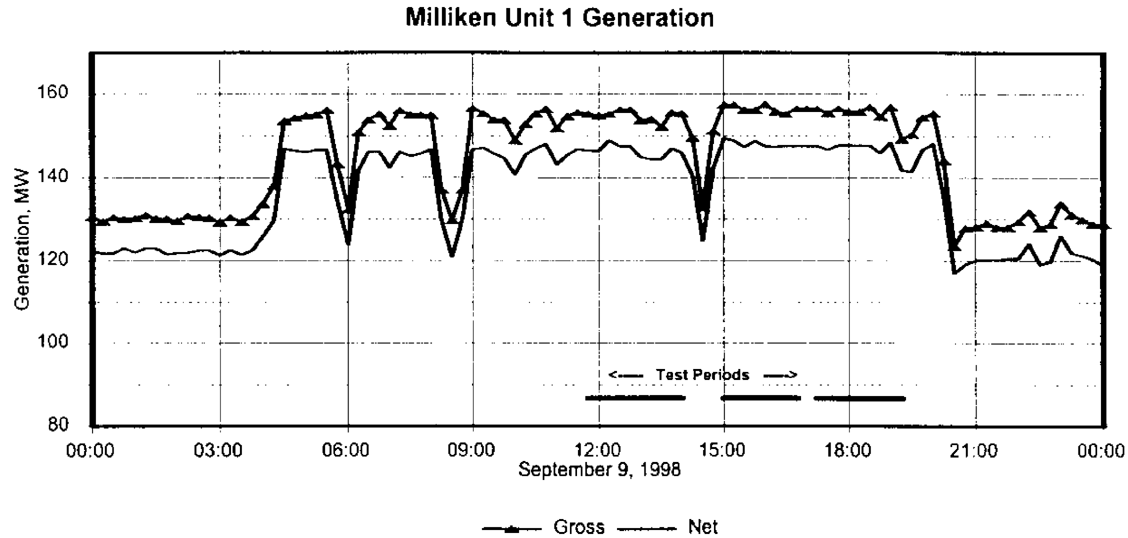
Overfire micronized coal addition does not adversely affect the performance of the Milliken electrostatic precipitator, as measured by removal efficiency or penetration, although the carbon content of the fly ash increases from 2.4% to 3.7%. However, absolute emission increased approximately 30% due to the increase in ESP inlet loadings.

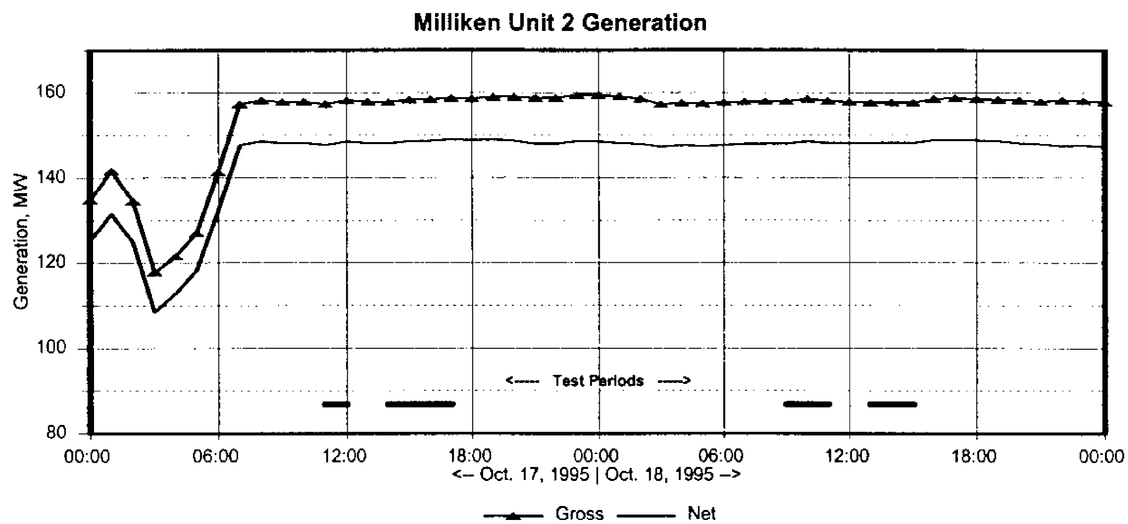
REFERENCE

1. Maskew, J. T. and DeVito, M. S. *"Milliken Clean Coal Technology Demonstration Project, Unit 2 Electrostatic Precipitator Performance Test Results Before and After Modification, Final Report,"* a report to New York State Electric & Gas Corporation, November 1996.

Figure 1

Electric Generation of Tested Unit During Test Programs





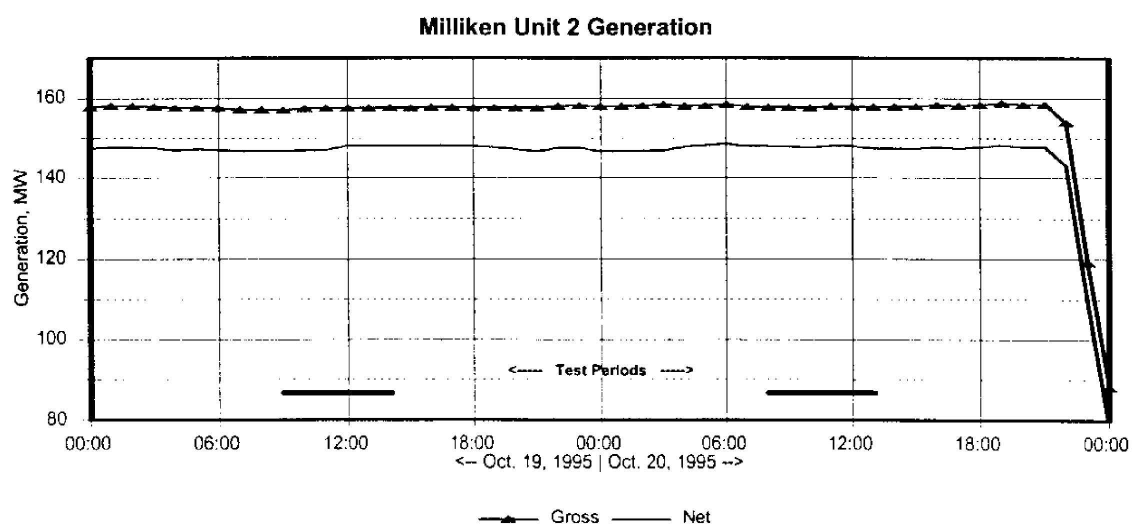
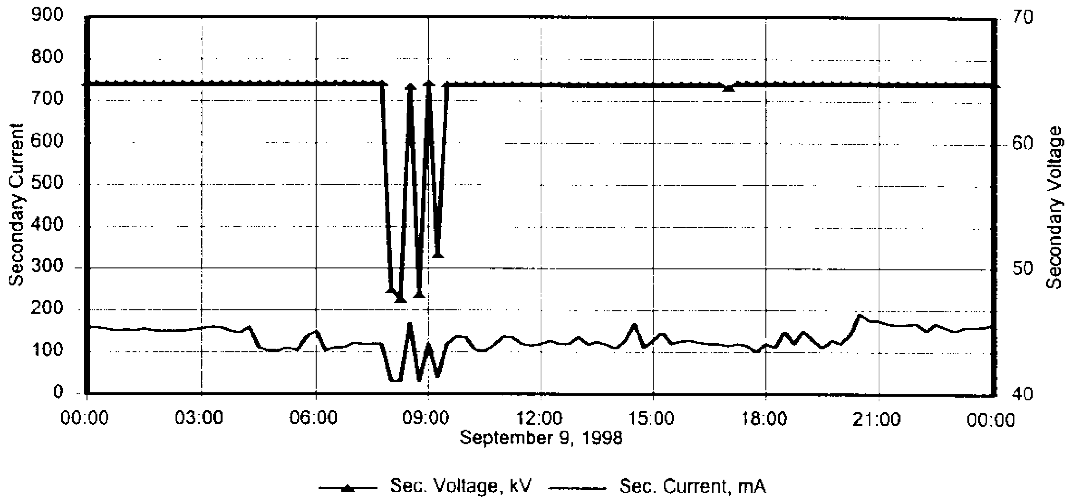


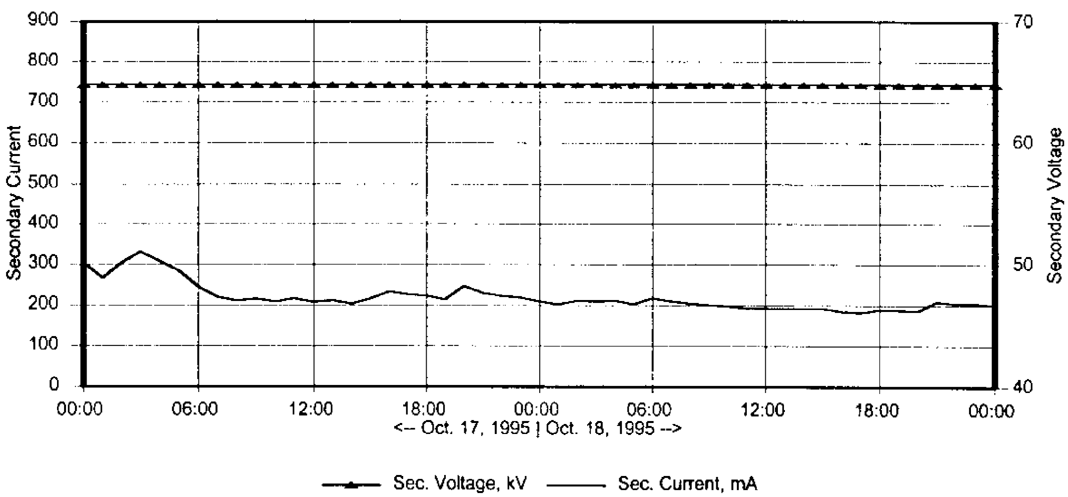
Figure 2

Secondary Voltage and Current for TSR-A1 During Test Programs

Milliken Unit 1 ESP -- TSR-A1



Milliken Unit 2 ESP -- TSR-A1



Milliken Unit 2 ESP -- TSR-A1

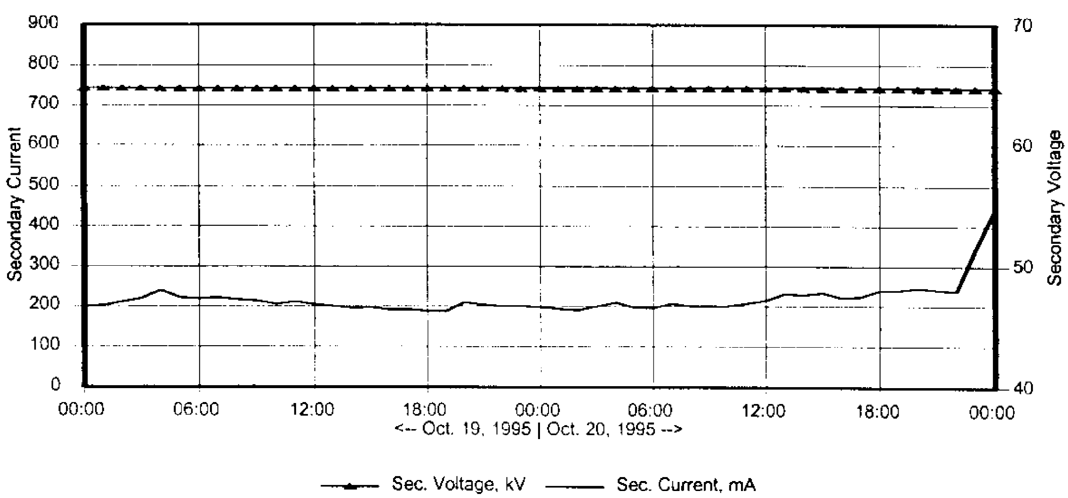
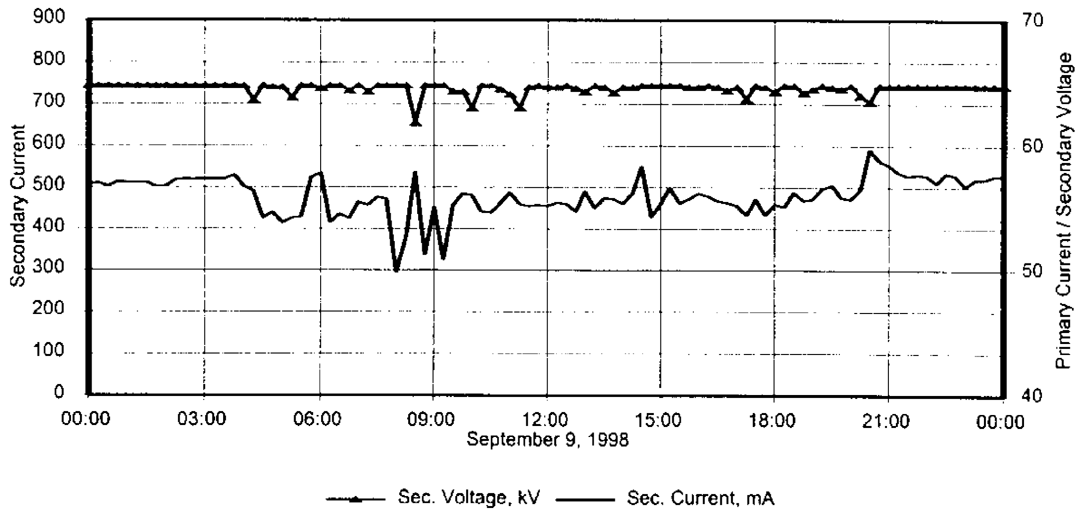


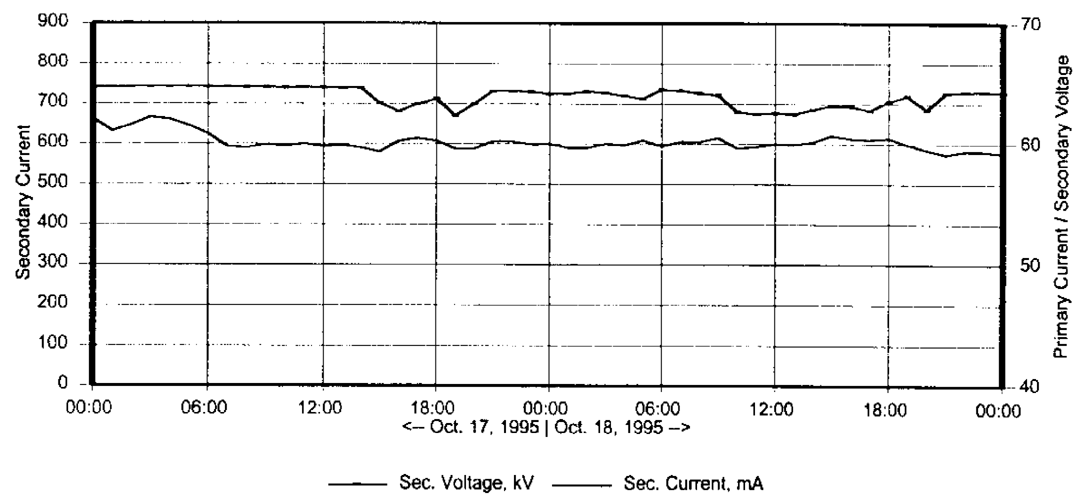
Figure 3

Secondary Voltage and Current for TSR-A2 During Test Programs

Milliken Unit 1 ESP -- TSR-A2



Milliken Unit 2 ESP -- TSR-A2



Milliken Unit 2 ESP -- TSR-A2

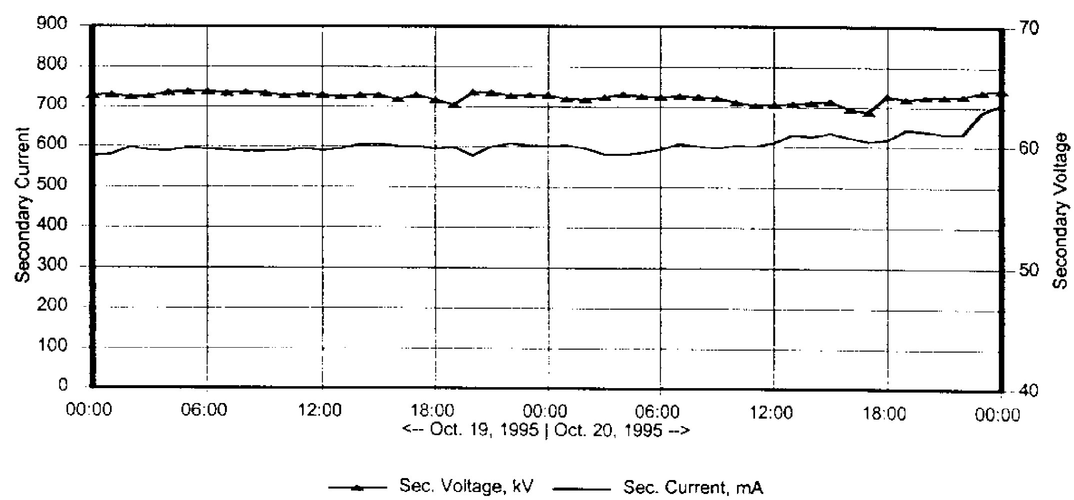
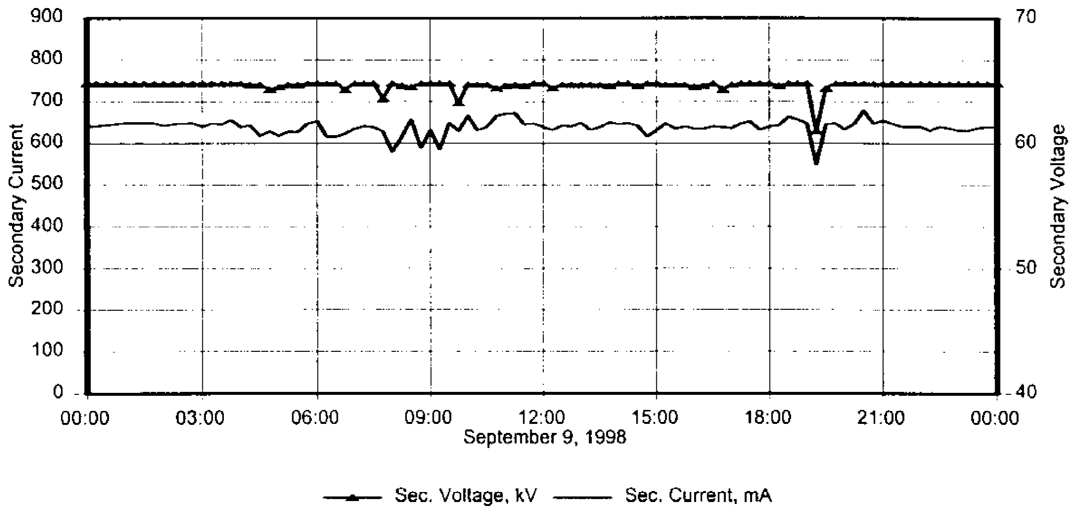


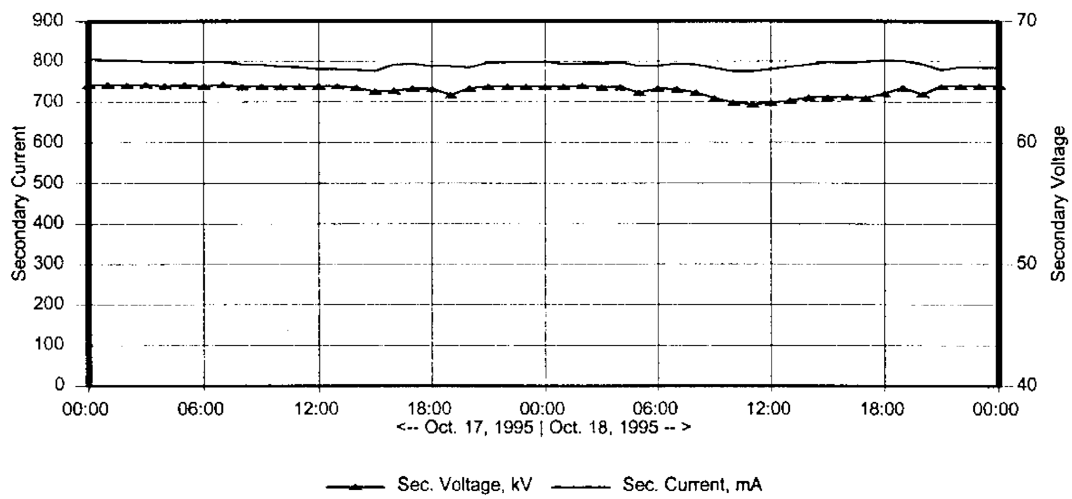
Figure 4

Secondary Voltage and Current for TSR-A3 During Test Programs

Milliken Unit 1 ESP – TSR-A3



Milliken Unit 2 ESP – TSR-A3



Milliken Unit 2 ESP – TSR-A3

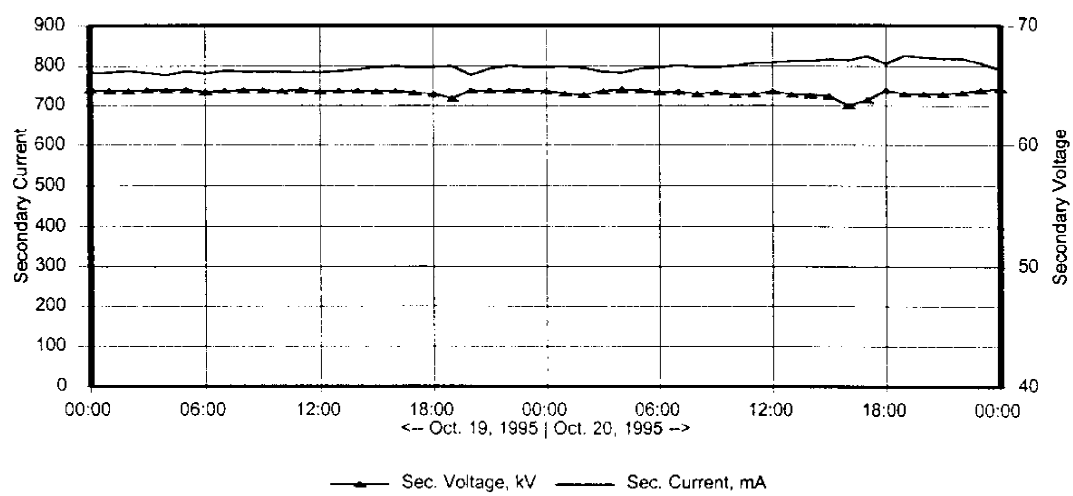


Figure 5

Secondary Voltage and Current for TSR-B1 During Test Programs

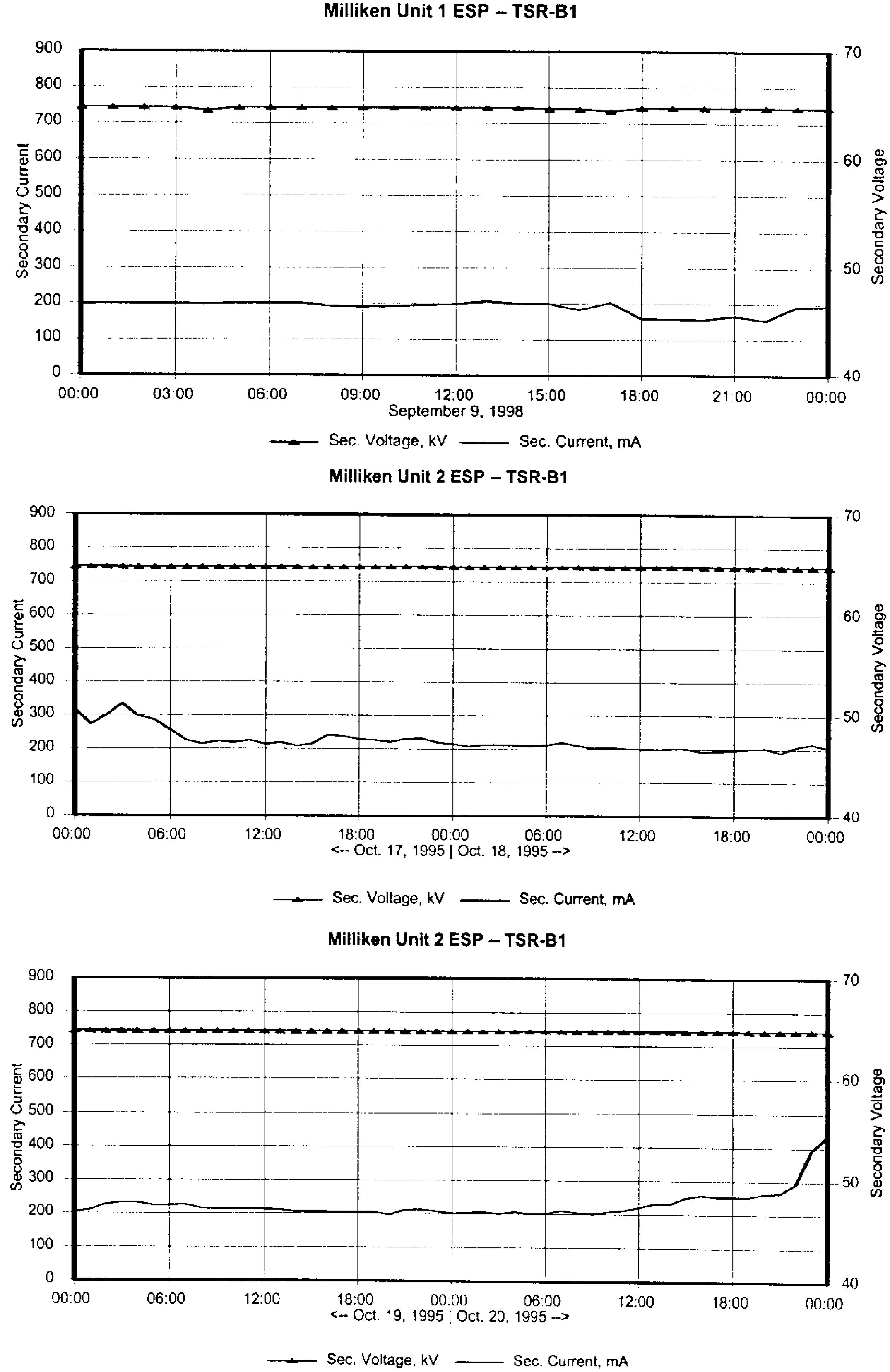
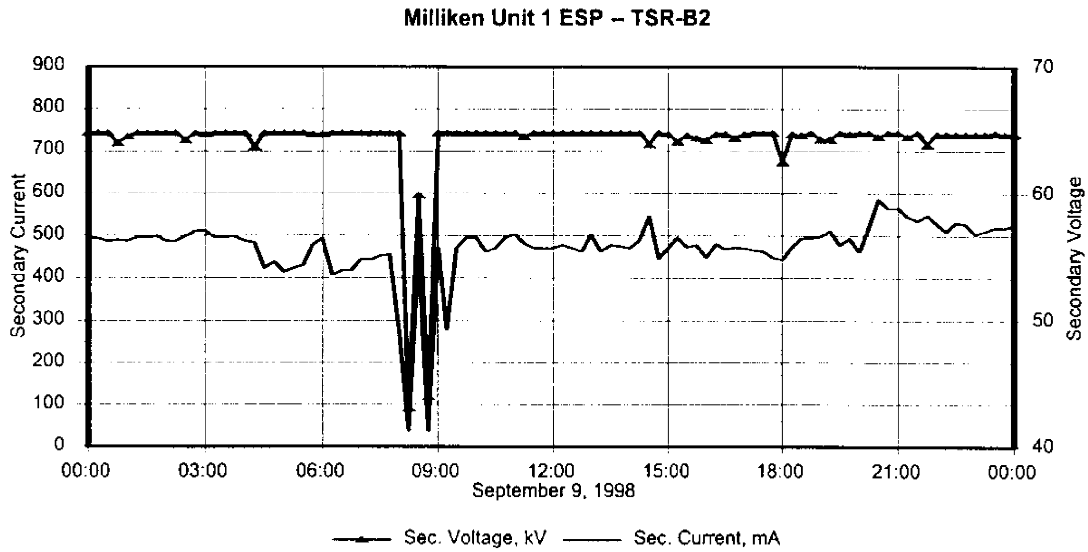
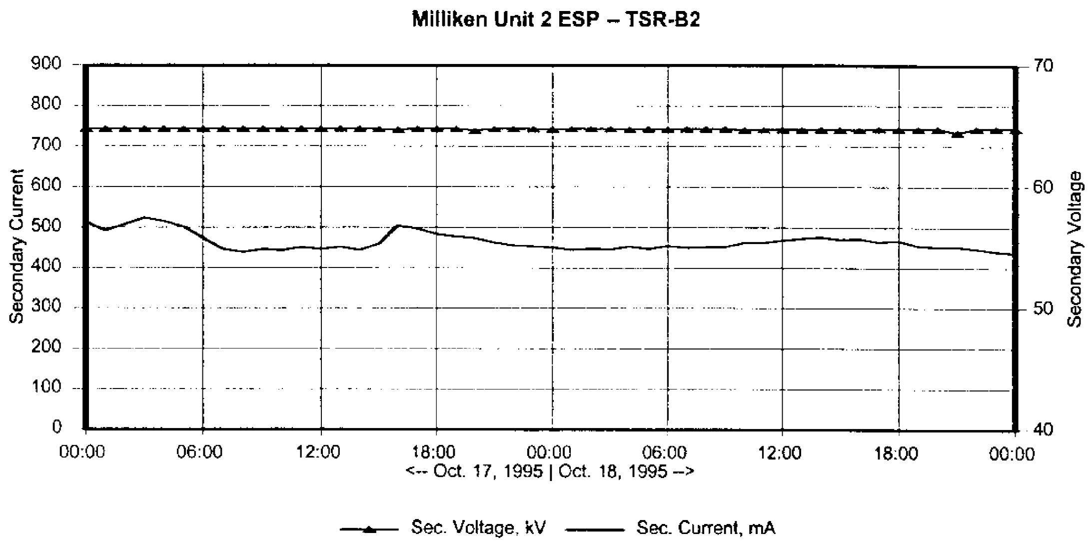


Figure 6

Secondary Voltage and Current for TSR-B2 During Test Programs





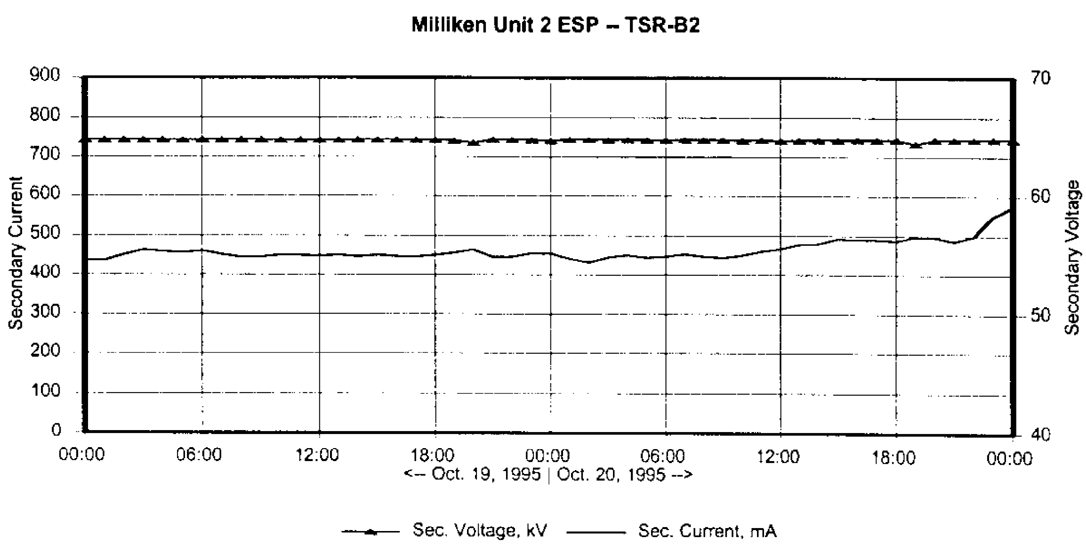
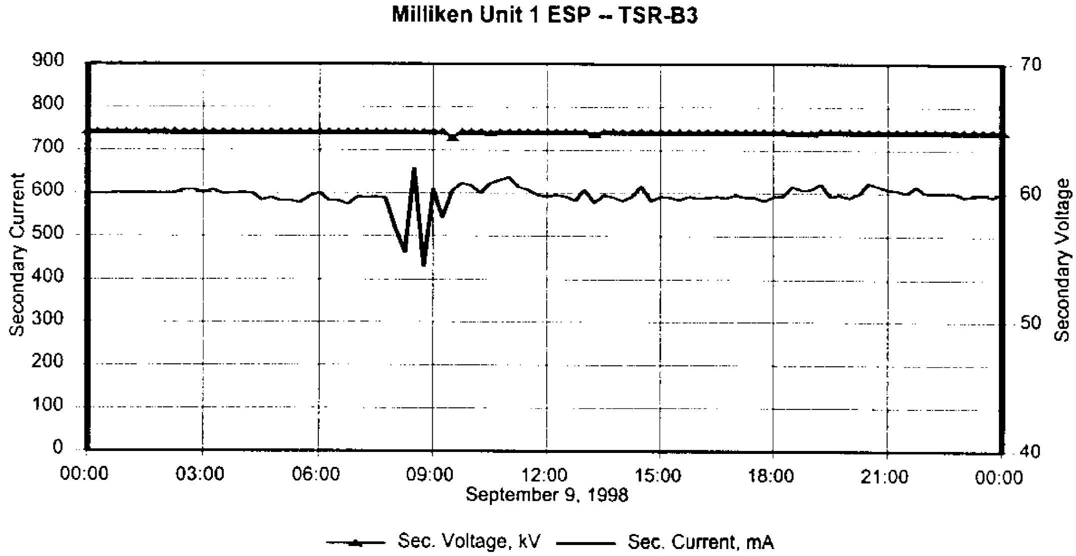
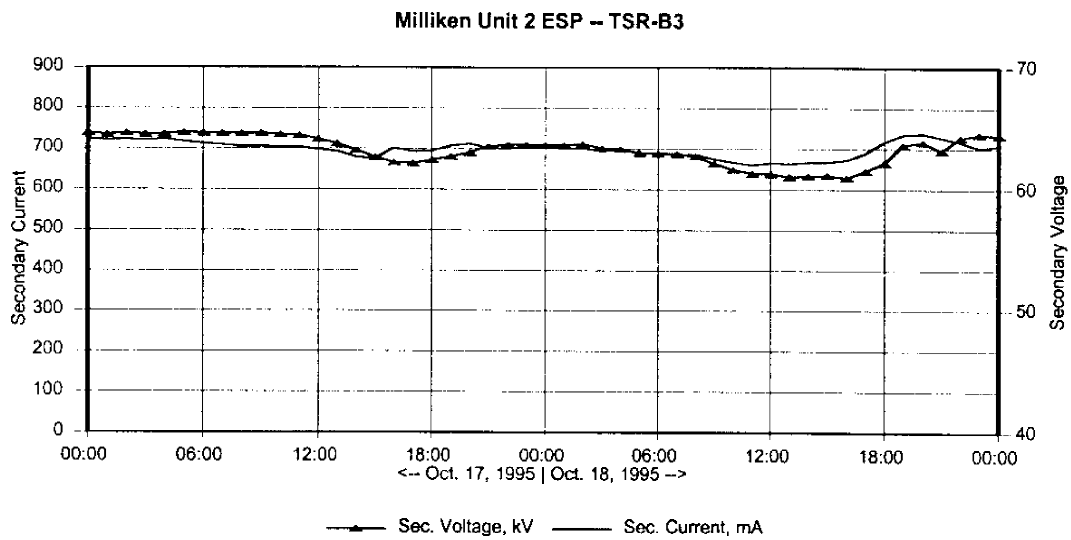


Figure 7

Secondary Voltage and Current for TSR-B3 During Test Programs





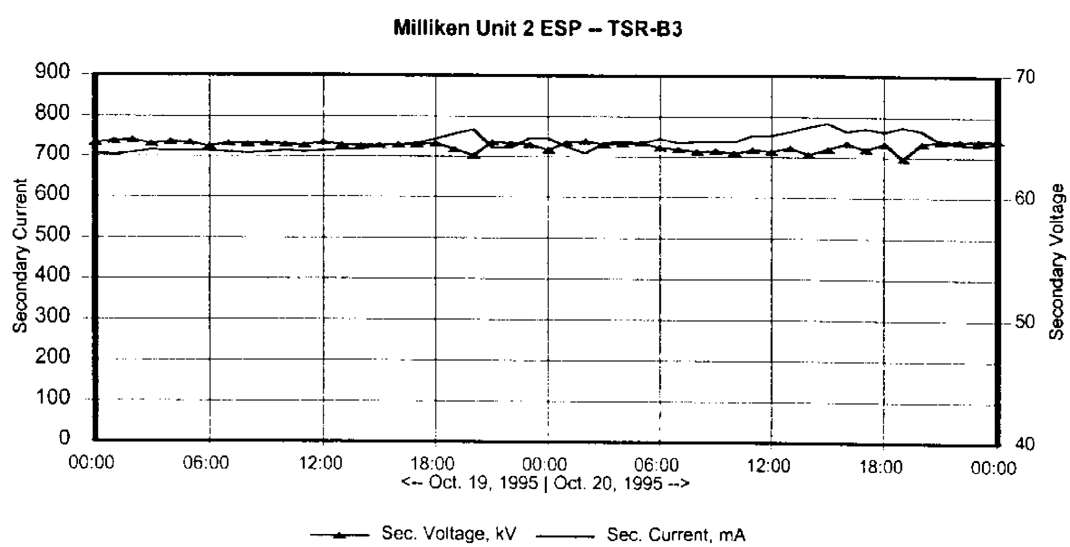


Figure 8

Selected Emissions During Test Programs

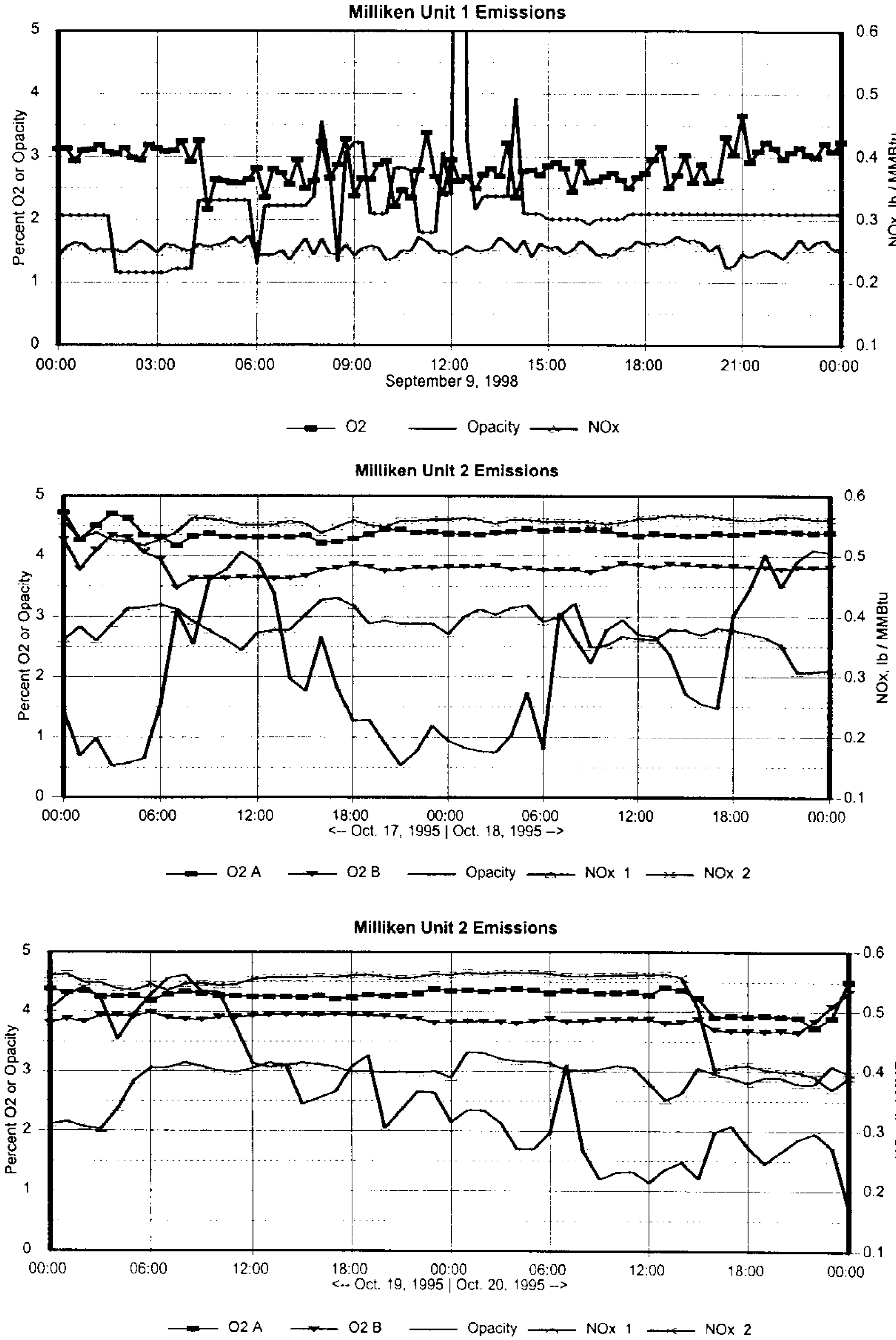


Figure 9

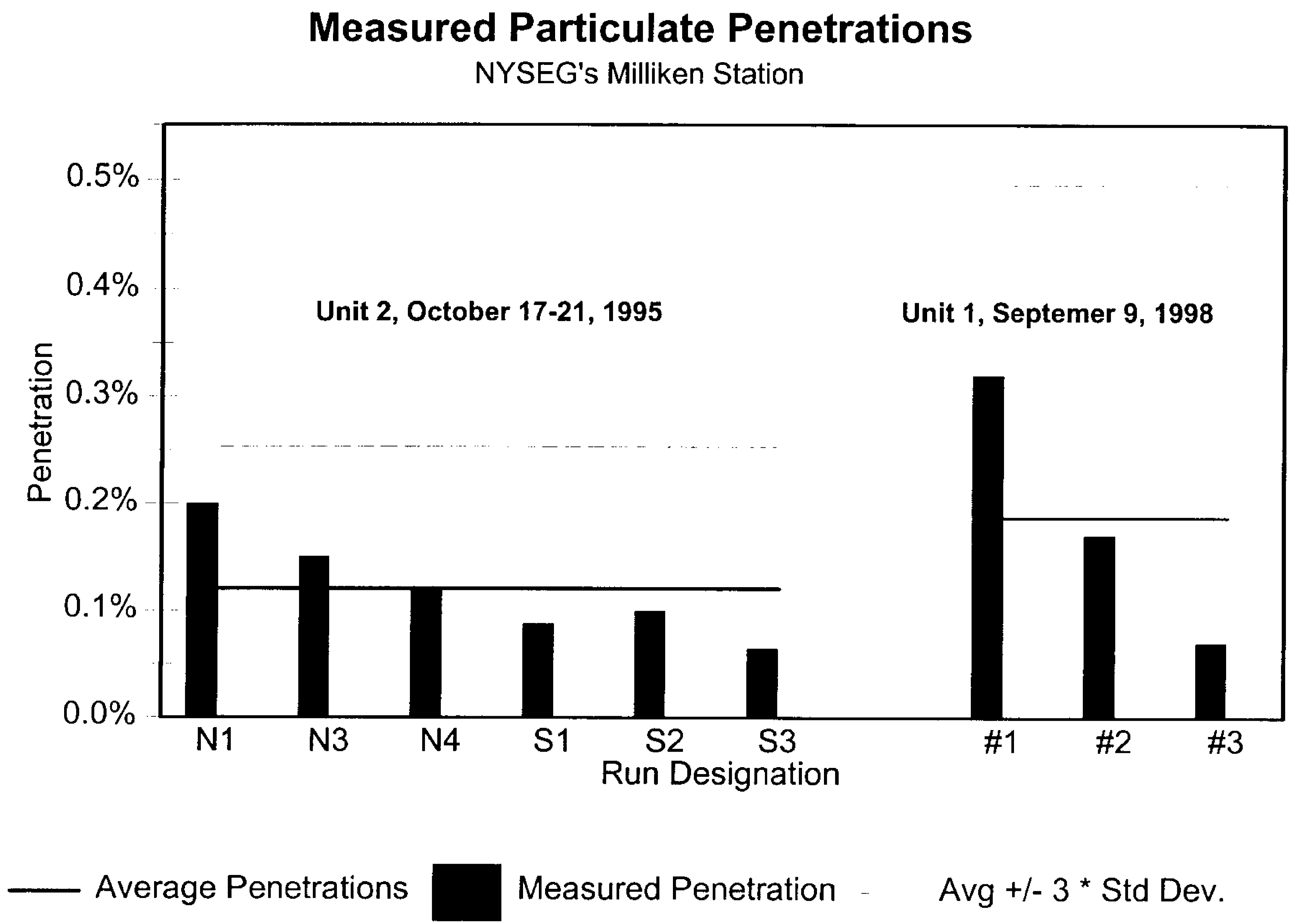

Measured Particulate Penetrations
NYSEG's Milliken Station
Penetration
0.5%
0.4%
0.3%
0.2%
0.1%
0.0%
Unit 2, October 17-21, 1995
Unit 1, Septemer 9, 1998
N1
N3
N4
S1
S2
S3
#1
#2
#3
Run Designation
Average Penetrations
Measured Penetration
Avg +/- 3 * Std Dev.

TABLE 1
MILLIKEN ESP PERFORMANCE TESTING – AVERAGE PARTICLE LOADINGS

	Unit 2 North ESP Oct. 1995	Unit 2 South ESP Oct. 1995	Unit 1 ESP Sept. 1998
Particulate Loading			
gr/dscf	2.487	2.327	3.157
lb/hr	3574	3349	9220*
lb/MM Btu	4.818	4.51	6.289
% ISOKINETIC			
minimum	100.59	100.61	98.37
maximum	101.99	105.67	103.77

* Value represents the total solids flow rate for both sides of the Unit 1 ESP.

TABLE 2
AVERAGE SULFUR LEVELS AT THE ESP INLET

	Unit 2 North ESP Oct. 1995	Unit 2 South ESP Oct. 1995	Unit 1 ESP Sept. 1998
SO_2 Calculations			
lb/dscf	1.79E-4	1.86E-4	2.99E-4
lb/hr	1,797	1,874	6,116*
ppmv @ Duct Conditions	1,128	1,174	1,901
ppmv @ 0% O_2	1,560	1,635	2,697

* Value represents the total solids flow rate for both sides of the Unit 1 ESP.

APPENDIX A

SAMPLING LOCATIONS

ESP Inlet

The two Unit 1 ESP inlet sampling locations are shown in Figure A–1. CONSOL conducted sampling in the inlet ducts immediately upstream of the ESP. Each duct is fitted with a total of five, 6" sampling ports. A sampling scheme using every sampling port was used for the PM sampling. Each port contains three sample points. This scheme resulted in a total of 10 ports and 30 sampling points for the combined ducts. PM sampling was conducted for three minutes at each point which resulted in a total sampling time of 90 min.

ESP Outlet

Figure A–1 also shows the two Unit 1 ESP outlet sampling locations. The layout for these ducts is a mirror image of that for the inlet locations. Sampling was conducted in the two outlet ducts immediately downstream of the ESP. Each duct is fitted with a total of five, 6" sampling ports. The sampling scheme was identical to that used in the inlet duct with three sample points in each port. This resulted in a total of 10 ports and 30 sampling points. PM sampling was conducted for three minutes at each point which resulted in a total sampling time of 90 min.

As-Fired Coal Samples

Coal samples were collected from each of the individual gravimetric feeders located upstream of the coal mills. These samples were obtained by manually activating the automatic samplers installed on each feeder. These samples were coordinated with the emission measurements. All of the samples for the day were combined into a single sample for the entire test program.

EXPERIMENTAL PROCEDURE

The emission sampling was conducted using EPA reference techniques, where applicable. In cases where no suitable reference method applied, sampling was conducted using EPA endorsed methodologies or other published, well-documented procedures. A summary of the sampling procedures used in this test program is provided below.

Selection of Sampling Points

The sampling points at both locations were selected as described in EPA Method 1. While both the ESP inlet and outlet locations failed to meet the optimum location criteria, these were the only location possible.

Volumetric Flow Rate

Individual point velocities and the duct volumetric flow rates were determined in conjunction with the PM sampling using the procedure outlined in EPA Method 2. The particulate sampling probes were equipped with calibrated type "S" Pitot assemblies complete with thermocouples.

Gas Composition (O_2, CO_2, and N_2)
Flue gas compositions at both locations were determined using a Teledyne Model Max 5 combustion gas analyzer. This instrument uses an electrochemical sensor to determine oxygen and calculates the CO_2 concentration based on fuel chemistry. Nitrogen is determined by difference. The O_2 and CO_2 concentration determined by this instrument were previously confirmed by ORSAT analysis conducted on gas bag samples. The dry molecular weight of the flue gas samples was calculated from these data using the calculations outlined in EPA Method 3.

Flue Gas Moisture Content
Flue gas moisture was determined by measuring the condensate collected in the impinger assemblies for each PM samples. This procedure is outlined in both EPA Method 4 and Method 5.

Particulate Matter (PM) Concentrations
PM sampling was conducted at both the ESP inlet and outlet as outlined in EPA Method 17. This method specifies the use of an in-stack filter at the front end of the sampling probe. Particulate matter is defined as any material collected on the filter at the duct temperature and pressure. Both the ESP inlet and outlet locations had a nominal average temperature of 290°F and an absolute pressure of 28.5" Hg.

A stainless steel filter canister fitted with a high efficiency ceramic filter was used for the inlet locations. This assembly holds up to 50 grams of particulate and is particularly well-suited for high particulate loading applications.

The location of the ESP outlet sampling ports made Method 5 sampling impossible. As a result, an in-stack filter system was used at this location. The high particulate removal efficiency of the ESP results in very low particulate concentrations in the outlet. To enhance the accuracy of our weight measurement of the collected sample, an in-stack 2.5 inch stainless steel filter holder fitted with a 2.5 inch quartz filter was used. These filters have greater weight stability and are also more easily recovered from the filter holder after sampling. Both attributes result in more accurate mass measurements. As with the inlet sampling, the filter temperature is maintained at the flue gas temperature. Particulate matter is defined as any material collected on the sampling media at duct conditions of ~290°F and an absolute pressure of ~28.5" Hg. A schematic illustrating the two particulate trains is shown in Figure A-2.

SO_2 Emissions
SO_2 emissions were measured by replacing the water solution in the PM sampling impingers with a 3% hydrogen peroxide solution. After sampling, the impinger contents were analyzed for SO_2 as described in EPA Method 6. This technique is a $BaCl_2$ titration to a thorin endpoint. These measurements were completed at the ESP inlet only.

QA/QC PROCEDURES

All of the testing and analysis were completed by trained individuals with experience specific to emission measurements and analysis. The sampling and associated QA/QC procedures were followed as prescribed in the sampling methods. All sampling was conducted under normal, baseload conditions.

Pretest calibrations were performed on the major sampling equipment, and included the Pitot tubes, sampling nozzles, dry test meters, meter orifices, barometer, and temperature readouts. The analytical balance used for the gravimetric filter analyses is checked out twice a year. The accuracy of this balance was checked daily with class "S" standard weights. The calibration data are on file at CONSOL R&D, Library, PA.

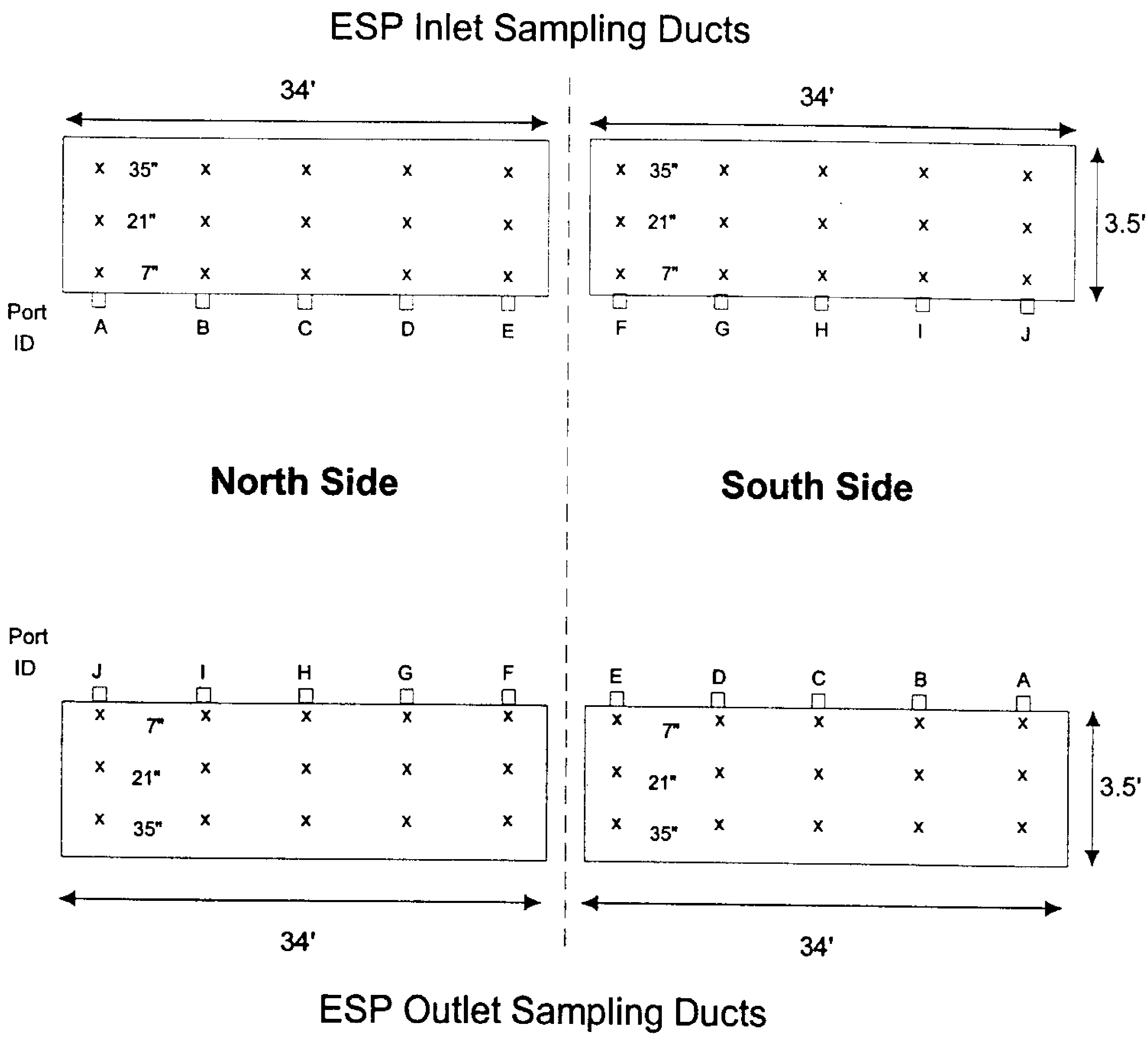
All field data were recorded on standard forms and are retained in a file binder at the CONSOL R&D office complex. Two senior test professionals checked all of the field data sheets and calculations.

The coal samples were analyzed in duplicate following standard ASTM methodology. All of the coal analyses fell well within the ASTM criteria for data quality. The analysis of standard reference material used as QC checks is available upon request.

The sampling team was in daily communication with the Unit 1 operators to assure that the unit was operating at the required test conditions.

RESULTS

Analyses for the coal and inlet-fly ash samples collected during the testing are shown in Table A-1. For purposes of comparison, comparable analyses from the baseline test program on Unit 2 in October 1998 are also listed. Results of the PM testing are shown in Table A-2.



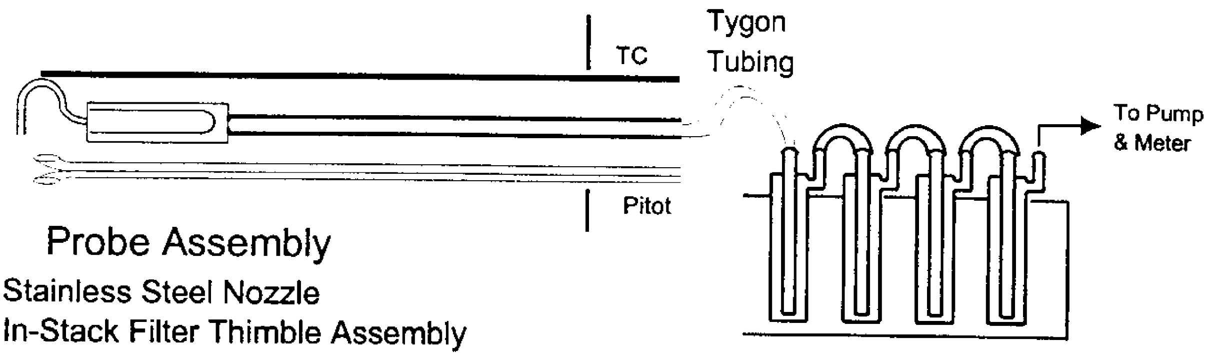
Total Ports Sampled per Duct- 5
Total Points Sampled per Duct- 15
Cross-Sectional Areas - 238 sq ft

Figure A-1 - Milliken Unit #1 ESP Sampling Locations

O:\APPRES\STACK\NYSEG95\PORTS

EPA Method 17 Particulate Sampling Trains

(ESP Inlet Sampling with Ceramic Thimble)



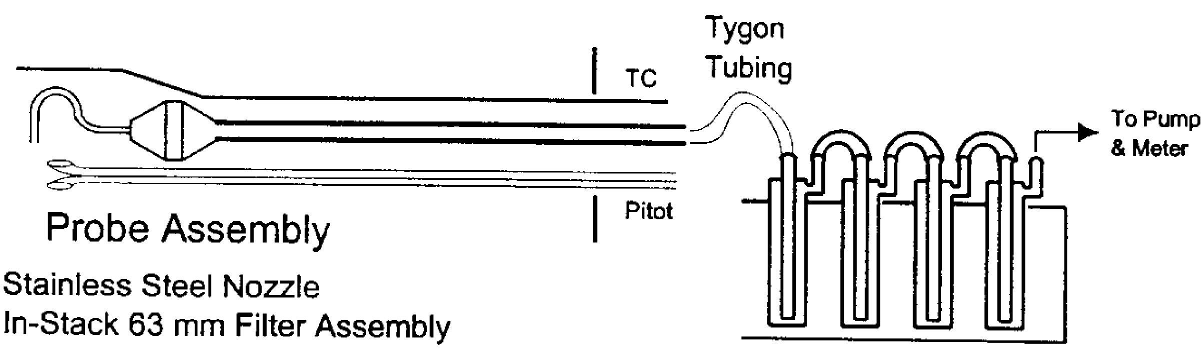
Probe Assembly

Stainless Steel Nozzle
In-Stack Filter Thimble Assembly
Ceramic Filter Thimble
Pitot Tube
Stack Thermocouple

Impinger Assembly

#1 & 2 - 3% H_2O_2
#3 - Blank
#4 - Silica Gel

(ESP Outlet Sampling with Quartz-Fiber Filter Disk)



Probe Assembly

Stainless Steel Nozzle
In-Stack 63 mm Filter Assembly
63 mm Quartz-Fiber Filter
Pitot Tube
Stack Thermocouple

Impinger Assembly

#1 & 2 - 3% H_2O_2
#3 - Blank
#4 - Silica Gel

Figure A-2 - Schematics of Particulate Sampling Trains

Table A-1
Analytical Data

COAL

Coal Type	<-- Bituminous -->		
Test Dates	10/17-18/95	9/9/98	
Coal analysis, wt% as received	Unit 2	Unit 1	
Carbon	73.68	73.87	
Hydrogen	4.77	4.73	
Nitrogen	1.47	1.38	
Oxygen (diff.)	5.18	3.67	
Sulfur	1.75	2.84	
Moisture	6.46	6.09	
Ash	6.69	7.42	
HHV	13,096	13,095	Btu / lb

Test Dates	10/17-18/95	9/9/98
Ash analysis, wt% ash	Unit 2	Unit 1
Li_2O	0.02	ND
Na_2O	0.65	
K_2O	1.73	
MgO	0.78	
CaO	2.83	
Fe_2O_3	18.26	
Al_2O_3	23.47	
SiO_2	47.44	
TiO_2	0.96	
P_2O_5	0.50	
SO_3	2.48	
Unknown	0.87	

Analysis of the daily composite.

ASH

Test Dates	10/17-18/95	9/9/98
Ash analysis, wt% as received	Unit 2	Unit 1
Carbon	2.40	3.69
Sulfur	0.45	0.57
Moisture	0.46	0.45 (Diff.)
Ash	96.87	95.29

Test Dates	10/17-18/95	9/9/98
Ash analysis, wt% ash	Unit 2	Unit 1
Li_2O	0.02	ND
Na_2O	0.66	
K_2O	1.70	
MgO	0.75	
CaO	2.66	
Fe_2O_3	17.37	
Al_2O_3	23.19	
SiO_2	47.63	
TiO_2	1.07	
P_2O_5	0.49	
SO_3	1.13	
Unknown	3.32	

Average of the analyses of the test samples.

TABLE A-2
MILLIKEN UNIT 2 ESP PERFORMANCE TESTING

North Side ESP

Location		ESP IN	ESP IN	ESP OUT	ESP IN	ESP OUT	ESP IN	ESP OUT	ESP OUT
Test #		#1	#2	#1	#3	#2	#4	#3	#4
Date		10-17-95	10-17-95	10-17-95	10-18-95	10-18-95	10-18-95	10-18-95	10-18-95
Start Time		0935	1430	0935	0839	0835	1250	1220	1520
Stop Time		1150	1640	1225	1030	1142	1440	1520	1720
Sample Type		M-17	M-17	M-17	M-17	M-17	M-17	M-17	M-17
SAMPLING DATA:									
Y factor of dry gas meter		0.973	0.973	0.996	0.973	0.996	0.973	0.996	0.996
Gas Volume	- ft^3	54.81	57.46	85.09	59.58	112.85	60.19	91.13	92.70
Delta H of dry gas meter	- inches H_2O	0.70	0.74	1.19	0.79	1.31	0.80	1.31	1.35
Meter Temperature	- °F	105.5	116.8	102.1	128.7	121.7	130.1	117.7	117.4
C Factor of pitot tube		0.761	0.761	0.774	0.761	0.774	0.761	0.774	0.774
Nozzle Diameter	- inch	0.246	0.246	0.274	0.246	0.274	0.246	0.274	0.274
A n (area of nozzle)	- ft^2	0.00033	0.00033	0.00041	0.00033	0.00041	0.00033	0.00041	0.00041
Area of Stack	- ft^2	119	119	119	119	119	119	119	119
H_2O Weight	- grams	71.9	70.9	106.6	83.9	139.6	91.5	132.1	125.7
Sample Time	- min	108	108	144	108	180	108	144	144
Barometric Pressure	- inches Hg	29.70	29.75	29.70	29.54	29.54	29.51	29.51	29.48
Static Pressure	- inches H_2O	-17.0	-16.3	-17.7	-17.3	-17.0	-17.3	-17.0	-17.0
% Oxygen		5.6	5.9	6.0	5.6	6.0	6.0	6.2	6.0
% Carbon Dioxide		13.4	13.1	13.0	13.4	13.0	13.0	12.8	13.0
% N_2 + CO		81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0
Stack Temp (Dry Bulb)	- °F	287	291	273	292	291	296	294	296
"S" sample (avg vel pressure)	- inches H_2O	0.347	0.369	0.335	0.395	0.353	0.399	0.355	0.370
Dust Wt.	- grams	6.8036	11.0943	0.0200	7.4694	0.0214	7.4687	0.0135	0.0158
CALCULATED DATA:									
DSCF SAMPLED	- ft^3	49.49	50.96	79.22	51.41	101.01	51.77	82.05	83.43
ABS ST PRES	- inches Hg	28.45	28.55	28.40	28.27	28.29	28.24	28.26	28.23
ABS ST TEMP	- °R	747	751	733	752	751	756	754	756
H_2O	- % by Vol	6.40	6.15	5.96	7.14	6.11	7.69	7.05	6.63
Water Volume	- ft^3	3.39	3.34	5.02	3.95	6.58	4.31	6.22	5.92
Dry Molecular Weight	- lb/lb-Mole	30.37	30.33	30.32	30.37	30.32	30.32	30.30	30.32
Wet Molecular Weight	- lb/lb-Mole	29.58	29.57	29.59	29.49	29.57	29.37	29.43	29.50
% Excess Air		35.5	38.1	39.0	35.5	39.0	39.0	40.8	39.0
Dry Mole Frac.		0.936	0.939	0.940	0.929	0.939	0.923	0.930	0.934
Wet Mole Frac.		0.064	0.061	0.060	0.071	0.061	0.077	0.070	0.066
GAS FLOW DATA:									
Gas Velocity	- fps	36.11	37.27	35.77	38.84	37.25	39.23	37.54	38.35
	- acfm	257818	266112	255411	277304	265975	280126	268027	273793
	- dscfm	162182	167556	164217	170823	166004	170454	164782	168466
Excess Air Free	- dscfm	118727	120256	117073	125052	118348	121520	115899	120102
PARTICULATE LOADING:									
	- Grains/dscf	2.121	3.359	0.0039	2.242	0.0033	2.226	0.0025	0.0029
	- lb/hr	2950	4826	5.5	3283	4.7	3254	3.6	4.2
	- lb/MM Btu	4.09	6.61	0.008	4.30	0.006	4.39	0.005	0.006
ESP Collection Efficiency				99.82%		99.85%		99.89%	99.87%
% ISOKINETIC		101.99	101.64	97.47	100.59	98.35	101.49	100.61	100.06
SO_2 CALCULATIONS:									
	- lb/dscf	1.74E-04	1.77E-04	1.60E-04	1.79E-04	1.79E-04	1.84E-04	1.84E-04	1.89E-04
	- lb/hr	1692	1784	1579	1831	1783	1880	1819	1913
@ Duct Conditions	- ppmv	1100	1121	1012	1131	1131	1161	1161	1196
@ 0% O_2	- ppmv	1503	1562	1420	1544	1586	1629	1651	1677
(O_2 Based)	- lb/MMBtu	2.35	2.44	2.22	2.40	2.47	2.53	2.57	2.61
COAL ANALYSIS:									
% Carbon		79.02	79.02	79.02	78.64	78.64	78.64	78.64	78.64
% Hydrogen		5.14	5.14	5.14	5.16	5.16	5.16	5.16	5.16
% Nitrogen		1.57	1.57	1.57	1.59	1.59	1.59	1.59	1.59
% Sulfur		1.85	1.85	1.85	1.88	1.88	1.88	1.88	1.88
% Oxygen		5.37	5.37	5.37	5.67	5.67	5.67	5.67	5.67
% Ash		7.05	7.05	7.05	7.06	7.06	7.06	7.06	7.06
% Volatile Matter		38.95	38.95	38.95	39.15	39.15	39.15	39.15	39.15
Btu/lb		14010	14010	14010	14020	14020	14020	14020	14020
Carbon Conversion		99.90%	99.90%	99.90%	99.90%	99.90%	99.90%	99.90%	99.90%
Calculated Feed Rate, lb/hr (dry)		50055	50555	49169	52976	49945	51284	48814	50685
F-Factor		9880	9880	9880	9828	9828	9828	9828	9828
Moisture		7.0%	7.0%	7.0%	6.3%	6.3%	6.3%	6.3%	6.3%
Calculated F-Factor Firing Rate -	lb/hr dry	102932	104257	101498	108909	103070	105832	100937	104598
Calculated F-Factor Firing Rate -	lb/hr wet	110679	112104	109138	116231	110000	112948	107724	111630
FLY ASH ANALYSIS:									
% Ash		96.69	96.31	----	95.97	----	96.76	----	----
% Carbon		2.49	2.95	----	3.18	----	2.60	----	----
% Sulfur		0.47	0.47	----	0.46	----	0.42	----	----
Calculated MWe Rating		146	148	144	154	146	150	143	148

TABLE A-3
MILLIKEN UNIT 2 ESP PERFORMANCE TESTING
South Side ESP

Location			ESP IN	ESP OUT	ESP IN	ESP OUT	ESP IN	ESP OUT
Test #			#1	#1	#2	#2	#3	#3
Date			10-19-95	10-19-95	10-19-95	10-19-95	10-20-95	10-20-95
Start Time			0835	0839	1350	1150	0825	0815
Stop Time			1025	1150	1550	1500	1025	1030
Sample Type			M-17	M-17	M-17	M-17	M-17	M-17
SAMPLING DATA:								
Y factor of dry gas meter			0.973	0.996	0.973	0.996	0.973	0.996
Gas Volume	-	ft^3	54.41	87.56	57.59	88.44	61.14	93.38
Delta H of dry gas meter	-	inches H_20	0.74	1.24	0.79	1.27	0.82	1.37
Meter Temperature	-	°F	97.7	103.2	97.9	103.4	123.9	125.1
C Factor of pitot tube			0.761	0.774	0.761	0.774	0.761	0.774
Nozzle Diameter	-	inch	0.246	0.274	0.246	0.274	0.246	0.274
A n (area of nozzle)	-	ft^2	0.00033	0.00041	0.00033	0.00041	0.00033	0.00041
Area of Stack	-	ft^2	119	119	119	119	119	119
H_2O Weight	-	grams	86.6	121.8	95.9	129.7	93.0	134.4
Sample Time	-	min	108	144	108	144	108	144
Barometric Pressure	-	inches Hg	29.65	29.65	29.65	29.60	29.46	29.46
Static Pressure	-	inches H_20	-17.5	-16.3	-17.0	-16.3	-17.0	-16.5
% Oxygen			5.7	6.5	5.9	6.3	5.8	6.5
% Carbon Dioxide			13.3	12.5	13.1	12.7	13.2	12.5
% N_2 + CO			81.0	81.0	81.0	81.0	81.0	81.0
Stack Temp (Dry Bulb)	-	°F	290	286	298	289	300	290
"S" sample (avg vel pressure)	-	inches H_20	0.370	0.349	0.381	0.355	0.410	0.373
Dust Wt.	-	grams	7.8308	0.0099	7.4413	0.0099	8.1563	0.0092
CALCULATED DATA:								
DSCF SAMPLED	-	ft^3	49.74	81.24	52.64	81.89	53.05	82.89
ABS ST PRES	-	inches Hg	28.36	28.45	28.40	28.40	28.21	28.25
ABS ST TEMP	-	°R	750	746	758	749	760	750
H_2O	-	% by Vol	7.58	6.60	7.90	6.94	7.63	7.10
Water Volume	-	ft^3	4.08	5.74	4.52	6.11	4.38	6.33
Dry Molecular Weight	-	lb/lb-Mole	30.36	30.26	30.33	30.28	30.34	30.26
Wet Molecular Weight	-	lb/lb-Mole	29.42	29.45	29.36	29.43	29.40	29.39
% Excess Air			36.3	43.7	38.1	41.8	37.2	43.7
Dry Mole Frac.			0.924	0.934	0.921	0.931	0.924	0.929
Wet Mole Frac.			0.076	0.066	0.079	0.069	0.076	0.071
GAS FLOW DATA:								
Gas Velocity	-	fps	37.52	36.88	38.29	37.32	39.88	38.41
	-	acfm	267876	263349	273387	266462	284710	274255
	-	dscfm	165224	165553	166473	165929	172271	169345
Excess Air Free	-	dscfm	120163	114065	119478	115912	124464	116678
PARTICULATE LOADING:								
	-	Grains/dscf	2.429	0.002	2.181	0.002	2.372	0.002
	-	lb/hr	3441	3	3114	3	3504	2
	-	lb/MM Btu	4.70	0.004	4.28	0.004	4.61	0.003
ESP Collection Efficiency				99.92%		99.91%		99.93%
% ISOKINETIC			100.61	99.14	105.67	99.72	102.92	98.89
SO_2 CALCULATIONS:								
	-	lb/dscf	1.87E-04	1.83E-04	1.77E-04	1.80E-04	1.94E-04	1.91E-04
	-	lb/hr	1855	1814	1763	1793	2003	1938
@ Duct Conditions	-	ppmv	1183	1151	1115	1136	1225	1202
@ 0% O_2	-	ppmv	1627	1671	1554	1627	1695	1745
(O_2 Based)	-	lb/MMBtu	2.53	2.61	2.42	2.54	2.63	2.72
COAL ANALYSIS:								
% Carbon			78.87	78.87	78.87	78.87	78.56	78.56
% Hydrogen			5.04	5.04	5.04	5.04	5.06	5.06
% Nitrogen			1.58	1.58	1.58	1.58	1.57	1.57
% Sulfur			1.86	1.86	1.86	1.86	1.88	1.88
% Oxygen			5.42	5.42	5.42	5.42	5.68	5.68
% Ash			7.23	7.23	7.23	7.23	7.25	7.25
% Volatile Matter			38.50	38.50	38.50	38.50	38.51	38.51
Btu/lb			13990	13990	13990	13990	13984	13984
Carbon Conversion			99.90%	99.90%	99.90%	99.90%	99.90%	99.90%
Calculated Feed Rate, lb/hr (dry)			50709	47754	50324	48628	52681	49040
F-Factor			9850	9850	9850	9850	9818	9818
Moisture			6.40%	6.40%	6.40%	6.40%	6.20%	6.20%
Calculated F-Factor Firing Rate	-	lb/hr dry	104637	99327	104041	100936	108786	101981
Calculated F-Factor Firing Rate	-	lb/hr wet	111792	106119	111155	107837	115976	108722
ASH ANALYSIS:								
% Ash			97.55	—	97.29	----	97.55	----
% Carbon			1.61	—	2.11	----	1.88	----
% Sulfur			0.49	—	0.42	----	0.42	----
Calculated MWe Rating			148	140	147	143	154	144

TABLE A-4
MILLIKEN UNIT 1 ESP PERFORMANCE TESTING

Location	Units	ESP IN	ESP OUT	ESP IN	ESP OUT	ESP IN	ESP OUT	3-Test Average ESP IN	3-Test Average ESP OUT
Test #		**#1**	**#1**	**#2**	**#2**	**#3**	**#3**		
Date		**9/9/98**	**9/9/98**	**9/9/98**	**9/9/98**	**9/9/98**	**9/9/98**		
Start Time		**1145**	**1232**	**1500**	**1502**	**1715**	**1715**		
Stop Time		**1400**	**1420**	**1650**	**1645**	**1910**	**1900**		
Sample Type		**M-17**	**M-17**	**M-17**	**M-17**	**M-17**	**M-17**		
SAMPLING DATA:									
Y factor of dry gas meter		1.015	1.050	1.015	1.050	1.015	1.050		
Gas Volume	- ft^3	47.75	52.86	45.35	54.32	46.45	53.69		
Delta H of dry gas meter	- inches H_2O	1.01	1.24	1.01	1.28	0.92	1.19		
Meter Temperature	- °F	97.8	99.8	96.9	104.6	102.2	103.2		
C Factor of pitot tube		0.796	0.797	0.796	0.797	0.796	0.797		
Nozzle Diameter	- inch	0.251	0.269	0.250	0.270	0.251	0.269		
A_n (area of nozzle)	- ft^2	0.00034	0.00039	0.00034	0.00040	0.00034	0.00039		
Area of Stack	- ft^2	238	238	238	238	238	238		
H_2O Weight	- grams	75.6	75.0	66.6	80.6	72.1	82.3		
Sample Time	- min	90	90	90	90	90	90		
Barometric Pressure	- inches Hg	29.18	29.18	29.18	29.18	29.18	29.18		
Static Pressure	- inches H_2O	-17.0	-17.2	-16.2	-16.3	-16.8	-16.8		
% Oxygen		6.3	7.2	6.2	7.3	6.0	7.3	6.2	7.3
% Carbon Dioxide		13.8	12.9	13.9	12.8	14.1	12.8	13.9	12.8
% N_2 + CO		79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9
Stack Temp (Dry Bulb)	- °F	296	285	297	290	300	292	298	289
"S" sample (avg vel pressure)	- inches H_2O	0.384	0.362	0.356	0.363	0.360	0.347		
Dust Wt.	- grams	9.6173	0.0348	8.2520	0.0174	8.9063	0.0071		
CALCULATED DATA:									
DSCF SAMPLED	- ft^3	44.84	51.19	42.65	52.17	43.27	51.68		
ABS ST PRES	- inches Hg	27.93	27.92	27.99	27.98	27.94	27.94		
ABS ST TEMP	- °R	756	745	757	750	760	752		
H_2O	- % by Vol	7.36	6.45	6.85	6.78	7.28	6.98	7.2	6.7
Water Volume	- ft^3	3.56	3.53	3.14	3.80	3.40	3.88		
Dry Molecular Weight	- lb/lb-Mole	30.46	30.35	30.47	30.34	30.50	30.34	30.48	30.34
Wet Molecular Weight	- lb/lb-Mole	29.54	29.55	29.62	29.50	29.59	29.48	29.58	29.51
% Excess Air		42.6	51.8	41.6	52.9	39.8	52.9	41	53
Dry Mole Frac.		0.926	0.935	0.931	0.932	0.927	0.930		
Wet Mole Frac.		0.074	0.065	0.069	0.068	0.073	0.070		
GAS FLOW DATA:									
Gas Velocity	- fps	40.36	38.96	38.80	39.13	39.15	38.35	39.44	38.81
	- acfm	576392	556288	554067	558751	559007	547608	563155	554216
	- dscfm	348138	344096	336747	342920	336326	334050	340404	340355
Excess Air Free	- dscfm	243197	225556	236851	223144	239773	217372	239940	222024
PARTICULATE LOADING:									
	- Grains/dscf	3.310	0.0105	2.985	0.0051	3.176	0.0021	3.157	0.006
	- lb/hr	9879	30.9	8620	15.1	9160	6.1	9219.5	17.4
	- lb/MM Btu	6.65	0.022	5.96	0.011	6.26	0.005	6.289	0.013
ESP Collection Efficiency by Concentration			99.68%		99.83%		99.93%		99.81%
ESP Collection Efficiency by Mass Loading			99.69%		99.82%		99.93%		99.81%
% ISOKINETIC		99.23	99.80	98.37	101.29	99.11	103.77		
SO_2 CALCULATIONS:									
	- lb/dscf	2.96E-04		3.02E-04		3.00E-04		2.99E-04	
	- lb/hr	6193		6100		6055		6116	
@ Duct Conditions	- ppmv	1881		1917		1906		1901	
@ 0% O_2	- ppmv	2693		2725		2674		2697	
(O_2 Based)	- lb/MMBtu	4.17		4.22		4.14		4.17	
COAL ANALYSIS:									
% Carbon		77.63	77.63	77.63	77.63	77.63	77.63	77.63	
% Hydrogen		5.12	5.12	5.12	5.12	5.12	5.12	5.12	
% Nitrogen		1.45	1.45	1.45	1.45	1.45	1.45	1.45	
% Sulfur		2.98	2.98	2.98	2.98	2.98	2.98	2.98	
% Oxygen		5.02	5.02	5.02	5.02	5.02	5.02	5.02	
% Ash		7.80	7.80	7.80	7.80	7.80	7.80	7.80	
% Volatile Matter		39.15	39.15	39.15	39.15	39.15	39.15	39.15	
Btu/lb		13944	13944	13944	13944	13944	13944	13944.00	
F-Factor		9825	9825	9825	9825	9825	9825	9825	
Moisture		1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	
Calculated F-Factor Firing Rate	- lb/hr dry	106507	98781	103728	97725	105008	95197	105081	
Calculated F-Factor Firing Rate	- lb/hr wet	107921	100093	105105	99022	106402	96461	106476	
FLY ASH ANALYSIS:									
% Ash		95.41		95.37		95.1		95.29	
% Carbon		3.51		3.79		3.78		3.69	
% Sulfur		0.63		0.54		0.53		0.57	

APPENDIX B

Operating Data Collected by the Plant Data Logger

BOILER / OPACITY DATA

Conditions at time of test.

Test 1

Date: September 9, 1998
Time: 1145 - 1420
ESP: Unit 1

Generator gross load 154.5 MW
Coal rate 55.7 ton / h
Heat rate 10,652 Btu / kWh

Electrical Data

TR Set # A-1

Primary voltage 243 V
Primary current 19.1 A
Secondary voltage 64.7 kV
Secondary current 122 mA

Sparking: Yes ☐ No ■
If Yes, Spark rate 0 sparks / min
Arcing: Yes ☐ No ■
Back corona: Yes ☐ No ■
TR status: On ■ Off ☐ Tripped ☐

TR Set # A-2

Primary voltage 357 V
Primary current 127.2 A
Secondary voltage 64.7 kV
Secondary current 462 mA

Sparking: Yes ■ No ☐
If Yes, Spark rate 0.8 sparks / min
Arcing: Yes ☐ No ■
Back corona: Yes ☐ No ■
TR status: On ■ Off ☐ Tripped ☐

TR Set # A-3

Primary voltage 405 V
Primary current 117.7 A
Secondary voltage 64.7 kV
Secondary current 640 mA

Sparking: Yes ■ No ☐
If Yes, Spark rate 0.5 sparks / min
Arcing: Yes ☐ No ■
Back corona: Yes ☐ No ■
TR status: On ■ Off ☐ Tripped ☐

TR Set #	B-1			
Primary voltage	267 V	Sparking:	Yes ■	No ☐
		If Yes, Spark rate	0.8 sparks / min	
Primary current	29.5 A	Arcing:	Yes ☐	No ■
Secondary voltage	64.8 kV	Back corona:	Yes ☐	No ■
Secondary current	180 mA	TR status:	On ■	Off ☐ Tripped ☐

TR Set #	B-2			
Primary voltage	360 V	Sparking:	Yes ■	No ☐
Primary current	85.7 A	If Yes, Spark rate	0.1 sparks / min	
Secondary voltage	64.8 kV	Arcing:	Yes ☐	No ■
Secondary current	473 mA	Back corona:	Yes ☐	No ■
		TR status:	On ■	Off ☐ Tripped ☐

TR Set #	B-3			
Primary voltage	423 V	Sparking:	Yes ■	No ☐
Primary current	105.9 A	If Yes, Spark rate	0.1 sparks / min	
Secondary voltage	64.8 kV	Arcing:	Yes ☐	No ■
Secondary current	594 mA	Back corona:	Yes ☐	No ■
		TR status:	On ■	Off ☐ Tripped ☐

Test Conditions

Inlet gas flow	576,392*	acfm	Water, Inlet	7.4*	%
	348,138*	dscfm	Oxygen, Inlet	6.3*	%, dry
Inlet mass loading	3.31*	gr / dscf	Pressure, Inlet	27.93*	inches of Hg
Outlet gas flow	556,288*	acfm	Efficiency	99.69*	%
	344,096*	dscfm			
Outlet mass loading	0.0105*	gr / dscf			

Boiler / Opacity Test Data

Inlet ESP temp.	296*	°F	Average opacity	3.04	%
Average temp. leaving Air heater	311	°F	Maximum opacity	5.19	%
			Soot blowing:	Operating ■	Off ☐
Exit ESP temp.	285*	°F			

Test 2

Date: September 9, 1998
Time: 1500 - 1650
ESP: Unit 1

Generator gross load 156.6 MW
Coal rate 56.7 ton / h
Heat rate 10,691 Btu / kWh

Electrical Data

TR Set # A-1

Primary voltage 243 V
Primary current 19.4 A
Secondary voltage 64.7 kV
Secondary current 123 mA

Sparking: Yes ☐ No ■
If Yes, Spark rate 0 sparks / min
Arcing: Yes ☐ No ■
Back corona: Yes ☐ No ■
TR status: On ■ Off ☐ Tripped ☐

TR Set # A-2

Primary voltage 356 V
Primary current 127.3 A
Secondary voltage 64.6 kV
Secondary current 461 mA

Sparking: Yes ■ No ☐
If Yes, Spark rate 1.0 sparks / min
Arcing: Yes ☐ No ■
Back corona: Yes ☐ No ■
TR status: On ■ Off ☐ Tripped ☐

TR Set # A-3

Primary voltage 405 V
Primary current 116.9 A
Secondary voltage 64.7 kV
Secondary current 636 mA

Sparking: Yes ■ No ☐
If Yes, Spark rate 0.9 sparks / min
Arcing: Yes ☐ No ■
Back corona: Yes ☐ No ■
TR status: On ■ Off ☐ Tripped ☐

TR Set #	B-1		
Primary voltage	268 V	Sparking:	Yes ■ No ☐
Primary current	30.5 A	If Yes, Spark rate	0.6 sparks / min
Secondary voltage	64.7 kV	Arcing:	Yes ☐ No ■
Secondary current	182 mA	Back corona:	Yes ☐ No ■
		TR status:	On ■ Off ☐ Tripped ☐

TR Set #	B-2		
Primary voltage	358 V	Sparking:	Yes ■ No ☐
Primary current	85.5 A	If Yes, Spark rate	1.1 sparks / min
Secondary voltage	64.6 kV	Arcing:	Yes ☐ No ■
Secondary current	471 mA	Back corona:	Yes ☐ No ■
		TR status:	On ■ Off ☐ Tripped ☐

TR Set #	B-3		
Primary voltage	422 V	Sparking:	Yes ■ No ☐
Primary current	104.7 A	If Yes, Spark rate	0.02 sparks / min
Secondary voltage	64.8 kV	Arcing:	Yes ☐ No ■
Secondary current	588 mA	Back corona:	Yes ☐ No ■
		TR status:	On ■ Off ☐ Tripped ☐

Test Conditions

Inlet gas flow	554,067* acfm	Water, Inlet	6.9* %
	366,747* dscfm	Oxygen, Inlet	6.2* %, dry
Inlet mass loading	2.98* gr / dscf	Pressure, Inlet	27.99* inches of Hg
Outlet gas flow	558,751* acfm	Efficiency	99.82* %
	342,920* dscfm		
Outlet mass loading	0.0051* gr / dscf		

Boiler / Opacity Test Data

Inlet ESP temp.	297 * °F	Average opacity	2.11 %
Average temp. leaving Air heater	312 °F	Maximum opacity	2.67 %
		Soot blowing:	Operating ■ Off ☐
Exit ESP temp.	290* °F		

Test 3

Date: September 9, 1998
Time: 1715 - 1910
ESP: Unit 1

Generator gross load 156.0 MW
Coal rate 56.2 ton / h
Heat rate 10,643 Btu / kWh

Electrical Data

TR Set # A-1

Primary voltage	240 V	Sparking:	Yes ☐	No ■	
Primary current	17.9 A	If Yes, Spark rate	0 sparks / min		
Secondary voltage	64.8 kV	Arcing:	Yes ☐	No ■	
Secondary current	118 mA	Back corona:	Yes ☐	No ■	
		TR status:	On ■	Off ☐	Tripped ☐

TR Set # A-2

Primary voltage	354 V	Sparking:	Yes ■	No ☐	
Primary current	125.8 A	If Yes, Spark rate	1.5 sparks / min		
Secondary voltage	64.5 kV	Arcing:	Yes ☐	No ■	
Secondary current	457 mA	Back corona:	Yes ☐	No ■	
		TR status:	On ■	Off ☐	Tripped ☐

TR Set # A-3

Primary voltage	405 V	Sparking:	Yes ■	No ☐	
Primary current	117.6 A	If Yes, Spark rate	1.1 sparks / min		
Secondary voltage	64.6 kV	Arcing:	Yes ☐	No ■	
Secondary current	640 mA	Back corona:	Yes ☐	No ■	
		TR status:	On ■	Off ☐	Tripped ☐

TR Set #	B-1							
Primary voltage	267	V	Sparking:	Yes ■	No ☐			
Primary current	29.7	A	If Yes, Spark rate	0.5	sparks / min			
Secondary voltage	64.8	kV	Arcing:	Yes ☐	No ■			
Secondary current	180	mA	Back corona:	Yes ☐	No ■			
			TR status:	On ■	Off ☐	Tripped ☐		

TR Set #	B-2					
			Sparking:	Yes ■	No ☐	
Primary voltage	358	V	If Yes, Spark rate	1.7	sparks / min	
Primary current	86.0	A	Arcing:	Yes ☐	No ■	
Secondary voltage	64.5	kV	Back corona:	Yes ☐	No ■	
Secondary current	474	mA	TR status:	On ■	Off ☐	Tripped ☐

TR Set #	B-3					
Primary voltage	424	V	Sparking:	Yes ■	No ☐	
Primary current	106.1	A	If Yes, Spark rate	0.1	sparks / min	
Secondary voltage	64.8	kV	Arcing:	Yes ☐	No ■	
Secondary current	597	mA	Back corona:	Yes ☐	No ■	
			TR status:	On ■	Off ☐	Tripped ☐

Test Conditions

Inlet gas flow	559,007*	acfm	Water, Inlet	7.3*	%
	366,326*	dscfm	Oxygen, Inlet	6.0*	%, dry
Inlet mass loading	3.18*	gr / dscf	Pressure, Inlet	27.94*	inches of Hg
Outlet gas flow	547,608*	acfm	Efficiency	99.93*	%
	334,050*	dscfm			
Outlet mass loading	0.0021*	gr / dscf			

Boiler / Opacity Test Data

Inlet ESP temp.	300 *	°F	Average opacity	2.09	%	
Average temp. leaving Air heater	312	°F	Maximum opacity	2.11	%	
			Soot blowing:	Operating ■	Off ☐	
Exit ESP temp.	292*	°F				