Final Report

Particulate Emissions Testing
Unit 1
Potomac River Generating Station
Alexandria, Virginia

Prepared for:

Mirant Potomac River, LLC
1400 North Royal Street
Alexandria, VA 22314

Prepared by:

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TABLE OF CONTENTS

Section *Page*

TABLE OF CONTENTS

Section *Page*

APPENDICES

TABLES

Number **Page**

Figures

Number **Page**

1.0 INTRODUCTION

1.1 OVERVIEW

TRC Environmental Corporation (TRC) of Lowell, Massachusetts was retained by Mirant Potomac River, LLC (Mirant) to provide sampling and analytical support in completing a Particulate Emission Test of Unit 1 of the Potomac River generating facility. The Test Program at the Potomac facility involved the completion of two series of emissions tests for particulate matter (PM), the first during normal unit operation and the second with the injection of TRONA upstream of hot side ESP fields. All tests were completed while Unit 1 was operating at 90% of full load (84MW) or greater.

1.2 SCOPE OF WORK

The test program required the completion of a series of three test runs for each operating condition. The testing determined the emission rate of particulate matter in terms of the emission standard (lb/MMBTU). The required measurement parameters and EPA test methods to accomplish the objective were:

40 CFR Part 60, Appendix A, EPA Methods

- Method 1 and 2 — Velocity
- Method 3A — Oxygen and Carbon Dioxide
- Method 4 — Moisture
- Method 201A — PM_{10}
- Method 202 — Condensable PM

Section 2 of this report presents a summary of the particulate emissions of each run. Section 3 contains plant operating data and overview of the sampling locations used. Section 4 describes the procedures used during the field sampling program. Section 5 outlines the procedures and

calculations used to analyze and report the samples during this test program. Section 6 presents an overview of TRC's quality assurance program.

2.0 SUMMARY OF RESULTS

This section presents a summary of the particulate emissions tests conducted at Unit 1 Potomac River Generating Station. The field sampling data sheets are located in Appendix A. The calculation summary forms can be found in Appendix B. The analytical data reports can be found in Appendix C. The facility process data can be found in Appendix D, and the equipment calibration data sheets can be found in Appendix E.

2.1 UNIT 1 –Baseline Operation

Three valid test runs were completed in accordance with EPA Method 201A/202. Tests were conducted on December 20th and 21st, 2005 with the unit operating normally without the injection of TRONA. The results of the three Method 201A/202 test runs (run nos, 2, 3 and 4) are presented in Table 2-1. The average particulate emission rate of 0.0350 lb/MMBTU is less than the current source total solid particulate emission limit of 0.12 lb/MMBTU.

An additional test run was performed on December 20th, 2005 (run No. 1). During this test run unit operation was disrupted when the bottom level pulverizer (D mill) had an interruption in coal feed (bridging in the bunker) that caused load to drop 30 minutes prior to the end of the test, from 85 MW to 50 MW. As a result, the run was not considered valid. A fourth run was performed to complete the test. The results of test run No. 1 are not presented in this section but have been included in Appendix B of this report.

2.2 UNIT 1 – With-Trona Operation

Three valid test runs were completed in accordance with EPA Method 201A/202. Tests were conducted on December 22nd and 23rd, 2005, with TRONA injection maintained at a rate that achieved an 80% reduction from baseline conditions. SO2 emissions averaged between 0.18 lb/MMBTU and 0.21 lb/MMBTU during the three test runs, compared to 1.07 lb/MMBTU SO2

under baseline conditions. The results of the three Method 201A/202 test runs (run nos. 1, 3, and 4) are presented in Table 2-2. The average particulate emission rate of 0.0186 lb/MMBTU is less than the current source total solid particulate emission limit of 0.12 lb/MMBTU.

An additional run for the With-Trona test was also required. This run was performed on December 23rd, 2005. During run No. 2 of this test, unit operation above 90% was interrupted when the B pulverizer (second level from the top) overheated and had to be taken offline for 2 hrs. After cooling down, the pulverizer was brought back online and the unit returned to full load. As a result, test run No. 2 was not considered valid and a fourth run was performed. Results from run No. 2 are not presented in this section, but have been included in Appendix B of this report.

TABLE 2-1. PM EMISSION SUMMARY FOR UNIT 1 – Normal Operation

RUN	*2*	*3*	*4*	*Average*
Net Sampling Time, minutes	91	94	89.5	91.5
Particulate Catch, mg	56.5	34.0	31.2	40.6
Volume of Gas Collected, (dscf) at 68^0F	39.504	38.763	37.759	38.675
CO_2 Concentration, % dry	11.8	12.5	12.6	12.3
O_2 Concentration, % dry	7.8	7.0	6.8	7.2
Particulate Matter Emission Rate, lb/MMBtu	0.0498	0.02833	0.0268	0.0350

TABLE 2-2. PM EMISSION SUMMARY FOR UNIT 1 – With-Trona Operation

RUN	*1*	*3*	*4*	*Average*
Net Sampling Time, minutes	97.25	90	89.75	92.3
Particulate Catch, mg	26.1	20.6	18.7	21.8
Volume of Gas Collected, (dscf) at 68^0F	39.900	36.935	35.808	37.548
CO_2 Concentration, % dry	12.5	12.4	12.4	12.4
O_2 Concentration, % dry	6.8	6.9	6.7	6.8
Particulate Matter Emission Rate, lb/MMBtu	0.0211	0.0182	0.0167	0.0186

3.0 PLANT OPERATING DATA AND SAMPLING LOCATION

3.1 PLANT OPERATING DATA

Mirant was responsible for the documentation of facility operating conditions during the test program. Plant operating data collected by Mirant plant personnel are provided in Appendix D. The following data was recorded electronically for each unit during each test run.

- Megawatts
- Opacity

3.2 SAMPLING LOCATION UNIT 1

TRC collected samples from Generating Unit #1. The outlet stack has an internal diameter of 156.1 inches. Four ports, located on the same plane, were present on the stack. TRC conducted a 12-point traverse. Table 3-1 presents these traverse points. Each port was sampled at 3 points to achieve the total of 12 points.

TABLE 3-1. VELOCITY TRAVERSE SAMPLING POINTS FOR UNIT 1

POINT	PERCENT OF STACK DIAMETER	DISTANCE FROM WALL (in.)
1	4.4	6.864
2	14.6	22.776
3	29.6	46.176

4.0 FIELD SAMPLING PROGRAM

4.1 OVERVIEW

This section describes the procedures that TRC followed during the field sampling program. Throughout the program TRC followed EPA Reference Methods 40 CFR Part 60 Appendix A. The remainder of this section is divided into several subsections: Field Program Description, Pre-sampling Activities, and Onsite Sampling Activities.

4.2 FIELD PROGRAM DESCRIPTION

The field sampling was conducted by TRC over the course of four consecutive days. The test methods that were utilized in accordance with 40 CFR Part 60 were as follows:

• EPA Method 1	Sample Velocity Traverse for Stationary Sources
• EPA Method 2	Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot tube)
• EPA Method 3B	Gas Analysis for the Determination of Emission Rate Correction Factor or Excess Air
• EPA Method 4	Determination of Moisture Content in Stack Gases
• EPA Method 201A	Determination of Particulate Matter Less Than 10 Microns in Diameter Emissions from Stationary Sources
• EPA Method 202	Determination of Condensible Particulate Matter Emissions from Stationary Sources

4.3 PRE-SAMPLING ACTIVITIES

Pre-sampling activities included equipment calibration, pre-cleaning of the sample train glassware, and other miscellaneous tasks. Each of these activities is described or referenced in

the following subsections. Other pre-sampling activities included team meetings, equipment packing, and finalization of all details leading up to the coordinated initiation of the sampling program.

4.3.1 Equipment Calibration

Inspection and calibration of the equipment is a crucial step in ensuring the successful completion of the field effort. All equipment was inspected for proper operation and durability prior to calibration. Calibration of the following equipment was conducted in accordance with the procedures outlined in EPA documents entitled "*Quality Assurance Handbook for Air Pollution Measurement Systems; Volume III - Stationary Source Specific Methods*" and 40 CFR Part 60 Appendix A. All calibrations were performed prior to the test program. Copies of the equipment calibration forms can be found in Appendix E.

4.4 ONSITE SAMPLING ACTIVITIES

Onsite sampling activities included conducting velocity traverses, sampling for particulate matter, moisture, oxygen and carbon dioxide.

4.4.1 EPA Methods 1 and 2 for Velocity Measurement

Velocity traverses were conducted at the sampling location with an S-type pitot assembly in accordance with 40 CFR Part 60, Appendix A, Method 1 "*Sample and Velocity Traverses for Stationary Sources*" and Method 2 "*Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)*". An S-type Pitot tube with an attached inclined manometer was used to measure the exhaust velocities of the outlet stack. An attached Type-K thermocouple with remote digital display was used to determine the flue gas temperature. During the test program, velocity measurements were conducted during each test run. The required number of velocity measurements points for the sampling location was determined following EPA Method 1.

4.4.2 EPA Method 3B for Flue Gas Molecular Weight

Oxygen and carbon dioxide concentrations were determined at the outlet stack for each test run according to EPA Reference Method 3B, "*Gas Analysis for the Determination of Emission Rate Correction Factor or Excess Air*".

Sample gas was drawn through a stainless steel probe, sampling line, and a moisture condenser. The gas sample was collected in an evacuated Tedlar bag. Prior to the Tedlar bag, the gas sample was drawn through a leak-free sample pump. Each sample was integrated over the 60 minute PM test run, with the collection of approximately 20 liters of sample gas.

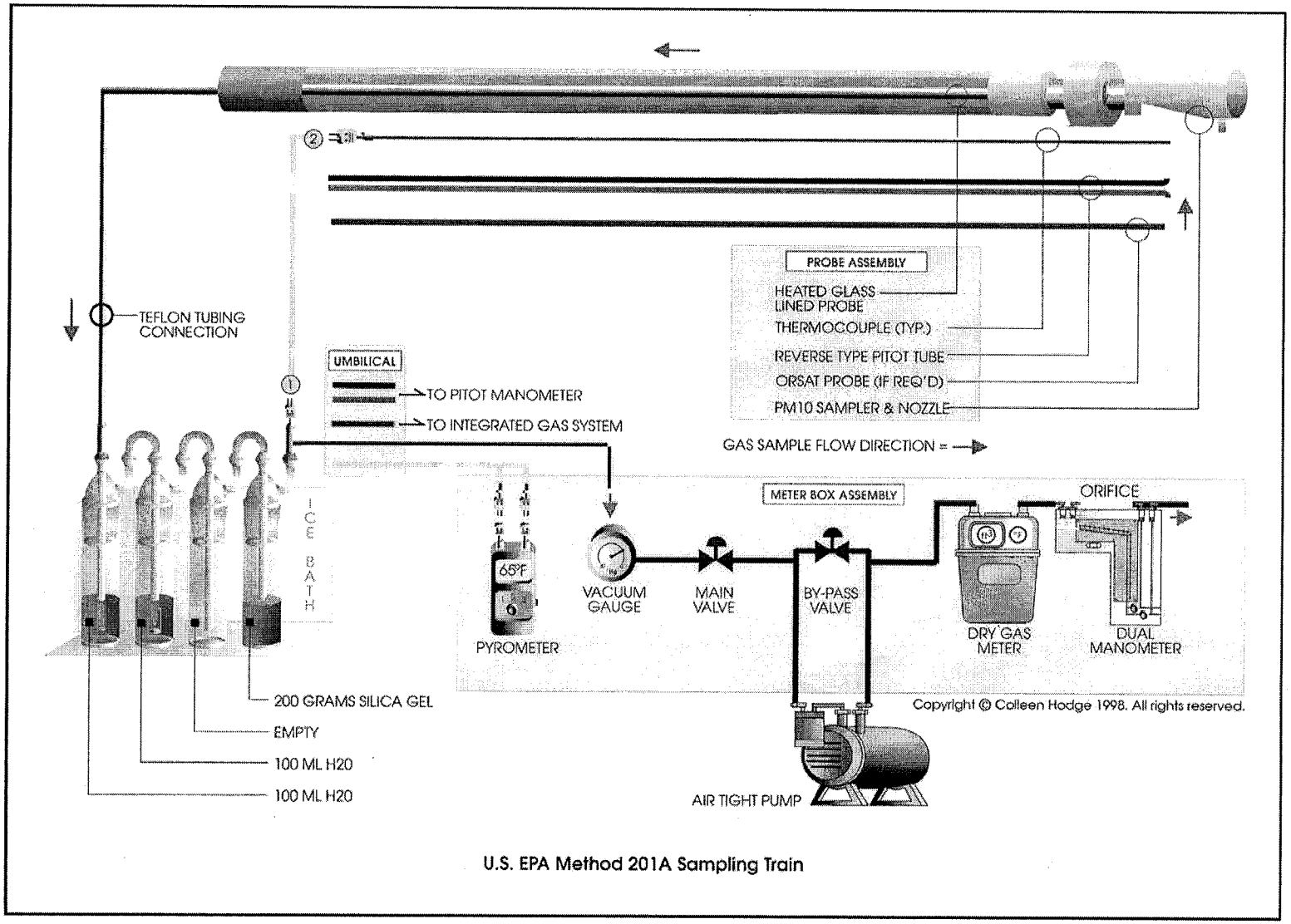
A sample from the Tedlar bag was introduced into the Orsat analyzer and analyzed for percent O_2 and percent CO_2. These concentrations were used to calculate the molecular weight of the gas stream for determining the gas stream velocity and excess air.

4.4.3 EPA Method 4 for Moisture Determination

Moisture was determined for each test run according to EPA Reference Method 4, "*Determination of Moisture Content in Stack Gases*". The principle of this method is to remove the moisture from the sample stream and determine moisture either volumetrically or gravimetrically. Method 4 was used in conjunction with the Method 201A/202 sampling train during the test program.

4.4.4 EPA Method 201A/202 for Particulate Matter

Particulate matter equal to or less than 10 microns in diameter (PM_{10}) was determined according to EPA Methods 201A and 202 (40 CFR Part 61, Appendix M). The sampling train consisted of a pre-cutter nozzle, an in-stack sizing device (cyclone), an in-stack filter, a heated glass probe with a S-type Pitot tube attached, four chilled impingers, and a metering console. A schematic of the sampling train is presented in Figure 4-1.



U.S. EPA Method 201A Sampling Train

FIGURE 4-1

The particulate with an aerodynamic size of $\leq$ 10 microns (PM10) was collected using an Anderson 280 Series cyclone followed by a 63 mm Whatman EPM2000 glass fiber filter. The Anderson cyclone and 63 mm filter were pre-heated prior to sampling. The first three impingers each contained 100 mL of HPLC Grade deionized, distilled (DI) water and the fourth contained silica gel. Initial weights for all impingers were determined gravimetrically prior to the run.

A preliminary velocity traverse (twelve points maximum) was performed to determine the velocity head (Δp) and gas temperature at each traverse point. Based on the flue gas parameters, the appropriate flowrate (acfm) into the nozzle was selected for the PM_{10} cut. The desired nozzle size was calculated; the nozzle closest to the desired size selected from the nozzles available, and the desired velocity into the selected nozzle were calculated. The desired velocity into the actual nozzle and the measured flue gas velocity at each traverse point were compared to verify that the isokinetic ratio could be maintained between 0.80 and 1.20. The sampling rate remained constant for the duration of the run while the sampling time at each traverse point was adjusted proportionally to the velocity at that point to provide a velocity weighted sample. The Δp measured for each point during the preliminary traverse was used to calculate the individual sampling durations during the test runs.

At the conclusion of each run, the pre-cutter nozzle/cyclone, probe, and filter were removed and the impinger contents were purged with nitrogen (N_2) to remove dissolved sulfur dioxide (SO_2) gases. The post-test nitrogen purge was performed at a rate of 20 L/min for duration of 60 minutes.

After the nitrogen purge, the post-test weight of all impingers was determined, and the DI water reagent was collected in a 1000 mL glass jar, and the liquid level marked. The silica gel was returned to the original container. The volume of water vapor condensed in the impingers and the volume of water vapor collected in the silica gel were summed and entered into moisture content calculations.

The pre-cutter nozzle and cyclone were rinsed with acetone into a 500 mL glass jar. The filter

was removed from the filter holder and placed into separate sample container and the front half of the filter holder was rinsed with acetone into the appropriate sample jar. The back-half of the filter holder, probe, impingers, and connecting glassware were rinsed twice with water into the 1000 mL jar containing the DI water reagent then twice with methylene chloride ($MeCl_2$) into a separate 500 mL glass jar.

The samples were analyzed in accordance with the procedures presented in Section 5.1.1 of this report.

5.0 ANALYTICAL PROCEDURES AND CALCULATIONS

This section delineates the analytical procedures and calculations, which were used to analyze and report the samples during this test program.

5.1 ANALYTICAL PROCEDURES

5.1.1 Particulate Matter

PM_{10} sampling analysis was accomplished by following the procedures in EPA Methods 201A and 202. The glass fiber filters were desiccated to a constant weight and placed in glass petri dishes and sealed with Teflon^R tape prior to testing. An identification label was placed on the petri dish. The containers used for the dry down of the acetone rinse were cleaned and dried in and an oven at 250°F. The containers were desiccated to a constant weight. All beakers utilized were of the low tare weight type (Teflon® insert).

The front-half acetone rinse was air dried in a tared container and then desiccated and weighed to a constant weight. The filter was desiccated and weighed to constant weight. The sum of the net weights for the probe wash and filter catch was used to calculate the concentration of filterable particulate matter.

The back-half DI water reagent and rinse and the back-half MeCl rinses were combined and extracted with MeCl to separate the organic and inorganic fractions. The organic fraction were desiccated and weighed to a constant weight. The inorganic fraction was analyzed in accordance with the method procedures (EPA Method 5F) for determination and correction of sulfate, chloride, and NH_4^+ contribution. The sum of the organic and inorganic fractions was reported as the total condensable particulate. The sum of the filterable and condensable particulate fractions was reported as the total PM_{10}.

5.2 CALCULATIONS

5.2.1 Flowrates

Calculations for the determination of dry gas sampled at standard conditions (dscf), gas velocity at stack conditions (afpm), and gas volumetric flow rate at standard conditions (dscfm) are as follows.

5.2.1.1 Volume of Dry Gas Sampled at Standard Conditions

Volume of dry gas sampled at standard conditions, dscf [a]

$$\text{dscf}^{a} = \frac{528 \times (Y) \times (VM) \times (PB + PM)}{29.92 \times (TM + 460)}$$

where:

[a]	=	Dry standard cubic feet at 68^0F (528^0R) and 29.92 inches of Hg
Y	=	Dry gas meter calibration factor
VM	=	Sample gas Volume, ft^3
PB	=	Barometric Pressure
PM	=	Average Orifice Pressure Drop, inches of Hg
TM	=	Average Dry Gas Temperature at meter, ^{0}F

5.2.1.2 Velocity of the Exhaust Gas

Stack gas velocity at stack conditions, afpm

$$\text{afpm} = 5130^{c} \times Cp \times SDE_{avg} \times \left[\frac{1}{PS \times MW}\right]^{1/2}$$

where:

$$^{b} = 5130 = \frac{85.5\ \text{ft}}{\text{sec}}\left[\frac{(\text{lb/lb - mole}) \times (\text{in. Hg})}{(^{\circ}\text{R}) \times (\text{in. H}_2\text{O})}\right] \times 60\ \text{sec/min}$$

Cp = Pitot tube coefficient

SDE_{avg} = $\left(\sqrt{\Delta P}\right)_{avg} \times \sqrt{\text{Stack Temp}_{avg}} + 460$

PS = Stack Pressure, absolute
inches of Hg = Barometric Pressure ± Avg Stack Static Pressure

MS = Molecular Weight of Wet Stack Gas

5.2.1.3 Volumetric Flow Rate of the Exhaust Gas

Stack gas volumetric flow rate at standard conditions, $dscfm^c$

$$dscfm^c = \frac{acfm \times 528 \times MD \times PS}{(29.92) \times (TS_{avg} + 460)}$$

where:

c = Dry standard cubic feet per minute at 68^0F (528^0R) and 29.92 in.Hg

MD = Mole Fraction of Dry Gas (dimensionless)

PS = Stack Pressure, absolute, inches of Hg

TS_{avg} = Average Stack Temperature

5.2.2 Particulate Matter - Grains per Dry Standard Cubic Foot

Emission rates in terms of grains per dry standard cubic feet (gr/dscf) were calculated using the PM_{10} emission rate in terms of milligrams (mg) divided by the volume of gas collected (dscf).

$$gr/dscf = 0.0154 \times \left[mg \div \left\{ \frac{528 \times (Y) \times (VM) \times (PB + PM)}{29.92 \times (TM + 460)} \right\} \right]$$

where:

dscf = Dry standard cubic feet at 68^0F (528^0R) and 29.92 inches Hg

0.0154 = 0.0154 grains per milligram

Y = Dry gas meter calibration factor

VM = Volume metered, ft^3

PB = Barometric Pressure, inches Hg

PM = Average Orifice Pressure Drop, inches Hg (Avg. ΔH inches H_2O) 13.6)

TM = Average Dry Gas Temperature at Meter, ^0F

5.2.3 Particulate Matter – Pounds per Million BTU

Emission rates were calculated in units of pollutant mass per quantity of heat input (lbs/MMBtu). The emission rate was calculated using the particulate (PM_{10}) and diluent concentrations and the fuel-specific F-factor derived from analysis of the fuel combusted and as specified in EPA Method 19. Measured PM_{10} emission concentrations were converted to a mass emission factor in terms of lbs/MMBtu using EPA Method 19, Equation 19-1:

$$PM_{10}\ (\text{lbs/MMBtu}) = \frac{PM_{10}(\text{gr/dscf})}{7000\ (\text{gr/lb})} \times F_d\ (\text{dscf/MMBtu}) \times \frac{20.9}{20.9 - \%\ O_{2\ \text{measured}}}$$

where:

F_d = Ratio of the volume of dry effluent gas to the gross calorific value of the As-fired fuel. (Fuel specific F-factor in terms of dscf/mmBtu was used).

5.2.4 Particulate Matter – Pounds per Hour

Emission rates in terms of pounds per hour (lbs/hr) were calculated using the PM emission concentration in terms of grains per dry standard cubic foot (gr/dscf), the outlet stack flowrate Q_s (dscfm) and the emission factor of 7000 grains in a pound (gr/lb).

$$PM_{10}\ (\text{lbs/hr}) = \frac{PM_{10}(\text{gr/dscf}) \times Qs(\text{dscfm}) \times 60\ \text{min/hr}}{7000\ \text{gr/lb}}$$

6.0 QUALITY ASSURANCE

6.1 OVERVIEW

TRC Environmental Corporation management is fully committed to an effective Quality Assurance/Quality Control Program whose objective is the delivery of a quality product. For much of TRC's work, that product is data resulting from field measurements, sampling and analysis activities, engineering assessments, and the analysis of gathered data for planning purposes. The Quality Assurance Program works to provide complete, precise, accurate, representative data in a timely manner for each project, considering both the project's needs and budget constraints.

This section highlights the specific QA/QC procedures to be followed on this Test Program.

6.2 FIELD QUALITY CONTROL SUMMARY

6.2.1 Calibration Procedures

Calibration of the field sampling equipment was performed prior to the field sampling effort. Copies of the calibration sheets were submitted to the field team leader to take onsite and for the project file. Calibrations were performed as described in the EPA publications "*Quality Assurance Handbook for Air Pollution Measurement Systems; Volume III - Stationary Source Specific Methods*" and EPA 40 CFR Part 60 Appendix A. Equipment to be calibrated included the sample metering system, nozzles, barometers, thermocouples, and Pitot tubes. All calibrations were available for review during the test program. Copies of the equipment calibration forms can be found in Appendix E.

6.2.2 Equipment Leak Checks

Prior to sampling, each sampling train was leak checked according to the procedures outlined in EPA Reference Method 201A/202. Final leak checks were performed to ensure that no leaks developed in the train during the course of the test run. All leakage rates, if any found, were recorded on the appropriate field data sheet.

6.2.3 Calibration Gases

All calibration gases used to conduct instrument calibrations were prepared in accordance with the EPA Protocol 1.

6.2.4 Cyclonic Flow Check

The absence of cyclonic flow within the outlet stack was established prior to sampling, in accordance with Section 2.4 of EPA Method 1.

6.2.5 Method Blanks

One Method blank for the Method 201A/202 sampling train was taken during the field sampling program to ensure sample quality.

6.3 SAMPLE CHAIN OF CUSTODY

The chain-of-custody of the samples are initiated and maintained as follows:

- Each sample was collected, labeled, sealed, and the liquid level marked on appropriate samples.
- The sample was recorded on the sample chain-of-custody form.
- Custody of the samples was retained by TRC until delivery to the analytical laboratory for analysis.

6.4 DATA REDUCTION, VALIDATION, AND REPORTING

Specific QC measures were used to ensure the generation of reliable data from sampling and analysis activities. Proper collection and organization of accurate information followed by clear and concise reporting of the data is a primary goal in all projects.

6.4.1 Field Data Reduction

The data collected was reviewed in the field by the Field Team Leader and at least one other field crew member. Any recording errors or discrepancies were noted in the field data sheet.

6.4.2 Laboratory Analysis Data Reduction

Analytical results were reduced to concentration units specified by the analytical procedures, using the equations provided in the analytical procedures.

6.4.3 Data Validation

TRC supervisory and QC personnel used validation methods and criteria appropriate to the type of data and the purpose of the measurement. Records of all data were maintained, including any judged to be an "outlying" or spurious value. The persons validating the data have sufficient knowledge of the technical work to identify questionable values.

Field sampling data was validated by the Field Team Leader and/or the Field QC Coordinator based on their review of the adherence to an approved sampling protocol and written sample collection procedure.

Analytical data was validated using criteria outlined below. TRC utilized results from the field method blank to further validate analytical results. Furthermore, TRC reviewed all laboratory raw analytical data to verify calculated results presented.

The following criteria were used to evaluate the field sampling data:

- Use of approved test procedures;
- Proper operation of the process being tested;
- Use of properly operating and calibrated equipment;
- Leak checks conducted before and after tests;
- Use of reagents conforming to QC specified criteria;
- Proper chain-of-custody maintained.

The criteria listed below were used to evaluate the analytical data:

- Use of approved analytical procedures;
- Use of properly operating and calibrated instrumentation;
- Results of Reagent and Method Blanks.

6.4.4 Data Reporting

All data was reported in standard units depending on the measurement and the ultimate use of the data. The bulk of the data was computer processed and reported using Excel as follows:

- Exhaust Gas Stream
  - Gas Properties:
    a. Moisture, dscf and percent by volume
    b. Flow rate, dscfm and acfm
    c. Pressure, mm of Hg
    d. Temperature, ^{0}F
  - Particulate:
    a. gr/dscf and lbs/MMBtu
  - Gas Diluents
    a. O_2, percent
    b. CO_2, percent