1.0 INTRODUCTION AND SUMMARY

1.1 PROGRAM OBJECTIVES

Montrose Air Quality Services, LLC (Montrose) was contracted by DTE Energy (DTE) to perform a series of air emission tests at the Renaissance Power Station (RPS) facility located in Carson City, MI. The compliance tests were conducted on one (1) Siemens EUTURBINE2SC (Unit 2) simple cycle gas turbine generator, to determine compliance with the source testing conditions of the Michigan Department of Environment, Great Lakes and Energy (EGLE).

The testing was conducted by Mr. John Hamner, Mr. Thomas Cassin, Mr. Mike Nummer, Mr. Shane Rabideau, Mr. Nicholas Woltcamp, Mr. Mathew Ojile, Mr. Trevor Tilmann, Mr. Zach Le Fever, Mr. Scott Dater, Mr. Ben Durham, and Mr. Craig Blohm of Montrose on March 16th thru 17th, 2021. Mr. John Hamner was the qualified individual on site, his QI Certifications are located in Appendix A. Mr. Mark Grigereit of DTE Energy coordinated the testing program. The tests were conducted according to a Protocol dated October 12, 2020 which was submitted to EGLE. Ms. Gina Angellotti and Ms. Lindsey Wells from EGLE were onsite and observed the testing program. Montrose performed the tests to measure the following emission parameters:

- Emission Compliance:
  - PM (total) as PM10/2.5 (lb/hr)
  - O_2 and CO_2 (% volume dry) – for molecular weight & dilution calculations
  - Stack volumetric flow rate (dscfm per Method 19) and moisture content (% by volume)
    - Fuel analysis ("F_d" factor, HHV, sulfur content)

This report presents the test results and supporting data, descriptions of the testing procedures, descriptions of the facility and sampling locations, and a summary of the quality assurance procedures used by Montrose. The average emission test results are summarized and compared to their respective permit limits and performance specifications in Table 1-1. Detailed results for individual test runs can be found in Section 5.0. All supporting data can be found in the appendices.

TABLE 1-1
SUMMARY OF AVERAGE COMPLIANCE RESULTS
DTE RENAISSANCE POWER STATION
TURBINE UNIT 2
Base CONDITION

Parameter	Unit 2 (3/16/21 thru 3/17/21)	Permit Limit
Unit Data:		
Fuel Heat Input (MMBtu/hr)	1,948.6	--
Total Particulate Matter (PM2.5/PM10):		
PM 10 lb/hr	5.01	9.0

1.2 PROJECT CONTACTS

A list of project participants is included below:

Facility Information

Source Location:	Renaissance Power Plant 950 N. Division Street Carson City, MI 48811	
Project Contact:	Mr. Mark Grigereit	
Company:	DTE Energy	
Telephone:	(313) 412-0305	
Email:	Mark.grigereit@dteenergy.com	

Agency Information

Regulatory Agency:	Michigan Department of Environment, Great Lakes and Energy	
Agency Contact:	Ms. Gina Angellotti	Ms. Lindsey Wells
Telephone:	(313) 418-0895	(517) 282-2345
Email:	AngellottiR1@michigan.gov	Wellsl8@michigan.gov

Testing Company Information

Testing Firm:	Montrose Air Quality Services, LLC (Montrose)	
Contact:	Barry Boulianne	John Hamner
Title:	VP Sales and Marketing	Client Project Manager
Telephone:	(313) 449-2361	(630) 715-3259
Email:	bboulianne@montrose-env.com	jhamner@montrose-env.com

2.0 SOURCE LOCATION INFORMATION

2.1 FACILITY DESCRIPTION

The plant provides electric power when requested to do so during periods of peak power demand or system need, and does not operate outside of those system requests so its operation is batch like. During periods of operation, there is not significant emissions variability.

Each turbine set consists of a compressor, combustion turbine, and generator. Mechanical energy is generated at the combustion turbine by drawing in ambient air by means of burning fuel and expanding the hot combustion gases in a four-stage turbine. The mechanical energy is converted to electrical energy through the generator.

Each turbine is equipped with dry low-NOX burners. Each unit has its own dedicated exhaust stack areas. Each turbine has a nominal heat input rating of 1,900 million Btu per hour, and is capable of producing 215 megawatts of electricity. The facility is equipped with a Distributed Control System (DCS) to monitor heat input. NOx emissions from the exhaust are continuously monitored as required by 40 CFR, Part 75. Carbon Monoxide (CO) stack emissions are continuously monitored per 40 CFR, Part 60

2.2 Process Operating Data

During each test run, fuel flow and fuel heat input to the gas turbine were continuously recorded on a data acquisition system. The data is averaged for each test run in the final report.

2.3 SAMPLING LOCATIONS

A total of sixteen 6" flanged sample ports are installed the unit with 8 installed on each the north and south walls of the exhaust ducts. Eight ports were selected for use on this program, 4 on each side.

The test location on Unit 2 at RNPP do not meet the minimum dimensional criteria of EPA Method1 (>2stack equivalent diameters downstream and > 0.5 diameters upstream from flow disturbances. The available sample locations are in fact inside of an area for the exhaust system contains silencer baffles that are separated with gaps where the exhaust gases pass between them. In addition to the complications related to the silencer baffles, the situation is further complicated by the relatively large overall dimensions of the exhaust ducting which is approximately 20' x 20' square with ports installed on opposing walls. A diagram of the sample plane is shown below. The figure shows 16 sample ports providing access to 8 gas path openings, arranged into 8 opposing pairs.

Traverse Points
A simplified diagram of the traverse points is provided in Figure 1.

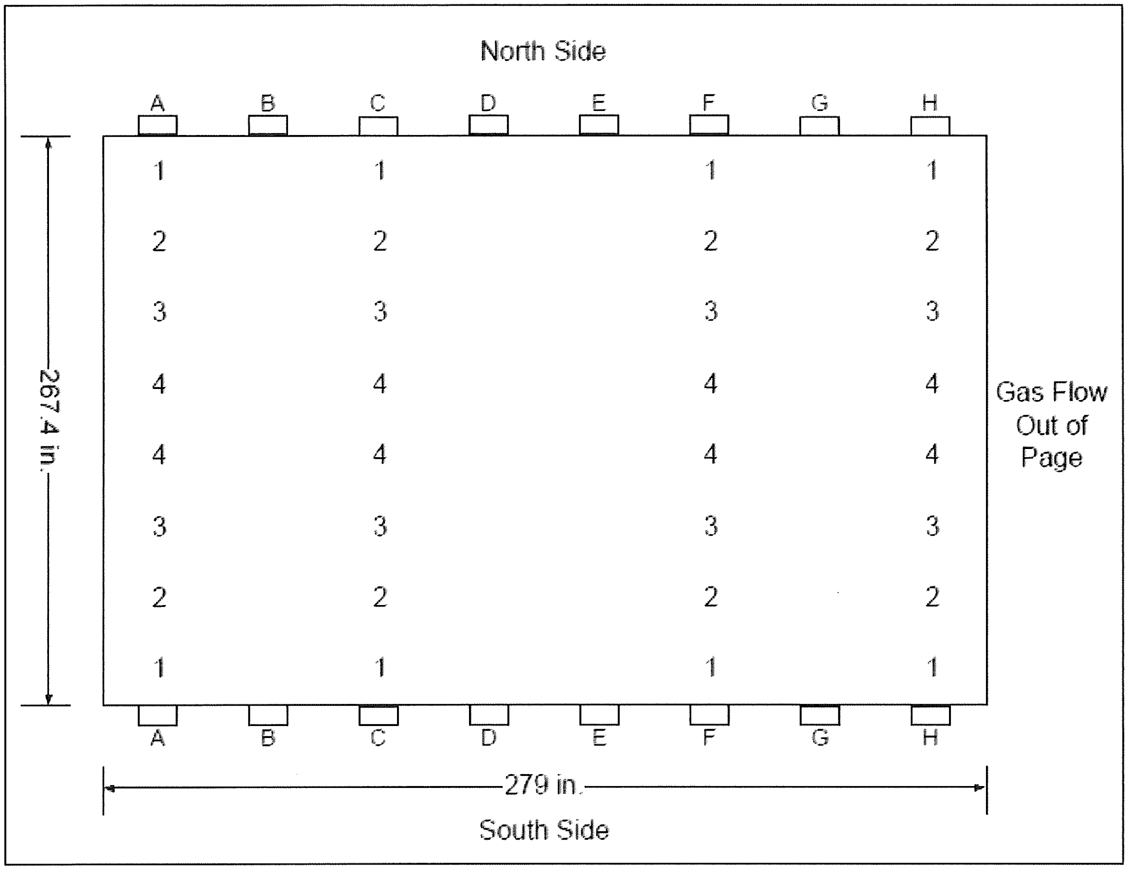

Figure 1

Sample Point Layout

3.0 TEST DESCRIPTION

3.1 PROGRAM OBJECTIVES

The objective of this test program was to prove compliance of Unit 2 with the permit limits. The results are presented in units consistent with those stated in the permit.

3.2 TEST CONDITIONS

Emission tests were performed while the source units were operating at the conditions required by the permit. Tests were performed at the following conditions:

- Condition 1: Base Load

Plant personnel established the test conditions and collected all applicable unit-operating data. Montrose monitored the collection of process data.

3.3 TEST PROGRAM SCHEDULE

The test program schedule is presented in Table 3-1.

TABLE 3-1
TEST MATRIX AND SCHEDULE

Date	Source ID/ Activity	Sample Runs	Sample Duration
March 15, 2021	Set-up	--	--
March 16, 2021	**Unit 2 Stack Base**		
	O_2 & CO_2	1-2	4 hour
	PM	1-2	4 hour
March 17, 2021	**Unit 2 Stack Base**		
	O_2 & CO_2	3	4 hour
	PM	3	4 hour

3.4 MONTROSE TEST PROCEDURES

The test procedures used for this test program are summarized in Table 3-2 below. Additional information regarding specific applications or modifications to standard procedures is presented in the following sub-sections.

TABLE 3-2
TEST PROCEDURES

Parameter	Measurement Principle	Reference Method
Volumetric flow rate	Pitot/temperature traverse	EPA 1, 2
Volumetric flow rate	Stoichiometric calculation	EPA 19
O_2	Paramagnetism	EPA 3A
CO_2	Non-dispersive infrared	EPA 3A
Moisture	Impinger weight gain	EPA 4
Particulate Matter	Gravimetry with condensable analysis	EPA 5/202

3.4.1 Gaseous Emissions

Concentrations of the gaseous constituents of stack gas carbon dioxide (CO_2) and oxygen (O_2) were measured using Montrose's dry extractive reference method (RM) monitor system in accordance with Methods 3A. This system meets the requirements of EPA method for gaseous species. Pertinent information regarding the performance of the method is presented below:

- Method Deviations: None
  - Method Options: N/A

Source gas was sampled for a period of 60 minutes for each of the conditions per source.

3.4.3 Particulate Matter Emissions

Emissions of total particulate matter (PM) were measured using a combination of EPA Methods 5 and 202. Pertinent information regarding the performance of the methods are presented below:

- Method Deviations: None
  - Method Options: A field train recovery blank was collected on-site; the glassware was baked for 6 hours prior to use. Additionally, pressurized nitrogen was used to purge all trains
  - Target and/or Minimum Required Sample Duration: 240 Minutes
  - Target and/or Minimum Required Sample Volume: >120 dscf
  - Analytical Laboratory: Montrose Elk Grove Village, IL

3.4.4 Volumetric Flow Rate

Stack gas volumetric flow rates were determined by the procedures outlined in EPA Method 19. Pertinent information regarding the performance of the method is presented below:

- F Factor: Oxygen based F factor, dry basis (F_d)
  - F Factor Source: Analysis of fuel samples
  - Heat Input Data: Calculated based on fuel flow rate and higher heating value
  - Higher Heating Value Source: Analysis of fuel samples.

Velocity flow rates and moisture content were determined using EPA Methods 2 and 4 in conjunction with each particulate matter test. The calculated Method 19 flow rates were used to calculate emissions in lb/hr.

3.4.6 Fuel Analysis

Sample gas from the facility's ethane blend natural gas fuel supply pipeline was collected and submitted for analysis. Pertinent information regarding the fuel analysis is presented below:

- Analytical Method: ASTM D-1945/ASTM D-3246
  - Sample Containers: Teflon-coated pressurized fuel bombs
  - Analytical Laboratory: Texas Oil Tech Laboratories, Inc., Houston

3.4.7 Process Data

The plant's unit operating data was used to document process conditions during the test runs. Unit operating data was provided by DTE personnel. Data presented in this report includes the following:

- Power output
- CEMS data
- Heat Input
- Fuel Flow

4.0 QUALITY ASSURANCE AND REPORTING

4.1 SAMPLING AND ANALYTICAL QA/QC

Montrose has instituted a rigorous QA/QC program for all of its air pollution testing. Quality assurance audits are performed as part of the test program to ensure that the final results are calculated from the highest quality data. The program ensures that the emission data reported are as accurate as possible. The procedures included in the cited reference methods were followed for all steps of preparation, sampling, calibration, and analysis. Montrose was responsible for preparation, calibration and cleaning of the sampling apparatus. Montrose also conducted the sampling and sample recovery, storage, and shipping.

Contract laboratories conducted some of the preparation and sample analyses as needed. The laboratories that were used are established leaders in development and performance of the reference methods for which they have been selected. Their credentials for adherence to the required quality assurance procedures are well known.

4.2 QUALITY CONTROL PROCEDURES

Our Quality Assurance Program provides our equipment maintenance and calibration schedule, quality control acceptance limits, and any corrective action that may be needed. For additional quality control, Montrose followed the procedures outlined below and in the method write-ups in Section 3.4.

4.2.1 Equipment Inspection and Maintenance

- Each critical piece of field equipment was assigned a unique identification number to allow tracking of its calibration history
    - All field equipment was visually inspected prior to testing and included pre-test calibration checks

4.3 DATA ANALYSIS, VALIDATION, AND UNCERTAINTY

The raw data collected during the sampling and analysis procedures were used to calculate the results of the testing program. The analysis or reduction of the data to the final results followed these steps, where appropriate to the test method:

- Check field-sampling data for accuracy and calculate appropriate data averages (e.g., temperatures, pressures, volumes, etc.).
  - Double check calculation of the data averages.
  - Review all in-house and contract laboratory reports and ensure that appropriate and/or required QA/QC steps were followed.
  - Enter field and laboratory data to established and verified computer spreadsheets for calculation of volumetric flow rates, mass emission rates or other appropriate results.
  - Double-check all lab and field data inputs.
  - Perform example calculations by hand using raw data on a single test run for each type of emission result reported.
  - Compile summary tables of results and review all table inputs.

This report includes copies of spreadsheet printouts (data input and results output) and example calculation checks. The field data sheets with average data calculations are also included. Standard conditions used for data reduction are 29.92 inches of mercury and 68 °F.

Both qualitative and quantitative factors contribute to field measurement uncertainty and should be taken into consideration when interpreting the results contained within this report. Whenever possible, Montrose personnel reduce the impact of these uncertainty factors by using approved and validated test methods. In addition, Montrose personnel perform routine instrument and equipment calibrations and ensure that the calibration standards, instruments, and equipment used during test events meet, at a minimum, test method specifications as well as the specifications of our Quality Manual and ASTM D 7036-04. The limitations of the various methods, instruments, equipment, and materials utilized during this test have been reasonably considered, but the ultimate impact of the cumulative uncertainty of this project is not fully identified within the results of this report.

5.0 DISCUSSION OF RESULTS

5.1 DETAILED DISCUSSION OF RESULTS

The average results are compared to the performance specifications in Table 1-1. Detailed results from the individual compliance test runs are presented in Tables 5-1 through 5-3.

Additional information is included in the appendices. Appendix A presents the quality assurance information, including instrument calibration data. Data sheets and plant data is included in Appendix B. Appendix C presents the general and specific equations used for the emissions calculations and computer spreadsheets. Appendix D presents the outside lab results.

5.2 PROBLEMS/DEVIATIONS/EXCEPTIONS

No problems, deviations, or exception occurred during this test program. The data provided by the plant was off by one hour from the test data collected by Montrose due to the change in daylight savings time.

TABLE 5-1
GASEOUS TEST RESULTS
UNIT 2 Base

Reference Method Test Run Data

Client:	DTE	Test Start Date:	Tuesday, March 16, 2021
Facility:	Renaissance	Test Completion Date:	3/17/2021
Source:	GT 2	Operator:	Tom Cassin
Test Location:	Stack		F Factor Information
Condition/Load:	Base	F_c	1800
Project Number:	049AS-006795	F_d	-
		Reference Method Measurement Basis:	Dry - Extractive
		CEMS Analyzer Measurement Basis:	-

Uncorrected Reference Method Analyzer Results

Run Number	Test Date	Start Minute	End Minute	CO (ppmvd)	NO_x (ppmvd)	SO_2 (ppmvd)	O_2 (% v/v Dry)	CO_2 (% v/v Dry)
1	03/16/21	8:15	12:45	-	-	-	13.65	4.09
2	03/16/21	13:27	17:55	-	-	-	13.62	4.08
3	03/17/21	7:40	12:06	-	-	-	13.68	4.09

Calibration Corrected Reference Method Analyzer Results
Moisture Basis As Measured

Run Number	Test Date	Start Minute	End Minute	CO (ppmvd)	NO_x (ppmvd)	SO_2 (ppmvd)	O_2 (% v/v Dry)	CO_2 (% v/v Dry)
1	03/16/21	8:15	12:45	-	-	-	13.73	4.09
2	03/16/21	13:27	17:55	-	-	-	13.75	4.07
3	03/17/21	7:40	12:06	-	-	-	13.77	4.08

TABLE 5-2
PARTICULATE TEST RESULTS
UNIT 2 NORTH Base

Client				DTE
Unit / Location				RENPP/2-North
A (stack area), ft^2				239.785
T_{ref} (reference temperature), °F				68
Test number	Run 1	Run 2	Run 3	Average
Date	3/16/21	3/16/21	3/17/21	--
Start / Stop time	8:15-12:45	13:27-17:55	7:40-12:06	--
F_d (fuel "F" factor @ 68°F), dscf/MMBtu	8615.60	8615.60	8615.20	--
F_d (fuel "F" factor @ T_{ref}), dscf/MMBtu	8615.60	8615.60	8615.20	--
Fuel Density, lb/scf (fuel std condition 60°F	0.0454	0.0454	0.0453	--
HHV (fuel higher heating value), Btu/scf	1050.21	1050.21	1049.18	--
Fuel Flow Rate, lb/sec	11.80	11.60	11.70	--
Fuel Heat Input, MMBTU/hr	982.7	966.0	975.5	--
Meter box number	CS7	CS7	CS7	--
C_p (pitot coefficient), dimensionless	0.8400	0.8400	0.8400	0.8400
Y (meter calibration factor), dimensionless	0.9970	0.9970	0.9970	0.997
θ (sample time), min	240.00	240.00	240.00	240.00
Nozzle diameter, in	0.178	0.178	0.178	0.178
P_{bar} (barometric pressure), in Hg	30.00	30.01	30.09	30.03
V_m (meter box volume), acf	147.127	147.668	146.391	147.062
V_{lc} (impinger liquid), g	256.6	257.3	246.9	253.6
T_m (meter temperature), °F	57.0	73.5	70.8	67.1
ΔH (meter pressure), in. H_2O	1.096	1.114	1.146	1.119
ΔP (velocity head), in. H2O	3.7479	3.6406	3.7230	3.7038
P_g (static pressure), in. Hg	-0.38	-0.37	-0.37	-0.37
T_s (stack temperature), °F	1068.6	1069.8	1070.1	1069.5
%O_2 (oxygen stack gas), % volume dry	13.73	13.75	13.77	13.75
%CO_2 (carbon dioxide stack gas), % volume dry	4.09	4.07	4.08	4.08
m_f (F½ particulate matter catch - filter), g	0.0028	0.0002	0.0031	0.0020
m_a (F½ particulate matter catch - acetone rinse), g	0.0021	0.0021	0.0020	0.0021
m_{cpm} (B½ particulate matter catch - total condensible, blank c	0.0026	0.0032	0.0020	0.0026
m_n (total particulate matter catch), g	0.0075	0.0055	0.0071	0.0067
$V_{m(std)}$ (standard sample volume), dscf	150.623	146.533	146.424	147.860
$V_{w(std)}$ (water vapor volume), scf	12.098	12.131	11.640	11.956
B_{ws} (moisture fraction), non-dimensional	0.0743	0.0765	0.0736	0.0748
Moisture, %	7.43	7.65	7.36	7.48
MW_{dry} (stack gas molecular weight), dry	29.204	29.201	29.204	29.203
MW_{wet} (stack gas molecular weight), wet	28.371	28.345	28.379	28.365
P_s (absolute stack pressure), in Hg	29.972	29.983	30.063	30.006
V_s (stack gas velocity), ft/sec	186.092	183.535	185.255	184.961
Q_{sd} (fuel heat input), dscfm	411,307	405,467	410,593	409,122
I (isokinetic ratio), %	101.57	100.47	98.91	100.32
G (F½ grain loading), gr/dscf	0.000502	0.000242	0.000537	0.000427
M (F½ mass emissions), lb/hr	1.77	0.84	1.89	1.50
E (F½ mass emissions), lb/MMBtu	0.001797	0.000869	0.001935	0.001534
G (B½ grain loading), gr/dscf	0.000266	0.000337	0.000211	0.000271
M (B½ mass emissions), lb/hr	0.94	1.17	0.74	0.95
E (B½ mass emissions), lb/MMBtu	0.000953	0.001210	0.000759	0.000974
G (total grain loading), gr/dscf	0.000768	0.000579	0.000748	0.000699
M (total mass emissions), lb/hr	2.71	2.01	2.63	2.45
E (total mass emissions), lb/MMBtu	0.00275	0.00208	0.002693	0.002508

TABLE 5-3
PARTICULATE TEST RESULTS
UNIT 2 SOUTH Base

Client				DTE
Unit / Location				RENPR2-South
A (stack area), ft^2				239.785
T_{ref} (reference temperature), °F				68
Test number	Run 1	Run 2	Run 3	Average
Date	3/16/21	3/16/21	3/17/21	--
Start / Stop time	8:15-12:45	13:27-17:55	7:40-12:06	--
F_d (fuel "F" factor @ 68°F), dscf/MMBtu	8615.19	8615.90	8615.20	--
F_d (fuel "F" factor @ T_{ref}), dscf/MMBtu	8615.19	8615.90	8615.20	--
Fuel Density, lb/scf (fuel std condition 60°F	0.0454	0.0454	0.0453	--
HHV (fuel higher heating value), Btu/scf	1050.21	1050.21	1049.18	--
Fuel Flow Rate, lb/sec	11.80	11.60	11.70	--
Fuel Heat Input, MMBTU/hr	982.7	966.0	975.5	--
Meter box number	CS4	CS4	CS4	--
C_p (pitot coefficient), dimensionless	0.8400	0.8400	0.8400	0.8400
Y (meter calibration factor), dimensionless	1.0240	1.0240	1.0240	1.024
θ (sample time), min	240.00	240.00	240.00	240.00
Nozzle diameter, in	0.170	0.170	0.170	0.170
P_{bar} (barometric pressure), in Hg	30.00	30.01	30.09	30.03
V_m (meter box volume), acf	158.600	154.480	154.950	156.010
V_{lc} (impinger liquid), g	253.4	255.5	249.2	252.7
T_m (meter temperature), °F	58.7	70.6	67.2	65.5
ΔH (meter pressure), in. H_2O	1.493	1.401	1.421	1.439
ΔP (velocity head), in. H2O	5.3944	4.9358	5.0350	5.1217
P_g (static pressure), in. Hg	-0.36	-0.36	-0.36	-0.36
T_s (stack temperature), °F	1078.9	1082.8	1080.5	1080.7
%O_2 (oxygen stack gas), % volume dry	13.73	13.75	13.77	13.75
%CO_2 (carbon dioxide stack gas), % volume dry	4.09	4.07	4.08	4.08
m_f (F½ particulate matter catch - filter), g	0.0031	0.0002	0.0024	0.0019
m_a (F½ particulate matter catch - acetone rinse), g	0.0043	0.0017	0.0030	0.0030
m_{cpm} (B½ particulate matter catch - total condensible, blank c	0.0024	0.0038	0.0021	0.0028
m_n (total particulate matter catch), g	0.0098	0.0057	0.0075	0.0077
$V_{m(std)}$ (standard sample volume), dscf	166.371	158.414	160.378	161.721
$V_{w(std)}$ (water vapor volume), scf	11.950	12.044	11.749	11.914
B_{ws} (moisture fraction), non-dimensional	0.0670	0.0707	0.0683	0.0686
Moisture, %	6.70	7.07	6.83	6.86
MW_{dry} (stack gas molecular weight), dry	29.204	29.201	29.204	29.203
MW_{wet} (stack gas molecular weight), wet	28.453	28.410	28.439	28.434
P_s (absolute stack pressure), in Hg	29.974	29.984	30.064	30.007
V_s (stack gas velocity), ft/sec	223.682	214.358	215.943	217.994
Q_{sd} (fuel heat input), dscfm	411,288	405,481	410,593	409,120
I (isokinetic ratio), %	102.21	102.17	101.99	102.13
G (F½ grain loading), gr/dscf	0.000686	0.000185	0.000520	0.000464
M (F½ mass emissions), lb/hr	2.42	0.64	1.83	1.63
E (F½ mass emissions), lb/MMBtu	0.002457	0.000664	0.001870	0.001664
G (B½ grain loading), gr/dscf	0.000223	0.000370	0.000202	0.000264
M (B½ mass emissions), lb/hr	0.78	1.29	0.71	0.93
E (B½ mass emissions), lb/MMBtu	0.000797	0.001329	0.000727	0.000951
G (total grain loading), gr/dscf	0.000909	0.000555	0.000722	0.000731
M (total mass emissions), lb/hr	3.20	1.93	2.54	2.56
E (total mass emissions), lb/MMBtu	0.00325	0.00199	0.002598	0.002615