ENVIRONMENTAL SOURCE SAMPLERS, INC. – AIR QUALITY CONSULTANTS

HONEYWELL INTERNATIONAL, INC.
HOPEWELL PLANT
AREA 9 C-TRAIN: TW-17 INLET/OUTLET
PART 60 CEMS RATAS AND
NOX REDUCTION EFFICIENCY
APRIL 21, 2015

ESS PROJECT NO. 0115-26

Prepared for:
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CERTIFICATION

This test report is submitted to Honeywell International, Inc. by Environmental Source Samplers, Inc., covering air emissions sampling conducted at the Honeywell International, Inc. Hopewell, Virginia facility on April 21, 2015. ESS operated within the requirements of ASTM D7036-04 during the test project. The data and results presented in this report are representative of the actual operating and test parameters.

Analytical reports are reviewed for completeness, accuracy, adherence to method protocol, and compliance with quality assurance guidelines and NELAC 2003 standards. The results relate only to the laboratory samples listed. Neither this certification nor report shall be reproduced except in full, without written approval of ESS. ESS laboratory (VELAP ID: 460039) is accredited through the Virginia Environmental Laboratory Accreditation Program (VELAP) for methods pertaining to filterable particulate matter, sulfuric acid, total reduced sulfur and hydrogen sulfide. ESS only subcontracts to laboratories with NELAP accreditation. All test results provided meet all requirements of NELAP unless labeled otherwise. Justification will be provided in Appendix D for all results that do not meet NELAP requirements. Certificates of Accreditation are available upon request.

Results Reviewed By:

Melanie Bethea, Director of US Operations
June 10, 2015

Report Reviewed and Finalized By:

Mark Looney, President
June 10, 2015

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SECTION 1
INTRODUCTION

1.0 INTRODUCTION

Environmental Source Samplers, Inc. (ESS) conducted air emissions sampling at the Honeywell - Hopewell Plant, located in Hopewell, Virginia. NOx reduction efficiency was determined while conducting a Relative Accuracy Test Audit (RATA) on Continuous Emission Monitoring Systems (CEMS) associated with process TW-17 inlet and outlet stacks on April 21, 2015.

The test series was conducted in accordance with 40 CFR Part 60 procedures. U.S. Environmental Protection Agency (EPA) Methods 7e and 3a, appearing in 40 CFR Part 60, Appendix A, were used to perform this gas sampling. EPA Methods 1 – 4 were used in conducting the moisture and flowrate measurements. Performance Specifications 2 and 6, appearing in 40 CFR Part 60, Appendix B, were also incorporated into the test series, as required.

Personnel present included:

Mr. Tom Varner, Honeywell International, Inc.
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SECTION 2
SUMMARY OF RESULTS

2.0 SUMMARY OF RESULTS

The test results are summarized below and detailed more completely on the following pages. Field data sheets are included in Appendix A, calculations in Appendix B, operational data in Appendix C, and calibration data in Appendix D.

Nine (9) runs were conducted at a single load condition for the parameters of interest. Part 60 requirements for NOx and flowrate monitors are 20 percent relative accuracy to meet the applicable Performance Specification requirements (PS 2, section 13.2 and PS 6, section 13.2).

Unit TW-17 Inlet– CEMS Summary Table

PARAMETER	CEM RA (%)
CEMS NOx (ppm)	17.85

Unit TW-17 Outlet – CEMS Summary Table

PARAMETER	CEM RA (%)
Flowrate (SCFM)	10.88
NOx (ppm)	14.24

Unit TW-17 – NOx Destruction Efficiency

PARAMETER	EMISSIONS
Inlet NOx (lb/hr)	595.25
Outlet NOx (lb/hr)	11.83
Destruction Efficiency (%)	98.01

HONEYWELL - HOPEWELL, VA
RELATIVE ACCURACY -TW-17 INLET
April 21, 2015

NOX (PPM)

RUN NO.	TEST	MONITOR	DIFFERENCE	%
1	4511.82	5197.15	-685.33	-15.19
2	4618.12	5492.78	-874.66	-18.94
3	4577.62	5324.16	-746.54	-16.31
4	4706.89	5402.89	-696.00	-14.79
5	4769.78	5714.06	-944.28	-19.80
6	5023.11	5922.25	-899.14	-17.90
7	5071.37	5901.72	-830.35	-16.37
8	5153.33	5851.32	-697.99	-13.54
9	5177.60	5767.02	-589.42	-11.38
AVG	4845.52	5619.26	-773.75	-16.02

MEAN OF DIFFERENCE	773.75
STANDARD DEVIATION	118.59
2.5% ERROR CONFIDENCE	91.16
RELATIVE ACCURACY (%)	17.85

HONEYWELL - HOPEWELL, VA
RELATIVE ACCURACY - TW-17 OUTLET
April 21, 2015

NOX (PPM)

RUN NO.	TEST	MONITOR	DIFFERENCE	%
1	77.54	67.74	9.80	12.64
2	90.23	76.95	13.28	14.71
3	77.60	68.15	9.45	12.18
4	109.07	92.82	16.25	14.90
5	119.52	105.51	14.01	11.73
6	116.64	110.46	6.18	5.30
7	92.01	87.27	4.74	5.15
8	92.28	78.18	14.10	15.28
9	91.71	83.27	8.44	9.20
AVG	96.29	85.59	10.70	11.23

MEAN OF DIFFERENCE	10.70
STANDARD DEVIATION	3.93
2.5% ERROR CONFIDENCE	3.02
RELATIVE ACCURACY (%)	14.24

HONEYWELL - HOPEWELL, VA
RELATIVE ACCURACY - TW-17 OUTLET
April 21, 2015

NOX (LB/HR)

RUN NO.	TEST	MONITOR	DIFFERENCE	%
1	9.31	9.46	-0.15	-1.65
2	11.07	10.72	0.35	3.12
3	9.57	9.49	0.08	0.86
4	13.41	12.99	0.42	3.13
5	14.69	15.03	-0.34	-2.29
6	14.52	15.84	-1.32	-9.06
7	11.32	12.56	-1.24	-10.97
8	11.39	11.24	0.15	1.30
9	11.24	11.94	-0.70	-6.25
AVG	11.83	12.14	-0.31	-2.42

MEAN OF DIFFERENCE	0.31
STANDARD DEVIATION	0.65
2.5% ERROR CONFIDENCE	0.50
RELATIVE ACCURACY (%)	6.81

HONEYWELL - HOPEWELL
DETERMINATION OF FLOWRATE - RESULTS
OUTLET TW-17

FIELD DATA												
Date		4/21/15	4/21/15	4/21/15	4/21/15	4/21/15	4/21/15	4/21/15	4/21/15	4/21/15	Average	
Run Number		1	2	3	4	5	6	7	8	9		
Run Start Time		12:15	12:45	13:15	13:45	14:15	14:45	15:15	15:45	16:15		hh:mm
Run Stop Time		12:35	13:05	13:35	14:05	14:35	15:05	15:35	16:05	16:35		hh:mm
Meter Calibration Factor	(Y)	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007		
Pitot Tube Coefficient	(C_p)	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	
Total Meter Volume	(V_m)	14.116			14.116			14.116			14.12	ft^3
Total Sampling Time	(Θ)	20.0			20.0			20.0			20.00	min
Average Meter Temperature	$(t_m)_{avg}$	69.5			74.0			74.0			72.50	°F
Average Stack Temperature	$(t_s)_{avg}$	543.9	545.0	545.7	545.6	545.7	544.8	546.0	548.9	548.2	545.97	°F
Absolute Stack Pressure	(P_s)	29.74	29.74	29.74	29.74	29.74	29.74	29.74	29.74	29.74	29.74	in Hg
Average Sample Rate		1.50			1.50			1.50			1.50	dscfm
Avg Square Root Pitot Pressure	$(\Delta p^{1/2})^2_{avg}$	1.016	1.062	1.076	1.074	1.074	1.101	1.070	1.080	1.065	1.07	$(in\ H_2O)^{1/2}$
MOISTURE CONTENT DATA												
Total Water Volume Collected	(V_{lc})	10.1			11.1			10.1			10.4	ml
Standard Water Vapor Vol	$(V_w)_{std}$	0.477			0.524			0.477			0.492	scf
Standard Meter Vol	$(V_m)_{std}$	13.992	13.992	13.992	13.992	13.992	13.992	13.876	13.876	13.876	13.954	dscf
Stack Moisture Content	(B_{wo})	3.29	3.29	3.29	3.61	3.61	3.61	3.32	3.32	3.32	3.41	%
GAS ANALYSIS DATA												
Run Number		1	2	3	4	5	6	7	8	9		
Carbon Dioxide Percentage	($\%CO_2$)	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	%
Oxygen Percentage	($\%O_2$)	5.4	5.4	5.5	5.4	5.4	5.4	5.4	5.4	5.4	5.4	%
Carbon Monoxide Percentage	(%CO)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	%
Nitrogen Percentage	($\%N_2$)	89.2	89.2	89.1	89.2	89.2	89.2	89.2	89.2	89.2	89.2	%
Dry Gas Molecular Wt	(M_d)	29.08	29.08	29.08	29.08	29.08	29.08	29.08	29.08	29.08	29.08	lb/lb-mole
Wet Stack Gas Molecular Wt	(M_s)	28.89	28.89	28.89	28.85	28.85	28.85	28.88	28.88	28.88	28.88	lb/lb-mole
Calculated Fuel Factor	(F_o)	2.870	2.870	2.852	2.870	2.870	2.870	2.870	2.870	2.870	2.868	
Percent Excess Air	(%EA)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	%
VOLUMETRIC FLOW RATE DATA												
Average Stack Gas Velocity	(v_s)	78.13	79.92	80.45	80.44	80.43	81.39	80.27	80.75	80.14	80.21	ft/sec
Stack Cross-Sectional Area	(A_s)	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07	ft^2
Actual Stack Flow Rate	(Q_a)	33138	33896	34119	34116	34112	34520	34042	34248	33987	34020	acfm
Wet Standard Stack Flow Rate	(Qsw)	17323	17702	17805	17804	17802	18031	17760	17817	17692	17748	wscfm
Dry Standard Stack Flow Rate	(Q_{sd})	16753	17119	17218	17162	17160	17381	17171	17225	17105	17144	dscfm
CEMS DATA												
Wet Standard Stack Flow Rate		19,210	19,155	19,148	19,244	19,511	19,718	19,791	19,777	19,721	19475	scfm
RELATIVE ACCURACY TEST DATA												
Difference		-1886	-1453	-1343	-1440	-1709	-1687	-2031	-1960	-2029	-1727	scfh
Percent Difference		-10.89	-8.21	-7.54	-8.09	-9.60	-9.36	-11.43	-11.00	-11.47	-9.73	%
Standard Deviation											266.83	
2.5% Error Confidence											205.10	%
T-Value											2.306	
Client Supplied WAF											0.9605	
BAF											1.00	
Relative Accuracy											10.88	

SECTION 3
PROCESS DESCRIPTION

3.0 PROCESS DESCRIPTION AND OPERATION

The Honeywell – Hopewell Plant is the world's largest single-site producer of caprolactam. Additionally, the facility produces ammonium sulfate, specialty polymers and other proprietary chemicals.

Source testing consisted of the "AREA 9" production unit. Area 9 provides components of the caprolactam, ammonium sulfate, and specialty products produced by the Hopewell Plant. The Area 9 sources tested were the inlet and outlet of the Nitrite section of "C" Train (TW-17). Testing of the Area 9 stacks is required in order to meet the monitoring requirements outlined in the facility Title V Permit (Condition 74) issued on October 1, 2014.

A CEMS is located at the inlet and outlet stack sampling locations – as previously delineated. Each CEMS unit is designed to monitor flowrate (KWSCFH or KSCFM, as noted) and NOx (ppm-wet).

CEM manufacturers, model numbers and serial numbers have previously been provided to the VADEQ-DAQ.

CEMS and process operating data appear in Appendix C to this report.

SECTION 4
SAMPLING POINT LOCATION

4.0 SAMPLING LOCATION

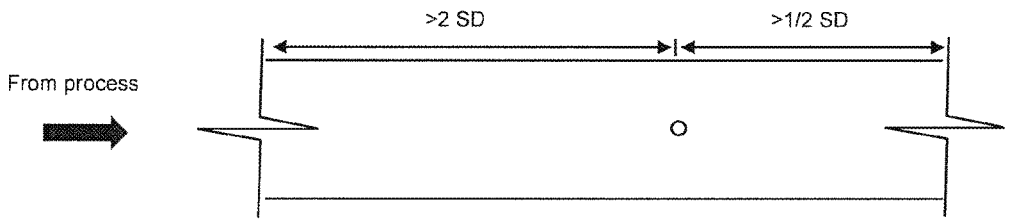
Each process unit directs their process emissions to dedicated emission points.

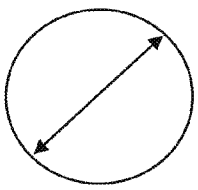
For TW-17 Inlet CEMS, the stack sampling plane is located in a thirty-two (32) inch diameter cross-section. In accordance with Performance Specification 2 and 3 procedures, a three (3) point traverse was conducted during each test run. Each point was sampled for 7.0 minutes, resulting in 21.0 minute test runs.

The TW-17 Outlet CEMS sampling plane is located in a thirty-six (36) inch diameter cross-section. The test ports are located approximately 19 feet downstream of a duct disturbance and approximately 39 feet upstream of a duct bend. For the purpose of measuring stack gas velocity, sixteen (16) points were sampled.

Diagrams of the sampling locations appear on the following pages.

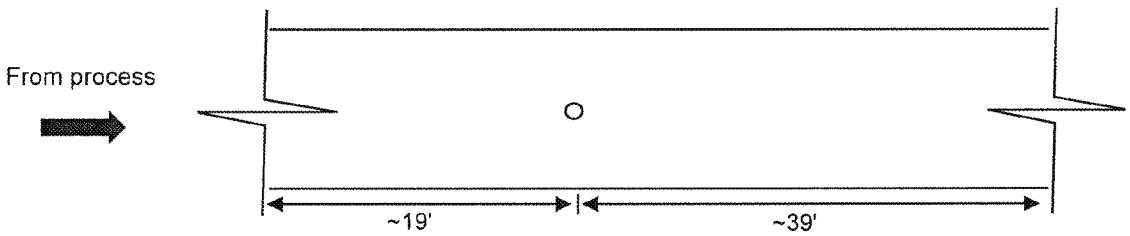
HONEYWELL INTERNATIONAL
HOPEWELL, VIRGINIA
TW-17 NITRITE TOWER INLET SAMPLING PLANE

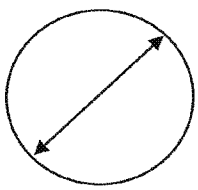




Stack Diameter = 32 "

HONEYWELL INTERNATIONAL
HOPEWELL, VIRGINIA
TW-17 NITRITE TOWER OUTLET SAMPLING PLANE





Stack Diameter = 36 "

Dist from inside stack wall to point	
1	34.8 "
2	32.2 "
3	29.0 "
4	24.4 "
5	11.6 "
6	7.0 "
7	3.8 "
8	1.6 "

SECTION 5
FIELD & ANALYTICAL PROCEDURES

5.0 FIELD AND ANALYTICAL PROCEDURES

Gaseous Emission Testing

The extractive monitoring system and all sampling and analysis procedures used in this testing program conform with the requirements of 40 CFR 60, Appendix A, reference methods 3a and 7e. For O_2, CO_2 and NOx sampling, the gas sample was extracted through a heated stainless steel sample probe having an in-stack filter. A heated teflon lined sample line delivered the gas sample from the heated probe to the VIA MAK II gas condensing unit. The sample was then directed through an un-heated teflon sample line to the sample pump and gas manifold, where the appropriate flowrate for each analyzer was set and the sample gas delivered to the analyzers. An Omega Data Acquisition System (DAS) recorded the data at each of the sampling points, and provided averages for each test run. The DAS was capable of handling eight (8) channels. During this test series, three (3) channels were used to record O_2, CO_2 and NOx.

EPA Protocol calibration gases were used to calibrate the instruments according to the applicable EPA methodology. The O_2, CO_2 and NOx calibration gases have been analyzed according to EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards, September, 1993 and as amended by EPA 600/R-12/531 on June 29, 2012.

NOx Analyzer

An API Model 200AH analyzer (S/N 192) was used to collect the NOx data. This monitor uses chemiluminescence in determining NO or NOx concentrations. NOx is defined as the sum of the NO and NO_2 gas concentrations. In the determination of NO, the sample is converted to NO_2 through association with ozone generated by the analyzer. A highly sensitive photomultiplier detector tube measures the light emitted by the photon emission. For the determination of NOx, the sample is directed to the reaction chamber, where the NO_2 is dissociated to form NO via the NO_2 to NO converter. The remainder of the analysis is then as described above through reaction with the ozone.

O_2 Analyzer

Oxygen was monitored with a California Analytical Instruments Model 200 Paramagnetic Oxygen Analyzer (PMA). The PMA cell consists of a dumbbell of diamagnetic material, which is temperature controlled electronically at 50 degrees C. The higher the oxygen concentration, the farther the dumbbell is deflected from its rest position. Surrounding the dumbbell is a coil of wire. A current is passed through this coil to return the dumbbell to its original position. The current applied is linearly proportional to the percent oxygen concentration in the sample gas.

Since the instrument is based on the magnetic property of oxygen (and unaffected by coexisting gas components), it is optimum for use in combustion type applications and for environmental control.

CO_2 Analyzer

A CAI Model 3300A non-dispersive infrared (NDIR) analyzer (S/N N3P1278T) was used in determining CO_2 concentrations. An infrared light beam emitted by the source passes through the measuring cell, which is filled with a continuously flowing gas sample. The light beam is partially absorbed by the CO_2 in the cell before reaching the front chamber of the detector. The difference in the amount of light absorbed between the front and rear chambers is dependent on the concentration of the CO_2 within the sample measurement cell. The pressure difference between the two (2) chambers is monitored by the micro-flow sensor connecting the two (2) chambers. The electrical signal from the sensor is converted into a DC signal for output to the data logger and front panel meter.

Moisture Sampling Train

Moisture sampling was conducted by EPA Method 4. An impinger sampling train was used to sample for stack gas moisture at the stack sampling location. Or, alternatively, the technicians recorded the wet-bulb and dry-bulb temperatures. The first two (2) impingers each contained about 100 mls of water or hydrogen peroxide, the third impinger was empty, and the fourth impinger contained silica gel. A sample was collected over a 20 - 40 minute period at a constant sampling rate of <.75 cubic feet per minute. The impingers were weighed prior to and following the test run to determine moisture gained. EPA Method 4 calculations were used to determine percent moisture.

QUALITY ASSURANCE ACTIVITIES

Gaseous Sampling: O_2, CO_2, NOx

Similar quality control and calibration procedures were used for each of the three (3) on-site instrumental gaseous analyzers: O_2, CO_2 and NOx. Upon arrival at the test site, each analyzer was unpacked and inspected for possible damage. The instruments were plugged in and allowed to warm up a minimum of 2 hours prior to attempting any calibration procedures. Care was taken to ensure that the analyzers were placed in a controlled temperature environment to minimize analyzer drift. The heated sample lines and probes were also allowed to heat to operating temperatures. The gas conditioner was installed and allowed to cool to an operating temperature of about 33 degrees F.

Electrical voltages supplied to the analyzers are critical for correct operation. Line voltages were checked to ensure that at least 110 volts A.C. were maintained.

While the instruments and sampling lines were warming up, the DAS and gas manifold system were set up. After the analyzers had stabilized, linearity checks were performed on each analyzer. The appropriate EPA Protocol calibration gases were introduced to the gas manifold system, and the data recorded with the DAS.

A zero, mid, and high calibration gas was introduced to the O_2, CO_2 and NOx monitors. Once the calibration procedure had commenced, the span and zero controls were not touched. If

it was necessary to adjust the zero or span, then the analyzer linearity check would have been started over. Each gas provided a response to the calibration gas within 2 percent of the span value of the instrument for O_2, CO_2 and NOx.

Following the successful completion of the instrument linearity checks, a sampling system bias check was required for the O_2, CO_2 and NOx analyzers. A leak check was performed across the sampling system consisting of the heated sample line, gas conditioner, unheated teflon sample line, unheated teflon calibration line, gas manifold, and sample pump. The zero and mid range gas for each of the analyzers was delivered to the system. The resulting concentrations were within 5 percent of the data recorded during the analyzer linearity checks previously recorded.

A system response time check was performed on the sampling system. Since NOx analyzers are the slowest to respond, the system response time was based upon the data collected from the NOx analyzer. The response time was the amount of time for the analyzer to display a 95 percent step change in gas concentration.

The instrument calibrations were checked with a zero and mid-level calibration gas prior to and following each test run.

The EPA Method 20 NO_2 to NO converter efficiency check is performed by introducing NO_2 gas into the analyzer in direct calibration mode and recording the NOx concentration displayed by the analyzer. The NO_2 to NO conversion efficiency, calculated according to Equation 7E–7, must be greater than or equal to 90 percent.

Calibration Procedures

EPA and VA DEQ procedures were followed in performing equipment calibrations. Procedures outlined in the EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, (EPA/600/R-94/038c) were followed, in addition to procedures outlined in the applicable reference methods.

The EPA Method 4 dry gas meter receives a complete calibration prior to and following each field use. The post test calibration must be within 5% of the pre-test calibration.

The procedures outlined in EPA Method 2, section 4.3 are used to verify that the stack temperature thermocouple and dry gas meter thermometer are within allowable tolerances. The absolute temperature measured with the gauge being calibrated and the reference gauge must agree within 1.5 percent.

Additional copies of test procedures may be obtained through the EPA website via www.ESSKnowsAir.com.

APPENDIX A
FIELD DATA

TW-17 INLET

HIGH	NOX	O2	CO2		
Run 1	PPM	%	%		
Pre Zero	4.8	0.011	0.029		
Pre Span	4665	12.06	8.011		
4/21/2015					
				O2 Diff	
12:15	4437.412	5.245	5.356	%	
12:16	4457.986	5.231	5.365		
12:17	4478.948	5.191	5.364		
12:18	4496.172	5.213	5.362		
12:19	4533.899	5.231	5.365		
12:20	4578.950	5.205	5.369		
12:21	4586.272	5.205	5.361	-0.020	1
12:22	4574.876	5.245	5.355		
12:23	4599.425	5.238	5.360		
12:24	4573.654	5.224	5.363		
12:25	4540.198	5.231	5.358		
12:26	4521.720	5.220	5.367		
12:27	4520.274	5.239	5.363		
12:28	4505.672	5.250	5.365	0.024	2
12:29	4513.056	5.210	5.370		
12:30	4485.660	5.250	5.365		
12:31	4484.544	5.214	5.370		
12:32	4475.458	5.221	5.361		
12:33	4471.296	5.225	5.365		
12:34	4494.056	5.178	5.373		
12:35	4473.484	5.222	5.366	-0.004	3
				AVG	5.226
AVERAGE	4514.429	5.223	5.364		
Post Zero	7.1	0.006	0.022		
Post Span	4658	12.01	8.015		

HIGH Run 2	NOX PPM	O2 %	CO2 %
Pre Zero	7.1	0.006	0.022
Pre Span	4658	12.01	8.015
4/21/2015			
12:45	4584.349	5.215	5.364
12:46	4606.990	5.197	5.375
12:47	4608.760	5.186	5.378
12:48	4593.378	5.208	5.371
12:49	4611.309	5.175	5.378
12:50	4609.243	5.171	5.384
12:51	4793.253	4.896	5.438
12:52	4716.358	5.077	5.411
12:53	4660.013	5.121	5.418
12:54	4616.597	5.197	5.393
12:55	4606.940	5.190	5.397
12:56	4603.093	5.197	5.389
12:57	4615.810	5.189	5.388
12:58	4599.598	5.236	5.363
12:59	4597.073	5.193	5.379
13:00	4634.621	5.139	5.385
13:01	4598.296	5.208	5.366
13:02	4559.234	5.277	5.362
13:03	4552.448	5.270	5.357
13:04	4554.794	5.266	5.363
13:05	4524.592	5.277	5.350
AVERAGE	4611.750	5.185	5.381
Post Zero	8.5	0.001	0.025
Post Span	4647	11.96	8.003

HIGH Run 3	NOX PPM	O2 %	CO2 %
Pre Zero	8.5	0.001	0.025
Pre Span	4647	11.96	8.003
4/21/2015			
13:15	4512.682	5.336	5.325
13:16	4548.536	5.282	5.342
13:17	4539.948	5.285	5.326
13:18	4523.957	5.322	5.329
13:19	4529.045	5.293	5.334
13:20	4549.232	5.293	5.344
13:21	4547.973	5.300	5.336
13:22	4570.236	5.285	5.335
13:23	4568.980	5.285	5.339
13:24	4571.649	5.289	5.346
13:25	4569.615	5.278	5.348
13:26	4582.532	5.281	5.351
13:27	4579.818	5.289	5.351
13:28	4607.158	5.245	5.352
13:29	4600.255	5.267	5.354
13:30	4585.147	5.289	5.339
13:31	4602.776	5.249	5.342
13:32	4596.903	5.281	5.345
13:33	4617.299	5.231	5.355
13:34	4626.733	5.228	5.358
13:35	4589.375	5.275	5.346
AVERAGE	4572.374	5.280	5.343
Post Zero	10.11	-0.006	0.02
Post Span	4660	11.89	7.998

HIGH Run 4	NOX PPM	O2 %	CO2 %
Pre Zero	10.11	-0.006	0.02
Pre Span	4660	11.89	7.998
4/21/2015			
13:45	4651.707	5.217	5.372
13:46	4675.271	5.203	5.358
13:47	4684.811	5.192	5.370
13:48	4667.212	5.232	5.365
13:49	4694.809	5.177	5.374
13:50	4691.638	5.199	5.372
13:51	4710.136	5.177	5.373
13:52	4701.687	5.195	5.375
13:53	4713.171	5.199	5.375
13:54	4719.721	5.174	5.379
13:55	4695.792	5.225	5.372
13:56	4730.960	5.163	5.383
13:57	4724.025	5.196	5.381
13:58	4737.830	5.160	5.375
13:59	4736.383	5.185	5.376
14:00	4713.661	5.218	5.370
14:01	4714.770	5.218	5.374
14:02	4720.819	5.188	5.378
14:03	4732.004	5.199	5.377
14:04	4759.149	5.185	5.372
14:05	4751.631	5.221	5.368
AVERAGE	4710.818	5.196	5.373
Post Zero	12.5	-0.01	0.028
Post Span	4666	11.8	7.991

HIGH Run 5	NOX PPM	O2 %	CO2 %
Pre Zero	12.5	-0.01	0.028
Pre Span	4666	11.8	7.991
4/21/2015			
14:15	4777.941	5.203	5.376
14:16	4742.510	5.246	5.355
14:17	4764.998	5.228	5.370
14:18	4743.332	5.258	5.360
14:19	4761.657	5.236	5.366
14:20	4753.328	5.240	5.359
14:21	4747.429	5.280	5.363
14:22	4787.730	5.207	5.376
14:23	4798.123	5.211	5.364
14:24	4756.847	5.273	5.359
14:25	4758.974	5.276	5.344
14:26	4752.357	5.298	5.344
14:27	4767.911	5.284	5.345
14:28	4765.890	5.309	5.345
14:29	4803.940	5.280	5.348
14:30	4777.694	5.302	5.345
14:31	4796.314	5.262	5.356
14:32	4816.816	5.265	5.364
14:33	4829.861	5.244	5.366
14:34	4839.342	5.255	5.357
14:35	4830.677	5.273	5.363
AVERAGE	4779.699	5.259	5.358
Post Zero	14.2	-0.014	0.047
Post Span	4672	11.89	7.989

HIGH Run 6	NOX PPM	O2 %	CO2 %
Pre Zero	14.2	-0.014	0.047
Pre Span	4672	11.89	7.989
4/21/2015			
14:45	4975.494	5.255	5.363
14:46	4997.085	5.212	5.369
14:47	4993.275	5.234	5.351
14:48	4997.690	5.234	5.351
14:49	5003.460	5.227	5.351
14:50	5005.651	5.238	5.354
14:51	5004.178	5.248	5.357
14:52	5027.981	5.227	5.370
14:53	5015.648	5.256	5.355
14:54	5041.607	5.216	5.364
14:55	5045.056	5.198	5.370
14:56	5046.799	5.216	5.356
14:57	5036.987	5.241	5.352
14:58	5051.940	5.205	5.352
14:59	5070.690	5.173	5.362
15:00	5067.156	5.209	5.363
15:01	5061.283	5.219	5.353
15:02	5041.754	5.220	5.354
15:03	5049.151	5.231	5.347
15:04	5031.281	5.252	5.338
15:05	5066.538	5.216	5.361
AVERAGE	5030.034	5.225	5.357
Post Zero	15.5	-0.01	0.054
Post Span	4661	11.84	7.985

HIGH Run 7	NOX PPM	O2 %	CO2 %
Pre Zero	15.5	-0.01	0.054
Pre Span	4661	11.84	7.985
4/21/2015			
15:15	5048.528	5.224	5.359
15:16	5056.348	5.224	5.359
15:17	5076.655	5.206	5.362
15:18	5069.219	5.213	5.366
15:19	5059.493	5.231	5.352
15:20	5064.259	5.217	5.358
15:21	5057.209	5.249	5.350
15:22	5062.860	5.257	5.339
15:23	5083.246	5.235	5.351
15:24	5054.954	5.264	5.337
15:25	5068.067	5.242	5.337
15:26	5066.661	5.268	5.350
15:27	5061.721	5.286	5.331
15:28	5068.498	5.261	5.329
15:29	5096.055	5.243	5.346
15:30	5075.522	5.264	5.333
15:31	5078.369	5.275	5.334
15:32	5109.369	5.228	5.338
15:33	5109.866	5.210	5.351
15:34	5085.471	5.272	5.341
15:35	5108.602	5.228	5.340
AVERAGE	5074.332	5.243	5.346
Post Zero	15.9	-0.015	0.062
Post Span	4665	11.97	7.994

HIGH Run 8	NOX PPM	O2 %	CO2 %
Pre Zero	15.9	-0.015	0.062
Pre Span	4665	11.97	7.994
4/21/2015			
15:45	5122.678	5.286	5.341
15:46	5137.263	5.268	5.329
15:47	5128.654	5.280	5.331
15:48	5149.616	5.247	5.332
15:49	5153.834	5.265	5.331
15:50	5162.362	5.247	5.337
15:51	5145.152	5.262	5.331
15:52	5155.536	5.254	5.332
15:53	5168.969	5.247	5.335
15:54	5149.631	5.262	5.326
15:55	5160.728	5.272	5.328
15:56	5146.185	5.290	5.340
15:57	5139.826	5.276	5.324
15:58	5156.480	5.262	5.336
15:59	5154.357	5.284	5.327
16:00	5166.509	5.280	5.333
16:01	5170.444	5.262	5.338
16:02	5181.574	5.244	5.333
16:03	5157.957	5.266	5.330
16:04	5163.762	5.255	5.334
16:05	5170.246	5.262	5.338
AVERAGE	5154.370	5.265	5.333
Post Zero	16.6	-0.019	0.064
Post Span	4658	11.92	8.002

HIGH	NOX	O2	CO2
Run 9	PPM	%	%
Pre Zero	16.6	-0.019	0.064
Pre Span	4658	11.92	8.002
4/21/2015			
16:15	5130.542	5.292	5.328
16:16	5130.857	5.284	5.325
16:17	5134.593	5.291	5.330
16:18	5149.303	5.266	5.340
16:19	5148.938	5.284	5.335
16:20	5146.302	5.291	5.325
16:21	5140.713	5.291	5.326
16:22	5149.844	5.270	5.321
16:23	5166.430	5.244	5.335
16:24	5167.426	5.256	5.335
16:25	5176.300	5.263	5.328
16:26	5179.311	5.248	5.319
16:27	5168.040	5.259	5.322
16:28	5164.167	5.256	5.330
16:29	5164.628	5.266	5.331
16:30	5181.598	5.256	5.341
16:31	5191.691	5.248	5.350
16:32	5201.455	5.234	5.339
16:33	5215.194	5.328	5.320
16:34	5241.586	5.278	5.334
16:35	5224.655	5.307	5.325
AVERAGE	5170.170	5.272	5.330
Post Zero	17.1	-0.021	0.07
Post Span	4650	11.897	8.011

TW-17 OUTLET

HIGH	NOX	O2	CO2		
Run 1	PPM	%	%		
Pre Zero	0.047	0.037	0.021		
Pre Span	72.05	12.02	8.012		
4/21/2015					
				O2 Diff	
12:15	85.875	5.405	5.421	%	
12:16	83.215	5.356	5.442		
12:17	96.872	5.326	5.448		
12:18	88.580	5.356	5.431		
12:19	77.904	5.390	5.437		
12:20	85.682	5.371	5.438		
12:21	94.440	5.364	5.442	-0.050	1
12:22	62.334	5.402	5.433		
12:23	80.182	5.432	5.438		
12:24	97.897	5.383	5.427		
12:25	73.297	5.391	5.414		
12:26	74.333	5.410	5.423		
12:27	78.334	5.432	5.422		
12:28	74.322	5.463	5.406	0.049	2
12:29	76.969	5.406	5.417		
12:30	62.374	5.467	5.416		
12:31	74.714	5.384	5.432		
12:32	61.511	5.426	5.413		
12:33	58.567	5.403	5.426		
12:34	89.642	5.361	5.436		
12:35	55.462	5.415	5.426	0.001	3
				AVG	5.414
AVERAGE	77.738	5.397	5.428		
Post Zero	0.05	0.027	0.03		
Post Span	72.12	11.98	8.007		

HIGH Run 2	NOX PPM	O2 %	CO2 %
Pre Zero	0.05	0.027	0.03
Pre Span	72.12	11.98	8.007
4/21/2015			
12:45	80.539	5.416	5.418
12:46	92.250	5.359	5.435
12:47	80.291	5.329	5.435
12:48	63.111	5.355	5.428
12:49	81.021	5.302	5.445
12:50	73.247	5.332	5.428
12:51	165.786	5.049	5.497
12:52	110.732	5.344	5.443
12:53	105.497	5.329	5.457
12:54	60.820	5.476	5.428
12:55	90.539	5.386	5.440
12:56	102.250	5.351	5.445
12:57	90.291	5.366	5.423
12:58	73.111	5.404	5.422
12:59	91.021	5.385	5.432
13:00	83.247	5.336	5.443
13:01	175.786	5.427	5.428
13:02	120.732	5.480	5.425
13:03	61.803	5.427	5.429
13:04	67.078	5.409	5.420
13:05	32.016	5.499	5.394
AVERAGE	90.532	5.370	5.434
Post Zero	0.057	0.038	0.042
Post Span	72.19	11.93	8.014

HIGH Run 3	NOX PPM	O2 %	CO2 %
Pre Zero	0.057	0.038	0.042
Pre Span	72.19	11.93	8.014
4/21/2015			
13:15	57.968	5.538	5.382
13:16	83.107	5.440	5.399
13:17	70.679	5.463	5.390
13:18	56.193	5.527	5.386
13:19	61.356	5.478	5.384
13:20	69.517	5.482	5.389
13:21	70.326	5.527	5.385
13:22	74.198	5.467	5.388
13:23	81.341	5.443	5.396
13:24	83.142	5.421	5.402
13:25	84.109	5.440	5.399
13:26	90.145	5.406	5.400
13:27	92.485	5.413	5.407
13:28	89.265	5.402	5.413
13:29	81.912	5.467	5.406
13:30	85.861	5.485	5.400
13:31	83.452	5.406	5.399
13:32	89.308	5.451	5.396
13:33	83.899	5.394	5.413
13:34	79.205	5.383	5.426
13:35	69.259	5.474	5.408
AVERAGE	77.939	5.453	5.398
Post Zero	0.066	0.042	0.05
Post Span	72.25	11.89	8.009

HIGH Run 4	NOX PPM	O2 %	CO2 %
Pre Zero	0.066	0.042	0.05
Pre Span	72.25	11.89	8.009
4/21/2015			
13:45	115.853	5.323	5.431
13:46	138.466	5.316	5.442
13:47	103.799	5.377	5.425
13:48	94.549	5.327	5.435
13:49	123.426	5.331	5.434
13:50	119.512	5.312	5.438
13:51	103.666	5.388	5.427
13:52	135.995	5.324	5.439
13:53	90.751	5.377	5.429
13:54	123.351	5.301	5.436
13:55	87.954	5.346	5.430
13:56	118.343	5.381	5.425
13:57	121.437	5.301	5.441
13:58	107.628	5.407	5.422
13:59	127.898	5.324	5.442
14:00	84.473	5.355	5.418
14:01	79.732	5.392	5.420
14:02	131.169	5.282	5.443
14:03	102.616	5.324	5.427
14:04	111.178	5.282	5.441
14:05	76.461	5.369	5.423
AVERAGE	109.441	5.340	5.432
Post Zero	0.074	0.053	0.047
Post Span	72.08	11.76	8.00

PLANT:	HONEYWELL - HOPEWELL
TEST LOCATION:	OUTLET TW-17
RUN NUMBER:	1
DATE:	4/21/2015
TIME START:	12:15
TIME STOP:	12:35
OPERATOR(S):	ID
METER BOX #:	S-39
CORRECTION FACTOR:	1.0007
BAR PRESSURE (HG):	29.69
STACK DIAMETER (FT):	3.00
PORT NIPPLE LENGTH (IN):	NA
NOZZLE SIZE:	NA
PROBE TEMP:	>250
PROBE SIZE/ID:	9V1
STACK PRESSURE (in. H2O):	0.65

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ENVIRONMENTAL SOURCE SAMPLERS, INC.

MOISTURE COLLECTED			GAS ANALYSIS			
	IMPINGER	SILICA GEL		CO_2%	O_2 %	TOTAL
FINAL	209.0	201.1	1	5.4	5.4	10.8
INITIAL	200.0	200.0	2			
DIFFERENCE	9.0	1.1	3			
TOTAL	10.1	MLS/GRAMS	AVG	5.4	5.4	10.8

METER BOX LEAK CHECK					PITOT LEAK CHECK	
						OK
START	0.000	@	14	IN HG	+	OK
STOP	0.000	@	7	IN HG	-	OK

VELOCITY MEASUREMENTS				MOISTURE MEASUREMENTS					
Point Measurement One Port Including Nipple Length (inch)	Reference Point	Pitot (in. H_2O) ΔP	Stack Temp (F)	Clock Time	Dry Gas Meter FT3	Orifice (in H_2O) ΔH	Dry Gas Temperature (F)	Vacuum	Comments
	A1	0.97	547	0.0	17.032	1.50	69	2	57
	2	1.20	548	5.0	20.558	1.50	69	2	55
	3	1.00	548	10.0	24.085	1.50	70	2	56
	4	1.05	548	15.0	27.611	1.50	70	2	55
	5	1.00	549	20.0	31.138				
	6	1.10	549						
	7	0.92	548						
	8	1.10	548						
	B1	1.00	539						
	2	1.00	531						
	3	0.98	532						
	4	0.85	531						
	5	1.10	549						
	6	0.92	548						
	7	1.10	548						
	8	1.00	539						

γ-Corr. Ft^3 Drawn	Avg Delta P	Avg Delta H	Avg Dry Gas Temp (F)	Avg Stack Temp (F)
14.12	1.0164	1.50	69.50	543.88

PLANT:	HONEYWELL - HOPEWELL
TEST LOCATION:	OUTLET TW-17
RUN NUMBER:	2
DATE:	4/21/2015
TIME START:	12:45
TIME STOP:	13:05
OPERATOR(S):	ID
METER BOX #:	S-39
CORRECTION FACTOR:	1.0007
BAR PRESSURE (HG):	29.69
STACK DIAMETER (FT):	3.00
PORT NIPPLE LENGTH (IN):	NA
NOZZLE SIZE:	NA
PROBE TEMP:	>250
PROBE SIZE/ID:	9V1
STACK PRESSURE (in. H2O):	0.70

ESS

ENVIRONMENTAL SOURCE SAMPLERS, INC.

MOISTURE COLLECTED			GAS ANALYSIS			
	IMPINGER	SILICA GEL		CO_2%	O_2 %	TOTAL
FINAL			1	5.4	5.4	10.8
INITIAL			2			
DIFFERENCE			3			
TOTAL		MLS/GRAMS	AVG	5.4	5.4	10.8

METER BOX LEAK CHECK				PITOT LEAK CHECK	
					OK
START	@		IN HG	+	OK
STOP	@		IN HG	-	OK

VELOCITY MEASUREMENTS				MOISTURE MEASUREMENTS					
Point Measurement One Port Including Nipple Length (inch)	Reference Point	Pitot (in. H_2O) ΔP	Stack Temp (F)	Clock Time	Dry Gas Meter FT3	Orifice (in H_2O) ΔH	Dry Gas Temperature (F)	Vacuum	Comments
	A1	0.95	546						
	2	1.20	548						
	3	1.10	548						
	4	1.10	548						
	5	1.10	549						
	6	0.95	549						
	7	1.10	543						
	8	1.20	546						
	B1	1.10	547						
	2	1.10	547						
	3	0.97	533						
	4	0.82	531						
	5	0.95	549						
	6	1.10	543						
	7	1.20	546						
	8	1.10	547						

γ-Corr. Ft^3 Drawn	Avg Delta P	Avg Delta H	Avg Dry Gas Temp (F)	Avg Stack Temp (F)
	1.0624			545.000

PLANT:	HONEYWELL - HOPEWELL
TEST LOCATION:	OUTLET TW-17
RUN NUMBER:	3
DATE:	4/21/2015
TIME START:	13:15
TIME STOP:	13:35
OPERATOR(S):	ID
METER BOX #:	S-39
CORRECTION FACTOR:	1.0007
BAR PRESSURE (HG):	29.69
STACK DIAMETER (FT):	3.00
PORT NIPPLE LENGTH (IN):	NA
NOZZLE SIZE:	NA
PROBE TEMP:	>250
PROBE SIZE/ID:	9V1
STACK PRESSURE (in. H2O):	0.67

ESS

ENVIRONMENTAL SOURCE SAMPLERS, INC.

MOISTURE COLLECTED				GAS ANALYSIS			
		IMPINGER	SILICA GEL		CO_2%	O_2 %	TOTAL
	FINAL			1	5.4	5.5	10.9
	INITIAL			2			
	DIFFERENCE			3			
	TOTAL		MLS/GRAMS	AVG	5.4	5.5	10.9

METER BOX LEAK CHECK				PITOT LEAK CHECK	
					OK
START	@		IN HG	+	OK
STOP	@		IN HG	-	OK

VELOCITY MEASUREMENTS				MOISTURE MEASUREMENTS					
Point Measurement One Port Including Nipple Length (inch)	Reference Point	Pitot (in. H_2O) ΔP	Stack Temp (F)	Clock Time	Dry Gas Meter FT3	Orifice (in H_2O) ΔH	Dry Gas Temperature (F)	Vacuum	Comments
	A1	0.97	547						
	2	1.10	549						
	3	1.20	549						
	4	1.20	549						
	5	1.00	548						
	6	0.98	548						
	7	1.20	545						
	8	1.20	546						
	B1	1.10	547						
	2	1.00	547						
	3	0.98	534						
	4	0.94	535						
	5	1.00	548						
	6	0.98	548						
	7	1.20	545						
	8	1.20	546						

γ-Corr. Ft^3 Drawn	Avg Delta P	Avg Delta H	Avg Dry Gas Temp (F)	Avg Stack Temp (F)
	1.0757			545.688

PLANT:	HONEYWELL - HOPEWELL
TEST LOCATION:	OUTLET TW-17
RUN NUMBER:	4
DATE:	4/21/2015
TIME START:	13:45
TIME STOP:	14:05
OPERATOR(S):	ID
METER BOX #:	S-39
CORRECTION FACTOR:	1.0007
BAR PRESSURE (HG):	29.69
STACK DIAMETER (FT):	3.00
PORT NIPPLE LENGTH (IN):	NA
NOZZLE SIZE:	NA
PROBE TEMP:	>250
PROBE SIZE/ID:	9V1
STACK PRESSURE (in. H2O):	0.67

ESS

ENVIRONMENTAL SOURCE SAMPLERS, INC.

MOISTURE COLLECTED				GAS ANALYSIS			
		IMPINGER	SILICA GEL		CO_2%	O_2 %	TOTAL
	FINAL	210.0	202.2	1	5.4	5.4	10.8
	INITIAL	200.0	201.1	2			
	DIFFERENCE	10.0	1.1	3			
	TOTAL	11.1	MLS/GRAMS	AVG	5.4	5.4	10.8

METER BOX LEAK CHECK					PITOT LEAK CHECK	
						OK
START	0.000	@	14	IN HG	+	OK
STOP	0.000	@	7	IN HG	-	OK

VELOCITY MEASUREMENTS				MOISTURE MEASUREMENTS					
Point Measurement One Port Including Nipple Length (inch)	Reference Point	Pitot (in. H_2O) ΔP	Stack Temp (F)	Clock Time	Dry Gas Meter FT3	Orifice (in H_2O) ΔH	Dry Gas Temperature (F)	Vacuum	Comments
	A1	0.97	549	0.0	31.170	1.50	74	2	52
	2	1.10	548	5.0	34.696	1.50	74	2	53
	3	1.20	548	10.0	38.223	1.50	74	2	53
	4	1.20	548	15.0	41.750	1.50	74	2	53
	5	1.10	550	20.0	45.276				
	6	1.00	549						
	7	1.10	543						
	8	1.20	546						
	B1	1.10	547						
	2	1.00	547						
	3	0.98	533						
	4	0.87	534						
	5	1.10	550						
	6	1.00	549						
	7	1.10	543						
	8	1.20	546						

γ-Corr. Ft^3 Drawn	Avg Delta P	Avg Delta H	Avg Dry Gas Temp (F)	Avg Stack Temp (F)
14.116	1.0741	1.500	74.000	545.625

PLANT:	HONEYWELL - HOPEWELL
TEST LOCATION:	OUTLET TW-17
RUN NUMBER:	5
DATE:	4/21/2015
TIME START:	14:15
TIME STOP:	14:35
OPERATOR(S):	ID
METER BOX #:	S-39
CORRECTION FACTOR:	1.0007
BAR PRESSURE (HG):	29.69
STACK DIAMETER (FT):	3.00
PORT NIPPLE LENGTH (IN):	NA
NOZZLE SIZE:	NA
PROBE TEMP:	>250
PROBE SIZE/ID:	9V1
STACK PRESSURE (in. H2O):	0.70

ESS

ENVIRONMENTAL SOURCE SAMPLERS, INC.

MOISTURE COLLECTED				GAS ANALYSIS			
		IMPINGER	SILICA GEL		CO_2%	O_2 %	TOTAL
	FINAL			1	5.4	5.4	10.8
	INITIAL			2			
	DIFFERENCE			3			
	TOTAL		MLS/GRAMS	AVG	5.4	5.4	10.8

METER BOX LEAK CHECK				PITOT LEAK CHECK	
					OK
START	@		IN HG	+	OK
STOP	@		IN HG	-	OK

VELOCITY MEASUREMENTS				MOISTURE MEASUREMENTS					
Point Measurement One Port Including Nipple Length (inch)	Reference Point	Pitot (in. H_2O) ΔP	Stack Temp (F)	Clock Time	Dry Gas Meter FT3	Orifice (in H_2O) ΔH	Dry Gas Temperature (F)	Vacuum	Comments
	A1	0.98	546						
	2	1.00	548						
	3	1.10	548						
	4	1.20	548						
	5	1.10	549						
	6	1.00	549						
	7	1.10	543						
	8	1.20	546						
	B1	1.20	547						
	2	1.00	547						
	3	0.97	535						
	4	0.96	536						
	5	1.20	548						
	6	1.10	549						
	7	1.00	549						
	8	1.10	543						

γ-Corr. Ft^3 Drawn	Avg Delta P	Avg Delta H	Avg Dry Gas Temp (F)	Avg Stack Temp (F)
	1.0739			545.688

PLANT:	HONEYWELL - HOPEWELL
TEST LOCATION:	OUTLET TW-17
RUN NUMBER:	6
DATE:	4/21/2015
TIME START:	14:45
TIME STOP:	15:05
OPERATOR(S):	ID
METER BOX #:	S-39
CORRECTION FACTOR:	1.0007
BAR PRESSURE (HG):	29.69
STACK DIAMETER (FT):	3.00
PORT NIPPLE LENGTH (IN):	NA
NOZZLE SIZE:	NA
PROBE TEMP:	>250
PROBE SIZE/ID:	9V1
STACK PRESSURE (in. H2O):	0.68

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ENVIRONMENTAL SOURCE SAMPLERS, INC.

MOISTURE COLLECTED			GAS ANALYSIS			
	IMPINGER	SILICA GEL		CO_2%	O_2 %	TOTAL
FINAL			1	5.4	5.4	10.8 ✓
INITIAL			2			
DIFFERENCE			3			
TOTAL		MLS/GRAMS	AVG	5.4	5.4	10.8

METER BOX LEAK CHECK				PITOT LEAK CHECK
				OK
START	@		IN HG	+ OK
STOP	@		IN HG	- OK

VELOCITY MEASUREMENTS				MOISTURE MEASUREMENTS					
Point Measurement One Port Including Nipple Length (inch)	Reference Point	Pitot (in. H_2O) ΔP	Stack Temp (F)	Clock Time	Dry Gas Meter FT3	Orifice (in H_2O) ΔH	Dry Gas Temperature (F)	Vacuum	Comments
	A1	0.97	546						
	2	1.10	548						
	3	1.20	548						
	4	1.20	548						
	5	1.10	549						
	6	1.00	549						
	7	1.10	516						
	8	1.10	543						
	B1	1.20	546						
	2	1.20	547						
	3	1.00	547						
	4	0.97	535						
	5	1.20	548						
	6	1.20	548						
	7	1.10	549						
	8	1.00	549						

γ-Corr. Ft^3 Drawn	Avg Delta P	Avg Delta H	Avg Dry Gas Temp (F)	Avg Stack Temp (F)
	1.1007			544.750

PLANT:	HONEYWELL - HOPEWELL
TEST LOCATION:	OUTLET TW-17
RUN NUMBER:	7
DATE:	4/21/2015
TIME START:	15:15
TIME STOP:	15:35
OPERATOR(S):	ID
METER BOX #:	S-39
CORRECTION FACTOR:	1.0007
BAR PRESSURE (HG):	29.69
STACK DIAMETER (FT):	3.00
PORT NIPPLE LENGTH (IN):	NA
NOZZLE SIZE:	NA
PROBE TEMP:	>250
PROBE SIZE/ID:	9V1
STACK PRESSURE (in. H2O):	0.70

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ENVIRONMENTAL SOURCE SAMPLERS, INC.

MOISTURE COLLECTED				GAS ANALYSIS			
		IMPINGER	SILICA GEL		CO_2%	O_2 %	TOTAL
	FINAL	209.0	203.3	1	5.4	5.4	10.8
	INITIAL	200.0	202.2	2			
	DIFFERENCE	9.0	1.1	3			
	TOTAL	10.1	MLS/GRAMS	AVG	5.4	5.4	10.8

METER BOX LEAK CHECK					PITOT LEAK CHECK	
						OK
START	0.000	@	12	IN HG	+	OK
STOP	0.000	@	5	IN HG	-	OK

VELOCITY MEASUREMENTS				MOISTURE MEASUREMENTS					
Point Measurement One Port Including Nipple Length (inch)	Reference Point	Pitot (in. H_2O) ΔP	Stack Temp (F)	Clock Time	Dry Gas Meter FT3	Orifice (in H_2O) ΔH	Dry Gas Temperature (F)	Vacuum	Comments
	A1	1.00	545	0.0	45.308	1.50	74	2	55
	2	1.10	547	5.0	48.834	1.50	74	2	55
	3	1.00	547	10.0	52.361	1.50	74	2	55
	4	1.10	547	15.0	55.887	1.50	74	2	55
	5	1.10	547	20.0	59.414				
	6	1.10	548						
	7	1.10	548						
	8	1.00	548						
	B1	1.20	548						
	2	1.10	548						
	3	0.98	537						
	4	0.96	536						
	5	1.10	547						
	6	1.10	547						
	7	1.10	548						
	8	1.10	548						

γ-Corr. Ft^3 Drawn	Avg Delta P	Avg Delta H	Avg Dry Gas Temp (F)	Avg Stack Temp (F)
14.116	1.0704	1.500	74.000	546.000

PLANT:	HONEYWELL - HOPEWELL
TEST LOCATION:	OUTLET TW-17
RUN NUMBER:	8
DATE:	4/21/2015
TIME START:	15:45
TIME STOP:	16:05
OPERATOR(S):	ID
METER BOX #:	S-39
CORRECTION FACTOR:	1.0007
BAR PRESSURE (HG):	29.69
STACK DIAMETER (FT):	3.00
PORT NIPPLE LENGTH (IN):	NA
NOZZLE SIZE:	NA
PROBE TEMP:	>250
PROBE SIZE/ID:	9V1
STACK PRESSURE (in. H2O):	0.69

ESS

ENVIRONMENTAL SOURCE SAMPLERS, INC.

MOISTURE COLLECTED			GAS ANALYSIS			
	IMPINGER	SILICA GEL		CO_2%	O_2 %	TOTAL
FINAL			1	5.4	5.4	10.8
INITIAL			2			
DIFFERENCE			3			
TOTAL		MLS/GRAMS	AVG	5.4	5.4	10.8

METER BOX LEAK CHECK				PITOT LEAK CHECK	
					OK
START	@		IN HG	+	OK
STOP	@		IN HG	-	OK

VELOCITY MEASUREMENTS				MOISTURE MEASUREMENTS					
Point Measurement One Port Including Nipple Length (inch)	Reference Point	Pitot (in. H_2O) ΔP	Stack Temp (F)	Clock Time	Dry Gas Meter FT3	Orifice (in H_2O) ΔH	Dry Gas Temperature (F)	Vacuum	Comments
	A1	0.95	550						
	2	1.10	550						
	3	1.10	550						
	4	1.10	550						
	5	1.10	550						
	6	1.10	550						
	7	1.00	551						
	8	1.20	549						
	B1	1.10	549						
	2	1.10	549						
	3	1.00	542						
	4	1.05	542						
	5	1.10	550						
	6	1.10	550						
	7	1.00	551						
	8	1.20	549						

γ-Corr. Ft^3 Drawn	Avg Delta P	Avg Delta H	Avg Dry Gas Temp (F)	Avg Stack Temp (F)
	1.0802			548.875

PLANT:	HONEYWELL - HOPEWELL
TEST LOCATION:	OUTLET TW-17
RUN NUMBER:	9
DATE:	4/21/2015
TIME START:	16:15
TIME STOP:	16:35
OPERATOR(S):	ID
METER BOX #:	S-39
CORRECTION FACTOR:	1.0007
BAR PRESSURE (HG):	29.69
STACK DIAMETER (FT):	3.00
PORT NIPPLE LENGTH (IN):	NA
NOZZLE SIZE:	NA
PROBE TEMP:	>250
PROBE SIZE/ID:	9V1
STACK PRESSURE (in. H2O):	0.67

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ENVIRONMENTAL SOURCE SAMPLERS, INC.

MOISTURE COLLECTED				GAS ANALYSIS			
		IMPINGER	SILICA GEL		CO_2%	O_2 %	TOTAL
	FINAL			1	5.4	5.4	10.8
	INITIAL			2			
	DIFFERENCE			3			
	TOTAL		MLS/GRAMS	AVG	5.4	5.4	10.8

METER BOX LEAK CHECK				PITOT LEAK CHECK	
					OK
START	@		IN HG	+	OK
STOP	@		IN HG	-	OK

VELOCITY MEASUREMENTS				MOISTURE MEASUREMENTS					
Point Measurement One Port Including Nipple Length (inch)	Reference Point	Pitot (in. H_2O) ΔP	Stack Temp (F)	Clock Time	Dry Gas Meter FT3	Orifice (in H_2O) ΔH	Dry Gas Temperature (F)	Vacuum	Comments
	A1	0.90	550						
	2	1.10	550						
	3	1.10	550						
	4	1.20	550						
	5	1.20	550						
	6	0.95	550						
	7	0.98	549						
	8	1.10	549						
	B1	1.10	548						
	2	1.10	548						
	3	1.10	541						
	4	1.10	540						
	5	0.95	550						
	6	0.98	549						
	7	1.10	549						
	8	1.10	548						

γ-Corr. Ft^3 Drawn	Avg Delta P	Avg Delta H	Avg Dry Gas Temp (F)	Avg Stack Temp (F)
	1.0645			548.188

APPENDIX B
CALCULATIONS

HONEYWELL - HOPEWELL, VA
NOX DESTRUCTION EFFICIENCY - TW-17
April 21, 2015

RUN NUMBER	1	2	3	4	5	6	7	8	9	AVG
INLET NOX (LB/HR)	541.49	566.36	564.66	578.69	586.37	625.46	623.83	635.92	634.45	595.25
OUTLET NOX (LB/HR)	9.31	11.07	9.57	13.41	14.69	14.52	11.32	11.39	11.24	11.83
DESTRUCTION EFF (%)	98.28	98.05	98.30	97.68	97.49	97.68	98.19	98.21	98.23	98.01

TW-17 INLET

HONEYWELL - HOPEWELL, VA
GASEOUS EMISSIONS DATA TW-17 INLET
April 21, 2015

RUN NUMBER	1	2	3	4	5	6	7	8	9
O2 SPAN (%)	20.99	20.99	20.99	20.99	20.99	20.99	20.99	20.99	20.99
O2 MEASURED (%)	5.22	5.19	5.28	5.20	5.26	5.23	5.24	5.27	5.27
O2 SPAN GAS (%)	11.98	11.98	11.98	11.98	11.98	11.98	11.98	11.98	11.98
O2 PRE-ZERO (%)	0.01	0.01	0.00	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02
O2 POST ZERO (%)	0.01	0.00	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02
O2 PRE-SPAN (%)	12.06	12.01	11.96	11.89	11.80	11.89	11.84	11.97	11.92
O2 POST SPAN (%)	12.01	11.96	11.89	11.80	11.89	11.84	11.97	11.92	11.90
INITIAL ZERO CAL BIAS (%)	-0.07	-0.09	-0.11	-0.15	-0.17	-0.19	-0.17	-0.19	-0.21
FINAL ZERO CAL BIAS (%)	-0.09	-0.11	-0.15	-0.17	-0.19	-0.17	-0.19	-0.21	-0.22
ZERO DRIFT (%)	-0.02	-0.02	-0.03	-0.02	-0.02	0.02	-0.02	-0.02	-0.01
INITIAL SPAN CAL BIAS (%)	0.52	0.29	0.05	-0.29	-0.71	-0.29	-0.52	0.10	-0.14
FINAL SPAN CAL BIAS (%)	0.29	0.05	-0.29	-0.71	-0.29	-0.52	0.10	-0.14	-0.25
SPAN DRIFT (%)	-0.24	-0.24	-0.33	-0.43	0.43	-0.24	0.62	-0.24	-0.11
O2 CORRECTED (%)	5.19	5.18	5.31	5.26	5.33	5.28	5.28	5.29	5.31

RUN NUMBER	1	2	3	4	5	6	7	8	9
CO2 SPAN (%)	15.91	15.91	15.91	15.91	15.91	15.91	15.91	15.91	15.91
CO2 MEASURED (%)	5.36	5.38	5.34	5.37	5.36	5.36	5.35	5.33	5.33
CO2 SPAN GAS (%)	8.01	8.01	8.01	8.01	8.01	8.01	8.01	8.01	8.01
CO2 PRE-ZERO (%)	0.03	0.02	0.03	0.02	0.03	0.05	0.05	0.06	0.06
CO2 POST ZERO (%)	0.02	0.03	0.02	0.03	0.05	0.05	0.06	0.06	0.07
CO2 PRE-SPAN (%)	8.01	8.02	8.00	8.00	7.99	7.99	7.99	7.99	8.00
CO2 POST SPAN (%)	8.02	8.00	8.00	7.99	7.99	7.99	7.99	8.00	8.01
INITIAL ZERO CAL BIAS (%)	-0.06	-0.11	-0.09	-0.12	-0.07	0.05	0.09	0.14	0.16
FINAL ZERO CAL BIAS (%)	-0.11	-0.09	-0.12	-0.07	0.05	0.09	0.14	0.16	0.19
ZERO DRIFT (%)	-0.04	0.02	-0.03	0.05	0.12	0.04	0.05	0.01	0.04
INITIAL SPAN CAL BIAS (%)	0.00	0.03	-0.05	-0.08	-0.13	-0.14	-0.16	-0.11	-0.06
FINAL SPAN CAL BIAS (%)	0.03	-0.05	-0.08	-0.13	-0.14	-0.16	-0.11	-0.06	0.00
SPAN DRIFT (%)	0.03	-0.08	-0.03	-0.04	-0.01	-0.03	0.06	0.05	0.06
CO2 CORRECTED (%)	5.35	5.37	5.34	5.37	5.36	5.35	5.34	5.32	5.31

RUN NUMBER	1	2	3	4	5	6	7	8	9
NOX SPAN (PPM)	9336.00	9336.00	9336.00	9336.00	9336.00	9336.00	9336.00	9336.00	9336.00
NOX MEASURED (PPM)	4514.43	4611.75	4572.37	4710.82	4779.70	5030.03	5074.33	5154.37	5170.17
NOX SPAN GAS (PPM)	4659.00	4659.00	4659.00	4659.00	4659.00	4659.00	4659.00	4659.00	4659.00
NOX PRE-ZERO (PPM)	4.80	7.10	8.50	10.11	12.50	14.20	15.50	15.90	16.60
NOX POST ZERO (PPM)	7.10	8.50	10.11	12.50	14.20	15.50	15.90	16.60	17.10
NOX PRE-SPAN (PPM)	4665.00	4658.00	4647.00	4660.00	4666.00	4672.00	4661.00	4665.00	4658.00
NOX POST SPAN (PPM)	4658.00	4647.00	4660.00	4666.00	4672.00	4661.00	4665.00	4658.00	4650.00
INITIAL ZERO CAL BIAS (%)	0.04	0.06	0.08	0.10	0.12	0.14	0.15	0.16	0.16
FINAL ZERO CAL BIAS (%)	0.06	0.08	0.10	0.12	0.14	0.15	0.16	0.16	0.17
ZERO DRIFT (%)	0.02	0.01	0.02	0.03	0.02	0.01	0.00	0.01	0.01
INITIAL SPAN CAL BIAS (%)	-0.01	-0.09	-0.20	-0.06	0.00	0.06	-0.05	-0.01	-0.09
FINAL SPAN CAL BIAS (%)	-0.09	-0.20	-0.06	0.00	0.06	-0.05	-0.01	-0.09	-0.17
SPAN DRIFT (%)	-0.07	-0.12	0.14	0.06	0.06	-0.12	0.04	-0.07	-0.09
NOX CORRECTED (PPM)	4511.82	4618.12	4577.62	4706.89	4769.78	5023.11	5071.37	5153.33	5177.60

HONEYWELL - HOPEWELL, VA
RATA SUMMARY -TOWER (TW-17)- INLET
April 21, 2015

NOX and FLOW RATA DATA

RUN NUMBER	1	2	3	4	5	6	7	8	9	AVG
DATE	4/21/2015	4/21/2015	4/21/2015	4/21/2015	4/21/2015	4/21/2015	4/21/2015	4/21/2015	4/21/2015	
TIME START (EST)	12:15	12:45	13:15	13:45	14:15	14:45	15:15	15:45	16:15	
TIME STOP (EST)	12:35	13:05	13:35	14:05	14:35	15:05	15:35	16:05	16:35	
FLOWRATE (DSCFM)	16,753	17,119	17,218	17,162	17,160	17,381	17,171	17,225	17,105	17,144
O2 (%)	5.2	5.2	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.27
CO2 (%)	5.4	5.4	5.3	5.4	5.4	5.4	5.3	5.3	5.3	5.35
NOX (PPMVD)	4,511.82	4,618.12	4,577.62	4,706.89	4,769.78	5,023.11	5,071.37	5,153.33	5,177.60	4,845.52
NOX (LB/HR)	541.49	566.36	564.66	578.69	586.37	625.46	623.83	635.92	634.45	595.25

CEM DATA	1	2	3	4	5	6	7	8	9	AVG
TIME START (EST)	12:15	12:45	13:15	13:45	14:15	14:45	15:15	15:45	16:15	
TIME STOP (EST)	12:35	13:05	13:35	14:05	14:35	15:05	15:35	16:05	16:35	
CEM NOX (PPM)	5,197.15	5,492.78	5,324.16	5,402.89	5,714.06	5,922.25	5,901.72	5,851.32	5,767.02	5,619.26
CEM NOX (LB/HR)	0.62	0.59	0.51	0.63	0.64	0.63	0.71	0.72	0.75	2.03

METHOD 7E & 19 CALCULATIONS
Derivation of Calculations and Ex. Calculations

A_n =	Cross-sectional area of nozzle, (ft^2)
B_{WO} =	Moisture content of flue gas (vol) as percent
D_n =	Nozzle diameter (in)
m_n =	Total mass of analyte collected, µg
MW=	Molecular weight of analyte collected,g mol^{-1}
Q_{sw} =	Hourly average volumetric flow during unit operation, wet basis, scfh.
t =	Sampling time (min)
$V_m(STD)$ =	Volume of gas sample measured by the dry gas meter, corrected to standard conditions, (dscf)
$V_n(STD)$ =	Nozzle velocity (ft/sec) at standard conditions
$V_s(STD)$ =	Stack velocity (ft/sec) at standard conditions

Verification of Calculations
From Run 1 (TW-17 Inlet)

	NOX
Conversion Factor	1.194E-07
ppmvd @ 15% O2	1694.9
ppm - wet	N/A
lb/hr	541.49
lb/mmbtu	N/A

Emissions (ppmvd @ 15% O2)

$$= \text{ppmvd} \times \frac{(20.9 - 15)}{(20.9 - O2)}$$

Emissions (ppmv-wet)

$$= \text{ppmvd} \times \left(1 - (B_{wo}/100) \right)$$

Emissions (lb/hr)

$$= \text{ppmvd} \times \text{Conversion Factor} \times \text{flowrate (DSCFM)} \times 60 \text{ min/hr}$$

Emissions (lb/mmBTU)

$$= \text{ppmvd} \times \text{Conversion Factor} \times \text{F-Factor (DSCFM)} \times 20.9/(20.9-O2)$$

Method 19 Fuel Factor

FUEL	O2 F- Factor
COAL	9780
NATURAL GAS	8710
OIL	9190
WOOD	9240
WOOD BARK	9600

Gaseous Data (NOX) BY METHOD 7E
Derivation of Calculations and Ex. Calculations

ACE =	Analyzer calibration error, percent of calibration span
B_{WS} =	Moisture content of sample gas as measured by Method 4 or other approved method, percent/100
C_{avg} =	Average unadjusted gas concentration indicated by data recorder for the test run, ppmv
C_D =	Pollutant concentration adjusted to dry conditions, ppmv
C_{Dir} =	Measured concentration of a calibration gas (low, mid, or high) when introduced in direct calibration mode, ppmv
C_{gas} =	Average effluent gas concentration adjusted for bias, ppmv
C_M =	Average of initial and final system calibration bias check responses for the upscale calibration gas, ppmv
C_{MA} =	Actual concentration of the upscale calibration gas, ppmv
C_{Native} =	Gas concentration in the stack gas as calculated in Section 12.6, ppmv
C_O =	Average of the initial and final system calibration bias check responses from the low-level (or zero) calibration gas, ppmv
C_{OA} =	Actual concentration of the low-level calibration gas, ppmv
C_S =	Measured concentation of a calibration gas (low, mid or high) when introduced in system calibration mode
CS =	Calibration span, ppmv
C_V =	Manufacturer certified concentration of a calibration gas (low, mid, or high), ppmv
D =	Drift assessment, percent of calibration span
SB =	System bias, percent of calibration span
SB_i =	Pre-run system bias, percent of calibration span
SB_{Final} =	Post-run system bias, percent of calibration span
SCE =	System calibration error, percent of calibration span
SCE_i =	Pre-run system calibration error, percent of calibration span
SCE_{Final} =	Post-run system calibration error, percent of calibration span

$$ACE = \frac{C_{Dir} - C_V}{CS} \times 100 \qquad SB = \frac{C_s - C_{Dir}}{CS} \times 100 \qquad Eff_{NO2} = \frac{C_{dir}}{C_V} \times 100$$

$$D = \left| SB_{Final} - SB_i \right| \qquad C_{gas} = (C_{Avg} - C_O)\frac{C_{MA}}{C_M - C_O}$$

Example Calculations for Run 1 NOx

Linearity Calculation

C_{Dir} = 9323.00 ppmv

C_V = 9336.00 ppmv

CS = 9336.00 ppmv

ACE = -0.139 %

Bias (Pre-Run Zero)

C_S = 4.80 ppmv

C_{Dir} = 1.20 ppmv

SB = 0.04 %

Effluent Gas Concentration (Corrected for Drift)

C_{avg} = 4514.43 ppmv

C_O = 5.95 ppmv

C_{MA} = 4659.00 ppmv

C_M = 4661.50 ppmv

C_{gas} = 4511.82 ppmv

Bias (Post Run Zero)

C_S = 7.10 ppmv

C_{Dir} = 1.20 ppmv

SB = 0.06 %

Bias (Pre-Run Upscale)

C_S = 4665.00 ppmv

C_{Dir} = 4666.00 ppmv

SB = -0.01 %

Bias (Post Run Upscale)

C_S = 4658.00 ppmv

C_{Dir} = 4666.00 ppmv

SB = -0.09 %

Zero Drift

SB_i = 0.04 %

SB_{Final} = 0.06 %

D = 0.02 %

Span Drift

SB_i = -0.01 %

SB_{Final} = -0.09 %

D = 0.07 %

TW-17 OUTLET

HONEYWELL - HOPEWELL, VA
GASEOUS EMISSIONS DATA TW-17 OUTLET
April 21, 2015

RUN NUMBER	1	2	3	4	5	6	7	8	9
O2 SPAN (%)	20.99	20.99	20.99	20.99	20.99	20.99	20.99	20.99	20.99
O2 MEASURED (%)	5.40	5.37	5.45	5.34	5.41	5.38	5.40	5.42	5.38
O2 SPAN GAS (%)	11.98	11.98	11.98	11.98	11.98	11.98	11.98	11.98	11.98
O2 PRE-ZERO (%)	0.04	0.03	0.04	0.04	0.05	0.09	0.08	0.09	0.08
O2 POST ZERO (%)	0.03	0.04	0.04	0.05	0.09	0.08	0.09	0.08	0.08
O2 PRE-SPAN (%)	12.02	11.96	11.93	11.89	11.76	11.89	11.92	11.88	11.83
O2 POST SPAN (%)	11.98	11.93	11.89	11.76	11.89	11.92	11.88	11.83	11.95
INITIAL ZERO CAL BIAS (%)	0.06	0.01	0.06	0.08	0.13	0.29	0.28	0.31	0.25
FINAL ZERO CAL BIAS (%)	0.01	0.06	0.08	0.13	0.29	0.28	0.31	0.25	0.27
ZERO DRIFT (%)	-0.05	0.05	0.02	0.05	0.16	-0.01	0.03	-0.06	0.01
INITIAL SPAN CAL BIAS (%)	0.33	0.14	-0.10	-0.29	-0.91	-0.29	-0.14	-0.33	-0.57
FINAL SPAN CAL BIAS (%)	0.14	-0.10	-0.29	-0.91	-0.29	-0.14	-0.33	-0.57	0.00
SPAN DRIFT (%)	-0.19	-0.24	-0.19	-0.62	0.62	0.14	-0.19	-0.24	0.57
O2 CORRECTED (%)	5.37	5.36	5.46	5.38	5.44	5.37	5.38	5.43	5.37

RUN NUMBER	1	2	3	4	5	6	7	8	9
CO2 SPAN (%)	15.91	15.91	15.91	15.91	15.91	15.91	15.91	15.91	15.91
CO2 MEASURED (%)	5.43	5.43	5.40	5.43	5.42	5.41	5.40	5.39	5.40
CO2 SPAN GAS (%)	8.01	8.01	8.01	8.01	8.01	8.01	8.01	8.01	8.01
CO2 PRE-ZERO (%)	0.02	0.03	0.04	0.05	0.05	0.05	0.04	0.05	0.05
CO2 POST ZERO (%)	0.03	0.04	0.05	0.05	0.05	0.04	0.05	0.05	0.06
CO2 PRE-SPAN (%)	8.01	8.01	8.01	8.01	8.00	8.02	8.01	8.02	8.02
CO2 POST SPAN (%)	8.01	8.01	8.01	8.00	8.02	8.01	8.02	8.02	8.01
INITIAL ZERO CAL BIAS (%)	-0.11	-0.06	0.02	0.07	0.05	0.07	0.03	0.09	0.05
FINAL ZERO CAL BIAS (%)	-0.06	0.02	0.07	0.05	0.07	0.03	0.09	0.05	0.14
ZERO DRIFT (%)	0.06	0.08	0.05	-0.02	0.02	-0.04	0.06	-0.04	0.09
INITIAL SPAN CAL BIAS (%)	0.01	-0.03	0.02	-0.01	-0.07	0.03	0.00	0.03	0.05
FINAL SPAN CAL BIAS (%)	-0.03	0.02	-0.01	-0.07	0.03	0.00	0.03	0.05	0.01
SPAN DRIFT (%)	-0.03	0.04	-0.03	-0.06	0.09	-0.03	0.03	0.03	-0.04
CO2 CORRECTED (%)	5.42	5.42	5.38	5.42	5.40	5.39	5.38	5.36	5.37

RUN NUMBER	1	2	3	4	5	6	7	8	9
NOX SPAN (PPM)	152.00	152.00	152.00	152.00	152.00	152.00	152.00	152.00	152.00
NOX MEASURED (PPM)	77.74	90.53	77.94	109.44	119.46	116.00	91.42	91.42	90.39
NOX SPAN GAS (PPM)	71.90	71.90	71.90	71.90	71.90	71.90	71.90	71.90	71.90
NOX PRE-ZERO (PPM)	0.05	0.05	0.06	0.07	0.07	0.09	0.07	0.09	0.10
NOX POST ZERO (PPM)	0.05	0.06	0.07	0.07	0.09	0.07	0.09	0.10	0.11
NOX PRE-SPAN (PPM)	72.05	72.12	72.19	72.25	72.08	71.70	71.37	71.54	70.95
NOX POST SPAN (PPM)	72.12	72.19	72.25	72.08	71.70	71.37	71.54	70.95	70.83
INITIAL ZERO CAL BIAS (%)	-0.05	-0.04	-0.04	-0.03	-0.03	-0.02	-0.03	-0.02	-0.01
FINAL ZERO CAL BIAS (%)	-0.04	-0.04	-0.03	-0.03	-0.02	-0.03	-0.02	-0.01	-0.01
ZERO DRIFT (%)	0.00	0.00	0.01	0.01	0.01	-0.01	0.01	0.01	0.00
INITIAL SPAN CAL BIAS (%)	-0.07	-0.02	0.03	0.07	-0.05	-0.30	-0.51	-0.40	-0.79
FINAL SPAN CAL BIAS (%)	-0.02	0.03	0.07	-0.05	-0.30	-0.51	-0.40	-0.79	-0.87
SPAN DRIFT (%)	0.05	0.05	0.04	-0.11	-0.25	-0.22	0.11	-0.39	-0.08
NOX CORRECTED (PPM)	77.54	90.23	77.60	109.07	119.52	116.64	92.01	92.28	91.71

HONEYWELL - HOPEWELL, VA
RATA SUMMARY -TOWER (TW-17)- OUTLET
April 21, 2015

NOX and FLOW RATA DATA

RUN NUMBER	1	2	3	4	5	6	7	8	9
DATE	4/21/2015	4/21/2015	4/21/2015	4/21/2015	4/21/2015	4/21/2015	4/21/2015	4/21/2015	4/21/2015
TIME START (EST)	12:15	12:45	13:15	13:45	14:15	14:45	15:15	15:45	16:15
TIME STOP (EST)	12:35	13:05	13:35	14:05	14:35	15:05	15:35	16:05	16:35
FLOWRATE (WSCFM)	17,323	17,702	17,805	17,804	17,802	18,031	17,760	17,817	17,692
FLOWRATE (DSCFM)	16,753	17,119	17,218	17,162	17,160	17,381	17,171	17,225	17,105
O2 (%)	5.4	5.4	5.5	5.4	5.4	5.4	5.4	5.4	5.4
CO2 (%)	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
NOX (PPMVD)	77.54	90.23	77.60	109.07	119.52	116.64	92.01	92.28	91.71
NOX (LB/HR)	9.31	11.07	9.57	13.41	14.69	14.52	11.32	11.39	11.24

CEM DATA	1	2	3	4	5	6	7	8	9
CEM FLOWRATE (SCFM)	19,210	19,155	19,148	19,244	19,511	19,718	19,791	19,777	19,721
CEM NOX (PPM)	67.74	76.95	68.15	92.82	105.51	110.46	87.27	78.18	83.27
CEM NOX (LB/HR)	9.46	10.72	9.49	12.99	15.03	15.84	12.56	11.24	11.94

HONEYWELL - HOPEWELL
DETERMINATION OF FLOWRATE - RESULTS
OUTLET TW-17

FIELD DATA												
Date		4/21/15	4/21/15	4/21/15	4/21/15	4/21/15	4/21/15	4/21/15	4/21/15	4/21/15	Average	
Run Number		1	2	3	4	5	6	7	8	9		
Run Start Time		12:15	12:45	13:15	13:45	14:15	14:45	15:15	15:45	16:15		hh:mm
Run Stop Time		12:35	13:05	13:35	14:05	14:35	15:05	15:35	16:05	16:35		hh:mm
Meter Calibration Factor	(Y)	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007		
Pitot Tube Coefficient	(C_p)	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	
Total Meter Volume	(V_m)	14.116			14.116			14.116			14.12	ft^3
Total Sampling Time	(Θ)	20.0			20.0			20.0			20.00	min
Average Meter Temperature	$(t_m)_{avg}$	69.5			74.0			74.0			72.50	°F
Average Stack Temperature	$(t_s)_{avg}$	543.9	545.0	545.7	545.6	545.7	544.8	546.0	548.9	548.2	545.97	°F
Absolute Stack Pressure	(P_s)	29.74	29.74	29.74	29.74	29.74	29.74	29.74	29.74	29.74	29.74	in Hg
Average Sample Rate		1.50			1.50			1.50			1.50	dscfm
Avg Square Root Pitot Pressure	$(\Delta p^{1/2})^2_{avg}$	1.016	1.062	1.076	1.074	1.074	1.101	1.070	1.080	1.065	1.07	$(in\ H_2O)^{1/2}$

MOISTURE CONTENT DATA												
Total Water Volume Collected	(V_{lc})	10.1			11.1			10.1			10.4	ml
Standard Water Vapor Vol	$(V_w)_{std}$	0.477			0.524			0.477			0.492	scf
Standard Meter Vol	$(V_m)_{std}$	13.992	13.992	13.992	13.992	13.992	13.992	13.876	13.876	13.876	13.954	dscf
Stack Moisture Content	(B_{wo})	3.29	3.29	3.29	3.61	3.61	3.61	3.32	3.32	3.32	3.41	%

GAS ANALYSIS DATA												
Run Number		1	2	3	4	5	6	7	8	9		
Carbon Dioxide Percentage	($\%CO_2$)	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	%
Oxygen Percentage	($\%O_2$)	5.4	5.4	5.5	5.4	5.4	5.4	5.4	5.4	5.4	5.4	%
Carbon Monoxide Percentage	(%CO)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	%
Nitrogen Percentage	($\%N_2$)	89.2	89.2	89.1	89.2	89.2	89.2	89.2	89.2	89.2	89.2	%
Dry Gas Molecular Wt	(M_d)	29.08	29.08	29.08	29.08	29.08	29.08	29.08	29.08	29.08	29.08	lb/lb-mole
Wet Stack Gas Molecular Wt	(M_s)	28.89	28.89	28.89	28.85	28.85	28.85	28.88	28.88	28.88	28.88	lb/lb-mole
Calculated Fuel Factor	(F_o)	2.870	2.870	2.852	2.870	2.870	2.870	2.870	2.870	2.870	2.868	
Percent Excess Air	(%EA)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	%

VOLUMETRIC FLOW RATE DATA												
Average Stack Gas Velocity	(v_s)	78.13	79.92	80.45	80.44	80.43	81.39	80.27	80.75	80.14	80.21	ft/sec
Stack Cross-Sectional Area	(A_s)	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.07	ft^2
Actual Stack Flow Rate	(Q_s)	33138	33896	34119	34116	34112	34520	34042	34248	33987	34020	acfm
Wet Standard Stack Flow Rate	(Qsw)	17323	17702	17805	17804	17802	18031	17760	17817	17692	17748	wscfm
Dry Standard Stack Flow Rate	(Q_{sd})	16753	17119	17218	17162	17160	17381	17171	17225	17105	17144	dscfm

CEMS DATA												
Wet Standard Stack Flow Rate		19,210	19,155	19,148	19,244	19,511	19,718	19,791	19,777	19,721	19475	scfm

RELATIVE ACCURACY TEST DATA												
Difference		-1686	-1453	-1343	-1440	-1709	-1687	-2031	-1960	-2029	-1727	scfh
Percent Difference		-10.89	-8.21	-7.54	-8.09	-9.60	-9.36	-11.43	-11.00	-11.47	-9.73	%
Standard Deviation											266.83	
2.5% Error Confidence											205.10	%
T-Value											2.306	
Client Supplied WAF											0.9605	
BAF											1.00	
Relative Accuracy											10.88	

FLOWRATE BY METHODS 1-4

Derivation of Calculations and Ex. Calculations

$$\Delta P_{avg} = \left(\frac{\sum(\Delta P)^{1/2}}{\text{number of sample points}} \right)^2$$

A_S = Area of the stack (ft^2)

C_P = Pitot tube coefficient

$$K_P = 85.49^{ft/sec} \left(\frac{(lb/lb\text{-}mole)(in\ Hg)}{(^\circ R)(in\ H_2O)} \right)^{1/2}$$

M_S = Molecular weight of flue gas, including water vapor

P_{BAR} = Barometric pressure (in Hg)

P_{ST} = P_{static} (in Hg)

P_S = Stack pressure = P_{BAR}. ± P_{static} (in Hg)

T_M = Average Meter Temperature (°F)

T_S = Flue gas temperature (°F)

V_M = Volume of gas sampled at meter conditions (ft^3)

V_MSTD = Volume of gas sampled at standard conditions (ft^3)

V_S = Velocity of flue gas (ft/sec)

V_{WC} = Volume of water condensed in impinger train (ml)

V_WSTD = Volume of water vapor in gas samples at standard conditions (ft^3)

Verification of Calculations

From Outlet Run 1

(V_M)STD =	13.992	DSCF
(V_W)STD =	0.477	ft^3
B_{WU} =	3.29	%
V_S =	78.13	FPS
ACFM =	33,138	CFM
DSCFM =	16,753	DSCFM
WSCFM =	17,323	WSCFM
WSCFH =	1039	KSCFH

Dry Gas Volume (FT^3)

$$(V_M)STD = \frac{(528^\circ R)}{(29.92\ in.Hg)} (V_m) \frac{P_{BAR}}{(T_M + 460)} \qquad (V_M)STD = 17.65\ (V_M) \frac{(P_{BAR})+(P_{ST})}{(T_M + 460)}$$

Volume of Water Vapor (FT^3)

$$(V_W)STD = nRT/P = \frac{\left(\frac{V_{WC}(gm)}{(18\ lb \times 454\ gm) / (lb\ mole \times lb)} \right) \times \left(\frac{21.85\ ft3 \times in.Hg.}{lb.\ mole\ ^\circ R} \right) \times \left(\frac{68^\circ + 460^\circ R}{1} \right)}{29.92}$$

Moisture Content (by volume)

$$B_{WO} = \frac{V_W STD}{V_W STD + V_M STD}$$

Velocity

$$V_S = (K_P)\ (C_P)(\Delta P)^{1/2}{}_{avg} \times \left(\frac{(T_S + 460)}{(M_S)\ (P_S)} \right)^{1/2}$$

Flowrates

ACFM = $(V_S)\ (A_S)$ (60 sec/min)

$$DSCFM = \frac{(ACFM)(P_S)(1-B_{wo})(528\ ^\circ R)}{(29.92\ in.Hg)(T_S-460^\circ)}$$

WSCFM = DSCFM/(1-B_{WO})

Relative Accuracy
Derivation of Calculations and Ex. Calculations (NOX)

d =	Arithmetic mean of the difference (between the RM and CEMS) of a data set
n =	Number of data sets (or runs) utilized in S_d and RA calculations
CC =	2.5 percent error confidence coefficient
RA =	Relative accuracy of the data set

All data must be compared on a common basis. Each RM run is corrected to the units of the emission standard with the corresponding Method 3a data. For this unit, the emission standard is SO2 (ppm corrected to O% O2). CEMS and RM data is collected on the same basis (ppmvd).

RA Supporting Calculations

$$d = \frac{1}{n} \sum_{i=1}^{n} d_i \quad \text{(where n = number of data points)}$$

$$S_d = \left[\frac{\sum_{i=1}^{n} d_i^2 - \left[\frac{\sum_{i=1}^{n} d_i}{n} \right]^2}{n-1} \right]^{1/2}$$

$$CC = \frac{t_{0.975}\ S_d}{n^{1/2}}$$

$$RA = \frac{|d| + |CC|}{\overline{RM}} \times 100$$

*In cases where the average emissions for the test are less than 50 percent of the applicable standard, substitute the emission standard value in the denominator in place of RM

t-Values

(Table 2-1 from PS 2)

n_a	$t_{0.975}$
9	2.306
10	2.262
11	2.228
12	2.201

The values in this table are corrected for n-1 degrees of freedom.

Example NOX PPM Calculations TW-17 Outlet

d =	10.70
S_d =	3.93
CC =	3.02
RM =	96.3
RA =	14.24

ACE =	Analyzer calibration error, percent of calibration span
B_{WS} =	Moisture content of sample gas as measured by Method 4 or other approved method, percent/100
C_{avg} =	Average unadjusted gas concentration indicated by data recorder for the test run, ppmv
C_D =	Pollutant concentration adjusted to dry conditions, ppmv
C_{Dir} =	Measured concentration of a calibration gas (low, mid, or high) when introduced in direct calibration mode, ppmv
C_{gas} =	Average effluent gas concentration adjusted for bias, ppmv
C_M =	Average of initial and final system calibration bias check responses for the upscale calibration gas, ppmv
C_{MA} =	Actual concentration of the upscale calibration gas, ppmv
C_{Native} =	Gas concentration in the stack gas as calculated in Section 12.6, ppmv
C_O =	Average of the initial and final system calibration bias check responses from the low-level (or zero) calibration gas, ppmv
C_{OA} =	Actual concentration of the low-level calibration gas, ppmv
C_S =	Measured concentation of a calibration gas (low, mid or high) when introduced in system calibration mode
CS =	Calibration span, ppmv
C_V =	Manufacturer certified concentration of a calibration gas (low, mid, or high), ppmv
D =	Drift assessment, percent of calibration span
SB =	System bias, percent of calibration span
SB_i =	Pre-run system bias, percent of calibration span
SB_{Final} =	Post-run system bias, percent of calibration span
SCE =	System calibration error, percent of calibration span
SCE_i =	Pre-run system calibration error, percent of calibration span
SCE_{Final} =	Post-run system calibration error, percent of calibration span

$$ACE = \frac{C_{Dir} - C_v}{CS} \times 100 \qquad SB = \frac{C_s - C_{Dir}}{CS} \times 100 \qquad Eff_{NO2} = \frac{C_{dir}}{C_v} \times 100$$

$$D = \left| SB_{Final} - SB_i \right| \qquad C_{gas} = (C_{Avg} - C_O)\frac{C_{MA}}{C_M - C_O}$$

Example Calculations for Run 1 NOx

Linearity Calculation

C_{Dir} = 151.20 ppmv

C_V = 152.00 ppmv

CS = 152.00 ppmv

ACE = -0.526 %

Bias (Pre-Run Zero)

C_S = 0.05 ppmv

C_{Dir} = 0.12 ppmv

SB = -0.05 %

Effluent Gas Concentration (Corrected for Drift)

C_{avg} = 77.74 ppmv

C_O = 0.05 ppmv

C_{MA} = 71.90 ppmv

C_M = 72.09 ppmv

C_{gas} = 77.54 ppmv

Bias (Post Run Zero)

C_S = 0.05 ppmv

C_{Dir} = 0.12 ppmv

SB = -0.04 %

Bias (Pre-Run Upscale)

C_S = 72.05 ppmv

C_{Dir} = 72.15 ppmv

SB = -0.07 %

Bias (Post Run Upscale)

C_S = 72.12 ppmv

C_{Dir} = 72.15 ppmv

SB = -0.02 %

Zero Drift

SB_i = -0.05 %

SB_{Final} = -0.04 %

D = 0.00 %

Span Drift

SB_i = -0.07 %

SB_{Final} = -0.02 %

D = 0.05 %

METHOD 7E & 19 CALCULATIONS
Derivation of Calculations and Ex. Calculations

A_n =	Cross-sectional area of nozzle, (ft^2)
B_{WO} =	Moisture content of flue gas (vol) as percent
D_n =	Nozzle diameter (in)
m_n =	Total mass of analyte collected, µg
MW=	Molecular weight of analyte collected,g mol^{-1}
Q_{sw} =	Hourly average volumetric flow during unit operation, wet basis, scfh.
t =	Sampling time (min)
V_m(STD) =	Volume of gas sample measured by the dry gas meter, corrected to standard conditions, (dscf)
V_n(STD) =	Nozzle velocity (ft/sec) at standard conditions
V_s(STD) =	Stack velocity (ft/sec) at standard conditions

Verification of Calculations
From Run 1 (TW-17 Outlet)

	NOX
Conversion Factor	1.194E-07
ppmvd @ 15% O2	29.5
ppm - wet	N/A
lb/hr	9.31
lb/mmbtu	N/A

Emissions (ppmvd @ 15% O2)

$$= \text{ppmvd} \times \frac{(20.9 - 15)}{(20.9 - O2)}$$

Emissions (ppmv-wet)

$$= \text{ppmvd} \times \left(1 - (B_{wo}/100) \right)$$

Emissions (lb/hr)

$$= \text{ppmvd} \times \text{Conversion Factor} \times \text{flowrate (DSCFM)} \times 60 \text{ min/hr}$$

Emissions (lb/mmBTU)

$$= \text{ppmvd} \times \text{Conversion Factor} \times \text{F-Factor (DSCFM)} \times 20.9/(20.9-O2)$$

Method 19 Fuel Factor

FUEL	O2 F- Factor
COAL	9780
NATURAL GAS	8710
OIL	9190
WOOD	9240
WOOD BARK	9600

APPENDIX C
OPERATIONAL DATA

AI_94010B.PV TW-17 Inlet and Outlet
AI_94011_NOX.PV
FI_94068.PV

R1	4/21/2015 12:15	4/21/2015 12:35
R2	4/21/2015 12:45	4/21/2015 13:05
R3	4/21/2015 13:15	4/21/2015 13:35
R4	4/21/2015 13:45	4/21/2015 14:05
R5	4/21/2015 14:15	4/21/2015 14:35
R6	4/21/2015 14:45	4/21/2015 15:05
R7	4/21/2015 15:15	4/21/2015 15:35
R8	4/21/2015 15:45	4/21/2015 16:05
R9	4/21/2015 16:15	4/21/2015 16:35

TW-17 Inlet and Outlet

	NOx IN ppm	NOx OUT ppm	Flow Rate SCFM	NOx OUT lb/hr
=PHDGetData("HPW	AI_94010B.PV	AI_94011_NOX.PV	FI_94068.PV	
Timestamp	94010B.PV - Average	1_NOX.PV - Average	_94068.PV - Average	
4/21/2015 12:15	5052.52	66.17	19296.32	9.29
4/21/2015 12:16	5052.37	60.25	19185.33	8.41
4/21/2015 12:17	5089.54	71.19	19235.44	9.96
4/21/2015 12:18	5056.66	71.26	19132.02	9.92
4/21/2015 12:19	5071.64	66.14	19153.76	9.21
4/21/2015 12:20	5092.47	76.14	19296.54	10.69
4/21/2015 12:21	5099.75	79.25	19222.82	11.08
4/21/2015 12:22	5080.46	71.74	19073.30	9.95
4/21/2015 12:23	5085.27	72.09	19293.01	10.12
4/21/2015 12:24	5066.68	73.43	19114.78	10.21
4/21/2015 12:25	5066.73	61.56	19204.49	8.60
4/21/2015 12:26	5082.81	70.99	19134.00	9.88
4/21/2015 12:27	5086.22	74.57	19033.48	10.32
4/21/2015 12:28	5071.51	65.56	19235.84	9.17
4/21/2015 12:29	5170.24	70.47	19195.60	9.84
4/21/2015 12:30	5320.94	71.41	19386.60	10.07
4/21/2015 12:31	5453.33	61.62	19273.48	8.64
4/21/2015 12:32	5533.61	64.30	19166.94	8.96
4/21/2015 12:33	5535.83	59.29	19192.08	8.28
4/21/2015 12:34	5535.83	61.13	19283.72	8.57
4/21/2015 12:35	5535.83	53.99	19290.40	7.57
	5197.15	67.74	19209.52	9.46

TW-17 Inlet and Outlet

	NOx IN ppm	NOx OUT ppm	Flow Rate SCFM	NOx OUT lb/hr
=PHDGetData("HPV	AI_94010B.PV	AI_94011_NOX.PV	FI_94068.PV	
Timestamp	94010B.PV - Average	1_NOX.PV - Average	_94068.PV - Average	
4/21/2015 12:45	5436.77	80.32	19133.27	11.18
4/21/2015 12:46	5490.37	87.92	19078.11	12.20
4/21/2015 12:47	5507.76	80.47	19175.72	11.22
4/21/2015 12:48	5514.67	68.48	19183.59	9.55
4/21/2015 12:49	5562.28	80.22	19180.26	11.19
4/21/2015 12:50	5598.87	89.54	19330.95	12.59
4/21/2015 12:51	5844.28	89.54	19237.78	12.53
4/21/2015 12:52	5673.15	89.54	19189.10	12.50
4/21/2015 12:53	5600.93	89.54	19128.64	12.46
4/21/2015 12:54	5508.14	89.54	19018.71	12.39
4/21/2015 12:55	5530.92	87.79	19225.21	12.27
4/21/2015 12:56	5545.48	77.55	19121.52	10.79
4/21/2015 12:57	5585.10	88.77	19121.28	12.34
4/21/2015 12:58	5499.81	76.36	18971.77	10.54
4/21/2015 12:59	5407.09	74.33	19363.06	10.47
4/21/2015 13:00	5417.81	105.53	19149.10	14.70
4/21/2015 13:01	5388.69	71.32	19100.45	9.91
4/21/2015 13:02	5290.53	54.80	19248.16	7.67
4/21/2015 13:03	5270.92	50.45	19055.94	6.99
4/21/2015 13:04	5336.70	49.02	19215.21	6.85
4/21/2015 13:05	5338.14	35.03	19023.57	4.85
	5492.78	76.95	19154.83	10.72

TW-17 Inlet and Outlet

	NOx IN ppm	NOx OUT ppm	Flow Rate SCFM	NOx OUT lb/hr
=PHDGetData("HPW	AI_94010B.PV	AI_94011_NOX.PV	FI_94068.PV	
Timestamp	)4010B.PV - Average	1_NOX.PV - Average	_94068.PV - Average	
4/21/2015 13:15	5269.55	49.05	19031.33	6.79
4/21/2015 13:16	5352.08	62.72	19219.77	8.77
4/21/2015 13:17	5368.43	60.70	19139.33	8.45
4/21/2015 13:18	5346.72	49.81	19196.67	6.95
4/21/2015 13:19	5417.73	52.16	19043.81	7.22
4/21/2015 13:20	5424.88	61.94	19218.09	8.66
4/21/2015 13:21	5402.40	66.22	19212.08	9.25
4/21/2015 13:22	5395.18	80.32	19036.40	11.12
4/21/2015 13:23	5396.40	68.82	19009.88	9.51
4/21/2015 13:24	5447.52	63.00	19165.40	8.78
4/21/2015 13:25	5433.61	65.64	19296.42	9.21
4/21/2015 13:26	5316.23	70.67	19073.49	9.80
4/21/2015 13:27	5301.90	69.81	19116.71	9.71
4/21/2015 13:28	5336.10	73.65	19109.53	10.24
4/21/2015 13:29	5261.12	77.84	19214.45	10.88
4/21/2015 13:30	5194.85	73.48	19313.52	10.32
4/21/2015 13:31	5210.17	81.20	19174.98	11.32
4/21/2015 13:32	5233.55	75.63	19135.66	10.53
4/21/2015 13:33	5232.96	81.27	19167.77	11.33
4/21/2015 13:34	5232.96	81.90	19133.93	11.40
4/21/2015 13:35	5232.96	65.28	19099.16	9.07
	5324.16	68.15	19148.02	9.49

TW-17 Inlet and Outlet

	NOx IN ppm	NOx OUT ppm	Flow Rate SCFM	NOx OUT lb/hr
=PHDGetData("HPV	AI_94010B.PV	AI_94011_NOX.PV	FI_94068.PV	
Timestamp	94010B.PV - Average	1_NOX.PV - Average	_94068.PV - Average	
4/21/2015 13:45	5420.60	86.12	19226.47	12.04
4/21/2015 13:46	5291.06	107.46	19272.14	15.06
4/21/2015 13:47	5234.80	111.82	19315.57	15.71
4/21/2015 13:48	5161.42	78.41	19053.51	10.87
4/21/2015 13:49	5255.16	95.07	19374.20	13.40
4/21/2015 13:50	5276.25	97.71	19315.90	13.73
4/21/2015 13:51	5259.70	97.71	19317.09	13.73
4/21/2015 13:52	5372.87	97.71	19179.89	13.63
4/21/2015 13:53	5412.03	97.71	19131.53	13.60
4/21/2015 13:54	5375.26	97.71	19330.95	13.74
4/21/2015 13:55	5377.75	81.41	19067.62	11.29
4/21/2015 13:56	5472.64	103.16	19283.02	14.47
4/21/2015 13:57	5509.80	97.40	19329.70	13.69
4/21/2015 13:58	5498.49	107.49	19256.77	15.05
4/21/2015 13:59	5443.93	100.96	19320.67	14.19
4/21/2015 14:00	5386.18	82.53	19186.47	11.52
4/21/2015 14:01	5485.71	72.96	19155.67	10.16
4/21/2015 14:02	5571.70	83.27	19252.75	11.66
4/21/2015 14:03	5588.34	90.47	19160.17	12.61
4/21/2015 14:04	5575.79	83.85	19308.62	11.78
4/21/2015 14:05	5491.13	78.26	19290.58	10.98
	5402.89	92.82	19244.25	12.99

TW-17 Inlet and Outlet

	NOx IN ppm	NOx OUT ppm	Flow Rate SCFM	NOx OUT lb/hr
=PHDGetData("HPV	AI_94010B.PV	AI_94011_NOX.PV	FI_94068.PV	
Timestamp	)4010B.PV - Average	1_NOX.PV - Average	_94068.PV - Average	
4/21/2015 14:15	5497.81	73.80	19198.24	10.30
4/21/2015 14:16	5396.09	63.98	19225.24	8.95
4/21/2015 14:17	5497.39	73.88	19194.37	10.31
4/21/2015 14:18	5444.25	67.50	19120.50	9.39
4/21/2015 14:19	5425.53	71.40	19190.14	9.96
4/21/2015 14:20	5321.86	67.25	19308.13	9.44
4/21/2015 14:21	5275.48	65.26	19144.07	9.09
4/21/2015 14:22	5386.62	83.53	19313.31	11.73
4/21/2015 14:23	5481.81	87.76	19290.97	12.31
4/21/2015 14:24	5592.68	84.72	19561.61	12.05
4/21/2015 14:25	5750.66	97.54	19710.89	13.98
4/21/2015 14:26	5864.74	103.28	19645.29	14.76
4/21/2015 14:27	5986.31	116.97	19709.43	16.77
4/21/2015 14:28	6009.22	131.30	19745.33	18.85
4/21/2015 14:29	6009.19	154.20	19630.69	22.02
4/21/2015 14:30	6009.21	138.96	19558.73	19.77
4/21/2015 14:31	6009.24	145.00	19843.65	20.93
4/21/2015 14:32	6009.29	150.34	19874.30	21.73
4/21/2015 14:33	6009.31	151.90	19830.57	21.91
4/21/2015 14:34	6009.31	143.26	19783.93	20.61
4/21/2015 14:35	6009.31	143.95	19851.11	20.78
	5714.06	105.51	19510.98	15.03

TW-17 Inlet and Outlet

	NOx IN ppm	NOx OUT ppm	Flow Rate SCFM	NOx OUT lb/hr
=PHDGetData("HPV	AI_94010B.PV	AI_94011_NOX.PV	FI_94068.PV	
Timestamp	94010B.PV - Average	1_NOX.PV - Average	_94068.PV - Average	
4/21/2015 14:45	5985.19	116.79	19723.38	16.75
4/21/2015 14:46	6007.05	130.63	19545.09	18.57
4/21/2015 14:47	5968.88	128.04	19570.87	18.22
4/21/2015 14:48	5801.46	127.38	19832.71	18.37
4/21/2015 14:49	5723.22	109.67	19838.13	15.82
4/21/2015 14:50	5784.83	109.10	20020.01	15.89
4/21/2015 14:51	5834.34	109.10	19820.64	15.73
4/21/2015 14:52	5901.04	109.10	19645.98	15.59
4/21/2015 14:53	5995.81	109.10	19722.73	15.65
4/21/2015 14:54	5905.09	109.10	19727.03	15.65
4/21/2015 14:55	5843.18	109.10	19840.37	15.74
4/21/2015 14:56	5870.00	109.10	19734.67	15.66
4/21/2015 14:57	5978.63	109.10	19503.60	15.48
4/21/2015 14:58	6009.02	118.21	19607.25	16.86
4/21/2015 14:59	6009.12	119.69	19533.88	17.00
4/21/2015 15:00	6009.21	119.93	19739.67	17.22
4/21/2015 15:01	6009.11	98.10	19704.00	14.06
4/21/2015 15:02	6009.11	87.97	19816.34	12.68
4/21/2015 15:03	5943.11	97.80	19774.31	14.06
4/21/2015 15:04	5835.38	90.81	19708.18	13.02
4/21/2015 15:05	5944.40	101.80	19675.60	14.57
	5922.25	110.46	19718.31	15.84

TW-17 Inlet and Outlet

	NOx IN ppm	NOx OUT ppm	Flow Rate SCFM	NOx OUT lb/hr
=PHDGetData("HPV	AI_94010B.PV	AI_94011_NOX.PV	FI_94068.PV	
Timestamp	)4010B.PV - Average	1_NOX.PV - Average	_94068.PV - Average	
4/21/2015 15:15	5933.26	95.06	19848.34	13.72
4/21/2015 15:16	5965.70	79.79	19827.10	11.51
4/21/2015 15:17	6009.24	91.34	19844.53	13.18
4/21/2015 15:18	6009.19	101.58	19918.99	14.72
4/21/2015 15:19	5955.83	100.35	19857.03	14.49
4/21/2015 15:20	6005.57	86.21	19731.35	12.37
4/21/2015 15:21	6009.16	93.19	19723.93	13.37
4/21/2015 15:22	6007.60	93.75	19803.63	13.50
4/21/2015 15:23	5984.36	84.44	19843.47	12.19
4/21/2015 15:24	5963.10	89.97	19755.16	12.93
4/21/2015 15:25	6009.22	92.73	19613.02	13.23
4/21/2015 15:26	5964.82	79.86	19766.70	11.48
4/21/2015 15:27	5757.10	77.87	19639.56	11.12
4/21/2015 15:28	5776.04	78.06	19858.15	11.27
4/21/2015 15:29	5870.15	76.06	19870.53	10.99
4/21/2015 15:30	5897.37	89.72	19819.33	12.93
4/21/2015 15:31	5843.99	99.81	19796.26	14.37
4/21/2015 15:32	5747.64	76.78	19811.18	11.06
4/21/2015 15:33	5742.24	69.84	19667.39	9.99
4/21/2015 15:34	5742.24	81.43	19948.90	11.81
4/21/2015 15:35	5742.24	94.94	19663.69	13.58
	5901.72	87.27	19790.87	12.56

TW-17 Inlet and Outlet

	NOx IN ppm	NOx OUT ppm	Flow Rate SCFM	NOx OUT lb/hr
=PHDGetData("HPV	AI_94010B.PV	AI_94011_NOX.PV	FI_94068.PV	
Timestamp	94010B.PV - Average	1_NOX.PV - Average	_94068.PV - Average	
4/21/2015 15:45	5875.84	64.17	19878.32	9.28
4/21/2015 15:46	5888.57	72.10	19917.20	10.44
4/21/2015 15:47	5913.65	73.25	19678.72	10.48
4/21/2015 15:48	5928.61	85.75	19613.06	12.23
4/21/2015 15:49	5864.05	76.70	19710.11	10.99
4/21/2015 15:50	5938.98	72.06	19891.44	10.42
4/21/2015 15:51	5916.35	72.06	19818.43	10.39
4/21/2015 15:52	5821.53	72.06	19876.28	10.42
4/21/2015 15:53	5765.75	72.06	19726.75	10.34
4/21/2015 15:54	5747.18	72.06	19705.77	10.33
4/21/2015 15:55	5778.13	91.46	19740.84	13.13
4/21/2015 15:56	5716.62	73.18	19648.43	10.46
4/21/2015 15:57	5755.38	74.94	19881.34	10.84
4/21/2015 15:58	5784.14	89.79	19890.17	12.99
4/21/2015 15:59	5798.15	86.40	19760.64	12.42
4/21/2015 16:00	5865.99	88.32	19928.13	12.80
4/21/2015 16:01	5914.05	92.96	19749.85	13.35
4/21/2015 16:02	5922.40	80.38	19738.86	11.54
4/21/2015 16:03	5899.02	75.03	19774.77	10.79
4/21/2015 16:04	5881.42	78.37	19701.26	11.23
4/21/2015 16:05	5901.89	78.62	19685.87	11.26
	5851.32	78.18	19776.96	11.24

TW-17 Inlet and Outlet

	NOx IN ppm	NOx OUT ppm	Flow Rate SCFM	NOx OUT lb/hr
=PHDGetData("HPV	AI_94010B.PV	AI_94011_NOX.PV	FI_94068.PV	
Timestamp	94010B.PV - Average	1_NOX.PV - Average	_94068.PV - Average	
4/21/2015 16:15	5777.66	62.31	19737.71	8.94
4/21/2015 16:16	5771.68	68.09	19687.32	9.75
4/21/2015 16:17	5747.42	68.86	19754.66	9.89
4/21/2015 16:18	5745.38	80.13	19615.47	11.43
4/21/2015 16:19	5757.77	87.96	19828.28	12.68
4/21/2015 16:20	5765.20	78.16	19801.94	11.26
4/21/2015 16:21	5786.60	69.09	19745.16	9.92
4/21/2015 16:22	5827.83	75.69	19535.63	10.75
4/21/2015 16:23	5817.52	89.72	19638.72	12.82
4/21/2015 16:24	5730.38	92.08	19869.65	13.31
4/21/2015 16:25	5736.26	89.68	19581.61	12.77
4/21/2015 16:26	5811.70	97.22	19742.18	13.96
4/21/2015 16:27	5732.76	80.93	19699.86	11.60
4/21/2015 16:28	5728.58	80.60	19744.83	11.57
4/21/2015 16:29	5736.96	82.75	19716.92	11.87
4/21/2015 16:30	5742.04	92.18	19923.13	13.36
4/21/2015 16:31	5823.72	102.34	19776.82	14.72
4/21/2015 16:32	5767.56	99.39	19635.46	14.19
4/21/2015 16:33	5766.82	88.01	19684.51	12.60
4/21/2015 16:34	5766.82	84.17	19606.04	12.00
4/21/2015 16:35	5766.82	79.28	19813.57	11.42
	5767.02	83.27	19720.93	11.94

APPENDIX D
CALIBRATION DATA

HONEYWELL - HOPEWELL, VA
CALIBRATION DATA TW-17 INLET

			Cylinder Value	Analyzer Response	Absolute Difference	Percent Difference
Date :	4/21/2015					
Gas :	O2					
		Zero Gas	0.000	0.025	0.025	0.119
Span :	20.990	Mid-range Gas	11.980	11.950	0.030	0.143
		High-range Gas	20.990	20.940	0.050	0.238

			Cylinder Value	Analyzer Response	Absolute Difference	Percent Difference
Date :	4/21/2015					
Gas :	CO2					
		Zero Gas	0.000	0.039	0.039	0.245
Span :	15.910	Mid-range Gas	8.006	8.011	0.005	0.031
		High-range Gas	15.910	15.914	0.004	0.025

			Cylinder Value	Analyzer Response	Absolute Difference	Percent Difference
Date :	4/21/2015					
Gas :	NOX					
		Zero Gas	0.000	1.200	1.200	0.013
Span :	9336.000	Mid-range Gas	4659.000	4666.000	7.000	0.075
		High-range Gas	9336.000	9323.000	13.000	0.139

Converter Efficiency Check

16:50	49.98	NO2 (PPM)=	52.2
16:51	50.12		
16:52	50.27		
AVERAGE	50.123		

Conv. Eff.= 96.0 %

response (sec):				
up	99	down	78
up	97	down	76
up	96	down	74
average:	97.3	average:	76.0

HONEYWELL - HOPEWELL, VA
CALIBRATION DATA TW-17 OUTLET

			Cylinder Value	Analyzer Response	Absolute Difference	Percent Difference
Date :	4/21/2015					
Gas :	O2					
		Zero Gas	0.000	0.025	0.025	0.119
Span :	20.990	Mid-range Gas	11.980	11.950	0.030	0.143
		High-range Gas	20.990	20.940	0.050	0.238

			Cylinder Value	Analyzer Response	Absolute Difference	Percent Difference
Date :	4/21/2015					
Gas :	CO2					
		Zero Gas	0.000	0.039	0.039	0.245
Span :	15.910	Mid-range Gas	8.006	8.011	0.005	0.031
		High-range Gas	15.910	15.914	0.004	0.025

			Cylinder Value	Analyzer Response	Absolute Difference	Percent Difference
Date :	4/21/2015					
Gas :	NOX					
		Zero Gas	0.000	0.118	0.118	0.078
Span :	152.000	Mid-range Gas	71.900	72.150	0.250	0.164
		High-range Gas	152.000	151.200	0.800	0.526

Converter Efficiency Check

				response (sec):				
					up	98	down	77
					up	96	down	75
16:41	48.38	NO2 (PPM)=	52.2		up	94	down	74
16:42	49.77				average:	96.0	average:	75.3
16:43	50.02							
AVERAGE	49.390							
Conv. Eff.=	**94.6 %**							

Airgas

Airgas Specialty Gases
630 United Drive
Durham , NC 27713
919-544-3773 Fax: 919-544-3774
www.airgas.com

CERTIFICATE OF ANALYSIS
Grade of Product: EPA Protocol

Part Number:	E03NI80E15A1140	Reference Number:	122-124420923-1
Cylinder Number:	CC64254	Cylinder Volume:	149.9 CF
Laboratory:	ASG - Durham - NC	Cylinder Pressure:	2015 PSIG
PGVP Number:	B22014	Valve Outlet:	590
Gas Code:	CO2,O2,BALN	Certification Date:	Feb 24, 2014

Expiration Date: Feb 24, 2022

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
CARBON DIOXIDE	8.000 %	8.006 %	G1	+/- 0.6% NIST Traceable	02/24/2014
OXYGEN	12.00 %	11.98 %	G1	+/- 0.4% NIST Traceable	02/24/2014
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	12061348	CC360808	11.002 % CARBON DIOXIDE/NITROGEN	+/- 0.6%	Jan 11, 2018
NTRM	09061416	CC273522	22.53 % OXYGEN/NITROGEN	+/- 0.4%	Mar 08, 2019

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Horiba VIA510 CO2 42399380022	Nondispersive Infrared (NDIR)	Feb 07, 2014
Horiba MPA510 O2 41499150042	Paramagnetic	Feb 07, 2014

Triad Data Available Upon Request

Notes:

A Williams

Approved for Release

ESS

Environmental Source Samplers, Inc.

Airgas

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Airgas Specialty Gases
630 United Drive
Durham , NC 27713
919-544-3773 Fax: 919-544-3774
www.airgas.com

Part Number:	E03NI73E15A4BQ4	Reference Number:	122-124453079-1
Cylinder Number:	CC454142	Cylinder Volume:	155.2 CF
Laboratory:	ASG - Durham - NC	Cylinder Pressure:	2015 PSIG
PGVP Number:	B22014	Valve Outlet:	590
Gas Code:	CO2,O2,BALN	Certification Date:	Sep 10, 2014

Expiration Date: Sep 10, 2022

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
OXYGEN	11.00 %	11.21 %	G1	+/- 1.0% NIST Traceable	09/10/2014
CARBON DIOXIDE	16.00 %	15.91 %	G1	+/- 0.6% NIST Traceable	09/10/2014
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	09060211	CC262370	9.961 % OXYGEN/NITROGEN	+/- 0.3%	Nov 08, 2018
NTRM	12061551	CC354889	19.87 % CARBON DIOXIDE/NITROGEN	+/- 0.6%	Jan 27, 2018

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Horiba VIA510 CO2 2L6YXWY0	Nondispersive Infrared (NDIR)	Aug 28, 2014
Horiba MPA510 O2 41499150042	Paramagnetic	Aug 28, 2014

Triad Data Available Upon Request

Approved for Release

ESS

Environmental Source Samplers, Inc.

Airgas

Airgas Specialty Gases
630 United Drive
Durham , NC 27713
919-544-3773 Fax: 919-544-3774
www.airgas.com

CERTIFICATE OF ANALYSIS
Grade of Product: EPA Protocol

Part Number:	E02NI79E15A0927	Reference Number:	122-124413623-1
Cylinder Number:	XC021149B	Cylinder Volume:	146.2 CF
Laboratory:	ASG - Durham - NC	Cylinder Pressure:	2015 PSIG
PGVP Number:	B22014	Valve Outlet:	590
Gas Code:	O2,BALN	Certification Date:	Jan 10, 2014

Expiration Date: Jan 10, 2022

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
OXYGEN	21.00 %	20.99 %	G1	+/- 0.5% NIST Traceable	01/10/2014
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	09061416	CC273522	22.53 % OXYGEN/NITROGEN	+/- 0.4%	Mar 08, 2019

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Horiba MPA510 O2 41499150042	Paramagnetic	Jan 06, 2014

Triad Data Available Upon Request

Notes:

C. Williams

Approved for Release

ESS

Environmental Source Samplers, Inc.

Airgas

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Airgas Specialty Gases
630 United Drive
Durham , NC 27713
919-544-3773 Fax: 919-544-3774
Airgas.com

Part Number:	E02NI99E15A0212	Reference Number:	122-124467943-1
Cylinder Number:	CC255360	Cylinder Volume:	144.3 CF
Laboratory:	ASG - Durham - NC	Cylinder Pressure:	2015 PSIG
PGVP Number:	B22014	Valve Outlet:	660
Gas Code:	NO,BALN	Certification Date:	Dec 16, 2014

Expiration Date: Dec 16, 2022

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	75.00 PPM	71.90 PPM	G1	+/- 1.0% NIST Traceable	12/09/2014, 12/16/2014
NITRIC OXIDE	75.00 PPM	71.79 PPM	G1	+/- 1.0% NIST Traceable	12/09/2014, 12/16/2014
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	13061042	CC423423	99.86 PPM NITRIC OXIDE/NITROGEN	+/- 0.8%	Nov 19, 2019
PRM	12328	680179	10.01 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Feb 14, 2012
GMIS	812201404	CC502156	4.867 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Aug 12, 2017

The SRM, PRM or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 6700 AHR0801549 NO	FTIR	Nov 20, 2014
Nicolet 6700 AHR0801549 NO	FTIR	Nov 20, 2014

Triad Data Available Upon Request

Approved for Release

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Environmental Source Samplers, Inc.

Airgas

Airgas Specialty Gases
630 United Drive
Durham, NC 27713
919-544-3773 Fax: 919-544-3774
www.airgas.com

CERTIFICATE OF ANALYSIS
Grade of Product: EPA Protocol

Part Number:	E03NI99E15A37Y1	Reference Number:	122-124338372-3
Cylinder Number:	SG9135836BAL	Cylinder Volume:	145 Cu.Ft.
Laboratory:	ASG - Durham - NC	Cylinder Pressure:	2015 PSIG
PGVP Number:	B22012	Valve Outlet:	660
Gas Code:	SN	Analysis Date:	Oct 05, 2012

Expiration Date: Oct 05, 2020

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty
NITRIC OXIDE	150.0 PPM	152.0 PPM	G1	+/- 1% NIST Traceable
SULFUR DIOXIDE	1400 PPM	1420 PPM	G1	+/- 1% NIST Traceable
NITROGEN	Balance			
Total oxides of nitrogen		152.0 PPM		For Reference Only

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Expiration Date
090615	090616	CC301470	996.9PPM SULFUR DIOXIDE/NITROGEN	Sep 18, 2015
NTRM	110605	CC331846	101.2PPM NITRIC OXIDE/NITROGEN	Feb 16, 2017
NTRM	090616	CC306690	1978.9PPM SULFUR DIOXIDE/NITROGEN	Sep 18, 2015

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 6700 AHR0801549 NO	FTIR	Sep 06, 2012
Nicolet 6700 AHR0801549 SO2	FTIR	Sep 06, 2012

Triad Data Available Upon Request

Notes:ANWPN 781289

Approved for Release

Page 1 of 122-124338372-3

PRAXAIR

Praxair Distribution Mid-Atlantic
145 Shimersville Rd.
Bethlehem, PA 18015
Tel: (610) 317-1608 Fax:(610) 758 8382
PGVP ID: FI2011

DocNumber: 000013758

CERTIFICATE OF ANALYSIS / EPA PROTOCOL GAS

Customer & Order Information:

CHEROKEE INSTRUMENTS INC *
901 BRIDGE ST
FUQUAY VARINA NC 275260

Praxair Order Number: 17906415
Customer P. O. Number: 11496
Customer Reference Number:

Fill Date: 9/23/2011
Part Number: NI NO4850E-AS
Lot Number: 917126621
Cylinder Style & Outlet: AS CGA 660
Cylinder Pressure & Volume: 2000 psig 140 cu. ft.

Certified Concentration:

Expiration Date:	10/6/2019		NIST Traceable
Cylinder Number:	CC164225		Analytical Uncertainty:
4659	ppm	NITRIC OXIDE	± 1 %
	Balance	NITROGEN	

NOx = 4659

NOx for Reference Only

Certification Information: *Certification Date:* 10/6/2011 *Term:* 96 Months *Expiration Date:* 10/6/2019

This cylinder was certified according to the 1997 EPA Traceability Protocol, Document #EPA-600/R-97/121, using Procedure G2. Do Not Use this Standard if Pressure is less than 150 PSIG.

PGVP ID# F12011

Analytical Data: *(R=Reference Standard, Z=Zero Gas, C=Gas Candidate)*

1. Component: NITRIC OXIDE

Requested Concentration: 4850 ppm
Certified Concentration: 4659 ppm
Instrument Used: TECO MODEL 42C 42CHL-55533-304
Analytical Method: CHEMILUMINESCENCE
Last Multipoint Calibration: 9/15/2011

Reference Standard Type: GMIS
Ref. Std. Cylinder # : CC116816
Ref. Std. Conc: 4086 PPM
Ref. Std. Traceable to SRM # : 2631a
SRM Sample # : 47-F-45
SRM Cylinder # : CAL016138

First Analysis Data:								Date:	9/28/2011
Z:	0	R:	4070	C:	4642	Conc:	4679.4		
R:	4060	Z:	0	C:	4614	Conc:	4651.2		
Z:	0	C:	4600	R:	4030	Conc:	4637.1		
UOM:	PPM			Mean Test Assay:			4655.9 PPM		

Second Analysis Data:								Date:	10/6/2011
Z:	0	R:	4070	C:	4642.8	Conc:	4668.7		
R:	4060	Z:	0	C:	4628.6	Conc:	4654.4		
Z:	0	C:	4628.6	R:	4060	Conc:	4654.4		
UOM:	PPM			Mean Test Assay:			4659.2 PPM		

Analyzed by: Robin Morgan for

Certified by: Megha Patel for John Pribish

Information contained herein has been prepared at your request by qualified experts within Praxair Distribution, Inc. While we believe that the information is accurate within the limits of the analytical methods employed and is complete to the extent of the specific analyses performed, we make no warranty or representation as to the suitability of the use of the information for any purpose. The information is offered with the understanding that any use of the information is at the sole discretion and risk of the user. In no event shall the liability of Praxair Distribution, Inc., arising out of the use of the information con tained herein exceed the fee established for providing such information.

PRAXAIR

Praxair
5700 South Alameda Street
Los Angeles, CA 90058
Tel:(323)585-2154 Fax:(714)542-6689
PGVP ID: F22012

DocNumber: 000039331

CERTIFICATE OF ANALYSIS / EPA PROTOCOL GAS

Customer & Order Information:

CHEROKEE INSTRUMENTS INC *G*MMS*
901 BRIDGE ST
FUQUAY VARINA NC275260000

Praxair Order Number: 20317939
Customer PO Number: 11837
Customer Reference Number:

Fill Date: 5/17/2012
Part Number: NI NO9000E-AS
Lot Number: 109213805
Cylinder Style and Outlet: AS CGA 660
Cylinder Pressure and Volume: 2000 psig 140 cu. ft.

Certified Concentration:

Expiration Date: 06/11/2020 Cylinder Number: CC139364			NIST Traceable Analytical Uncertainty:
9336	ppm	NITRIC OXIDE	± 2 %
	Balance	NITROGEN	

NOx ppm = 9336 ppm

NOX for Reference Only

Certification Information:

Certification Date : 6/11/2012 *Term :* 96 Months *Expiration Date :* 06/11/2020

This cylinder was certified according to the 1997 EPA Traceability Protocol, Document #EPA-600/R-97/121, using Procedure G2.
Do Not Use this Standard if Pressure is less than 150 PSIG.

G2 analysis was done using Environics 2000 @ 35% {c.f.=0.35}
PGVP ID # F22012

Analytical Data:

(R=Reference Standard, Z=Zero Gas, C=Gas Candidate)

1. Component: NITRIC OXIDE

Requested Concentration: 9000 ppm
Certified Concentration: 9336 ppm
Instrument Used: Thermo Electron 42i S/N 072602432C
Analytical Method: Chemiluminescence
Last Multipoint Calibration: 05/16/2012

Reference Standard Type: GMIS
Ref. Std. Cylinder #: CC116550
Ref. Std. Conc: 3134 ppm
Ref. Std. traceable to SRM #: 2631a
SRM Sample #: 47-E-29
SRM Cylinder #: CAL014349

First Analysis Data:						Date:	05/31/2012
Z:	0	R:	3130	C:	3250	Conc:	3254
R:	3130	Z:	0	C:	3250	Conc:	3254
Z:	0	C:	3250	R:	3130	Conc:	3254
UOM:	ppm					Mean Test Assay:	3254 ppm

Second Analysis Data:						Date:	06/11/2012
Z:	0	R:	3130	C:	3270	Conc:	3274
R:	3130	Z:	0	C:	3280	Conc:	3284
Z:	0	C:	3280	R:	3130	Conc:	3284
UOM:	ppm					Mean Test Assay:	3281 ppm

Analyzed by: Nelson Ma

Certified by: Rolonda Kaywood

Information contained herein has been prepared at your request by qualified experts within Praxair Distribution, Inc. While we believe that the information is accurate within the limits of the analytical methods employed and is complete to the extent of the specified analyses performed, we make no warranty or representation as to the suitability of the use of the information for any purpose. The information is offered with the understanding that any use of the information is at the sole discretion and risk of the user. In no event shall the liability of Praxair Distribution, Inc. arising out of the use of the information contained herein exceed the fee established for providing such information.

Making Our Planet More Productive

ESS

Environmental Source Samplers, Inc.

Airgas

Airgas Specialty Gases
630 United Drive
Durham , NC 27713
919-544-3773 Fax: 919-544-3774
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Part Number:	X02AI99C15A0PY6	Reference Number:	122-124477755-1A
Cylinder Number:	CC502025	Cylinder Volume:	146.2 CF
Laboratory:	ASG - Durham - NC	Cylinder Pressure:	2015 PSIG
Analysis Date:	Feb 18, 2015	Valve Outlet:	660
Lot Number:	122-124477755-1A		

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
NITROGEN DIOXIDE	55.00 PPM	52.20 PPM	+/- 2%
AIR	Balance		

C S Williams
Approved for Release

ESS

DRY GAS METER CALIBRATION USING CRITICAL ORIFICES

Quality - Service - Reliability

1) Select three critical orifices to calibrate the dry gas meter which bracket the expected operating range.
2) Record barometric pressure before and after calibration procedure.
3) Run at maximum attainable vacuum (open coarse valve, close fine valve), for period of 5 minutes minimum for large orifice up to 10 minutes for smallest orifice.
4) Record readings in outlined boxes below, other columns are automatically calculated.

DATE: 12/30/2014
METER BOX #: S-39
METER SERIAL #: 28647
CRITICAL ORIFICE SET SERIAL #: 1314

BAROMETRIC PRESSURE (in Hg):	INITIAL	FINAL	AVG (P_{bar})
	30.25	30.25	30.25

IF Y VARIATION EXCEEDS 2.00%, ORIFICE SHOULD BE RECALIBRATED

ORIFICE #	RUN #	K' FACTOR (AVG)	TESTED VACUUM (in Hg)	DGM READINGS (FT^3) INITIAL	DGM READINGS (FT^3) FINAL	DGM READINGS (FT^3) NET (V_m)	TEMPERATURES °F AMBIENT	TEMPERATURES °F DGM INLET INITIAL	TEMPERATURES °F DGM INLET FINAL	TEMPERATURES °F DGM OUTLET INITIAL	TEMPERATURES °F DGM OUTLET FINAL	TEMPERATURES °F DGM AVG	ELAPSED TIME (MIN) θ	DGM ΔH (in H_2O)	(1) V_m (STD)	(2) V_{cr} (STD)	(3) Y	Y VARIATION (%)
17	1	0.4547	20	726.589	732.40	5.811	42	46	46	47	46	46.25	10.00	1.10	6.1452	6.1409	0.9993	
17	2	0.4547	20	732.40	738.205	5.805	42	46	47	47	47	46.75	10.00	1.10	6.1328	6.1409	1.0013	
17	3	0.4547	20	738.205	744.014	5.809	43	47	46	47	48	47	10.00	1.10	6.1340	6.1348	1.0001	
																AVG =	1.0003	-0.04
19	1	0.5283	18	744.568	751.310	6.742	44	50	48	48	49	48.75	10.00	1.40	7.0998	7.1207	1.0029	
19	2	0.5283	18	751.310	758.054	6.744	44	49	50	50	51	50	10.00	1.40	7.0845	7.1207	1.0051	
19	3	0.5283	18	758.054	764.823	6.769	44	50	50	51	51	50.5	10.00	1.40	7.1038	7.1207	1.0024	
																AVG =	1.0035	0.28
24	1	0.6680	16	557.556	566.114	8.558	44	48	48	49	50	48.75	10.00	2.30	9.0319	9.0037	0.9969	
24	2	0.6680	16	566.114	574.661	8.547	45	50	50	49	50	49.75	10.00	2.30	9.0026	8.9948	0.9991	
24	3	0.6680	16	574.661	583.222	8.561	45	50	50	50	51	50.25	10.00	2.20	9.0063	8.9948	0.9987	
																AVG =	0.9982	-0.24

USING THE CRITICAL ORIFICES AS CALIBRATION STANDARDS:
The following equations are used to calculate the standard volumes of air passed through the DGM, V_m (std), and the critical orifice, V_{cr} (std), and the DGM calibration factor, Y. These equations are automatically calculated in the spreadsheet above.

AVERAGE DRY GAS METER CALIBRATION FACTOR, Y = 1.0007

(1) $V_m\,(std) = K_1\, V_m \dfrac{P_{bar} + (\Delta H/13.6)}{T_m}$ = Net volume of gas sample passed through DGM, corrected to standard conditions

K_1 = 17.64 °R/in. Hg (English), 0.3858 °K/mm Hg (Metric)
T_m = Absolute DGM avg. temperature (°R - English, °K - Metric)

(2) $V_{cr}\,(std) = K' \sqrt{\dfrac{P_{bar}\,\theta}{T_{amb}}}$ = Volume of gas sample passed through the critical orifice, corrected to standard conditions

T_{amb} = Absolute ambient temperature (°R - English, °K - Metric)
K' = Average K' factor from Critical Orifice Calibration

(3) $Y = \dfrac{V_{cr}\,(std)}{V_m\,(std)}$ = DGM calibration factor

S-39 12.30.14

DRY GAS METER CALIBRATION USING CRITICAL ORIFICES

1) Select three critical orifices to calibrate the dry gas meter which bracket the expected operating range.
2) Record barometric pressure before and after calibration procedure.
3) Run at maximum attainable vacuum (open coarse valve, close fine valve), for period of 5 minutes minimum for large orifice up to 10 minutes for smallest orifice.
4) Record readings in outlined boxes below, other columns are automatically calculated.

DATE: 5/8/2015
METER BOX #: S-39
METER SERIAL #: 28647
CRITICAL ORIFICE SET SERIAL #: 1314

BAROMETRIC PRESSURE (in Hg):	INITIAL	FINAL	AVG (P_{bar})
	29.71	29.71	29.71

IF Y VARIATION EXCEEDS 2.00%, ORIFICE SHOULD BE RECALIBRATED

ORIFICE #	RUN #	K' FACTOR (AVG)	TESTED VACUUM (in Hg)	DGM READINGS (FT^3) INITIAL	DGM READINGS (FT^3) FINAL	DGM READINGS (FT^3) NET (V_m)	TEMPERATURES °F AMBIENT	TEMPERATURES °F DGM INLET INITIAL	TEMPERATURES °F DGM INLET FINAL	TEMPERATURES °F DGM OUTLET INITIAL	TEMPERATURES °F DGM OUTLET FINAL	TEMPERATURES °F DGM AVG	ELAPSED TIME (MIN) θ	DGM ΔH (in H_2O)	(1) V_m (STD)	(2) V_{cr} (STD)	(3) Y	Y VARIATION (%)
19	1	0.5283	18	312.579	319.138	6.559	74	77	78	77	78	48.25	10.00	1.50	6.7926	6.7942	1.0002	1.7732878
19	2	0.5283	18	319.138	325.679	6.541	75	78	78	79	79	47.75	10.00	1.50	6.7806	6.7878	1.0011	1.7748627
19	3	0.5283	18	325.679	332.231	6.552	75	78	79	79	79	48.25	10.00	1.50	6.7853	6.7878	1.0004	1.7766105
																AVG =	1.0006	0.00

USING THE CRITICAL ORIFICES AS CALIBRATION STANDARDS:
The following equations are used to calculate the standard volumes of air passed through the DGM, V_m (std), and the critical orifice, V_{cr} (std), and the DGM calibration factor, Y. These equations are automatically calculated in the spreadsheet above.

AVERAGE DRY GAS METER CALIBRATION FACTOR, Y = 1.0006

(1) $V_m\,(std) = K_1\, V_m \dfrac{P_{bar} + (\Delta H/13.6)}{T_m}$ = Net volume of gas sample passed through DGM, corrected to standard conditions

K_1 = 17.64 °R/in. Hg (English), 0.3858 °K/mm Hg (Metric)

T_m = Absolute DGM avg. temperature (°R - English, °K - Metric)

(2) $V_{cr}\,(std) = K' \sqrt{\dfrac{P_{bar}\,\theta}{T_{amb}}}$ = Volume of gas sample passed through the critical orifice, corrected to standard conditions

T_{amb} = Absolute ambient temperature (°R - English, °K - Metric)

K' = Average K' factor from Critical Orifice Calibration

(3) $Y = \dfrac{V_{cr}\,(std)}{V_m\,(std)}$ = DGM calibration factor

S-39_5.8.15 post

TYPE "S" PITOT TUBE CALIBRATION SUMMARY

PITOT TUBE CALIBRATIONS

PITOT TUBE ID	α1	α2	β1	β2	γ	θ	A, in	Z, in	W, in	PA, in	PB, in	Dt, in	DATE
Individual Pitot Tubes													
1V1	1.0	1.0	0.9	0.9	1.0	1.0	0.982	0.017	0.017	0.500	0.494	0.380	1/2/2015
3V1	1.2	1.2	0.8	0.8	1.0	0.8	0.980	0.017	0.014	0.475	0.472	0.380	1/2/2015
3V2	1.0	1.4	1.0	1.0	0.8	0.8	0.980	0.014	0.014	0.486	0.488	0.380	1/2/2015
4V1	1.0	1.3	0.8	0.8	0.8	1.0	0.980	0.014	0.017	0.486	0.488	0.381	1/2/2015
4V2	1.3	1.5	0.8	1.3	0.8	0.6	0.982	0.014	0.010	0.490	0.492	0.375	1/2/2015
5V1	1.2	1.2	1.2	1.3	1.0	0.8	0.988	0.017	0.014	0.492	0.492	0.379	1/2/2015
5V2	1.2	1.4	1.3	1.0	0.7	0.8	0.985	0.012	0.014	0.502	0.501	0.378	1/2/2015
6V1	1.6	1.3	1.0	1.3	0.8	0.7	0.983	0.014	0.012	0.496	0.494	0.378	1/2/2015
6V2	1.6	1.2	1.0	1.2	1.0	0.7	0.978	0.017	0.012	0.495	0.494	0.378	1/2/2015
7V1	1.1	0.9	1.0	1.5	1.2	0.8	0.982	0.021	0.014	0.485	0.484	0.378	1/2/2015
9V1	1.1	0.9	0.6	0.8	0.7	1.0	0.988	0.012	0.017	0.487	0.483	0.378	1/2/2015
9V3	1.2	1.0	0.6	0.8	0.7	1.0	0.988	0.012	0.017	0.487	0.483	0.378	1/2/2015
9V4	0.9	1.0	1.2	0.8	1.3	1.3	0.787	0.018	0.018	0.494	0.492	0.256	1/2/2015
10V1	0.8	1.0	0.9	0.8	1.0	1.0	0.820	0.014	0.014	0.494	0.492	0.258	1/2/2015
12V1	0.9	1.2	0.9	0.8	1.0	1.0	0.880	0.015	0.015	0.494	0.492	0.256	1/2/2015
12V2	1.0	1.0	1.0	1.0	1.1	0.7	0.975	0.019	0.012	0.482	0.484	0.262	1/2/2015
15V1	1.3	1.0	1.3	1.2	1.0	0.8	0.982	0.017	0.014	0.498	0.496	0.380	1/2/2015
Probes Mounted W/Electronic Protractors (RATA dedicated)													
S2GA	0.8	1.0	0.5	1.2	0.8	0.8	0.972	0.014	0.014	0.499	0.498	0.373	1/2/2015
S2GB	0.5	0.3	0.5	1.0	0.2	0.3	0.980	0.003	0.005	0.494	0.495	0.373	1/2/2015
S10-06	0.4	0.9	0.6	1.2	0.4	0.5	0.980	0.007	0.009	0.497	0.495	0.375	1/2/2015
12VSA	0.6	0.8	0.5	0.8	0.4	0.4	0.980	0.007	0.007	0.498	0.496	0.375	1/2/2015
S-2005	0.6	0.4	0.4	0.4	0.2	0.0	0.978	0.003	0.000	0.496	0.496	0.373	1/2/2015

Thermocouple Calibrations

ID	CAL DATE	CAL SOURCE	REF TEMP, F	TC TEMP, F	DIFF, %
DGM S-25	1/2/2015	POINT 1	32	32	0.00
		POINT 2	50	51	-0.20
		POINT 3	212	212	0.00
		POINT 4	500	500	0.00
DGM S-27	1/2/2015	POINT 1	32	32	0.00
		POINT 2	50	50	0.00
		POINT 3	212	213	-0.15
		POINT 4	500	500	0.00
DGM S-35	1/2/2015	POINT 1	32	32	0.00
		POINT 2	50	51	-0.20
		POINT 3	212	212	0.00
		POINT 4	500	500	0.00
DGM S-36	1/2/2015	POINT 1	32	32	0.00
		POINT 2	50	50	0.00
		POINT 3	212	212	0.00
		POINT 4	500	501	-0.10
DGM S-37	1/2/2015	POINT 1	32	32	0.00
		POINT 2	50	50	0.00
		POINT 3	212	211	0.15
		POINT 4	500	499	0.10
DGM S-38	1/2/2015	POINT 1	32	32	0.00
		POINT 2	50	49	0.20
		POINT 3	212	212	0.00
		POINT 4	500	500	0.00
DGM S-39	1/2/2015	POINT 1	32	31	0.20
		POINT 2	50	49	0.20
		POINT 3	212	212	0.00
		POINT 4	500	500	0.00
DGM 5042	1/2/2015	POINT 1	32	32	0.00
		POINT 2	50	50	0.00
		POINT 3	212	213	-0.15
		POINT 4	500	501	-0.10

CALIBRATION INSTRUMENT USED IS AN EXTECH INSTRUMENTS MODEL NO. 42312 (S/N 50000139) CALIBRATOR/THERMOMETER.

POST TEST THERMOCOUPLE CALIBRATIONS
May 10, 2015

THERM ID	REFERENCE TEMPERATURE (F)	THERMOMETER READING (F)	PERCENT DIFFERENCE
S-30	68	69	-0.19
S-31	68	69	-0.19
S-27	32	32	0.00
	68	68	0.00
	212	212	0.00
	250	250	0.00
	300	301	-0.13
S-35	32	32	0.00
	68	68	0.00
	212	213	-0.15
	250	251	-0.14
	300	300	0.00
S-36	32	32	0.00
	68	67	0.19
	212	211	0.15
	250	250	0.00
	300	300	0.00
S-37	32	31	0.20
	68	67	0.19
	212	212	0.00
	250	250	0.00
	300	300	0.00
S-38	32	32	0.00
	68	68	0.00
	212	211	0.15
	250	249	0.14
	300	300	0.00
S-39	32	32	0.00
	68	69	-0.19
	212	213	-0.15
	250	250	0.00
	300	301	-0.13
5042	32	32	0.00
	68	68	0.00
	212	213	-0.15
	250	250	0.00
	300	301	-0.13
S-40 (a)	32	32	0.00
	68	69	-0.19
	212	212	0.00
	250	251	-0.14
	300	301	-0.13
S-40 (b)	32	32	0.00
	68	68	0.00
	212	211	0.15
	250	250	0.00
	300	300	0.00

POST TEST PITOT TUBE CALIBRATIONS

PITOT TUBE ID	α1	α2	β1	β2	γ	θ	A, in	Z, in	W, in	PA, in	PB, in	Dt, in	DATE
3V1	0.9	0.9	0.9	1.0	1.0	1.0	0.823	0.014	0.014	0.494	0.494	0.258	5/10/2015
3P1	0.9	1.0	1.0	1.0	0.8	1.0	0.81	0.011	0.014	0.503	0.504	0.379	5/10/2015
3P2	0.8	1.1	1.0	0.8	0.8	1.0	0.99	0.014	0.017	0.505	0.506	0.378	5/10/2015
3V2	0.7	0.8	0.9	0.9	1.0	1.0	0.885	0.015	0.015	0.497	0.497	0.260	5/10/2015
4P1	0.9	1.0	1.0	1.0	1.0	1.0	0.99	0.017	0.017	0.502	0.502	0.383	5/10/2015
4V1	1.2	1.0	0.8	1.2	1.2	0.7	0.982	0.021	0.012	0.478	0.480	0.262	5/10/2015
4V2	1.2	1.1	1.1	1.4	1.2	1.0	0.980	0.021	0.017	0.498	0.498	0.380	5/10/2015
5P1	1.0	0.9	1.0	1.0	1.0	0.8	0.899	0.016	0.013	0.504	0.504	0.380	5/10/2015
5V1	1.3	1.2	1.1	1.3	1.0	0.8	0.988	0.017	0.014	0.492	0.492	0.379	5/10/2015
5V2	1.0	1.2	1.2	0.8	0.7	1.0	0.982	0.012	0.017	0.501	0.503	0.378	5/10/2015
6P1	0.9	1.0	0.9	0.8	1.0	0.8	0.9	0.016	0.013	0.501	0.503	0.380	5/10/2015
6P2	1.0	0.9	1.0	0.9	0.9	0.8	0.897	0.014	0.013	0.501	0.502	0.380	5/10/2015
7P1	0.9	1.0	0.8	0.8	1.0	0.9	0.998	0.017	0.016	0.504	0.501	0.381	5/10/2015
7P2	1.0	1.0	0.9	0.8	1.0	0.9	0.997	0.017	0.016	0.504	0.501	0.381	5/10/2015
8P1	0.8	0.9	0.9	0.9	0.9	0.9	0.995	0.016	0.016	0.503	0.503	0.380	5/10/2015
8P2	0.9	1.0	1.0	0.9	1.0	0.8	0.839	0.015	0.012	0.501	0.501	0.378	5/10/2015
9P1	1.0	1.0	0.9	1.0	0.9	1.0	0.767	0.012	0.013	0.502	0.502	0.378	5/10/2015
9P2	0.9	1.0	0.9	0.8	0.6	0.9	0.808	0.008	0.013	0.505	0.502	0.386	5/10/2015
9V3	1.0	0.9	0.6	0.9	0.7	1.0	0.988	0.012	0.017	0.488	0.486	0.379	5/10/2015
10P1	1.2	1.2	0.9	0.9	1.2	0.9	0.904	0.019	0.014	0.504	0.505	0.403	5/10/2015
10P2	1.2	1.4	1.2	1.1	1.1	1.0	0.900	0.017	0.016	0.501	0.502	0.402	5/10/2015
15V1	1.1	1.0	1.3	1.2	1.1	0.8	0.982	0.019	0.014	0.498	0.496	0.380	5/10/2015
15PR1	1.1	0.8	0.7	0.6	0.7	0.7	0.998	0.012	0.012	0.503	0.501	0.384	5/10/2015
15PR2	1.2	0.8	0.6	0.7	0.6	0.6	0.998	0.010	0.010	0.501	0.501	0.385	5/10/2015

Source Evaluation Society

P. O. Box 12124
Research Triangle Park
North Carolina 27709

January 9, 2013

Richard D. Sitter
Environmental Source Samplers, Inc.
436 Raleigh Street
Wilmington, NC 28412

Subject: Qualified Source Tester Application No. 2013-754
Qualification Notice - Manual Gas Volume Measurements and Isokinetic Particulate Sampling Methods
- Manual Gaseous Pollutants Source Sampling Methods

Dear Mr. Sitter:

It is my pleasure to inform you that you have satisfied the requirements of the Source Evaluation Society Qualified Source Testing Individual program for the group exam(s) listed above. As a member of the successful candidates in this SES program, you should be proud of this distinction within the source emissions testing community. I am confident that you will continue to uphold the standards of technical excellence and ethical conduct embodied in the SES mission statement.

The enclosed Qualification Notice(s) and SES identification card are your permanent record of this achievement. This status is valid for the period shown on the Qualification Notice.

Congratulations on your achievement and I wish you continued success in your future endeavors. Please see attached a permission letter if you wish to have your information posted on the SES web site.

Sincerely yours,

Peter R. Westlin
SES QSTI/QSTO Review Committee Chairman

cc: Roy Owens, SES QSTI/QSTO Review Board Member
Glenn England, SES QSTI/QSTO Review Board Member
C. David Bagwell, SES QSTI/QSTO Review Board Member
Karen D. Kajiya-Mills, SES QSTI/QSTO Review Board Member
Peter S. Pakalnis, SES QSTI/QSTO Review Board Member
Gail Westlin, SES QSTI/QSTO Review Committee Administrator

SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

LET IT BE KNOWN THAT

RICHARD D. SITTER

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

MANUAL GAS VOLUME MEASUREMENTS AND ISOKINETIC PARTICULATE SAMPLING METHODS

ISSUED THIS 9TH DAY OF JANUARY 2013 AND EFFECTIVE UNTIL JANUARY 8TH, 2018

Peter R. Westlin, QSTI/QSTO Review Board

C. David Bagwell, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Karen D. Kajiya-Mills, QSTI/QSTO Review Board

LeRoy Owens, QSTI/QSTO Review Board

Glenn C. England, QSTI/QSTO Review Board

APPLICATION NO. 2013-754

SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

LET IT BE KNOWN THAT

RICHARD D. SITTER

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

MANUAL GASEOUS POLLUTANTS SOURCE SAMPLING METHODS

ISSUED THIS 9TH DAY OF JANUARY 2013 AND EFFECTIVE UNTIL JANUARY 8TH, 2018

Peter R. Westlin, QSTI/QSTO Review Board

C. David Bagwell, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Karen D. Kajiya-Mills, QSTI/QSTO Review Board

LeRoy Owens, QSTI/QSTO Review Board

Glenn C. England, QSTI/QSTO Review Board

APPLICATION NO. 2013-754

App. #
2013-754

Source Evaluation Society
P. O. Box 12124
Research Triangle Park, NC 27709-2124

RICHARD D. SITTER
Qualified Source Testing Individual

MANUAL GAS VOLUME MEASUREMENTS AND ISOKINETIC PARTICULATE SAMPLING METHODS - Effective Jan. 9, 2013 through Jan. 8, 2018 *(exam date: 1/6/12)*
MANUAL GAS SOURCE SAMPLING METHODS - Effective Jan. 9, 2013 through Jan. 8, 2018 *(exam date: 1/6/12)*

Source Evaluation Society
P. O. Box 12124
Research Triangle Park
North Carolina 27709

March 15, 2011

Tiberiu Munteanu
Environmental Source Samplers, Inc.
436 Raleigh Street
Wilmington, NC 28412

Subject: Qualified Source Tester Application No. 2011-512
Qualification Notice - Manual Gaseous Pollutants Source Sampling Methods

Dear Mr. Munteanu:

It is my pleasure to inform you that you have satisfied the requirements of the Source Evaluation Society Qualified Source Test Individual program for group exam(s) listed above. As a member of the successful candidates in this SES program, you should be proud of this distinction within the source emissions testing community. I am confident that you will continue to uphold the standards of technical excellence and ethical conduct embodied in the SES mission statement.

The enclosed Qualification Notice(s) and SES identification card are your permanent record of this achievement. This status is valid for the period shown on the Qualification Notices.

Congratulations on your achievement and I wish you continued success in your future endeavors. Please see attached a permission letter if you wish to have your information posted on the SES web site.

Sincerely yours,

Peter R. Westlin
SES QSTI/QSTO Review Committee Chairman

cc: Roy Owens, SES QSTI/QSTO Review Board Member
Glenn England, SES QSTI/QSTO Review Board Member
C. David Bagwell, SES QSTI/QSTO Review Board Member
Karen D. Kajiya-Mills, SES QSTI/QSTO Review Board Member
Peter S. Pakalnis, SES QSTI/QSTO Review Board Member
Gail Westlin, SES QSTI/QSTO Review Committee Administrator

Source Evaluation Society
P. O. Box 12124
Research Triangle Park
North Carolina 27709

July 31, 2012

Tiberiu Munteanu
Environmental Source Samplers, Inc.
436 Raleigh Street
Wilmington, NC 28412

Subject: Qualified Source Tester Application No. 2011-512
Qualification Notice - Gaseous Pollutants Instrumental Sampling Methods
(exam date: 1/20/12)

Dear Mr. Munteanu:

It is my pleasure to inform you that you have satisfied the requirements of the Source Evaluation Society Qualified Source Testing Individual program for group exam(s) listed above. As a member of the successful candidates in this SES program, you should be proud of this distinction within the source emissions testing community. I am confident that you will continue to uphold the standards of technical excellence and ethical conduct embodied in the SES mission statement.

The enclosed Qualification Notice(s) and SES identification card are your permanent record of this achievement. This status is valid for the period shown on the renewal Qualification Notice.

Congratulations on your achievement and I wish you continued success in your future endeavors.

Sincerely yours,

Peter R. Westlin
SES QSTI/QSTO Review Committee Chairman

cc: Roy Owens, SES QSTI/QSTO Review Board Member
Glenn England, SES QSTI/QSTO Review Board Member
C. David Bagwell, SES QSTI/QSTO Review Board Member
Karen D. Kajiya-Mills, SES QSTI/QSTO Review Board Member
Peter S. Pakalnis, SES QSTI/QSTO Review Board Member
Gail Westlin, SES QSTI/QSTO Review Committee Administrator

NEW. DO YOU APPROVE SES RELEASING INFORMATION, UPON REQUEST, ABOUT WHETHER YOU HAVE PASSED A METHOD GROUP EXAM? (The information released will be if you passed an exam and the date of the exam. This information is in support of ASTM D-7036-D.) YES ☐ NO ☐ IF YOU AGREE, PLEASE SIGN BELOW.

Signature: _____ Date: _____

Source Evaluation Society
P. O. Box 12124
Research Triangle Park
North Carolina 27709

August 24, 2011

Tiberiu Munteanu
Environmental Source Samplers, Inc.
436 Raleigh Street
Wilmington, NC 28412

Subject: Qualified Source Tester Application No. 2011-512
Qualification Notice - Manual Gas Volume Measurements and Isokinetic Particulate Sampling Methods (exam date 2/4/11)

Dear Mr. Munteanu:

It is my pleasure to inform you that you have satisfied the requirements of the Source Evaluation Society Qualified Source Testing Individual program for group exam(s) listed above. As a member of the successful candidates in this SES program, you should be proud of this distinction within the source emissions testing community. I am confident that you will continue to uphold the standards of technical excellence and ethical conduct embodied in the SES mission statement.

The enclosed Qualification Notice(s) and SES identification card are your permanent record of this achievement. This status is valid for the period shown on the Qualification Notice.

Congratulations on your achievement and I wish you continued success in your future endeavors.

Sincerely yours,

Peter R. Westlin
SES QSTI/QSTO Review Committee Chairman

cc: Roy Owens, SES QSTI/QSTO Review Board Member
Glenn England, SES QSTI/QSTO Review Board Member
C. David Bagwell, SES QSTI/QSTO Review Board Member
Karen D. Kajiya-Mills, SES QSTI/QSTO Review Board Member
Peter S. Pakalnis, SES QSTI/QSTO Review Board Member
Gail Westlin, SES QSTI/QSTO Review Committee Administrator

SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

LET IT BE KNOWN THAT

TIBERIU MUNTEANU

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

MANUAL GASEOUS POLLUTANTS SOURCE SAMPLING METHODS

ISSUED THIS 15TH OF MARCH 2011 AND EFFECTIVE UNTIL MARCH 14TH, 2016

Peter R. Westlin, QSTI/QSTO Review Board

C. David Bagwell, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Karen D. Kajiya-Mills, QSTI/QSTO Review Board

LeRoy Owens, QSTI/QSTO Review Board

Glenn C. England, QSTI/QSTO Review Board

APPLICATION NO. 2011-512

SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

LET IT BE KNOWN THAT

TIBERIU MUNTEANU

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

MANUAL GAS VOLUME MEASUREMENTS AND ISOKINETIC PARTICULATE SAMPLING METHODS

ISSUED THIS 24TH DAY OF AUGUST 2011 AND EFFECTIVE UNTIL AUGUST 23RD , 2016

Peter R. Westlin, QSTI/QSTO Review Board

C. David Bagwell, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Karen D. Kajiya-Mills , QSTI/QSTO Review Board

LeRoy Owens, QSTI/QSTO Review Board

Glenn C. England, QSTI/QSTO Review Board

APPLICATION NO. 2011-512

SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

LET IT BE KNOWN THAT

TIBERIU MUNTEANU

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

GASEOUS POLLUTANTS INSTRUMENTAL SAMPLING METHODS

ISSUED THIS 31st DAY OF JULY 2012 AND EFFECTIVE UNTIL JULY 30TH, 2017

Peter R. Westlin, QSTI/QSTO Review Board

C. David Bagwell, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Karen D. Kajiya-Mills, QSTI/QSTO Review Board

LeRoy Owens, QSTI/QSTO Review Board

Glenn C. England, QSTI/QSTO Review Board

APPLICATION NO. 2011-512

App. #
2011-512

Source Evaluation Society
P. O. Box 12124
Research Triangle Park, NC 27709-2124

TIBERIU MUNTEANU

Qualified Source Testing Individual

MANUAL GAS VOLUME MEASUREMENTS AND ISOKINETIC PARTICULATE SAMPLING METHODS - **Effective Aug. 24, 2011 through Aug. 23, 2016** *(exam date: 2/4/11)*
GASEOUS POLLUTANTS INSTRUMENTAL SAMPLING METHODS
- **Effective Mar. 15, 2011 through Mar. 14, 2016** *(exam date: 11/19/10)*
GASEOUS POLLUTANTS INSTRUMENTAL SAMPLING METHODS
- **Effective Jul. 31, 2012 through Jul. 30, 2017** *(exam date: 1/20/12)*

Source Evaluation Society

P. O. Box 12124
Research Triangle Park
North Carolina 27709

December 22, 2010

Charles A. Garner
Environmental Source Samplers
436 Raleigh St.
Wilmington, NC 28412

Subject: Qualified Source Tester Application No. 2009-306
Qualification Notice - Manual Gas Volume Measurements and Isokinetic Particulate Sampling Methods
- Manual Gaseous Pollutants Source Sampling Methods
- Gaseous Pollutants Instrumental Sampling Methods
- Hazardous Metals Measurement Sampling Methods

Dear Mr. Garner:

It is my pleasure to inform you that you have satisfied the requirements of the Source Evaluation Society Qualified Source Test Individual program for group exam(s) listed above. As a member of the successful candidates in this SES program, you should be proud of this distinction within the source emissions testing community. I am confident that you will continue to uphold the standards of technical excellence and ethical conduct embodied in the SES mission statement.

The enclosed Qualification Notice(s) and SES identification card are your permanent record of this achievement. This status is valid for the period shown on the Qualification Notices.

Congratulations on your achievement and I wish you continued success in your future endeavors. Please see attached a permission letter if you wish to have your information posted on the SES web site.

Sincerely yours,

Peter R. Westlin
SES QSTI/QSTO Review Committee Chairman

cc: Roy Owens, SES QSTI/QSTO Review Board Member
Glenn England, SES QSTI/QSTO Review Board Member
C. David Bagwell, SES QSTI/QSTO Review Board Member
Karen D. Kajiya-Mills, SES QSTI/QSTO Review Board Member
Peter S. Pakalnis, SES QSTI/QSTO Review Board Member
Gail Westlin, SES QSTI/QSTO Review Committee Administrator

SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

LET IT BE KNOWN THAT

CHARLES A. GARNER

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

MANUAL GAS VOLUME MEASUREMENTS AND ISOKINETIC PARTICULATE SAMPLING METHODS

ISSUED THIS 22ND OF DECEMBER 2010 AND EFFECTIVE UNTIL DECEMBER 21ST, 2015

Peter R. Westlin, QSTI/QSTO Review Board

C. David Bagwell, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Karen D. Kajiya-Mills, QSTI/QSTO Review Board

LeRoy Owens, QSTI/QSTO Review Board

Glenn C. England, QSTI/QSTO Review Board

APPLICATION NO. 2009-306

ESS

Environmental Source Samplers, Inc.

ED_001846_00000219-00098

SOURCE EVALUATION SOCIETY

SES

Qualified Source Testing Individual

LET IT BE KNOWN THAT

CHARLES A. GARNER

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

MANUAL GASEOUS POLLUTANTS SOURCE SAMPLING METHODS

ISSUED THIS 22ND DAY OF DECEMBER 2010 AND EFFECTIVE UNTIL DECEMBER 21ST, 2015

Peter R. Westlin, QSTI/QSTO Review Board

C. David Bagwell, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Karen D. Kajiya-Mills, QSTI/QSTO Review Board

LeRoy Owens, QSTI/QSTO Review Board

Glenn C. England, QSTI/QSTO Review Board

APPLICATION NO. 2009-306

SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

LET IT BE KNOWN THAT

CHARLES A. GARNER

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

GASEOUS POLLUTANTS INSTRUMENTAL SAMPLING METHODS

ISSUED THIS 22ND DAY OF DECEMBER 2010 AND EFFECTIVE UNTIL DECEMBER 21ST, 2015

Peter R. Westlin, QSTI/QSTO Review Board

C. David Bagwell, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Karen D. Kajiya-Mills, QSTI/QSTO Review Board

LeRoy Owens, QSTI/QSTO Review Board

Glenn C. England, QSTI/QSTO Review Board

APPLICATION NO. 2009-306

SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

LET IT BE KNOWN THAT

CHARLES A. GARNER

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

HAZARDOUS METALS MEASUREMENT SAMPLING METHODS

ISSUED THIS 22ND DAY OF DECEMBER 2010 AND EFFECTIVE UNTIL DECEMBER 21ST 2015

Peter R. Westlin, QSTI/QSTO Review Board

C. David Bagwell, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Karen D. Kajiya-Mills, QSTI/QSTO Review Board

LeRoy Owens, QSTI/QSTO Review Board

Glenn C. England, QSTI/QSTO Review Board

APPLICATION NO. 2009-306

ESS

Environmental Source Samplers, Inc.

ED_001846_00000219-00101

Source Evaluation Society
P. O. Box 12124
Research Triangle Park, NC 27709-2124

CHARLES A. GARNER

Qualified Source Testing Individual

MANUAL GAS VOLUME MEASUREMENTS AND ISOKINETIC PARTICULATE SAMPLING METHODS - **Effective December 22, 2010 through December 21, 2015**

MANUAL GAS SOURCE SAMPLING METHODS
- **Effective December 22, 2010 through December 21, 2015**

GASEOUS POLLUTANTS INSTRUMENTAL SAMPLING METHODS
- **Effective December 22, 2010 through December 21, 2015**

HAZARDOUS METALS MEASUREMENT SAMPLING METHODS
- **Effective December 22, 2010 through December 21, 2015**