CAPE CANAVERAL ENERGY CENTER
UNITS 3A, 3B, and 3C
BREVARD COUNTY, FLORIDA

CERTIFICATION TEST PROTOCOL

PREPARED FOR: FLORIDA POWER AND LIGHT COMPANY

PREPARED BY: CUSTOM INSTRUMENTATION SERVICES CORPORATION

2/15/13

7841 SOUTH WHEELING COURT • ENGLEWOOD, COLORADO 80112
TEL: (303) 790-1000 FAX: (303) 790-7292

CERTIFICATION TEST PROTOCOL

1.0 OVERVIEW

The Cape Canaveral Energy Center is a nominal 1,250 megawatt (MW) power plant located in Brevard County, Florida. The facility consists of three nominal 250 MW Model 8000H gas turbines with three supplementary-fired heat recovery steam generators (HRSG) and a common 500 MW steam-electric generator. The individual turbines are identified as 3A, 3B, and 3C. The gas-fired combined cycle units will use ultralow sulfur (ULS) fuel oil as backup fuel. Exhaust gases from each turbine are discharged into the atmosphere through stacks approximately 149 feet above grade. A dedicated CEMS will monitor emissions from each turbine.

The Air Permit issued by the Florida Department of Environmental Protection requires Continuous Emission Monitoring Systems (CEMS) for oxides of nitrogen (NO_x), carbon monoxide (CO) and oxygen (O_2) be installed on the exhaust stacks of each gas turbine. The CEMS instrumentation will be used to demonstrate continuous compliance with the allowable emission limitation set forth in the permit. The CEMS also has to meet the monitoring and reporting requirements of the following:

Title 40 Code of Federal Regulations (CFR), Part 75 Appendix A
Specifications and Test Procedures (NOx and O2 analyzers)

Title 40 CFR, Part 60, Appendix B
Performance Specification 4/4A - *Specifications and Test Procedures for Carbon Monoxide (CO) Continuous Emission Monitoring Systems in Stationary Sources*

2. CERTIFICATION STRATEGY

The certification testing includes procedures to satisfy both sets of regulations. To verify the accuracy of the analyzers and the sample locations, field testing will be conducted on the CEMS. The testing consists of a Relative Accuracy Test Audit (RATA), linearity check, Cylinder Gas Audit (CGA), 7-day calibration error test, and a cycle time test. All testing will be performed while the plant is operating at normal load. In addition, testing will be performed on the DAHS to verify formulas and missing data routines. All tests will be performed according to the prescribed methodologies described in 40 CFR Part 60 Appendix B, 40 CFR Part 75 Appendix A and Florida Department of Environmental Protection regulations. The pass/fail criteria for each test are listed in Table 1. The results of all tests performed for 40 CFR 75 will provided in XML format.

2.1 Relative Accuracy Test Audit

Air Hygiene was contracted by Custom Instrumentation Services, Inc. (CiSCO), the CEMS supplier, to provide testing to support the Part 60 and Part 75 Relative Accuracy Test Audits (RATA) at Cape Canaveral Energy Center. During the test, values will be recorded every minute and then averaged for the duration of the test period. These values are compared to the test teams values for the same test period. A RATA Protocol is provided in Appendix 1.

2.2 Linearity Check / Cylinder Gas Audit

CiSCO will perform the linearity test required by 40 CFR 75, Appendix A. The high range of the NO_x analyzers and the O_2 analyzers will be challenged three times with each of three levels of calibration gas (low, mid and high). A linearity test is not required on NO_x analyzer span values less than or equal to 30 ppm (as per 40 CFR 75, Appendix A, 6.2). The gases used will be EPA Protocol calibration gases certified within 2 percent of the specified concentration. The mean difference between the analyzer response and the calibration gas value, as a percentage of the calibration gas value, must be within 5%. Results are also acceptable if the difference between the mean response and the calibration gas is within 5 ppm for NO_x and 0.5% O_2. A report will be printed which shows the analyzer response for each injection. The results for the three runs will then be tabulated and will be included in the final report. The gases to be used are listed in Table 2.

In lieu of the Part 60 regulations, which do not require an initial CGA for the CO monitoring system, FPL, at their discretion may perform Cylinder Gas Audits on both ranges of the CO analyzers. Each analyzer will be challenged three times with two levels of calibration gas (low and mid). The mean difference between the analyzer response and the calibration gas value, as a percentage of the calibration gas value, must be within 15%. Results are also acceptable if the difference between the mean response and the calibration gas is within 5 ppm CO. A report will be printed which shows the analyzer response for each injection. The results for the three runs will then be tabulated and will be included in the final report. The gases to be used are listed in Table 2.

2.3 Calibration Error Tests

CiSCO will perform the 7-Day Calibration Error Tests on the high range of the NO_x analyzers and the O_2 analyzers in accordance with 40 CFR 75 Appendix A. A Calibration Error Tests is not required on NO_x analyzer span values of 50 ppm or less (as per 40 CFR 75, Appendix A, 6.3.1). Each analyzer will be challenged with zero and calibration gases each day for seven consecutive operating days (not necessarily consecutive calendar days). This data will be included in the final report. The analyzer response must be within 2.5% of span for NO_x and within 0.5% O_2 for the O_2 analyzer. Results are also acceptable if the difference is within 5 ppm for NO_x. A calibration report will be printed out daily and the results for the seven day period will be tabulated. The gases to be used are listed in Table 2.

2.4 Cycle Time Test

CiSCO will perform the cycle time tests for NO_x and O_2 pollutant concentration monitors in accordance to 40 CFR 75 Appendix A. To perform the cycle time test, the low and high ranges of the NO_x analyzers and the O_2 analyzers will be challenged with a zero gas and high level (80 to 100% of span) calibration gas. Both the upscale and down scale cycle times will be determined. The response time to reach 95% of the gas value must be less than 15 minutes for each analyzer. The longer of the two analyzers response time is the NO_x system response time. An audit report will be printed which shows the analyzer response. The results for each analyzer will then be tabulated. The gases to be used are listed in Table 2. This data will be included in the final report.

CiSCO will perform a response time test on the CO analyzers as per 40 CFR 60, Appendix B, Performance Specification 4A. To perform the response time test, the low and high ranges of the CO analyzers will be challenged three times with a zero gas and high level (80 to 100% of span) calibration gas. Both the upscale and down scale response times will be determined. The response time to reach 95% of the gas value must be less than 90 seconds for each analyzer. An audit report will be printed which shows the analyzer response. The results for each analyzer will then be tabulated. The gases to be used are listed in Table 2. This data will be included in the final report.

2.5 CEMS Calibration Drift Tests

In accordance with 40 CFR 60, Appendix B, Performance Specification (PS) 4A, CiSCO will perform calibration drift tests on the CO analyzers once a day for seven consecutive operating days. Both the low and high ranges of the CO analyzers must meet a limit of 5 percent drift, for 6 out of 7 days. This limit can be found in Section 13.1 of PS4A.

Note: FPL has obtained guidance and approval from Florida Department of Environmental Protection (FDEP) on past projects to perform the calibration drift test for CO on seven consecutive unit operating days rather than seven consecutive calendar days. This is consistent with other calibration drift requirements currently identified in 40 CFR Part 75, Appendix A, 6.3.1, and with 40 CFR Part 60.334(b)(1) Subpart GG.

2.6 *DAHS TESTING*

The DAHS verification consists of two tests; verification that all formulas identified in the monitoring plan are correctly programmed and verification that all necessary missing data procedures are correctly programmed. The DAHS tests will follow the procedures identified in 40 CFR Part 75 and applicable policy manuals. In addition, the software vendor will verify that all missing data scenarios are correct. A software verification statement and the formula verifications will be provided in the final report.

TABLE 1: CEMS CERTIFICATION PERFORMANCE SPECIFICATIONS

	PASS/FAIL CRITERIA	CITATION
RATA, NO_x lb/mmBtu	7.5% RA or ±0.015 lb/mmBtu (for annual RA frequency)	40 CFR 75 App. B, 2.3.1.2(f)
LINEARITY NO_x High O_2	 5% of gas value or 5 ppm 5% of gas value or 0.5% O_2	 40 CFR75 App. A, 3.2
CALIBRATION ERROR NO_x High O_2	 2.5% of span or 5 ppm if span ≤200 ppm [R-A] 0.5% O_2	 40 CFR 75 App. A, 3.1
CYCLE TIME TEST NO_x High, NO_x Low, O_2	 ≤15 minutes	 40 CFR 75 App. A, 3.5
RATA CO lb/hr, ppm @ 15% O_2	 10% RA, 5% of standard, 5 ppm	 40 CFR 60, App. B, PS4/4A
CALIBRATION DRIFT TEST CO High, CO Low	 5.0% of range for 6 of 7 days	 40 CFR 60, App. B, PS4/4A See Note in Section 2.5
CYLINDER GAS AUDIT CO	 15% CGA error, 5 ppm	 40 CFR 60, App. F
RESPONSE TIME TEST CO High, CO Low	 ≤90 seconds	 40 CFR 60, App. B, PS4A
DAHS ACCURACY	Verify formulas and missing data routines	40 CFR 75 App. A, 4

TABLE 2: GAS REQUIREMENTS FOR CERTIFICATION

	GAS TYPE	RANGE	CONCENTRATION
LINEARITY CHECK *	EPA Protocol	NO_x High	Low - 40-60 ppm Mid - 100 - 120 ppm High - 160 - 200 ppm
		O_2 High	Low - 5 - 7.5% Mid - 12.5 - 15% High - 20 - 25 (21% air)
CALIBRATION ERROR**	EPA Protocol	NO_x High O_2 High	Zero, 160 - 200 ppm Zero, 20 - 25 (21% air)
CYCLE TIME	EPA Protocol EPA Protocol	NO_x Low NO_x High O_2 High	Zero, 8 - 10 ppm Zero, 160 - 200 ppm Zero, 20 - 25 (21% air)
CYLINDER GAS AUDIT	Certified Master	CO Low	Low - 4 - 6 ppm Mid - 10 - 12 ppm
	Certified Master	CO High	Low - 300 - 450 ppm Mid - 750 - 900 ppm
CALIBRATION DRIFT	Certified Master Certified Master	CO Low CO High	Zero, 16 - 20 ppm Zero, 1200 - 1500 ppm
RESPONSE TIME	Certified Master Certified Master	CO Low CO High	Zero, 16 - 20 ppm Zero, 1200 - 1500 ppm

*** No linearity check is required on span values of 30 ppm or less.**
**** No calibration error test is required on span values of 50 ppm or less**

APPENDIX 1

CEMS RELATIVE ACCURACY TEST AUDIT PROTOCOL

Testing Solutions for a Better World

CONTINUOUS EMISSIONS MONITORING SYSTEM RELATIVE ACCURACY TEST AUDIT AND LINEARITY TEST PROTOCOL

FOR
THREE SIEMENS 8000H CEMS (UNITS 3A, 3B, AND 3C)

PREPARED FOR
CUSTOM INSTRUMENTATION SERVICES CORPORATION
AND
FLORIDA POWER & LIGHT

AT THE
CAPE CANAVERAL ENERGY CENTER
BREVARD COUNTY, FLORIDA

Florida Department of Environmental Protection

February 13, 2013

Corporate Headquarters
1600 W Tacoma Street
Broken Arrow, OK 74012

AIR HYGIENE, INC.
(918) 307-8865 or (888) 461-8778
www.airhygiene.com

Remote Testing Offices
Las Vegas, NV 89156
Ft. Worth, TX 76028
Humble, TX 77338
Shreveport, LA 71115
Miami, FL 33101
Philadelphia, PA 19136

CONTINUOUS EMISSIONS MONITORING SYSTEM RELATIVE ACCURACY TEST AUDIT AND LINEARITY TEST PROTOCOL

FOR
THREE SIEMENS 8000H
CEMS (UNITS 3A, 3B, AND 3C)

PREPARED FOR
CUSTOM INSTRUMENTATION SERVICES CORPORATION
AND
FLORIDA POWER & LIGHT

AT THE
CAPE CANAVERAL ENERGY CENTER
BREVARD COUNTY, FLORIDA

Florida Department of Environmental Protection

February 13, 2013

Prepared By:

Danny Parr, QSTI, Director of Operations

rev - 0

Corporate Headquarters
1600 W Tacoma Street
Broken Arrow, OK 74012

AIR HYGIENE, INC.
(918) 307-8865 or (888) 461-8778
www.airhygiene.com

Remote Testing Offices
Las Vegas, NV 89156
Ft. Worth, TX 76028
Humble, TX 77338
Shreveport, LA 71115
Miami, FL 33101
Philadelphia, PA 19136

Table of Contents

1.0 INTRODUCTION

1.1 General Facility Description

The Cape Canaveral Energy Center (CCEC) is owned and operated by Florida Power and Light Company (FPL) and is located at 6000 North U.S. Highway 1, Brevard County Florida. Florida is within the jurisdiction of USEPA Region 4. Two existing residual fuel and natural gas units (Unit 1 and Unit 2) have been shut down and dismantled and a new 1250 MW natural gas fired combined cycle unit has been constructed at the CCEC. The new unit is designated Unit 3 and is comprised of three 250 megawatt Model 8000H gas turbine-electrical generator sets with evaporative inlet cooling systems, three supplementary-fired heat recovery steam generators (HRSG's) with SCR reactors, one nominal 460 MMBtu/hr (LHV) gas fired duct burner located with-in each of the three HRSG's, three 149-foot exhaust stacks and a common 500-MW steam electrical generator. This "3-on-1" combined cycle technology yields a total generating capacity of approximately 1,250 MW.

Dry-low NOX combustion technology for gas firing and water injection during oil firing are utilized to reduce NOX emissions and selective catalytic reduction is employed to further reduce NOX emissions. The Florida Department of Environmental Protection issued permit allows each of the combustion turbines to operate 8,760 hours per year. The permit does limit the total heat input fired by the duct burners to provide additional steam-generated electrical power to 3,697,920 MMBtu divided between the three HRSG's during any consecutive 12-month period while combusting natural gas. Each CT will primarily combust pipeline natural gas with ultralow sulfur distillate (ULSD) fuel oil as a back-up fuel.

The nominal maximum heat input rating for each combustion turbine is 2,586 MMBtu/hr. With the duct burners, this number increases to 3,046 MMBtu/hr. According to the facility's air permit each CT is limited to a maximum heat input of 2,586 MMBtu/hr while firing natural gas and 2,440 MMBtu/hr while firing ultralow sulfur distillate (ULSD) fuel oil.

The 8000H stacks are circular and measure 21.95 feet (ft) (263.38 inches) in inner diameter at the test ports which are approximately 138 ft above grade level with an exit elevation of approximately 150 ft above grade level. The test ports are located 44.31 ft (531.75 inches) downstream and approximately 12 ft (144 inches) upstream from the nearest disturbances.

A single, dedicated continuous emissions monitoring system (CEMS) is installed on each unit. Each of the three CEMS configurations includes a Thermo Environmental Instruments (TECO) Model 42i/LS dual-range (0-10 and 0-200 parts per million (ppm)) nitrogen oxide (NOx) analyzer; TECO Model 48i dual range (0-20 and 0-1500 ppm) carbon monoxide (CO) analyzer; and Servomex Model 1440D single range (0-25 percent (%)) oxygen (O_2) analyzer. Each unit includes a View Node and Operator Interface Terminal in the shelter however there is one data acquisition and handling system (DAHS) for the three units.

1.2 Reason for Testing

CCEC is a newly constructed facility subject to the regulatory requirements of the Florida Department of Environmental Protection (FDEP) and the United States Environmental Protection Agency (EPA) for relative accuracy test audits (RATAs) and other aspects of CEMS certification (e.g. linearity tests). As such, testing will include monitoring for nitrogen oxides (NOx), carbon monoxide (CO), and oxygen (O_2) to conduct RATAs on all units following the guidelines of 40 Code of Federal Regulations (CFR)

Part 60 and Part 75. Testing will also include performing linearity tests on each NOx and O_2 CEMS analyzer at each applicable range following the guidelines of 40 CFR Part 75.

2.0 SUMMARY

2.1 Owner Information

Company:	Florida Power & Light
Contact:	Mark Lemasney
Mailing Address:	6000 North U.S. Highway 1 Brevard County, Florida 33470
Office:	(321) 639-5510
Cell:	(561) 801-1440
Email:	MARK.LEMASNEY@FPL.COM

2.2 CEMS Contractor Information

Company:	Custom Instrumentation Services Corporation (CiSCO)
Contact:	Sarah Gray, Environmental Scientist
Mailing Address:	7841 South Wheeling Court Englewood, Colorado 80112
Office:	(303) 790-1000 ext 115
Fax:	(303) 790-7292
Email:	sgray@ciscocems.com

2.3 Test Contractor Information

Company:	Air Hygiene International, Inc.
Contact:	Danny Parr, Director of Operations
Mailing Address:	1600 West Tacoma Street Broken Arrow, Oklahoma 74012
Office:	(918) 994-4173
Cell:	(918) 809-8947
Fax:	(918) 307-9131
Email:	danny@airhygiene.com
Website:	www.airhygiene.com

2.4 Expected Test Start Date

Test dates are yet to be determined. Further notification will be provided by CiSCO and/or FPL as a testing schedule is determined.

2.5 Testing Schedule

The following schedule indicates specific activities required to be done each day; however, the schedule is flexible and can be extended as necessary if there are operational or testing delays. If there are no operational delays, this schedule can be completed as detailed by the testing crew. The details below describe the activities to be conducted.

Pre-test Activities	**Due Date**
1. Receive site safety training	day of arrival for setup
2. Conduct site inspection and pre-test meeting	per CiSCO and/or Air Hygiene
3. Prepare draft electronic test protocol	prior to start of project

On-Site Pre-testing Schedule	**Time**
Day 0 – Pre-test, initial site mobilization and setup	
• Arrive at site and attend safety training class	08:00 – 09:00
• Setup on first unit	09:00 – 11:00
• Conduct preliminary testing of test equipment	11:00 – 13:00

RATA Testing	**Time**
Day 1 – RATA, Units 3A, 3B, and 3C simultaneously, normal load	
• Daily setup and calibrations	08:00 – 09:00
• Conduct stratification testing on three units	09:00 – 10:00
• Stratification testing for NOx and O_2	
• Conduct Testing for NOx, CO, and O_2 on three units	10:00 – 16:00
• NOx, CO, and O_2 testing: 9-12, 21-minute runs	

Linearity testing schedules will be determined by FPL and/or CiSCO as CEMS are available.

Activities after Testing	**Sequential Days**
• Demobilization of Testing Crew	Day 1
• Preparation of draft hard copy test report	Days 2 – 9
• Submit for review to CiSCO	Day 10
• Review and comment on draft by CiSCO	Days 11 – 14
• Incorporate CiSCO comments into draft copy	Days 15 – 19
• Submit for review to FPL	Day 20
• Review and comment on draft by FPL	Days 21 – 24
• Incorporate FPL comments into draft copy	Days 25 – 29
• Final reports delivered to FPL	Day 30

2.6 Hardcopy RATA Report Content

The hard-copy RATA Reports will be submitted to CiSCO within 30 days of completion of testing and meet the requirements of the FDEP and the EPA for stack emissions testing and CEMS certification. The reports will include discussion of the following:

- Introduction
- Plant and Sampling Location Description
- Summary and Discussion of Test Results Relative to Acceptance Criteria
- Sampling and Analytical Procedures
- QA/QC Activities
- Test Results and Related Calculations
- Sampling Log and Chain-of-Custody Records
- Audit Data Sheets

CiSCO personnel will conduct cycle response time tests and compile necessary information for the 7-day drift tests. Data will be submitted to Air Hygiene and included in the CEMS certification reports as necessary. The final certification report will be provided by CiSCO.

2.7 Equipment and Procedures

Test methods and parameters to satisfy 40 CFR Part 60 and 75 will include:

40 CFR Part 60, EPA Method 1 for sample location
40 CFR Part 60, EPA Method 3a for oxygen (O_2)
40 CFR Part 60, EPA Method 7e for nitrogen oxides (NOx)
40 CFR Part 60, EPA Method 10 for carbon monoxide (CO)
40 CFR Part 60, EPA Method 19 for F-Factor determination of stack exhaust flow
40 CFR Part 60, Appendix B, Performance Specifications #2, 3, and 4/4a
40 CFR Part 75, Appendix A and B for NOx-diluent

2.8 Proposed Variations

After the successful completion of a stratification test for NOx, CO, and O_2, RATAs will be conducted from one point if the test passes under the appropriate 40 CFR 75 criteria. 40 CFR 60 criteria for CO will be overridden.

2.9 RATA Sampling Strategy

Relative accuracy test audits (RATAs) are used to verify the ability of a CEMS to accurately measure and report a given pollutant concentration or emissions rate from an affected source and to determine any bias in those measurements. The RATA is required for initial CEMS certification and, depending on those results, must be performed periodically thereafter during routine operation of the source. These relative accuracy tests will be carried out in accordance with the procedures in 40 CFR Part 60 and Part 75 (NOx-diluent). In addition, a bias test will be performed on the NOx-diluent system to meet 40 CFR 75 requirements.

The RATAs will be performed while the units are operating above 50 percent of the maximum operating load, as required under 40 CFR Part 60, and while the unit is operating within the normal or alternative normal load, as required under 40 CFR Part 75. The RATA pass/fail criteria will be determined by comparing the results from the CEMS to concurrent measurements from reference method (RM) analyzers over a prescribed series of test runs. Units of comparison for each pollutant will include: NOx (ppmvd, ppmvd@15%O_2, lb/hr, and lb/MMBtu); CO (ppmvd, ppmvd@15%O_2, and lb/hr); and O_2 (%), to the extent these units are available from the CEMS DAHS.

In accordance with 40 CFR 60, Appendix B, PS 2, Section 13.2, the NOx (ppmvd, ppmvd@15%O_2, and lb/hr) RATA results will be acceptable if the relative accuracy (RA) does not exceed 20.0 percent when average emissions during the test are greater than 50 percent of the emission standard or alternative relative accuracy (ARA) does not exceed 10.0 percent when the average emissions during the test are less than 50 percent of the emission standard. Part 60 further requires that the unit be operating at greater than 50 percent of normal load.

In accordance with 40 CFR 75, Appendix A, Section 3.3.2(a) and (b), the NOx-diluent (lb/MMBtu) RATA results will be acceptable if the relative accuracy (RA) does not exceed 10.0 percent or if during the RATA the average NOx emission rate is less than or equal to 0.2 lb/MMBtu and the average difference between the CEMS and reference method (RM) values does not exceed 0.02 lb/MMBtu. Passing this set of criteria requires the CEMS to be retested after no more than two quality assured operating quarters. Alternatively, in accordance with 40 CFR 75, Appendix B, Section 2.3.1.2(a) and (f), and Appendix B, Figure 2, the NOx-diluent RATA results will be acceptable if the RA does not exceed 7.5 percent or if during the RATA the average NOx emission rate is less than or equal to 0.2 lb/MMBtu and the average difference between the CEMS and RM values does not exceed 0.015 lb/MMBtu. Passing this set of criteria allows the CEMS to be retested after four quality assured operating quarters or at least within eight calendar quarters.

In accordance with 40 CFR 60, Appendix B, PS 3, Section 13.2, the O_2 (%) RATA results will be acceptable if the average difference between the CEMS and reference method (RM) values does not exceed 1.0 percent absolute.

In accordance with 40 CFR 60, Appendix B, PS 4 and 4A, Sections 13.2 of each, the CO (ppmvd, ppmvd@15%O_2, and lb/hr) relative accuracy (RA) test results will be acceptable if the RA does not exceed 10.0 percent, if the average difference between the CEMS and reference method (RM) values plus the 2.5 percent confidence coefficient (2.5%CC) does not exceed 5.0 parts per million (ppm), or if the alternative relative accuracy (ARA) does not exceed 5.0 percent. Part 60 further requires that the unit be operating at greater than 50 percent of normal load.

2.10 Linearity Testing Strategy

The Linearity Test is required for initial CEMS certification and will be carried out in accordance with the procedures in 40 CFR Part 75. This testing will be performed on the high range of the NOx analyzer and single range O_2 analyzer, on each CEMS. Linearity tests will be conducted while the units are combusting fuel at typical duct temperatures and pressures; however, it is not necessary for the units to be generating electricity during the tests.

Linearity tests will be checked at three concentration levels (low, mid, and high) using EPA Protocol No. 1 gases, supplied by Air Hygiene, as required by 40 CFR Part 75. Linearity test results are considered to be acceptable for the CEMS if the difference between the known check gas concentration and the analyzer response is less than or equal to five percent of the reference concentration at each reference level. Alternative acceptance criteria are defined further in the regulations.

APPENDIX A
QA/QC PROGRAM

TESTING QUALITY ASSURANCE ACTIVITIES

A number of quality assurance activities are undertaken before, during, and after each testing project. The following paragraphs detail the quality control techniques, which are rigorously followed during testing projects.

Each instrument's response is checked and adjusted in the field prior to the collection of data via multi-point calibration. The instrument's linearity is checked by first adjusting its zero and span responses to zero nitrogen and an upscale calibration gas in the range of the expected concentrations. The instrument response is then challenged with other calibration gases of known concentration and accepted as being linear if the response of the other calibration gases agreed within ± 2 percent of range of the predicted values.

After each test run, the analyzers are checked for zero and span drift. This allows each test run to be bracketed by calibrations and documents the precision of the data just collected. The criteria on acceptable data is that the instrument drift shall be no more than 3 percent of the full-scale response. Quality assurance worksheets are prepared to document the multipoint calibration checks and zero to span checks performed during the tests (**See Appendix D**).

The sampling systems are leak checked by demonstrating that a vacuum greater than 10 in Hg could be held for at least 1 minute with a decline of less than 1 in. Hg. A leak test is conducted after the sample system is set up and before the system is dismantled. These checks are performed to ensure that ambient air has not diluted the sample. Any leakage detected prior to the tests would be repaired and another leak check conducted before testing commenced.

The absence of leaks in the sampling system is also verified by a sampling system bias check. The sampling system's integrity is tested by comparing the responses of the analyzers to the calibration gases introduced via two paths. The first path is directly into the analyzer and the second path via the sample system at the sample probe. Any difference in the instrument responses by these two methods is attributed to sampling system bias or leakage. The criteria for acceptance is agreement within 5% of the span of the analyzer.

The control gases used to calibrate the instruments are analyzed and certified by the compressed gas vendors to ± 1% accuracy for all gases. EPA Protocol No. 1 gases will be used where applicable to assign concentration values traceable to the National Institute of Standards and Technology (NIST), Standard Reference Materials.

AIR HYGIENE maintains a large variety of calibration gases to allow the flexibility to accurately test emissions over a wide range of concentrations.

APPENDIX B
TEST EQUIPMENT CONFIGURATION AND DESCRIPTION

INSTRUMENT CONFIGURATION AND OPERATIONS FOR GAS ANALYSIS

The sampling and analysis procedures to be used conform in principle with the methods outlined in the Code of Federal Regulations, Title 40, Part 60, Appendix A, Methods 1, 3a, 7e, 10, and 19.

Figure 1 depicts the sample system that will be used for the NOx, CO, and O_2 tests. A stainless steel probe will be inserted into the sample ports of the stack to extract gas measurements from the emission stream at three points located at 0.4 (15.7), 1.2 (47.2), and 2.0 (78.7) meters (inches) from the wall of the stack or a single point in the stack determined after passing an initial stratification test. The gas sample will be continuously pulled through the probe and transported via 3/8 inch heat-traced Teflon® tubing to a stainless steel minimum-contact condenser designed to dry the sample and through Teflon® tubing via a stainless steel/Teflon® diaphragm pump and into the sample manifold within the mobile laboratory. From the manifold, the sample will be partitioned to the NOx, CO, and O_2 analyzers through rotameters that control the flow rate of the sample.

The schematic (Figure 1) shows that the sample system will also be equipped with a separate path through which a calibration gas can be delivered to the probe and back through the entire sampling system. This allows for convenient performance of system bias checks as required by the testing methods.

All instruments will be housed in an air-conditioned, trailer-mounted mobile laboratory. Gaseous calibration standards will be provided in aluminum cylinders with the concentrations certified by the vendor according to EPA Protocol No. 1.

This general schematic also illustrates the analyzers to be used for the tests (i.e., NOx, CO, and O_2). All data from the Reference Method continuous monitoring instruments are recorded on a Logic Beach Hyperlogger. The Hyperlogger retrieves calibrated emissions data from each instrument every second. An average value is recorded every 30 seconds.

The stack gas analysis for O_2 concentrations will be performed in accordance with procedures set forth in EPA Method 3a. The O_2 analyzer uses a paramagnetic cell detector.

EPA Method 7e will be used to determine concentrations of NOx. A chemiluminescence analyzer will be used to determine the nitrogen oxides concentration in the gas stream. A NO_2 in nitrogen certified gas cylinder will be used to verify at least a 90 percent NO_2 conversion on the day of the test.

CO emission concentrations will be quantified in accordance with procedures set forth in EPA Method 10.

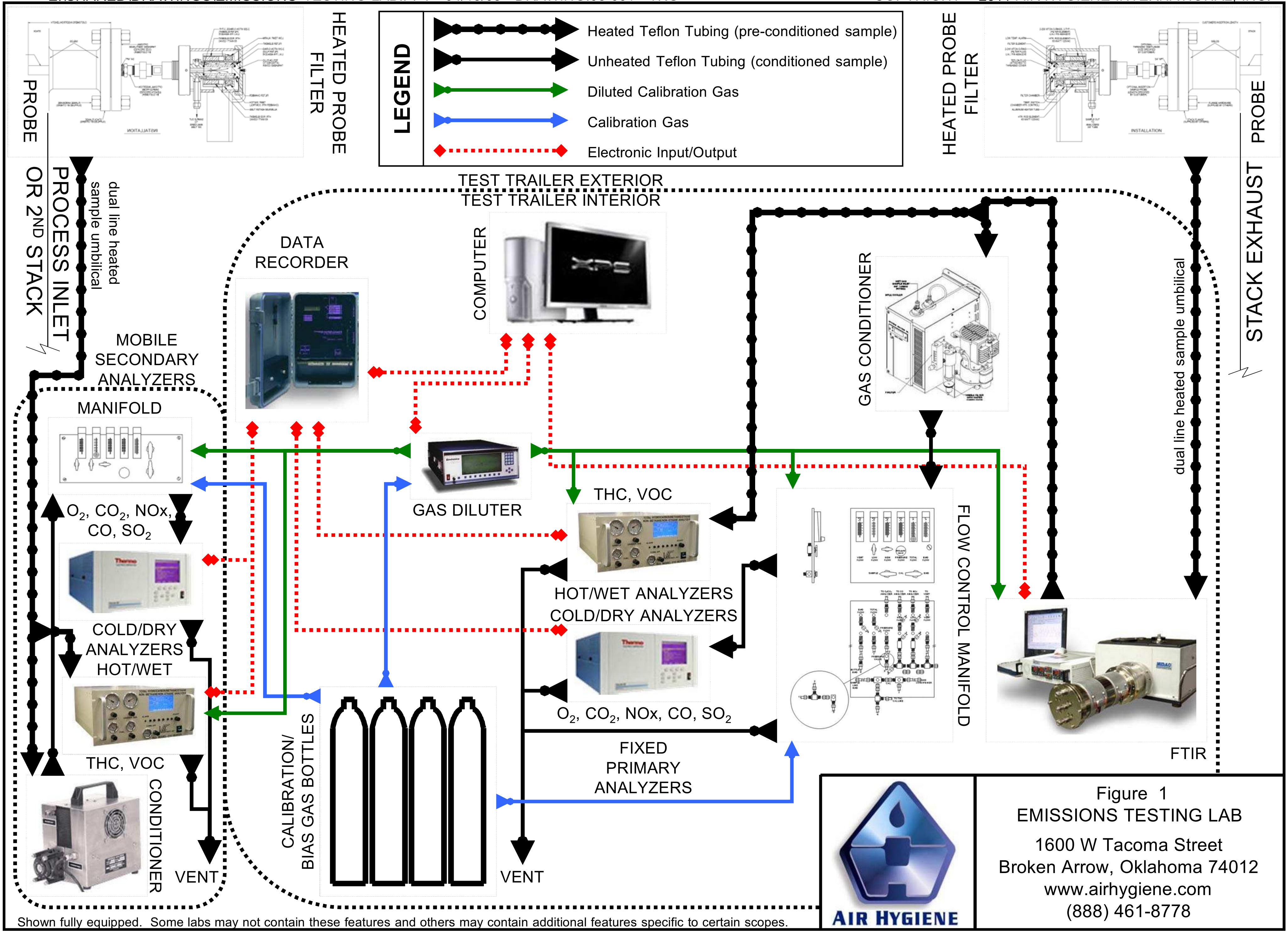


Figure 1
EMISSIONS TESTING LAB

1600 W Tacoma Street
Broken Arrow, Oklahoma 74012
www.airhygiene.com
(888) 461-8778

Shown fully equipped. Some labs may not contain these features and others may contain additional features specific to certain scopes.

TABLE #1: ANALYTICAL INSTRUMENTATION

Parameter	Model and Manufacturer	Max. Ranges	Sensitivity	Detection Principle
NOx	API 200AH or equivalent [(1)]	User may select up to 5,000 ppm	0.1 ppm	Thermal reduction of NO_2 to NO. Chemiluminescence of reaction of NO with O_3. Detection by PMT. Inherently linear for listed ranges.
CO	API 300 or equivalent	User may select up to 3,000 ppm	0.1 ppm	Infrared absorption, gas filter correlation detector, microprocessor based linearization.
O_2	CAI 200 or equivalent	0-25%	0.1%	Paramagnetic cell, inherently linear.

[(1)] When applicable, to avoid interference from ammonia slip, API analyzers will be fitted with molybdenum converters and TECO analyzers contain in-line ammonia scrubbers.

TABLE #2: ANALYTICAL INSTRUMENTATION TESTING CONFIGURATION

Parameter	Sample Methodology	Example Range	Sensitivity	Calibration Gases (based on example range)
NOx	RATA	0-10 ppm	0.1 ppm	Zero = 0 ppm nitrogen Mid = 4-6 ppm High = 10 ppm
CO	RATA	0-10 ppm	0.1 ppm	Zero = 0 ppm nitrogen Mid = 4-6 ppm High = 10 ppm
O_2	RATA	0-21%	0.1%	Zero = 0 ppm nitrogen Mid = 8.4-12.6% High = 21%

APPENDIX C
STACK DRAWINGS

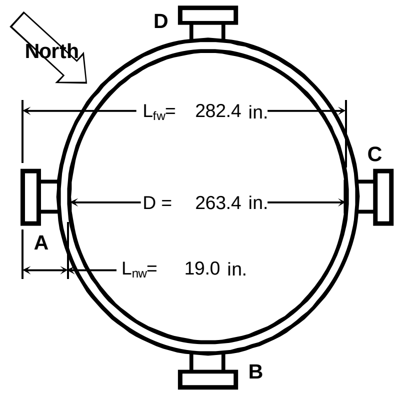
METHOD 1 - STRATIFICATION TEST FOR A CIRCULAR SOURCE

Company	CiSCO	**Date**	March 2013
Plant Name	Cape Canaveral Energy Center	**Project #**	cis-13-capecanaveral.fl-rata#1
Equipment	Siemens 8000H	**# of Ports Available**	4
Location	Brevard County, Florida	**# of Ports Used**	4

Circular Stack or Duct Diameter			
Distance to Far Wall of Stack	(L_{fw})	282.38	in.
Distance to Near Wall of Stack	(L_{nw})	19.00	in.*
Diameter of Stack	(D)	263.38	in.
Area of Stack	(A_s)	378.35	ft^2

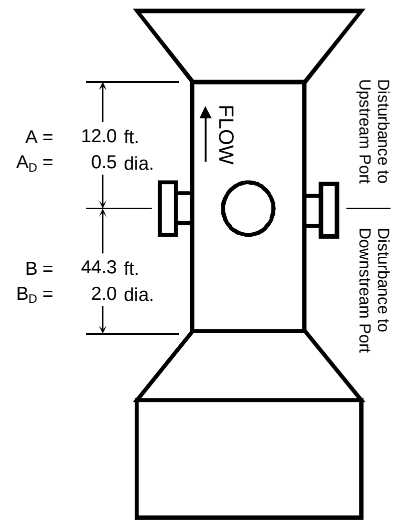
*assume 19 in. reference (must be measured and verified in field)

Distance from Disturbances to Port			
Distance Upstream	(A)	144.00	in.
Diameters Upstream	(A_D)	0.55	diameters
Distance Downstream	(B)	531.75	in.
Diameters Downstream	(B_D)	2.02	diameters



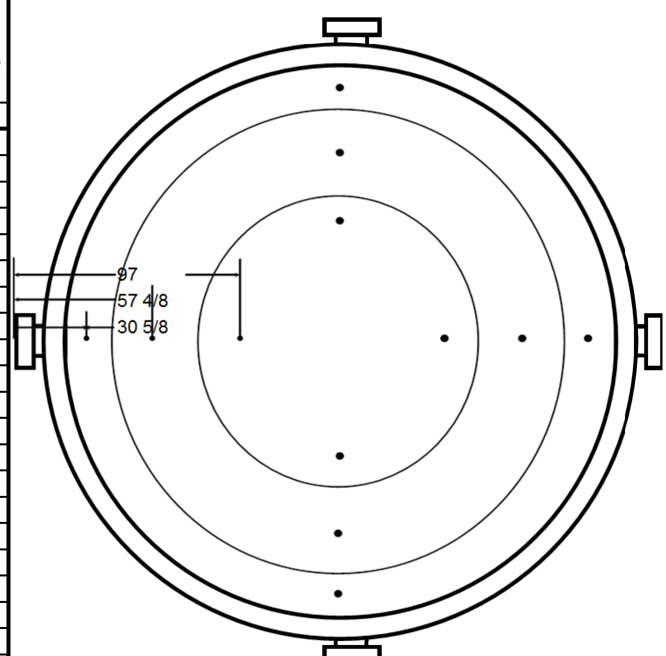
Number of Traverse Points Required					
Diameters to Flow Disturbance		Minimum Number of[1] Traverse Points		Minimum Number of Traverse Points Comp Stratification	
Down (B_D) Stream	Up (A_D) Stream	Particulate Points	Velocity Points	Criteria	Points
2.00-4.99	0.50-1.24	24	16	○ RM 7E 8.1.2	12 RM1 pts
5.00-5.99	1.25-1.49	20	16	○ Alt 7E 8.1.2	3 points
6.00-6.99	1.50-1.74	16	12		
7.00-7.99	1.75-1.99	12	12		
>= 8.00	>=2.00	8 or 12[2]	8 or 12[2]	**Minimum Number of Traverse Points RATA Stratification**	
Upstream Spec		24	16		
Downstream Spec		24	16		
Traverse Pts Required		24	16	**Criteria**	**Points**
				● Part75/60	12 RM1 pts
				○ 75 abrv (a)	3 points
				○ 75 abrv (b)	6 points
				12 points	

[1] Check Minimum Number of Points for the Upstream and Downstream conditions, then use the largest.
[2] 8 for Circular Stacks 12 to 24 inches
12 for Circular Stacks over 24 inches



Number of Traverse Points Used				
4	**Ports by**	3	**Pts / port**	**Stratification Traverse (RATA)**
12	**Pts Used**	12	**Required**	

Traverse Point Number	**Percent of Stack Diameter**	**Distance from Inside Wall**	**Distance Including Reference Length**
	%	in.	in.
1	4.4%	11 5/8	30 5/8
2	14.6%	38 4/8	57 4/8
3	29.6%	78	97
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			



APPENDIX D
EXAMPLE TEMPLATES AND CALCULATIONS

RATA - FIELD DATA SHEET

AIR HYGIENE

Company:	
Location:	
Date:	
Unit Make and Model:	
Unit Number:	
Serial Number:	
Data Recorded By:	
Tested With AHI Unit(s):	Truck(s): Trailer(s):
LDEQ Warmup/Cal Req:	On (Day/Time): Cal (Day/Time):

Stack Dia. = __________
Measured By: __________
Measured With: __________

CYLINDER SERIAL NUMBERS		O_2	NOx	CO
	Low			
	Mid			
	High			

CYLINDER SERIAL NUMBERS		THC	CO_2	SO_2
	Low			
	Mid			
	High			

RUN INFORMATION	Run #1	Run #2	Run #3	Run #4	Run #5	Run #6	Run #7	Run #8	Run #9	Run #10	Run #11	Run #12
Time Start (hh:mm:ss)												
Time Stop (hh:mm:ss)												
Rated Power (MW or hp)												
Actual Power (MW or hp)												
Barometric Pressure (in. Hg)												
Ambient Temperature (^oF)												
Relative Humidity (%)												
CEMS DATA for O_2												
CEMS DATA for NOx									-			
CEMS DATA for CO												
CEMS DATA for SO_2												

CALIBRATION	O_2		NOx		CO		SO_2	
	Conc.	Actual	Conc.	Actual	Conc.	Actual	Conc.	Actual
Zero Gas								
Low Gas								
Mid Gas								
High Gas								

NO_2 CONVERSION	
NO_2 Gas (ppm)	
NO Reading (ppm)	
NOx Reading (ppm)	
Cylinder Num	

BIAS	O_2		NOx		CO		SO_2	
	Zero	Mid	Zero	Mid	Zero	Mid	Zero	Mid
Initial Run #1								
Run #1 / Run #2								
Run #2 / Run #3								
Run #3 / Run #4								
Run #4 / Run #5								
Run #5 / Run #6								
Run #6 / Run #7								
Run #7 / Run #8								
Run #8 / Run #9								
Run #9 / Run #10								
Run #10 / Run #11								
Run #11 / Run #12								
Run #12 Final								
Bias Gas Actual Conc.		______		______		______		______

REPORT INFORMATION		
	INSTRUMENT	SERIAL #
O_2		
NOx		
CO		
THC		
CO_2		
SO_2		

RESPONSE TIME		
	TIME (hh:mm)	RESP (min)
Gas Inject	/ /	
1^{st} Inst. @ 95%	/ /	/ /
2^{nd} Inst. @ 95%	/ /	/ /
3^{rd} Inst. @ 95%	/ /	/ /

Air Permit # :	
Plant Name or Location:	
Date:	
Project Number:	
Manufacturer & Equipment:	
Model:	
Serial Number:	
Unit Number:	
Test Load:	
Tester(s) / Test Unit(s):	

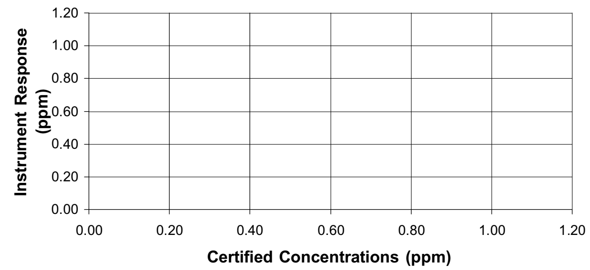
		RUN																	
	UNITS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Start Time	hh:mm:ss																		
End Time	hh:mm:ss																		
Bar. Pressure	in. Hg																		
Amb. Temp.	°F																		
Rel. Humidity	%																		
Spec. Humidity	lb water / lb air																		
Comb. Inlet Pres.	psig																		
NOx Water Inj.	gpm																		
Total Fuel Flow	SCFH																		
Heat Input	MMBtu/hr																		
Power Output	megawatts																		
Steam Rate	lb/hr																		

Calibration Date:
Client:

NOx Span (ppm) =

THERMO 42H (NOx Analyzer)				
Certified Concentration (ppm)	**Instrument Response (ppm)**	**Calibration Error (%)**	**Absolute Conc. (ppm)**	**Pass or Fail (±2%, ≤0.5ppm)**
Linearity =				

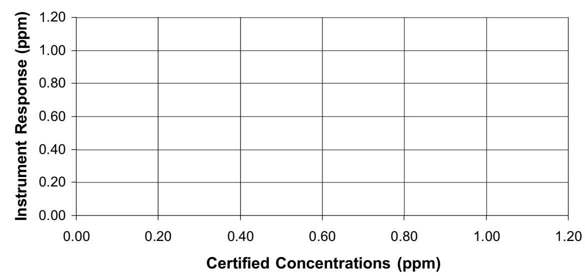
THERMO 42H (NOx Analyzer) Linearity Plot



CO Span (ppm) =

API 300 (CO Analyzer)				
Certified Concentration (ppm)	**Instrument Response (ppm)**	**Calibration Error (%)**	**Absolute Conc. (ppm)**	**Pass or Fail (±2%, ≤0.5ppm)**
Linearity =				

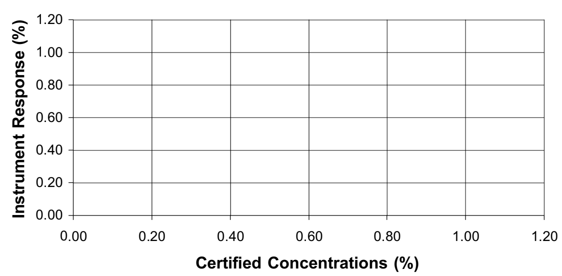
API 300 (CO Analyzer) Linearity Plot



O2 Span (%) =

SERVOMEX 1400 (O_2 Analyzer)				
Certified Concentration (ppm)	**Instrument Response (ppm)**	**Calibration Error (%)**	**Absolute Conc. (ppm)**	**Pass or Fail (±2%, ≤0.5%)**
Linearity =				

SERVOMEX 1400 (O2 Analyzer) Linearity Plot



NOx Converter Efficiency

Date:

Analyzer:

RM 7E, (08-15-06), 8.2.4.1 Introduce a concentration of 40 to 60 ppmv NO_2 to the analyzer in direct calibration mode and record the NOx concentration displayed by the analyzer. ... Calculate the converter efficiency using Equation 7E-7 in Section 12.7. The specification for converter efficiency in Section 13.5 must be met. ... The NO_2 must be prepared according to the EPA Traceability Protocol and have an accuracy within 2.0 percent.

Audit Gas: NO_2 Concentration (C_v), ppmvd

Converter Efficiency Calculations:

Analyzer Reading, NO Channel, ppmvd

Analyzer Reading, NOx Channel, ppmvd

Analyzer Reading, NO_2 Channel ($C_{Dir(NO2)}$), ppmvd

Converter Efficiency, %

RM 7E, (08-15-06), 13.5 NO2 to NO Conversion Efficiency Test (as applicable). The NO2 to NO conversion efficiency, calculated according to Equation 7E-7 or Equation 7E-9, must be greater than or equal to 90 percent.

$$Eff_{NO2} = \left(\frac{C_{Dir}}{C_V}\right) \times 100$$

Eq. 7E-7 = $\frac{\text{ppmvd}}{\text{ppmvd}}$ x 100 =

Date/Time	Elapsed Time	NOx	NO
mm/dd/yy hh:mm:ss	Seconds	ppmvd	ppmvd

DRIFT AND BIAS CHECK		
Strat Test Pre and Post QA/QC Check	Diluent 1	Pollutant 1
Initial Zero		
Final Zero		
Avg. Zero		
Initial UpScale		
Final UpScale		
Avg. UpScale		
Sys Resp (Zero)		
Sys Resp (Upscale)		
Upscale Cal Gas		
Initial Zero Bias		
Final Zero Bias		
Zero Drift		
Initial Upscale Bias		
Final Upscale Bias		
Upscale Drift		
Alternative Specification Abs Diff: Initial Zero		
Final Zero		
Initial Upscale		
Final Upscale		
Calibration Span		
3% of Range (drift)		
5% of Range (bias)		

Respone Time (min)		
Sys. Response (min)		

INJECTIONS

Date/Time mm/dd/yy hh:mm:ss z s z s

x

Source Information	
Company	
Plant Name	
Equipment	
Location	

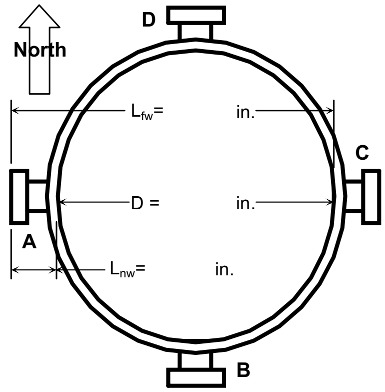
Test Information	
Date	
Project #	
Unit Number	
Load	
Number of Ports Available	
Number of Ports Used	

Stack and Test Type			
○	Isokinetic Traverse (Wet Chemistry Testing)		**Circular Stack**
○	Velocity Traverse (Flow and Flow RATA Test)		
○	Stratification Traverse (Compliance Test)	☐ RM 20	
◉	**Stratification Traverse (RATA)**	☐ Part 60 ☑ Part 75	

METHOD 1 - STRATIFICATION TEST FOR A CIRCULAR SOURCE

Company		**Date**	
Plant Name		**Project #**	
Equipment		**# of Ports Available**	
Location		**# of Ports Used**	

Circular Stack or Duct Diameter			
Distance to Far Wall of Stack	(L_{fw})		in.
Distance to Near Wall of Stack	(L_{nw})		in.
Diameter of Stack	(D)		in.
Area of Stack	(A_s)		ft^2

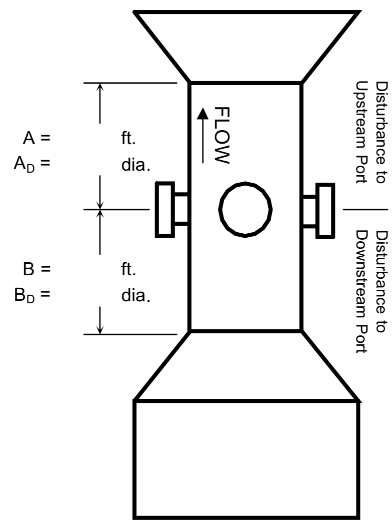


Distance from Disturbances to Port			
Distance Upstream	(A)		in.
Diameters Upstream	(A_D)		diameters
Distance Downstream	(B)		in.
Diameters Downstream	(B_D)		diameters

Number of Traverse Points Required					
Diameters to Flow Disturbance		Minimum Number of[1] Traverse Points		Minimum Number of Traverse Points Comp Stratification	
Down (B_D) Stream	Up (A_D) Stream	Particulate Points	Velocity Points	Criteria	Points
2.00-4.99	0.50-1.24	24	16	○ RM 7E 8.1.2	12 RM1 pts
5.00-5.99	1.25-1.49	20	16	○ Alt 7E 8.1.2	3 points
6.00-6.99	1.50-1.74	16	12		
7.00-7.99	1.75-1.99	12	12		
>= 8.00	>=2.00	8 or 12[2]	8 or 12[2]	**Minimum Number of Traverse Points RATA Stratification**	
Upstream Spec					
Downstream Spec					
Traverse Pts Required				**Criteria**	**Points**
				○ Part75/60	12 RM1 pts
				○ 75 abrv (a)	3 points
				○ 75 abrv (b)	6 points

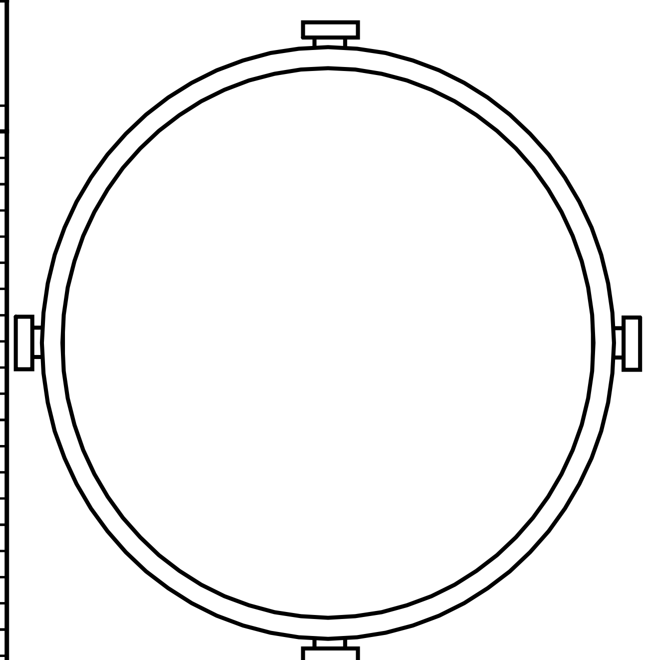
[1] Check Minimum Number of Points for the Upstream and Downstream conditions, then use the largest.

[2] 8 for Circular Stacks 12 to 24 inches
12 for Circular Stacks over 24 inches



Number of Traverse Points Used				
	Ports by		**Pts / port**	**Stratification Traverse (RATA)**
	Pts Used		**Required**	

Traverse Point Locations			
Traverse Point Number	**Percent of Stack Diameter**	**Distance from Inside Wall**	**Distance Including Reference Length**
	%	in.	in.
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			



STRATIFICATION TRAVERSE (RATA) RESULTS

Company		Date	
Plant Name		Project #	
Equipment		# of Ports Available	
Location		# of Ports Used	

Stack Dimensions				Traverse Data			
Diameter or Length of Stack	(D)		in.		Ports by		Pts / port
Width of Stack	(W)		in.		Pts Used		Required
Area of Stack	(A_s)		ft^2	Run Start		Run End	

Traverse Point	Time Per Point	Point Start Time	Point Stop Time (Reading)	Diluent 1	Percent Difference	Pollutant 1	Percent Difference
	min.	hh:mm:ss	hh:mm:ss	%	%	ppm	%
Average							

RATA SAMPLE POINTS FOR CIRCULAR STACK

Company		Date	
Plant Name		Project #	
Equipment		# of Ports Available	
Location		# of Ports Used	

Stack Dimensions				Traverse Data			
Diameter or Length of Stack	(D)		in.		Ports by		Pts / port
Width of Stack	(W)		in.		Pts Used		Required
Area of Stack	(A_s)		ft^2	Run Start		Run End	

40 CFR 75 Criteria

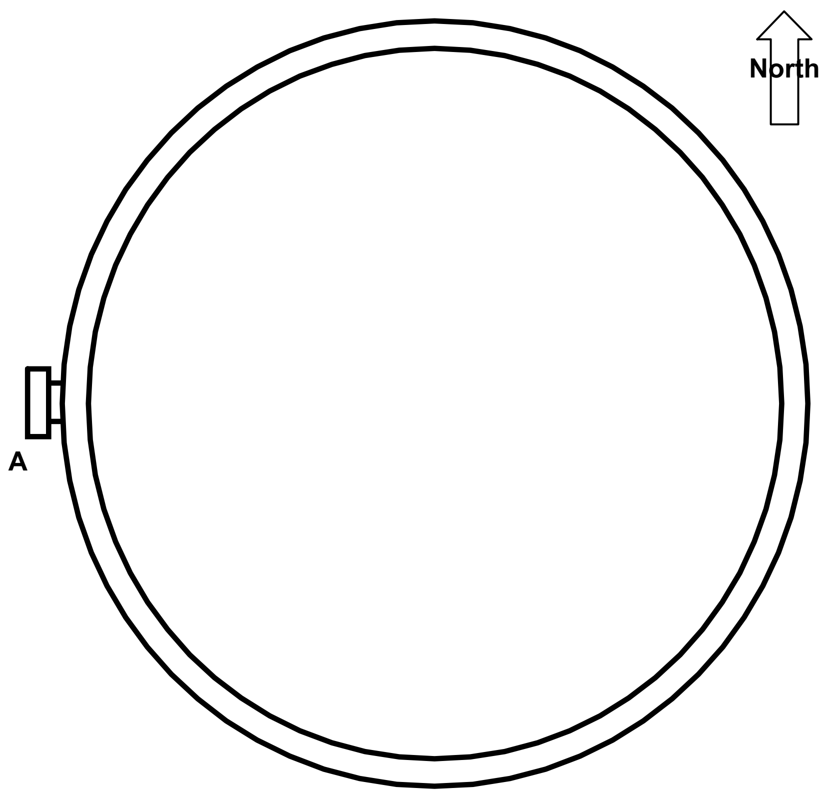
Stratification Results	
Maximum Percent Difference	No Test
Maximum Pollutant Conc. Diff.	No Test
Maximum Diluent Conc. Diff.	No Test
Stack Diameter	in.

Stratification Conclusions	
Maximum % Diff.	No Stratification Anticipated
Maximum Conc. Diff.	No Stratification Anticipated
Stack Diameter	D > 93.6 in.

Use Short RM Measurement Line

Traverse Point Number	Percent of Stack Diameter	Distance from Inside Wall	Distance Including Reference Length
	%	in.	in.
1			
2			
3			

Test Type
- ☐ Moisture, for MW
- ☐ Moisture, for wet-to-dry
- ☑ Gas
- ☐
- ☐ 6.5.6(b)(2) alt. points could apply



Traverse-AHI v4.4

Fuel Data

Fuel F_d factor		SCF/MMBtu
Fuel Heating Value (HHV)		Btu/SCF

Weather Data

Barometric Pressure		in. Hg
Relative Humidity		%
Ambient Temperature		° F
Specific Humidity		lb H_2O / lb air

Unit Data

Unit Load		megawatts
Heat Input		lb/MMBtu
Steam Rate		Steam lb/hr
Combustor Inlet Pres.		psig
NOx Control Water Injection		gpm
Est. Stack Moisture		%
Stack Exhaust Flow (M2)		SCFH
Stack Exhaust Flow (M19)		SCFH

Run - 1

Date/Time (mm/dd/yy hh:mm:ss)	Elapsed Time (seconds)	O_2 (%)	NOx (ppmvd)	CO (ppmvd)

RAW AVERAGE

	O_2	NOx	CO
Serial Number:			
	(%)	**(ppmvd)**	**(ppmvd)**
Initial Zero			
Final Zero			
Avg. Zero			
Bias			
Initial UpScale			
Final UpScale			
Avg. UpScale			

Upscale Cal Gas

EMISSIONS DATA	O_2	NOx	CO
Corrected Raw Average (ppm/% dry basis)			
Corrected Raw Average (ppm/% wet basis)			
Concentration (ppm@ %O_2)			
Concentration (ppm@ %O_2 &ISO)			
Emission Rate (lb/hr)			
Emission Rate (tons/day) at 24 hr/day			
Emission Rate (tons/year) at 8760 hr/yr			
Emission Rate (lb/MMBtu)			
Emission Rate (g/hp*hr)			

DRIFT AND BIAS CHECK			
Run - 1	O2	NOx	CO
Raw Average			
Corrected Average			
Initial Zero			
Final Zero			
Avg. Zero			
Initial UpScale			
Final UpScale			
Avg. UpScale			
Sys Resp (Zero)			
Sys Resp (Upscale)			
Upscale Cal Gas			
Initial Zero Bias			
Final Zero Bias			
Zero Drift			
Initial Upscale Bias			
Final Upscale Bias			
Upscale Drift			
Alternative Specification Abs Diff — Initial Zero			
Final Zero			
Initial Upscale			
Final Upscale			
Calibration Span			
3% of Range (drift)			
5% of Range (bias)			

DRIFT AND BIAS CHECK			
Run - 2	O2	NOx	CO
Raw Average			
Corrected Average			
Initial Zero			
Final Zero			
Avg. Zero			
Initial UpScale			
Final UpScale			
Avg. UpScale			
Sys Resp (Zero)			
Sys Resp (Upscale)			
Upscale Cal Gas			
Initial Zero Bias			
Final Zero Bias			
Zero Drift			
Initial Upscale Bias			
Final Upscale Bias			
Upscale Drift			
Alternative Specification Abs Diff — Initial Zero			
Final Zero			
Initial Upscale			
Final Upscale			
Calibration Span			
3% of Range (drift)			
5% of Range (bias)			

NOx RATA Data Sheet

RUN #	RUN TIME	USED	UNIT LOAD	RM	CEMS	RM-CEMS	
			(MW)	(ppmvd)	(ppmvd)	(diff)	($diff^2$)
1		NO					
2		NO					
3		NO					
4		NO					
5		NO					
6		NO					
7		NO					
8		NO					
9		NO					
10		NO					
11		NO					
12		NO					
	Total						
	Average						
	Number of Runs						
	Standard Deviation						
	T-value						
	Confidence Coefficient						
	Relative Accuracy =						

Part 60, Appendix B, Performance Specification 2,
8.4.1 RA Test Period. Conduct the RA test according to the procedure given in Sections 8.4.2 through 8.4.6 while the affected facility is operating at more than 50 percent of normal load, or as specified in an applicable subpart.
13.2 Relative Accuracy Performance Specification. The RA of the CEMS must be no greater than 20 percent when RM is used in the denominator of Eq. 2-6 (average emissions during test are greater than 50 percent of the emission standard) or 10 percent when the applicable emission standard (permit limit) is used in the denominator of Eq. 2-6 (average emissions during test are less than 50 percent of the emission standard).
Eq. 2.6 RA=([|d|+|CC|]*100)/RM

Part 75, Appendix A,
3.3.7 Relative Accuracy for NOX Concentration Monitoring Systems
(a) The following requirement applies only to NOX concentration monitoring systems (i.e., NOX pollutant concentration monitors) that are used to determine NOX mass emissions, where the owner or operator elects to monitor and report NOX mass emissions using a NOX concentration monitoring system and a flow monitoring system.
(b) The relative accuracy for NOX concentration monitoring systems shall not exceed 10.0 percent. Alternatively, for affected units where the average of the reference method measurements of NOX concentration (this means ppm) during the relative accuracy test audit is less than or equal to 250.0 ppm, the difference between the mean value of the continuous emission monitoring system measurements and the reference method mean value shall not exceed ± 15.0 ppm, wherever the 10.0 percent relative accuracy specification is not achieved.

Part 75, Appendix B,

2.3.1.2 Reduced RATA Frequencies. Relative accuracy test audits of primary and redundant backup SO_2 pollutant concentration monitors, CO_2 pollutant concentration monitors (including O_2 monitors used to determine CO_2 emissions), CO_2 or O_2 diluent monitors used to determine heat input, moisture monitoring systems, NO_X concentration monitoring systems, flow monitors, NO_X-diluent monitoring systems or SO_2-diluent monitoring systems may be performed annually (i.e., once every four successive QA operating quarters, rather than once every two successive QA operating quarters) if any of the following conditions are met for the specific monitoring system involved:

(a) The relative accuracy during the audit of an SO_2 or CO_2 pollutant concentration monitor (including an O_2 pollutant monitor used to measure CO_2 using the procedures in appendix F to this part), or of a CO_2 or O_2 diluent monitor used to determine heat input, or of a NO_X concentration monitoring system, or of a NO_X-diluent monitoring system, or of an SO_2-diluent continuous emissions monitoring system is ≤ 7.5 percent;

(e) For low SO_2 or NO_X emitting units (average SO_2 or NO_X reference method concentrations ≤ 250 ppm) during the RATA, when an SO_2 pollutant concentration monitor or NO_X concentration monitoring system fails to achieve a relative accuracy ≤ 7.5 percent during the audit, but the monitor mean value from the RATA is within ± 12 ppm of the reference method mean value;

Figure 2 to Appendix B of Part 75_Relative Accuracy Test Frequency Incentive System.

RATA	Semiannual(percent)(1)	Annual(1)
SO_2 or NO_X(3)	7.5% < RA ≤ 10.0% or ± 15.0 ppm(2)	RA ≤ 7.5% or ± 12.0 ppm(2)
SO_2-diluent	7.5% < RA ≤ 10.0% or ± 0.030 lb/mmBtu(2)	RA ≤ 7.5% or ± 0.025 lb/mmBtu(2)
NO_X-diluent	7.5% < RA ≤ 10.0% or ± 0.020 lb/mmBtu(2)	RA ≤ 7.5% or ± 0.015 lb/mmBtu(2)
Flow	7.5% < RA ≤ 10.0% or ± 1.5 fps(2)	RA ≤ 7.5%
CO_2 or O_2	7.5% < RA ≤ 10.0% or ± 1.0% CO_2/O_2(2)	RA ≤ 7.5% or ± 0.7% CO_2/O_2(2)
Moisture	7.5% < RA ≤ 10.0% or ± 1.5% H_2O(2)	RA ≤ 7.5% or ± 1.0% H_2O(2)

(1) The deadline for the next RATA is the end of the second (if semiannual) or fourth (if annual) successive QA operating quarter following the quarter in which the CEMS was last tested. Exclude calendar quarters with fewer than 168 unit operating hours (or, for common stacks and bypass stacks, exclude quarters with fewer than 168 stack operating hours) in determining the RATA deadline. For SO_2 monitors, QA operating quarters in which only very low sulfur fuel as defined in § 72.2, is combusted may also be excluded. However, the exclusion of calendar quarters is limited as follows: the deadline for the next RATA shall be no more than 8 calendar quarters after the quarter in which a RATA was last performed.

(2) The difference between monitor and reference method mean values applies to moisture monitors, CO_2, and O_2 monitors, low emitters, or low flow, only.

(3) A NO_X concentration monitoring system used to determine NO_X mass emissions under § 75.71.

CO RATA Data Sheet

RUN #	RUN TIME	USED	UNIT LOAD (MW)	RM (ppmvd)	CEMS (ppmvd)	RM-CEMS (diff)	(diff^2)
1		NO					
2		NO					
3		NO					
4		NO					
5		NO					
6		NO					
7		NO					
8		NO					
9		NO					
10		NO					
11		NO					
12		NO					
Total							
Average							
Number of Runs							
Standard Deviation							
T-value							
Confidence Coefficient							

Relative Accuracy =
|d (difference in ppm)| + CC =

Part 60, Appendix B, Performance Specification 4,
1.2.1 This specification is for evaluating the acceptability of carbon monoxide (CO) continuous emission monitoring systems (CEMS) at the time of installation or soon after and whenever specified in an applicable subpart of the regulations. This specification was developed primarily for CEMS having span values of 1,000 ppmv CO.
13.2 Relative Accuracy. The RA of the CEMS must be no greater than 10 percent when the average RM value is used to calculate RA or 5 percent when the applicable emission standard (permit limit) is used to calculate RA.

Part 60, Appendix B, Performance Specification 4A,
1.2.1 This specification is for evaluating the acceptability of carbon monoxide (CO) continuous emission monitoring systems (CEMS) at the time of installation or soon after and whenever specified in an applicable subpart of the regulations. This specification was developed primarily for CEMS that comply with low emission standards (less than 200 ppmv).
13.2 Relative Accuracy. The RA of the CEMS must be no greater than 10 percent when the average RM value is used to calculate RA, 5 percent when the applicable emission standard (permit limit) is used to calculate RA, or within 5 ppmv when the RA is calculated as the absolute average difference between the RM and CEMS plus the 2.5 percent confidence coefficient.

O_2 RATA Data Sheet

RUN #	RUN TIME	USED	UNIT LOAD	RM	CEMS	RM-CEMS	
			(MW)	(%)	(%)	(diff)	($diff^2$)
1		NO					
2		NO					
3		NO					
4		NO					
5		NO					
6		NO					
7		NO					
8		NO					
9		NO					
10		NO					
11		NO					
12		NO					
Total							
Average							
Number of Runs							
Standard Deviation							
T-value							
Confidence Coefficient							

Average Difference =

Relative Accuracy =

Part 60, Appendix B, Performance Specification 3,
13.2 CEMS Relative Accuracy Performance Specification. The RA of the CEMS must be no greater than 1.0 percent O2 or CO2. (Where RA is defined as the average difference between nine runs.)

Part 75, Appendix A,
3.3.3 Relative Accuracy for CO2 and O2 Monitors
The relative accuracy for CO2 and O2 monitors shall not exceed 10.0 percent. The relative accuracy test results are also acceptable if the difference between the mean value of the CO2 or O2 monitor measurements and the corresponding reference method measurement mean value, calculated using equation A-7 of this appendix, does not exceed ± 1.0 percent CO2 or O2.

Part 75, Appendix B,
2.3.1.2 Reduced RATA Frequencies
Relative accuracy test audits of primary and redundant backup SO2 pollutant concentration monitors, CO2 pollutant concentration monitors (including O2 monitors used to determine CO2 emissions), CO2 or O2 diluent monitors used to determine heat input, moisture monitoring systems, NOX concentration monitoring systems, flow monitors, NOX-diluent monitoring systems or SO2-diluent monitoring systems may be performed annually (i.e., once every four successive QA operating quarters, rather than once every two successive QA operating quarters) if any of the following conditions are met for the specific monitoring system involved:
(a) The relative accuracy during the audit of an SO2 or CO2 pollutant concentration monitor (including an O2 pollutant monitor used to measure CO2 using the procedures in appendix F to this part), or of a CO2 or O2 diluent monitor used to determine heat input, or of a NOX concentration monitoring system, or of a NOX-diluent monitoring system, or of an SO2-diluent continuous emissions monitoring system is ≤ 7.5 percent;

(h) For a CO_2 or O_2 monitor, when the mean difference between the reference method values from the RATA and the corresponding monitor values is within ± 0.7 percent CO_2 or O_2; and

Figure 2 to Appendix B of Part 75_Relative Accuracy Test Frequency Incentive System.

RATA	Semiannual(percent)(1)	Annual(1)
SO_2 or NO_X(3)	7.5% < RA ≤ 10.0% or ± 15.0 ppm(2)	RA ≤ 7.5% or ± 12.0 ppm(2)
SO_2-diluent	7.5% < RA ≤ 10.0% or ± 0.030 lb/mmBtu(2)	RA ≤ 7.5% or ± 0.025 lb/mmBtu(2)
NO_X-diluent	7.5% < RA ≤ 10.0% or ± 0.020 lb/mmBtu(2)	RA ≤ 7.5% or ± 0.015 lb/mmBtu(2)
Flow	7.5% < RA ≤ 10.0% or ± 1.5 fps(2)	RA ≤ 7.5%
CO_2 or O_2	7.5% < RA ≤ 10.0% or ± 1.0% CO_2/O_2(2)	RA ≤ 7.5% or ± 0.7% CO_2/O_2(2)
Moisture	7.5% < RA ≤ 10.0% or ± 1.5% H_2O(2)	RA ≤ 7.5% or ± 1.0% H_2O(2)

(1) The deadline for the next RATA is the end of the second (if semiannual) or fourth (if annual) successive QA operating quarter following the quarter in which the CEMS was last tested. Exclude calendar quarters with fewer than 168 unit operating hours (or, for common stacks and bypass stacks, exclude quarters with fewer than 168 stack operating hours) in determining the RATA deadline. For SO_2 monitors, QA operating quarters in which only very low sulfur fuel as defined in § 72.2, is combusted may also be excluded. However, the exclusion of calendar quarters is limited as follows: the deadline for the next RATA shall be no more than 8 calendar quarters after the quarter in which a RATA was last performed.

(2) The difference between monitor and reference method mean values applies to moisture monitors, CO_2, and O_2 monitors, low emitters, or low flow, only.

(3) A NO_X concentration monitoring system used to determine NO_X mass emissions under § 75.71.

CO RATA Data Sheet

RUN #	RUN TIME	USED	UNIT LOAD (MW)	RM (lb/hr)	CEMS (lb/hr)	RM-CEMS (diff)	RM-CEMS ($diff^2$)
1		NO					
2		NO					
3		NO					
4		NO					
5		NO					
6		NO					
7		NO					
8		NO					
9		NO					
10		NO					
11		NO					
12		NO					
Total							
Average							
Number of Runs							
Standard Deviation							
T-value							
Confidence Coefficient							

Relative Accuracy =
|d (difference in ppm)| + CC =

Part 60, Appendix B, Performance Specification 4,
1.2.1 This specification is for evaluating the acceptability of carbon monoxide (CO) continuous emission monitoring systems (CEMS) at the time of installation or soon after and whenever specified in an applicable subpart of the regulations. This specification was developed primarily for CEMS having span values of 1,000 ppmv CO.
13.2 Relative Accuracy. The RA of the CEMS must be no greater than 10 percent when the average RM value is used to calculate RA or 5 percent when the applicable emission standard (permit limit) is used to calculate RA.

Part 60, Appendix B, Performance Specification 6,
13.2 CERMS Relative Accuracy (must be a rate i.e. lb/hr). The RA of the CERMS shall be no greater than 20 percent of the mean value of the RM's test data in terms of the units of the emission standard, or 10 percent of the applicable standard (permit limit), whichever is greater.

NOx RATA Data Sheet

RUN #	RUN TIME	USED	UNIT LOAD	RM	CEMS	RM-CEMS	
			(MW)	(lb/MMBtu)	(lb/MMBtu)	(diff)	($diff^2$)
1		NO					
2		NO					
3		NO					
4		NO					
5		NO					
6		NO					
7		NO					
8		NO					
9		NO					
10		NO					
11		NO					
12		NO					
Total							
Average							
Number of Runs							
Standard Deviation							
T-value							
Confidence Coefficient							
Relative Accuracy =							

Part 60, Appendix B, Performance Specification 2,
8.4.1 RA Test Period. Conduct the RA test according to the procedure given in Sections 8.4.2 through 8.4.6 while the affected facility is operating at more than 50 percent of normal load, or as specified in an applicable subpart.
13.2 Relative Accuracy Performance Specification. The RA of the CEMS must be no greater than 20 percent when RM is used in the denominator of Eq. 2-6 (average emissions during test are greater than 50 percent of the emission standard) or 10 percent when the applicable emission standard (permit limit) is used in the denominator of Eq. 2-6 (average emissions during test are less than 50 percent of the emission standard).
Eq. 2.6 RA=([|d|+|CC|]*100)/RM

Part 75, Appendix A,
3.3.2 Relative Accuracy for NOX-Diluent Continuous Emission Monitoring Systems
(a) The relative accuracy for NOX-diluent continuous emission monitoring systems shall not exceed 10.0 percent.
(b) For affected units where the average of the reference method measurements of NOX emission rate (this means lb/MMBtu) during the relative accuracy test audit is less than or equal to 0.200 lb/mmBtu, the difference between the mean value of the continuous emission monitoring system measurements and the reference method mean value shall not exceed ±0.020 lb/mmBtu, wherever the relative accuracy specification of 10.0 percent is not achieved.

7.6.5 Bias Adjustment

(b) For single-load RATAs of SO2 pollutant concentration monitors, NOX concentration monitoring systems, and NOX-diluent monitoring systems and for the single-load flow RATAs required or allowed under section 6.5.2 of this appendix and sections 2.3.1.3(b) and 2.3.1.3(c) of appendix B to this part, the appropriate BAF is determined directly from the RATA results at normal load, using Equation A-12. Notwithstanding, when a NOX concentration CEMS or an SO2 CEMS or a NOX-diluent CEMS installed on a low-emitting affected unit (i.e., average SO2 or NOX concentration during the RATA ≦ 250 ppm or average NOX emission rate ≦ 0.200 lb/mmBtu) meets the normal 10.0 percent relative accuracy specification (as calculated using Equation A-10) or the alternate relative accuracy specification in section 3.3 of this appendix for low-emitters, but fails the bias test, the BAF may either be determined using Equation A-12, or a default BAF of 1.111 may be used.

Part 75, Appendix B,

2.3.1.2 Reduced RATA Frequencies. Relative accuracy test audits of primary and redundant backup SO2 pollutant concentration monitors, CO2 pollutant concentration monitors (including O2 monitors used to determine CO2 emissions), CO2 or O2 diluent monitors used to determine heat input, moisture monitoring systems, NOX concentration monitoring systems, flow monitors, NOX-diluent monitoring systems or SO2-diluent monitoring systems may be performed annually (i.e., once every four successive QA operating quarters, rather than once every two successive QA operating quarters) if any of the following conditions are met for the specific monitoring system involved:

(a) The relative accuracy during the audit of an SO2 or CO2 pollutant concentration monitor (including an O2 pollutant monitor used to measure CO2 using the procedures in appendix F to this part), or of a CO2 or O2 diluent monitor used to determine heat input, or of a NOX concentration monitoring system, or of a NOX-diluent monitoring system, or of an SO2-diluent continuous emissions monitoring system is ≤ 7.5 percent;

(f) For units with low NOX emission rates (average NOX emission rate measured by the reference method during the RATA ≤ 0.200 lb/mmBtu), when a NOX-diluent continuous emission monitoring system fails to achieve a relative accuracy ≤ 7.5 percent, but the monitoring system mean value from the RATA, calculated using Equation A-7 in appendix A to this part, is within ± 0.015 lb/mmBtu of the reference method mean value;

Figure 2 to Appendix B of Part 75_Relative Accuracy Test Frequency Incentive System.

RATA	Semiannual(percent)(1)	Annual(1)
SO2 or NOX(3)	7.5% < RA ≤ 10.0% or ± 15.0 ppm(2)	RA ≤ 7.5% or ± 12.0 ppm(2)
SO2-diluent	7.5% < RA ≤ 10.0% or ± 0.030 lb/mmBtu(2)	RA ≤ 7.5% or ± 0.025 lb/mmBtu(2)
NOX-diluent	7.5% < RA ≤ 10.0% or ± 0.020 lb/mmBtu(2)	RA ≤ 7.5% or ± 0.015 lb/mmBtu(2)
Flow	7.5% < RA ≤ 10.0% or ± 1.5 fps(2)	RA ≤ 7.5%
CO2 or O2	7.5% < RA ≤ 10.0% or ± 1.0% CO2/O2(2)	RA ≤ 7.5% or ± 0.7% CO2/O2(2)
Moisture	7.5% < RA ≤ 10.0% or ± 1.5% H2O(2)	RA ≤ 7.5% or ± 1.0% H2O(2)

(1) The deadline for the next RATA is the end of the second (if semiannual) or fourth (if annual) successive QA operating quarter following the quarter in which the CEMS was last tested. Exclude calendar quarters with fewer than 168 unit operating hours (or, for common stacks and bypass stacks, exclude quarters with fewer than 168 stack operating hours) in determining the RATA deadline. For SO2 monitors, QA operating quarters in which only very low sulfur fuel as defined in § 72.2, is combusted may also be excluded. However, the exclusion of calendar quarters is limited as follows: the deadline for the next RATA shall be no more than 8 calendar quarters after the quarter in which a RATA was last performed.

(2) The difference between monitor and reference method mean values applies to moisture monitors, CO2, and O2 monitors, low emitters, or low flow, only.

(3) A NOX concentration monitoring system used to determine NOX mass emissions under § 75.71.

Relative Accuracy Test Data
CEMS Results (NOx)

Parameter:	Oxides of Nitrogen
Date of Test:	
Reference Method:	EPA Method 7e
CEMS Analyzer Type:	Chemiluminescence
Manufacturer:	Advanced Pollution Instrumentation (API)
Model #:	200 AH
Serial #:	1234-56-789

RUN #	RUN TIME	UNIT LOAD	CONCENTRATIONS		RATES	
		(MW)	(ppmvd)	(ppm@ %O_2)	(lb/hr)	(lb/MMBtu)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Relative Accuracy Test Data
CEMS Results (CO)

Parameter:	Carbon Monoxide
Date of Test:	
Reference Method:	EPA Method 10
CEMS Analyzer Type:	Infrared Absorption
Manufacturer:	Advanced Pollution Instrumentation (API)
Model #:	300
Serial #:	1234-56-789

RUN #	RUN TIME	UNIT LOAD	CONCENTRATIONS		RATES	
		(MW)	(ppmvd)	(ppm@ %O_2)	(lb/hr)	(lb/MMBtu)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Relative Accuracy Test Data
CEMS Results (O_2)

Parameter:	Oxygen
Date of Test:	
Reference Method:	EPA Method 3a
CEMS Analyzer Type:	Paramagnetic Cell
Manufacturer:	Servomex
Model #:	1440
Serial #:	1234-56-789

RUN #	RUN TIME	UNIT LOAD	CONC.
		(MW)	(%)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

Relative Accuracy Test Data
Reference Method Results (NOx)

Parameter:	Oxides of Nitrogen
Date of Test:	
Reference Method:	EPA Method 7e
RM Analyzer Type:	Chemiluminescence
Manufacturer:	Advanced Pollution Instrumentation (API)
Model #:	200 AH
Serial #:	

RUN #	RUN TIME	UNIT LOAD	CONCENTRATIONS		RATES	
		(MW)	(ppmvd)	(ppm@ %O_2)	(lb/hr)	(lb/MMBtu)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Relative Accuracy Test Data
Reference Method Results (CO)

Parameter:	Carbon Monoxide
Date of Test:	
Reference Method:	EPA Method 10
RM Analyzer Type:	Infrared Absorption
Manufacturer:	Advanced Pollution Instrumentation (API)
Model #:	300
Serial #:	

RUN #	RUN TIME	UNIT LOAD	CONCENTRATIONS		RATES	
		(MW)	(ppmvd)	(ppm@ %O_2)	(lb/hr)	(lb/MMBtu)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Relative Accuracy Test Data
Reference Method Results (O_2)

Parameter:	Oxygen
Date of Test:	
Reference Method:	EPA Method 3a
RM Analyzer Type:	Paramagnetic Cell
Manufacturer:	Servomex
Model #:	1440
Serial #:	

RUN #	RUN TIME	UNIT LOAD	CONC.
		(MW)	(%)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

EXAMPLE CALCULATIONS (INFORMATION)

Specific Humidity (RH_{sp})

Note: RHsp (gr/lb) calculated using temperature, relative humidity, and barometric pressure with psychrometric chart, psychrometric calculator, or built in psychrometric algorithm.

$$RH_{sp}(lb/lb) = \left[\left(\frac{gr}{lb}\right) \times \frac{lb}{7000\ gr}\right]$$

RH_{sp}= $\frac{\text{gr}}{\text{lb}}$ x $\frac{\text{l lb}}{\text{7000 gr}}$ = $\frac{\text{lb } H_2O}{\text{lb Air}}$

Fuel Flow Conversion (Q_f)

Note: Qf(lb/min) is a value uptained from the source operator.

$$Q_f = \left[Q_f \times G \times \left(\frac{1}{MW_{Fuel}}\right)\right]$$

Q_f = $\frac{\text{lb}}{\text{min}}$ x $\frac{\text{60 min}}{\text{hr}}$ x $\frac{ft^3}{\text{lb-mol}}$ x $\frac{\text{lb-mol}}{\text{lb}}$ = SCFH

Combustor Inlet Pressure / Compressor Discharge Pressure (CIP / CDP)
(corrected from gauge to atmospheric pres. and conv. to mm Hg.)

Note: CIP / CDP (psig) is a value obtained from the source operator.

$$CIP/CDP = \left[(psig + P) \times \frac{51.71493\ mmHg}{1 psi}\right]$$

CIP / CDP = (psig +) x $\frac{\text{51.71493 mmHg}}{\text{1 psia}}$ = mmHg (abs)

Heat Rate (MMBtu/hr)

$$HR = \frac{HHV_{DRY} \times Q_f}{1,000,000}$$

Heat Rate = $\frac{\text{Btu}}{\text{SCF}}$ x $\frac{\text{SCF}}{\text{hr}}$ x $\frac{\text{MMBtu}}{10^6 \text{ Btu}}$ = $\frac{\text{MMBtu}}{\text{hr}}$

Estimated Stack Gas Moisture Content (B_{ws})

$$B_{ws}(\%) = \frac{2 \times Q_f}{Q_s} \times 100$$

B_{ws} = 2 x $\frac{\text{SCF}}{\text{hr}}$ x $\frac{\text{hr}}{\text{SCF}}$ x 100 = %

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (CALIBRATION)

Analyzer Calibration Error

RM 7E, (08-15-06), 12.2 Analyzer Calibration Error. For non-dilution systems, use Equation 7E-1 to calculate the analyzer calibration error for the low-, mid-, and high-level calibration gases. (calc for analyzer mid gas, if applicable)

$$ACE = \left(\frac{C_{Dir} - C_V}{CS}\right) \times 100$$

Eq. 7E-1

ACE = $\frac{\text{ppm - ppm}}{\text{ppm}}$ x 100 = %

Calibration Error and Estimated Point, RM 25A, THC Analyzer

RM 25A, (07-19-06), 8.4 Calibration Error Test. Immediately prior to the test series (within 2 hours of the start of the test), introduce zero gas and high-level calibration gas at the calibration valve assembly. Adjust the analyzer output to the appropriate levels, if necessary. Calculate the predicted response for the low-level and mid-level gases based on a linear response line between the zero and high-level response. Then introduce low-level and mid-level calibration gases successively to the measurement system. ... These differences must be less than 5 percent of the respective calibration gas value. (calc for THC analyzer mid gas, if applicable)

$$E_P = \frac{C_{Dir(H)} - C_{Dir(Z)}}{C_{V(H)} - C_{V(Z)}} \times C_{Dir(M)} + C_{Dir(Z)}$$

Eq. of a line
y=mx+b

E_p = $\frac{\text{ppm - ppm}}{\text{ppm - ppm}}$ x ppm + = ppm

$$ACE = \left(\frac{C_{Dir} - C_V}{CS}\right) \times 100$$

Eq. 7E-1

ACE_{THC} = $\frac{\text{ppm - ppm}}{\text{ppm}}$ x 100 = %

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (BIAS, DRIFT, AND CORRECTED RAW AVERAGE)

System Bias

RM 7E, (08-15-06), 12.3 System Bias. For non-dilution systems, use Equation 7E-2 to calculate the system bias separately for the low-level and upscale calibration gases. (calc for analyzer upscale gas, Run 1 initial bias, if applicable)

$$SB = \left(\frac{C_S - C_{Dir}}{CS}\right) \times 100$$ Eq. 7E-2

SB = (ppm - ppm) / ppm x 100 = %

Drift Assessment

RM 7E, (08-15-06), 12.5 Drift Assessment. Use Equation 7E-4 to separately calculate the low-level and upscale drift over each test run. (calc for analyzer upscale drift, Run 1, if applicable)

$$D = \left|SB_{final} - SB_i\right|$$ Eq. 7E-4

D = | % - % | = %

Alternative Drift and Bias

RM 7E, (08-15-06), 13.2 / 13.3 System Bias and Drift. Alternatively, the results are acceptable if |Cs – Cdir| is ≤ 0.5 ppmv or if |Cs – Cv| is ≤ 0.5 ppmv (as applicable). (calc for analyzer initial upscale, Run 1, if applicable)

$$SB / D_{Alt} = \left|C_S - C_{Dir}\right|$$ Eq. Section 13.2 and 13.3

SB / D_{Alt} = | ppm - ppm | = ppm

Bias Adjusted Average

RM 7E, (08-15-06), 12.6 Effluent Gas Concentration. For each test run, calculate Cavg, the arithmetic average of all valid concentration values (e.g., 1-minute averages). Then adjust the value of Cavg for bias, using Equation 7E-5. (calc for analyzer, Run 1, if applicable)

$$C_{Gas} = \left(C_{Avg} - C_O\right) \times \left(\frac{C_{MA}}{C_M - C_O}\right)$$ Eq. 7E-5

C_{Gas} = (ppm - ppm) x (ppm / (ppm - ppm)) = ppm

EXAMPLE CALCULATIONS (BSFC)

Using LHV with Q_f (Btu/hp*hr)

$$BSFC\ (Btu / hp \cdot hr) = Q_f$$

BSFC = Btu / hp*hr = Btu / hp*hr

Using HHV with Q_f (SCFH)

$$BSFC\ (Btu / hp \cdot hr) = \frac{HHV \times Q_f}{bhp}$$

BSFC = Btu / SCF x SCF / hr x 1 / hp = Btu / hp*hr

Using LHV with Q_f (SCFH)

$$BSFC\ (Btu / hp \cdot hr) = \frac{LHV \times Q_f}{bhp}$$

BSFC = Btu / SCF x SCF / hr x 1 / hp = Btu / hp*hr

Using HHV with Q_f (Btu/hp*hr)

$$BSFC\ (Btu / hp \cdot hr) = \frac{Q_f \times HHV}{LHV}$$

BSFC = N/A Btu / hp*hr x Btu / SCF x scf / Btu = Btu / hp*hr

EXAMPLE CALCULATIONS (Emissions based on Table 29 values)

Emission Rate (lb/hr)
Q_f (Btu/hp*hr))

$$E(lb / hr) = \frac{E_{g / hp \cdot hr} \times bhp}{453.6}$$

E (lb/hr) = g / hp*hr x lb / 453.6 g x hp = lb / hr

Emission Rate (g/hp-hr)
Q_f (Btu/hp*hr))

$$E(g / hp \cdot hr) = CRA \times Q_f \times FFactor \times MW \times \frac{1}{10^6} \times \frac{1}{10^6} \times \frac{453.6}{G} \times \frac{20.9\%}{20.9\% - CRA_{O_2}}$$

E (g/hp-hr) = ppm x Btu / hp*hr x SCF / MMBtu x lb / lb-mol x 1 parts / 10^6 ppm x 1 MMBtu / 10^6 Btu x 453.6 g / lb x lb-mol / SCF x 20.9% / (20.9% - %) = g / hp*hr

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (RUNS)

Stack Exhaust Flow (Q_S) - RM19

$$Q_S = \left(\frac{FFactor \times Q_f \times HHV}{1{,}000{,}000} \right) \times \left(\frac{20.9\%}{20.9\% - C_{Gas(O2)}} \right)$$

Q_S = SCF/MMBtu x SCF/hr x Btu/SCF x MMBtu/10^6 Btu x (20.90% / (20.9% - %)) = SCFH

NO_2 Conversion Efficiency Correction

RM 7E, (08-15-06), 12.8 NO2 - NO Conversion Efficiency Correction. If desired, calculate the total NOX concentration with a correction for converter efficiency using Equations 7E-8. (calc for non-bias corrected (raw) NOx gas, Run 1, if applicable)

$$NOx_{Corr} = NO + \frac{NOx - NO}{Eff_{NO2}} \times 100$$ Eq. 7E-8

NOx_{Corr} = ppm + (ppm - ppm) / % x 100 = ppm

Moisture Correction

RM 7E, (08-15-06), RM7E, (08-15-06), 12.10 Moisture Correction. Use Equation 7E-10 if your measurements need to be corrected to a dry basis. (calc for THC analyzer, Run 1, if applicable) Note: Calculations may not match as Run 1 results are typically also bias adjusted

$$C_D = \frac{C_W}{1 - B_{WS}}$$ Eq. 7E-10

C_D = ppmvw / (1 -) = ppmvd

Diluent-Corrected Polutant Concentration, O_2 Based

RM 20, (11-26-02), 7.3.1 Correction of Pollutant Concentration Using O2 Concentration. Calculate the O2 corrected pollutant concentration, as follows: (calc for gas, Run 1, if applicable)

$$C_{adj} = C_{Gas(Target)} \times \left(\frac{20.9\% - AdjFactor}{20.9\% - C_{Gas(O2)}} \right)$$ Eq. 20-4

C_{adj} = ppm x ((20.9% - %) / (20.9% - %)) = ppm@%O_2

Diluent-Corrected Polutant Concentration, CO_2 Based

RM 20, (11-26-02), 7.3.2 Correction of Pollutant Concentration Using CO2 Concentration. Calculate the CO2 corrected pollutant concentration, as follows: (calc for gas, Run 1, if applicable)

$$C_{adj} = C_{Gas(Target)} \times \frac{X_{CO2}}{C_{Gas(CO2)}}$$ Eq. 20-5

C_{adj} = ppm x % / % =

7.2 CO_2 Correction Factor. If pollutant concentrations are to be corrected to percent O_2 and CO_2 concentration is measured in lieu of O_2 concentration measurement, a CO_2 correction factor is needed. Calculate the CO_2 correction factor as follows: 7.2.1 Calculate the fuel specific F_o, as follows:

$$F_0 = \frac{0.209 F_d}{F_c}$$ Eq. 20-2

F_0 = 0.209 x SCF/MMBtu / SCF/MMBtu =

7.2.2. Calculate the CO_2 correction factor for correcting measurement data to percent oxygen, as follows:

$$X_{CO2} = \frac{20.9\% - AdjFactor}{F_0}$$ Eq. 20-3

X_{CO2} = (20.9% - %) / = %

Diluent-Corrected Polutant Concentration Corrected to ISO Conditions

40CFR60.335(b)(1), Conversion for conc. at ISO Conditions (68°F, 1 atm). Calculate, as follows: (calc for @% with Run 1 data, if applicable)

$$C_{ISO} = C_{Adj} \times \sqrt{\frac{P_r}{P_o}} \times e^{(19 \times (H_O - 0.00633))} \times \left(\frac{288}{T_a} \right)^{1.53}$$

C_{ISO} = ppm@%O_2 x $\left(\sqrt{\frac{(psig + 14.69232\ psi) / 0.01933677\ psi/mm\ Hg.}{(psig + \ psi) / 0.01933677\ psi/mm\ Hg.}} \right)$ x $2.718^{(19x(\quad lb/lb-0.00633))}$ x $\left(\frac{288\ K}{K}\right)^{1.53}$ = ppm@% and ISO

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (RUNS)

Emissions Rate (lb/hr)

Calculation for pound per hour emission rate. Calculate, as follows: (calc for gas Run 1, if applicable)

$$E_{lb/hr} = \frac{C_{Gas}}{10^6} \times \frac{Q_S \times MW}{G}$$

$$E_{lb/hr} = \frac{\text{ppm}}{10^6 \text{ ppm/part}} \times \frac{\text{SCFH} \times \text{lb/lb-mol}}{\text{SCF/lb-mol}} = \frac{\text{lb}}{\text{hr}}$$

Emissions Rate (ton/year)

Calculation for tons per year emission rate based on 8760 hours per year. Calculate, as follows: (calc for gas Run 1, if applicable)

$$E_{ton/yr} = \frac{E_{lb/hr} \times hr_{year}}{2000}$$

$$E_{ton/yr} = \frac{\text{lb}}{\text{hr}} \times \frac{\text{hr}}{\text{year}} \times \frac{\text{ton}}{2000 \text{ lb}} = \frac{\text{ton}}{\text{year}}$$

Emissions Rate (lb/MMBtu)

RM 19, (07-19-06), 12.2 Emission Rates of PM, SO2, and NOx. Select from the following sections the applicable procedure to compute the PM, SO2, or NOx emission rate (E) in ng/J (lb/million Btu). (calc for gas Run 1, if applicable)

Oxygen Based

12.2.1 Oxygen-Based F Factor, Dry Basis. When measurements are on a dry basis for both O_2 (%O_2d) and pollutant (Cd) concentrations, use the following equation:

$$E_{lb/MMBtu} = \frac{C_{Gas} \times F_d Factor \times Conv_C \times 20.9\%}{20.9\% - C_{Gas(O2)}}$$

Eq. 19-1

$$E_{lb/MMBtu} = \frac{\text{ppm} \times \text{SCF/MMBtu} \times \text{lb/ppm*ft}^3 \times 20.9\%}{20.9\% - \quad \%} = \frac{\text{lb}}{\text{MMBtu}}$$

Carbon Dioxide Based

12.2.4 Carbon Dioxide-Based F Factor, Dry Basis. When measurements are on a dry basis for both CO_2 (%CO_2d) and pollutant (Cd) concentrations, use the following equation:

$$E_{lb/MMBtu} = \frac{C_{Gas} \times F_d Factor \times Conv_C \times 100\%}{C_{Gas(CO2)}}$$

Eq. 19-6

$$E_{lb/MMBtu} = \frac{\text{ppm} \times \text{SCF/MMBtu} \times \text{lb/ppm*ft}^3 \times 100\%}{\%} = \frac{\text{lb}}{\text{MMBtu}}$$

Conversion Constant

Convc for

$$Conv_c(lb / ppm \cdot ft^3) = \frac{\frac{MW}{G}}{10^6}$$

$$Conv_c = \frac{\frac{\text{lb}}{\text{lb}\cdot\text{mole}} \times \frac{\text{lb}\cdot\text{mole}}{\text{SCF}}}{10^6} = \frac{\text{lb}}{\text{ppm-ft}^3}$$

Sulfur Dioxide Rate (lb/MMBtu), 40CFR60, App. A, RM 19, Eq. 19-25 (11/20/03)

$$SO_2(lb / MMBtu) = 0.97 \times K \times \frac{S(wt\%)}{GCV}$$

$$SO_2 = 0.97 \times \frac{2\text{x}10^4 \text{ Btu}}{\text{wt\%} \cdot \text{MMBtu}} \times \frac{\text{wt\%}}{\text{Btu/lb}} = \frac{\text{lb}}{\text{MMBtu}}$$

Emissions Rate (g/hp-hr)

Calculation for grams per horsepower-hour. Calculate, as follows: (calc for gas Run 1, if applicable)

$$E_{g/hp \cdot hr} = \frac{E_{lb/hr} \times 453.6}{mw \times 1314.022} \; or \; \frac{E_{lb/hr} \times 453.6}{hp}$$

$$E_{g/hp\text{-}hr} = \frac{\text{lb}}{\text{hr}} \times \frac{453.6 \text{ g}}{\text{lb}} \times \frac{1}{\text{mw}} \times \frac{\text{mw}}{1314.022 \text{ hp}} = \frac{\text{g}}{\text{hp*hr}}$$

$$E_{g/hp\text{-}hr} = \frac{\text{lb}}{\text{hr}} \times \frac{453.6 \text{ g}}{\text{lb}} \times \frac{1}{\text{hp}} = \frac{\text{g}}{\text{hp*hr}}$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (RATA RESULTS)

Difference (d)

40 CFR 75, App A, (08-04-06), 7.3.1 Arithmetic Mean. Calculate the arithmetic mean of the differences, d , of a data set as follows. (calc for data, if applicable. Note: This is an example calculation which may not have any bearing on the actual test requirements.)

$$d = \sum_{i=1}^{n} d_i$$ Eq. A-7

d = - =

Standard Deviation

40 CFR 75, App A, (08-04-06), 7.3.2 Standard Deviation. Calculate the standard deviation, Sd, of a data set as follows: (calc for data, if applicable. Note: This is an example calculation which may not have any bearing on the actual test requirements.)

$$S_d = \sqrt{\frac{\sum_{i=1}^{n} d_i^2 - \left[\frac{\left(\sum_{i=1}^{n} d_i\right)^2}{n}\right]}{n-1}}$$ Eq. A-8

$S_d = \sqrt{\frac{\ \ -\ ^2\ [\ \ ]^2}{\ -\ 1}} =$

Confidence Coefficient

40 CFR 75, App A, (08-04-06), 7.3.3 Confidence Coefficient. Calculate the confidence coefficient (one-tailed), cc, of a data set as follows. (calc for data, if applicable. Note: This is an example calculation which may not have any bearing on the actual test requirements.)

$$CC = t_{0.025} \times \frac{S_d}{\sqrt{n}}$$ Eq. A-9

CC = x $\frac{\ }{\sqrt{\ }}$ =

T-Values	n	2	3	4	5	6	7	8	9
	$t_{0.025}$	12.706	4.303	3.182	2.776	2.571	2.447	2.365	2.306

2.5 percent confidence coefficients

Relative Accuracy

40 CFR 75, App A, (08-04-06), 7.3.4 Relative Accuracy. Calculate the relative accuracy of a data set using the following equation. (calc for data, if applicable. Note: This is an example calculation which may not have any bearing on the actual test requirements.)

$$RA = \frac{|d_{AVG}| + |CC|}{RM_{AVG}} \times 100$$ Eq. A-10

RA = $\frac{|\ | + |\ |}{\ }$ x 100 = %

Alternative Relative Accuracy

40 CFR 75, App A, (08-04-06), Alternative Relative Accuracy. Calculate the alternative relative accuracy of a data set using the following equation. (calc for data, if applicable. Note: This is an example calculation which may not have any bearing on the actual test requirements.)

$$ARA = \frac{|d_{AVG}| + |CC|}{AS} \times 100$$

RA = $\frac{|\ | + |\ |}{\ }$ x 100 = %

Bias Adjustment Factor (BAF)

40 CFR 75, App A, (08-04-06), 7.6.5 Bias Adjustment. (a) If the monitor or monitoring system fails to meet the bias test requirement, adjust the value obtained from the monitor using the following equation: (calc for data, if applicable. Note: This is an example calculation which may not have any bearing on the actual test requirements.)

$$BAF = 1 + \left(\frac{|d_{AVG}|}{CEM_{AVG}}\right)$$ Eq. A-12

d_{AVG}= < |CC| = ⇨ BAF = 1 + $\frac{|\ |}{\ }$ =

Note: BAF only applies if the mean difference (d) is greater than the absolute value of the confidence coefficient.

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

RM 7E, (08-15-06), 12.1 Nomenclature. The terms used in the equations are defined as follows:

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.
C_D = Pollutant concentration adjusted to dry conditions.
C_{Dir} = Measured concentration of a calibration gas (low, mid, or high) when introduced in direct calibration mode.
C_{Gas} = Average effluent gas concentration adjusted for bias.
C_M = Average of initial and final system calibration bias (or 2-point system calibration error) check responses for the upscale calibration gas.
C_{MA} = Actual concentration of the upscale calibration gas, ppmv.
C_O = Average of the initial and final system calibration bias (or 2-point system calibration error) check responses from the low-level (or zero) calibration gas.
C_S = Measured concentration of a calibration gas (low, mid, or high) when introduced in system calibration mode.
C_{SS} = Concentration of NOx measured in the spiked sample.
C_{Spike} = Concentration of NOx in the undiluted spike gas.
C_{Calc} = Calculated concentration of NOx in the spike gas diluted in the sample.
C_V = Manufacturer certified concentration of a calibration gas (low, mid, or high).
C_W = Pollutant concentration measured under moist sample conditions, wet basis.
CS = Calibration span.
D = Drift assessment, percent of calibration span.
E_p = The predicted response for the low-level and mid-level gases based on a linear response line between the zero and high-level response.
Eff_{NO2} = NO_2 to NO converter efficiency, percent.
H = High calibration gas, designator.
L = Low calibration gas, designator.
M = Mid calibration gas, designator.
NOFinal = The average NO concentration observed with the analyzer in the NO mode during the converter efficiency test in Section 16.2.2.
NOxCorr = The NOx concentration corrected for the converter efficiency.
NOxFinal = The final NOx concentration observed during the converter efficiency test in Section 16.2.2.
NOxPeak = The highest NOx concentration observed during the converter efficiency test in Section 16.2.2.
Q_{Spike} = Flow rate of spike gas introduced in system calibration mode, L/min.
Q_{Total} = Total sample flow rate during the spike test, L/min.
R = Spike recovery, percent.
SB = System bias, percent of calibration span.
SB_i = Pre-run system bias, percent of calibration span.
SB_f = Post-run system bias, percent of calibration span.
SB / D_{Alt} = Alternative absolute difference criteria to pass bias and/or drift checks.
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.
Z = Zero calibration gas, designator.

40CFR60.355(b)(1), (09-20-06), Nomenclature. The terms used in the equations are defined as follows:

P_r = reference combustor inlet absolute pressure at 101.3 kilopascals ambient pressure, mm Hg
P_o = observed combustor inlet absolute pressure at test, mm Hg
H_o = observed humidity of ambient air, g H_2O/g air
e = transcendental constant, 2.718
T_a = ambient temperature, K

Small Engine and FTIR Nomenclature. The terms used in the equations are defined as follows:

bhp = brake horsepower
hp = horsepower
Q_{sys} = system flow (lpm)
Q_m = matrix spike flow (lpm)

RM 19, (07-29-06), 12.1 Nomenclature. The terms used in the equations are defined as follows:

AdjFactor = percent oxygen or carbon dioxide adjustment applied to a target polltant
B_{wa} = Moisture fraction of ambient air, percent.
Btu = British thermal unit
$\%_C$ = Concentration of carbon from an ultimate analysis of fuel, weight percent.
$\%_{CO2d}$,$\%_{CO2w}$ = Concentration of carbon dioxide on a dry and wet basis, respectively, percent.
CIP / CDP = Combustor inlet pressure / compressor discharge pressure (mm Hg); note, some manufactures reference as PCD.
E = Pollutant emission rate, ng/J (lb/million Btu).
E_a = Average pollutant rate for the specified performance test period, ng/J (lb/million Btu).
E_{ao}, E_{ai} = Average pollutant rate of the control device, outlet and inlet, respectively, for the performance test period, ng/J (lb/million Btu).
E_{bi} = Pollutant rate from the steam generating unit, ng/J (lb/million Btu).
E_{bo} = Pollutant emission rate from the steam generating unit, ng/J (lb/million Btu).
E_{ci} = Pollutant rate in combined effluent, ng/J (lb/million Btu).
E_{co} = Pollutant emission rate in combined effluent, ng/J (lb/million Btu).
E_d = Average pollutant rate for each sampling period (e.g.,24-hr Method 6B sample or 24-hr fuel sample) or for each fuel lot (e.g., amount of fuel bunkered), ng/J (lb/million Btu).
E_{di} = Average inlet SO_2 rate for each sampling period d, ng/J (lb/million Btu).
E_g = Pollutant rate from gas turbine, ng/J (lb/million Btu).
E_{ga} = Daily geometric average pollutant rate, ng/J (lbs/million Btu) or ppm corrected to 7 percent O_2.
E_{jo},E_{ji} = Matched pair hourly arithmetic average pollutant rate, outlet and inlet, respectively, ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.
E_h = Hourly average pollutant, ng/J (lb/million Btu).
E_{hj} = Hourly arithmetic average pollutant rate for hour "j," ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.
EXP = Natural logarithmic base (2.718) raised to the value enclosed by brackets.
Fc = Ratio of the volume of carbon dioxide produced to the gross calorific value of the fuel from Method 19
F_d, F_w, F_c = Volumes of combustion components per unit of heat content, scm/J (scf/million Btu).
ft^3 = cubic feet
G = ideal gas conversion factor
(385.23 SCF/lb-mol at 68 deg F & 14.696 psia)
GCM = gross Btu per SCF (constant, compound based)
GCV = Gross calorific value of the fuel consistent with the ultimate analysis, kJ/kg (Btu/lb).
GCV_p, GCV_r = Gross calorific value for the product and raw fuel lots, respectively, dry basis, kJ/kg (Btu/lb).
$\%_H$ = Concentration of hydrogen from an ultimate analysis of fuel, weight percent.
H_b = Heat input rate to the steam generating unit from fuels fired in the steam generating unit, J/hr (million Btu/hr).
H_g = Heat input rate to gas turbine from all fuels fired in the gas turbine, J/hr (million Btu/hr).
$\%_{H2O}$ = Concentration of water from an ultimate analysis of fuel, weight percent.
H_r = Total numbers of hours in the performance test period (e.g., 720 hours for 30-day performance test period).
K = volume of combustion component per pound of component (constant)
K = Conversion factor, 10^{-5} (kJ/J)/(%) [10^6 Btu/million Btu].
K_c = (9.57 scm/kg)/% [(1.53 scf/lb)/%].
K_{cc} = (2.0 scm/kg)/% [(0.321 scf/lb)/%].
K_{hd} = (22.7 scm/kg)/% [(3.64 scf/lb)/%].
K_{hw} = (34.74 scm/kg)/% [(5.57 scf/lb)/%].
K_n = (0.86 scm/kg)/% [(0.14 scf/lb)/%].
K_o = (2.85 scm/kg)/% [(0.46 scf/lb)/%].
K_s = (3.54 scm/kg)/% [(0.57 scf/lb)/%].
K_{sulfur} = $2x10^4$ Btu/wt%-MMBtu
K_w = (1.30 scm/kg)/% [(0.21 scf/lb)/%].
lb = pound
ln = Natural log of indicated value.
L_p,L_r = Weight of the product and raw fuel lots, respectively, metric ton (ton).
$\%_N$ = Concentration of nitrogen from an ultimate analysis of fuel, weight percent.
$M_{\%}$ = mole percent
mol = mole
MW = molecular weight (lb/lb-mol)
MW_{AIR} = molecular weight of air (28.9625 lb/lb-mole)[1]
NCM = net Btu per SCF (constant based on compound)
$\%_O$ = Concentration of oxygen from an ultimate analysis of fuel, weight percent.
$\%_{O2d}$, $\%_{O2w}$ = Concentration of oxygen on a dry and wet basis, respectively, percent.
P_B = barometirc pressure, in Hg
P_s = Potential SO2 emissions, percent.
$\%_S$ = Sulfur content of as-fired fuel lot, dry basis, weight percent.
S_e = Standard deviation of the hourly average pollutant rates for each performance test period, ng/J (lb/million Btu).
$\%_{Sf}$ = Concentration of sulfur from an ultimate analysis of fuel, weight percent.
S(wt%) = weight percent of sulfur, per lab analysis by appropriate ASTM standard
S_i = Standard deviation of the hourly average inlet pollutant rates for each performance test period, ng/J (lb/million Btu).
S_o = Standard deviation of the hourly average emission rates for each performance test period, ng/J (lb/million Btu).
$\%S_p$, $\%S_r$ = Sulfur content of the product and raw fuel lots respectively, dry basis, weight percent.
SCF = standard cubic feet
SH = specific humidity, pounds of water per pound of air
$t_{0.95}$ = Values shown in Table 19-3 for the indicated number of data points n.
T_{amb} = ambient temperature, ^oF
W/D Factor = 1.0236 = conv. at 14.696 psia and
68 deg F (ref. Civil Eng. Ref. Manual, 7th Ed.)
X_{CO2}=CO_2 Correction factor, percent.
X_k = Fraction of total heat input from each type of fuel k.

Calculations, Formulas, and Constants

The following information supports the spreadsheets for this testing project.

Given Data:

Ideal Gas Conversion Factor = 385.23 SCF/lb-mol at 68 deg F & 14.696 psia

Fuel Heating Value is based upon Air Hygiene's fuel gas calculation sheet. All calculations are based upon a correction to 68 deg F & 14.696 psia

High Heating Values (HHV) are used for the Fuel Heating Value, F-Factor, and Fuel Flow Data per EPA requirements.

ASTM D 3588

Molecular Weight of NOx (lb/lb-mole) =	46.01
Molecular Weight of CO (lb/lb-mole) =	28.00
Molecular Weight of SO2 (lb/lb-mole) =	64.00
Molecular Weight of THC (propane) (lb/lb-mole) =	44.00
Molecular Weight of VOC (methane) (lb/lb-mole) =	16.00
Molecular Weight of NH3 (lb/lb-mole) =	17.03
Molecular Weight of HCHO (lb/lb-mole) =	30.03

40CFR60, App. A., RM 19, Table 19-1

Conversion Constant for NOx =	0.0000001194351
Conversion Constant for CO =	0.0000000726839
Conversion Constant for SO2 =	0.0000001661345
Conversion Constant for THC =	0.0000001142175
Conversion Constant for VOC (methane) =	0.0000000415336
Conversion Constant for NH_3 =	0.0000000442074
Conversion Constant for HCHO =	0.0000000779534

NOTE: units are lb/ppm*ft^3

Formulas:

1. Corrected Raw Average (C_{Gas}), 40CFR60, App. A, RM 7E, Eq. 7E-5 (08/15/06)

$$C_{Gas} = (C_{Avg} - C_O) \times \left(\frac{C_{MA}}{C_M - C_O} \right)$$

2. Correction to % O_2, 40CFR60, App. A, RM 20, Eq. 20-5 (11/26/02)

$$C_{adj} = C_{Gas\,(Target)} \times \left(\frac{20.9\% - AdjFactor}{20.9\% - C_{Gas\,(O2)}} \right)$$

3. Emission Rate in lb/hr

$$E_{lb/hr} = \frac{C_{Gas}}{10^6} \times \frac{Q_S \times MW}{G}$$

4. Emission Concentration in lb/MMBtu (O_2 based)

$$E_{lb/MMBtu} = \frac{C_{Gas} \times F_d Factor \times Conv_C \times 20.9\%}{20.9\% - C_{Gas\,(O2)}}$$

5. Emission Concentration in lb/MMBtu (CO_2 based)

$$E_{lb/MMBtu} = \frac{C_{Gas} \times F_d Factor \times Conv_C \times 100\%}{C_{Gas\,(CO2)}}$$

RATA SHEET CALCULATIONS

d = Reference Method Data - CEMS Data

S_d = Standard Deviation

CC = Confident Coefficient

n = number of runs

$t_{0.025}$ = 2.5 percent confidence coefficent T-values

RA = relative accuracy

ARA = alternative relative accuracy

BAF = Bias adjustment factor

n	t	n	t	n	t
2	12.706	7	2.447	12	2.201
3	4.303	8	2.365	13	2.179
4	3.182	9	2.306	14	2.160
5	2.776	10	2.262	15	2.145
6	2.571	11	2.228	16	2.131

1. Difference

$$d = \sum_{i=1}^{n} d_i$$

2. Standard Deviation

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

3. Confident Coefficient

$$CC = t_{0.025} \times \frac{S_d}{\sqrt{n}}$$

4. Relative Accuracy

$$RA = \frac{|d_{AVG}| + |CC|}{RM_{AVG}} \times 100$$

5. Alternative Relative Accuracy

$$ARA = \frac{|d_{AVG}| + |CC|}{AS} \times 100$$

5. Bias Adjustment Factor

$$BAF = 1 + \left(\frac{|d_{AVG}|}{CEM_{AVG}} \right)$$

APPENDIX E
STATEMENT OF QUALIFICATIONS

STATEMENT OF QUALIFICATIONS - 2012

AIR HYGIENE, INC.

Testing Solutions for a Better World

Corporate Headquarters:
1600 West Tacoma Street
Broken Arrow, OK 74012

(918) 307-8865
(888) 461-8778

AIR HYGIENE, INC.

Remote Office Locations:
Las Vegas, NV 89156
Ft. Worth, TX 76028
Humble, TX 77338
Shreveport, LA 71115
Philadelphia, PA 19136

WWW.AIRHYGIENE.COM

Follow us on Twitter @AirHygiene

STATEMENT OF QUALIFICATIONS

AIR HYGIENE

AIR EMISSION TESTING SERVICES

www.airhygiene.com

January, 2012

INTRODUCTION

AIR HYGIENE INTERNATIONAL, INC. (**AIR HYGIENE**) is a professional air emission testing services firm operating from corporate headquarters in Broken Arrow, Oklahoma for 15 years. Additional field offices with ready for field use testing labs are strategically located in Shreveport, Louisiana; Fort Worth and Houston, Texas; Las Vegas, Nevada; Atlanta, Georgia; and Philadelphia, Pennsylvania to serve all fifty (50) United States, Mexico, and Canada. **AIR HYGIENE** specializes in air emission testing services for combustion sources burning multiple fuels with multiple control devices and supporting equipment.

AIR HYGIENE has testing laboratories which serve all fifty (50) of the United States and North America. Each mobile laboratory can be equipped with the following equipment and capabilities:

1. State-of-the-Art air emission analyzers, computers, and datalogging software.
2. Dual racks for multiple source testing simultaneously or multiple points on a single source (in/out SCR, etc.)!
3. NIST traceable gases for the most accurate calibration. Ranges as low as five (5) ppm!
4. PM_{10}, NH_3, **mercury (Hg)**, sulfuric acid mist (H_2SO_4), SO_3, and formaldehyde sampling equipment!
5. VOC testing with on-board gas chromatograph to remove methane and ethane!
6. On-board printers to provide hard copies of testing information on-site!
7. Networking capabilities to provide real-time emission data directly into the control room!

AIR HYGIENE is known for providing professional services which include the following:

- Superior, cost saving services to our clients!
- High quality emission testing personnel with service oriented, friendly attitude!
- Meeting our client's needs whether it is 24 hour a day testing or short notice mobilization!
- Using great equipment that is maintained and dependable!
- Understanding the unique startup and operational needs associated with combustion sources!

MISSION STATEMENT

Our mission is to provide innovative, practical, top-quality services allowing our clients to increase operating efficiency, save money, and comply with federal/state requirements. We believe our first responsibility is to the client. In providing our unique services, the owners of **AIR HYGIENE** demand ethical conduct from each employee of the company. The character and integrity of **AIR HYGIENE** employees allows our clients to feel confidence in the air testing services of **AIR HYGIENE**. Through a long-term commitment to this mission, **AIR HYGIENE** is known as a company committed to improving our clients' operations.

AIR HYGIENE … Does work worth paying for every time!
… Is well known for our emission testing services and uncompromising efforts to serve our clients!
… Does work that matters!
… Is proud of our emission testing capabilities!
… Provides exciting growth opportunities for energetic individuals!

AIR HYGIENE, INC.

Testing Solutions for a Better World

AIR HYGIENE Testing Services Summary

AIR HYGIENE is a privately-held professional services firm headquartered in Broken Arrow, Oklahoma with additional field offices in Las Vegas, NV; Houston, TX; Ft. Worth, TX; Shreveport, LA; and Philadelphia, PA. **AIR HYGIENE** specializes in emission testing services for a variety of industries including solid, liquid, & gas fired utility plants, turbines, engines, refineries, printers, glass plants, chemical plants, various manufacturers and related industries.

AIR HYGIENE provides turn-key emission testing services with fast-turnaround which include:

1. Pre-test site visit
2. Consulting on port locations and setup
3. Preparation of test plan for state agency
4. Coordination with state agency for emission testing
5. On-site emission testing services
6. Preparation of draft and final reports

AIR HYGIENE has a recently expanded corporate headquarters, testing warehouse, and training center. A newly constructed 32,000 square foot facility was completed in 2011. It expands our testing services capabilities with a larger, upgraded laboratory space and it houses a one-of-a-kind indoor stack, in a climate controlled environment. This provides a full service training center, available to both employees and customers to further develop testing knowledge and skills. Lastly, our expanded facilities better meet our operational needs, expand our test lab production capabilities, and help build upon our reputation of having the very best stack testing lab in the world!

AIR HYGIENE has mobile laboratories that serve all 50 United States and North America. **AIR HYGIENE** has performed over 20,000 emission tests on a variety of sources. **AIR HYGIENE** has fifteen (15) QSTI certified project managers and has received interim accreditation from STAC per ASTM D7036.

AIR HYGIENE performs air emission certification compliance testing on combustion sources (natural gas, biomass, coal, fuel oil, jet fuel, etc), NSPS sources, ICR MACT testing, and Title V compliance sites. Our experience ranges from emission testing for new PSD facilities, ICR, MACT, and RACT required performance certification testing to Relative Accuracy Test Audits (RATA Tests) for Continuous Emission Monitoring Systems (CEMS) and Parametric Emission Monitoring Systems (PEMS).

AIR HYGIENE performs FTIR testing by EPA Method 320 321, & ASTM D-6348 for Hazardous Air Pollutants (HAPS) including formaldehyde, benzene, xylene, toluene, hexane, ammonia, hydrogen chloride, etc. This methodology provides real-time analysis of these critical pollutants.

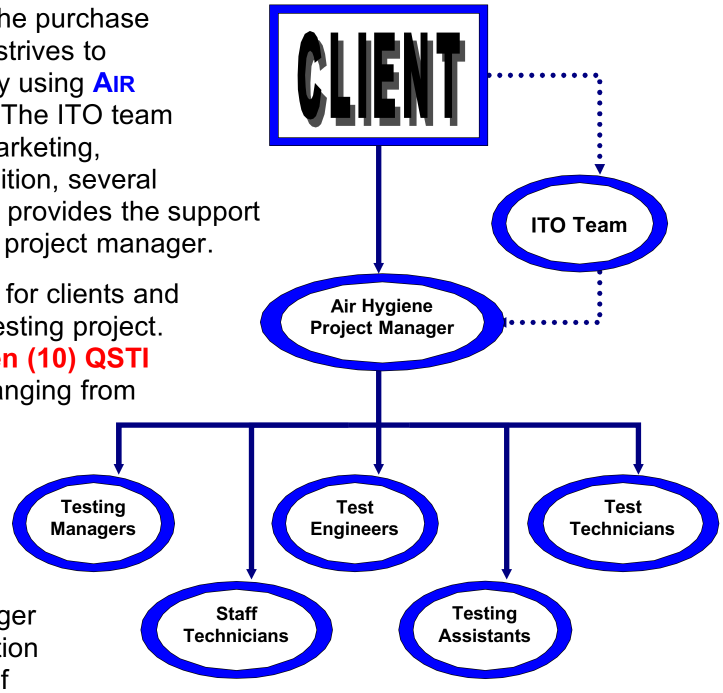
AIR HYGIENE specializes in the following types of pollutants and EPA Reference Methods (RM):

- Exhaust Flow – RM 2 &/or 19
- Carbon Dioxide (CO_2) – RM 3a
- Oxygen (O_2) – RM 3a &/or 20
- Moisture – RM 4
- Particulates (PM) – RM 5(filterable) & 202/OTM-028
- PM < 10 microns (PM_{10}) – RM 201a
- PM < 2.5 microns ($PM_{2.5}$) – RM 201b
- PM sizing (elzone analysis)
- Sulfur Dioxide (SO_2) – RM 6c
- Nitrogen Oxides (NOx) – RM 7e &/or 20
- Sulfuric Acid Mist (SO3) – RM 8a (control condensate)
- Opacity – RM 9
- Carbon Monoxide (CO) – RM 10
- Hydrogen Sulfide (H_2S) – RM 11
- Lead – RM 12
- Dioxin & Furans – RM 23
- Total Hydrocarbons (THC) – RM 25a
- Volatile Organic Compounds (VOC) RM 25a & RM 18
- Metals – RM 29
- Chrome – RM 306
- Formaldehyde – RM 320 & ASTM D-6348 (FTIR)
- HAPS – FTIR – RM 320, 321, & ASTM D-6348 (FTIR)
- Ammonia – RM 320, CTM-027, or BAAQMD ST-1B
- Mercury – RM 30b-Sorbent Tubes (both with on-site analysis, Ontario-Hydro, and RM

AIR HYGIENE, INC.
1600 West Tacoma Street
Broken Arrow, OK 74012
(888) 461-8778
www.airhygiene.com

EMISSION TESTING TEAM

Air Hygiene International, Inc. (**AIR HYGIENE**) intends to exceed your expectations on every project. From project management to field-testing teams, we're committed to hard work on your behalf. The job descriptions and flowchart below outline **AIR HYGIENE**'s client management strategy for your testing services.



From the initial request through receipt of the purchase order, the Inquisition To Order (ITO) team strives to inform every client of the benefits gained by using **AIR HYGIENE** for their emission testing project. The ITO team includes representatives from the sales, marketing, operations, and contracts divisions. In addition, several support staff assist to ensure the ITO team provides the support for client needs as requested by a client or project manager.

Project Managers are the primary contact for clients and ultimately responsible for every emission testing project. **AIR HYGIENE**'s Project Managers include **ten (10) QSTI certified** testing experts with experience ranging from masters level, professional engineers to industry experts with over 10,000 testing projects completed. Each project is assigned a Project Manager based primarily upon geographic location, then industry experience, contact history, and availability. The Project Manager prepares the testing strategy and organization for the project. This includes preparation of testing protocol; coordination with state agencies, client representatives, and any interested third parties. The site testing and report preparation are executed under the direction of the Project Manager from start to finish.

Testing Managers have completed Air Hygiene's rigorous demonstration of capability training program and are capable of operating all testing equipment and performing all test methods required for your testing project. Testing Managers assist Project Managers by leading the field testing when required, preparing draft reports, calibrating equipment, and overseeing testing team on-site. **AIR HYGIENE**'s staff includes **three (3) QSTI certified** testing managers.

Test Engineers have significant background and understanding of emission testing or related services. Test Engineers prepare pre-test drawings for port location, ensure on-site logistics for electrical and mechanical/structural needs, and conduct on site testing as directed by the Project Manager and/or Testing Manager. Test Engineers often have special understanding of process and/or regulations applicable to specific testing jobs, which provide great value to both the client and Project Manager in testing strategies.

Test Technicians experience ranges from new hire with technical degree and experience to technicians who have performed 500 emission tests. All test technicians have a basic understanding of emission training and are involved in daily training and under supervision to continue to develop testing skills. Each have testing experience with **AIR HYGIENE** equipment along with a variety of industries and source equipment. Test Technicians may operate isokinetic sampling trains or gas analyzers on-site under the direction of the Project Manager and assist with preparation of field reports and quality assurance procedures.

Staff Technicians are entry-level personnel who have performed less than 500 emission tests. Staff Technicians perform pre-test equipment preparation, on-site test preparation, and testing assistance under the direction of Project Manager and/or Testing Manager. Staff Technicians connect sampling probes to ports, raise and lower equipment to and from sampling platform, and other support activities under the direction of the Project Manager and/or Testing Manager.

Testing Assistants are entry-level personnel who have performed less than 100 emission tests. Testing Assistants help with equipment set-up, teardown, and simple testing procedures (i.e. move probe, fill ice bath, clean impingers, etc.) as directed.

TESTING EXPERIENCE

AIR HYGIENE testing personnel include **fifteen (15) QSTI certified** test managers and account for more than one hundred fifty (150) years of combined testing experience and over 20,000 emission tests. Our testing services have involved interaction with all 50 state agencies and EPA regional offices. **AIR HYGIENE** testing personnel are rigorously trained on EPA reference test methods from 40 CFR Part 51, 60, 63, and 75 along with ASTM methods. All testing personnel are instructed and tested on test responsibilities and must complete a “Demonstration of Capability” test per the **AIR HYGIENE** Quality Assurance Manual and the **AIR HYGIENE** Emission Testing Standard Operating Procedures Handbook.

AIR HYGIENE has completed testing on over 500 power plants including in excess of 2,500 combustion turbines and 100 coal fired boilers 250,000 megawatts (MW). ***Let us add your project to our list of satisfied customers!***

TESTING SUCCESS STORIES

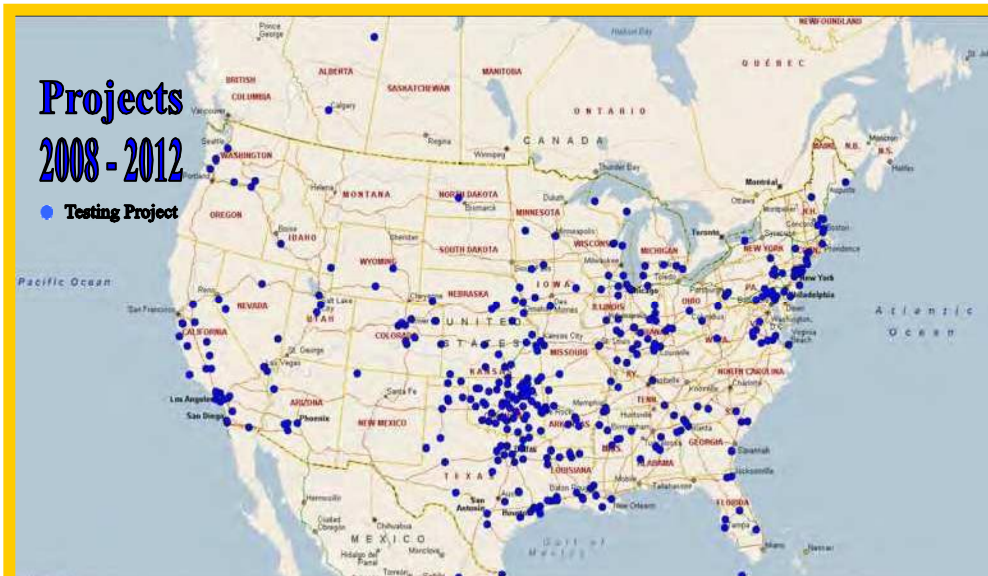
AIR HYGIENE personnel have performed thousands of testing projects which have yielded significant benefits for our clients. The following project descriptions briefly discuss some of these emission testing projects.

- Conducted **Mercury (Hg)**, PM, selected metals, HCl, Chlorine, and gas testing to verify status with the industrial boiler MACT on six coal fired units at three (3) locations.
- Conducted inlet/outlet baghouse emission testing for **Mercury (Hg)** to determine control efficiency using Ontario-Hyrdo testing methodology.
- Conducted numerous projects optimizing SCR performance by conducting inlet & outlet SCR analysis for NH_3, NOx, flow, and Oxygen. Used information to assist with flow optimization and AIG tuning.
- Conducted federal and state required compliance testing for NOx, CO, PM-10 (front & back-half), SO_2, VOC, Ammonia, Formaldehyde, Opacity, RATA testing (NOx and CO) for new and updated power plants with both simple and combined cycle turbines firing natural gas and fuel oil.
- Conducted dry low NOx burner tuning and performance testing for various models of GE, Siemens Westinghouse, Mitsubishi, Pratt & Whitney, and ABB combustion turbines to verify manufacturer’s emission guarantees for clients in preparation for compliance testing.
- Performed power plant emission testing for natural gas & fuel oil fired combustion turbines. Tests included federal required testing per 40 CFR Part 75, state air permit requirements, RATA testing, and emission testing to verify manufacturer’s guarantee’s during electric/heat output performance testing.

TESTING LOCATIONS

AIR HYGIENE bases mobilization charges on the distance from your site to the closest of seven (7) regional starting points covering all 50 United States. These include Las Vegas, Tulsa, Houston, Fort Worth, Shreveport, Atlanta, and Philadelphia.

Each start point is located such that the **AIR HYGIENE** test teams can mobilize to your site within 24 hours at affordable costs to ensure we are price competitive to any U.S. location.



COMBUSTION TESTING SERVICES SUMMARY

Thank you for your consideration of the combustion emission testing services of Air Hygiene International, Inc. (**AIR HYGIENE**). The following list details the testing services and extras **AIR HYGIENE** includes with each testing job.

Types of Air Testing Services for Combustion Sources:

- Boiler or Turbine tuning/mapping for NOx, CO, O2, CO2, flow, temperature, &/or NH_3 emissions
- Pollutant testing to verify EPC contractual emission guarantees
- Research and Development (R&D) emission data research and emissions optimization
- **Mercury (Hg) testing with on-site data**
- 40 CFR Part 60 Subpart GG or KKKK – Turbine Compliance Testing
- 40 CFR Part 75 – Acid Rain Classified Equipment Testing
- 40 CFR Part 75 Appendix E – Peaking Plant CEMS alternative NOx emissions versus Heat Input mapping
- RATA Testing on CEMS systems for NOx, CO, SO_2, CO_2 or O_2, Flow (3-D & Wall effects)
- QA/QC Plans, Monitoring Plans, Linearity Checks, Testing Protocols, etc. are provided with our high quality, service oriented emission testing services
- Initial permit compliance testing for PM, PM-10, PM-2.5, SO_2, NOx, CO, H2SO4, HCl, Hg, exhaust flow, moisture, O_2, CO_2, Ammonia, Formaldehyde, other HAPs

AIR HYGIENE will provide the following testing services:

- On-site, real-time test data
- Fuel F-Factor calculation data sheet
- Experienced emission testing personnel
- Flexible testing schedules to meet your needs
- Electronic reports provided on CD upon request
- Extensive experience with all 50 state agencies in the U.S., Mexico, & Canada
- EPA Protocol 1 Certified Gases (one percent accuracy) for precise calibration
- Low range (0-10 ppm) equipment calibration and measurement available
- Test protocol preparation, coordination with state agency, and site personnel
- Numerous mobile testing labs, which may be used for your projects across the U.S.
- State-of-the-art data logging technology to allow real-time examination of meaningful emission data
- Monitor your emissions data measured in our test lab from your control room via our datalogging network system and/or 4-20 mA output data directly fed to your DAHS!

AIR HYGIENE is committed to providing testing teams that will take the time to meet your needs. We ensure the job is completed on time with the least amount of interruption to your job and site operation as possible. Thank you for considering our services.

AIR HYGIENE, INC.

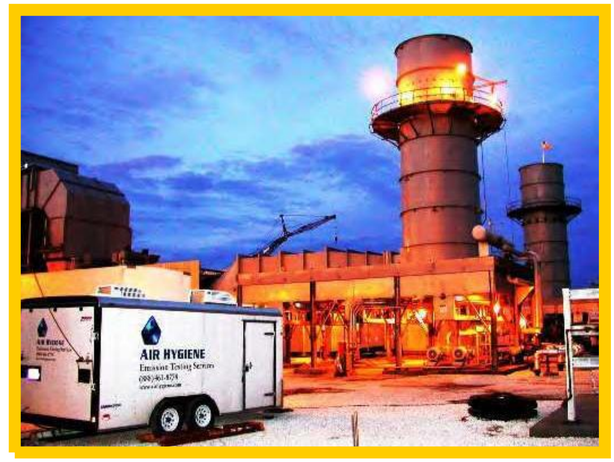
Testing Solutions for a Better World

SYNERGISTIC APPROACH TO POWER PLANT CONSTRUCTION PROJECT TESTING

Power plants continue to be built, modified, and improved across the United States. These new or modified facilities are at the forefront of clean energy. Emission rates and limits continue to decrease. These units are very efficient, environmentally friendly, and meet the stringent requirements set forth by the Environmental Protection Agency (EPA) and associated state agencies. **AIR HYGIENE** has developed a unique strategy to help owners demonstrate compliance with testing solutions for difficult sampling locations to meet complicated requirements.

Unique Testing Strategy

AIR HYGIENE has developed a synergistic approach to assisting the various groups involved in the completion of a commissioning/startup unit or modification project. **AIR HYGIENE** strives to combine the multiple testing aspects involved with bringing a combustion unit to commercial service. By conducting the various emission tests required for a new combustion unit using one test company, the following benefits are a given:



1. Save money by…
   a. Reduced mobilizations
   b. Combined tests yield reduced fuel usage and site time
   c. Bulk projects receive quantity discounts
2. Improve efficiency through familiarity with site needs
3. Site personnel and testing team are comfortable working together

These projects typically involve some or all of the following groups. There is not a defined set of responsibilities that will match every project. The table below simply suggests a typical list of testing responsibilities.

Responsible Party	**Testing Responsibilities**
Owner	Initial and on-going federal and state compliance testing (i.e. NSPS Sub GG, Part 75, Operating Air Permit, etc.)
Operator	Initial and on-going federal and state compliance testing (i.e. NSPS Sub GG, Part 75, Operating Air Permit, etc.)
Turbine/Boiler manufacturer	Contractual emission guarantees of unit (i.e. NOx, SO2, CO, VOC, PM-10, NH3, H2SO4)
EPC & Construction Company	Contractual emission guarantees including control devices (i.e. NOx, SO2, CO, VOC, PM-10, NH3, H2SO4)
CEMS Supplier	Initial RATA testing (i.e. NOx, CO, SO2, CO2, O2, flow)
Lending Party (i.e. bank)	No responsibility, but concerned with outcome of all tests
Environmental Consultant	Concerned with air permit and overall compliance; may select the test contractor and provide oversight for testing

Example Project:

A recent project provides a prime example of the synergistic benefits of using **AIR HYGIENE** to perform your commissioning/startup or remodification testing needs for performance and compliance. Eight GE Frame 7FA turbines were taken from performance testing through compliance testing in 20 days. The following tests were performed on each turbine:

- NOx tuning and mapping
- Contractual performance testing for NOx, CO, VOC, SO_2, NH_3, & PM_{10}
- 40 CFR Part 60 Subpart GG: testing for NOx and CO at max load
- 40 CFR Part 75: NOx & CO RATA certification on CEMS
- State required compliance testing for NOx, CO, VOC, NH_3(on-site analysis), formaldehyde (on-site analysis by FTIR), opacity and SO_2 burning natural gas

Test data was provided on-site for all tests, except PM-10. Electronic files were e-mailed for review to the turbine manufacturer, owner & operator, and environmental consultant within 24 hours following completion of site work. Complete reports including PM-10 were submitted to interested parties within 10 days following each blocks completion.

Power Plant Testing Experience

AIR HYGIENE personnel have over one hundred (100) years of testing experience on combustion turbines, coal fired boilers, gas fired boilers, landfill gas, wood fired, & diesel fired engines across the United States. **AIR HYGIENE** has 15 combustion labs serving all 50 states from one corporate office in Tulsa, OK and five (5) additional field offices (Houston, TX; Ft. Worth, TX; Shreveport, Louisiana; Las Vegas, NV; & Philadelphia, PA). **AIR HYGIENE** has tested plants ranging from 50 to 2,000 megawatts in both simple and combined cycle operation with controls including:

- Selective Catalytic Reduction - Ammonia injection
- Steam/Water injection
- Sprint injection
- Dry Low NOx burners (DLN)

AIR HYGIENE has completed testing at over 500 plants on 2,500 combustion turbines, 100 coal fired boilers, 100 gas fired boilers, and other sources representing 250,000 plus megawatts (MW). **AIR HYGIENE** has proven through our numerous projects that we can be relied upon for uncompromised quality, service flexibility, and loyalty to our clients no matter where the job nor what the situation may be. ***Let us add your upcoming project to our list of satisfied customers!***

Relative Accuracy Test Audit (RATA) Services

AIR HYGIENE, INC.

Why Air Hygiene is the Clear Choice for your next RATA:

- **Interim Accredited AETB**
- **On-site Draft RATA Reports!**
- **Reviewed Draft Report in 5 Days!**
- **Ammonia RATAs On-site!**
- **Time Shared CEMS RATA Testing!**
- **RATAs on Dilution Systems!**
- **PM-10 and Hg RATA Testing!**
- **CEMS XML Reporting by ECMPS!**
- **Quarterly Linearity/CGA Testing!**
- **Rental of EPA Protocol Gases!**
- **CEMS XML Reporting by ECMPS!**
- **3-D Flow RATA Testing!**
- **Hard working, Flexible Testing Team**
- **Over 5,000 Rata Tests Performed**

Corporate Headquarters:
1600 West Tacoma Street
Broken Arrow, OK 74012

(918) 307-8865
(888) 461-8778

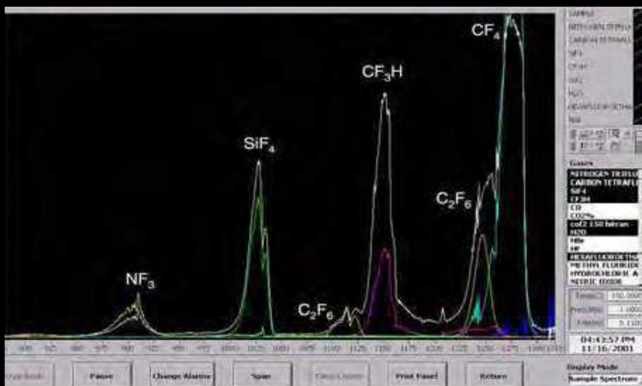
AIR HYGIENE, INC.

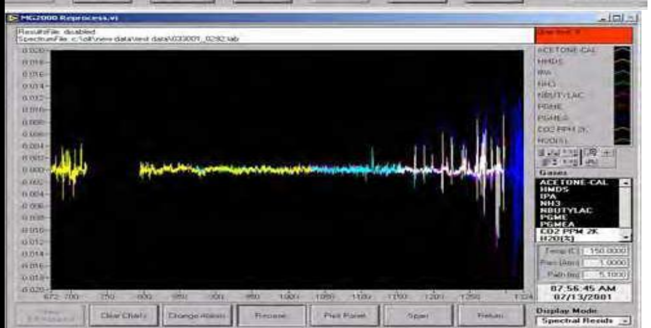
Remote Office Locations:
Las Vegas, NV 89156
Ft. Worth, TX 76028
Humble, TX 77338
Shreveport, LA 71115
Philadelphia, PA 19136

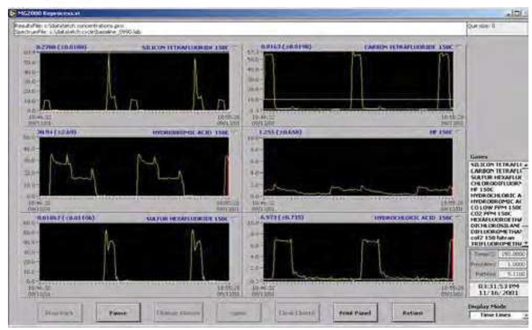
WWW.AIRHYGIENE.COM

Fourier Transform Infrared (FTIR) Spectroscopy

AIR HYGIENE, INC.







Why Air Hygiene FTIR Labs are the Solution for your Testing Needs!

- Five (5) FTIR labs for formaldehyde, VOCs, & HAPS by EPA Method 320/321 & ASTM D-6348!
- Real-time data on-site for evaluation!
- On-site draft test reports & final report in 5 Days!
- Catalyst performance analysis (inlet & outlet testing) on-site with real-time data!
- Greenhouse Gases measured real-time, on-site (N2O, CO2, CH4)!
- SCR tuning with point-by-point data, real-time for NH3, NO, & NO2!
- Speciated VOC's on-site!
- Portable power by on-board generator!
- Hard Working, Flexible Testing Teams!

Corporate Headquarters:
1600 West Tacoma Street
Broken Arrow, OK 74012

(918) 307-8865
(888) 461-8778

AIR HYGIENE, INC.

Remote Office Locations:
Las Vegas, NV 89156
Ft. Worth, TX 76028
Humble, TX 77338
Shreveport, LA 71115
Philadelphia, PA 19136

WWW.AIRHYGIENE.COM

Combustion Engine Testing

AIR HYGIENE, INC.

Why Air Hygiene is the Solution for your Engine Testing!

- Five (5) FTIR Labs for formaldehyde, VOCs, & HAPS!
- Twenty (20) test labs providing testing anytime & anywhere!
- On-site draft test reports & final report in 10 Days!
- Catalyst performance analysis (in/out CO measurement on-site!
- Portable power by on-board generator!
- LDEQ, CARB, & SCAQMD Certified!
- MACT Floor testing for over 80 engines!
- VOC's by on-site GC for methane/ethane!
- Part 60 - JJJJ Testing (NOx, CO, VOC)!
- RICE MACT (Part 63 - ZZZZ) Testing!
- Hard Working, Flexible Testing Teams!
- Tests in all 50 states, Mexico, & Canada!

Corporate Headquarters:
1600 West Tacoma Street
Broken Arrow, OK 74012

(918) 307-8865
(888) 461-8778

AIR HYGIENE, INC.

WWW.AIRHYGIENE.COM

Remote Office Locations:
Las Vegas, NV 89156
Ft. Worth, TX 76028
Humble, TX 77338
Shreveport, LA 71115
Miami, FL 33101
Philadelphia, PA 19136

INSTRUMENT CONFIGURATION AND OPERATIONS FOR GAS ANALYSIS

The sampling and analysis procedures used by **AIR HYGIENE** during tests conform in principle with the methods outlined in the Code of Federal Regulations, Title 40, Part 60, Appendix A, Methods 3a, 6c, 7e, 10, 18, 19, 20, and 25a.

The flowchart on the next page depicts the sample system used by **AIR HYGIENE** for analysis of oxygen (O_2), carbon dioxide (CO_2), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NOx), and volatile organic compounds (VOC) tests. A heated stainless steel probe is inserted into the sample ports of the stack to extract gas measurements from the emission stream. The gas sample is continuously pulled through the probe and transported via 3/8 inch heat-traced Teflon® tubing to a stainless steel minimum-contact condenser designed to dry the sample through Teflon® tubing via a stainless steel/Teflon® diaphragm pump and into the sample manifold within the mobile laboratory. From the manifold, the sample is partitioned to the O_2, CO_2, SO_2, CO, and NOx analyzers through glass and stainless steel rotameters that control the flow rate of the sample. The VOC sample is measured as a wet gas.

The flowchart shows that the sample system is also equipped with a separate path through which a calibration gas can be delivered to the probe and back through the entire sampling system. This allows for convenient performance of system bias checks as required by the testing methods.

All instruments are housed in an air-conditioned trailer which serves as a mobile laboratory. Gaseous calibration standards are provided in aluminum cylinders with the concentrations certified by the vendor. EPA Protocol No. 1 is used to determine the cylinder concentrations where applicable (i.e. NO_x calibration gases).

All data from the continuous monitoring instruments are recorded on a Logic Beach Hyperlogger which retrieves calibrated electronic data from each instrument every second and reports an average of the collected data every 30 seconds and 10 seconds. The averaging time can be selected to meet the clients needs. **This data is available instantaneously for printout, statistical analysis, viewable by actual values, or examined by a trending graph!**

The number of test runs, test loads, and length of runs is based upon federal and state requirements for the facility. Typical run times associated with emission testing are as follows:

Type of Test	# of runs	Length of runs
O_2 Traverse (GG)	1 run @ low load (8 – 48 points)	2 minutes per point
NOx Stratification Test	1 run @ base load (12 points)	2 – 4 minutes per point
Subpart GG or KKKK	3 runs @ 4 loads (30%, 50%, 75%, & 100%)	15 – 60 minutes per run
RATA	9 – 12 runs @ normal load	21 minutes per run
State Permit Test (gases)	3 runs @ base load	1 hour per run
State Permit Test (particulates)	3 runs @ base load	2 – 4 hours per run

The stack gas analysis for O_2 and CO_2 concentrations are performed in accordance with procedures set forth in EPA Method 3a (EPA Method 20 for O_2 on combustion turbines). The O_2 analyzer uses a paramagnetic cell detector. The CO_2 analyzer uses an infrared detector.

CO emission concentrations are quantified in accordance with procedures set forth in EPA Method 10. A continuous nondispersive infrared (NDIR) analyzer is used for this purpose.

NOx emission concentrations are measured in accordance with procedures set fort in EPA Method 7e and/or 20. A chemiluminescence analyzer is used to determine the nitrogen oxides concentration in the gas stream.

Total hydrocarbons (THC), non-methane, non-ethane hydrocarbons also known as volatile organic compounds (VOC) are analyzed in accordance with procedures set forth in EPA Methods 18 & 25a. A flame ionization detector calibrated with methane is used to determine the THC concentration in the gas stream and VOCs analyzed by GC to determine methane, ethane, and remaining VOCs per EPA Method 18 determination with gas chromatograph using FID detector.

TESTING QUALITY ASSURANCE ACTIVITIES

A number of quality assurance activities are undertaken before, during, and after turbine testing projects. This section describes each of those activities.

Each instrument's response is checked and adjusted in the field prior to the collection of data via multi-point calibration. The instrument's linearity is checked by first adjusting its zero and span responses to zero nitrogen and an upscale calibration gas in the range of the expected concentrations. The instrument response is then challenged with other calibration gases of known concentration and accepted as being linear if the response of the other calibration gases agreed within ± two percent of range of the predicted values.

NO_2 to NO conversion is checked via direct connect with a EPA Protocol certified concentration of NO_2 in a balance of nitrogen. Conversion is verified to be above 90 percent.

Instruments are both factory tested and periodically field challenged with interference gases to verify the instruments have less than a two percent interference from CO_2, SO_2, CO, NO, and O_2.

After each test run, the analyzers are checked for zero and span drift. This allows each test run to be bracketed by calibrations and documents the precision of the data collected. The criterion for acceptable data is that the instrument drift is no more than three percent of the full-scale response. Quality assurance worksheets summarize all multipoint calibration linearity checks and the zero to span checks performed during the tests are included in the test report.

The sampling systems is leak-checked by demonstrating that a vacuum greater than 10 in. Hg can be held for at least one minute with a decline of less than one in. Hg. A leak test is conducted after the sample system is set up and before the system is dismantled. This test is conducted to ensure that ambient air does not dilute the sample. Any leakage detected prior to the tests is repaired and another leak check conducted before testing will commence.

The absence of leaks in the sampling system is also verified by a sampling system bias check. The sampling system's integrity is tested by comparing the responses of the analyzers to the responses of the calibration gases introduced via two paths. The first path is directly into the analyzers and the second path includes the complete sample system with injection at the sample probe. Any difference in the instrument responses by these two methods is attributed to sampling system bias or leakage. The criterion for acceptance is agreement within five percent of the span of the analyzer.

The control gases used to calibrate the instruments are analyzed and certified by the compressed gas vendors to ± one percent accuracy for all gases. EPA Protocol No. 1 is used, where applicable, to assign the concentration values traceable to the National Institute of Standards and Technology (NIST), Standard Reference Materials (SRM). The gas calibration sheets as prepared by the vendor are included in the test report.


QUALITY ASSURANCE PROGRAM SUMMARY

AIR HYGIENE has received interim accreditation from the Source Testing Accreditation Council (STAC) per ASTM D7036 as an Air Emission Testing Body (AETB). Air Hygiene also maintains current accreditation from LDEQ, CARB, SCAQMD, and PADEP.

AIR HYGIENE has **fifteen (15) Qualified Stack Testing Individuals (QSTI)** on staff providing testing leadership for every testing project.

AIR HYGIENE ensures the quality and validity of its emission measurement and reporting procedures through a rigorous quality assurance (QA) program. The program is developed and administered by an internal QA team and encompasses five major areas:

1. QA reviews of reports, laboratory work, and field testing;
2. Equipment calibration and maintenance;
3. Chain-of-custody;
4. Training; and
5. Knowledge of current test methods.

QA Reviews

AIR HYGIENE's review procedure includes review of each source test report, along with laboratory and fieldwork, by the QA Team.

The most important review is the one that takes place before a test program begins. The QA Team works closely with technical division personnel to prepare and review test protocols. Test protocol review includes selection of appropriate test procedures, evaluation of interferences or other restrictions that might preclude use of standard test procedures, and evaluation and/or development of alternate procedures.

Equipment Calibration and Maintenance

The equipment used to conduct the emission measurements is maintained according to the manufacturer's instructions to ensure proper operation. In addition to the maintenance program, calibrations are carried out on each measurement device according to the schedule outlined by the Environmental Protection Agency. Quality control checks are also conducted in the field for each test program. Finally, **AIR HYGIENE** participates in a PT gas program by analyzing blind gases semi-annually to ensure continued quality.

Chain-of-Custody

AIR HYGIENE maintains full chain-of-custody documentation on all samples and data sheets. In addition to normal documentation of changes between field sample custodians, laboratory personnel, and field test personnel, **AIR HYGIENE** documents every individual who handles any test component in the field (e.g., probe wash, impinger loading and recovery, filter loading and recovery, etc.). Samples are stored in a locked area to which only **AIR HYGIENE** personnel have access. Field data sheets are secured at **AIR HYGIENE**'s offices upon return from the field.

Training

Personnel's training is essential to ensure quality testing. **AIR HYGIENE** has formal and informal training programs, which include:

1. A requirement for all technicians to read and understand Air Hygiene Incorporated's QA manual;
2. In-house training relating to 40 CFR Part 60 Appendix A methods and QA meetings on a regular basis;
3. OSHA 40 hour Hazwopper Training;
4. Visible Emission (Opacity) Training;
5. Maintenance of training records.

Knowledge of Current Test Methods

With the constant updating of standard test methods and the wide variety of emerging test procedures, it is essential that any qualified source tester keep abreast of new developments. **AIR HYGIENE** subscribes to services, which provide updates on EPA reference methods, rules, and regulations. Additionally, source test personnel regularly attend and present papers at testing and emission-related seminars and conferences. **AIR HYGIENE** personnel maintain membership in various relevant organizations associated with gas fired turbines.

February 5, 2011

To Whom It May Concern,

RE: Air Hygiene Accreditation

Air Hygiene is committed to the highest quality of emission testing services. In efforts to ensure continuous compliance with testing requirements provided with exceptional expertise to benefit the customer, Air Hygiene is committed to a rigorous training program as part of our QA/QC plan and participates in accreditation by 3rd party auditors and state/federal agency programs.

Air Hygiene ownership believes in training and demonstration of capabilities through testing and performance. Air Hygiene has fifteen (15) Qualified Stack Testing Individuals (QSTI) covering all four (4) group methods. These QSTI certified personnel lead all projects and oversee all testing. Air Hygiene has received interim accreditation from the Stack Testing Accreditation Council (STAC) for our ASTM D7036 application. This program is still in its startup phase and has not completed any field audits, but our plan is to be in the first group of field audited companies. Meanwhile, Air Hygiene has developed an ASTM specific QA/QC plan following ISO 17025 and it was approved in our initial company review allowing interim accreditation. Air Hygiene has also been accredited by state audit programs in Louisiana and California.

Finally, Air Hygiene continues to push for the highest quality in testing services and skills on the site for our customers. The planned development of the Air Hygiene Training Center at our new corporate headquarters will help further this goal. In addition, it will provide opportunities for our peers and respective observing agencies to receive training opportunities in a controlled setting representative of true field sites. Expected completion of the Air Hygiene Training Facility is schedule for April, 2011!

STACK TESTING ACCREDITATION COUNCIL 500 W. Wood Street, Palatine, IL, director@betterdata.org

June 9, 2010

Quinn Bierman
Air Hygiene International, Inc.
5634 South 122nd East Avenue, Suite F
Tulsa, Oklahoma 74146

Dear Mr. Bierman,

On behalf of the STAC Board of Directors, I am pleased to inform you that Air Hygiene International, Inc. has been granted interim accreditation by the Stack Testing Accreditation Council (STAC). After careful review of your Quality System documentation and procedures, STAC has determined that they are in conformance with ASTM D7036-04 "Standard Practice for the Competency of Air Emission Testing Bodies". Final accreditation is contingent upon successful completion of your field audit. Please see Module 3 of STAC policy documentation for scheduling requirements.

During this period of interim accreditation, Air Hygiene may not claim to be a STAC accredited organization. This requires evidence that your Quality System is effectively implemented in your organization as determined by the field assessment. You may claim, however, that your Quality System meets ASTM D7036 requirements.

Please note that the Attestation of Compliance you signed as part of your application for accreditation requires Air Hygiene to be in continuous compliance with the provisions of ASTM D7036. You are also required to comply with all relevant STAC policies and procedures. I encourage you to review this information.

If you have any questions, please feel free to contact me at 847-654-4569. Thank you for your participation in the STAC process and congratulations.

Yours truly,

Scott Evans
Managing Director

cc: Scott Swiggard, STAC Chair