EMISSION TESTING PROTOCOL
for the four (4)
GE COMBUSTION TURBINES-CT (#1 - #4)
and the SOLAR CENTAUR TURBINE
prepared for
XYZ POWER MARKETING
XYZ Power Station
TNRCC Permit No. XXX-XXX-C (PSD)
January 4, 2001

Prepared by:

Quinn A. Bierman, President

Table of Contents

I. INTRODUCTION

A. Reason for Testing

An emission test will be performed on the new natural gas fired Combustion Turbine Generators to meet the Federal NSPS Subpart GG and the TNRCC Permit No. XXX-XXX-C (PSD) requirements.

B. Equipment Description

The natural gas fired combustion turbine generators will be four (4) General Electric (GE) PG7121EA simple cycle turbines and one (1) Solar Centaur turbine. The turbines are classified as peaking units and will produce electrical power as necessary for the operation. The GE combustion turbines are rated to operate at 80 megawatts (MW) each and the Solar Turbine at 3.5 MW. The emission points will be from an exhaust stack with approximately a 10' diameter stack on the GE turbines and 4' diameter stack on the Solar turbine.

II. SUMMARY

A.	**Company:**	XYZ Power Marketing
	Contact person:	John Doe
	Mailing address:	P.O. Box 555 Houston, TX 55345
	Telephone:	(555) 555-5555
	e-mail:	N/A
B.	**Site Name:**	XYZ Power Plant
	Location:	Houston, TX
C.	**Test Contractor:**	Air Hygiene International, Inc.
	Contact Person:	Quinn A. Bierman, President
	Mailing Address:	5819 South Owasso Tulsa, OK 74105
	Telephone:	(918) 746-7680
	Fax:	(918) 746-7659
	e-mail:	**quinn@airhygiene.com**
	website:	**www.airhygiene.com**
D.	**Proposed Test Dates:**	Monday, February 21, 2001 through Friday, February 25, 2001

E. Testing Schedule

Activity	Time
Solar Turbine	
➢ Daily Setup & Calibrations	6:30 a.m. – 8:30 a.m. (Day 1)
➢ Perform Peak Load Testing	8:30 a.m. – 10:00 a.m. (Day 1)
➢ Perform 75% Load Testing	10:00 a.m. – 11:30 a.m. (Day 1)
➢ Perform 50% Load Testing	11:30 a.m. – 1:00 p.m. (Day 1)
➢ Perform 30% Load Testing	1:00 p.m. – 2:30 p.m. (Day 1)
➢ Teardown from Solar Turbine	2:30 p.m. – 4:00 p.m. (Day 1)
GE Turbines #1 & #2	
➢ Setup on GE Turbines #1 & #2	4:00 p.m. – 6:00 p.m. (Day 1)
➢ Daily Setup & Calibrations	6:30 a.m. – 8:30 a.m. (Day 2)
➢ Perform Peak Load Testing	8:30 a.m. – 7:00 p.m. (Day 2)
➢ Daily Setup & Calibrations	6:30 a.m. – 8:30 a.m. (Day 3)
➢ Perform 75% Load Testing	8:30 a.m. – 11:00 a.m. (Day 3)
➢ Perform 50% Load Testing	11:00 a.m. – 12:30 p.m. (Day 3)
➢ Perform 30% Load Testing	12:30 p.m. – 3:00 p.m. (Day 3)
➢ Teardown from Turbines #1 & #2	3:00 p.m. – 4:00 p.m. (Day 3)
GE Turbines #3 & #4	
➢ Setup on Turbines #3 & #4	4:00 p.m. – 6:00 p.m. (Day 3)
➢ Daily Setup & Calibrations	6:30 a.m. – 8:30 a.m. (Day 4)
➢ Perform Peak Load Testing	8:30 a.m. – 7:00 p.m. (Day 4)
➢ Daily Setup & Calibrations	6:30 a.m. – 8:30 a.m. (Day 5)
➢ Perform 75% Load Testing	8:30 a.m. – 11:00 a.m. (Day 5)
➢ Perform 50% Load Testing	11:00 a.m. – 12:30 p.m. (Day 5)
➢ Perform 30% Load Testing	12:30 p.m. – 3:00 p.m. (Day 5)
➢ Teardown from Turbine #3 & #4	3:00 p.m. – 4:00 p.m. (Day 5)

F. Report Format

A report detailing the results of each test will be prepared. This project will have three (3) separate reports generated from the testing on each GE turbine (only the subpart GG report required for the Solar Turbine). These reports are as follows:

1. Subpart GG Turbine Test Report (Specific Condition #7)
2. Part 75 Appendix E Report (Specific Condition #9)
3. TNRCC Permit Required Testing Report (Specific Condition #10)

These reports will meet the requirements of the TNRCC and the EPA for compliance/certification testing and will include a discussion of the following:

- Introduction
- Plant and Sampling Location Description
- Summary and Discussion of Results
- Sampling and Analytical Procedures
- QA/QC Activities
- Results and Calculations
- Raw Field Data and Calibration Data Sheets
- Sampling Log and Chain-of-Custody Records
- Audit Data Sheets

G. Equipment & Procedures

1. Equipment Specifications:
   Four (4) GE PG7121EA combustion turbines rated at 80 MW.
   One (1) Solar Centaur combustion turbine rated at 3.5 MW.

2. Reference method (RM) tests to be performed on the sources:

   <u>Turbine Test Methods and Parameters to Satisfy 40 CFR Part 60 Subpart GG</u>
   EPA Method 20 for Oxygen
   EPA Method 20 for Nitrogen Oxides (NOx) - with limits @ 12 ppmvd corrected to 15% Oxygen
   EPA Method 10 for Carbon Monoxide (CO) - with limits @ 25 ppmvd corrected to 15% Oxygen
   EPA Method 19 for exhaust flow using Dry Oxygen F-Factor, recent fuel gas analysis, and fuel flow
   Fuel gas analysis analyzed for sulfur content following 40 CFR 60.335(d) or stain tube

   <u>Turbine Test Methods and Parameters to Satisfy TNRCC Permit No. xxx-xxx-C (PSD)</u>
   EPA Method 1 sample location for exhaust testing
   EPA Method 2 for velocity and volumetric exhaust flow rate
   EPA Method 3a for Molecular Weight
   EPA Method 4 for Moisture in stack gas
   EPA Method 5 for Particulate Matter (PM collected will be treated as PM-10)
   EPA Method 10 for CO
   EPA Method 20 for NOx and Oxygen
   EPA Method 25a for non-methane organic emissions (referenced in permit limits as volatile organic compounds (VOC))
   40 CFR 60.335(d) for SO2

3. Proposed Variations:
   a. None

4. Sampling Procedures:
   <u>Turbines – Subpart GG Test</u>
   Emission tests on the turbines will be tested using continuous reading analyzers for NOx, CO, and Oxygen after conditioning the gas through a heated sample line, thermo-electric chiller, with moisture removal to eliminate any contact with water. Three 20-minute sample runs will be performed on each combustion turbine at four test loads (30%, 50%, 75% and 100% of maximum rated load – 80 MW). During the turbine tests, the following data will be recorded during each test run: (turbine speed, PCD, output power, fuel flow, exhaust temperature, ambient temperature, ambient pressure and ambient % relative humidity) Fuel flow data will be used with a calculated dry oxygen f-factor (DSCFex/MMBtu) from the fuel gas analysis to determine exhaust flow and emission rates via EPA Method 19. A fuel gas sample will be collected with an evacuated stainless steel cylinder following applicable ASTM and EPA methods and analyzed by an accredited laboratory.

   Note: At peak load the permit required testing for PM, VOC, etc. will be performed in conjunction with the Subpart GG testing for NOx and CO. At the peak load three, 3-hour test runs will be performed or at least 100 dscf will be sampled for the PM-10 test.

   <u>Permit Required Turbine Emission Test</u>
   Emission test runs shall be conducted at 90 percent or greater of the full load. The test will include three, three-hour test runs with analysis for PM-10, NOx, CO, VOC, Oxygen, Carbon Dioxide, Velocity, Moisture, and Stack Gas Molecular Weight.

5. Quality Control/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 it's 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. A NO2 conversion check is performed each day of testing. NO2 to NO conversion is checked via direct connect with an EPA Protocol certified concentration of NO2 in a balance of nitrogen. Conversion is verified to be above 90%.

After each test run, the analyzers are checked for zero and span drift. This allowed each test run to be bracketed by calibrations and documents the precision of the data just collected. The criterion for acceptable data is that the instrument drift is no more than 3 percent of the full-scale response. Quality assurance worksheets are repaired to document the multipoint calibration checks and zero to span checks performed during the tests.

The sampling systems is 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. This test was conducted to ensure that ambient air had 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 was 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 criterion for acceptance is agreement within 5% of the span of the analyzer.

APPENDIX A

QA/QC PROGRAM

QA/QC PROGRAM

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 described as follows:

QA Reviews

AIR HYGIENE's review procedure includes a 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.

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

1. Attendance at EPA-sponsored training courses;
2. Enrollment in EPA correspondence courses;
3. A requirement for all technicians to read and understand Air Hygiene Incorporated's QA manual;
4. In-house training and QA meetings on a regular basis; and
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.

COMBUSTION 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 it's 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 allowed each test run to be bracketed by calibrations and documents the precision of the data just collected. The criteria for acceptable data are that the instrument drift is 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.

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. This test was conducted to ensure that ambient air had 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 was 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 are 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 was used where applicable to assign the 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 & DESCRIPTION

INSTRUMENT CONFIGURATION AND OPERATIONS FOR EMISSIONS ANALYSIS

The sampling and analysis procedures used during tests conform in principle with the methods outlined in the Code of Federal Regulations, Title 40, Part 60, Appendix A, Methods 2, 3a, 4, 5, 10, 19, 10, and 25a.

Gas Analysis:
The sample system to be used for the NOx, CO, VOC, CO_2 and O_2 tests is configured per the following description. A stainless steel probe will be inserted into the sample port of the stack. 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 is partitioned to the NOx, CO, VOC, CO_2 and O_2 analyzers through glass and stainless steel rotameters that controlled the flow rate of the sample. **See attached schematic**

The schematic shows that the sample system was also equipped with a separate path through which a calibration gas could 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-mounted mobile laboratory. Gaseous calibration standards are provided in aluminum cylinders with the concentrations certified by the vendor. EPA Protocol No. 1 was used to determine the cylinder concentrations where applicable (i.e. NO_x, O_2, N_2, etc. calibration gases).

The schematic provides a description of the analyzers used for the instrument portion of the tests. All data from the 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 20. The O_2 analyzer uses a paramagnetic cell detector.

CO_2 concentrations will be performed in accordance with procedures set forth in EPA Method 3a. The CO_2 analyzer uses an infrared detector for analysis.

NOx emission concentrations will be determined by EPA Method 20. A chemiluminescence analyzer will be used to provide the analysis. The NOx mass emission rates will be calculated as if all the NOx were in the NO_2. This approach corresponds to EPA's convention. However, it tends to overestimate the actual stack NOx mass emission rates, since the majority of the NOx is in the form of NO which is less dense (i.e. lbs of emissions per ppmv concentration) than the NO_2 form of NOx. This gives a worst case scenario of NOx emissions.

CO emission concentrations will be quantified in accordance with procedures set forth in EPA Method 10 using 6c restrictions. A continuous nondispersive infrared (NDIR) analyzer was used for this purpose.

VOC emission concentrations will be measured in accordance with procedures set forth in EPA Method 25a using an FID detector. The analyzer will be calibrated with propane gases and reported as propane using a molecular weight of 44. The total hydrocarbons analyzed by the FID will be adjusted for methane content in the fuel gas to determine VOC. Hence, if the methane content of the fuel gas is 90% and the analyzer reads a concentration of 15 ppm, the following equation would be used:

VOC = THC * (1 – methane fraction of fuel gas)
VOC = 15 ppm * (1 – 0.9)
VOC = 15 ppm * (0.1)
VOC = 1.5 ppm

Particulate Sampling

Velocity will be measured with a calibrated s-type pitot tube per EPA Method 2 requirements. Moisture will be collected via EPA Method 4. Particulate samples will be collected by EPA Method 5 by an isokinetic sampling train during three, 3-hour test runs.

ANALYTICAL INSTRUMENTATION SPECIFICATIONS

Parameter	Model & Manufacturer	Max. Range	Sensitivity	Response Time (sec.)	Detection Principle
NOx	TECO 42H or API 200	User may select any range up to 5000 ppm	0.1 ppm	30	Thermal reduction of NO_2 to NO Chemiluminescence of reaction of NO with O_3. Detection by PMT. Inherently linear for listed ranges.
THC	TECO 51 or MSA 8800	User may select any range up to 10,000 ppm	0.1 ppm	30	Flame Ionization detector with microprocessor based linearization.
CO	TECO 48H or API 300	User may select any range up to 1000 ppm	0.1 ppm	30	Infrared absorption, gas filter correlation detector, microprocessor based linearization.
CO_2	Fuji or CAI 300	User may select any range up to 20%	0.1%	15	Infrared Detector
O_2	Servomex 1400 or CAI 300	User may select any range up to 25%	0.1%	15	Paramagnetic cell, inherently linear.

ANALYTICAL INSTRUMENTATION TESTING CONFIGURATION

Parameter	Sample Methodology	Selected Range	Sensitivity	Response Time (sec.)	Calibration Gases
NOx	Subpart GG & TNRCC	0-300 ppm	0.1 ppm	30	Zero = 0 ppm nitrogen Extra Low = 20 – 30 ppm Low = 60 – 90 ppm Mid = 135 – 165 ppm High = 240 – 270 ppm
THC	TNRCC	0 – 100 ppm	0.1 ppm	30	Zero = 0 ppm nitrogen Low = 25 – 35 ppm Mid = 45 – 55 ppm High = 80 – 90 ppm
CO	Subpart GG & TNRCC	0-100 ppm	0.1 ppm	30	Zero = 0 ppm nitrogen Low = 20 – 30 ppm Mid = 40 – 60 ppm High = 80 – 100 ppm
CO_2	TNRCC	1-20%	0.1%	15	Zero = 0 ppm nitrogen Mid = 9% High = 19%
O_2	Subpart GG & TNRCC	1-25%	0.1%	15	Zero = 0 ppm nitrogen Mid = 12% High = 21%