

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

**SOURCE TEST PROTOCOL FOR
THE MEASUREMENT OF
NITROGEN OXIDES, VOLATILE ORGANIC COMPOUNDS,
CARBON MONOXIDE, AND OXYGEN FROM
STATIONARY ENGINES SUBJECT TO
SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT RULE 1110.2**

November 21, 2008

SOURCE TEST ENGINEERING BRANCH

MONITORING & ANALYSIS

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ATTACHMENT I

District Method 100.1 General Requirements and NO₂ To NO Converter Efficiency
Check Procedure

**SOURCE TEST PROTOCOL FOR
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1.0 OVERVIEW AND APPLICABILITY

On February 1, 2008, the South Coast Air Quality Management District (District) amended Rule 1110.2, which limits emissions of nitrogen oxides (NO_x), volatile organic compounds (VOC), and carbon monoxide (CO) from gaseous and liquid-fueled stationary and portable engines with rated capacities greater than 50 brake horsepower. Compliance with this rule is based on District standard test methods, or test methods that allow the use of hand-held portable monitors. In general, stationary non-emergency engine operators are required to conduct source tests for NO_x, VOC reported as carbon, and CO concentrations (concentrations in ppm by volume, corrected to 15 percent oxygen on a dry basis) at least once every two years, or every 8,760 operating hours, whichever occurs first, or every three years if the engine has operated less than 2,000 hours since the last source test. Operators must submit a protocol for testing their engines to the District at least 60 days before the scheduled test date, and receive written approval before conducting the test. This protocol has been developed to make it easier for operators to prepare a protocol, and to ensure standardization of test procedures including the use of: specified test conditions, required test methods, specifications for test equipment, data collection/reporting, and quality assurance procedures.

The facility may fulfill the source test protocol requirement for any Rule 1110.2 source test by agreeing to follow this standard protocol, and submitting the information below:

- Name, address, phone number of the primary contacts in (1) the organization that operates the engine and (2) the organization that will perform the test;

- Information from the District Permit – application number, permit number, emission limits and equipment description;
- The proposed test date;
- Loads to be tested, test duration at each load, and pollutants to be measured at each load;
- Whether Method 25.1, Method 25.3, or both will be used for VOC testing; and
- Parameters to be measured, including those in the Inspection and Monitoring Plan required by subparagraph (f)(1)(D) of the rule.

An independent testing laboratory, which meets the requirements of South Coast Air Quality Management District's Rule 304, Subdivision (k), must conduct the test. The source testing contractor must meet the non-conflict of interest requisite specified per Rule 304(k) and provide a non-conflict of interest statement in the final report. The source testing contractor shall be approved under the SCAQMD Laboratory Approval Program (LAP). Following the test, the laboratory shall prepare a report of findings, including all raw data sheets/charts, and analytical data. Testing must demonstrate to the satisfaction of the Executive Officer that the test data was obtained using the protocol described herein.

When equipment at a facility subject to District Rule 1110.2 cannot be tested using this standard protocol, the operator may submit a modified protocol for written approval of the Executive Officer.

2.0 ENVIRONMENTAL TEST CONDITIONS

2.1 AMBIENT TEMPERATURE

The ambient temperature shall be monitored and recorded at fifteen minute intervals during each test.

2.2 AMBIENT RELATIVE HUMIDITY

The ambient relative humidity shall be monitored and recorded before and after each test.

2.3 AMBIENT BAROMETRIC PRESSURE

The ambient barometric pressure shall be monitored and recorded before and after each test.

3.0 ENGINE AND PROCESS DESCRIPTION

3.1 ENGINE DESCRIPTION

The type of engine (i.e., rich/lean burn, spark/compression ignited, portable/ stationary engine, etc.), and control equipment shall be noted in the source test report. Additionally, the rated brake horsepower and fuel type (i.e., natural gas, digester gas, landfill gas, diesel fuel, etc.) shall be recorded. Tester shall record the equipment make, model, serial number, application number, permit number and purpose of the engine (e.g., pump, compressor, generator, etc.). Tester shall also record the following information:

- a) Information regarding the fuel flow meter(s) which includes the make, model, serial number, and the most recent calibration date;
- b) Information on the pollution control equipment, including the type of control (selective catalytic reduction, etc.), manufacturer of the control equipment, control parameters (ammonia injection rate, oxygen sensor voltage output, catalyst inlet and outlet temperature, catalyst differential static pressure, etc.), and other parameters required to be monitored by the Inspection and Monitoring Plan;
- c) A description of other monitoring equipment, such as instruments for determining horsepower output, engine load, electricity produced and waste heat utilization;
- d) Information regarding the operating schedule of the equipment. Include information such as whether the equipment operates "on demand", the peak periods of operation, and the operational hours in hours per day, days per week, and weeks per year;
- e) Information regarding the engine's normal duty cycle (i.e., steady load or load variation), the load range over which the engine operates (excluding idle) and any load restrictions in the Permit to Operate;

3.2 PROCESS DESCRIPTION

A description of the process operation during sampling shall include, but not be limited to, the following information:

- a) Provide a stepwise description explaining the entire process operation (relating to the engine). The description shall also include a schematic of this process;
- b) Indicate whether the operation was a continuous or batch process. If it was a batch process, state the length of each batch interval, and when (within this interval) the test was performed;
- c) The engine load in terms of electrical kilowatts produced or other available measure and the extent of modulation of load and/or fuel input rate during sampling;
- d) Whether the engine had operated normally;
- e) The fuel usage rate; and
- f) Miscellaneous data, such as fuel pressure and temperature, catalyst inlet and outlet temperatures, air-fuel ratio controller set points, O₂ sensor outputs, SCR ammonia or urea flows, and parameters required to be monitored by the Inspection and Monitoring Plan.

3.3 TEST CONDITIONS

The source test must include NO_x, CO and VOC testing for at least 30 minutes with the engine operating in its normal duty cycle and testing for NO_x and CO for at least 15 minutes each at the engine's maximum and minimum (excluding idle) loads or the highest and lowest loads that can be practically achieved at the time of testing. If the maximum or minimum load cannot be achieved at the time of testing, the test report must describe the circumstance that prevented the desired load from being achieved. Testing at maximum and minimum loads is not required if the permit restricts the engine to one defined load, $\pm 10\%$.

All data acquired by the source tester must be reported; i.e., no “unofficial” pre-testing is allowed, and a test run that shows noncompliance must be completed and reported.

4.0 ANALYTICAL REQUIREMENTS USING STANDARD DISTRICT METHODS

4.1 DISTRICT METHOD 100.1

Simultaneous and concurrent stack gas measurements of NO_x, CO, and oxygen shall be determined by following District Method 100.1, and using the following types of analyzers. Other types of analyzer principles may be employed upon written approval by the District.

Gas Constituent	Analyzer Principle
NO _x	Chemiluminescent
CO	Non-Dispersive Infrared (NDIR)
Oxygen	Electrochemical or Paramagnetic

The sample concentration must fall within 20 to 95% of the analyzer range for at least 95% of the time. To determine the best analyzer range, a preliminary screening of the gas concentration may be necessary; however, it is mandatory that the results from this preliminary screening be included as part of the continuous DAS and stripchart output which is submitted with the test report. Since the carbon dioxide and oxygen concentrations in combustion products are related stoichiometrically, it is strongly recommended that carbon dioxide also be measured during gas sampling to partially verify the data quality. Carbon dioxide sampling is also addressed in District Method 100.1.

When VOC sampling is required, both the Method 100.1 and VOC samples must be collected simultaneously for at least 30 minutes. VOC sampling is discussed in Section 4.2 of this protocol.

4.1.1 SAMPLE CONDITIONING REQUIREMENTS

For Method 100.1 testing, proper sample conditioning is essential for representative sampling. Sample conditioning includes removal of particulate matter and moisture in the sample gas stream without removal of the pollutants of interest. In particular, NO₂, due to its high solubility in water, is more susceptible to scrubbing than, for example, NO or CO.

The District recommends a gas sampling system which can be used universally. The set up includes a heated 1/4 inch stainless steel probe with 50-80 μ (micron) size sintered 316 stainless steel or ceramic filter at the tip and a short (not more than 6 feet) heated Teflon line to a sample conditioning system. The temperature of the probe and the Teflon line shall be maintained at about 250 °F. The conditioning system consists of a pair of standard Greenburg-Smith impingers with the stems cut to about 1 inch length from the top, immersed in a bath containing water and dry ice pellets, and immediately followed by a thermo-electric cooler or permeation drier. The gas temperature at the outlet of the impinger shall be less than 60 °F, and the gas at the drier outlet shall be maintained at a dew point less than 37 °F. If the drier cannot be directly connected to the impinger outlet then a Teflon line heated to 10 °F above the impinger outlet gas temperature can be used for connection. Another particulate filter (~ 5 μ) shall be in line immediately after the cooler/drier. **All sample conditioning temperatures shall be measured and recorded (preferably on the strip chart) once sampling has commenced, and at least every 15 minutes thereafter until the end of sampling.** If the moisture content of the exhaust gas is below 5% and the sample gas flow rate is less than 10 liter/minute, the impinger set-up need not be used as long as no moisture condensation occurs in the system and the conditioned sample is maintained at the required dew point.

Precaution: Never let the water in the impingers accumulate more than 1/4 of the impinger's height. Do not let the water bath freeze around the impingers; it may cause

cracking of glass impingers. Make sure that the thermo-electric cooler/permeation drier has adequate design capacity. A good maintenance schedule shall be followed for the cooler/drier.

An example of a non-universally applicable water removal system is a refrigerated cooling coil based system. A refrigerated cooling coil system scrubs out a high percentage of the highly water soluble pollutants due to comparatively high residence time and intimate contact between the sample gases and water droplets collected on the inside wall of the coil. This type of sample conditioner is not suitable in all cases.

Other systems may be used, upon District's approval, as long as they meet the requirement for water removal immediately after separation from the gas stream and are designed to minimize water contact with the gas stream.

4.1.2 INSTRUMENTAL ANALYZER PROCEDURES

A general guideline for conducting Method 100.1 is included in Attachment I. The guideline is provided to clarify and emphasize some of the key points of Method 100.1 requirements.

Leak checks must be performed before and after conducting the series of engine tests. Follow the leak check procedure as stated in Method 100.1.

Analyzer calibration error, system bias and linearity checks must be performed before and after conducting the series of engine tests. In addition, bias checks must be performed at two hour intervals, per Section 2.6.2 of Method 100.1. A system response time test must be performed before the concentration sampling. Tester shall survey possible interferences emitted by the equipment, and perform interference response tests, if necessary.

NO₂ to NO converter efficiency check must be performed at the beginning of each test day. The converter efficiency check procedure is included in Attachment I.

4.1.3 FIELD SAMPLING PROCEDURE

Field sampling shall follow the procedures in Section 2.6 of District Method 100.1.

Testers may address stratification issues as follows:

- a) Stack diameters less than 4" ID may be sampled at a single point located at the centroid of the stack, as long as the sampling point is located a minimum of five stack diameters downstream, and three stack diameters upstream of a flow disturbance.
- b) For stack diameters greater than or equal to 4" ID and less than 12" ID, a minimum of three traverse points through the centroid of the stack and along the line of highest expected stratification shall be performed at 16.7%, 50%, and 83.3% of the stack diameter. As required for stack diameters less than 4" ID, the sampling point shall be located a minimum of five stack diameters downstream, and three stack diameters upstream of a flow disturbance.
- c) For stack diameters greater than or equal to 12" ID, or for sampling locations that do not meet the minimum upstream and downstream requirements above, the probe traversing procedure specified in Section 2.6 of Method 100.1 shall be performed.

All QA/QC requirements of Method 100.1 shall be strictly followed. All field and laboratory data, including calculations, annotated chart traces, and calibration results, shall be submitted with the test report.

Record the process variables listed in Section 3.2. Fuel flow rate shall be recorded at the beginning and end of the test, and at a maximum of ten minute intervals during sampling. For totalizing fuel meters, calculate the fuel flow rate from volumetric reads taken at these same intervals. If the totalizing fuel meter does not update a minimum of ten

volumetric units during the test period to obtain a read at each interval, fuel flow rate may be calculated by timing a rotating test dial. The timing of the rotating test dial must take place over a minimum of 60 seconds. For example, if a 100 cubic foot test dial goes around once in 20 seconds, it will be necessary to record the time it takes the dial to go around 3 times, for a total of 300 cubic feet. If necessary, measure gas pressure and temperature to correct the flow to 29.92"Hg (absolute) and 60°F.

4.1.4 DATA ACQUISITION SYSTEM (DAS)

A DAS must be used to record and report the analyzer readings. The DAS must provide one-minute and 15-minute averages in units of ppm for NO_x and CO, and in percent for O₂ (and CO₂, if desired). A copy of the continuous strip chart and DAS output, beginning from the preliminary screening (or pre-test calibrations if a screening was not conducted), and ending following the final post-test calibrations, must be included in the final report.

4.2 **DISTRICT METHODS 25.1 AND 25.3**

Stack gas measurements of VOC shall be sampled and analyzed using either District Methods 25.1 or 25.3, as applicable. In general, Method 25.1 is used to collect samples with stack VOC concentrations greater than, or equal to 50 ppm as carbon (ppmC), whereas Method 25.3 is used for VOC sampling of concentrations less than 50 ppmC. Method 25.3 also requires that the VOC captured in the Method 25.3 traps be less than 25 ppmC. In some instances, use of Method 25.3 for VOC concentrations greater than 50 ppmC will be recommended when stack exhausts contain high concentrations of carbon dioxide and moisture (i.e., when the moisture percentage multiplied by the carbon dioxide percentage exceeds 100). Due to the uncertainties in the outlet concentrations, it is recommended (but not required) that both Methods 25.1 and 25.3 samples be collected and analyzed at each location. In contrast with Method 100.1, the VOC analyses by Methods 25.1 and 25.3 are not performed at the test site, and require that the transfer of

sample ownership be documented (chain of custody) from the equipment preparation to the final laboratory analysis. To properly characterize the emissions, it is mandatory that samples for VOC be collected concurrently with the NO_x, CO, and O₂ samples.

Following the laboratory analysis, a comparison shall be made between the O₂ and CO results in the canister with the Method 100.1 or portable analyzer results to assess the uniformity of the sampling locations and the analytical procedures.

4.2.1 METHODS 25.1 AND 25.3 VOC SAMPLING GUIDELINES

In order to assess precision, duplicate samples are required for the VOC test during the normal duty cycle. Testers shall also address stratification and other pre-test issues prior to sampling (see Section 3.1 of District Method 25.3, which is also applicable to Method 25.1). It is important that the sampling equipment be thoroughly cleaned prior to use in the field. To assure adequate equipment preparation for Method 25.3 equipment, one field blank set consisting of one trap is required for each day of testing. It is also important that the field notes be legible and complete, and include items such as the testing date, testing personnel, the pre-test and post-test leak check results, trap and tank identification numbers, probe locations, tank pressure readings at 10 minute intervals, the start and stop times, and process operating data. Caution shall be applied to avoid contaminating the probe tips through excessive handling, or by scraping VOC laden objects. During sampling, testers shall monitor the ice level of the condensate traps, and maintain a constant flow rate. Note that the entire Method 25.3 sampling probe must be exposed to the heat of the stack in order to avoid condensation. In addition, the final canister gauge reading shall be between 2" and 15" Hg at the end of the test.

4.2.2 METHODS 25.1 AND 25.3 ANALYTICAL GUIDELINES

Analytical procedures must be performed strictly per District procedures. Deviations to the analytical methodology are not acceptable, unless approved in writing by the District prior to testing. Methods 25.1 and 25.3 laboratory data and calculations shall be

submitted with the test report, including detailed annotations of GC traces and other analytical reports. The results of all QA/QC and calibration procedures required by Methods 25.1 and 25.3 must be verified with data, and included with the test report. The time sequence of injections, including calibration checks and standards injections, must be annotated to allow a quick identification of each sample peak. Additionally, analytical calculations must be submitted showing the proper units. If a spreadsheet is employed, then detailed sample calculations shall be included with the test report. The total VOC determined separately from each duplicate trap/ canister sampling system shall be compared against the mean VOC result. If the percent difference from the mean of either duplicate pair differs by more than 20%, the VOC data will be considered potentially suspect, and the tester shall include a detailed assessment of the data quality in the Test Critique section of the report.

The Method 25.1 and 25.3 canister samples shall be analyzed for O₂, CO₂, and CO by District Method 10.1. The calibration gases used must bracket the sample concentrations in the canisters, and certified to an analytical accuracy of $\pm 1\%$. Ambient air shall not be used to calibrate the instruments.

5.0 ANALYTICAL REQUIREMENTS USING PORTABLE ANALYZER METHOD

Portable analyzer sampling and analysis is an alternative to District Method 100.1 for testing natural gas fired units, and relies on ASTM Test Method D6522. Copies of this method is available for purchase at the following website: www.astm.org.

5.1 START UP

5.1.1 ANALYZERS

Allow analyzers to warm up according to manufacturer's instructions, and Section 10.3 of ASTM D6522.

5.1.2 HEATED SAMPLING LINE

Energize sample pump and sample line. Allow temperatures and flows to come to equilibrium. Since the absence of a heated sampling line may cause the NO₂ to be under-reported, heated lines must be used to demonstrate that NO_x concentrations meet emission limits. However, the use of a heated line is optional for AQMD tests when demonstrating that NO_x concentrations exceed the required limits.

5.1.3 MOISTURE REMOVAL SYSTEM

The dew point of the conditioned gas shall not be greater than 50°F. Testing shall not be performed if the ambient temperature falls below 55°F unless the sampling line between the moisture removal system and the analyzer is heated above the dew point.

5.2 ANALYZER CALIBRATION

Use NIST traceable calibration gases which are certified to a minimum accuracy of $\pm 2\%$. The use of blended gases for calibrations is acceptable as long as the quality of the calibration gas meets or exceeds EPA Protocol G1 or G2 procedures, and the calibration gas is not used beyond its expiration date. A high span calibration gas shall be selected

according to ASTM D6522 procedures. Calibrate the analyzers according to ASTM D6522 using zero gas, mid-level gas, and high-range gas. Calibrating the oxygen analyzer using ambient air is acceptable for stack oxygen concentrations greater than 10 percent. For in-stack concentrations less than or equal to 10 percent, one of the blended calibration gases shall be oxygen at a certified concentration between 9 percent and 11 percent. Calibrations of each analyzer must be performed prior to and following each sampling test day. Linearity may be checked using a gas divider if it is calibrated according to EPA Method 205.

The analyzers shall meet the zero calibration error, span calibration error, interference response, linearity, and stability check response specifications of ASTM D6522, Section 9, except that linearity and stability checks may be conducted once every calendar week. The pre- and post-test zero and span calibration error checks must be performed at the sampling location according to Sections 10.4.1 and 10.7.1 of ASTM D6522.

5.3 DATA RECORDING

The data shall be recorded using procedures in Section 7.12 of ASTM D6522. The recorder must allow each data point to be read at least once every minute.

5.4 FIELD SAMPLING PROCEDURE

5.4.1 SAMPLE POINT LOCATIONS

With the exception of single point sampling for exhaust stack configurations described in Section 5.4.2(a), traverse sampling shall be performed along one cross-sectional axis of the stack, using three points at 16.7, 50, and 83.3 percent of the stack diameter. The sampling location upstream and downstream of flow disturbances shall be selected as described in Section 10.1 of ASTM D6522.

5.4.2 TRAVERSE SAMPLING

At the start of the test, record the time and ambient conditions. Do not interrupt the flow to the portable analyzer. Follow the Sample Collection procedures of ASTM D6522 (Section 10.6) with the following exceptions:

- a) Stack diameters less than 4" ID may be sampled at a single point located at the centroid of the stack, as long as the sampling point is located a minimum of five stack diameters downstream, and three stack diameters upstream of a flow disturbance. Gas concentrations shall be recorded at one minute intervals throughout the sampling periods required by Rule 1110.2.
- b) For stacks greater than or equal to 4" ID, gas concentrations shall be recorded at one minute intervals for ten consecutive minutes at each of the three traverse points during the normal duty cycle. During maximum or minimum engine loads, gas concentrations shall be recorded at one minute intervals for five consecutive minutes at the same three traverse locations. Note that although thirty minutes of testing will be conducted during the normal duty cycle, the actual sampling time will be longer, depending on the response time or stability time. Identify the traverse points being sampled along with the gas concentrations at each point.

Determine the arithmetic mean of the gas concentrations measured during the test period. Record the process variables and equipment firing rate per Section 3.2.

5.4.3 CELL TEMPERATURE MONITORING

Not required if sensors are temperature controlled. Sensor temperature shall not exceed 125 degrees F.

5.4.4 INTERFERENCE VERIFICATION AND RE-ZEROING

Refer to Sections 10.8 and 10.9 of ASTM D6522. In addition to the interference checks required by ASTM D6522, an annual interference check of the NO and NO₂ sensors shall be performed when testing combustion devices which have a potential to emit SO₂

concentrations greater than 10 ppm. The interference check procedure should consider both positive and negative biases in the data, and shall demonstrate (using an equation similar to that in Section 11.2 of ASTM D6522) that the combined NO and NO₂ interference responses due to SO₂ contribute less than 5% of the NO_x concentration in the stack. The tester shall justify the SO₂ concentration selected for interference verification using historical data, or mass balance calculations.

6.0 TESTING UNDER NON-IDEAL CONDITIONS

The following is a discussion of some common non-ideal conditions and their solutions in source testing:

If there are fluctuations in the process or operating conditions, such as, changes in load, the testing may continue as long as the operating conditions are recorded to show each fluctuation. If the combustion equipment shuts down completely or if there are severe fluctuations during sampling, testing may be repeated during acceptable operating conditions. The severity of fluctuations will be determined on a case-by-case basis. If the device has the tendency to operate at a non-ideal condition for testing, a protocol for testing at such condition shall be submitted for review and approval prior to testing.

If there are dampers or bypass stacks present, testing shall be conducted as follows:

- 1) If excess air is frequently introduced to the exhaust stack at a variable rate, concentration testing shall be performed while no excess air is introduced to the exhaust stack.
- 2) When all or part of the exhaust gas is frequently restricted to or bypassed from the exhaust stack, concentration testing shall be performed while the total exhaust gas is routed to the exhaust stack.

All changes in process and operating conditions and test interruptions must be noted with the beginning and ending times of each occurrence on the field data sheets.

For multiple stacks, perform sampling at each of the stacks during acceptable testing conditions. Generally, sampling at each stack need not be performed simultaneously if compliance of a concentration limit is tested and stratification is not a concern. Tests for mass emission based limits however, will require simultaneous sampling at all stacks.

Due to the complexities involved, the District shall be consulted whenever a device with multiple stacks is tested.

Because the oxygen correction term is in the denominator of the equation presented in Section 7.1.2, errors in oxygen measurements at concentrations approaching 20.9% are greatly magnified in the calculation of NO_x or CO emissions. Hence, an alternative procedure for accurately determining NO_x and CO emissions at high oxygen concentrations is necessary. For stack oxygen concentrations exceeding 19%, facilities may follow the procedures outlined in Section 8.0 of the Rule 1146 protocol to calculate emissions in units of pounds per million Btu (lb/MMBtu). See the District's "Protocol For The Measurement Of Nitrogen Oxides, Carbon Monoxide, And Oxygen From Sources Subject To South Coast Air Quality Management District Rule 1146" for details of this procedure. Note that emissions expressed as lb/MMBtu may be converted to a parts per million (ppm) basis once the EPA F-Factor of the fuel is determined (see 40CFR60 Appendix A, Method 19).

Rich burn engines can present problems due to very low oxygen concentrations in the exhaust. For these cases, the oxygen concentration can often be stoichiometrically calculated based on CO₂ measurements in the exhaust.

If other non-ideal testing conditions exist, the facility must address them in the submitted source test protocol for review and approval prior to testing.

7.0 CALCULATIONS

Calculations shall be carried out to at least one significant digit beyond that of the acquired data and then shall be rounded off after final calculation to three significant digits for each run. All rounding off of numbers shall be in accordance with the ASTM E380-82 procedures.

7.1 NO_x, CO, AND VOC EMISSIONS

7.1.1 CONCENTRATION CORRECTIONS

All emission concentrations determined using District Method 100.1 or hand-held portable analyzers shall be corrected according to Section 2.7 of District Method 100.1, or per Section 11.1 of ASTM D6522.

For hand-held portable analyzers, NO_x data less than 10 ppm shall be reported as "< 10 ppm", and then corrected per Section 11.1 of ASTM D6522. However, if the correction reduces the concentration value (i.e. < 9 ppm), the result shall be reported as "< 10 ppm".

VOC concentrations sampled and analyzed by District Method 25.3 shall be adjusted by a bias correction factor. Refer to Section 5.3 of Method 25.3 for the calculation procedure using this correction factor.

7.1.2 NO_x OR CO EMISSION (Concentration at 15% O₂)

Compute using the following:

$$N = (P) \frac{20.9 - 15}{20.9 - \%O_2}$$

Where:

N = NO_x or CO concentration (ppm) corrected to 15% O₂;

P = NO_x or CO concentration, (ppm), dry basis, measured in the flue gas and adjusted per Section 7.1.1;

%O₂ = Oxygen concentration (%), dry basis, measured in the flue gas and adjusted per Section 7.1.1.

7.1.3 VOC EMISSION (Concentration at 15% O₂)

Compute using the following:

$$V = (C) \frac{20.9 - 15}{20.9 - \%O_2}$$

Where:

V = VOC concentration (ppm) corrected to 15% O₂;

C = VOC concentration, (ppm), dry basis, measured in the flue gas and adjusted per Section 7.1.1, as applicable;

%O₂ = Oxygen concentration (%), dry basis, measured in the flue gas and adjusted per Section 7.1.1.

7.1.4 NO_x, CO, AND VOC EMISSION FOR NON-BIOGAS ELECTRICITY GENERATION ENGINES (Lb/MW_e-Hr)

The following equation shall be used to calculate the Lb/MW_e-hr NO_x, CO or VOC:

$$\text{Lb/MW}_e\text{-hr} = K \times N \times Q / \text{MW}_e$$

Where,

K = .00368* for NO_x, .00224* for CO and .00128* for VOC (as methane)

N = average pollutant concentration during sampling period, ppmvd @ 15% O₂

Q = average rate of fuel input during sampling period, MMBtu/hr

MW_e = average rate of net megawatt electricity output** during sampling period

- * These constants apply only for natural gas, propane and/or butane fuel. For other fuels, the constants can be derived using the following equation:

$$K = 9.19 \times 10^{-9} \times F_d \times \text{Mol.-Wt.}$$

Where,

F_d = “F factor” in 40CFR60, Appendix A, Method 19

Mol.-Wt. = molecular weight of pollutant (46 NO_x, 28 CO, 16 methane)

- ** Net electricity production is the gross electricity production by the generator minus the parasitic loads needed to operate the cogen plant (water pump, etc.).

8.0 QUALITY ASSURANCE/ QUALITY CONTROL (QA/QC)

The test and analytical equipment shall meet all QA/QC requirements cited throughout this Protocol, and where none is cited, shall be calibrated as a minimum within the requirements set forth in SCAQMD Source Test Manual Chapter III, Calibrations.

8.1 PRESSURE MEASUREMENT

Pressure measurement instruments shall have an error no greater than the following values:

<u>Measurement</u>	<u>Accuracy</u>	<u>Precision</u>
Gas and Liquid Pressure	$\pm 5\%$ (of Reading)	$\pm 2\%$ (of Range)

8.2 TEMPERATURE MEASUREMENTS

Temperature measuring instruments shall have an error no greater than the following values:

<u>Accuracy</u>	<u>Precision</u>
$\pm 1.5\%$ of Reading	$\pm 1.5\%$ of Reading

8.3 FUEL GAS FLOW

The gas meter reading (if required) shall be corrected to dry standard conditions (60°F, 14.7 psia), and adjusted for instrument calibration. Calibration curves shall be used if required. The overall accuracy of gas flow measurements shall be equal to or less than 2% of the actual value.

8.4 NON-GASEOUS FUEL USAGE MEASUREMENTS

The accuracy of non-gaseous fuel use measurements, using calibration curves if required, shall be equal to or less than $\pm 2\%$ of the actual value. Calibration data shall be submitted with the test report.

8.5 TIME

The elapsed time measurement shall be measured with an instrument that is accurate within ± 0.5 seconds per hour.

9.0 REPORT

9.1 REPORT INFORMATION

The following information is to be included in the test report:

1. All printouts, must be included in the final report and must be clearly identified as to:

-location/source	-range changes
-operator initials	-range of measurement
-date/running times	-calibrations
-actual test interval	-cal gas concentration/cyl. no.
-contaminant/diluent	-range of calibration
2. A summary of the Source Test results.
3. A brief process description, including all information listed in Section 3.0.
4. A simple schematic diagram of the process, showing the sampling location, with respect to the upstream and downstream flow disturbances.
5. The sampling and analytical procedures. Be specific about all aspects of sampling and analysis. Include diagrams of test equipment and methods.
6. Complete raw field data, including production data indicative of the testing interval, analyses, and the test results (show all calculations).
7. Calibration data regarding all sampling and measuring equipment utilized during testing (see District Source Testing Manual, Chapter III or "Quality Assurance Handbook For Air Pollution Measurement Systems", Vol. III, U.S. EPA-600/4-77-0276).
8. A signed statement confirming that the testing laboratory satisfies all criteria for an independent laboratory, as defined by District Rule 304(k).
9. A statement signed by the engine operator that the engine was not tuned or serviced since at least 40 operating hours or one week prior to the source test.

9.2 REPORT FORMAT

The report shall be submitted in a hardcopy format. For ease of processing however, it is recommended that an electronic copy accompany the hardcopy report. In addition, each page of the final test report (including raw analytical and field data, as well as other third party reports) must have a unique and sequential page number which can be referenced in correspondences. The information in the final report shall be formatted as follows:

- I. Table of Contents
- II. Executive Summary
- III. Results Table
- IV. Introduction
- V. Equipment/ Process Description including fuel meter(s), if applicable. This section shall include a statement that verifies acceptability of the method test location and the operating condition during the test.
- VI. Test Critique
- VII. List of Sampling and Analytical Methods Used. This section shall include a list of the test methods used. Do not include copies or descriptions of the source test methods if the methods were adhered to as written. If exceptions were made to the methods, submit only an explanation of the exceptions.
- VIII. Appendices
 - A. SCAQMD Method Results
 - B. Portable Analyzer Results
 - C. Schematics of Stack Sampling Locations
 - D. Field Data Sheets - testing method and process data sheets shall be compiled in separate sections
 - E. QA/QC
 - F. Laboratory Analytical Data
 - G. Calibration Data and Calculations
 - H. Calibration Gas Certificates
 - I. Chain of Custody Information (as necessary)
 - J. Process Operating Data Including Fuel Usage During Test
 - K. Calculations Using Fuel F-Factor (if necessary)
 - L. Certifications

ATTACHMENT I

**DISTRICT METHOD 100.1 GENERAL REQUIREMENTS AND
NO₂ TO NO CONVERTER EFFICIENCY CHECK PROCEDURE**

GENERAL CONTINUOUS GAS MONITORING REQUIREMENTS

The District requires continuous gas monitoring equipment employing sample extraction and conditioning, and electronic detection, to be conducted strictly according to District Method 100.1, with the emphasis upon representativeness, documentation, and quality assurance. This includes, in part:

1. Gas analyzers must meet minimum acceptable standards for method of detection, sensitivity, noise, precision, linearity, and interference (see TABLE 100.1-1 for details). Also, the gas sample extraction and conditioning equipment (probe, filter, pump, conditioner, connective plumbing, etc., and data acquisition and logging equipment shall meet minimum acceptable specifications, as described in Method 100.1.
2. It is recommended that the entire sampling system for continuous gas monitoring instruments should be leak checked before and after each test run by evacuating the system to a minimum of 20 in. Hg vacuum, and plugging for a period of 5 minutes. The resultant loss of vacuum can not exceed 1 in. Hg during this period.
3. Calibration of all analyzers must be accomplished at zero, mid span (40-60% of full scale range), and high span (80-95% of full scale range). The lowest practicable range should be selected for monitoring, so that the measured emission values are within 20-95% of the range. If a significant amount of the data are outside of this range, the data may be rejected, depending upon the application.
4. The calibration gases must be certified according to EPA Protocol Number 1, or certified to an analytical accuracy of $\pm 1\%$ and be NIST traceable (except cal gases used for system bias check), following EPA-600/R93/224, "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards", TABLE 2-2. Superblend or multi-component blend gas recertifications are based upon the individual component(s) with the shortest recertification date.
5. Field calibrations employing gas dilution systems (mass flow or critical orifice) must be performed in accordance with EPA Method 205, "Gas Dilution Verification Protocol", or available "Draft" SCAQMD Method, and supported with appropriate documentation. A 5-point check is required.
6. A calibration error check, and zero/span drift check must be performed before and after each test run. Calibration error must be less than $\pm 2\%$ of the range of measurement for zero, mid, and high range calibration gases. Zero/span drift must be less than $\pm 3\%$ of the range of measurement.
7. A system bias check must be performed before and after each test run by alternately introducing cal gases to the entire sampling system, then to the gas analyzer(s), for comparison. The difference can not exceed $\pm 5\%$ of the analyzer range.
8. Semi-annual analyzer certifications consisting of linearity plot, calibration curve, response time, and interference response must be furnished with the other calibrations to satisfy Q/A documentational requirements.
9. NO_x measurement must be performed in the NO_x mode of the analyzer. An NO₂ to NO converter is required if NO₂ constitutes 5% or more of the total NO_x in the sample stream, or

the rule or permit condition requires "NO_x" monitoring. The NO₂ to NO converter must be at least 90% efficient (use the NO₂ to NO converter efficiency procedure). The converter should be high temperature (650°C) stainless steel, if no NH₃ is present. If NH₃ is present in the sample stream, then a low temperature (350°C) molybdenum catalyst must be used in the converter. This check must be done at the beginning of the test.

10. The connective tubing from the probe to the sample conditioner must be heated above the dewpoint and the dewpoint reported. The sample conditioner must be able to maintain a dewpoint temperature of 37°F or less.
11. Data recorder resolution must be at least 0.5% of the range of measurement. A data point for each contaminant/diluent monitored must be recorded at least once/minute. Analog chart recorders must have a minimum 10-inch chart width, with 100 minor divisions.
12. All facets of testing must be continuously recorded. This includes the 3-point calibration, system bias, calibration error, and zero/span drift checks, which must precede and conclude each test run.
13. All chart traces, or digital printouts, must be included in the final report and must be clearly identified as to:
 - location/source
 - operator initials
 - date/running times
 - actual test interval
 - contaminant/diluent
 - range changes
 - range of measurement
 - calibrations
 - cal gas concentration/cyl. no.
 - range of calibration
14. When more than one gas trace is shown on a chart, the individual traces must be distinguishable by color coding or some other means (original charts may be submitted, and returned following evaluation). If a gas measurement range has been "offset" from zero, or zero has been "transposed" to the right side of the recorder chart, it must be clearly identified. this offset should not be more than 5-small divisions of the chart. This data must be corrected using the ratio of the offset.
15. Gaseous measurements must be conducted a minimum of 15 continuous minutes at each load or specified condition, after the readings have stabilized (RECLAIM reference method sampling requires a minimum of 30 continuous minutes at each load for RATAs).
16. Sampling locations not meeting the minimum site selection standards for District Method 1 must be tested for absence of stratification. (A gaseous constituent concentration profile differing more than 10% between any two monitoring points within the same cross-sectional plane of a stack or duct indicates stratification.) If stratification is present, and alternate approved site selection or modification is not possible, then special monitoring (see Chapter X of the District Source Testing Manual) will be required.

NO₂ TO NO CONVERSION TEST PROCEDURE
(Alternative to O₃ Titration Method-40 CFR 50.1, Appendix F)

1. NO_x Analyzer Requirements

- a. Full span range 0-20 ppm or 0-25 ppm
- b. Equipped with NO and NO_x modes

2. Auditing Gas Requirements

- a. NO₂ in air (or N₂): Use NO₂ in air for a stainless steel converter.
- b. Concentration of NO₂: 15 to 18 ppm ± 0.5 ppm (*C₀, ppm*)
- c. Recertification: An audit gas should be recertified after six months.

3. Calibration Gas Requirements

- a. Concentration: NO (17 to 19 ppm) with less than 0.1 ppm NO₂ - High Span
NO (10 to 13 ppm) with less than 0.1 ppm NO₂ - Mid Span
- b. Zero Gas: High purity N₂

4. Calibration of Analyzer:

- a. Calibrate NO mode with the NO calibration gases.
- b. Calibrate NO_x mode with the same gases without any gain adjustment.
- b1. If the analyzer is equipped with two independent gain adjusting circuits, skip 4.b., then repeat 4.a. for the NO_x mode.

5. Conversion Efficiency (CE) Test

- a. Analyze the audit gas with NO mode. Read and standardize concentration. (*C₁, ppm*)
- b. Analyze the audit gas with NO_x mode. Read and standardize concentration. (*C₂, ppm*)

6. Calculation for Conversion Efficiency:

$$\%CE = \frac{|C_2 - C_1|}{C_0} \times 100$$

7. Criteria for Acceptability of CE

- a. %CE must be larger than 90%.
- b. C₁ must be less than 5 % of total NO_x (NO + NO₂) in the NO₂ audit gas (Section 2b).

NOTE: NO₂ audit gas concentration of higher value than what is specified in *Section 2*, may be required where NO₂ present in the exhaust gas being measured is greater than 30 ppm. Select the NO₂ gas within 10% of the expected NO₂ concentration in the exhaust.