Mashantucker Pequot Tribal Nation
Natural Resources Protection
Air Quality Program

Air Quality Permit

Draft

Permit No.: **Con-004**
Public Notice: **July 14, 2022**
Date of Issue:

When final, this Permit certifies that **GWR Connecticut, LLC, 201 Rainmaker Drive, Mashantucket, CT,** has been granted a Permit to Construct a hotel and water park. This project consists of numerous fuel combustion sources including boilers, water heaters, package units, and other miscellaneous equipment described herein to provide heat and hot water. The facility will also install an emergency generator. All units are to combust natural gas.

General Conditions

1. The Permittee shall be subject to the requirements of the Mashantucket Pequot Tribal Nation (MPTN) Clean Air Program (47 M.P.T.L.) and all conditions stated within this Permit.
2. Representatives from the MPTN Air Quality Program (AQP) must be granted access during all hours at which the facility is in operation, for the purpose of determining compliance with this and any other Tribal or Federal air pollution control requirements, regulations or law.
3. The Permittee shall furnish to the AQP, within a reasonable time, any information that the AQP may request in writing to determine whether cause exists for revising, revoking and reissuing, or terminating the Permit, or to determine compliance with the Permit. For any such information claimed to be confidential, you must also submit a claim of confidentiality in accordance with 40 CFR Part 2, Subpart B.
4. The issuance of this Permit does not prevent the future adoption by the AQP of pollution control rules, standards or orders more stringent than those in existence at the time of issuance and does not prevent the enforcement of these rules, standards or orders against the Permittee.
5. The source shall maintain compliance with all applicable Tribal or Federal air pollution control rules or regulations at all times.
    a. The MPTN AQP attempts to draft complete permits, meaning that they contain provisions of testing, reporting and record keeping necessary for compliance with both the tribal and federal programs. Specifically, provisions are included in this Permit necessary to comply with §40 CFR Parts 60 and 63 ('NSPS' and 'NESHAP'). However, the Permittee should note that the MPTN AQP does not have delegation of this section of the Clean Air Act. Therefore, since the Permittee is solely responsible for compliance, the Permittee should review the applicable parts of the federal Clean Air Act to determine whether compliance with the provisions of this Permit will assure complete compliance with applicable federal standards and regulations.
    b. The Permittee shall not cause or contribute to a violation, or interfere with maintenance of, the National Ambient Air Quality Standards.
6. This Permit does not convey any property rights of any sort or any exclusive privilege.
7. The provisions of this Permit are severable, and in the event of any challenge to any portion of this Permit, or if any portion is held invalid, the remaining Permit conditions shall remain valid and in force.
8. All emission limitations specified within this Permit are based on a 1-hour average consistent with applicable EPA monitoring protocols.
9. This Permit to Construct shall become invalid if construction is not commenced within 18-months after receipt of such approval, if construction is discontinued for a period of 18-months or more, or if construction is not completed within 60 months. The Administrator may extend the 18-month period upon a satisfactory showing that an extension is justified.

Conditions on Permit to Construct

Proposed (5) Water Park Boilers

1. Boilers installed shall be Thermal Solutions AMP-4000 boilers or equivalent, meaning:
    a. units shall be designed to combust only natural gas;
    b. combined maximum nameplate heat input shall not exceed, by more that 10%, the stated combined maximum heat input rating of 20 MMBtu/hr;
    c. units shall be documented in accordance with Condition 2, below, as emitting **NOx** at no greater a concentration than **10 ppmvd @ 3% O_2**.
2. The Owner/Operator shall, within 90 days after first fire complete Initial Tuning and Testing using the procedures specified in this Permit, unless documentation acceptable to the AQP is provided to demonstrate that the units comply with the NOx emission limit stated. Acceptable documentation includes:
    a. certified testing completed for, or by, a state or regional air quality program (e.g. California's South Coast Air Quality Control District) or,
    b. other certified 3rd party testing acceptable to the AQP.
3. The operating hours for these boilers shall be unrestricted.

Proposed (6) Large Water Heaters

1. Units installed must be Raypak XTherm 3005 units or equivalent, meaning:
    a. units shall be designed to combust only natural gas;
    b. combined maximum nameplate heat input shall not exceed, by more than 10%, the stated combined maximum heat input rating of 18 MMBtu/hr;
    c. units shall have been certified Low NOx compliant with BAAQMD's Rule 9-7, or similar air quality district rule, that establishes **NOx** emission limits less than or equal to **30 ppmvd @ 3% O_2**.
2. The operating hours for these water heaters shall be unrestricted.

Proposed (2) Small Water Heaters

1. Units installed must be AO Smith BTH-199 units or equivalent, meaning:
    a. units shall be designed to combust only natural gas;
    b. combined maximum nameplate heat input shall not exceed, by more than 10%, the stated combined maximum heat input rating of 400 MBtu/hr;
    c. units shall have been certified Low NOx compliant with SCAQMD's Rule 1146.2, or similar air quality district rule, that establishes **NOx** emission limits less than or equal to **20 ppmvd @ 3% O_2**.
2. The operating hours for these water heaters shall be unrestricted.

Proposed (1) Emergency Generator

1. The engine for the generator installed shall be Cummins GTA50E or equivalent, meaning:
    a. The engines will be designed to combust only natural gas;
    b. The maximum brake horsepower rating shall not exceed, by more than 10%, 1135 hp;
    c. units shall have been certified by USEPA for Non-Emergency Operation under 40 CFR 60, Subpart JJJJ (Table 1), including:
        i. emissions of **NOx** shall not exceed **1.0 g/hp-hr**;
        ii. emissions of **CO** shall not exceed **2.0 g/hp-hr**; and,
        iii. emissions of **VOCs** shall not exceed **0.7 g/hp-hr**.
2. Prior to first fire, the Owner/Operator shall provide the AQP with the EPA Certificate of Conformity, matching the physical nameplate on the unit, that the engine meets the emissions limitations specified, or other documentation from the manufacturer that the engine is certified to meet the emission standards and information as required in 40 CFR parts 1048, 1054, and 1060, as applicable.
3. The generator shall be equipped with a non-resettable hour meter to record runtime.
4. The hours of operation for this engine shall be compliant with the requirements for an Emergency Engine as defined within 40 CFR Part 60, subpart JJJJ (see Operating Conditions within this Permit for more detail).
5. For the purposes of the facility's Potential to Emit, operating hours for this engine shall be 500 hours/yr.

Miscellaneous Non-Exempt Equipment

Laundry Dryers (7)

1. The six (6) larger units installed shall be Milnor M202DR or equivalent, meaning:
    a. The units will be designed to combust only natural gas;
    b. The combined maximum nameplate heat input shall not exceed, by more than 10%, the stated combined maximum heat input rating of 2.424 MMBtu/hr.
2. The single smaller unit installed shall be a Milnor M82 or equivalent, meaning:
    a. The units will be designed to combust only natural gas;
    b. The maximum nameplate heat input shall not exceed, by more than 10%, the stated maximum heat input rating of 270 MBtu/hr.
3. All units shall vent through an Energenics FRP-20 lint filtering system or equivalent, meaning that the design lint (particulate matter) removal efficiency shall be 98%.
4. Volatile organic compounds discharged by laundry dryers are assumed to be negligible.
    a. Within 90-days of commencing operation, the Owner/Operator shall provide the AQP a list, and an estimated quantity of anticipated use, of detergents, fabric softeners and any other laundry additives.
    b. As authorized by 47 M.P.T.L., in the future, limits on quantity/types of fragranced laundry products may be established.

Ironer

The maximum nameplate heat input for the ironer installed shall not exceed, by more than 10%, the stated maximum heat input rating of 1.2 MMBtu/hr.

Roof Top, Energy Recovery and other Heating and Ventilation Units

1. All fuel burning units installed shall be designed to combust only natural gas.
2. The combined maximum nameplate heat input for all natural gas units in this category shall not exceed 18 MMBtu/hr.
3. No single unit shall exceed a maximum heat input rating of 2 MMBtu/hr.

Miscellaneous Exempt Equipment

The Owner/Operator shall maintain list of exempt equipment and provide a copy of the list to the AQP upon request.

Operating Conditions

1. Emission limitations established and made a part of the construction portion of this Permit shall be incorporated into and become enforceable operational limitations.
2. The source shall be in compliance with all applicable Tribal and Federal air pollution control rules or regulations at the time the stationary source commences operation.
3. The Permittee shall, at all times, properly operate and maintain all sources and systems of treatment and control, and the appurtenances related to them which are installed or used by the Permittee to achieve compliance with the conditions of the Permit.
    a. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate process controls, including appropriate quality assurance procedures.
    b. It is not a defense for the Owner/Operator, in an enforcement action, that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this Permit.
    c. A violation by the Owner/Operator of any Emission Limitation, Emission Standard or any other condition contained in a permit shall subject the Owner/Operator to any or all enforcement penalties, including permit revocation, available under the Clean Air Program. No subsequent permit will be issued until violations have been resolved to the satisfaction of the AQP.
4. This Permit is valid only for the emission unit(s), Owner/Operator, facility, mode of operation and special conditions stated in the application, or Permit. The Owner/Operator can transfer the Permit to a new Owner/Operator only if:
    a. the mode of operation and emissions do not change;
    b. the MPTN AQP determines that no other change in the Permit is necessary; and,
    c. a written agreement between the current and new Permittee is submitted to the MPTN AQP containing the specific date for transfer of permit responsibility, coverage, and liability.
5. Modifications to Facility
    a. Owners/Operators seeking to undertake any one or more modification that meets the definition of a Minor Modification (12 LUR, sub 12.2, Ch, 1, §3b(16)) must obtain a Permit to Construct prior to Beginning Actual Construction on the Modification.
    b. Owners/Operators seeking to undertake a modification for which a new Permit to Construct is not required but that involves a new unit subject to an Emissions Standard (12 LUR, sub 12.2, Ch, 1, §3b(8)) with post operational requirements must apply for an administrative revision at least thirty (30) days prior to undertaking the modification.
    c. For any other modification that does not require a new permit or administrative permit revision, the Owner/Operator must register those changes by supplying the information listed in paragraph 7 below, to the MPTN AQP within thirty 30 days after beginning operation.

6. The Owner/Operator shall maintain an up-to-date list of all facility emission units including units exempt units (e.g. kitchen equipment). This information must be provided to the AQP within 90-days of the facility becoming fully operational and annually thereafter within the Annual Emissions Statement. At minimum this information shall include:
    a. type of unit;
    b. make and model number;
    c. maximum heat input nameplate rating;
    d. emission factor (if provided by manufacturer).

Emergency Generator

1. The generator must be operated as an Emergency stationary internal combustion engine as defined within 40 CFR Part 60, subpart JJJJ (40 CFR § 60.4248, pursuant to 40 CFR § 60.4243(d)):
    a. there is no time limit on use of the generator in emergency situations.
    b. you may operate the generator under limited circumstances a maximum of 100 hours per calendar year for non-emergency situations specified in 40 CFR §60.4243(d). For example:
        i. maintenance testing and readiness checks, provided that the tests are recommended by federal, state or local government, the manufacturer, the vendor, the regional transmission organization or equivalent balancing authority and transmission operator, or the insurance company associated with the engine.
        ii. Other provisions within 40 CFR §60.4243(d) allow limited use under very specific circumstances. Owners/Operators are urged to refer to the current version of the CFRs before engaging in those activities.
2. The Owner/Operator shall install, operate, and maintain a non-resettable runtime meter. Runtime shall be recorded on a monthly basis or more frequent.
3. An Owner/Operator who decides to operate for other non-emergency as allowed under the provisions within 40 CFR §60.4243(d), must:
    a. provide notification to the AQP of the facility's intent to do so with a detailed description of the specific circumstances when the engine will be run;
    b. record separately all runtime hours during maintenance testing and readiness checks, and other allowable non-emergency operation, to document compliance with the applicable hour per calendar year limit(s).
4. Any non-compliant use of the generator shall be reported immediately to the MPTN AQP.
5. The Owner/Operator of an emergency generator shall not initiate a manual test or schedule maintenance on the emergency generator on days when air quality is predicted to be at least "unhealthy for sensitive groups" as defined in the US EPA's Air Quality Index.

6. The Owner/Operator shall perform all inspections and maintenance required by the manufacturer of the engine and the catalyst, if one exists.
    a. Each time the generator is visited for routine maintenance, all exhaust components shall be inspected. Any observed leaks must be repaired and reported to the MPTN AQP.
    b. Annually, at minimum, perform an engine tune-up including: set and maintain at all times the proper ignition/injection timing of the engine. Units with catalysts should be set in accordance with specifications, if any, provided by the catalyst manufacturer, otherwise the engine should be tuned to the specifications of the engine manufacturer.
7. The Owner/Operator shall maintain all records of maintenance and repairs and provide a copy to the AQP upon request.

Boilers and/or Large Water Heaters (>2 MMBtu/hr)

1. Burner shall be inspected routinely, at minimum as specified by the manufacturer. Clean or replace any components of the burner as necessary.
2. At minimum, the Owner/Operator shall complete an annual tune-up including the inspection, adjustment, cleaning or replacement of fuel-burning equipment, including the burners and moving parts necessary for proper operation as specified by the manufacturer.
    a. Unless otherwise specified by the manufacturer, the procedures identified within paragraph 1 of the Initial Tuning and Testing section of this Permit shall be utilized.
    b. Adjust the burner as necessary to optimize the flame pattern.
    c. Inspect the system controlling the air-to-fuel ratio, as applicable, and ensure that it is correctly calibrated and functioning properly.
    d. Optimize total emissions of CO while maintain compliance with the NO_X emission limit specified within this Permit.
    e. Measure the concentrations in the effluent stream of CO and NOx in parts per million, by volume, and oxygen in volume percent, before and after the adjustments are made (measurements may be either on a dry or wet basis, as long as it is the same basis before and after the adjustments are made). Measurements may be taken using a portable analyzer.
    f. Record, maintain on-site and submit as part of your Annual Emissions Statement, documentation that such tune-up was completed within report containing:
        i. the concentrations of NOx and CO in the effluent stream in parts per million by volume, and oxygen in volume percent, measured at high fire or typical operating load, before and after the tune-up of the boiler or process heater;
        ii. a description of any corrective actions taken as a part of the tune-up.

Initial Tuning and Testing for Non-Certified Boilers

1. When required, the Owner/Operator shall provide, at least 30-days prior to testing, notice to the AQP of the date and time when the initial tuning and testing will occur.
2. The notice to the AQP shall also include, the manufacturer's commissioning procedures and tuning specifications necessary to meet the NOx emission standard specified within this Permit while minimizing emissions of CO; otherwise the following procedures will be followed:
    a. Perform an efficiency test using manufacturer's specified procedures, procedures specified in ASME/ANSI Boiler Test Code 4.1, or alternate procedures authorized by the MPTN AQP.
    b. Adjust the combustion process of the boiler in accordance with manufacturer's specifications, procedures specified in Chapter 5, Combustion Efficiency Tables, (Taplin Harry R., Fairmont Press 1991), or to minimize total emissions of NOx, and to the extent practicable minimize emissions of CO.
3. Using a portable emissions analyzer, NOx and CO emissions shall be measured at the minimum, intermediate and maximum firing rates consistent with normal operation. The portable emissions analyzer shall be used according to the Portable Electrochemical Analyzer Procedure CTM-34 attached as Appendix 1 of this Permit.
4. Records of this initial tuning and testing for non-certified boilers, including all results of the NOx and CO readings, must be submitted to the AQP within 30-days after completion. The submittal must be signed by a duly authorized representative of the facility certifying that based on information and belief formed after reasonable inquiry, the statements and information are true, accurate, and complete to the best of his/her knowledge and belief.

Recordkeeping Requirements

1. The Owner/Operator must maintain all required records on-site for a period of five years and make them available to representatives of the MPTN AQP upon request.
2. This five-year period is automatically extended in the event of unresolved enforcement action or request from the MPTN AQP.
3. At minimum records shall include:
    a. all documents associated with any event that resulted in a violation of an applicable Emission Limitation or Emissions Standard. Such records must fully describe the cause of the violation and the reason(s) the violation was unavoidable, including:
        i. identification of unit or units involved;
        ii. date, time and duration of the event;
        iii. whether the event was caused by maintenance, malfunction, emergency or other activity;
        iv. identification of each limitation or standard exceeded including the specific Air Pollutant(s) involved; and, estimated emission rate during the event; and
        v. description of any best management practices employed to limit emissions during the event;
        vi. copies of all reports required by the conditions of this Permit;
    b. records of unit specific maintenance and monitoring; including,
        i. the date(s) when maintenance and analyses were performed;
        ii. the company or entity that performed the analyses;
        iii. the analytical techniques or methods used;
        iv. the results of such analyses; and,
        v. the operating conditions existing at the time of sampling or measurement;
    c. all data used to complete the Annual Emissions Statement.

Reporting Requirements

In the event that emissions of air contaminants in excess of any emission standard in this Permit occur due to a malfunction, the facility Owner/Operator shall report such malfunction by telephone to the MPTN AQP as soon as possible during normal working hours, but in any event not later than two working days after becoming aware that the malfunction occurred. Within 30 days thereafter, the facility Owner/Operator shall submit a written report to the MPTN AQP describing the malfunction, the corrective action taken, identification of air contaminants, and an estimate of the emission rates.

Annual Emissions Statement

1. The Owner/Operator shall provide to the MPTN AQP, on or before March 1st each year, records of activities during the previous calendar year sufficient for the AQP to estimate actual facility emissions. Such records are to include, at minimum:
    a. Generator Runtime records as required under the Operating Conditions section of this Permit. At minimum, the monthly readings of the runtime meter.
    b. Records of monthly fuel usage recorded from all facility meters.
2. Emission Reports shall also include the following:
    a. documentation that the required annual tune-up maintenance on the generator and large boilers and/or water heaters had been completed, including:
        i. the date(s) when performed;
        ii. the company or entity that performed the service;
        iii. reference to the procedure used (e.g. manufacturer/permit specified);
        iv. the results of effluent NOx and CO taken with the portable analyzer; and,
        v. the operating conditions (i.e. firing rate) at the time of measurement.
    b. up-to-date list of all facility emission units. This information must be provided to the AQP within 90-days of the facility becoming fully operational and annually, within Annual Emissions Statement, thereafter. At minimum this information shall include:
        i. type of unit;
        ii. make and model number;
        iii. maximum heat input nameplate rating;
        iv. emission factor (if provided by manufacturer); and,
    c. certification by a duly authorized representative. A duly authorized representative must sign a form provided by the MPTN AQP to verify the truth, accuracy, and completeness of the emission report. This certification shall state that, based on information and belief formed after reasonable inquiry by the duly authorized representative, the statements and information in the document are true, accurate, and complete. The certification shall include the full name, title, original signature, date of signature and telephone number of the duly authorized representative;

Table 1
Facility Wide Emissions*
Air Quality Permit Con-004
Great Wolf Lodge

Unit Type	Nameplate Rating	Nat Gas Thrghput.	Usage hr/yr	Annual Heat Input	Annual Gas Usage	Potential Emissions													
						NOx		CO		PM, PM_{10}, $PM_{2.5}$		VOC		SO_2		Total HAPs[3]		Hexane (Max)[4]	
Boilers	mmBtu/hr*	mmscf/hr		mmBtu/yr	mmscf/yr	lb/mmBtu[1]	TPY	lb/mmBtu[1]	TPY	lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	TPY
(5) Thermal Solutions, AMP-4000 (or Equiv.)	20.000	0.0195	8,760	175,200	170.6	0.0121	1.06	0.0591	5.18	7.6	0.65	5.5	0.47	0.6	0.05	1.89	0.16	1.8	0.154
Hot Water Heaters						lb/mmBtu[2]	TPY	lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	TPY
(6) Raypak, Xtherm 3005 (or Equiv.)	18.000	0.0175	8,760	157,680	153.5	0.0364	2.87	84	6.45	7.6	0.58	5.5	0.42	0.6	0.05	1.89	0.15	1.8	0.138
(2) A.O. Smith, Cyclone MXI, BTH-199 (or Equiv.)	0.400	0.0004	8,760	3,504	3.4	0.0243	0.04	40	0.07	7.6	0.01	5.5	0.01	0.6	0.00	1.89	0.00	1.8	0.003
Emergency Generator	bhp					g/bhp-hr	TPY	g/bhp-hr	TPY	lb/mmBtu	TPY	g/bhp-hr	TPY	lb/mmBtu	TPY	lb/mmBtu	TPY	lb/mmBtu	TPY
(1) Cummins, GTA50E (or Equiv.)	11.700	1,135	500	5,850	3.8	1.0	0.63	2.0	1.25	0.00991	0.03	0.7	0.44	0.0006	0.002	0.0722	0.211	0.00111	0.003
Miscellaneous Non-Exempt Equipment						lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	TPY
(6) Milnor, MLG202DR Dyer (or Equiv)[5]	2.424	0.0024	8,760	21,234	20.7	100	1.03	84	0.87	7.6	0.08	5.5	0.06	0.6	0.01	1.89	0.02	1.8	0.019
(1) Milnor, MLG-82 Dyer (or Equiv)[5]	0.270	0.0003	8,760	2,365	2.3	94	0.11	40	0.05	7.6	0.01	5.5	0.01	0.6	0.00	1.89	0.00	1.8	0.002
Chicago, Imperial 232 Ironer	1.200	0.0012	8,760	10,512	10.2	100	0.51	84	0.43	7.6	0.04	5.5	0.03	0.6	0.00	1.89	0.01	1.8	0.009
HVAC Units (various)	16.200	0.0158	8,760	141,912	138.2	100	6.91	84	5.80	7.6	0.53	5.5	0.38	0.6	0.04	1.89	0.13	1.8	0.124
Miscellaneous Exempt Equipment						lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	TPY	lb/mmscf	b/mmBt	lb/mmscf	TPY
Kitchen Units, Small Heaters, etc.	5.800	0.0056	8,760	50,808	49.5	94	2.33	40	0.99	7.6	0.19	5.5	0.14	0.6	0.01	1.89	0.047	1.8	0.045
Maximum Annual Emissions, Tons per Year (TPY)*							**15.5**		**21.1**		**2.1**		**1.9**		**0.2**		**0.7**		**0.50**

Footnotes:

* Permit allows nameplate (size) flexibility for final units selected.

[1] Emissions Factor based on vendor provided - 10 ppmvd NOx & 80 ppmvd CO

[2] Emissions Factors based on certification by other AQMD, provided as either 20 or 30 ppmvd

[3] Emissions of HAPs based on AP-42 5th Edition: Table 3.2-2 (July 2000) for I.C. Lean Burn; and Tables 1.4-2, 1.4-3, and 1.4-4 (July 1998) for External Natural Gas Combustion

[4] Hexane was determined to be the HAP with the greatest PTE.

[5] PM from non-combustion included with add-on lint capture rated 98% efficient

Appendix 1

Portable Electrochemical Analyzer Procedure, CTM-34

Test Method - Determination of Oxygen, Carbon Monoxide and Oxides of Nitrogen from Stationary Sources

For Periodic Monitoring

(Portable Electrochemical Analyzer Procedure)

1. APPLICABILITY AND PRINCIPLE

1.1 Applicability. This method is applicable to the determination of nitrogen oxides (NO and NO_2), carbon monoxide (CO) and oxygen (O_2) concentrations in controlled and uncontrolled emissions from combustion sources using fuels such as natural gas, propane, butane, and fuel oils. This method is designed to provide a reasonable assurance of compliance using periodic monitoring or testing. This method is not intended for use where an EPA reference test method is required. Due to inherent cross sensitivities of electrochemical (EC) cells, this method should not be applied to other pollutants or emission sources without a complete investigation of possible analytical interferences and a comparative evaluation with other EPA test methods.

1.2 Principle. A gas sample is extracted from a stack and is conveyed to a portable EC analyzer for determination of NO, NO_2, CO and O_2 gas concentrations. Analyzer performance specifications and test procedures are provided to ensure reliable data. Additions to, or modifications of, vendor supplied analyzers (e. g. heated sample lines, thermocouples, flow meters, etc.) may be required to meet the design specifications of this test method. Changes that diminish the analyzer from the as-verified (see Definitions, Section 3.15) configuration are not permitted.

2. RANGE AND SENSITIVITY

2.1 Analytical Range. The instrument and EC cell design will determine the analytical range for each gas component. The nominal range is defined by choosing a span gas concentration near the maximum anticipated flue gas concentration for that constituent or near the permitted level as determined by the appropriate regulatory agency.

2.1.1 NO, NO_2 and CO Span Gases. Choose a span gas concentration such that the average stack gas reading for each test run is between 25 and 150 percent of the span gas concentration. Alternatively, choose the span gas such that it does not exceed twice the concentration equivalent to the permitted level. If the actual emissions exceed 150 percent of the span gas value at any time during the sampling run, the test run for that channel shall be invalid. The NO_2 span gas concentration should be selected at a level within the NO_2 sensor's measuring range, but for span gas stability and availbility considerations, above 75 ppm (in a base of air)is acceptable.

Prepared by The Institute of Clean Air Companies
1660 L Street, NW, Suite 1100
Washington DC 20036
September 8, 1999

2.1.2 O_2 Span Gas. The difference between the span gas concentration and the average stack gas reading for each sample run shall be less than 15% O_2. Where the stack oxygen readings are above 6%, dry ambient air (20.9% O_2) may be used for the span gas. Oxygen readings below 6% should be verified with low concentration calibration gas.

2.2 Sensitivity Range. The minimum detectable limit depends on the nominal range and resolution of the electrochemical cell and signal to noise ratio of the measurement system. The minimum detectable limit should be 2 percent of the nominal range or 1 ppm, whichever is less restrictive.

3. DEFINITIONS

3.1 Measurement System. The total equipment required for the determination of gas species concentrations. The measurement system consists of the following major subsystems:

3.1.1 Sample Interface. The portion of a system used for one or more of the following: sample acquisition, sample transport, sample conditioning or protection of the analyzer from the effects of the stack effluent, particulate matter and condensed moisture.

3.1.2 Interference Gas Scrubber. A device used to remove or neutralize compounds likely to interfere with the selective operation of the cell.

3.1.3 Electrochemical Cell. A device, similar to a fuel cell, that senses a specific gas and generates a current output proportional to the gas concentration.

3.1.4 Moisture Removal System. Any device used to reduce the concentration of moisture in the sample stream for protecting the EC cells from the damaging effects of condensation and for minimizing errors in readings caused by the scrubbing of soluble gases.

3.1.5 Data Recorder. A strip chart recorder, computer or digital recorder for logging measurement data from the analyzer output. The digital data display may be used when taking manual measurements.

3.2 Nominal Range. The range of concentrations over which each cell is operated (25% to 150% of span gas value). Several nominal ranges may be used for any given cell as long as the calibration and repeatability check for that range remains within specification.

3.3 Span Gas. A known concentration of a gas in an appropriate diluent gas.

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3.4 Zero Calibration Error. The gas concentration output exhibited by the gas analyzer in response to zero-level calibration gas.

3.5 Span Calibration Error. The difference between the gas concentration exhibited by the gas analyzer and the known concentration of the span gas.

3.6 Interference Check. A method of quantifying analytical interference from components in the stack gases other than the targeted analyte.

3.7 Repeatability Check. A method of demonstrating that an EC operated over a given nominal range provides a stable and consistent response and is not significantly affected by repeated exposure to the targeted analyte.

3.8 Response Time. The amount of time required for the measurement system to display 95 percent of a step change in gas concentration.

3.9 Initial EC Cell Temperature. The temperature of the EC cells recorded during the most recent pretest calibration check.

3.10 Sample Flow Rate. The flow rate of the gas sample through the analyzer. In some situations, EC cells can experience drift with the changes in flow rate. The flow rate must be monitored during calibration and testing.

3.11 Measurement Cycle. A timed three-phase cycle whereby an analyzer's response rises through a ramp-up phase followed by a stable test data collection phase then purged of the gas sample during a refresh phase. The "Ramp-up Phase" exposes the analyzer to the gas sample for 5 minutes ($t_0 - t_5$). The "Test Data Phase" is the time of the stabilized gas sample measurements ($t_5 - t_7$) with recordings starting at $t_{5:15}$. The "Refresh Phase" is the timed process where the EC cells are purged or flushed with fresh air ($t_7 - t_{15}$). The refresh phase replenishes requisite O_2 and moisture in the electrolyte reserve and provides a mechanism to de-gas (desorption) the interference gas scrubbers and filters to ensure a stable and accurate EC cell response. A diagram of this measurement cycle is shown in Figure 1A. Measurement cycles can be coupled together for evaluations lasting hours providing all other test method specifications are met. Measurement cycles may deviate from those recommended in this protocol if they are approved by the applicable regulatory agency.

3.12 Test Day. A time not to exceed twelve hours from the time of the pre-test verification to the post-test verification. During this time, testing may occur without further need of calibration providing all other testing specifications have been met.

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3.13 Pre-Test/Post-Test Verification. The procedure executed at the beginning and end of each test day to bracket test readings with a controlled performance assurance test.

3.14 NO_x Measurement. If the NO_2 percentage of NO_x is less than 10 percent, you may either measure NO_2 or estimate total NO_x by adding to the NO measurement that amount representing the estimated percentage of NO_2. Historical values may be used to establish the percent of NO_2 provided the determination of NO_2 was based on a stack test. Direct measurement of NO_2 shall be required if the NO_2 percentage is greater than 10 percent of the total NO_X.

3.15 "As-verified". Refers to the analyzer and sampling system configuration as was tested by independent third party organizations (i.e. EPA ETV, SCAQMD, TUV or equivalent).

4. MEASUREMENT SYSTEM PERFORMANCE SPECIFICATIONS

4.1 Zero Calibration Error. The zero level output shall be less than or equal to ± 3 percent of the span gas value or ± 1 ppm, whichever is less restrictive, for the NO, NO_2 and CO channels and less than or equal to ± 0.3 percent O_2 for the O_2 channel (see Section 6.2.1 for zero calibration procedure).

4.2 Span Calibration Error. The average calculated "test data phase" error shall be less than or equal to ± 5 percent of the span gas value or ± 1 ppm, whichever is less restrictive, for the NO, NO_2, CO and O_2 channels. The maximum allowable deviation of any single "test data phase" reading shall be less than or equal to ± 2 percent or 1ppm, whichever is less restrictive, of the average (see Section 6.2.2 for span calibration procedure).

4.3 Interference Response. The CO, NO, and NO_2 interference response must be less than or equal to ± 5 percent of the span gas concentration. Analyzers that have been verified for interference response by a recognized agency (Section 5.1.10) shall be considered in compliance with this interference check specification. The potential for interference from other flue gas constituents should be reviewed with the analyzer manufacturer based on site-specific data (see Section 6.3 for interference response procedure).

4.4 Repeatability Check Response. The calculated average of the "test data phase" for the NO, NO_2 and CO span gases shall not vary more than ± 3 percent or ± 1 ppm, whichever is less restrictive, of the span gas value over four measurement cycles (see Section 6.4 for repeatability check procedure).

5. APPARATUS AND REAGENTS

5.1 Measurement System. Use any measurement system that meets the performance and design

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specifications in Sections 4 and 5 of this method. The sampling system shall maintain the gas sample at conditions that will prevent condensation in the lines or when it contacts the EC cells. A diagram of an acceptable measurement system is shown in Figure 2. The essential components of the measurement system are described below.

5.1.1 Sample Probe. Glass, stainless steel or other non-reactive material of sufficient length to traverse the sample points. The sample probe shall be designed to prevent condensation.

5.1.2 Sample Line. Non-reactive tubing designed to transport the effluent from the sample probe to the moisture removal system. The sample line shall be designed to prevent condensation.

5.1.3 Sample Transport Lines. Non-reactive tubing to transport the sample from the moisture removal system to the electrochemical cell.

5.1.4 Calibration Assembly. A three-way valve assembly, tee or equivalent for introducing calibration gases at ambient pressure to the sample probe during calibration checks. The assembly shall be designed such that only calibration gas is processed and that calibration gases flow through all gas path filters.

5.1.5 Moisture Removal System. A chilled condenser or similar device to remove condensate continuously from the sample gas while maintaining minimal contact between the condensate and the sample gas shall be required if the NO_2 portion of NO_x is greater than 10 percent. Alternatively, for gas streams with less than 10 percent NO_2, a device that uses ambient means to condense moisture from the gas stream before the EC cells is acceptable for this method.

5.1.6 Particulate Filter. Filters before the inlet of the analyzer may be used to prevent accumulation of particulate material in the measurement system and extend the useful life of the components. All filters shall be fabricated of materials that are non-reactive to the gas being sampled.

5.1.7 Sample Pump. A leak-free pump that will provide the sample gas to the system at a flow rate sufficient to minimize the response time of the measurement system. If upstream of the EC cells, the pump shall be constructed of any material that is non-reactive to the gas being sampled.

5.1.8 Sample Flow Rate Monitoring. A rotameter or equivalent device must be used to measure the sample flow rate through the analyzer such that either:

1. The analyzer sample flow rate must not vary by more than ± 10% throughout the pre-test & post-test verification calibrations and source measurement cycles, or
2. The analyzer sample flow rate must be maintained within a tolerance range that does not affect the gas concentration readings by more than ± 3%. This flow rate tolerance range must be as-verified or

certified by the analyzer manufacturer. (Appendix B)

5.1.9 Sample Gas Manifold. A manifold used to divert a portion of the sample gas stream to the analyzer and the remainder to the by-pass discharge vent. This is to be used on high pressure exhaust streams to prevent damage to the measurement system and to avoid false readings. The sample gas manifold should also include provisions for introducing calibration gases directly to the analyzer. The manifold may be constructed of any material that is non-reactive to the gas being sampled.

5.1.10 Gas Analyzer. A device containing EC cells to determine the NO, NO_2, CO and O_2 concentrations in the sample gas stream and, if necessary, to correct for interference effects. The analyzer shall meet the applicable performance specifications of Section 4 and 5 of this method. It is recommended that the analyzer shall be verified for NO_x measurements by a recognized testing agency (e.g. ETV, SCAQMD or TUV) or as approved by EPA Method 301 verification.

5.1.11 Data Recorder. A strip chart recorder, computer or digital recorder for logging analyzer output data. The data recorder resolution (i. e. readability) shall be at least 1 ppm for CO, NO and NO_2; 0.1% for O_2; and one degree (C or F) for temperature. Alternatively, a digital or analog meter having the same resolution may be used to obtain the analyzer responses and the readings may be recorded manually.

5.1.12 Interference Gas Scrubber. A device used by some analyzers to remove interfering compounds upstream of a CO electrochemical cell. If external interference gas scrubbers are required in the original as-verified configuration, they must be used with this protocol. The gas scrubber should have a means to determine when the agent is exhausted. The scrubbing agent shall be changed in accordance with the manufacturer's recommendations.

5.1.13 EC Cell Temperature Indicator. The analyzer shall be equipped with a temperature measurement device (e.g. thermocouple, thermistor or equivalent) to monitor the EC cell temperature. The temperature may be monitored at the surface, within the cell, or in close proximity to the cells such that it indicates the operating temperature of the cells. At no time shall the analyzer be used outside the manufacturer's recommended operating range.

5.2 Calibration Gases. The calibration gases for the gas analyzer shall be CO in nitrogen or CO in nitrogen and O_2, NO in nitrogen, NO_2 in air and O_2 in nitrogen. Clean, dry air (20.9 percent O_2) may be used for calibration of the O_2 cell.

5.2.1 Span Gases. Used for calibration and error checking. Select concentrations according to procedures specified in Section 2.

5.2.2 Zero Gas. Concentration of less than 0.25 percent of the span gas for each component. Fresh air, free from ambient CO and NOx or other combustion gases, may be used.

6. MEASUREMENT SYSTEM PERFORMANCE CHECK PROCEDURES

The following procedures define the process to follow in order to verify analyzer performance and accuracy during the test day measurement cycles.

6.1 Calibration Gas Concentration Verification. For the span gases, use certified calibration gases. For O_2 calibration and CO and NO_x zero gas, fresh air, free from ambient CO and NO_x shall be permitted. Alternative certification techniques may be used if they are approved in writing by the applicable regulatory agency.

6.2 Pre-Test Verification (Calibration). Conduct the following procedure once for each nominal range that is to be used on each EC cell before taking test data during the field test day. Repeat the calibration check if a cell is replaced. There is no prescribed order that the EC cells must be calibrated in. However, each cell must complete the measurement cycle during the calibration check. Assemble the measurement system by following the manufacturer's recommended procedures for preparing and preconditioning the gas analyzer. Assure the system has no leaks and verify the gas scrubbing agent is not depleted.

6.2.1 Zero Calibration Check Procedure. Calibrate the O_2 EC cell at 20.9 percent using fresh air. For the O_2, CO, NO and NO_2 EC cells introduce the zero gas and record the reading. Include the time, EC cell temperature, and sample flow rate on a form similar to Figure 3 (see Section 4.1 for specifications).

6.2.2 Span Calibration Check Procedure. Individually inject each span gas into the analyzer and record the zero start time (t_0). Record all analyzer output responses, the EC cell temperature, and the flow rate during this “ramp-up phase” once per minute for the first 5 minutes. At 5 minutes (t_5) begin the “test data phase” and record readings every 15 seconds for a total of two minutes ($t_{5:15} – t_7$) or as required by permit conditions. The “refresh phase” will be performed for the next eight minutes ($t_7 – t_{15}$) with fresh air, free from CO, NOx and other pollutants. Record data every minute. Repeat the steps in Section 6.2.2 to verify the calibration for each component gas. Gases shall be injected through the entire sample handling system.

6.2.3 Calibration Check Calculation. Calculate mean average of the readings from the “test data phase” ($t_5 - t_7$). The acceptable mean average is within ± 5 percent of the span gas concentration and the maximum deviation from the average for each of the individual readings ($t_{5:15} – t_7$) is less than or equal to ±

2 percent. Record the average value and maximum deviation for each species monitored. Data shall conform to Section 4.2. If an invalid calibration is exhibited, take corrective action and repeat the analyzer calibration check until acceptable performance is achieved (see Figure 1B). The flow rate and EC cell temperature shall conform to the specifications in Section 5.1.8 and 5.1.13, respectively.

Example: If the span gas value is 100 ppm, the average of the readings for that parameter may be within ±5 ppm of 100 ppm, i.e. 95 to 105 ppm. The test cycle is invalid if the maximum deviation of any single reading comprising that average is greater than ±2% or 2 ppm (i.e. average = 102 ppm; single readings of below 100 ppm and above 104 ppm are disallowed).

6.3 Interference Check. During the calibration check of a single gas species (e.g. CO), record the response displayed by the other EC cells (i.e. NO & NO_2). Record the interference response for each EC cell to each calibration gas. The interference will conform to the specifications in Section 4.3.

6.4 Repeatability Check. Conduct the following procedure once for each nominal range that is to be used on each electrochemical cell (NO, NO_2 and CO) within five days prior to each field test program. If a field-test program lasts longer than five days, this procedure shall be performed before each five days of analyzer operation. Perform the repeatability check if a cell is replaced or if a cell is exposed to gas concentrations greater than 150 percent of the highest span gas concentration.

6.4.1 Repeatability Check Procedures. Perform a measurement cycle by injecting the span gas into the analyzer and record the readings. Follow Section 6.2.2 procedures. Record the readings on a form similar to the one found in Figure 3. Repeat the measurements for a total of four cycles. During the repeatability checks, do not adjust the system except where necessary to achieve the correct calibration gas flow rate at the analyzer.

6.4.2 Repeatability Check Calculations. Determine the highest and lowest average "test data phase" concentration recorded from the repeatability check and record the results on a form similar to Figure 3. The absolute value of the difference between the maximum and minimum average values recorded during the test must not vary more than ± 3 percent or 1 ppm whichever is less restrictive of the span gas concentration results (see Figure 1C).

6.5 Post-Test Verification (Calibration). Perform the post-test verification calibration check in the same manner as shown in Section 6.2 of this method at the end of each test day. If the post-test verification calibration checks do not meet the specifications, all test data for that component, based upon that test day calibration are null and void and re-calibration and re-testing is required. Make no changes to the sampling system or analyzer calibration until all of the post-test verification checks have been recorded.

7. EMISSION TEST PROCEDURE

7.1 Selection of Sampling Site and Sampling Points.

7.1.1 Reciprocating Engines. Select a sampling site located at least two stack diameters downstream of any disturbance (e.g. turbocharger exhaust, crossover junction or recirculation take-off) and one-half stack diameter upstream of the gas discharge to the atmosphere. Use a sampling location at a single point near the center of the duct or use the point required by the local regulator.

7.1.2 Combustion Turbines. Select a sampling site and sample points according to the procedures in 40 CFR, Part 60, Appendix A, Method 20. An alternative sampling location and/or sample from a single point in the center of the duct may be used if previous test data demonstrate that the stack gas concentrations of CO, NO_x and O_2 do not vary significantly across the duct diameter. Use of the point required by the local regulator is also acceptable.

7.1.3 Process Boilers. Select a sampling site located at least two stack diameters downstream of any disturbance and one-half stack diameter upstream of the gas discharge to atmosphere. Use a sampling location at a single point near the center of the duct or use the point required by the local regulator.

7.2 Sample Collection. Prior to sample collection, ensure that the pre-test verification has been performed in accordance with Section 6.2. Zero the analyzer with fresh air. Position the probe at the first sampling point and begin the measurement cycle at the same flow rate used during the calibration check. Begin the 5-minute "ramp-up phase" (t_0 - t_5). Record the gas sample readings, sample flow rate and EC cell temperature on a form similar to Figure 3. The "test data phase" runs for two minutes ($t_5 - t_7$). Record the readings at 15-second intervals beginning at $t_{5:15}$. The "refresh phase" begins at t_7 and runs for 8 minutes (t_7 to t_{15}) or until the analyzer has "refreshed" in accordance with the manufacturer's specification. Record the readings. For each run use the "test data phase" measurements to calculate the average effluent concentration.

7.3 EC Cell Temperature and Flow Monitoring. For each measurement cycle, the temperature measurement of the EC cells shall not vary more than ± 10^0F. The overall EC cell temperature variation shall be less than ± 20^0F from the pre-test verification check to the final post-test verification check. The sample flow rate shall be in accordance with Section 5.1.8.

7.4 Post-Test Verification Check. Conduct the post-test verification check after the test run or set of

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test runs and within 12 hours of the initial calibration check. Conduct span and zero calibration checks using the procedure in Section 6.2. Make no changes to the sampling system or analyzer calibration until all post-test verification checks have been recorded. If the zero or span calibration error exceeds the specification in Sections 4.1 and 4.2 then all test data collected since the previous successful calibration checks are invalid and re-calibration and re-testing is required. If the sampling system is disassembled or the analyzer calibration is adjusted, repeat the calibration check before conducting the next source test.

8. EMISSION CALCULATION

The average gas effluent concentration is determined from the mean average gas concentration calculated using the emissions data collected during the "test data phase". Emissions may be calculated and reported in units of the allowable emission limit as specified in the permit or as required by the local agency for purposes of facility compliance. The emissions may be stated in units of pounds per hour (lbs/hr), grams per horsepower-hour (gm/hp-hr), pounds per million Btu (lbs/MMBtu) or as required for the facility. Appendix A provides example test result forms with emission rate calculations, f-factors, and the flow rate certification procedure for analyzer manufactures. Alternately, EPA Reference Method 19 may also be used as the basis for calculating the emissions and EPA Reference Methods 1-4 may be used to obtain a stack volumetric flow rate.

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FIGURES

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FIGURES - 1A, 1B, 1C

Figure 1A - Measurement Cycle, 15 Min. (For calibration and source measurements)

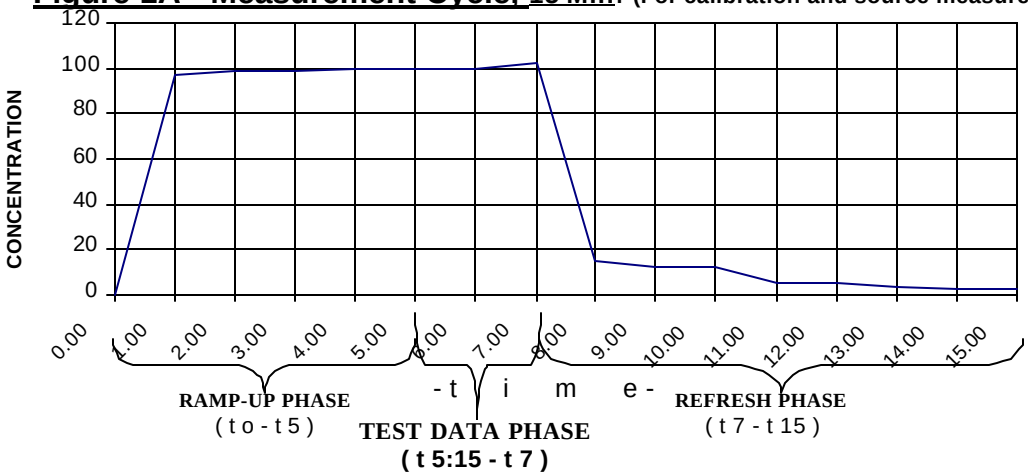

Figure 1B - Span Calibration (For span calibration only)

Span Calibration Error - The calculated "TEST DATA PHASE" average shall be less than ± 5% of the span or ± 1ppm whichever is less restrictive for NO, NO2, CO and O2. The **Maximum Allowable Deviation** of any single "test data phase" reading shall be ± 2% or 1ppm, whichever is less restrictive, of the average. (The example below does not meet this specification)

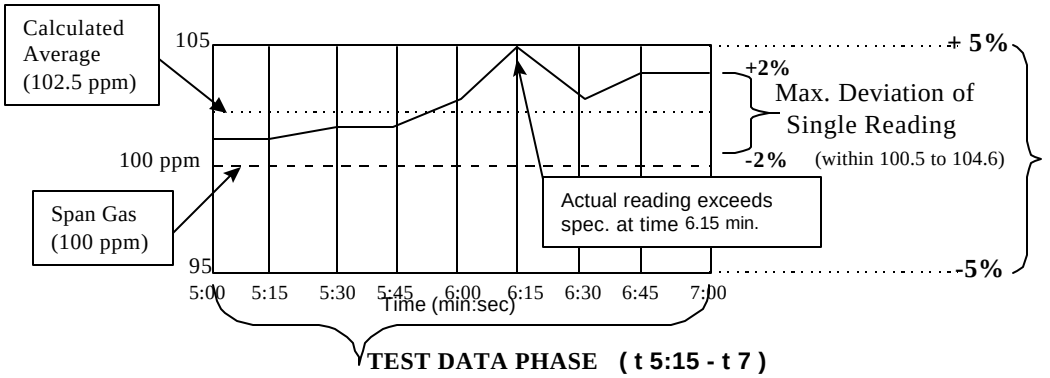

Figure 1C - Repeatability 4 Measurement cycles = 1 hour (for repeatability calibration only)

Repeatability - The calculated average for the "TEST DATA PHASE" for NO, NO2 & CO shall not vary more than ± 3% or ± 1 ppm, whichever is less restrictive, of the span gas value for 4 measurement cycles

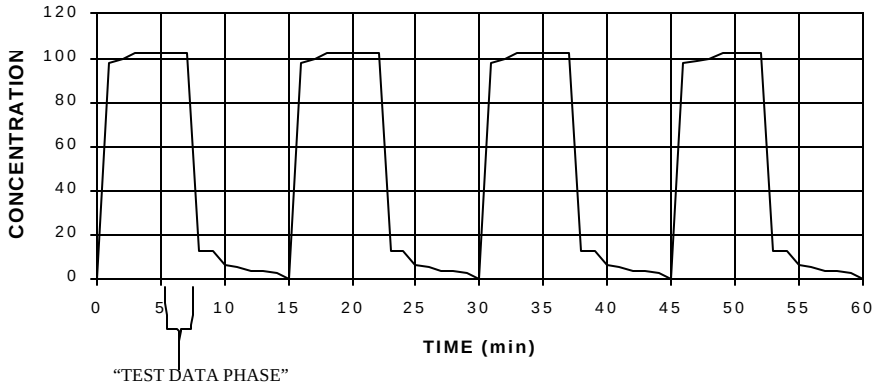

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Figure 2 - Calibration & Testing Schematic

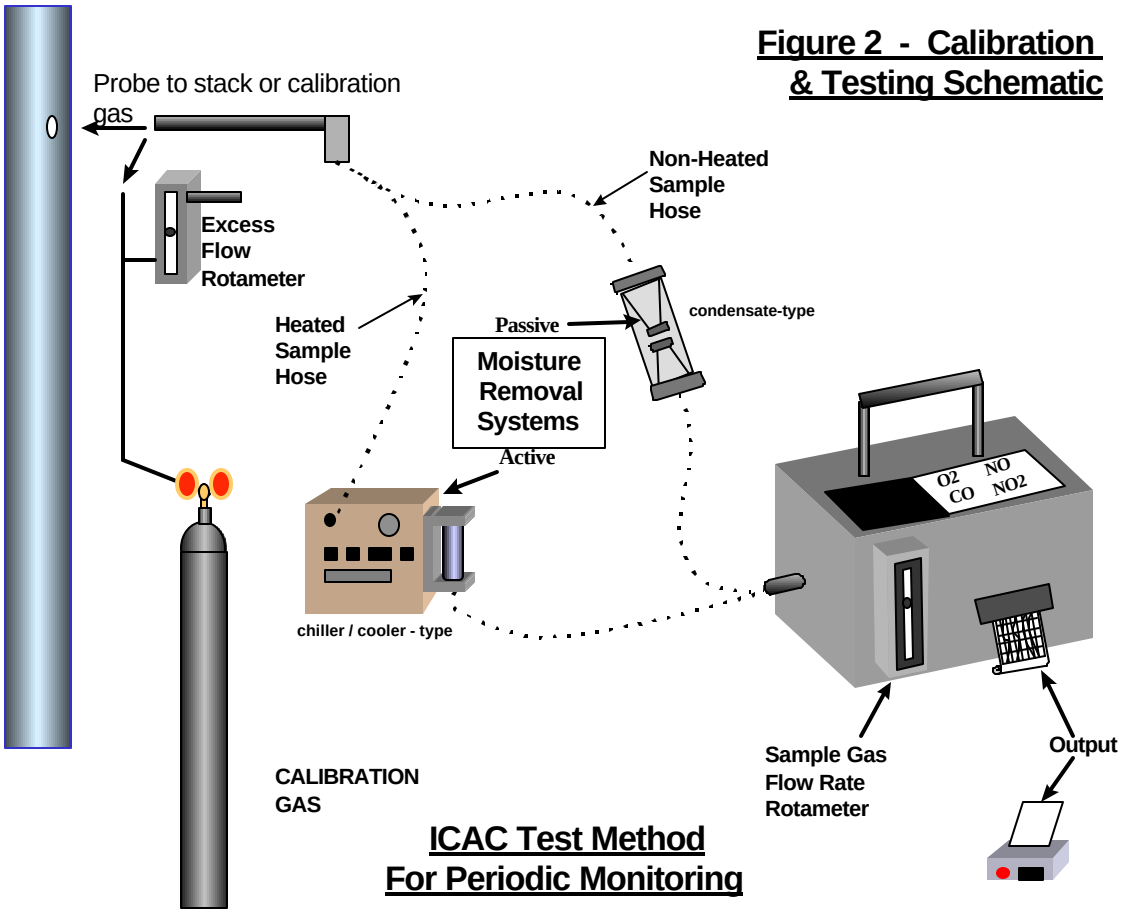

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Figure 3 - Periodic Monitoring Report

Facility Name & Address Phone				**Emission Point**			
Analyzer make & model:				**Serial #**			
Calibration Gas Verification Information							
Calibration Gas Info. (manufacturer, expiration, etc.)	**Gas type**	**O_2 %**	**CO ppm**	**NO ppm**	**NO_2 ppm**		
	Concent.						

MEASUREMENT CYCLE (circle measurement task below)

Pre-Test Verification *(zero, span, interference)* / ***Repeatability*** *(once per five days)* / ***Source Test*** *(_____)* / ***Post-Test Verification*** *(zero, span Interference)*

	Date:	**Analyzer Response**				**Cell Temp**	**Flow Rate**
Three Phases	**Start time**: AM /	**O_2%**	**CO ppm**	**NO ppm**	**NO_2 ppm**		
RAMP-UP Phase	t_1						
	t_2						
	t_3						
	t_4						
	t_5						
TEST DATA Phase	$t_{5:15}$						
	$t_{5:30}$						
	$t_{5:45}$						
	$t_{6:00}$						
	$t_{6:15}$						
	$t_{6:30}$						
	$t_{6:45}$						
	$t_{7:00}$						
Mean Average Concentration (sum of $t_{5:15}$ through $t_{7:00}$ ÷ 8)							
Maximum Deviation (no single reading exceeds ± 2% of mean average)							
Acceptable "Test Data Phase"		***Yes or No***	***Yes or No***	***Yes or No***	***Yes or No***		
RE-FRESH Phase	t_7						
	t_8						
	t_9						
	t_{10}						
	t_{11}						
	t_{12}						
	t_{13}						
	t_{14}						
	t_{15}						
Stop Time AM / PM							
Cell Temperature (± 10°F for each run, Not to exceed 20° F for test day) and Sample Flow Rate are within specifications (± 10% or as verified)						***Yes or No***	***Yes or No***

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APPENDIX A

Test Results - Boilers & Heaters
(Operated at 90% of permitted load or greater during test? Yes or NO)

Facility name, address		**Emission Point:**
		Test date:

NAME: **DATE:**

Fuel Consumption (cf/hr, or gal/hr, etc...)	Fuel Heat Content (Btu/cf, or Btu/gal, etc...)	Boiler / Heater tested firing rate (MMBtu/hr, or hp/hr, etc...)

The tester may chose to correct the emissions data for a test run using the pre-test verification calibration and post-test verifications results. Use equation below for this correction.

$$C_{GAS} = (C_A - C_{PO}) \times \frac{C_S}{C_{PS} - C_{PO}}$$

- C_{GAS} = corrected flue gas concentration
- C_A = "Test Data Phase" average concentration indicated by portable analyzer
- C_{PO} = average of Pre-test and Post-test Zero check
- C_{PS} = average of Pre-test and Post-test Span checks
- C_S = actual concentration of span gas

Emission Calculations:

$$\text{lb/MMBtu NOx} = (\text{ppm NOx}_{\text{corrected}})\ (1.19\times10^{-7})\ (\text{F Factor}_{\text{Note 1}})\ \left(\frac{20.9}{20.9 - O_2\%_{\text{corrected}}}\right)$$

$$\text{lb/MMBtu CO} = (\text{ppm CO}_{\text{corrected}})\ (7.27\times10^{-8})\ (\text{F Factor}_{\text{Note 1}})\ \left(\frac{20.9}{20.9 - O_2\%_{\text{corrected}}}\right)$$

$$\text{lb/hr NOx} = (\text{lb/MMBtu NOx})\ (\text{Heat Input}_{\text{Note 2}})$$

$$\text{lb/hr CO} = (\text{lb/MMBtu CO})\ (\text{Heat Input}_{\text{Note 2}})$$

Note 1: Use "F Factor" unless calculated based on the actual fuel gas composition and the higher heating value of the fuel.

Note 2: Heat input shall be based on the average hourly fuel usage rate during the test and the higher heating value of the fuel consumed if the boiler / heater is equipped with a fuel meter or the permitted maximum heat input if a fuel meter is

NOx (NO + NO_2) Results

Ave. Tested NO ppm	NO ppm (corrected)	Ave. Tested NO_2 ppm	NO_2 ppm (corrected)	NOx ppm (corrected)	As Tested	Allowable
					lb/MMBtu =	lb/MMBtu =
					lb/hr =	lb/hr =

O_2 Results		**CO Results**			
Ave. Tested O_2 %	O_2 % (corrected)	Ave. Tested CO ppm	CO ppm (corrected)	As Tested	Allowable
				lb/MMBtu =	lb/MMBtu =
				lb/hr =	lb/hr =

Test Results - Reciprocating Engines - Below 500 HP
(Operated at 90% of permitted load or greater during test? YES or NO)

Facility name, address		**Emission Point:**
		Test date:

NAME: **DATE:**

Suction/ Discharge Pressure	RPM	Fuel Throughput "compressed"	Fuel consumed "burned"	Fuel Heat Content	Unit Fuel Useage Spec.	Engine Tested Horsepower

The tester may chose to correct the emissions data for a test run using the pre-test verification calibration and post-test verifications results. Use equation below for this correction.

$$C_{GAS} = (C_A - C_{PO}) \times \frac{C_S}{C_{PS} - C_{PO}}$$

C_{GAS} = corrected flue gas concentration
C_A = "Test Data Phase" average concentration indicated by portable analyzer
C_{PO} = average of Pre-test and Post-test Zero check
C_{PS} = average of Pre-test and Post-test Span checks
C_S = actual concentration of span gas

Emission Calculations:

$$\text{gm/hp-hr NOx} = (\text{ppm NOx}_{\text{corrected}})(1.19\times10^{-7})(\text{F Factor}_{\text{Note 1}})\left(\frac{20.9}{20.9-O_2\%_{\text{corrected}}}\right)(\text{Specific Fuel Consumption}_{\text{Note 2}})(10^{-6})(454)$$

$$\text{gm/hp-hr CO} = (\text{ppm CO}_{\text{corrected}})(7.27\times10^{-8})(\text{F Factor}_{\text{Note 1}})\left(\frac{20.9}{20.9-O_2\%_{\text{corrected}}}\right)(\text{Specific Fuel Consumption}_{\text{Note 2}})(10^{-6})(454)$$

$$\text{lb/hr NOx} = \frac{(\text{gm/hp-hr NOx})(\text{Engine Horsepower}_{\text{Note 3}})}{454}$$

$$\text{lb/hr CO} = \frac{(\text{gm/hp-hr CO})(\text{Engine Horsepower}_{\text{Note 3}})}{454}$$

Note 1: Use "F Factor" unless calculated based on the actual fuel gas composition and the higher heating value of the fuel.
Note 2: Use Manufacture's specific fuel composition based on the higher heating value of the fuel. If the manufacturer does not provide a lower heating value, then multiply by 1.11 to obtain the specific fuel consumption based upon the higher heating value of the fuel
Note 3: Use derived operating horsepower (include calculation method). If derived horsepower is not available or cannot be obtained, use site rated horsepower.

NOx (NO + NO_2) Results

Ave. Tested NO ppm	NO ppm (corrected)	Ave. Tested NO_2 ppm	NO_2 ppm (corrected)	NOx ppm (corrected)	As Tested	Allowable
					gm/hp-hrs =	gm/hp-hrs =
					lb/hr =	lb/hr =

O_2 Results		CO Results			
Ave. Tested O_2 %	O_2 % (corrected)	Ave. Tested CO ppm	CO ppm (corrected)	As Tested	Allowable
				gm/hp-hrs =	gm/hp-hrs =
				lb/hr =	lb/hr =

Test Results - Reciprocating Engines - Above 500 HP Not Equipped w/ Fuel Meter
(Operated at 90% of permitted load or greater during test? YES or NO)

Facility name, address		**Emission Point:**
		Test date:

NAME: **DATE:**

Suction/ Discharge Pressure	RPM	Fuel Throughput "compressed"	Fuel consumed "burned"	Fuel Heat Content	Unit Fuel Useage Spec.	Engine Tested Horsepower

The tester may chose to correct the emissions data for a test run using the pre-test verification calibration and post-test verifications results. Use equation below for this correction.

$$C_{GAS} = (C_A - C_{PO}) \times \frac{C_S}{C_{PS} - C_{PO}}$$

C_{GAS} = corrected flue gas concentration
C_A = "Test Data Phase" average concentration indicated by portable analyzer
C_{PO} = average of Pre-test and Post-test Zero check
C_{PS} = average of Pre-test and Post-test Span checks
C_S = actual concentration of span gas

Emission Calculations:

$$\text{gm/hp-hr NOx} = (\text{ppm NOx}_{\text{corrected}})\,(1.19\times10^{-7})\,(\text{F Factor}_{\text{Note 1}})\left(\frac{20.9}{20.9-O_2\%_{\text{corrected}}}\right)(\text{Specific Fuel Consumption}_{\text{Note 2}})\,(10^{-6})\,(454)$$

$$\text{gm/hp-hr CO} = (\text{ppm CO}_{\text{corrected}})\,(7.27\times10^{-8})\,(\text{F Factor}_{\text{Note 1}})\left(\frac{20.9}{20.9-O_2\%_{\text{corrected}}}\right)(\text{Specific Fuel Consumption}_{\text{Note 2}})\,(10^{-6})\,(454)$$

$$\text{lb/hr NOx} = \frac{(\text{gm/hp-hr NOx})(\text{Engine Horsepower}_{\text{Note 3}})}{454}$$

$$\text{lb/hr CO} = \frac{(\text{gm/hp-hr CO})(\text{Engine Horsepower}_{\text{Note 3}})}{454}$$

Note 1: Use "F Factor" unless calculated based on the actual fuel gas composition and the higher heating value of the fuel.
Note 2: Default Specific Fuel Consumption (Btu/hp-hr) shall be as defined below for the particular type of engine.
Use 9,400 Btu/hp-hr (as default) for 4-cycle and 2-cycle lean burn engines.
Use 11,000 Btu/hp-hr (as default) for 2-cycle non-lean burn engines.
Note 3: Site-rated engine horsepower

NOx (NO + NO_2) Results

Ave. Tested NO ppm	NO ppm (corrected)	Ave. Tested NO_2 ppm	NO_2 ppm (corrected)	NOx ppm (corrected)	As Tested	Allowable
					gm/hp-hrs =	gm/hp-hrs =
					lb/hr =	lb/hr =

O_2 Results		**CO Results**			
Ave. Tested O_2 %	O_2 % (corrected)	Ave. Tested CO ppm	CO ppm (corrected)	As Tested	Allowable
				gm/hp-hrs =	gm/hp-hrs =

				lb/hr =	lb/hr =

Test Results - Reciprocating Engines & Combustion Turbines - Above 500 HP w/ Fuel Meter

(Operated at 90% of permitted load or greater during test? YES or NO)

Facility name, address		**Emission Point:**
		Test date:

NAME: **DATE:**

Suction/ Discharge Pressure	RPM	Fuel Throughput "compressed"	Fuel consumed "burned"	Fuel Heat Content	Unit Fuel Useage Spec.	Engine Tested Horsepower

The tester may chose to correct the emissions data for a test run using the pre-test verification calibration and post-test verifications results. Use equation below for this correction.

$$C_{GAS} = (C_A - C_{PO}) \times \frac{C_S}{C_{PS} - C_{PO}}$$

C_{GAS} = corrected flue gas concentration
C_A = "Test Data Phase" average concentration indicated by portable analyzer
C_{PO} = average of Pre-test and Post-test Zero check
C_{PS} = average of Pre-test and Post-test Span checks
C_S = actual concentration of span gas

Emission Calculations:

$$\text{lb/hr NOx} = (\text{ppm NOx}_{\text{corrected}})\,(1.19\times10^{-7})\,(\text{F Factor}_{\text{Note 1}})\left(\frac{20.9}{20.9-O_2\%_{\text{corrected}}}\right)(\text{Heat Input / hr}_{\text{Note 2}})$$

$$\text{lb/hr CO} = (\text{ppm CO}_{\text{corrected}})\,(7.27\times10^{-8})\,(\text{F Factor}_{\text{Note 1}})\left(\frac{20.9}{20.9-O_2\%_{\text{corrected}}}\right)(\text{Heat Input / hr}_{\text{Note 2}})$$

$$\text{gm/hp-hr NOx} = \frac{(\text{lb/hr NOx})\,(454)}{(\text{Tested Horsepower}_{\text{Note 3}}) \text{ or } (\text{Calculated Engine Horsepower}_{\text{note 4}})}$$

$$\text{gm/hp-hr CO} = \frac{(\text{lb/hr CO})\,(454)}{(\text{Tested Horsepower}_{\text{Note 3}}) \text{ or } (\text{Calculated Engine Horsepower}_{\text{note 4}})}$$

Note 1: Use "F-factor" unless calculated based on the actual fuel gas composition and the higher heating value of the fuel.
Note 2: Heat input / hr. (MMBtu/hr) shall be based on the average hourly fuel usage during the test and the higher heating value of the fuel consumed
Note 3: Tested Horsepower is directly determined during test.
Note 4: Calculated Engine Horsepower = $\frac{(\text{Heat Input per Hour}_{\text{Note 2}})\,(10^6)}{(\text{Specific Fuel Consumption}_{\text{- See default below*}})}$

* use 9,400 Btu/hp-hr (as default) for 4-cycle and 2-cycle lean burn engines
* use 11,000 Btu/hp-hr (as default) for 2-cycle non-lean burn engines

For combustion turbine horsepower that cannot be determined during testing, the emissions shall be reported in terms of concentration (ppm by volume, dry basis) corrected to 15 percent O_2 . Calculation to corrected to 15% O_2 is shown below:

ppm $NOx_{@ 15\% O2}$ = ppm NOx corrected (5.9) ppm $CO_{@ 15\% O2}$ = ppm CO corrected (5.9)

NOx (NO + NO_2) Results

Ave.Tested NO ppm	NO ppm (corrected)	Ave.Tested NO_2 ppm	NO_2 ppm (corrected)	NOx ppm (corrected)	As Tested	Allowable
					gm/hp-hrs =	gm/hp-hrs =
					lb/hr =	lb/hr =

O_2 Results		CO Results			
Ave. Tested O_2 %	O_2 % (corrected)	Ave. Tested CO ppm	CO ppm (corrected)	As Tested	Allowable
				gm/hp-hrs =	gm/hp-hrs =
				lb/hr =	lb/hr =

F-Factors

An “F-Factor” is the ratio of the gas volume of the products of combustion to the heat content of the fuel.

F_d - Dry Factor, Includes all components of combustion less water.

F_w - Wet Factor, Includes all components of combustion.

F_c - Carbon Factor, Includes only carbon dioxide

Note: Since F-Factors include water resulting only from combustion of hydrogen in the fuel, The procedures using F_w factors are not applicable for computing emissions from steam generating units with wet scrubbers or with other processes that add water (e.g. steam injection).

F- Factors for Various Fuels [1]

	F_d		F_w		F_c	
Fuel Type	**dscm /J**	**dscf /10^6 Btu**	**wscm / J**	**wscm /10^6 Btu**	**scm / J**	**scf /10^6 Btu**
Coal:						
Anthracite[2]	$2.71 * 10^{-7}$	10000	$2.83 * 10^{-7}$	10540	$0.530 * 10^{-7}$	1970
Bituminus[2]	$2.63 * 10^{-7}$	9780	$2.86 * 10^{-7}$	10640	$0.484 * 10^{-7}$	1800
Lignite	$2.65 * 10^{-7}$	9860	$3.21 * 10^{-7}$	11950	$0.513 * 10^{-7}$	1910
Oil[3]	$2.47 * 10^{-7}$		$2.77 * 10^{-7}$	10320	$0.383 * 10^{-7}$	1420
Gas:						
Natural	$2.43 * 10^{-7}$	8710	$2.85 * 10^{-7}$	10610	$0.287 * 10^{-7}$	1040
Propane	$2.34 * 10^{-7}$	8710	$2.74 * 10^{-7}$	10200	$0.321 * 10^{-7}$	1190
Butane	$2.34 * 10^{-7}$	8710	$2.79 * 10^{-7}$	10390	$0.337 * 10^{-7}$	1250
Wood	$2.48 * 10^{-7}$	9240			$0.492 * 10^{-7}$	1830
Wood bark	$2.58 * 10^{-7}$	9600			$0.516 * 10^{-7}$	1920
Municiple	$2.57 * 10^{-7}$	9570			$0.488 * 10^{-7}$	1820
Solid Waste	********					

[1] Determined at standard conditions : 20° C (68° F) and 760 mm (29.92 in Hg).

[2] As classified according to ASTM D388-77.

[3] Crude, residual, or distillate.

Reader note: F-Factor table copied from US EPA 40 CFR, Pt 60, Appendix A, Method 19 -Determination of Sulfur Dioxide Removal efficiency and Particulate Martter, Sulfer Dioxide and Nitrogen Oxides Emissions Rates.

APPENDIX B

Batch Testing of Portable Gas Analyzer Flow Rate.

Background

In order to meet the requirements of Section 5.1.8 for sample flow rate, the manufacturer has the option of providing the user with a maximum and minimum allowable sample flow rate (outside of the method specified ± 10 percent) provided that the manufacturer performs a batch certification of flow rate vs. gas reading shift.

Procedure

Size of Batch

The manufacturer must randomly sample a portable gas analyzer once every three months or every 50 units, whichever comes first, from a production batch.

Testing

The manufacturer must monitor the flow rate of the sample and the gas concentration of the calibration (pollutant) gas continuously. Once the analyzer has reached a stable gas reading. The flow rate and concentration are recorded. The sample flow rate is then changed to the minimum recommended flow rate in 0.1 liter increments / min, through the full range of certified flow. The manufacturer must record the gas readings for each increment and compare these against the initial analyzer reading.

Each test must consist of three (3) identical runs. Each error band must include a standard deviation at 95 percent confidence level interval (per US EPA 40 CFR 60 Appendix B, PS1).

Documentation

The manufacturer must provide a certificate with each analyzer indicating conformance with the requirements of Section 5.1.8.