


San Joaquin Valley
Unified Air Pollution Control District
Permit Services

Emissions Monitoring for Rules 4701 and 4702

Approved By: <u></u> Arnaud Marjollet Director of Permit Services	Approval Date: <u>April 29, 2004</u> Revision Date: <u>February 15, 2017</u>
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Purpose: To identify pre-approved monitoring procedures that can be used to satisfy Rule 4701, Internal Combustion Engines - Phase I, and Rule 4702, Internal Combustion Engines - Phase II monitoring requirements, and to establish criteria for case-by-case approval of other monitoring proposals. An applicant may choose from the pre-approved monitoring procedures, or may make a different monitoring proposal for approval by the APCO. This policy identifies more than one pre-approved monitoring procedure for some control technologies. Applicants have the option of choosing the alternative most suitable to their needs.

An application for Authority to Construct must be submitted to the District in order to add or change monitoring permit conditions for any engine, regardless of whether or not the engine is equipped with an external emission control device.

I. Applicability

This policy applies to internal combustion engines that are subject to the monitoring requirements of District Rules 4701 and 4702.

II. Background

Rule 4701

Section 5.4.1 of Rule 4701 requires the owner of any engine equipped with an external emissions control device to install and maintain either continuous emission monitoring equipment for NO_x, CO and oxygen, as identified in Rule 1080 (Stack Monitoring), or install and maintain APCO-approved alternate monitoring consisting of one or more of the following:

- periodic NO_x and CO emission concentrations,
- engine exhaust oxygen concentration,
- air-to-fuel ratio,
- flow rate of reducing agents added to engine exhaust,
- catalyst inlet and exhaust temperature,
- catalyst inlet and exhaust oxygen concentration,
- other operational characteristics.

Section 5.4.2 of Rule 4701 requires the owner of any engine without an external emissions control device to monitor operational characteristics recommended by the engine manufacturer or emission control system supplier, and approved by the APCO. Examples of emission control devices which are not external include pre-combustion chamber (PCC), pre-stratified charge (PSC) systems, etc. Note: Air/fuel ratio controllers alone are not considered emission control devices.

As the requirements of sections 5.4.1 and 5.4.2 of Rule 4701 differ, monitoring proposal criteria for each case will be addressed in separate sections.

Section 5.4.3 of Rule 4701 requires monitoring of the NO_x emissions at least once per calendar quarter (in which a source test is not performed) with a portable analyzer regardless of the monitoring method used to satisfy sections 5.4.1 or 5.4.2.

Rule 4702

For Non-AO Spark-Ignited Engines

Section 5.8.1 of Rule 4702 requires the operator of all external control device-equipped engines and all engines with a rated brake horsepower of 1,000 hp or greater and where the engine is permitted to operate more than 2,000 hours per calendar year, to install and maintain either continuous emission monitoring equipment for NO_x, CO and oxygen, as identified in Rule 1080 (Stack Monitoring), or install and maintain APCO-approved alternate monitoring consisting of one or more of the following:

- periodic NO_x and CO emission concentrations,
- engine exhaust oxygen concentration,
- air-to-fuel ratio,
- flow rate of reducing agents added to engine exhaust,
- catalyst inlet and exhaust temperature,
- catalyst inlet and exhaust oxygen concentration,
- other operational characteristics.

note: these criteria are the same as identified in section 5.4.1 of Rule 4701

Section 5.8.2 of Rule 4702 requires the operator of any engine not subject to section 5.8.1 to monitor operational characteristics recommended by the engine manufacturer or emission control system supplier, and approved by the APCO. As the requirements of sections 5.8.1 and 5.8.2 of Rule 4702 differ, monitoring proposal criteria for each case will be addressed in separate sections.

Section 5.8.9 of Rule 4702 requires monitoring of the NO_x emissions at least once per calendar quarter (in which a source test is not performed) with a portable analyzer regardless of the monitoring method used to satisfy sections 5.8.1 or 5.8.2.

For All Other Engines

Section 5.9.3 of Rule 4702 requires the operator of AO spark-ignited and compression-ignited engines subject to section 5.2, and engines subject to section 4.2 to monitor operational characteristics recommended by the engine manufacturer or emission control system supplier.

Section 5.9.5 of Rule 4702 requires monitoring of the NO_x emissions with a portable analyzer to demonstrate compliance with section 5.2, the monitoring frequency depends on the type of the engine.

Similarity between Rule 4701 and Rule 4702

It is important to note that the monitoring required by section 5.4.1 of Rule 4701 is essentially the same as that required by section 5.8.1 of Rule 4702, aside from which engines must be equipped with monitoring.

Additionally the monitoring required by section 5.4.2 of Rule 4701 is essentially the same as that required by section 5.8.2 of Rule 4702.

And similarly, the monitoring required by section 5.4.3 of Rule 4701 is essentially the same as that required by section 5.8.9 of Rule 4702.

Therefore, monitoring required by section 5.4.1 of Rule 4701 and section 5.8.1 of Rule 4702 will be addressed together. And monitoring required by section 5.4.2 of Rule 4701 and section 5.8.2 of Rule 4702 will be addressed together.

Because monitoring required by section 5.4.3 of Rule 4701 and section 5.8.9 of Rule 4702 (quarterly monitoring of NO_x emissions) applies regardless of the monitoring method chosen to comply with the other sections, each pre-approved scenario will include conditions ensuring compliance with these sections.

III. Guiding Principles

The guiding principle of this policy in reference to monitoring requirements of Rules 4701 and 4702 is to establish monitoring procedures that provide a reasonable assurance of compliance with applicable emissions limits, while encouraging preventative maintenance and repair of emission systems. The primary goal is to ensure that a control technology, once installed or otherwise employed, is properly operated and maintained so that the control efficiency does not deteriorate to the point where the engine fails to remain in compliance with an applicable emission limit.

An approvable monitoring procedure must (1) document continued operation within ranges of specified emissions-related performance indicators (such as emissions, control device parameters, and process parameters) that provide a reasonable assurance of compliance with applicable emission limits; (2) record and indicate any deviations from these ranges; and (3) require prompt response to any deviations either by correcting the deviations or by demonstrating compliance with applicable emissions limitations by further emissions testing.

If the equipment is found to be operating outside acceptable ranges for emission limits or emissions-related performance indicators, owners will be required to take prompt corrective actions to the equipment as well as notify the District that potential compliance problems may exist. Specific requirements for taking corrective action and notification are addressed in the individual monitoring procedures included in Sections VI and VII of this policy.

Devising an approvable monitoring procedure requires a clear understanding of the pollutant formation mechanisms, the manner by which the control technology reduces emissions, and the parameters that contribute to the degradation of performance of the control technology. See Appendix A for discussion of NO_x formation mechanisms and control techniques.

Testing and engineering data may be needed to identify and establish acceptable ranges or levels of surrogate parameters that can serve as indicators of acceptable performance.

Many facilities that have IC engines subject to the monitoring requirements of Rule 4701 and/or 4702 are Title V sources. Although the monitoring requirements in this policy often meet Title V monitoring and recordkeeping requirements, the Title V permit may require additional monitoring not covered by this policy.

IV. Definitions

The following definitions are applicable to this policy:

- A. **Normal Range or Level:** A range or a level for a surrogate parameter, based on source testing and engineering data, designed to provide a reasonable assurance of compliance with applicable emissions limits.
- B. **Surrogate Parameter:** A parameter (such as a control device parameter, a process parameter, or exhaust gas emission concentration when measured with a portable analyzer) that can be used as an indicator of the emission control system performance.

V. Compliance Issues

The surrogate parameters are seen as indicators that provide a reasonable assurance that the engine or emission control system has been properly maintained and is operating in compliance with the applicable emission limits. However, excursions from normal ranges or levels for these surrogate parameters alone may not serve as credible evidence of the violation of an applicable emission limit. Such excursions place a burden on the owner to either correct the situation or conduct additional testing to verify compliance under the new operating conditions.

Therefore, as condition of approval for an alternate monitoring procedure in lieu of CEM's, the engine operator must agree to take prompt corrective actions of excursions and document those actions. Excursions must be rectified within 8 hours unless source testing using an approved method to show compliance under the observed operating conditions is conducted within 60 days. Alternatively, if excursions are corrected after more than 8 hours and the permittee stipulates a violation has occurred, source testing will not be required. For excursions of surrogate parameters (excluding excursions of emission concentrations measured with a portable analyzer), a portable analyzer may be used to establish compliance with applicable emission limits at the new surrogate parameter values. For excursions of emission concentrations, compliance testing must follow EPA approved test methods. Where monitoring with a portable emissions analyzer is allowed, testing using EPA approved methods can be substituted for testing with a portable emissions analyzer. Retesting shall be performed under the same operational conditions that existed when the excursion was first detected.

District Rule 1100, Equipment Breakdown, defines a breakdown and specifies the procedures to follow if a breakdown occurs. Should any excursion from normal ranges/levels for either emissions or surrogate parameters be detected, and the cause of such excursion can be traced to a viable breakdown condition as defined in Rule 1100, then the owner/operator may seek relief from enforcement action by fully complying with Rule 1100, including notification and immediate undertaking of appropriate corrective measures to come into compliance

For engines that operate intermittently throughout the year, the engines need not be started solely to perform monitoring required by this policy. Monitoring shall be performed within 5 days of restarting the engine unless monitoring has been performed within the time period specified on the permit. Records must be maintained of the dates of non-operation to validate extended monitoring frequencies allowed by this section.

Normal range or level for surrogate parameters shall be re-established at each scheduled source test. Should different ranges or levels be established, for non-Title V sources the Permit to Operate shall be revised administratively to reflect the new ranges or levels. For Title V sources, an application is required to change ranges or levels.

Appendix B contains a flow chart detailing courses of action when an excursion is detected.

VI. Pre-Approved Alternate Monitoring Procedures for Engines Subject to Section 5.4.1 of Rule 4701 and/or Section 5.8.1 of Rule 4702 (Including Requirements of Section 5.4.3 of Rule 4701, and/or 5.8.9 of Rule 4702, and /or 5.9.3 of Rule 4702

Alternate monitoring procedure that requires monitoring of catalyst temperature differential and NO, CO and O₂ rates shall not be allowed for any new engine or any existing engine changing alternate monitoring procedures. Existing facilities may continue to use this procedure provided testing continues to show correlation between surrogate parameters and emissions.

(Note: For engines subject to less stringent monitoring required by section 5.4.2 of Rule 4701 and/or section 5.8.2 of Rule 4702, an applicant may choose one of the options listed here in Section VI of this policy in lieu of the options listed in Section VII.)

The following alternate monitoring procedures have been approved as meeting the applicable provisions of section 5.4.1 of Rule 4701 and 5.8.1 of Rule 4702: (When more than one alternate monitoring procedure is compatible with a given control technique, the applicant may select the option most suitable to their needs).

A. Monitoring of NO_x, CO, And O₂ Concentrations

COMPATIBLE NO_x CONTROL TECHNIQUES: All units subject to the monitoring requirements of Rule 4701 and/or Rule 4702 will be allowed to monitor NO_x, CO, and O₂ concentrations.

FREQUENCY: Monitoring of NO_x, CO and O₂ shall be conducted at least once per calendar quarter (in which a source test is not performed). Monitoring shall be performed not less than once every month for 12 months if a deviation is observed during 2 consecutive quarterly monitorings. The NO_x and CO emission concentrations shall be corrected to 15% O₂.

- For engines subject to section 5.9.5.2, monitoring is required on at least once every 6 months that the engine is operated.
- For engines subject to section 5.9.5.3, monitoring is required on at least once every 24 months that the engine is operated.

MEASUREMENT: The exhaust gas shall be monitored for NO_x, CO, and O₂ concentrations with a portable emission monitor that meets District specifications prescribed in Compliance's Portable Emission Analyzer Policy for Industry, COM 1150B.

RESULTS: NO_x and CO concentrations corrected to 15% O₂.

NORMAL RANGE OR LEVEL: NO_x and CO concentrations, corrected to 15% O₂, at or below the emissions limits specified in the permit.

REPORTING: If the equipment is operated outside the normal range or level for either NO_x or CO and the deviation is not corrected within 8 hours, the District shall be notified within the following 1 hour. Deviations corrected within 8 hours must only be recorded.

RECORDKEEPING: The date and time of measurement, and NO_x and CO concentrations (corrected to 15% O₂) shall be recorded. If any deviations from the normal range or level are observed, the types of corrective actions taken and the time and dates of such corrective action shall also be recorded. Records shall be kept onsite for a period of five years, and made available for inspection upon request.

PERMIT CONDITIONS: The permit must outline the facility's approach to monitoring and the manner by which a normal range/level for surrogate parameters is established. The permit must also include requirements for adequate recordkeeping and reporting, prompt notification and correction of excursions from the normal range of operations. The following general conditions must be incorporated in permits for which alternate monitoring is allowed:

1. The permittee shall monitor and record the stack concentration of NO_x, CO, and O₂ at least once every calendar quarter (in which a source test is not performed) using a portable emission monitor that meets District specifications. [In-stack O₂ monitors may be allowed if approved by the APCO.] Monitoring shall be performed not less than once every month for 12 months if 2 consecutive deviations are observed during quarterly monitoring. Monitoring shall not be required if the engine is not in operation, i.e. the engine need not be started solely to perform monitoring. Monitoring shall be performed within 5 days of restarting the engine unless monitoring has been performed within the last month if on a monthly monitoring schedule, or within the last quarter if on a quarterly monitoring schedule. Records must be maintained of the dates of non-operation to validate extended monitoring frequencies. [District Rules 4701 and 4702]

For engines subject to section 5.9.5.2, the above condition is replaced with the following condition:

- 1a. The permittee shall monitor and record the stack concentration of NO_x, CO, and O₂ at least once every six months (in which a source test is not performed) using a portable emission monitor that meets District specifications. [In-stack O₂ monitors may be allowed if approved by the APCO.] Monitoring shall be performed not less than once every quarter for 12 months if 2 consecutive deviations are observed during the semi-annually monitoring. Monitoring shall not be required if the engine is not in operation, i.e. the engine need not be started solely to perform monitoring. Monitoring shall be performed within 5 days of restarting the engine unless monitoring has been performed within the last quarter if on a quarterly monitoring schedule, or within the last half year if on a semi-annually monitoring schedule. Records must be maintained of the dates of non-operation to validate extended monitoring frequencies. [District Rule 4702]

For engines subject to section 5.9.5.3, the above condition is replaced with the following condition:

- 1b. The permittee shall monitor and record the stack concentration of NO_x, CO, and O₂ at least once every twenty-four months (in which a source test is not performed) using a portable emission monitor that meets District specifications. [In-stack O₂ monitors may be allowed if approved by the APCO.] Monitoring shall be performed not less than once every half year for 12 months if 2 consecutive deviations are observed during the biannually monitoring. Monitoring shall not be required if the engine is not in operation, i.e. the engine need not be started solely to perform monitoring. Monitoring shall be performed within 5 days of restarting the engine unless monitoring has been performed within the last half year if on a semi-annually monitoring schedule, or within the last two years if on a biannually monitoring schedule. Records must be maintained of the dates of non-operation to validate extended monitoring frequencies. [District Rule 4702]

2. If either the NO_x or CO concentrations corrected to 15% O₂, as measured by the portable analyzer, exceed the allowable emission concentration, the permittee shall return the emissions to within the acceptable range as soon as possible, but no longer than 8 hours after detection. If the portable analyzer readings continue to exceed the allowable emissions concentration after 8 hours, the permittee shall notify the District within the following 1 hour, and conduct a certified source test within 60 days of the first exceedance. In lieu of conducting a source test, the permittee may stipulate a violation has occurred, subject to enforcement action. The permittee must then correct the violation, show compliance has been re-established, and resume monitoring procedures. If the deviations are the result of a qualifying breakdown condition pursuant to Rule 1100, the permittee may fully comply with Rule 1100 in lieu of the performing the notification and testing required by this condition. [District Rules 4701 and 4702]
3. All alternate monitoring parameter emission readings shall be taken with the unit operating either at conditions representative of normal operations or conditions specified in the permit-to-operate. The analyzer shall be calibrated, maintained, and operated in accordance with the manufacturer's specifications and recommendations or a protocol approved by the APCO. Emission readings taken shall be averaged over a 15 consecutive-minute period by either taking a cumulative 15 consecutive-minute sample reading or by taking at least five (5) readings, evenly spaced out over the 15 consecutive-minute period. [District Rules 4701 and 4702]
4. The permittee shall maintain records of: (1) the date and time of NO_x, CO, and O₂ measurements, (2) the O₂ concentration in percent and the measured NO_x and CO concentrations corrected to 15% O₂, (3) make and model of exhaust gas analyzer, (4) exhaust gas analyzer calibration records, and (5) a description of any corrective action taken to maintain the emissions within the acceptable range. [District Rules 4701 and 4702]

B. Monitoring of Catalyst Inlet and Outlet Temperatures, Ammonia Injection Rate, and NO_x, CO, and O₂ Concentrations

COMPATIBLE NO_x CONTROL TECHNIQUES: Units with SCR will be allowed to monitor catalyst inlet and outlet temperatures, ammonia injection rate, and NO_x, CO, and O₂ concentrations.

FREQUENCY: Monitoring of the catalyst inlet and outlet temperatures and ammonia injection rate shall be conducted at least once every week. Monitoring of NO_x, CO and O₂ shall be conducted at least once every calendar quarter (in which a source test is not performed). The NO_x and CO emission concentrations shall be corrected to 15% O₂.

MEASUREMENT: Catalyst inlet and outlet exhaust temperatures shall be monitored with a temperature-indicating device. The ammonia injection rate shall be determined using appropriate equipment and methods. The exhaust gas shall be monitored for NO_x, CO, and O₂ concentrations with a portable emission monitor that meets District specifications prescribed in Compliance's Portable Emission Analyzer Policy for Industry, COM 1150B.

RESULTS: Catalyst temperature differential ($T_{OUT} - T_{IN}$), ammonia injection rate, and NO_x and CO concentrations corrected to 15% O₂.

NORMAL RANGE OR LEVEL: Temperature differential equal to or greater than the range established by testing of the unit and specified on the permit; ammonia injection rate within the range established by testing of the unit and specified on the permit; NO_x and CO concentrations, corrected to 15% O₂, below the emissions limits specified in the permit. Normal range or level shall be re-established at each scheduled source test.

REPORTING: If the equipment is operated outside the normal range or level for either NO_x or CO, temperature differential, or ammonia injection rate and the deviation is not corrected within 8 hours, the District shall be notified within the following 1 hour. Deviations corrected within 8 hours must only be recorded.

RECORDKEEPING: The date and time of temperature and emission measurement, measured ammonia injection rate, catalyst inlet and outlet temperatures, and NO_x and CO concentrations (corrected to 15% O₂) shall be recorded. If any deviations from the normal range or level (temperature or NO_x/CO emissions) are observed, the types of corrective actions taken and the time and dates of such corrective action shall also be recorded. Records shall be kept for a period of five years, and made available for inspection upon request.

PERMIT CONDITIONS: The permit must outline the facility's approach to monitoring and the manner by which a normal range/level for surrogate parameters is established. The permit must also include requirements for adequate recordkeeping and reporting, prompt notification and correction of excursions from the normal range of operations. The following general conditions must be incorporated in permits for which alternate monitoring is allowed:

1. The permittee shall monitor and record the catalyst inlet and outlet temperatures and ammonia injection rate at least once per week. Monitoring shall not be required if the engine is not in operation, i.e. the engine need not be started solely to perform monitoring. Monitoring shall be performed within 5 days of restarting the engine unless monitoring has been performed within the last week. Records must be maintained of the dates of non-operation to validate extended monitoring frequencies. [District Rules 4701 and 4702]
- 2a. The minimum acceptable catalyst temperature differential and ammonia injection rate shall be established by source testing this unit. [District Rules 4701 and 4702]

The above condition should be changed to the following upon conversion of the Authority to Construct to a Permit to Operate:

- 2b. The catalyst temperature differential ($\text{Temp}_{\text{out}} - \text{Temp}_{\text{in}}$) shall be not be less than [*describe level at which compliance was demonstrated at the initial source test*] degrees F, and ammonia injection rate shall not be less than [*describe level at which compliance was demonstrated at the initial source test*]. [District Rules 4701 and 4702]
3. If either the catalyst temperature differential or ammonia injection rate is lower than the normal range/level, the permittee shall return the temperature differential and/or ammonia injection rate to the normal range/level as soon as possible, but no longer than 8 hours after detection. If the catalyst temperature differential rate or ammonia injection rate is not returned to the normal range/level within 8 hours, the permittee shall notify the District within the following 1 hour, and conduct a source test within 60 days of the first exceedance, to demonstrate compliance with the applicable emission limits at the new temperature differential or ammonia injection rate. A District-approved portable analyzer may be used in lieu of a source test to demonstrate compliance. In lieu of conducting a source test, the permittee may stipulate a violation has occurred, subject to enforcement action. The permittee must then correct the violation, show compliance has been re-established, and resume monitoring procedures. If the deviations are the result of a qualifying breakdown condition pursuant to Rule 1100, the permittee may fully comply with Rule 1100 in lieu of the performing the notification and testing required by this condition. [District Rules 4701 and 4702]
4. The permittee shall maintain records of: (1) the date and time of temperature and ammonia injection rate measurements, (2) the measured temperatures and ammonia injection rate, and (3) a description of any corrective action taken to maintain the temperature differential and/or the ammonia injection rate within the acceptable range. [District Rules 4701 and 4702]

5. The permittee shall monitor and record the stack concentration of NO_x, CO, and O₂ at least once every calendar quarter (in which a source test is not performed) using a portable emission monitor that meets District specifications. [In-stack O₂ monitors may be allowed if approved by the APCO.] Monitoring shall not be required if the engine is not in operation, i.e. the engine need not be started solely to perform monitoring. Monitoring shall be performed within 1 day of restarting the engine unless monitoring has been performed within the last quarter. Records must be maintained of the dates of non-operation to validate extended monitoring frequencies. [District Rules 4701 and 4702]
6. If either the NO_x or CO concentrations corrected to 15% O₂, as measured by the portable analyzer, exceed the allowable emissions concentration, the permittee shall notify the District, and return the emissions to within the acceptable range as soon as possible, but no longer than 8 hours after detection. If the portable analyzer readings continue to exceed the allowable emissions concentration after 8 hours, the permittee shall notify the District within the following 1 hour and conduct a source test within 60 days of the first exceedance. In lieu of conducting a source test, the permittee may stipulate a violation has occurred, subject to enforcement action. The permittee must then correct the violation, show compliance has been re-established, and resume monitoring procedures. If the deviations are the result of a qualifying breakdown condition pursuant to Rule 1100, the permittee may fully comply with Rule 1100 in lieu of the performing the notification and testing required by this condition. [District Rules 4701 and 4702]
7. All alternate monitoring parameter emission readings shall be taken with the unit operating either at conditions representative of normal operations or conditions specified in the permit-to-operate. The analyzer shall be calibrated, maintained, and operated in accordance with the manufacturer's specifications and recommendations or a protocol approved by the APCO. Emission readings taken shall be averaged over a 15 consecutive-minute period by either taking a cumulative 15 consecutive-minute sample reading or by taking at least five (5) readings, evenly spaced out over the 15 consecutive-minute period. [District Rules 4701 and 4702]
8. The permittee shall maintain records of: (1) the date and time of NO_x, CO, and O₂ measurements, (2) the O₂ concentration in percent and the measured NO_x and CO concentrations corrected to 15% O₂, (3) make and model of exhaust gas analyzer, (4) exhaust gas analyzer calibration records, and (5) a description of any corrective action taken to maintain the emissions within the acceptable range. [District Rules 4701 and 4702]

VII. Pre-Approved Monitoring Procedures for Engines Subject to Section 5.4.2 of Rule 4701 and/or Section 5.8.2 of Rule 4702 (Including Requirements of Section 5.4.3 of Rule 4701, and/or 5.8.9 of Rule 4702, and/or 5.9.3 of Rule 4702)

The following alternate monitoring procedures have been approved as meeting the applicable provisions of section 5.4.2 of Rule 4701 and 5.8.2 of Rule 4702 (When more than one alternate monitoring procedure is compatible with a given control technique, the applicant may select the option most suitable to their needs):

(Note: In lieu of the options below, an applicant subject to section 5.4.2 of Rule 4701 and/or section 5.8.2 of Rule 4702 may choose one of the more stringent options listed in Section VI of this policy.)

A. Monitoring of Exhaust O₂ Concentration (and NO_x as required by sections 5.4.3 of Rule 4701 and/or section 5.8.9 of Rule 4702, and/or 5.9.5 of Rule 4702)

COMPATIBLE NO_x CONTROL TECHNIQUES: Only units with lean burn combustion ($\geq 4\%$ O₂ in exhaust) will be allowed to monitor exhaust O₂ concentration and NO_x emissions.

FREQUENCY: Monitoring of exhaust O₂ shall be conducted at least once every month. Monitoring of O₂ and NO_x concentrations shall be conducted at least once per calendar quarter (in which a source test is not performed).

- For engines subject to section 5.9.5.2, monitoring is required on at least once every 6 months that the engine is operated.
- For engines subject to section 5.9.5.3, monitoring is required on at least once every 24 months that the engine is operated.

MEASUREMENT: The exhaust gas shall be monitored for NO_x and O₂ concentration with a portable emission monitor that meets District specifications prescribed in Compliance's Portable Emission Analyzer Policy for Industry, COM 1150B.

RESULTS: Direct reading of O₂ concentration and NO_x concentration corrected to 15% O₂.

NORMAL RANGE OR LEVEL: O₂ concentration within the range established by testing of the unit, or based on manufacturer's information, and specified on the permit, and NO_x concentration, corrected to 15% O₂, at or below the emissions limit specified in the permit.

REPORTING: If the equipment is operated outside the normal range or level for either O₂ concentration or NO_x concentration and the deviation is not corrected within 8 hours, the District shall be notified within the following 1 hour. Deviations corrected within 8 hours must only be recorded.

RECORDKEEPING: The date and time of O₂ and NO_x (corrected to 15% O₂) concentration measurement and the measured concentrations shall be recorded. If any deviations from the normal range or level are observed, the types of corrective actions taken and the time and dates of such corrective action shall also be recorded. Records shall be kept for a period of five years, and made available for inspection upon request.

PERMIT CONDITIONS: The permit must outline the facility's approach to monitoring and the manner by which a normal range/level for surrogate parameters is established. The permit must also include requirements for adequate recordkeeping and reporting, prompt notification and correction of excursions from the normal range of operations. The following general conditions must be incorporated in permits for which alternate monitoring is allowed:

1. The permittee shall monitor and record the stack concentration of O₂ at least once every month and the stack concentration of NO_x and O₂ at least once every calendar quarter (in which a source test is not performed) using a portable emission monitor that meets District specifications. [In-stack O₂ monitors may be allowed if approved by the APCO.] Monitoring shall not be required if the engine is not in operation, i.e. the engine need not be started solely to perform monitoring. Monitoring shall be performed within 5 days of restarting the engine unless monitoring has been performed within the last month. [District Rules 4701 and 4702]

For engines subject to section 5.9.5.2, the above condition is replaced with the following condition:

- 1a. The permittee shall monitor and record the stack concentration of NO_x, CO, and O₂ at least once every six months (in which a source test is not performed) using a portable emission monitor that meets District specifications. [In-stack O₂ monitors may be allowed if approved by the APCO.] Monitoring shall be performed not less than once every quarter for 12 months if 2 consecutive deviations are observed during the semi-annually monitoring. Monitoring shall not be required if the engine is not in operation, i.e. the engine need not be started solely to perform monitoring. Monitoring shall be performed within 5 days of restarting the engine unless monitoring has been performed within the last quarter if on a quarterly monitoring schedule, or within the last half year if on a semi-annually monitoring schedule. Records must be maintained of the dates of non-operation to validate extended monitoring frequencies. [District Rule 4702]

For engines subject to section 5.9.5.3, the above condition is replaced with the following condition:

- 1b.** The permittee shall monitor and record the stack concentration of NO_x, CO, and O₂ at least once every twenty-four months (in which a source test is not performed) using a portable emission monitor that meets District specifications. [In-stack O₂ monitors may be allowed if approved by the APCO.] Monitoring shall be performed not less than once every half year for 12 months if 2 consecutive deviations are observed during the biannually monitoring. Monitoring shall not be required if the engine is not in operation, i.e. the engine need not be started solely to perform monitoring. Monitoring shall be performed within 5 days of restarting the engine unless monitoring has been performed within the last half year if on a semi-annually monitoring schedule, or within the last two years if on a biannually monitoring schedule. Records must be maintained of the dates of non-operation to validate extended monitoring frequencies. [District Rule 4702]
- 2a.** The acceptable exhaust gas O₂ range shall be established from manufacturer's information, or by source testing this unit. [District Rules 4701 and 4702]

The above condition should be changed to the following upon conversion of the Authority to Construct to a Permit to Operate:

- 2b.** The exhaust gas O₂ concentration shall be maintained between XXX and XXX % O₂. [District Rules 4701 and 4702]
- 3.** If either the O₂ concentration or the NO_x concentration corrected to 15% O₂, as measured by the portable analyzer, is outside the permitted range, the permittee shall return the O₂ and/or NO_x to within the acceptable range as soon as possible, but no longer than 8 hours after detection. If the portable analyzer readings continue outside the permitted range after 8 hours, the permittee shall notify the District within the following 1 hour, and conduct a certified source test within 60 days of the first exceedance. In lieu of conducting a source test, the permittee may stipulate a violation has occurred, subject to enforcement action. The permittee must then correct the violation, show compliance has been re-established, and resume monitoring procedures. If the deviations are the result of a qualifying breakdown condition pursuant to Rule 1100, the permittee may fully comply with Rule 1100 in lieu of the performing the notification and testing required by this condition. [District Rules 4701 and 4702]

4. All alternate monitoring parameter emission readings shall be taken with the unit operating either at conditions representative of normal operations or conditions specified in the permit-to-operate. The analyzer shall be calibrated, maintained, and operated in accordance with the manufacturer's specifications and recommendations or a protocol approved by the APCO. Emission readings taken shall be averaged over a 15 consecutive-minute period by either taking a cumulative 15 consecutive-minute sample reading or by taking at least five (5) readings, evenly spaced out over the 15 consecutive-minute period. [District Rules 4701 and 4702]
5. The permittee shall maintain records of: (1) the date and time of O₂ and NO_x measurements, (2) the O₂ concentration in percent and the measured NO_x concentration corrected to 15% O₂, (3) make and model of exhaust gas analyzer, (4) exhaust gas analyzer calibration records, and (5) a description of any corrective action taken to maintain the emissions within the acceptable range. [District Rules 4701 and 4702]

VIII. Case-By-Case Approvals of Other Alternate Monitoring Procedures

The permittee may seek a case-by-case approval of monitoring procedures other than those pre-approved above. For engines subject to the monitoring requirements of section 5.4.1 of Rule 4701 and/or section 5.8.1 of Rule 4702, the applicant must provide a technical justification and demonstrate that the parameters to be monitored have a strong correlation with NO_x and CO emissions, and will provide a reasonable assurance of compliance. For engines subject to the monitoring requirements of section 5.4.2 of Rule 4701 or section 5.8.2 of Rule 4702, the applicant must demonstrate that the operational characteristics to be monitored are recommended by the engine manufacturer or control system supplier, or show that the operational characteristics proposed to be monitored will provide a reasonable assurance of compliance. Monitoring proposals are to be submitted to the Director of Permit Services for approval. (Once Director's approval is granted for a monitoring procedure, the evaluation and the associated documents must be distributed to the other regional offices and posted to the District's intranet site and website. Subsequent approval of identical proposals may be made by the Regional Permit Services Manager.) Monitoring proposal should contain information on the following:

- A. **Control technology** - This should include specific details about the how the control technology operates and how NO_x reduction occurs.
- B. **Monitored Parameters** - This should describe the correlation between the proposed monitoring parameters and NO_x emissions.
- C. **Measurement** - This should include the specifics of the proposed measuring equipment and the location(s) of the equipment.
- D. **Frequency** - This should include a justification showing that the frequency of monitoring proposed is sufficient to show ongoing compliance.
- E. **Results** -The permit must contain an enforceable condition specifying the acceptable range of values for all parameters to be monitored. For engines with external control devices, the range(s) may be established by source testing of the unit. For engines without external control devices, the range(s) may be obtained from the engine manufacturer or control system supplier, or by source testing of the unit.

APPENDIX A

IC Engine NO_x Formation Mechanisms and Control Techniques

I. NO_x Formation Mechanisms

A. Thermal NO_x:

During combustion, O₂ and N₂ combine to form nitric oxide (NO) and nitrogen dioxide (NO₂) in the high temperature zone. The main factors affecting the quantity of NO_x formed are (1) the peak temperature, (2) the amount of oxygen present in the high temperature zone and (3) the fuel combusted. Thermal NO_x represents a majority of the NO_x formed in an internal combustion engine.

B. Fuel NO_x:

During combustion, nitrogen in the fuel can react with O₂ to form NO_x. The rate of fuel nitrogen NO_x formation is dependent upon the amount of nitrogen contained in the fuel and the oxygen concentration present in the high temperature zone. Most natural gas contains little or no fuel bound nitrogen. The percentage of fuel NO_x formed in an internal combustion engine is usually negligible in comparison to amount of thermal NO_x formed.

C. Prompt NO_x:

During combustion, NO_x can also form due to the reaction of molecular nitrogen with free radicals such as HCN, NH, and N present in the combustion zone(s). These reactions are not related to the peak temperature. Therefore, combustion modifications do not have a strong influence on the NO_x formed by this mechanism. The percentage of prompt NO_x formed in an internal combustion engine is usually negligible in comparison to amount of thermal NO_x formed.

II. NO_x Control Techniques

A. Internal Control Techniques - Lean Burn Combustion

Operating with high excess air (fuel lean combustion) reduces the peak temperature achieved. This inhibits the reactions responsible for thermal NO_x. Lean burn combustion is usually accomplished through special combustion features such as a pre-combustion chamber and pre-stratifying the intake charge. Air/fuel ratio controllers are often used with either system to maximize the reduction in emissions, increase engine efficiency, and maximize the power output.

1. Pre-Combustion Chamber

Pre-combustion chambers are designed to allow the initial combustion to occur in a fuel-rich environment. Once the combustion process is initiated, the flame travels from the pre-combustion chamber into the main combustion chamber and subsequently ignites an extremely lean (fuel-lean) mixture. This is essentially an internal control device. The effectiveness of this type of system is not expected to change over time.

2. Pre-Stratified Charge

As in pre-combustion chamber systems, initial combustion in a pre-stratified charge system occurs in a fuel-rich environment. Pre-stratified charge systems are generally used as retrofit systems for 4-cycle natural gas-fired engines. During combustion, additional air is introduced into the engine, which cools the propagating flame and reduces thermal NO_x . This is essentially an internal control device. The effectiveness of this type of system is not expected to change over time.

B. External Control Techniques

1. Exhaust Gas Recirculation (EGR)

A portion of the exhaust gas stream is recycled back into the main combustion zone by extracting it from the exhaust and mixing it with the combustion air or the combustion air/fuel mixture. This reduces thermal NO_x formation by reducing the peak temperature and by diluting the oxygen content in the combustion zone. The NO_x reduction varies directly with the EGR rate up to the limit of combustion stability.

2. Exhaust Gas Treatment

NO_x can be reduced to molecular nitrogen by adding flue gas treatment systems located in the engine exhaust. The two basic system types used on IC engines are listed below:

a. Selective Catalytic Reduction

Ammonia is injected into the exhaust upstream of a catalyst bed. The ammonia reduces the NO_x on the catalyst surface. The operating range for SCR catalysts is typically 550°F to 750°F . Any particular SCR catalyst has a narrow temperature window for optimum operation. Variations in exhaust gas temperature of 50°F can have an impact on NO_x reduction efficiency. Also, the molar ratio of ammonia to NO_x is critical to NO_x reduction. Injection rates of ammonia at higher than the stoichiometric amount enhances NO_x reduction but results in increased ammonia emissions (ammonia slip). The ammonia must be injected such that uniform distribution occurs across the catalyst bed.

b. Non-Selective Catalytic Reduction and Two Stage Catalytic Systems

In the absence of oxygen, the exhaust gas is passed through a catalyst bed where NO_x is reduced to N_2 and CO_2 . Oxygen remaining in the exhaust is then used to oxidize HC's and CO into CO_2 and H_2O . These reactions can occur in a single catalyst, or in separate catalysts (two stage).

Single catalyst systems, which are designed to promote both of these reactions simultaneously, are referred to as Non-Selective Catalytic Reduction catalysts, or simply three-way catalysts. In order for a three-way catalyst to be effective in reducing NO_x , HC, and CO emissions, the air/fuel ratio must be precisely maintained; therefore, an air/fuel ratio controller is necessary.

In two stage systems, additional oxygen may be injected into the exhaust after the NO_x reduction catalyst in order to enhance the oxidation of HC's and CO in the second catalyst. An air/fuel ratio controller is not necessary for a two stage catalyst system as the amount of oxygen injected upstream of the second catalyst section is determined by other system parameters. However, an air/fuel ratio controller is commonly used to provide more effective control of emissions.

NSCR can only be used on rich-burn engines where there are sufficient hydrocarbons and CO in the exhaust gas stream to act as the reducing agent for NO_x . As such, NSCR is generally limited to 4-cycle, naturally aspirated (non-turbocharged and non-supercharged) engines. In some cases, 4-cycle turbocharged engines may still have oxygen-deficient exhaust to which NSCR can be applied. NSCR cannot be effectively applied to 2-cycle engines as the exhaust oxygen concentration is too high to reduce NO_x .

There are several variables that can affect catalyst performance. Phosphorus (an additive in some lubricating oils), sulfur, lead and arsenic can irreversibly poison the catalyst material. The catalyst can be masked (or coated) by chemicals or particulate adsorbing to the surface. Degradation of the catalyst is possible over time due to these factors.

APPENDIX B

Excursion Flow Chart

