San Joaquin Valley
Unified Air Pollution Control District

Permit Services

Emissions Monitoring for Rules 4305, 4306, and 4320

Approved By: _____ Arnaud Marjollet, Director of Permit Services	Approval Date: April 28, 2008
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Purpose: To identify pre-approved monitoring schemes that can be used as alternatives to continuous emissions monitoring systems (CEM's), and to establish procedures and criteria for case-by-case approval of other alternate monitoring proposals for compliance with Rule 4305, Boilers, Steam Generators, and Process Heaters - Phase II, Rule 4306, Boilers, Steam Generators, and Process Heaters - Phase III, and Rule 4320 Advanced Emission Reduction Options for Boilers, Steam Generators, and Process Heaters Greater Than 5.0 MMBtu/hr. As an alternative to CEM's, an applicant may choose from the pre-approved monitoring schemes or may make a different alternate 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 with the following exception: At permit renewal or by request from the Permittee, alternate monitoring permit conditions for a given scheme may be updated to current policy conditions for that same scheme.

I. Applicability

This policy applies to boilers, steam generators, and process heaters that are subject to monitoring requirements of District Rules 4305, 4306, and 4320.

II. Background

Rules 4305, 4306, and 4320 require that the owner of any unit subject to the emissions limits of the rules shall either install and maintain 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 exhaust emission concentrations,
- periodic exhaust oxygen concentration,
- flow rate of reducing agent added to exhaust,
- catalyst inlet and exhaust temperature,
- catalyst inlet and exhaust oxygen concentration,
- periodic flue gas recirculation rate,
- other operational characteristics.

III. Guiding principles

The guiding principle of this policy in reference to monitoring requirements of Rules 4305, 4306, and 4320 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 unit 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 Section VI 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 boilers, steam generators, and process heaters subject to the monitoring requirements of Rules 4305, 4306, and 4320 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 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 equipment 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 equipment operator must agree to take prompt corrective actions of excursions and document those actions. Excursions must be rectified within 1 hour of operation after detection 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 1 hour of operation after detection 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 analyzer is allowed, testing using EPA approved methods can be substituted for testing with a portable analyzer. Retesting shall be performed under the same operational conditions that existed when the excursion was first detected.

Note: the procedures contained within this policy apply to monitoring performed by the permittee for the purpose of complying with the alternate monitoring requirements of Rules 4305, 4306, and 4320. Monitoring performed by the District for compliance purposes cannot be used to satisfy permittee's alternate monitoring requirements. In addition, District performed monitoring for compliance purposes is not subject to this policy.

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.

As with source testing, emissions monitoring with a portable analyzer shall be performed during normal operation, as specified in Rules 4305, 4306, and 4320.

For units that operate intermittently throughout the year, the units need not be started solely to perform monitoring required by this policy. Monitoring shall be performed within 5 days of restarting the units 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.

When a permittee switches from one alternate monitoring scheme to another (through an Authority to Construct), additional, out of schedule source testing to establish surrogate parameter ranges or levels shall not be required. Permittee may establish the ranges or levels using a portable analyzer, and re-establish the ranges or levels at the next scheduled source test.

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

VI. Pre-Approved Alternate Monitoring Schemes

Alternate monitoring procedure that requires monitoring of the FGR valve(s), for units where the FGR valve position is continuously or intermittently varied in conjunction with the opening and closing of the fuel-throttling valve through linkage between the FGR valve and the fuel-throttling valve, shall not be allowed for any new boiler, steam generator, or heater or any existing boiler, steam generator, or heater changing alternate monitoring procedures. In addition, alternate monitoring procedure that requires monitoring of the FGR valve(s), for units where the FGR fan speed is continuously or intermittently varied, shall not be allowed for any new boiler, steam generator, or process heater or any existing boiler, steam generator, or process heater changing alternate monitoring procedures. Existing facilities may continue to use these procedures provided testing continues to show correlation between surrogate parameters and emissions.

The following alternate monitoring schemes have been approved as meeting the applicable provisions of Rules 4305,4306, and 4320: (When more than one alternate monitoring scheme is compatible with a given control technique, the applicant may select the option most suitable to their needs.)

A. Periodic Monitoring of NO_X, CO, and O_2 Concentrations

COMPATIBLE NO_X CONTROL TECHNIQUES: All units subject to the monitoring requirements of Rules 4305, 4306, and 4320 will be allowed to monitor NO_X, CO, and O_2 concentrations.

FREQUENCY: Monitoring of NO_X, CO and O_2 shall be conducted at least once per month (in which a source test is not performed).

MEASUREMENT: The exhaust gas shall be monitored for NO_X, CO, and O_2 concentrations with a portable analyzer that meets District specifications prescribed in Compliance's Portable Emission Analyzer Policy for Industry, COM 1150B.

RESULTS: NO_X and CO concentrations corrected to 3% O_2.

NORMAL RANGE OR LEVEL: NO_X and CO concentrations, corrected to 3% O_2, 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 1 hour of operation after detection, the District shall be notified within the following 1 hour. Deviations corrected within 1 hour of operation after detection must only be recorded.

RECORDKEEPING: The date and time of measurement, and NO_X and CO concentrations (corrected to 3% O_2) 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. {4315} The permittee shall monitor and record the stack concentration of NO_X, CO, and O2 at least once every month (in which a source test is not performed) using a portable analyzer that meets District specifications. Monitoring shall not be required if the unit is not in operation, i.e. the unit need not be started solely to perform monitoring. Monitoring shall be performed within 5 days of restarting the unit unless monitoring has been performed within the last month. [District Rules 4305, 4306, and 4320]

2. {4316} If either the NO_X or CO concentrations corrected to 3% O2, as measured by the portable analyzer, exceed the allowable emissions concentration, the permittee shall return the emissions to within the acceptable range as soon as possible, but no longer than 1 hour of operation after detection. If the portable analyzer readings continue to exceed the allowable emissions concentration after 1 hour of operation after detection, 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 4305, 4306, and 4320]

3. {4317} 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 4305, 4306, and 4320]

4. {4318} The permittee shall maintain records of: (1) the date and time of NO_X, CO, and O2 measurements, (2) the O2 concentration in percent by volume and the measured NOX and CO concentrations corrected to 3% 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 4305, 4306, and 4320]

B. Periodic Determination of FGR Rate by Temperature Measurement &

C. Periodic Determination of FGR Rate by O_2 Measurement

COMPATIBLE NO_X CONTROL TECHNIQUES: Units with Flue Gas Recirculation (FGR), including units that use a low NO_X burner or conventional burners with off-stoichiometric combustion will be allowed to monitor flue gas recirculation rate.

FREQUENCY: Monitoring of the FGR rate shall be conducted at least once per week.

MEASUREMENT: The FGR rate is the amount of exhaust gas recycled to the combustion chamber divided by the fresh combustion air and recycled exhaust gas introduced into the burner. Two methods for determining the FGR rate are listed below (Depending on the flue gas recirculation method, other calculation methodologies may be more appropriate):

i) Temperature Measurement - The stack, windbox and ambient temperature readings can be used to calculate the FGR rate. (See Appendix C) [Only for units where flue gas and fresh air are mixed upstream of the burner.].

ii) O_2 Measurement - The stack and windbox O_2 readings can be used to calculate the FGR rate. (See Appendix D) [Only for units where flue gas and fresh air are mixed upstream of the burner.].

RESULTS: Flue gas recirculation rate

NORMAL RANGE OR LEVEL: Flue gas recirculation rate equal to or greater than the value established by testing of the unit or other representative units and specified on 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 the FGR rate and the deviation is not corrected within 1 hour of operation after detection, the District shall be notified within the following 1 hour. Deviations corrected within 1 hour of operation after detection must only be recorded.

RECORDKEEPING: The date and time of measurement, the temperature and/or O_2 level measured, the calculated FGR rate, and the firing rate 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.

PEMIT 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:

B. Periodic Determination of FGR Rate by Temperature Measurement:

1. {4324} The flue gas recirculation rate shall be determined at least on a weekly basis by measuring the stack temperature (Ts), windbox temperature (Tw), and ambient temperature (Ta) and using the following equation: FGR rate = {Tw - Ta)/(Ts - Ta)} x 100%. Monitoring shall not be required if the unit is not in operation, i.e. the unit need not be started solely to perform monitoring. Monitoring shall be performed within 5 days of restarting the unit 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 4305, 4306, and 4320]

2a. {4325} The minimum flue gas recirculation rate shall be established by source testing this unit or other representative units per Rules 4305 and 4306 and as approved by the District. The normal range/level shall be no lower than the minimum flue gas recirculation rate with which compliance with applicable NOX and CO emission limits has been demonstrated through source testing at a similar firing rate. [District Rules 4305, 4306, and 4320]

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

2b. The flue gas recirculation rate shall not be less than XX% at firing rates less than XX%. The flue gas recirculation rate shall not be less than XX% at firing rates greater than XX% and less than XX%. The flue gas recirculation rate shall not be less than XX% at firing rates greater than XX%. [District Rules 4305, 4306, and 4320]

3. {4069} Normal range or level for the flue gas recirculation rate shall be re-established during each source test required by this permit. [District Rules 4305,4306, and 4320]

4. {4326} If the flue gas recirculation rate is less than the normal range/level, the permittee shall return the flue gas recirculation rate to the normal range/level as soon as possible, but no longer than 1 hour of operation after detection. If the flue gas recirculation rate is not returned to the normal range/level within 1 hour of operation after detection, 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 flue gas recirculation 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 4305, 4306, and 4320]

5. {4327} The permittee shall maintain records of the date and time of temperature measurements, the measured temperatures, the calculated flue gas recirculation rate, and the firing rate at the time of the temperature measurements. The records shall also include a description of any corrective action taken to maintain the flue gas recirculation rate within the acceptable range. [District Rules 4305, 4306, and 4320]

C. Periodic Determination of FGR Rate by O_2 Measurement:

1. {4328} The flue gas recirculation rate shall be determined at least on a weekly basis by measuring the stack O2% by volume (Os), and windbox O2% by volume (Ow) using the following equation: FGR rate = {Ow - 20.9)/(Os - 20.9)} x 100%. Monitoring shall not be required if the unit is not in operation, i.e. the unit need not be started solely to perform monitoring. Monitoring shall be performed within 5 days of restarting the unit 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 4305, 4306, and 4320]

2a. {4329} The minimum flue gas recirculation rate shall be established by source testing this unit or other representative units per Rules 4305 and 4306 and as approved by the District. The normal range/level shall be no lower than the minimum flue gas recirculation rate with which compliance with applicable NOX and CO emission limits has been demonstrated through source testing at a similar firing rate. [District Rules 4305, 4306, and 4320]

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

2b. The flue gas recirculation rate shall not be less than XX% at firing rates less than XX%. The flue gas recirculation rate shall not be less than XX% at firing rates greater than XX% and less than XX%. The flue gas recirculation rate shall not be less than XX% at firing rates greater than XX%. [District Rules 4305, 4306, and 4320]

3. {4069} Normal range or level for the flue gas recirculation rate shall be re-established during each source test required by this permit. [District Rules 4305, 4306, and 4320]

4. {4330} If the flue gas recirculation rate is less than the normal range/level, the permittee shall return the flue gas recirculation rate to the normal range/level as soon as possible, but no longer than 1 hour of operation after detection. If the flue gas recirculation rate is not returned to the normal range/level within 1 hour of operation after detection, 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 flue gas recirculation 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 4305, 4306, and 4320]

5. {4331} The permittee shall maintain records of the date and time of oxygen concentration measurements, the measured oxygen concentrations, the calculated flue gas recirculation rate, and the firing rate at the time of the oxygen concentration measurements. The records shall also include a description of any corrective action taken to maintain the flue gas recirculation rate within the acceptable range. [District Rules 4305, 4306, and 4320]

D. Monitoring of Burner Mechanical Adjustments and O_2 Concentration

COMPATIBLE NOx CONTROL TECHNIQUES: Units which use staged air low NO_X burners will be allowed to monitor burner mechanical adjustments and exhaust gas O_2 concentration. Staged air low NO_x burners operate by limiting the oxygen availability in the primary combustion zone. This is done by setting the burner mechanical adjustments. Once the burner is adjusted it is not expected to change over time.

FREQUENCY: Monitoring of the exhaust gas O_2 concentration and visibly monitoring the mechanical burner linkages/adjustments shall be conducted at least once per week.

MEASUREMENT: The exhaust gas O_2 shall be measured with a portable analyzer or an in-stack analyzer that meets District specifications prescribed in Compliance's Portable Emission Analyzer Policy for Industry, COM 1150B.. The applicant shall outline in writing the mechanical adjustments made to the burner. This should include a description of how these mechanical settings can be visibly inspected.

RESULTS: Exhaust gas O_2 concentration and settings for mechanical adjustments

NORMAL RANGE OR LEVEL: Exhaust gas O_2 concentration and settings for the burner mechanical adjustments within the ranges established by testing of the unit or other representative units and specified on 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 the exhaust O_2 concentration or the burner mechanical settings and the deviation is not corrected within 1 hour of operation after detection, the District shall be notified within the following 1 hour. Deviations corrected within 1 hour of operation after detection must only be recorded.

RECORDKEEPING: The date and time of measurement, the O_2 level measured, and the burner's mechanical adjustment settings 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.

PEMIT 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. {4332} The stack O2 concentration measurement and inspection of [list mechanical adjustments/settings] shall be conducted at least on a weekly basis. Monitoring shall not be required if the unit is not in operation, i.e. the unit need not be started solely to perform monitoring. Monitoring shall be performed within 5 days of restarting the unit 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 4305, 4306, and 4320]

2a. {4333} The normal range/level of stack O_2 concentration and visible mechanical burner settings shall be established by source testing this unit or other representative units per Rules 4305 and 4306 and as approved by the District. The normal range/level shall be that for which compliance with applicable NOX and CO emission limits has been demonstrated through source testing at a similar firing rate. [District Rules 4305, 4306, and 4320]

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

2b. The stack O_2 concentration shall maintained between X% and X% at firing rates less than XX%. The stack O_2 concentration shall maintained between X% and X% at firing rates greater than XX% and less than XX%. The stack O_2 concentration shall maintained between X% and X% at firing rates greater than XX%. [District Rules 4305, 4306, and 4320]

2c. The burner mechanical settings shall be maintained at [*describe settings at which compliance was demonstrated at the initial source test*]. [District Rules 4305, 4306, and 4320]

3. {4334} Normal range or level for the stack O_2 concentration and burner mechanical settings shall be re-established during each source test required by this permit. [District Rules 4305,4306, and 4320]

4. {4335} If the either the stack O2 concentration or visible mechanical burner settings are less than the normal range/level, the permittee shall return the stack O2 concentration and visible mechanical burner settings to the normal range/level as soon as possible, but no longer than 1 hour of operation after detection. If the stack O2 concentration and visible mechanical burner settings are not returned to the normal range/level within 1 hour of operation after detection, 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 stack O2 concentration and visible mechanical burner settings. 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 4305, 4306, and 4320]

5. {4336} The permittee shall maintain records of the date and time of O2 measurements and burner adjustments, the measured O2 concentrations (% by volume) and firing rate at the time of O2 measurement, and the observed setting for [LIST ADJUSTMENTS TO INSPECTED]. The records must also include a description of any corrective action taken to maintain the O2 concentration and the burner mechanical settings within the acceptable range. [District Rules 4305, 4306, and 4320]

E. Monitoring of the FGR valve(s) setting

COMPATIBLE NO_X CONTROL TECHNIQUES: Units equipped with FGR where the FGR rate is set by one or more mechanical valve adjustments will be allowed to monitor the FGR valve(s) setting. Units where the FGR valve position is continuously or intermittently varied in conjunction with the opening and closing of the fuel-throttling valve through linkage between the FGR valve and the fuel-throttling valve are precluded from using this technique. In addition, units where the FGR fan speed is continuously or intermittently varied are also precluded from using this technique.

FREQUENCY: Monitoring of the FGR valve(s) setting shall be conducted at least once per week.

MEASUREMENT: The applicant shall outline in writing how the FGR valve(s) is/are mechanically set. The applicant shall also outline how the FGR valve(s) mechanical setting can be visibly inspected.

RESULTS: Mechanical setting for the FGR valve(s)

NORMAL RANGE OR LEVEL: FGR valve(s) mechanical setting equal to or greater (more FGR) than the value established by testing of the unit or other representative units and specified on 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 the FGR valve(s) mechanical setting and the deviation is not corrected within 1 hour of operation after detection, the District shall be notified within the following 1 hour. Deviations corrected within 1 hour of operation after detection must only be recorded.

RECORDKEEPING: The date and time of observation and the FGR valve(s)' mechanical settings 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.

PEMIT 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. {4337} The flue gas recirculation valve(s) setting shall be monitored at least on a weekly basis. Monitoring shall not be required if the unit is not in operation, i.e. the unit need not be started solely to perform monitoring. Monitoring shall be performed within 5 days of restarting the unit 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 4305, 4306, and 4320]

2a. {4338} The acceptable settings for the flue gas recirculation valve(s) shall be established by source testing this unit or other representative units per Rules 4305 and 4306 and as approved by the District. The normal range/level shall be that for which compliance with applicable NOx and CO emissions rates have been demonstrated through source testing at a similar firing rate. [District Rules 4305, 4306, and 4320]

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

2b. The flue gas recirculation valve(s) setting shall not be less than [*describe valve(s) setting at which compliance was demonstrated at the initial source test*] at firing rates less than XX%. The flue gas recirculation valve(s) setting shall not be less than [*describe valve(s) settings at which compliance was demonstrated at the initial source test*] at firing rates greater than XX% and less than XX%. The flue gas recirculation valve(s) setting shall not be less than [*describe valve(s) settings at which compliance was demonstrated at the initial source test*] at firing rates greater than XX%. [District Rules 4305, 4306, and 4320]

3. {4082} Normal range or level for the flue gas recirculation valve(s) settings shall be re-established during each source test required by this permit. [District Rules 4305, 4306, and 4320]

4. {4340} If the flue gas recirculation valve(s) setting is less than the normal range/level, the permittee shall return the flue gas recirculation valve(s) setting to the normal range/level as soon as possible, but no longer than 1 hour of operation after detection. If the flue gas recirculation valve(s) setting is not returned to the normal range/level within 1 hour of operation after detection, 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 flue gas recirculation valve(s) setting. 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 4305, 4306, and 4320]

5. {4341} The permittee shall maintain records of the date and time of flue gas recirculation valve(s) settings, the observed setting, and the firing rate at the time of the flue gas recirculation valve(s) setting measurements. The records must also include a description of any corrective action taken to maintain the flue gas recirculation valve(s) setting within the acceptable range. [District Rules 4305, 4306, and 4320]

F. Monitoring of the FGR fan variable frequency drive (VFD) output and fuel flow rate

COMPATIBLE NO_x CONTROL TECHNIQUES: Units equipped with forced FGR where the FGR rate is set by varying the FGR fan speed will be allowed to monitor the FGR fan VFD output. This type of FGR system uses a separate exhaust gas blower to recirculate the flue gas back into the flame for combustion. The VFD adjusts the speed of the FGR fan which then controls the FGR rate.

FREQUENCY: Monitoring of the FGR fan VFD hertz output, the natural gas firing rate, and the firing rate percentage value shall be conducted at least once per week.

MEASUREMENT: The FGR fan VFD hertz output shall be determined by reading the VFD display. The firing rate shall be obtained from the unit display and is read in terms of percentage. Fuel flow (natural gas only) will be obtained from a dedicated fuel meter installed at the burner fuel train inlet of the unit. The gas meter will indicate current ft^3/min flow and non-resettable totalized usage.

RESULTS: FGR fan VFD hertz output, the firing rate percentage, and the fuel flow in ft^3/min.

NORMAL RANGE OR LEVEL: The FGR fan VFD hertz output, the natural gas firing rate, and the firing rate percentage value equal to or greater (more FGR) than the value established by testing of the unit or other representative units and specified on 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 the FGR VFD hertz output and the deviation is not corrected within 1 hour of operation after detection, the District shall be notified within the following 1 hour. Deviations corrected within 1 hour of operation after detection must only be recorded.

RECORDKEEPING: The date and time of observation and the FGR fan hertz output, the firing rate percentage, and the fuel flow in ft^3/min 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.

PEMIT 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. {4898} The boiler shall be equipped with displays for monitoring the flue gas recirculation (FGR) fan variable frequency drive (VFD) hertz output, the natural gas firing rate in raw cubic feet per minute, and the firing rate percentage value. [District Rules 4305, 4306, and 4320]

2a. {4899} The normal range or level of FGR fan VFD output value shall be established by testing emissions from this unit or other representative units as approved by the District. The normal range/level shall be those for which compliance with applicable NOx and CO emission rates have been demonstrated through source testing at a similar firing rate. [District Rules 4305, 4306, and 4320]

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

2b. The FGR fan VFD output value shall not be less than XX.X Hz at firing rates less than XX%. The FGR fan VFD output value shall not be less than XX.X Hz at firing rates equal to or greater than XX% and less than XX%. The FGR fan VFD output value shall not be less than XX.X Hz at firing rates equal to or greater than XX% and less than XX%. The FGR fan VFD output value shall not be less than XX.X Hz at firing rates equal to or greater than XX%. [District Rules 4305, 4306, and 4320]

3. {4900} The normal range or level for the FGR fan VFD output value shall be re-established during each source test required by this permit. [District Rules 4305, 4306, and 4320]

4. {4901} The FGR fan VFD hertz output, the natural gas firing rate in raw cubic feet per minute, the date and time the test was conducted, and the firing rate percentage value as indicated by the variable frequency controllers will be taken for each test rate shall be inspected on at least a weekly basis. [District Rules 4305, 4306, and 4320]

5. {4902} The permittee shall maintain records of the FGR fan VFD hertz output, the natural gas firing rate in raw cubic feet per minute, the date and time the test was conducted, and the firing rate percentage value. The records must also include a description of any corrective action taken to maintain the FGR fan VFD output above the minimum acceptable rate. These records shall be retained at the facility for a period of no less than five years and shall be made available for District inspection upon request. [District Rules 4305, 4306, and 4320]

6. {4903} If the FGR fan VFD output deviates from the acceptable range/level for more than one hour, the permittee shall notify the District and take corrective action within one (1) hour after detection. If the FGR fan VFD output is not corrected within one hour, the permittee shall conduct an emissions test within 60 days, utilizing District-approved test methods, to demonstrate compliance with the applicable emissions limits at observed the FGR fan VFD output value. [District Rules 4305, 4306, and 4320]

G. Monitoring of the FGR fan speed and fuel flow rate

COMPATIBLE NO_X CONTROL TECHNIQUES: Units equipped with forced FGR where the FGR rate is set by varying the FGR fan speed will be allowed to monitor the FGR fan speed. This type of FGR system uses a separate exhaust gas blower to recirculate the flue gas back into the flame for combustion.

FREQUENCY: Monitoring of the FGR fan speed, the natural gas firing rate, and the firing rate percentage value shall be conducted at least once per week.

MEASUREMENT: The FGR fan speed shall be determined by reading the RPM speed meter. The firing rate shall be obtained from the unit display and is read in terms of percentage. Fuel flow (natural gas only) will be obtained from a dedicated fuel meter installed at the burner fuel train inlet of the unit. The gas meter will indicate current ft^3/min flow and non-resettable totalized usage.

RESULTS: FGR fan speed, the firing rate percentage, and the fuel flow in ft^3/min.

NORMAL RANGE OR LEVEL: The FGR fan speed, the natural gas firing rate, and the firing rate percentage value equal to or greater (more FGR) than the value established by testing of the unit or other representative units and specified on 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 the FGR fan speed and the deviation is not corrected within 1 hour of operation after detection, the District shall be notified within the following 1 hour. Deviations corrected within 1 hour of operation after detection must only be recorded.

RECORDKEEPING: The date and time of observation and the FGR fan speed, the firing rate percentage, and the fuel flow in ft^3/min 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.

PEMIT 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. {4904} The boiler shall be equipped with displays for monitoring the flue gas recirculation (FGR) fan speed, the natural gas firing rate in raw cubic feet per minute, and the firing rate percentage value. [District Rules 4305, 4306, and 4320]

2a. {4905} The normal range or level of FGR fan speed shall be established by testing emissions from this unit or other representative units as approved by the District. The normal range/level shall be those for which compliance with applicable NOx and CO emission rates have been demonstrated through source testing at a similar firing rate. [District Rules 4305, 4306, and 4320]

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

2b. The FGR fan speed shall not be less than XXX rpm at firing rates less than XX%. The FGR fan speed shall not be less than XXX rpm at firing rates equal to or greater than XX% and less than XX%. The fan speed shall not be less than XXX rpm at firing rates equal to or greater than XX% and less than XX%. The FGR fan speed shall not be less than XXX rpm at firing rates equal to or greater than XX%. [District Rules 4305, 4306, and 4320]

3. {4906} Normal range or level for the FGR fan speed shall be re-established during each source test required by this permit. [District Rules 4305, 4306, and 4320]

4. {4907} The FGR fan speed, the natural gas firing rate in raw cubic feet per minute, the date and time the test was conducted, and the firing rate percentage value will be taken for each test rate shall be inspected on at least a weekly basis. [District Rules 4305, 4306, and 4320]

5. {4908} The permittee shall maintain records of the FGR fan speed, the natural gas firing rate in raw cubic feet per minute, the date and time the test was conducted, and the firing rate percentage value. The records must also include a description of any corrective action taken to maintain the FGR fan speed above the minimum acceptable rate. These records shall be retained at the facility for a period of no less than five years and shall be made available for District inspection upon request. [District Rules 4305, 4306, and 4320]

6. {4909} If the FGR fan speed deviates from the acceptable range/level for more than one hour, the permittee shall notify the District and take corrective action within one (1) hour after detection. If the FGR fan speed is not corrected within one hour, the permittee shall conduct an emissions test within 60 days, utilizing District-approved test methods, to demonstrate compliance with the applicable emissions limits at observed the FGR fan speed. [District Rules 4305, 4306, and 4320]

H. Periodic monitoring of NO_X, CO, O_2, and ammonia slip emissions concentrations for units equipped with selective catalytic reduction (SCR)

COMPATIBLE NO_X CONTROL TECHNIQUES: Units equipped with SCR which utilize a catalytic bed and a reducing agent, usually ammonia, to convert NO_X to nitrogen and oxygen will be allowed to monitor NO_X, CO, O_2 and ammonia. For units equipped with SCR ammonia is injected into the exhaust system up stream of a catalyst which creates a reducing atmosphere. The exhaust stream then passes through a catalyst, which promotes the reduction reaction. The reduction reaction results in nitrogen oxide being converted to nitrogen and oxygen.

FREQUENCY: Monitoring of NO_X, CO, O_2 and ammonia readings shall be conducted at least once per month (in which a source test is not performed).

MEASUREMENT: The exhaust gas shall be monitored for NO_X, CO, and O_2 concentrations with a portable analyzer that meets District specifications prescribed in Compliance's Portable Emission Analyzer Policy for Industry, COM 1150B. In addition, the exhaust gas shall be monitored for ammonia concentration with gas detection tubes (Dräger® brand or District approved equivalent).

RESULTS: NO_X, CO, and ammonia concentrations corrected to 3% O_2.

NORMAL RANGE OR LEVEL: NO_X, CO, and ammonia concentrations, corrected to 3% O_2, at or below the emissions limits specified in the permit.

REPORTING: If the equipment is operated outside the normal range or level for NO_X, CO, and ammonia and the deviation is not corrected within 1 hour of operation after detection, the District shall be notified within the following 1 hour. Deviations corrected within 1 hour of operation after detection must only be recorded.

RECORDKEEPING: The date and time of measurement, and NO_X, CO, and ammonia concentrations (corrected to 3% O_2) 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.

PEMIT 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. {4319} The permittee shall monitor and record the stack concentration of NOx, CO, NH3 and O2 at least once during each month in which source testing is not performed. NOx, CO and O2 monitoring shall be conducted utilizing a portable analyzer that meets District specifications. NH3 monitoring shall be conducted utilizing gas detection tubes (Draeger brand or District approved equivalent). Monitoring shall not be required if the unit is not in operation, i.e. the unit need not be started solely to perform monitoring. Monitoring shall be performed within 5 days of restarting the unit unless it has been performed within the last month. [District Rules 4305, 4306, and 4320]

2. {4320} If the NOx, CO or NH3 concentrations, as measured by the portable analyzer or the District approved ammonia monitoring equipment, exceed the permitted levels the permittee shall return the emissions to compliant levels as soon as possible, but no longer than 1 hour of operation after detection. If the portable analyzer or the ammonia monitoring equipment continue to show emission limit violations after 1 hour of operation following detection, 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 that is subject to enforcement action has occurred. 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 4305, 4306, and 4320]

3. {4321} All NOx, CO, O2 and ammonia emission readings shall be taken with the unit operating at conditions representative of normal operation or under the conditions specified in the Permit to Operate. The NOx, CO and O2 analyzer as well as the NH3 emission monitoring equipment shall be calibrated, maintained, and operated in accordance with the manufacturer's specifications and recommendations or a protocol approved by the APCO. Analyzer 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 readings, evenly spaced out over the 15 consecutive-minute period. [District Rules 4305, 4306, and 4320]

4. {4322} Ammonia emissions readings shall be conducted at the time the NOx, CO and O2 readings are taken. The readings shall be converted to ppmvd @ 3% O2. [District Rules 4305, 4306, and 4320]

5. {4323} The permittee shall maintain records of: (1) the date and time of NOx, CO, NH3 and O2 measurements, (2) the O2 concentration in percent by volume and the measured NOx, CO and NH3 concentrations corrected to 3% O2, (3) make and model of the portable analyzer, (4) portable analyzer calibration records, (5) the method of determining the NH3 emission concentration, and (6) a description of any corrective action taken to maintain the emissions at or below the acceptable levels. [District Rules 4305, 4306, and 4320]

VII. Pre-Approved Monitoring Procedures for Units without NO_X Reduction Technology

With respect to monitoring, the current versions of Rules 4305, 4306, and 4320 do not differentiate between units equipped with NO_X reduction technology versus those without NO_X reduction technology. All units subject to the monitoring requirements of these rules must utilize the same degree of monitoring.

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. 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. 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 tothe 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 units equipped with NO_X reduction technology, the range(s) may be established by source testing of the unit or through source test data for other units determined by the APCO to be applicable to the unit. For units not equipped with NO_X reduction technology, the range(s) may be obtained from the equipment manufacturer or control system supplier, or by source testing of the unit.

APPENDIX A

External Combustion NO_X Formation Mechanisms and Control Techniques

I. NO_X Formation Mechanisms

A. Thermal NO_X:

In fossil fuel combustion, O_2 and N_2 combine to form nitric oxide (NO) and nitrogen dioxide (NO_2) in the high temperature zones in the burner flame. The main factors affecting the quantity of NO_X formed by thermal fixation are (1) the flame temperature, (2) the residence time of the combustion gases in the peak temperature zone, and (3) the amount of oxygen present in the peak temperature zone. This is the primary NO_X formation mechanism for natural gas fired combustion equipment.

B. Fuel NO_X:

In fossil fuel combustion, fuel bound nitrogen can react with O_2 to form NO_X emissions. The rate of NO_X formation due to fuel nitrogen converted is dependent upon the amount of nitrogen contained in the fuel, oxygen concentration present in the flame and the mixing rate of the fuel and air. Most natural gas contains no fuel bound nitrogen.

C. Prompt NO_X:

In fossil fuel 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 burner flame. These reactions are not related to the peak flame temperature. Therefore, combustion modifications do not have a strong influence on the NO_X formed by this mechanism.

II. NO_X Control Techniques

A. Low Excess Air Operation

Operating with low excess air reduces the O_2 concentration in the peak temperature zone. This inhibits the reactions responsible for both thermal and fuel bound NO_X. Low excess air operation is generally used in conjunction with other NO_X control techniques. Low excess air operation is usually accomplished through the use of an O_2 analyzer/controller.

B. Conventional Burner with Off-Stoichiometric Combustion (Staged Combustion)

Combustion of the fuel is carried out in two stages. The first stage is a fuel rich zone in the region of the primary flame. The second stage is an air rich zone that completes the combustion of the fuel. Staging the combustion results in lower NO_X emissions by 1) limiting available O_2 for NO_X formation in the fuel rich primary stage, 2) lowering flame temperature in the fuel rich primary stage, and 3) flame temperature is lower in the air rich secondary stage. Common off-stoichiometric combustion systems in conventional burners are listed below:

1. Overfire Air Ports (OFA)

Separate air injection nozzles are located above the burner(s). The burner(s) are operated fuel rich and the overfire air ports maintain the rest of the combustion.

2. Biased Firing

In boilers with multiple burners, some burners are operated fuel rich while other burners are operated air rich in a staggered configuration.

3. Burners Out of Service

In boilers with multiple burners, some burners are operated fuel rich while other burners are not fired but provide combustion air only.

C. Flue Gas Recirculation (FGR)

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 two types of FGR systems are forced draft and induced draft. Forced draft systems use a separate exhaust gas blower to recirculate the flue gas. Induced draft systems use the primary combustion blower to recirculate the flue gas. In both systems the primary combustion air and the recycled exhaust gas are typically mixed in the windbox. As the FGR rate increases, the amount of NO_X produced decreases.

D. Low NO_X Burner

Low NO_X burners control mixing of fuel and air in a pattern that keeps flame temperature low and dissipates the heat quickly. Low NO_X burners incorporate many design principles to achieve low NO_X operation. Some low NO_X burners use multiple design principles. The design principles are listed below.

1. Staged Air Burners

Staged air burners operate with a fuel rich primary zone and air rich secondary zone (off-stoichiometric combustion). The fuel rich primary zone reduces the O_2 available for NO_X formation and can lower combustion temperatures in both zones.

2. Staged Fuel Burners

The fuel is added in stages. The first stage is an oxygen rich, fuel lean stage in which the peak zone temperature is reduced. The second stage is a fuel rich, oxygen lean stage that carries out the combustion. Lower flame temperature reduces the formation of thermal NO_X.

3. Pre-Mix Burners

Fuel and air are pre-mixed prior to introduction into the burner. Good mixing allows complete combustion to take place with less excess air. Operating with low excess air reduces the O_2 concentration in the peak temperature zone. This inhibits the sets of reactions responsible for both thermal and fuel bound NO_X formation.

4. Internal Recirculation

Burner geometry induces combustion gases to recirculate in the combustion zone. This reduces NO_X formation by reducing the flame temperature and diluting the oxygen content in the peak temperature zone similar to FGR.

5. Radiant Burners

Radiant burners have an incandescent surface that transfers heat as radiant energy from the burner to the heat exchanger walls. The burner consists of a porous ceramic fiber matrix. Pre-mixed gas and air are forced through the openings in the ceramic fiber matrix. Once ignition occurs, combustion stabilizes on the outer surface of the ceramic burner. The burner operates at a lower temperature than conventional burners. The low burner temperature reduces the formation of thermal NO_X.

E. Flue Gas Treatment

NO_X can be reduced to molecular nitrogen by adding flue gas treatment systems located after the boiler firebox. The two basic system types are listed below:

1. Selective Noncatalytic Reduction

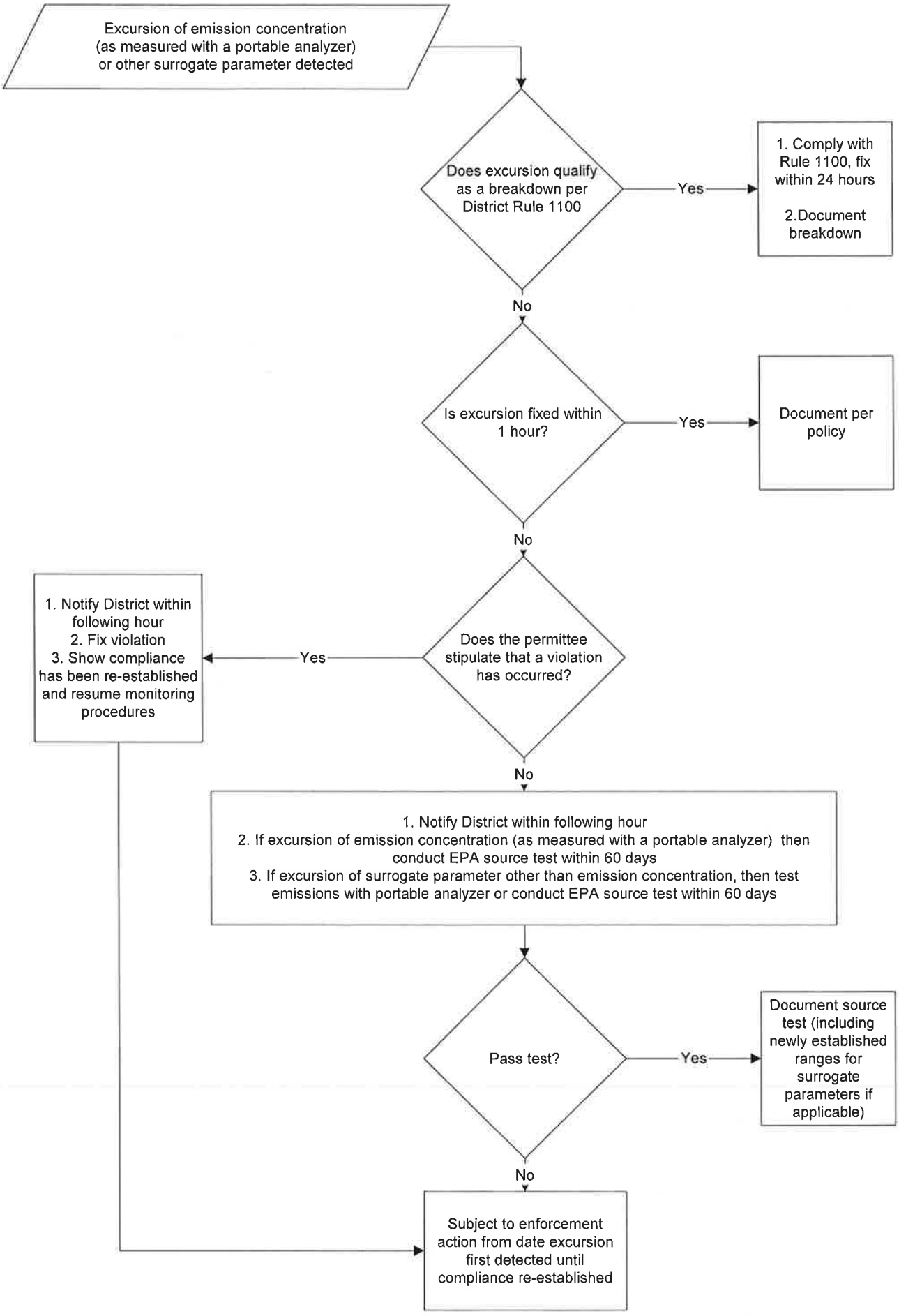
Ammonia (NH_3) or urea (NH_2CONH_2) is injected into the post combustion zone of the boiler. The ammonia/urea reacts with the NO_X formed during combustion to form molecular nitrogen and water. This reaction is largely dependent upon temperature. The reaction only occurs at temperatures between 1600° F and 2000° F. At temperatures above 2000° F the nitrogen in the ammonia/urea is oxidized to produce NO_X. At temperatures below 1600° F the ammonia/urea passes through unreacted. Due to the temperature dependence of the reaction the location of the ammonia/urea injectors is critical. The optimum injection point changes with boiler load. Due to this fact most SNCR systems have two sets of injection points. The ratio of the ammonia/urea concentration to the NO_X concentration is an important parameter. Injection of ammonia/urea at a higher stoichiometric ratio increases NO_X conversion efficiency but also increases ammonia/urea slip.

2. Selective Catalytic Reduction (SCR)

Ammonia is injected through a series of nozzles arranged in a grid to facilitate uniform mixing prior to 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. There are a variety of problems that can affect catalyst bed performance. Phosphorus, lead and arsenic can irreversibly poison the catalyst material. The catalyst can also be masked by chemicals or particulate adsorbing to the surface. The ratio of the ammonia concentration to the NO_X concentration is critical. Injection of ammonia at a higher stoichiometric ratio increases NO_X conversion efficiency but also increases ammonia slip. The ammonia injection grid must also uniformly mix and atomize the ammonia.

APPENDIX B

Excursion Flow Chart


Excursion of emission concentration (as measured with a portable analyzer) or other surrogate parameter detected
Does excursion qualify as a breakdown per District Rule 1100
Yes
1. Comply with Rule 1100, fix within 24 hours
2.Document breakdown
No
Is excursion fixed within 1 hour?
Yes
Document per policy
No
Does the permittee stipulate that a violation has occurred?
Yes
1. Notify District within following hour
2. Fix violation
3. Show compliance has been re-established and resume monitoring procedures
No
1. Notify District within following hour
2. If excursion of emission concentration (as measured with a portable analyzer) then conduct EPA source test within 60 days
3. If excursion of surrogate parameter other than emission concentration, then test emissions with portable analyzer or conduct EPA source test within 60 days
Pass test?
Yes
Document source test (including newly established ranges for surrogate parameters if applicable)
No
Subject to enforcement action from date excursion first detected until compliance re-established

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APPENDIX C

Computation of FGR Rate Using Temperatures

Computation of FGR Rate Using Temperature

The theory behind the determination of the flue gas recirculation rate using temperature observation is conservation of energy. The heat content of the mixed combustion air is the sum of the heat contained in the recirculated flue gas and the heat contained in the fresh combustion air. This simplified analysis assumes the heat carrying capacity per unit mass (c_p) of the fresh combustion air, the recirculated flue gas, and the combined combustion air is the same. For the temperatures, pressures, and gases involved this assumption introduces insignificant error. The largest potential source of error is that the combined combustion air temperature measured may not be the final equilibrium temperature of the mixture. If this occurs, this procedure will compute flue gas recirculation rates lower than actual. However, provided the temperatures are always measured at the same locations, the relative amount of flue gas recirculated may be ascertained.

define FGR rate as the amount of flue gas recirculated divided by combustion air supplied to the firebox (which is the sum of the fresh air provided and the flue gas recirculated):

1. FGR = amt. recirculated / (amt. fresh + amt. recirculated)

from conservation of energy at constant specific heat (c_p):

2. (amt. fresh x T_{fresh}) + (amt. recirc. x T_{recirc}) = (amt. fresh + amt. recirc.) x (T_{comb})
   (amt. fresh x T_{fresh}) + (amt. recirc. x T_{recirc}) = (amt. fresh) x T_{comb}+ (amt. recirc.) x T_{comb}

combining terms and re-arranging:

(amt. recirc) x (T_{recirc} - T_{comb}) = (amt. fresh) x (T_{comb} -T_{fresh})
amt. recirc = (amt. fresh) x [(T_{comb} - T_{fresh}) / (T_{recirc} - T_{comb})]

substituting in equation 1:

$$FGR = \frac{(\text{amt. fresh}) \times [(T_{comb} - T_{fresh}) / (T_{recirc} - T_{comb})]}{(\text{amt. fresh}) + (\text{amt. fresh}) \times [(T_{comb} - T_{fresh}) / (T_{recirc} - T_{comb})]}$$

canceling the like terms "(amt. fresh)", substituting the identity "(T_{recirc} -T_{comb})/(T_{recirc}-T_{comb})" for the "1" in the denominator and canceling the like terms "(T_{recirc} - T_{comb})" yields:

FGR = (T_{comb} - T_{fresh}) / (T_{recirc} - T_{fresh})

APPENDIX D

Computation of FGR Rate Using Oxygen Measurements

Computation of FGR Rate Using Oxygen Measurements

The theory behind the determination of the flue gas recirculation rate using oxygen concentration observations is conservation of species. The amount of oxygen in the mixed combustion air flue gas is the sum of the oxygen contained in the recirculated flue gas and the oxygen contained in the fresh combustion air. The largest potential source of error is that the combined combustion air oxygen measurement may not reflect a complete (or perfect) mixture. If so, this procedure will compute flue gas recirculation rates lower than actual. However, provided the oxygen content of the combined combustion air is always measured at the same location, the relative amount of flue gas recirculated may be ascertained.

define FGR rate as the amount of flue gas recirculated divided by combustion air supplied to the firebox (which is the sum of the fresh air provided and the flue gas recirculated):

1. FGR = amt. recirculated / (amt. fresh + amt. recirculated)

from conservation of species : (Note, O_2 fresh =.209 or 20.9 % by volume):

2. (amt. fresh x $O_{2\ fresh}$) + (amt. recirc. x $O_{2\ recirc}$) = (amt. fresh + amt. recirc.) x ($O_{2\ comb}$)
   (amt. fresh x $O_{2\ fresh}$) + (amt. recirc x $O_{2\ recirc}$) = (amt. fresh) x $O_{2\ comb}$ + (amt. recirc) x $O_{2\ comb}$

combining terms and re-arranging:

(amt. recirc) x ($O_{2\ recirc}$ - $O_{2\ comb}$) = (amt. fresh) x ($O_{2\ comb}$ -$O_{2\ fresh}$)
amt. recirc = (amt. fresh) x [($O_{2\ comb}$ - $O_{2\ fresh}$) / ($O_{2\ recirc}$ - $O_{2\ comb}$)]

substituting in equation 1:

$$FGR = \frac{\text{(amt. fresh)} \times [(O_{2\ comb} - O_{2\ fresh}) / (O_{2\ recirc} - O_{2\ comb})]}{\text{(amt. fresh)} + \text{(amt. fresh)} \times [(O_{2\ comb} - O_{2\ fresh}) / (O_{2\ recirc} - O_{2\ comb})]}$$

canceling the like terms "(amt. fresh)", substituting the identity "($O_{2\ recirc}$ - $O_{2\ comb}$)/($O_{2\ recirc}$-$O_{2\ comb}$)" for "1" in the denominator and canceling like terms "($O_{2\ recirc}$ - $O_{2\ comb}$)" yields:

FGR = ($O_{2\ comb}$ - $O_{2\ fresh}$) / ($O_{2\ recirc}$ - $O_{2\ fresh}$)