Monitoring Challenges for New Gas Combustion Turbines

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INTRODUCTION

As federal, state and local air quality regulations develop, there is a trend of decreasing emission limits and increasing monitoring requirements. Massachusetts is one state that has been at the forefront of this trend so that owners and operators of new gas combustion turbines face unique monitoring challenges. New turbines are often subject to 2 parts per million corrected (ppmc) or lower emission limits for oxides of nitrogen (NO_x), carbon monoxide (CO), and ammonia (NH_3) slip as well as numerical startup, shutdown and event based emission limits requiring continuous monitoring for compliance. These low NO_x emission limits create challenging certification projects according to 40 CFR 60 Appendix B Performance Specifications. Multiple technologies are available for continuous ammonia monitoring systems requiring a facility to determine the best available option while facing a lack of state and federal regulatory guidance on the certification and on-going quality assurance (QA) of ammonia monitors. Finally, data acquisition and handling system (DAHS) configurations are complicated by multiple compliance limits and averaging periods.

NO_X ANALYZER CERTIFICATION CHALLENGES

Low steady state emission limits combined with startup and shutdown emission limits require the installation of dual range NO_x analyzers that can accurately capture emissions across all modes of operation. Most new turbines must satisfy 2 ppmc NO_x steady state emission limits which typically require a 10 ppm low scale range NO_x analyzer. The 10 ppm NO_x scale range can be difficult to satisfy the 2.5% performance specification as well the relative accuracy test audit (RATA) requirements in 40 CFR 60, Appendix B, Performance Specification 2. During the 7-day calibration error test for initial and re-certification, a 10 ppm NO_x analyzer low range subject to 40 CFR 60 Appendix B certification requirements cannot drift by more than 0.25 ppm. During the RATA, the NO_x CEMS must satisfy a performance specification of 10 percent of the emissions standard (i.e. 0.2 ppm) or 20 percent of the reference method (i.e. ≤ 0.4 ppm).

If the unit is also subject to 40 CFR 75 monitoring requirements the owner/operator may request to certify the CEMS using the 40 CFR 75 Appendix A requirements in lieu of the Performance Specification 2 requirements. This allows for an exemption to the 7-day calibration error test for NO_x analyzer span values less than or equal to 50 ppm, an alternative 7-day calibration error test passing criteria of ±5 ppm for span values less than or equal to 200 ppm and alternative NO_x lb/mmbtu RATA passing criteria. Importantly, 40 CFR 60 Subpart KKKK, applicable to new combustion turbines, also allows for the NO_x CEMS to be certified according to 40 CFR 75 Appendix A, if the facility receives approval from the state or local agency.

If the 7-day calibration error test must satisfy the 2.5% of span 40 CFR 60 Appendix B, Performance Specification, the facility must rigorously monitor the daily analyzer drift. Normal zero / span adjustments are allowed following each day's calibration error test and adjustments should be made if there is risk that the analyzer will drift beyond the allowable 0.25 ppm error the next day. Importantly, zero and span adjustments should be made 24 hours prior to the next daily calibration to the extent practicable so that the reported results accurately reflect the analyzer's 24-hour drift.

While a facility may request and be granted approval to adopt 40 CFR 75 requirements, the applicable emission limits should impact the on-going QA procedures and passing criteria. The alternative 40 CFR 75 on-going daily calibration error test passing criteria is 5 ppm for span values less than or equal to 50 ppm, which may be considered unacceptable for NO_x CEMS used to demonstrate compliance with 2 ppmc emission limits. For this reason, best practice is to adjust the NO_x analyzer anytime the calibration error exceeds the 2.5% of span primary performance specification or at most when the drift exceeds two times the primary performance specification (i.e. 0.5 ppm on a 10 ppm scale range).

The successful certification of the NO_x CEMS is dependent on the project team having clear understanding of the applicable requirements including allowable drift, procedures for zero and span adjustments as well as the RATA passing criteria. Site specific procedures and acceptable drift thresholds should be developed and included within the facility's Quality Assurance / Quality Control (QA/QC) Plan.

CONTINUOUS AMMONIA MONITORING

Most new combustion turbines will be equipped with selective catalytic reduction (SCR) to control NO_x emissions. However, SCR results in ammonia slip emissions that may also be subject to continuous monitoring requirements. New combustion turbines equipped with SCR may be required to continuously monitor ammonia slip and comply with hourly emission limits.

Unlike the more typical NO_x, CO and SO_2 CEMS, there is limited state and federal guidance regarding the certification and on-going quality assurance (QA) testing of NH_3 monitoring systems. In 1993, the United States Environmental Protection Agency (USEPA) surveyed 12 state and local air agencies asking whether the agency had any plans to adopt regulations concerning NH_3 CEMS. None of the 12 agencies had plans and two agencies stated that they would wait for USEPA guidance.[1] Twenty-five years later, there is still no finalized federal Performance Specification and minimal on-going QA requirements specific to NH_3 CEMS. USEPA drafted preliminary performance specifications for NH_3 CEMS in 2005[2] though the proposed specifications have never been published in the Federal Registrar. The Texas Commission on Environmental Quality (TECQ) has included some NH_3 monitoring and QA requirements within their state regulations.[3] Facilities must propose and adopt a QA program to ensure accurate monitoring and reporting of NH_3 emissions. The QA tests that a facility may choose to adopt depend on the specific measurement technology chosen.

While there are several measurement techniques available to continuously monitor NH_3 emissions, the most common methodology is an indirect NO_x differential technique. In this methodology, two samples are taken simultaneously, one is conditioned and sent to a primary NO_x analyzer while the NH_3 in the second sample is converted to nitrogen oxide (NO) at a one-to-one ratio before being measured in a second NO_x analyzer. The difference between these two samples is equal to the NH_3 concentration in the stack. Using this technique, a facility can reasonably be expected to adopt either 40 CFR 60 Appendix B, Performance Specificity 2 or 40 CFR 75 Appendix A analyzer specific QA tests for the second NO_x analyzer (e.g. daily calibrations, Calibration Gas Audit (CGA)/linearity, cycle time tests, etc.) However, these QA checks only confirm that the NO_x analyzer is accurately measuring the converted NO emissions. The TECQ regulations require a quarterly CGA using ammonia calibration gas to check the ammonia converters efficiency. To ensure that the NH_3 is being converted to NO as expected, the facility should adopt as best practice a NH_3 converter efficiency checks, NH_3 relative accuracy test audits (RATAs), or both.

A facility may also choose a more direct measurement of NH_3 emissions. While the indirect NO_x differential methodology is appealing due to the familiarity with NO_x analyzers and relative low cost, the use of two NO_x analyzers can increase the NH_3 CEMS error and impact the system's ability to accurately monitor low emissions. Although multiple direct measurement techniques exist (e.g. Cavity Ring Down Spectroscopy), in-situ tunable diode lasers (TDL) have become the main alternative to the NO_x differential methodology. While there is no specified Performance Specification for NH_3, a facility utilizing a TDL analyzer can review and develop a QA/QC program based upon applicable portions of 40 CFR 60 Appendix B, Performance Specification 18 and 40 CFR 60 Appendix F, Procedure 6, both of which were developed for the measurement of Gaseous Hydrogen Chloride.

A mass balanced NH_3 monitoring approach has previously been utilized at some facilities where NO_x emissions are measured before and after the SCR and used in conjunction with the ammonia injection rate to calculate the NH_3 slip emissions. Typically, the pre-SCR NO_x analyzer is located close to the SCR, and the sample location point may not be representative of pre-SCR NO_x levels over time or various operating scenarios (e.g. startup and shutdown). This requires a correction factor to be included in the NH_3 slip calculation that may not be representative of all operating scenarios and may change over time. For these reasons, this approach is not recommended for new installations, especially for facilities that must demonstrate compliance with both 2 ppmc NO_x and NH_3 slip emission limits.[4]

Specifications and procedures adopted should be clearly outlined in the facility's QA/QC Plan and submitted for regulatory approval. The QA/QC Plan should describe requirements for initial certification as well as on-going QA/QC procedures.

AGGREGATING DATA FOR EVENT BASED EMISSION LIMITS

New permits in Massachusetts often include numerical startup, shutdown and event based emission limits and definitions. A facility subject to these emission limits must carefully considering how data is reduced and aggregated within the DAHS for on-going compliance. The end of a startup event must be defined within the DAHS using available process signals or time-based restrictions. The facility must balance ensuring that the unit has reached steady state and that emissions have stabilized after the emissions controls come online with the need to minimize the duration of the startup event to ensure that mass emissions do not exceed the permit limit.

The facility must also consider how the DAHS will transition from demonstrating compliance between event based emissions limit and hourly steady state permit limits. The USEPA's Startup, Shutdown, and Malfunction (SSM) rule finalized on May 22, 2015 clarified that emission limits must apply continuously during all modes of operation.[5] For these reasons, a facility should carefully consider how these startup, shutdown and event based emission limits are handled. For transparency, the data reduction requirements for both event based and hourly emission limits should be outlined within the facility's QA/QC Plan or specified within quarterly reports.

SUMMARY

New combustion turbines in Massachusetts may be subject to lower steady state as well as numerical startup, shutdown and event based emission limits and may be subject to additional continuous monitoring requirements compared to prior requirements applicable the electric generation industry. To successfully complete the 40 CFR 60 Appendix B, Performance Specification 2 certification testing on a NO_x CEMS, a facility must have well-defined 7-day calibration error test and RATA procedures. While 40 CFR 75 certification procedures can be utilized in some circumstances, care should be given to the development of the on-going QA procedures. Minimal NH_3 CEMS monitoring and QA/QC regulatory guidance requires facilities to propose their own QA/QC program that will allow for accurate monitoring and reporting of NH_3 emissions. Facilities should refer to existing 40 CFR 60 Performance Specifications and procedures when developing their QA/QC program and adopt applicable procedures and performance specifications based on the specific monitoring technology utilized. Continuous monitoring for compliance with mass based startup, shutdown or other event based emission limits combined with steady-state hourly averages can increase the complexity of DAHS configurations. A well-documented QA/QC Plan will help facilities comply with the stringent and unique compliance requirements applicable to new combustion turbines.

REFERENCES

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