Maintaining Continuous Emissions Monitoring Systems to Achieve High Reliability

Practical Considerations for Implementing and Following Preventive Maintenance Procedures

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Abstract

Continuous Emissions Monitoring Systems (CEMS) maintenance procedures are critical for ensuring high levels of CEMS availability to meet permit and regulatory mandates. It's important to identify and establish a series of maintenance activities that will provide a high level of confidence in the data reported by the CEMS and will ensure that emission-monitoring data is complete, representative, and of known precision and accuracy.

Step by step maintenance and corrective action activities are outlined in the CEMS Operation and Maintenance (O&M) Manual and in the CEMS Quality Assurance/Quality Control (QA/QC) manual. The frequency and type of maintenance activities are directed by the manufacturers of the equipment components and at times by regulatory specifications, which are then referenced in the O&M and QA/QC manuals.

Routine daily checks on monitored parameters can also define other possible operation problems that need to be resolved. Operational problems necessitate immediate corrective action. Some items, such as filter checks, may not exhibit a failure condition until damage has occurred to other components. Initially, these items require careful and frequent checking to determine replacement frequency specific to individual applications. Any changes of the operating characteristics of the system should trigger a maintenance response to prevent loss of data and equipment damage. This includes paying attention to any shift (sudden or prolonged) in one direction and close observation of the visual indicators in the system.

Certain types of maintenance activities and corrective actions may trigger the need for performing various types of tests once the activity has been completed. The post maintenance test is done to demonstrate that the CEMS is once again in prime working condition. The type of post maintenance test performed is dependant on the type of maintenance or corrective action event and may range from a simple calibration check to a full or partial re-certification event.

Following the steps on routine preventative maintenance as well as any additional maintenance requirements on all equipment supplied with the CEM system will greatly reduce emergency or breakdown repairs. All necessary spare parts, tools, and equipment should be available to the persons responsible for the upkeep of the CEMS at all times. This is critical to plant owners and operators as too much system downtime can affect data availability requirements.

Proper adherence to preventive maintenance activities is crucial to ensuring the accuracy, reliability and life of the CEMS. These activities, when conducted regularly and on time provide the best return on time invested to extending the life of the CEMS. Failure to perform preventive maintenance can result in unreliable data and damaged equipment.

Background

In the last few years several state agencies have performed on-site audits at facilities in their jurisdiction. These audits included overseeing that the CEMS preventive maintenance activities and other QA/QC related activities are being fully documented and performed in accordance with manufacturers' recommendations and regulatory specifications. A common thread that has arisen from several of these audits is a lack of or very poor documentation and recorded maintenance events to demonstrate that proper maintenance routines have been fully implemented.

Poor documentation procedures and a lack of proof that routine preventive maintenance procedures have been followed can result in the loss of confidence of the valid quality of the emissions data recorded by the CEMS. This can result in the data being declared out-of-control. Depending on individual circumstances, the regulatory agency may impose fines and require partial to full re-certification of the CEMS until the agency is satisfied that the system is once again recording valid, quality-assured data.

CEMS Preventive Maintenance Considerations

Frequency of maintenance depends on many variables such as geographic location (humidity and seasonal temperature fluctuations), fuel type, stack temperature and moisture content, etc. Filters may need to be changed more frequently in a "dirty" environment or less often under "clean" conditions. Consequently, scheduled maintenance intervals will vary from the general guidelines given in the CEMS O&M manual, QA/QC manual, and manufacturers' recommendations.

The procedures from the O&M and QA/QC manuals should be reviewed on an annual basis. Procedures need to take into account technicians' experience in working with and maintaining the CEMS for the individual facility. Certain maintenance procedures may have to be performed more frequently as the CEMS ages and equipment components begin to wear.

CEMS alarms indicate that service is required. They do not necessarily indicate that the collected data is invalid. The alarms do indicate that the system is operating outside of the design tolerance and incorrect data and equipment damage will occur if the system continues operation without corrective action. For this reason, the alarms themselves should be tested on a regular basis to assure that they are operating as designed. All alarm conditions require quick attention and resolution.

Log Book Maintenance

It's important that a logbook be kept and maintained to track all scheduled and unscheduled maintenance, calibration-gas bottle pressures and any other anomalies or information relevant to the history of the individual CEMS. This will also serve as a record of maintenance performed to manufacturers' instructions for warranty purposes.

Consistent with the Code of Federal Regulations (CFR) Title 40 Part 60 Appendix F and Part 75 Appendix B, a record of all testing, maintenance, or repair activities performed on any monitoring system or component must be maintained in a location and format suitable for inspection. The logbook must include entries for:

1. Any testing, adjustment, repair, replacement, or preventive maintenance action performed on any monitoring system.
2. Corrective actions associated with a monitor's outage period.
3. Any adjustment that re-characterizes a system's ability to record and report emissions data must be recorded (e.g., changing of temperature and pressure coefficients and dilution ratio settings).
4. The procedures used to make the adjustment(s).
5. Individual entries must include the date, time and description of corrective and preventive maintenance procedures performed on each CEMS.

In addition, a central CEMS file should be kept at the facility. This CEMS file contains maintenance check forms, QA audit results, corrective action forms, and calibration gas certificates of analysis. This central file also serves as an archive for all CEMS records including maintenance logbooks, daily data summaries, maintenance request forms, strip charts (as applicable), fuel analysis reports, fuel flow meter accuracy results (as applicable), etc.

All maintenance activities, whether routine or non-routine, need to be documented by date, time, type of activity or corrective action, name of technician performing the checks, total time needed to complete the check, and the results of the post-maintenance required compliance check. This information is to be logged in the appropriate CEMS logbook and maintenance check forms.

Best Times to Schedule Maintenance and Minimizing System Downtime

Although not always possible, preventive maintenance should be scheduled around planned or unplanned outages, turbine/boiler system overhaul periods, off-line periods or in short intervals. Performing maintenance during these off times will help in keeping a high percent monitor availability level. Preventive maintenance activities should be scheduled prior to any planned periodic QA audit such as the quarterly linearity, calibration gas audit (CGA) or annual relative accuracy test audit (RATA). This ensures optimal equipment operation and successful completion of the QA audit. Note that the data acquisition and handling system (DAHS) is required to be in operational status at all times.

Some maintenance can be performed while the CEMS is operating, without effecting data integrity or system availability. Much of the CEMS servicing requires placing the system in Maintenance Mode to perform the work.

If the system is equipped with a certified back-up CEMS then perform service, calibration and a complete function and accuracy check of the back-up system prior to transferring the data-recording task to the back-up system. Ensure that the back-up CEMS is accurately analyzing, recording and reporting data before beginning the maintenance or repairs on the primary unit.

For 40CFR Part 75 reporting systems, use Like-Kind analyzers if available for times when a primary analyzer is out of service due to repair or servicing. Ensure the required linearity test has been performed in accordance with 40CFR Part 75 specifications on the Like-Kind analyzer when it's brought into service. Keep a log of the number of operating hours while the Like-Kind analyzer is in use to avoid going over the operating limit (720 operating hrs/yr) defined in 40 CFR Part 75 for Like-Kind usage.

Spending excessive amounts of time in Maintenance Mode will also affect hourly emission averages. This in turn affects data availability. To help prevent loss of data it is helpful to know what constitutes a valid hour of data. During normal sampling, a valid hour of data requires four valid 15-minute averages. A 15-minute average containing only one valid 10-second output from the system controller (PLC or data logger) is considered valid.

Limiting time in Maintenance Mode to 30 minutes or less per maintenance operation will make the servicing "transparent" to the system. Note that most systems purge for 30 seconds upon exiting Maintenance Mode and then remain invalid for up to 10 minutes. This brings the total time in either maintenance or invalid to 40 minutes. Do not attempt to "squeeze" that extra minute of service time out of an hour if it can wait until the next hour. Two valid 15-minute averages are required during a "maintenance/calibration hour" and 10 out of the 15 available minutes for one valid

15-minute average may already be used up by the purge cycle. Keep careful track of the time spent in Maintenance Mode with a wristwatch or a stopwatch.

It is important to note that this information for data acquisition and a valid average may be affected by changes in the Environmental Protection Agency (EPA) rules or applicable state regulations. It is strongly recommended that current EPA and state guidelines for valid data should be adhered to and maintenance and repairs should be coordinated so as not to adversely affect valid data averages.

Test Requirements Following a Maintenance Event

Certain maintenance events will trigger the need to perform diagnostic testing or re-certification to ensure that the CEMS has been returned to optimum operating condition after the maintenance activity. The minimum requirement for a post maintenance event is performance of a calibration check. Other types of maintenance activity may require performance of a linearity check, a RATA or complete re-certification of the affected component(s).

Essentially any change, other than routine maintenance or quality assurance activities, that affects the monitors measuring systems or analysis systems in such a way that measurements or calibrations have changed significantly, triggers a re-certification.

These changes may require EPA notification and re-certification. Replacement of analyzers in total will require re-certification unless the analyzer was previously certified as a backup for a given CEM.

Re-certification of the CEMS may also be triggered if the facility makes a replacement, modification, or change to the flue gas handling system or the unit operation that significantly changes the flow or concentration profile of the monitored emissions.

For re-certification testing, the affected facility must re-perform all initial certification tests as outlined in the site's original certification test protocol (located under separate cover), as approved by the local Administrator. Approval and notice of re-certification test dates must be obtained by petition or may be provided in written guidance from the regulatory agency.

A few regulations such as 40 CFR Part 75 have developed lists of types of maintenance activities and the required post maintenance tests in response to the activity. There is typically a regulatory time-line for completing any required tests. It's important that these types of maintenance and post-maintenance test events be noted in the CEMS reference documentation such as the QA/QC manual. Technicians servicing the CEMS must be trained to be are aware of any post maintenance testing requirements and deadlines. Failure to complete the required post maintenance test could result in the system being in an out-of-control condition until the required tests have been successfully completed.

Spare Parts Inventory

A spare parts inventory required for the maintenance and repair of the system should be kept up to date and maintained at all facilities. Some parts should be kept on hand at all times to ensure system availability and reliability. Spare parts lists are typically divided by the frequency of use.

Consumable Parts - Consumable spare parts includes parts that will need to be replaced on a routine basis to maintain system accuracy and reliability. These parts must be kept on hand to perform routine preventative maintenance though the life of the system.

Basic Spare Parts - Basic spare parts include parts that will need to be replaced to maintain system accuracy and reliability in case of a typical failure. These parts should be kept on hand to perform basic repairs or maintenance though the life of the system.

Critical Spare Parts - Critical spare parts include parts that will need to be replaced to maintain system accuracy and reliability in case of a major failure or which may be long lead items from the equipment manufacturer. These parts should be kept on hand to perform major repairs or maintenance though the life of the system.

DAHS Spare Parts - A supply of backup media should also be available for periodic backup of the DAHS database. The type of media is dependent on the backup strategies employed by the facility but may include preformatted blank CD-ROM disks, tape cartridges, zip drives, etc. DAHS related consumables also include printer items such as paper, ink cartridges or toner cartridges.

Conclusion

Whether a CEMS is old or new, successful strategies for extending the life and reliability of CEMS operation must be implemented and followed. These strategies include developing routine system checks and preventive maintenance activities based on manufacturers' recommendations and the facilities experience with the CEMS and the general operating environment of the CEMS equipment. Strategies must include performing requisite post activity audits to ensure the system is operating reliably and reporting quality assured data. Technicians who service the CEMS must be properly trained to perform any required maintenance and to troubleshoot, diagnose, and fix equipment malfunctions.

Operational checks include a well-established list of items that must be checked on a daily, weekly, monthly, quarterly and yearly schedule. Components of such a checklist include calibration gas bottle pressures and expiration dates, daily calibration drift

checks, various system pressures and vacuum gauge readings, and checking display panel error messages.

Preventive maintenance activities are critical to the accuracy, reliability and life of the CEMS. Ensuring performance of these activities on a regular schedule will provide the best return on time invested to extending the life of the CEMS. Failure to perform preventive maintenance can result in the most preventable harm to the quality of the data obtained by the system. Preventive maintenance performed during outages, off-line periods, or in short duration intervals will help tremendously to increase percent monitor availability. Planning routine preventive maintenance around other QA activities will enhance successful RATAs and quarterly linearity and CGA tests and reduce costs.