EVALUATION OF METHODS AND PROTOCOLS FOR OPERATION OF A CERMS AT A MUNICIPAL WASTE COMBUSTOR

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ABSTRACT

Regional Waste Systems (RWS) evaluated protocols and methods for operation of a continuous emission rate monitoring system (CERMS) for its municipal waste combustor (MWC) located in Portland, Maine. This continuous measurement of mass emissions (lb/hr) would be in addition to the existing continuous monitoring of the concentration (ppm) of NOx, SO2, and CO emissions using a continuous emissions monitoring system (CEMS) as required of RWS and all other MWC facilities under federal and state rules. The study of CERMS protocols and methods identified the individual components required for a CERMS, evaluated existing methods of measuring MWC unit load and of ensuring "good combustion", identified and evaluated the existing continuous monitoring regulatory requirements for MWCs and other major sources, evaluated the state of the practice for the use of CERMS, evaluated CERMS data quality, and identified and evaluated existing protocols for CERMS. Finally, a protocol was developed for trial operation of the CERMS considering the above evaluations.

BACKGROUND AND APPROACH

The work presented herein provides technical documentation for the Maine Department of Environmental Protection (MEDEP) to consider in determining the appropriate use, if any, of CERMS for measuring mass emission rates and for specifying the methods and protocols for the operation of the monitors as part of RWS' Part 70 Air Emission License.

While it may be desirable that a single instrument be available to continuously monitor mass emission rates of NOx, SO2 and CO, this is not the case. Rather, a number of instruments are collectively required to provide measurements that allow mass emission rates to be calculated. By United States Environmental Protection Agency (USEPA) convention (specifically 40 CFR Part 60), these instruments are referred to as a continuous emission rate monitoring system, or CERMS. This manuscript has adopted the following conventions to be consistent with USEPA nomenclature:

1. "CEMS" refers to the continuous emissions monitoring system which measures and reports pollutant concentrations in units of parts per million (ppm),

2. "CERMS" refers to the continuous emissions rate monitoring system which consists of the integrated flow rate monitor and CEMS with other parameter monitoring equipment and a data acquisition and handling system (DAHS) which can compute mass emission rates per unit of time or per unit of heat input. The instruments which comprise the CERMS are shown in Figure 1. In addition to the flow monitor and existing CEMS components at RWS, the CERMS includes a wet oxygen analyzer.
Phase I of the study evaluated the need for a CERMS at RWS. The potential for a CERMS to improve facility performance (thereby reducing emissions) and to improve environmental quality were considered. Federal and state regulations and current state-of-the-practice for MWCs were also considered.

Phase II of the study developed a protocol for the trial operation of a CERMS at RWS. The protocol was based on the protocols developed for other CERMS applications and on an analysis of CERMS data quality.

**PHASE I: BASIS FOR THE USE OF A CERMS**

A protocol for operation of a CERMS monitoring program cannot be established unless, and until, an objective is established for how the resulting data will be used. This study examines the potential reasons for requiring a system to measure mass emission rates and establishes an objective for operation of the CERMS at the facility. A protocol is developed to guide the operation of the system to satisfy the objective.

The need for requiring a CERMS could be driven by a positive response to the following goal:

GOAL: The use of a CERMS will improve RWS' normal operations by reducing facility emissions and/or improve environmental quality.

**Facility Performance**

The first step of the study evaluated the potential for a CERMS to improve boiler control or combustion efficiency, thereby reducing facility emissions. The evaluation compared the use of CERMS to existing USEPA procedures to demonstrate Good Combustion Practice (GCP) which specifically require MWCs to use methods other than CERMS, namely steam flow, carbon monoxide emissions, and temperature entering the particulate control device. From a regulatory compliance perspective, facility performance for all MWCs is judged by the GCP standard.

Facility performance parameters that can potentially be monitored with a CERMS include boiler load, variability of combustion air flow, and air leakage into the boiler or exhaust gas handling system. Additionally, startup/shutdown conditions at MWCs have not been well-characterized with respect to exhaust flows and pollutant mass emission rates, data which can potentially be obtained with a CERMS.

With respect to boiler load, USEPA determined that steam flow and boiler feedwater flow were more representative of boiler load than exhaust flow measurements [1]. Utilities have experienced considerable difficulty when using CERMS to estimate boiler heat input rates as required under 40 CFR Part 75 [2]. Steam flow has been used as a measure of boiler load for more than a century. With the metering equipment available to MWCs and utilities, steam flow is arguably the most accurately monitored parameter in power plants today. Given the strong correlation between steam flow and boiler load, and the uncertainties with correlating continuous exhaust flow measurements to boiler load, a CERMS would not provide an improved measure of boiler load.

With respect to combustion air flow, RWS' facility is designed such that the boilers operate at a fixed total air flow for each steam flow set point. The process control system automatically varies underfire air and overfire air to maintain a selected steam flow set point and the required amount of boiler oxygen (approximately 8 percent). As steam production rises above the set point, underfire air is reduced and overfire air is increased. As steam production drops below the set point, the reverse occurs. The net result of the opposing action of underfire air and overfire air is a virtually constant total combustion air supply as determined by the steam flow set point. The continuous measurement of total boiler exhaust gas flow using a CERMS does not improve the ability to determine the proper ratio of underfire air and overfire air to maintain steam flow at the set point.

With respect to leakage of air into the flue gas system, RWS currently uses oxygen monitors for this purpose. Monitors are located at the boiler outlet prior to the scrubber and in the ductwork between the electrostatic precipitator and the stack. Because of the uncertainty in exhaust flow measurements compared to oxygen concentration measurements [3], increases in exhaust oxygen concentration are a more reliable indicator of air leaks than increases in exhaust flow rate. Therefore, the continuous measurement of total boiler exhaust gas flow using a CERMS would not provide an improved measure of air leaks.

Finally with respect to startup/shutdown conditions, RWS and MWCs in general have collected little mass emission rate data during these periods. CO emissions would be of greatest concern during these conditions. Annual stack tests are
performed only during full load conditions. While CEMS data can provide readings of CO concentration during startup/shutdown periods, measurements of exhaust flow are unavailable to calculate mass emission rates for CO. However, CO mass emission rate data provide no benefit to facility performance during startups and shutdowns. CO concentration alone is sufficient to assist with maintaining optimal conditions during startups and controlled shutdowns. In the case of emergency shutdowns, RWS must cut off the combustion process as quickly as possible to ensure the safety of personnel, minimize emissions, and protect plant equipment. Furthermore, the use of a CERMS to provide mass emission rate data over the short-term durations of low flow conditions is questionable [3] (see Table 1 presented later in this manuscript).

Thus, the first step found that a CERMS will not improve facility performance and would not provide any more accurate data than that already obtained by the USEPA approved methods for demonstrating GCP. Consequently, a CERMS would be at best a redundant method of measuring facility performance. The significant on-going operational costs of a CERMS cannot be justified on the basis of improved facility performance.

Environmental Quality

The second step of the study consisted of an evaluation of the potential benefits of using CERMS to improve environmental quality. Dispersion modeling of worst case (unrealistically conservative) potential emissions and exhaust flow rates showed that ambient impacts from the facility are minimal compared to the ambient air quality standards and PSD increments prescribed to be protective of human health and the environment [4]. The availability of data from a CERMS would not provide a more definitive finding of fact that air quality impacts are protective of human health and the environment.

Regulatory Requirements

The third step of the study consisted of an evaluation of existing regulations to determine if a CERMS can provide additional benefits for demonstrating compliance and to confirm that CERMS are not required for RWS by statute or regulation. The emission limitations contained in the NSPS (40 CFR Part 60 Subpart Cb) and MEDEP Chapters 121 and 138 impose comprehensive emission limitations for criteria pollutants, MWC organics (dioxins/furans), and heavy metals. The NSPS were set after exhaustive scientific evaluation of the public health concern related to emissions from MWCs, along with the cost and availability of air pollution control technology to reduce emissions from MWCs to the lowest practical level. Operational standards were set to demonstrate “good combustion practices”. In addition, Maine standards are more stringent than the corresponding federal standards for certain parameters, such as mercury. Neither the NSPS nor Maine rules require the operation of a CERMS at RWS.

The compliance assurance requirements of MEDEP Chapter 140 and the source surveillance requirements of MEDEP Chapter 117 are sufficient to fully document compliance with all applicable emission standards. USEPA’s Periodic Monitoring Guidance for Title V Operating Permits Program [5] was intended to establish a national benchmark for compliance monitoring. The guidance had provided that: “all new standards proposed under the authority of Section 111 NSPS and Section 112 NESHAP after November 15, 1990 are presumed to have adequate monitoring to meet the periodic monitoring requirement for those standards.” Thus, even if the guidance had not been vacated by the U.S. Court of Appeals, the guidance clearly would not have required the use of CERMS because the NSPS at 40 CFR Part 60 Subpart Cb did not prescribe CERMS.

USEPA’s “Any Credible Evidence Revisions” adopted on February 24, 1997, [62 FR 8313] provides that any citizen can file suit against a source based on any evidence. Thus, while a regulatory agency such as the MEDEP may understand the constraints and limitations of the use of data collected with the CERMS, anybody could allege a violation of license conditions or emission standards as a result of the inappropriate use of data collected by a CERMS. Instrument malfunction or downtime could be the basis for an enforcement action even if emissions were meeting all applicable emission standards. Furthermore, the measurement uncertainty of flow rate sensors may result in false exceedances which could result in unnecessary enforcement action, particularly when all measurements required by the NSPS and MEDEP rules indicate the facility is in compliance.

The regulatory review clearly establishes that a CERMS is not required under the existing regulatory framework for MWCs in
Maine and would not provide a more reliable basis for documentation of continuous compliance with the various emission limitations or GCP requirements. Additionally, the USEPA's credible evidence rules could cause CERMS data to be used inappropriately, leading to unnecessary enforcement action when all other required measurements demonstrate compliance.

State of the Practice for CERMS Use

An evaluation of all available air permits issued to MWCs in the United States was conducted to identify the best performing municipal waste combustors (MWCs) and identify MWCs where CERMS are required. The comprehensive evaluation of permits showed that there is no trend toward requiring CERMS as part of Title V operating permits at other MWCs.

Of the facilities having gaseous mass emission limits, only 10 of the permits included a specified compliance mechanism. Of these, 6 required compliance determination through periodic stack testing and 4 through use of continuous emission monitors (CEMS) and emission/flow rate factors. Of the facilities having gaseous mass emission limits with unspecified compliance mechanisms, permits for two facilities required installation of monitoring equipment to demonstrate compliance with mass and concentration-based emission limits; however, no specific equipment or procedures were specified.

One facility was identified that had a permit that specifically required monitoring mass emission rates using a CERMS. That facility was New Hanover County Wastec in North Carolina. Investigation of the facility revealed that the CERMS was required on only one of three units and was necessary to establish that emissions were below the thresholds requiring PSD review of the project. Annual mass emission rate must be reported to demonstrate that the facility is not subject to PSD rules.

The analysis identified two California MWC facilities, one located in the City of Commerce and the other in Long Beach, where CERMS are being used. It was learned that flow rate sensors are being used in combination with CEMS to measure mass emission rate. The permits for these facilities, issued by the South Coast Air Quality Management District (SCAQMD), require demonstration of compliance with daily mass emission limits for NOx, SO2, and CO using a system that continuously measures and records the values of these pollutants.

The information reported on the operation of continuous mass emission rate measurement systems at the two California MWC facilities does not represent state of the practice with respect to other MWC facilities such as RWS for the following reasons:

- Since the 1986-1987 period when these facilities and their emission rate monitoring systems began operation, no other MWC facilities in the country have adopted a similar type of continuous mass emission rate monitoring system. If these systems had been demonstrated to be effective in enhancing facility operation or improving environmental quality, they would have been installed or required elsewhere.

- The NSPS for MWCs, first proposed in 1989 and subsequently modified in 1995 and 1997 (subsequent to the startup of these California facilities), did not adopt a CERMS or other flow rate monitoring system-based requirement. Instead, the NSPS required the installation and operation of CEMS to measure pollutant concentrations and steam or feedwater flow to measure operating load.

- The Commerce and Long Beach facilities are located in the SCAQMD (the Los Angeles/Orange County area), the only area in the country designated as extreme non-attainment for ozone. Measures adopted in the SCAQMD are not necessarily appropriate in other areas of the country.

Thus, the CERMS at the two California facilities do not represent the current state of the practice at MWCs. In the 14 years that have passed since the time that the CERMS were installed at these two facilities, no subsequent installations, regulations or permits have mandated the use of CERMS at MWCs.

In most cases where mass emission limits are imposed on MWCs, compliance is determined using fuel factors, steam flows, or other surrogates for estimating heat input; or compliance with the mass emission limit is determined by annual stack testing while CEMS are used to document compliance with concentration-based standards.

A similar evaluation of Maine air licenses showed there is no actual precedent for mandating CERMS in Maine. It identified only the Georgia-Pacific paper mill in Woodland as one instance where the use of a CERMS was required by the air emission license. Georgia-Pacific's NOx RACT license
amendment specified the use of a "flow monitor/CRM". Georgia Pacific is required to meet mass emission limits (lb/hr) for a power boiler and recovery boiler but is allowed a degree of flexibility by averaging emissions between the units. While this one example of the incorporation of a CERMS into an air emissions license provides for emissions averaging consistent with the NSPS for MWCs, this degree of compliance flexibility cannot be applied to RWS because the MEDEP regulations governing MWCs do not allow emissions averaging.

Maine has not required the use of a CERMS as part of a compliance demonstration for any Title V permit, has not been included in any PSD permit for the combined cycle gas-fired electric utility generators, and has not been required on any permit for any other existing municipal waste combustor. The review of each of the other three municipal waste combustor permits in Maine showed that:

- No NOx RACT amendment set lb/hour emission limits,
- No NOx RACT amendment required measurement of stack gas volumetric flow, and
- No NOx RACT amendment required records of waste combusted, steam flow, or ash generated.

**Conclusion, Phase I**

This study concludes that the use of a CERMS at the RWS facility does not fulfill the stated goal. CERMS will not enable the facility to improve its operation nor improve environmental quality. Furthermore, CERMS are not required by applicable regulations, and the legal authority to require them is called into question by the action of the U.S. Court of Appeals in *Appalachian Power Company v. EPA*. The study found that use of CERMS at MWCs does not represent the current state of the practice for CERMS. Therefore, the study concludes that a requirement to operate a CERMS at the RWS facility is not justified.

**PHASE II: PROTOCOL DEVELOPMENT**

Despite the outcome of the Phase I findings, a protocol for the trial operation of a CERMS at the RWS facility was prepared. As stated previously, an objective for operation of the CERMS needs to be established to prepare the protocol. The following objective was prepared:

**OBJECTIVE:** Operate the CERMS for a period of one year, comparing CERMS-measured annual emissions against annual emissions estimated by alternative methods.

To prepare the protocol, CERMS data quality were evaluated, existing protocols for the use of CERMS were reviewed, and alternative methods for estimating annual emissions were identified.

**CERMS Data Quality**

Precision and accuracy of the CERMS is an important factor in determining whether the use of flow monitors can be justified. However, it becomes the central issue for determining how data collected from the CERMS can be used.

The calculation of mass emission rate by a CERMS is dependent on the measurements recorded by the four instruments identified in Figure 1 along with temperature and pressure measurements. Each of the instruments has an associated bias and precision, and these inaccuracies are propagated through the calculation of mass emission rate. Each of the parameters measured has variability due to process conditions that is also propagated through the calculation of mass emission rate. A probabilistic computer modeling technique commonly known as Monte Carlo simulation analysis was used to assess the propagation of process variability and instrument accuracy through the calculation of mass emission rate. The Monte Carlo technique was also used to assess instrument malfunction rates and the resulting data recovery implications.

The CERMS data quality evaluation expanded on work originally conducted for RWS by Midwest Research Institute (MRI) [6]. The purpose of expanding the MRI work was to:

- incorporate process variability in the analysis,
- incorporate biases and uncertainties from flow rate sensor calibration procedures into the analysis, including biases due to pitot tube misalignment and stack wall effects,
- provide results for additional parameters such as standard exhaust flow and dry standard exhaust flow, and
- quantify the effects of time averaging on propagated errors.

The expanded CERMS data quality evaluation supports the following conclusions [3]:

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A protocol for operation of a CERMS must carefully consider error propagation and instrument malfunctions to ensure that noncompliance is not solely the result of measurement inaccuracy or poor data recovery.

Continuous measurements of mass emission rates are biased by inaccuracies in the reference method calibration procedures [2]. The resulting measurements are, on average, 5.0% greater than the true mass emission rate for RWS. Swirling flow and pitch flow conditions, should they exist in the stack, would cause this bias to be greater.

Continuous measurements of mass emission rates are subject to measurement error propagated from pollutant analyzer measurements of concentration, wet and dry oxygen measurements for moisture correction, and flow rate sensor measurements of actual exhaust flow rate. The resulting imprecision amounts to 13.4% at one standard deviation for 1-hour average measurements.

CERMS measurement errors diminish in significance with increasing time averages. Imprecision due to calibration and biases in general, however, propagate through the increasing time averages. Table 1 provides NOx mass emission rate errors for averaging periods ranging from an hour to a year.

There is considerable variation in hourly mass emission rates even when assuming a constant concentration. This variation is due to the propagation of measurement errors and to variations in exhaust flow resulting from process variability.

Malfunction rates for a CERMS are likely to be much greater than for a CEMS because of the additional instrumentation required to perform measurements.

Review of Existing Protocols

Existing methods were used to assist with the development of a site-specific monitoring protocol. The analysis identified two federal methods that provide guidance: 40 CFR Part 60, Appendix B, Specification 6; and 40 CFR Part 75, Appendix A. CERMS used under Part 75 are for the purpose of quantifying SO2 and NOx emissions under the USEPA allowance trading programs, which do not apply to MWCs. The procedures specified under 40 CFR Part 75, Appendix A, are not practical because they require the operator to verify system accuracy at three load levels. MWCs are designed to operate at either full load or nearly full load, not at reduced loads. Appendix A would require a total overhaul of the current CEMS quality control system and data recording system to account for the stricter CEMS operating tolerances. The RWS facility's NOx and SO2 CEMs are not designed to meet the operating tolerances specified within Part 75. Application of these procedures could, therefore, create a possibility of noncompliance with the CEMS and data reporting requirements of MEDEP Chapter 121, Emission Limitations and Emission Testing of Resource Recovery Facilities, along with those of MEDEP Chapter 117, Source Surveillance.

While not directly applicable, 40 CFR Part 60, Appendix B, Performance Specification 6 (PS-6) is more consistent with respect to integration into the current CEMS and data recording system at the facility. Therefore, the methods and procedures found within PS-6 were selected as the framework for a site-specific protocol to operate the CERMS.

Protocol Summary

As neither the NSPS guidance nor the Acid Rain related procedures are directly appropriate as a protocol for use at a MWC, a site-specific protocol was developed. In addition to equipment specifications, sensor location, calibration methods, etc., the protocol specifies the data collection, averaging and reporting procedures necessary to assure that its use is consistent with the precision and accuracy of the individual components of the system.

The effects of measurement error are significantly reduced with increasing averaging periods. The results indicate that the averaging period for mass emission rate limits should be at least one month in length to minimize the potential for noncompliance due solely to measurement error. In addition, the value of the limit should be reflective of the variability in mass emission rates for the selected period of time. Therefore, the data reporting section of the protocol proposes using the data for only long term averaging periods.

Data recovery requirements for a CERMS cannot be based on the data recovery requirements established for a CEMS because the CERMS incorporates several instruments each with its own data recovery limitations. The results of the instrument malfunction analysis indicate that a data recovery requirement of 80 percent for the CERMS is roughly equivalent to the 90 percent data recovery requirement for the CEMS. Additionally,
the error propagation analysis showed that using default assumptions for temperature and pressure have little effect on measurement error. Thus, the proposed protocol provides that the CERMS will be operated with default temperature and pressure values and that a data recovery requirement of 80 percent be applied to the CERMS to minimize the potential for noncompliance due solely to poor data recovery.

Because much of the bias is the result of stack wall effects, the bias in the CERMS measurement can be reduced by employing Method 2H in the flow rate sensor calibration procedures. The proposed protocol, therefore, incorporates the Method 2H procedure that can be used to derive a wall effects adjustment factor (WAF) for circular ducts that are greater than 3.3 feet in diameter.

Bias due to pitot tube misalignment, as well as non-axial exhaust flow, may be reduced by incorporating Method 2F in the flow rate sensor calibration procedure. Because imprecision due to pitot tube misalignment carries through to even long-term average emission rate measurements, methods or procedures used to minimize pitot tube misalignment error will improve the results of continuous mass emission rate monitoring. Therefore, Method 2F is also incorporated into the proposed protocol.

The following summarizes elements of the protocol related to the flow rate sensor that supplement the RWS facility’s existing quality assurance/quality control program for its CEMS:

1. **The Flow Rate Sensor Daily Calibration Error Check** will be used to verify the operational drift from the probe to the output. It can be initiated manually or by a signal from the datalogger that closes a contact on the flow monitor. The datalogger will be programmed to present a contact closure to the flow monitor that will initiate the Calibration Error Check at a specific time each day.

2. **The CERM Daily Calibration Drift (CD)** will be calculated from the “measured” mass emission rate versus the “reference” mass emission rate. The CEM instrument is checked for calibration drift along with the flow sensor and the combined results comprise the “measured” mass emission rate. The reference mass emission rate is calculated using the reference gas value and the flow sensor output.

3. **The Annual Relative Accuracy Test Audit (RATA)** will be conducted on the CERMS as a whole in accordance with PS-6. For the flow rate sensor, the reference method shall be 40 CFR Part 60, Appendix A, Reference Methods: 2F and 2H. Reference Method 2H shall be employed to calculate a Wall Affect Factor (WAF) to calibrate the flow rate sensor to correct for errors within the Reference Method. The RATA shall be conducted at greater than 50% load. The flow rate sensor and all analyzers must simultaneously pass the audit. The individual reference methods within 40 CFR Part 60 Appendix A along with the Performance Specifications within 40 CFR Part 60 Appendix B shall apply to each instrument.

   An acceptable Relative Accuracy for the CERMS shall be no greater than 20% of the mean value of the reference method test data (as per PS-6) in terms of units of the standard, or 10% of the applicable standard, whichever is greater. In a CERMS, the flow rate sensor, diluent analyzers, and each individual gaseous pollutant analyzer must all meet these requirements in the units of the mass-based standard. Therefore, if the individual pollutant analyzer and flow rate sensor passes the RATA, but the combined CERMS error exceeds the allowable tolerance when calculated to the mass-based emission standard, the CERMS would fail the RATA for that particular emission standard.

1. **Data Recovery** for the CERMS is a function of four instruments including the CEMS, wet and dry oxygen monitors, and the flow monitor. A 90 percent data recovery rate is required for the CEMS alone while an 80 percent data recovery rate is required for the CERMS.

2. **Daily Operational Checks and Preventative Maintenance** of the flow rate sensors will be conducted in accordance with the manufacturer’s recommendations found within the sensor’s Operations Manual and the requirements of PS-6. These daily checks, which will be performed identically on both the Flue A and Flue B flow rate sensors, are delineated in the protocol. Daily and other checks of the other CERMS components (NOx, CO, SO2, and O2 analyzers) are described in RWS’ existing CEMS QA Manual.

3. **Data Reporting and Storage** will use a polling computer that stores the hourly values of mass emission rate on its fixed disk for a period of one year. The contents of the fixed disk are backed up to tape on a daily basis.
from the existing CEMS is printed and stored as hourly values and daily averages for each of the pollutants on a daily basis. The same procedure will be used for storing values of mass emission rate. The data records will be maintained according to the requirements of CMR Chapter 117. An annual report of the total annual mass emissions for each measured pollutant (NOx, SO2, CO) will be submitted to the MEDEP to meet the requirement for emissions inventory reporting under MEDEP Chapter 137. An engineering assessment of reliability of using the CERMS for mass emissions calculations versus the alternative method mass emissions calculations will be conducted after the first year of operation of the CERMS. The comparison will identify which alternative method provides an estimate of mass emissions that is closest to that determined by the CERMS. Within 4 months of the completion of a 1-year sample period, the engineering assessment will be submitted to the MEDEP. If the CERMS provides materially more accurate and reliable results, there may be a reasonable justification for its continued operation. Conversely, if it is shown that conventional alternatives are equally reliable indicators of operating loads and resulting mass emission rates, then CERMS should not be required in the Title V permit.

**Alternative Methods**

The performance of the CERMS, using the site-specific protocol developed in this Report, has not been demonstrated. The protocol provides that CERMS performance will be compared to alternative methods that use a combination of engineering formulas in conjunction with CEMS data, steam flow data, stack test results or other measurements. Therefore, the protocol provides for the operation of the CERMS for a one-year trial period after which a comprehensive evaluation of its performance will be completed.

The following summarizes the presented alternatives:

1. **Estimating Mass Emission Rates from CEMS Data and Stack Test Flow Rates.** This method involves the calculation of the CEMS-measured average concentration of the gaseous pollutants for the year, which in turn is multiplied by an average exhaust flow rate calculated from historical stack test records. The result is an estimate of the annual mass emission rate of the gaseous pollutants.

2. **Estimating Heat Input, Exhaust Gas Flow, and Mass Emission Rate from Steam Flow and CEMS Data.** This method uses continuous steam flow measurements and a boiler efficiency estimate to provide an estimate of continuous heat input. In a separate calculation, continuous CEMS concentration measurements are combined with continuous dry oxygen measurements and the USEPA Method 19 F-factor for MSW of 9,570 dscf/MBtu to obtain an estimate of the emission rate expressed in pounds per million Btu. This is then combined with the estimated heat input to calculate a mass emission rate.

3. **Estimating Heat Input, Exhaust Gas Flow, and Emission Rate from MSW Receipts and CEMS Data.** This method is similar to the steam flow method described above. In this case, however, heat input is calculated from MSW receipts and MSW heat content (as measured by higher heating value) rather than steam flow measurements.

4. **Estimating Emission Rates from MSW Receipts, Default Emission Factors, and Measured Removal Efficiencies.** This method calculates emissions from MSW receipts and emission factors supplied by USEPA. The emission factors provide an estimate of pollutant mass emissions per amount of MSW burned. While USEPA's AP-42 compilation of emission factors (included as Appendix L of this Report) provides emissions factors for mass burn MWCs, RWS has historically used emission factors supplied in USEPA's i-Steps software to report annual emissions.

5. **Estimating Emission Rates from Stack Test Results.** This method involves the extrapolation of stack test results to an annual time period. Annual stack tests typically consist of three consecutive 1 to 4-hour measurements of pollutant emission rates. The reported emission rate is the average of the three measurements, generally determined by multiplying the flow rate measured using 40 CFR Part 60, Appendix A, Reference Methods by the pollutant concentration measured using a CEMS. Stack testing companies commonly extrapolate the resulting measurement by multiplying it by the number of hours the facility operates during the year.

Five alternate methods were identified for estimating mass emission rates. In all cases, it is only appropriate to use these alternate methods for estimating long-term emissions (annual
preferred) because of underlying assumptions and measurement uncertainties. Examples include using average exhaust flow rates based on stack tests, boiler efficiency estimates, and MSW receipts, none of which provide real-time continuous data for RWS. While the protocol proposes to use the alternative methods to calculate annual average mass emission rates, these procedures can likely provide reasonably accurate measurements for time periods as short as a month. Given the variability of MSW feed rates and exhaust flows, these approaches would likely be inadequate for shorter time periods.

One alternate method, namely steam flow, was identified for estimating heat input rate (i.e., boiler load). This steam-flow based method is significant because the USEPA presently requires MWCs to use steam flow for demonstrating compliance with boiler load requirements.

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References


Figure 1: Components of the CERMS at RWS

Notes:
Shaded boxes indicate new components required to assemble a CERMS from the existing CEMS.
Boxes include names of equipment manufacturers.
Table 1. Estimated Relative Measurement Error of NO\textsubscript{X} Emission Rate

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