GENERAL SERVICES CONTRACT
CENTRAL GENERATION AUTOMATION/ CONTINUOUS EMISSIONS MONITORING SYSTEMS (CEMS) MAINTENANCE SERVICES
Specification No. CEMS22-27

This GENERAL SERVICES CONTRACT (hereinafter referred to as "Contract"), is made and entered into as of the date fully executed below, by and between Orange County Sanitation District (hereinafter referred to as "OC San") and CEMTEK Environmental, Inc. DBA CEMTEK KVB-Enertec (hereinafter referred to as "Contractor"), and collectively referred to herein as the "Parties."

R E C I T A L S

WHEREAS, OC San desires to retain the services of Contractor for Central Generation Automation/Continuous Emissions Monitoring Systems (CEMS) maintenance services ("Services") as described in Exhibit "A" attached hereto and incorporated herein by this reference; and

WHEREAS, Contractor is qualified to perform the Services by virtue of experience, training, education, and expertise; and

WHEREAS, OC San desires to engage Contractor to provide the Services; and

WHEREAS, OC San selected Contractor to provide the Services in accordance with Ordinance No. OC SAN-56; and

WHEREAS, on October 26, 2022, OC San's Board of Directors or Operations Committee, by minute order, authorized execution of this Contract.

NOW, THEREFORE, in consideration of the above recitals and the mutual promises and benefits specified below, the Parties agree as follows:

1. General.

1.1 This Contract and all exhibits hereto are made by OC San and the Contractor.

1.2 The following exhibits, in order of precedence, are incorporated by reference and made part of this Contract.

Exhibit "A" – Scope of Work
Exhibit "B" – Proposal
Exhibit "C" – Determined Insurance Requirement Form
Exhibit "D" – Contractor Safety Standards
Exhibit "E" – Human Resources Policies

1.3 In the event of any conflict or inconsistency between the provisions of this Contract and any of the provisions of the exhibits hereto, the provisions in the Contract shall control and thereafter the provisions in the document highest in precedence shall be controlling.

1.4 Except as expressly provided otherwise, OC San accepts no liability for any expenses, losses, or actions incurred or undertaken by Contractor as a result of work performed in anticipation of acquisition of the Services by OC San.

1.5 Work Hours: The work required under the Contract may include normal business hours, evenings, and weekends. All meetings or work with OC San staff shall be scheduled Monday through Friday, between the hours of 7:30 a.m. and 5:30 p.m. OC San will not pay for travel time.

1.6 Days: Shall mean calendar days, unless otherwise noted.

1.7 OC San holidays (non-working days) are as follows: New Year's Day, Martin Luther King, Jr. Day, Presidents' Day, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day, Day after Thanksgiving, Christmas Eve, and Christmas Day.

1.8 Work: Shall mean all work, labor, and materials necessary to provide the Services.

1.9 The provisions of this Contract may be amended or waived only by an amendment executed by authorized representatives of both Parties.

1.10 The various headings in this Contract are inserted for convenience only and shall not affect the meaning or interpretation of this Contract or any paragraph or provision hereof.

2. Scope of Work.

2.1 Contractor shall perform the Services identified in Exhibit "A" in accordance with generally accepted industry and professional standards.

2.2 Modifications to Scope of Work. OC San shall have the right to modify the Scope of Work at any time. All modifications must be made by an amendment signed by both Parties.

2.3 Familiarity with Work. By executing this Contract, Contractor warrants that: (a) it has investigated the work to be performed; (b) it understands the facilities, difficulties, and restrictions of the work under this Contract; and (c) it has examined the site of the work and is aware of all conditions at the site. Should Contractor discover any latent or unknown condition materially differing from those inherent in the work or as represented by OC San, it shall immediately inform OC San of this and shall not proceed, except at Contractor's risk, until written instructions are received from OC San.

2.4 Performance. Time is of the utmost importance in the performance of the provisions hereof.

3. Contract Term.

3.1 The term of this Contract shall be for five (5) years commencing on November 22, 2022, and continuing through November 21, 2027.

3.2 Extensions. The term of this Contract may be extended only by an amendment signed by both Parties.

4. Compensation.

4.1 As compensation for the Services provided under this Contract, OC San shall pay Contractor a total amount not to exceed Six Hundred Sixty-seven Thousand, Five Hundred Dollars ($667,500.00).

4.2 Contractor shall provide OC San with all required premiums and/or overtime work at no charge beyond the amount specified above.

5. **Payments and Invoicing.**

5.1 OC San shall pay itemized invoices for work completed in accordance with Exhibit "A", at the prices identified in Exhibit "B", thirty (30) days from receipt of the invoice and after approval by OC San's Project Manager or designee. OC San shall be the determining party, in its sole discretion, as to whether the Services have been satisfactorily completed.

5.2 Contractor shall submit its invoices to OC San Accounts Payable by electronic mail to APStaff@OCSan.gov. In the subject line include "INVOICE" and the Purchase Order Number.

6. **California Department of Industrial Relations Registration and Record of Wages.**

6.1 To the extent Contractor's employees and/or its subcontractors perform work related to this Contract for which Prevailing Wage Determinations have been issued by the California Department of Industrial Relations (DIR) as more specifically defined under Labor Code section 1720 et seq., prevailing wages are required to be paid for applicable work under this Contract. It is Contractor's responsibility to interpret and implement any prevailing wage requirements and Contractor agrees to pay any penalty or civil damages resulting from a violation of the prevailing wage laws.

6.2 Contractor and its subcontractors shall comply with the registration requirements of Labor Code section 1725.5. Pursuant to Labor Code section 1771.4(a)(1), the work is subject to compliance monitoring and enforcement by the California Department of Industrial Relations (DIR).

6.3 Pursuant to Labor Code section 1773.2, a copy of the prevailing rate of per diem wages is available upon request at OC San's principal office. The prevailing rate of per diem wages may also be found at the DIR website for prevailing wage determinations at http://www.dir.ca.gov/DLSR/PWD.

6.4 Contractor and its subcontractors shall comply with the job site notices posting requirements established by the Labor Commissioner per Title 8, California Code of Regulations section 16461(e). Pursuant to Labor Code sections 1773.2 and 1771.4(a)(2), Contractor shall post a copy of the prevailing rate of per diem wages at the job site.

6.5 Contractor and its subcontractors shall maintain accurate payroll records and shall comply with all the provisions of Labor Code section 1776. Contractor and its subcontractors shall submit payroll records to the Labor Commissioner pursuant to Labor Code section 1771.4(a)(3). Pursuant to Labor Code section 1776, the Contractor and its subcontractors shall furnish a copy of all certified payroll records to OC San and/or the general public upon request, provided the public request is made through OC San, the Division of Apprenticeship Standards, or the Division of Labor Standards Enforcement of the Department of Industrial Relations. Pursuant to Labor Code section 1776(h), penalties for non-compliance with a request for payroll records may be deducted from progress payments.

6.5.1 As a condition to receiving payments, Contractor agrees to present to OC San, along with any request for payment, all applicable and necessary certified payrolls and other required documents for the period covering such payment request. Pursuant to Title 8, California Code of Regulations section 16463, OC San shall withhold any portion of a payment, up to and including the entire payment amount, until certified payroll forms and any other required documents are properly submitted. In the event certified payroll forms do not comply with the requirements of Labor Code section 1776, OC San may continue to withhold sufficient funds to cover estimated wages and penalties under the Contract.

6.6 The Contractor and its subcontractors shall comply with Labor Code section 1774 and section 1775. Pursuant to Labor Code section 1775, the Contractor and any of its subcontractors shall forfeit to OC San a penalty of not more than two hundred dollars ($200) for each calendar day, or portion thereof, for each worker paid less than the prevailing rates as determined by the DIR for the work or craft in which the worker is employed for any work.

6.6.1 In addition to the penalty and pursuant to Labor Code section 1775, the difference between the prevailing wage rates and the amount paid to each worker for each calendar day or portion thereof for which each worker was paid less than the prevailing wage rate shall be paid to each worker by the Contractor or its subcontractor.

6.7 Contractor and its subcontractors shall comply with Labor Code sections 1810 through 1815. Contractor and its subcontractors shall restrict working hours to eight (8) hours per day and forty (40) hours per week, except that work performed in excess of those limits shall be permitted upon compensation for all excess hours worked at not less than one and one-half (1.5) times the basic rate of pay, as provided in Labor Code section 1815. The Contractor shall forfeit, as a penalty to OC San, twenty-five dollars ($25) per worker per calendar day during which such worker is required or permitted to work more than eight (8) hours in any one calendar day and forty (40) hours in any one calendar week in violation of Labor Code sections 1810 through 1815.

6.8 Contractor and its subcontractors shall comply with Labor Code sections 1777.5, 1777.6, and 1777.7 concerning the employment of apprentices by Contractor or any subcontractor.

6.9 Contractor shall include, at a minimum, a copy of the following provisions in any contract it enters into with any subcontractor: Labor Code sections 1771, 1771.1, 1775, 1776, 1777.5, 1810, 1813, 1815, 1860, and 1861.

6.10 Pursuant to Labor Code sections 1860 and 3700, the Contractor and its subcontractors will be required to secure the payment of compensation to employees. Pursuant to Labor Code section 1861, Contractor, by accepting this contract, certifies that:

> "I am aware of the provisions of section 3700 of the Labor Code which require every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that code, and I will comply with such provisions before commencing the performance of the work of this contract."

Contractor shall ensure that all its contracts with its subcontractors provide the provision above.

7. **Damage to OC San's Property.** Any of OC San's property damaged by Contractor, any subcontractor, or by the personnel of either will be subject to repair or replacement by Contractor at no cost to OC San.

8. **Freight (F.O.B. Destination).** Unless otherwise stated on the Purchase Order, Contractor assumes full responsibility for all transportation, transportation scheduling, packing, handling, insurance, and other services associated with delivery of all products deemed necessary under this Contract.

9. **Audit Rights.** Contractor agrees that, during the term of this Contract and for a period of three (3) years after its expiration or termination, OC San shall have access to and the right to examine any directly pertinent books, documents, and records of Contractor relating to the invoices submitted by Contractor pursuant to this Contract..

10. **Contractor Safety Standards and Human Resources Policies.** OC San requires Contractor and its subcontractor(s) to follow and ensure their employees follow all Federal, State, and local regulations as well as the Contractor Safety Standards while working at OC San locations. If, during the course of the Contract, it is discovered that the Contractor Safety Standards do not comply with Federal, State, or local regulations, the Contractor is required to follow the most stringent regulatory requirement at no additional cost to OC San. Contractor, its subcontractors, and all of their employees shall adhere to the safety requirements in Exhibit "A," all applicable Contractor Safety Standards in Exhibit "D," and the Human Resources Policies in Exhibit "E."

11. **Insurance.** Contractor and all its subcontractors shall purchase and maintain, throughout the term of this Contract and any periods of warranty or extensions, insurance in amounts equal to the requirements set forth in the signed Exhibit "C" – Determined Insurance Requirement Form. Contractor shall not commence work under this Contract until all required insurance is obtained in a form acceptable to OC San, nor shall Contractor allow any subcontractor to commence service pursuant to a subcontract until all insurance required of the subcontractor has been obtained. Failure to obtain and maintain the required insurance coverage shall result in termination of this Contract.

12. **Indemnification and Hold Harmless Provision.** Contractor shall assume all responsibility for damages to property and/or injuries to persons, including accidental death, which may arise out of or may be caused by Contractor's Services under this Contract, or by its subcontractor(s), or by anyone directly or indirectly employed by Contractor, and whether such damage or injury shall accrue or be discovered before or after the termination of the Contract. Except as to the sole active negligence of or willful misconduct of OC San, Contractor shall indemnify, protect, defend, and hold harmless OC San, its elected and appointed officials, officers, agents, and employees from and against any and all claims, liabilities, damages, or expenses of any nature, including attorneys' fees: (a) for injury to or death of any person, or damage to property, or interference with the use of property arising out of or in connection with Contractor's performance under the Contract, and/or (b) on account of use of any copyrighted or uncopyrighted material, composition, or process; or any patented or unpatented invention, article, or appliance furnished or used under the Contract, and/or (c) on account of any goods and services provided under this Contract. This indemnification provision shall apply to any acts or omissions, willful misconduct, or negligent misconduct, whether active or passive, on the part of Contractor or anyone employed by or working under Contractor. To the maximum extent permitted by law, Contractor's duty to defend shall apply whether or not such claims, allegations, lawsuits, or proceedings have merit or are meritless. In no event will this indemnity

apply to damage, injury or death resulting from the sole negligence of OC San. In the event of the joint or concurrent negligence of the parties, each party shall be liable in proportion to their respective share of negligence. Contractor agrees to provide this defense immediately upon written notice from OC San, and with well qualified, adequately insured, and experienced legal counsel acceptable to OC San. This section shall survive the expiration or early termination of the Contract.

13. **Independent Contractor.** The relationship between the Parties hereto is that of an independent contractor and nothing herein shall be deemed to make Contractor an OC San employee. During the performance of this Contract, Contractor and its officers, employees, and agents shall act in an independent capacity and shall not act as OC San's officers, employees, or agents. Contractor and its officers, employees, and agents shall obtain no rights to any benefits which accrue to OC San's employees.

14. **Subcontracting and Assignment.** Contractor shall not delegate any duties nor assign any rights under this Contract without the prior written consent of OC San. Any such attempted delegation or assignment shall be void.

15. **Disclosure.** Contractor agrees not to disclose, to any third party, data or information generated from this Contract without the prior written consent from OC San.

16. **Non-Liability of OC San Officers and Employees.** No officer or employee of OC San shall be personally liable to Contractor, or any successor-in-interest, in the event of any default or breach by OC San, or for any amount which may become due to Contractor or to its successor, or for breach of any obligation under the terms of this Contract.

17. **Third-Party Rights.** Nothing in this Contract shall be construed to give any rights or benefits to anyone other than OC San and Contractor.

18. **Applicable Laws and Regulations.** Contractor shall comply with all applicable Federal, State, and local laws, rules, and regulations. Contractor also agrees to indemnify and hold OC San harmless from any and all damages and liabilities assessed against OC San as a result of Contractor's noncompliance therewith. Any provision required by law to be included herein shall be deemed included as a part of this Contract whether or not specifically included or referenced.

19. **Licenses, Permits, Ordinances, and Regulations.** Contractor represents and warrants to OC San that it has obtained all licenses, permits, qualifications, and approvals of whatever nature that are legally required to provide the Services. Any and all fees required by Federal, State, County, City, and/or municipal laws, codes, and/or tariffs that pertain to the work performed under this Contract will be paid by Contractor.

20. **Regulatory Requirements.** Contractor shall perform all work under this Contract in strict conformance with applicable Federal, State, and local regulatory requirements including, but not limited to, 40 CFR 122, 123, 124, 257, 258, 260, 261, and 503, Title 22, 23, and Water Codes Division 2.

21. **Environmental Compliance.** Contractor shall, at its own cost and expense, comply with all Federal, State, and local environmental laws, regulations, and policies which apply to the Contractor, its subcontractors, and the Services, including, but not limited to, all applicable Federal, State, and local air pollution control laws and regulations.

22. South Coast Air Quality Management District's Requirements. It is Contractor's responsibility to ensure that all equipment furnished and installed be in accordance with the latest rules and regulations of the South Coast Air Quality Management District (SCAQMD). All Contract work practices, which may have associated emissions such as sandblasting, open field spray painting, or demolition of asbestos containing components or structures shall comply with the appropriate rules and regulations of SCAQMD.

23. Warranties. Contractor's Warranty (Guarantee): If within a one (1) year period of completion of work specified in Exhibit "A," OC San informs Contractor that any portion of the Services provided fails to meet the standards required under this Contract, Contractor shall, within the time agreed to by OC San and Contractor, take all such actions as are necessary to correct or complete the noted deficiency(ies) at Contractor's sole expense.

24. Dispute Resolution.

24.1 In the event of a dispute as to the construction or interpretation of this Contract, or any rights or obligations hereunder, the Parties shall first attempt, in good faith, to resolve the dispute by mediation. The Parties shall mutually select a mediator to facilitate the resolution of the dispute. If the Parties are unable to agree on a mediator, the mediation shall be conducted in accordance with the Commercial Mediation Rules of the American Arbitration Agreement, through the alternate dispute resolution procedures of Judicial Arbitration through Mediation Services of Orange County ("JAMS"), or any similar organization or entity conducting an alternate dispute resolution process.

24.2 In the event the Parties are unable to timely resolve the dispute through mediation, the issues in dispute shall be submitted to arbitration pursuant to Code of Civil Procedure, Part 3, Title 9, sections 1280 et seq. For such purpose, an agreed arbitrator shall be selected, or in the absence of agreement, each party shall select an arbitrator, and those two (2) arbitrators shall select a third. Discovery may be conducted in connection with the arbitration proceeding pursuant to Code of Civil Procedure section 1283.05. The arbitrator, or three (3) arbitrators acting as a board, shall take such evidence and make such investigation as deemed appropriate and shall render a written decision on the matter in question. The arbitrator shall decide each and every dispute in accordance with the laws of the State of California. The arbitrator's decision and award shall be subject to review for errors of fact or law in the Superior Court for the County of Orange, with a right of appeal from any judgment issued therein.

25. Remedies. In addition to other remedies available in law or equity, if the Contractor fails to make delivery of the goods and Services or repudiates its obligations under this Contract, or if OC San rejects the goods or Services or revokes acceptance of the goods and Services, OC San may (a) cancel the Contract; (b) recover whatever amount of the purchase price OC San has paid, and/or (c) "cover" by purchasing, or contracting to purchase, substitute goods and Services for those due from Contractor. In the event OC San elects to "cover" as described in (c), OC San shall be entitled to recover from Contractor as damages the difference between the direct cost of the substitute goods and Services and the Contract price. Notwithstanding anything to the contrary set forth in this Contract, Contractor will not be liable to OC San for any consequential damages, including loss of investment, loss of product or bonding capacity, business interruption, or inability to obtain other contracts, in each case under this Agreement, whether such liability arises in contract, tort (including negligence or strict liability), or otherwise, except to the extent such liability arises from such Contractor's fraud, gross negligence, recklessness, willful misconduct, or violation of Applicable Laws or, with respect to Contractor, Contractor's (a) indemnity obligations for third party Claims, (b) breach of its confidentiality obligations, or (c) infringement or misappropriation of intellectual property.

26. **Force Majeure.** Neither party shall be liable for delays caused by accident, flood, acts of God, fire, labor trouble, war, acts of government, or any other cause beyond its control, but the affected party shall use reasonable efforts to minimize the extent of the delay. Work affected by a force majeure condition may be rescheduled by mutual consent of the Parties.

27. **Termination.**

27.1 OC San reserves the right to terminate this Contract for its convenience, with or without cause, in whole or in part, at any time, by written notice from OC San. Upon receipt of a termination notice, Contractor shall immediately discontinue all work under this Contract (unless the notice directs otherwise). OC San shall thereafter, within thirty (30) days, pay Contractor for work performed (cost and fee) through the date of termination. Contractor expressly waives any claim to receive anticipated profits to be earned during the uncompleted portion of this Contract. Such notice of termination shall terminate this Contract and release OC San from any further fee, cost, or claim hereunder by Contractor other than for work performed through the date of termination.

27.2 OC San reserves the right to terminate this Contract immediately upon OC San's determination that Contractor is not complying with the Scope of Work requirements, if the level of service is inadequate, or for any other default of this Contract.

27.3 OC San may also immediately terminate this Contract for default, in whole or in part, by written notice to Contractor:

- if Contractor becomes insolvent or files a petition under the Bankruptcy Act; or
- if Contractor sells its business; or
- if Contractor breaches any of the terms of this Contract; or
- if the total amount of compensation exceeds the amount authorized under this Contract.

27.4 All OC San's property in the possession or control of Contractor shall be returned by Contractor to OC San on demand or at the expiration or early termination of this Contract, whichever occurs first.

28. **Attorney's Fees.** If any action at law or in equity or if any proceeding in the form of an Alternative Dispute Resolution (ADR) is necessary to enforce or interpret the terms of this Contract, the prevailing party shall be entitled to reasonable attorney's fees, costs, and necessary disbursements in addition to any other relief to which the prevailing party may be entitled.

29. **Waiver.** The waiver by either party of any breach or violation of, or default under, any provision of this Contract shall not be deemed a continuing waiver by such party of any other provision or of any subsequent breach or violation of this Contract or default thereunder. Any breach by Contractor to which OC San does not object shall not operate as a waiver of OC San's rights to seek remedies available to it for any subsequent breach.

30. **Severability.** If any section, subsection, or provision of this Contract; or any agreement or instrument contemplated hereby; or the application of such section, subsection, or provision is held invalid, the remainder of this Contract or instrument in the application of such section, subsection, or provision to persons or circumstances other than those to which it is held invalid, shall not be affected thereby, unless the effect of such invalidity shall be to substantially frustrate the expectations of the Parties.

31. Survival. The provisions of this Contract dealing with payment, warranty, indemnity, and forum for enforcement shall survive expiration or early termination of this Contract.

32. Governing Law. This Contract shall be governed by and interpreted under the laws of the State of California and the Parties submit to jurisdiction in the County of Orange in the event any action is brought in connection with this Contract or the performance thereof.

33. Notices.

33.1 All notices under this Contract must be in writing. Written notice shall be delivered by personal service, by electronic telecommunication, or sent by registered or certified mail, postage prepaid, return receipt requested, or by any other overnight delivery service which delivers to the noticed destination and provides proof of delivery to the sender. Rejection or other refusal to accept or the inability to deliver because of changed address for which no notice was given as provided hereunder shall be deemed to be receipt of the notice, demand, or request sent. All notices shall be effective when first received at the following addresses:

OC San: Darius Ghazi
Senior Buyer
Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, CA 92708
DGhazi@ocsan.gov

Contractor: Tom Kulesza
Aftermarket Sales & Service Manager
CEMTEK Environmental, Inc. DBA CEMTEK KVB-Enertec
3041 S. Orange Avenue
Santa Ana, CA 92707
tkulesza@cemteks.com

33.2 Each party shall provide the other party written notice of any change in address as soon as practicable.

34. Read and Understood. By signing this Contract, Contractor represents that it has read and understood the terms and conditions of the Contract.

35. Authority to Execute. The persons executing this Contract on behalf of the Parties warrant that they are duly authorized to execute this Contract and that by executing this Contract, the Parties are formally bound.

36. Entire Agreement. This Contract constitutes the entire agreement of the Parties and supersedes all prior written or oral communications and all contemporaneous oral agreements, understandings, and negotiations between the Parties with respect to the subject matter hereof.

IN WITNESS WHEREOF, intending to be legally bound, the Parties hereto have caused this Contract to be signed by their duly authorized representatives.

ORANGE COUNTY SANITATION DISTRICT

Dated: ____________ By:____
Chad P. Wanke
Chair, Board of Directors

Dated: ____________ By:____
Kelly A. Lore
Clerk of the Board

Dated: ____________ By:____
Ruth Zintzun
Purchasing & Contracts Manager

CEMTEK ENVIRONMENTAL, INC. DBA CEMTEK KVB-ENERTEC

Dated: ____________ By:____

Keith Crabbe, Chief Operating Officer
Name and Title of Officer

CMM

Exhibit “A”

SCOPE OF WORK

EXHIBIT A
SCOPE OF WORK
CENTRAL GENERATION AUTOMATION/ CONTINUOUS EMISSIONS MONITORING SYSTEMS (CEMS) MAINTENANCE SERVICES
SPECIFICATION NO. CEMS22-27

EXECUTIVE SUMMARY/OVERVIEW

Orange County Sanitation District (OC San) operates three (3) 3500hp engines at Plant No .1 and five (5) 4200hp engines at Plant No. 2. The engines generate electricity using digester gas and natural gas as fuel sources. Contractor will maintain eight (8) Continuous Emissions Monitoring Systems (CEMS, Non-RECLAIM) and their associated appurtenances including the following:

Plant 1: Unit 1 – 16BFCP755A, Unit 2 – 16CFCP755A, and Unit 3 – 16DFCP755A

Plant 2: Unit 1 – 26BFCP753A, Unit 2 - 26CFCP753A, Unit 3 - 26DFCP753A, Unit 4 – 26EFCP753A, and Unit 5 – 26FFCP753A

The term of this Maintenance Service Contract is five (5) years effective November 22, 2022 ending November 21, 2027.

1 Purpose

Contractor shall provide on-site CEMS maintenance services, consumables & repair parts, training, system compliance with applicable rule/ regulations, and reporting/engineering/regulatory report services.

2 Description

Digester gas produced at Plant Nos. 1 and 2 is compressed, dried, and used as fuel in the engines coupled with generators to produce electricity. Digester gas is compressed and dried by running chilled water from the absorption chillers through a digester gas-to chilled water heat exchanger. The primary function of the engine generators is to produce electricity. Heat recovery systems installed on the engine exhaust and engine jacket water system are used for digester heating and building heating.

Plant Nos. 1 and 2 are within the jurisdiction of the South Coast Air Quality Management District (SCAQMD). SCAQMD has established regulations aimed at reducing and controlling air emissions from combustion sources, such as the Central Generation engines. In February 2008, SCAQMD amended Rule 1110.2, lowering the emission limits for nitrogen oxides (NOx), volatile organic compounds (VOCs), and carbon monoxide (CO) from internal combustion engines. In 2009, Project J-79-1 installed control panels, PLCs, and operating software's for each engine. In 2016, OC San completed Project J-111, which equipped the Central Generation engines at both plants with emission control systems (catalytic oxidizer/selective catalytic reduction system with digester gas cleaning systems) to comply with the reduced phased-in emission limits stipulated under SCAQMD Rule 1110.2 (now 1179.1).

Each certified CEMS unit (Non-RECLAIM CEMS) measures nitrogen oxides (NOx), carbon monoxide (CO) and oxygen (O2) concentrations on a dry basis from each engine exhaust stack. The CEMS units are certified in accordance with the monitoring requirements of the applicable protocols found in SCAQMD Rules 218 and 218.1 and EPA 40 CFR 60 Appendices B and F.

3 Project/Work Elements

3.1 CEMS Maintenance Services

3.1.1 On-site Maintenance

Contractor shall make every effort to notify OC San a minimum of one (1) week prior to scheduled maintenance visits. For each CEMS unit under this Contract, the following audits and maintenance activities are provided as applicable and at the frequencies required by the applicable rules and SCAQMD certification:

The OC San Quality Assurance Plan (QAP) document is the controlling document for scheduled preventative maintenance activities and records (See Appendix A).

3.1.1.1 Monthly Maintenance Services

In addition to the onsite-maintenance activities, the Contractor shall perform a total of sixty (60) monthly maintenance services as detailed in the OC San QAP which includes but is not limited to the following:

a) Complete inspection to verify proper operation of entire system
b) Perform leak checks on each system component
c) Replace sample probe filters as required (Contractor to perform required tests if filters are replaced with non-identical filters)
d) Replace sample conditioning filters as required
e) Replace analyzer filters as required
f) Rebuild analyzer sample pumps according to manufacturer's recommendation
g) Rebuild sample transport pumps according to manufacturer's recommendation
h) Verify zero air generator for proper operation
i) Replace zero air generator filters / chemicals as required
j) Perform manual calibrations as required
k) Complete analyzer maintenance checklists
l) Perform flow monitor flow and leak checks
m) Inspect and verify proper operation of HVAC Systems located on top of each CEMS units and perform any maintenance as needed
n) Inspect and verify proper operation of Air Clean up Panels in the CEMS and perform any maintenance as needed
o) Document and submit maintenance service visit reports

3.1.1.2 Quarterly Maintenance Services

In addition to the maintenance services performed on a monthly basis, the Contractor shall perform a total of twenty (20) quarterly maintenance services as detailed in OC San's QAP (See Appendix A).

3.1.1.3 Semi-annual Maintenance Services

In addition to the maintenance services performed on a monthly and quarterly basis, the Contractor shall perform a total of ten (10) semi-annual maintenance activities as detailed in OC San's QAP and in addition shall perform the following:

a) Check and replace instrument air filters as needed
b) Check calibration of the pressure and temperature transducers

c) Quarterly Calibration Gas Audit (CGA) for three quarters of each year. The three quarterly CGAs will be performed for 1st quarter, 2nd quarter, and 3rd quarter of each year.

3.1.1.4 Annual Maintenance Services

In addition to the maintenance services performed on a monthly, quarterly, and semi-annual frequency, the Contractor shall perform a total of five (5) annual maintenance services as detailed in OC San's QAP and in addition shall perform the following:

a) Attend annual safety meetings conducted by the OC San
b) Submit annual safety plan
c) Provide annual certificate of insurance covering Contractor staff working on District premises
d) Monthly maintenance
e) Quarterly maintenance
f) Bi-annual on-site inspection of system
g) Maintain back-up configuration (image) of DAHS workstation and PLC programs
h) Maintain version control of DAHS software system and PLC programs
i) Assisting with Annual RATA

3.1.2 Regulatory Updates

In 2021, SCAQMD adopted Rules 218.2, titled Continuous Emissions Monitoring Systems General Provisions, and 218.3, titled Continuous Emissions Monitoring Systems Performance Specifications. Under the Contract, the Contractor shall review the newly adopted rules, SCAQMD Rules 218.2 and 218.3, submit a CEMS update plan to OC San for consideration, and accordingly update the DAHS and the QAPs to incorporate the necessary changes as required by the aforementioned regulations no later than September 1, 2023. Additionally, the Contractor shall summarize the changes made to the DAHS and the QAPs and transmit the summary of those changes to OC San for review, discussion and staff training. At a minimum, the Contractor shall assume multiple training sessions equating to 4-hours of staff training on the updates implemented.

3.1.3 Consumable & Repair Parts

Contractor shall supply all consumable parts for five (5) years. Contractor shall be responsible to supply all repair parts necessary for the conductance of all repairs or equipment malfunction for five (5) years. At the end of the five (5) year Contract, Contractor shall replenish the OC San inventory of consumable and Repair Parts. OC San shall supply all calibration gases required to perform quarterly cylinder gas audits and daily calibrations.

3.1.4 Repair Services

Contractor shall respond to a repair request within 48 hours or less of notification by the OC San. Contractor shall provide phone support to a site representative in an effort to identify the problem or dispatch a Contractor's service engineer to the site to resolve the stated problem. Direct contact numbers to be used during normal business hours and off-hours for incident response (i.e. repair service) shall be supplied upon award of contract.

Pre-paid repair service includes identification of the problem and repair of the equipment as required. Contractor shall conduct any required testing triggered by Contractor performed activities under this Contract per the QAP.

3.2 Reporting Services

3.2.1 CGA Reporting

Contractor shall generate three quarterly reports each year for submittal to OC San for review, comments, and file retention. Contractor will be required to coordinate with OC San in the generation of such reports, providing requested documentation in a timely manner so that the report deadlines may be met.

All reporting issues or concerns identified by the Contractor will be directed to the OC San's designated contacts, capable of confirming plant operation and CEMS hardware maintenance activities.

3.2.2 Daily/Weekly DAHS Monitoring

Contractor shall provide a list of daily and weekly CEMS/DAHS Monitoring tasks to OC San and additionally provide initial training to the CenGen PPOs and annual refresher thereafter, so all stakeholders are in a mutual understanding on what to expect in maintaining the CEMSs at its best performances. The training subjects at a minimum to cover activities performed by OC San's PPOs include:

a) Data Validation Review
b) Calibration Review, including what to do when CEMS calibrations drift out of Tolerance
c) Alarm Review
d) Exceedance Coding and Notification
e) Monitor Downtime Coding
f) Changing the calibration gas values in DAHS when changing out gas bottles
g) Performing calibration gas bottle inventory and gas bottle change out

3.3 Engineering Services

3.3.1 On-Site Annual Engineering Configuration Review

Contractor shall provide a total of five (5) on-site visits for engineering support with loading major software releases, implementing configuration changes, review of regulatory requirements, system inspection, disk clean-up, review of displays and alarms, and other related services. The OC San shall provide Contractor with a single point of contact while the services are performed on-site. The number of days allotted for this service shall be 1 day for each site - Plant No. 1 and Plant No. 2. Contractor shall be performing these annual on-site visits.

3.4 Regulatory Services

3.4.1 Annual Regulatory Consultation

Annually, Contractor shall provide ten (10) hours of consultation on regulatory and certification related matters pertaining to EPA 40CFR60, SCAQMD Rule 1110.2, Rule 1179.1, Rule 218, Rule 218.1, Rule 218.2, and/or Rule 218.3. Consultation includes discussion of issues via telephone, electronic mail, in-person or virtual meetings, and provision of discussion papers.

3.4.2 Annual QA/QC Review

By July 1st of each calendar year, during the term of the Contract, the Contractor shall conduct an annual review of OC San's quality assurance/quality control plan in conjunction with OC San staff. Upon completion of this review, Contractor will generate a report documenting the plan's compliance with current EPA/ SCAQMD regulations or, should areas not be compliant, the report will detail areas where the plan is deficient and must be reviewed. If any discrepancies are noted between the QA/QC control plan and current EPA/ SCAQMD regulations either by the Contractor or OC San staff, the Contractor shall coordinate and address any QAP updates with OC San.

4 Staff Assistance

Contractor will be assigned a single point of contact on this project ("Project Manager"). Any meetings and/or correspondence related to this project shall be scheduled and approved by the Project Manager.

Continuous Emissions Monitoring System (CEMS)

Quality Assurance Plan (QAP)

SCAQMD Rule 218.1 and SCAQMD Rul2 1110.2
40 CFR 60, Appendix F

Project Title: CEMS
Job Number: J-79-1A
Process Code: Plant 1=16

Date: September 2014
Revision: 3
CEMTEK Project No.: 50173, 50419

Prepared for:

Orange County Sanitation District – Reclamation Plant 1
IC Engine Units 1 thru 3
Fountain Valley, CA

SCAQMD Facility ID: 017301

Prepared by:
CEMTEK Environmental, Inc.
3041 S. Orange Ave
Santa Ana, CA 92707-4247
Phone: 714-437-7100
Fax: 714-437-7177
www.cemteks.com

CEMTEK Environmental

[End of section. This document is formatted for double-sided printing.]

Preface

Notices:
Product names referenced in this manual are trademarks of their respective manufacturers.

The information in this document has been carefully compiled and edited. While this material is believed to be accurate, no responsibility is assumed for possible inaccuracies or omissions.

Cautions and Warnings:
Before performing any maintenance on the CEMS components refer to the manufacturers' manuals. Observe all manufacturers' cautions and warnings noted in the component manuals. Also read all safety labels that may be posted on equipment.

General Warnings: *The technicians performing maintenance should be familiar with all safety warnings contained in the individual manufacturer's manuals. All maintenance must be performed in accordance with facility safety procedures.*

Most components need to be powered off before major maintenance to prevent potential electrical shock hazards. Maintenance performed on electrical equipment must be conducted in accordance with facility Lockout/Tagout (LO/TO) procedures

Some components can be damaged by small amounts of static electricity. Before performing any maintenance, use a properly grounded antistatic wrist strap to be worn while handling any instrument's internal components.

Some components such as the probe or heating elements on some analyzer types may be extremely hot to the touch. Wear protective heat-resistant gloves when handling.

Other components such as optical assemblies and capillaries in the analyzers are made of glass and must be handled carefully.

Be careful when using solvents or abrasive materials for cleaning to avoid damage to components. Check manufacturers' manuals for recommended cleaning materials and procedures.

Revision Log:

Revision No.	Revision Date	Revised Sections	Notes
3	September 2014	All	Reformat to updated template. Revisions added for CEMS upgrade (Inlet NO_X analyzer). Supersedes previous versions of the QAP.

Contact Information

West Coast Office	East Coast Office
CEMTEK Environmental, Inc. 3042 S. Orange Ave. Santa Ana, CA 92707-4247 Ph.: 714-437-7100 Fax: 714-437-7177	CEMTEK Systems, Inc. 2012 South Wood Ave. Linden, New Jersey 07036 Ph.: 908-474-9630 Fax: 908-474-9413
For parts and service call: 1-888-400-0200 or order online at www.cemtekparts.com	
For 24-hour emergency service call: 1-888-400-0201	
Website: www.cemteks.com	

Additional Reference Material

Refer to the following manuals for additional information located under separate cover.

Code of Federal Regulations, Title 40, Part 60 (eCFR website): In the pull down list select Title 40 and then follow the links to Part 60
http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=%2Findex.tpl

Facility's Air Permit

DAHS User Guide

CEMS Operation and Maintenance Manual

EPA's Emission Measurement Center, use to download copies of EPA test methods: http://www.epa.gov/ttn/emc/

South Coast Air Quality Management District (SCAQMD) website:
http://www.aqmd.gov/

[End of section. This document is formatted for double-sided printing.]

Contents

Contents v
Tables viii
1 Quality Assurance Plan Overview 1-1
1.1 Introduction 1-1
1.2 Quality Assurance Plan Objective 1-1
1.3 Quality Audit Procedures Overview 1-2
1.4 Document Control 1-3
1.5 Facility Responsibilities 1-3
2 Facility and CEMS Description 2-1
2.1 Facility Description 2-1
2.1.1 Emission Limits 2-1
2.2 CEMS System Description 2-1
2.2.1 Analyzers Included in the CEMS 2-1
2.3 Sample System Overview 2-2
2.3.1 Sample Probe 2-2
2.3.2 Sample Probe 2-3
2.3.3 Sample Line 2-3
2.3.4 Vacuum Gauge – VG1, VG2 2-3
2.3.5 Sample Pump – SP1, SP2 2-3
2.3.6 Sample Gas Cooler – GC1, GC2 2-4
2.3.7 Cooler Drain Pumps – DP1/DP2, DP3/DP4 2-4
2.3.8 Ammonia Scrubber – AS1 2-4
2.3.9 Moisture Sensor – MS1, MS2 2-4
2.3.10 Filter – F1, F2 2-5
2.3.11 Solenoid Valve and Trim Valve – SV8, SV10, TV1, TV2 2-5
2.3.12 Flow Switch – FS1, FS2 2-5
2.3.13 Total Sample Flow Meter – RM1, RM5 2-5
2.3.14 Analyzer Flow Meter – RM2, RM3, RM6 2-5
2.3.15 Pressure Gauge – PG2, PG3 2-5
2.3.16 Back Pressure Regulator – BPR1, BPR2 2-5
2.4 Analytical Instruments 2-5
2.4.1 TEI Model 42i-LS NO_X and NO_X/O_2 Analyzer 2-6
2.4.2 TEI Model 48i CO Analyzer 2-7
2.5 Instrument Air Subsystem 2-7
2.5.1 Hand Valves – HV1, HV2, HV3 2-7
2.5.2 Pressure Gauge and Pressure Switch – PG1, PS1 2-7
2.5.3 Filter Regulator – FR1 2-8
2.6 Redundant Air Clean Up Panel 2-8
2.6.1 Hand Valves – HV4, HV5, HV6 2-8
2.6.2 Particulate Filters – F1, F2, F3 2-8
2.6.3 Refrigerated Air Dryer – RAD1 2-8
2.6.4 Coalescing Filter – CF1 2-8
2.6.5 Heatless Air Dryer – HAD1 2-9
2.7 Calibration Gas Subassembly 2-9

2.7.1 Calibration Gas Regulator – REG1 thru REG9 2-9
2.7.2 Calibration Gas Solenoid Valves 2-9
2.7.3 Calibration Flow Rotameter – RM4, RM7 2-10
2.8 Operator Interface Terminal 2-10
2.9 CEMS Controller 2-10
2.10 Data Acquisition and Handling System 2-11
3 CEMS Routine Operation Procedures 3-1
3.1 General 3-1
3.2 Component Check 3-1
3.3 Temperature Control 3-1
3.4 Front Panel Switches and Indicators 3-1
3.5 Initial Startup 3-2
3.5.1 Normal System Sampling Flow Verification 3-3
3.6 Shutdown and Storage 3-3
3.7 Routine Operation 3-4
3.8 Probe Purge 3-5
3.9 CEMS Calibrations 3-5
3.9.1 Automatic Calibrations 3-5
3.9.2 Post Maintenance Calibration and Leak Check 3-6
4 Data Recording and Reporting 4-1
4.1 Data Acquisition System 4-1
4.2 SCAQMD Valid Data Requirements 4-2
4.3 Electronic Reporting 4-3
5 Quality Control Activities 5-1
5.1 Introduction 5-1
5.2 Calibration Audit Gases 5-1
5.2.1 Safety Procedures for High Pressure Gas Cylinders 5-2
5.2.2 Calibration Gas Cylinder Change Out 5-3
5.3 Daily Calibration Error Check 5-4
5.3.1 Conducting the Daily Calibration Error Test 5-4
5.3.2 Additional Calibration Error Tests and Adjustments 5-6
5.3.3 Re-calibration Limits 5-7
5.3.4 Out-of-Control Limits 5-7
6 Quality Assurance Activities 6-1
6.1 Introduction 6-1
6.2 Quarterly Assessments 6-1
6.3 Cylinder Gas Audit – Part 60 6-1
6.3.1 Cylinder Gas Audit Procedure 6-1
6.3.2 Out-of-Control Period 6-3
6.4 Annual Relative Accuracy Test Audit 6-3
6.4.1 Sampling Strategies 6-4
6.4.2 Correlation of Data 6-5
6.4.3 O_2 Relative Accuracy Test 6-5
6.4.4 NO_X Relative Accuracy Test 6-6
6.4.5 CO Relative Accuracy 6-7
6.4.6 Flow Relative Accuracy Test 6-7
6.4.7 Relative Accuracy Calculations 6-8
6.4.8 Out-of-Control Period 6-9

6.5 Sampling System Bias Test 6-9
7 Recertification and Diagnostic Tests 7-1
7.1 Introduction 7-1
7.2 Diagnostic Tests and Recertification Events 7-1
7.2.1 Diagnostic Tests and Recertification Summary Tables 7-1
7.2.2 SCAQMD Recertification Procedures 7-9
7.2.3 Impact of Recertification Events on Data Acceptability 7-9
8 Routine Preventive Maintenance 8-1
8.1 Introduction 8-1
8.2 Logbook Maintenance 8-1
8.3 Minimize Downtime during Routine Maintenance 8-2
8.4 System Checks 8-2
8.4.1 Calibration Failure 8-3
8.4.2 Abnormal Measurement Output Voltage/Current 8-4
8.4.3 Water Contamination 8-4
8.4.4 Moisture Sensor Check 8-4
8.4.5 Sample System Particulate Filter Check 8-5
8.4.6 Routine Maintenance for the Sample Probe 8-5
8.4.7 Routine Maintenance for the Sample Line 8-6
8.4.8 Routine Maintenance for the Sample Conditioning Unit 8-6
8.4.9 Replacing Ammonia Scrubber 8-6
8.4.10 Instrument Air Filter Service Check 8-7
8.4.11 Peristaltic Pump Tubing Replacement 8-8
8.4.12 Sample Pump Diaphragm Replacement 8-9
8.4.13 NO_X Converter Check 8-10
8.4.14 Analyzer Cabinet Temperature Control 8-11
8.5 CEMS Preventive Maintenance Schedule 8-11
8.5.1 Daily Preventive Maintenance 8-14
8.5.2 Weekly Preventive Maintenance 8-18
8.5.3 Monthly Preventive Maintenance 8-20
8.5.4 Quarterly Preventive Maintenance 8-21
8.5.5 Semiannual Preventive Maintenance 8-24
8.5.6 Annual Preventive Maintenance 8-26
9 Corrective Maintenance and Troubleshooting 9-1
9.1 Introduction 9-1
9.1.1 Troubleshooting the System 9-1
9.1.2 CEMS Leak Check Procedure 9-2
9.1.3 Flow Balance Procedure 9-3
9.2 Sample Cooler 9-4
9.3 Troubleshooting the AirTak Heatless Air Dryer 9-5
9.4 Troubleshooting the AirTak Refrigerated Air Dryer 9-7
9.5 Troubleshooting the NOX Analyzer 9-8
9.6 Troubleshooting the TEI Model 48i CO Analyzer 9-11
10 Recommended Spare Parts 10-1
11 Emission Equations 11-1
11.1 Monitored Parameters 11-1
11.2 Equations 11-1

Tables

Table 2-1: CEMS Analyzers Summary Information 2-2
Table 5-1: Daily Calibration Gas Specifications 5-4
Table 5-2: Excessive Calibration Error Criteria – Part 60 5-8
Table 6-1: CGA Calibration Gas Specifications – Part 60 6-2
Table 7-1: Like Replacements Only 7-2
Table 7-2: Unlike Replacements Only 7-6
Table 9-1: Troubleshooting the Sampling System 9-1
Table 9-2: Sample Cooler Troubleshooting Overview 9-4
Table 9-3: Heatless Air Dryer Troubleshooting 9-5
Table 9-4: Refrigerated Air Dryer Troubleshooting 9-7
Table 9-5: NO_X Analyzer General Troubleshooting 9-8
Table 9-6: NO_X Analyzer Alarm Messages 9-9
Table 9-7: CO Analyzer General Troubleshooting 9-11
Table 9-8: CO Analyzer Alarm Messages 9-12

1 Quality Assurance Plan Overview

1.1 Introduction

This document is intended to satisfy the requirements of the South Coast Air Quality Management District (SCAQMD) Rule 218.1 and 1110.2. SCAQMD regulations require development of a quality control program. This document is in compliance with this requirement.

Note that the facility has chosen the 40 CFR 60, Appendix B and Appendix F option on the SCAQMD ST-220 CEMS Application Form (Item 14) for Non-RECLAIM CEMS. Appendix B details specifications required to certify the CEMS analyzers. Appendix F details on-going Quality Assurance/Quality Control procedures for the CEMS.

This Quality Assurance Plan (QAP) has been developed for the gas continuous emissions monitoring systems (CEMS) for the Orange County Sanitation District (OCSD) Reclamation Plant No. 1 located in Fountain Valley, CA.

1.2 Quality Assurance Plan Objective

The QAP establishes operational procedures that will ensure data and measurements are accurate and precise. At no time will non-quality assured data be reported as valid data.

The objective of the QAP is to establish a series of QA and QC activities that will provide a high level of confidence in the data reported by the CEMS. The QAP provides guidelines for implementing QA and QC activities needed to ensure that emission-monitoring data are complete, representative, and of known precision and accuracy.

Quality Control (QC): The procedures, policies, and corrective actions necessary to ensure product quality. QC procedures are routine activities. These activities include but are not limited to daily calibrations and routine preventive maintenance activities as defined by manufacturers of the various hardware components of the CEM system and by regulatory agencies.

QC procedures are specific maintenance activities necessary to optimize the CEMS performance and reliability. These activities include daily, weekly, monthly, quarterly, semiannual and annual checks and inspections. Corrective actions, such as corrective maintenance and recalibrations, are performed when the specification limits 40 CFR 60, Appendix F or SCAQMD Rule 218 are exceeded.

Quality Assurance (QA): A series of checks performed to ensure the QC procedures are functioning properly. Quality assurance is often used to define “external” activities (that is functions performed on a more occasional basis). The activities include but are not limited to required periodic quarterly and annual audits.

QA procedures consist of a series of checks and audits that are performed on the CEMS on a predetermined as well as an "as needed" basis. The resulting assessments activate QC measures and corrective actions. After the corrective actions are performed, the data quality is again assessed. The quality of the data will determine whether the corrective actions were successful or whether further actions are required.

This QAP only summarizes the QA/QC activities. Operation and Maintenance manuals from the analyzer manufacturers were used in the development of QC procedures. These documents are maintained at the facility and provide detailed procedures for calibration, troubleshooting, and repair for the CEM system major equipment components. These documents should be used as a major reference source whenever maintenance activities occur. The manufacturers' manuals are located as appendices in the CEMS Operation and Maintenance manual.

1.3 Quality Audit Procedures Overview

The following is a brief description of the type and frequency of QA/QC procedures, as outlined in SCAQMD Rule 218 and 40 CFR 60 Appendix F as applicable.

Daily Assessments:

- Two-point (Zero and Span) calibration drift tests for all pollutant concentration and diluent monitors.
- If an Out-of-control event occurs the appropriate maintenance and corrective action(s) will be performed and the daily assessment repeated for the affected monitor.
- Data recording and tabulation of all calibration error tests according to month, day, and magnitude.

Quarterly Assessments

- Quarterly two-point cylinder gas audit (CGA) for CO monitors (40 CFR 60, Appendix F, Section 5.1.2).
- If an Out-of-control event occurs the appropriate maintenance and corrective action(s) will be performed and the quarter assessment repeated for the affected monitor.

Annual QA Activities

- Annual Relative Accuracy Test Audit
- If an Out-of-control event occurs the appropriate maintenance and corrective action(s) will be performed and the annual assessment repeated for the affected monitor.

1.4 Document Control

This QAP is a controlled document. The QAP should be reviewed on an annual basis and updated when needed to reflect changes in regulatory requirements. It should also be updated if any changes in scheduled maintenance routines are indicated after experience in operating the system after a prolonged period of time. Maintenance schedules can vary depending upon site-specific conditions (example, filters may need to be changed more often in a “dirty” environments or less often under “clean” conditions) or as the system ages certain maintenance routines may have to be performed more often. The schedule of preventive maintenance routines outlined in Chapter 8 of this QAP are based on manufacturers’ recommendations and experience from the CEMTEK field service technicians. The maintenance schedule may need adjusting over time based on site-specific conditions.

When modifications to the QAP become necessary, responsible facility personnel will be designated to ensure that any required revisions are made to the QAP document, providing a copy of any revisions to all individuals or groups that need to be aware of such changes. The plant operating procedures, equipment operation and maintenance (O&M) manuals, and other documents that are referenced in this QAP are not controlled documents and therefore are not subject to this document revision procedures.

To ensure that all copies of the QAP are revised to contain current procedures, the following document control headers and footers are provided on each page:

Revision Number
Date of Revision
Section/Page Number

1.5 Facility Responsibilities

Certain individuals and groups at the facility will have designated responsibilities to ensure that QA/QC activities are performed as required by this QAP program. The following is a fairly typical organizational structure of responsibilities.

Environmental Affairs Group (as equivalent to individual facilities):

- Oversees the CEMS QA/QC program
- Reviews all plans and reports for accuracy
- Prepares certification/recertification applications and notifications
- Stays abreast of Federal, State and local regulation updates that may affect the CEMS programs and interprets as required
- Coordinates and schedules CEMS audits, diagnostic tests and certification/recertification tests as required
- Submits emission summary reports and certification/recertification test results to the regulatory agency(s) as required
- Supports and provides training in the administration and maintenance of the CEMS Data Acquisition and Handling System (DAHS)
- Reviews CEMS data for validity and makes any necessary corrections so the proper data will be entered in the quarterly reports

- Ensures records are maintained for out-of-control conditions
- Notifies the Plant Manager of any abnormal conditions that cannot be resolved within existing CEMS procedures in a reasonable amount of time
- Prepares emission summary reports for approval and submittal in a timely manner at the end of the reporting periods to allow review prior to submittal
- Maintains files of all plant CEMS data (hard copy and electronic), reports, calibration gas certificates
- Notifies appropriate plant personnel of scheduled CEMS audits and certification/recertification tests
- Arranges for support needed by contractors for relative accuracy test audits (RATAs) and certification/recertification tests
- Provides plant resources to assist contractors during RATAs and certification or recertification testing

Plant manager:

- Designates and manages manpower and other resources needed to properly maintain and operate the CEMS
- Reviews and approves all plant-specific CEMS plans, procedures, and reports

Maintenance managers and shift supervisors:

- Reviews CEMS calibration reports on a daily basis and responds to CEMS alarms
- Notifies the Plant Manager of any abnormal conditions so immediate action can be taken to return the system to normal operating conditions
- Notifies the environmental staff and maintenance technicians of CEMS malfunctions
- Ensures that a spare parts inventory is maintained based on manufacturers' recommendations and plant operating experience with the CEMS
- Ensures that the inventory of EPA Protocol calibration gases is well maintained
- Ensures that work requests for preventive maintenance and priority jobs on the CEMS are scheduled and completed in a timely manner

Maintenance and instrument technicians:

- Performs all maintenance (routine and corrective) to keep the CEMS running according to specifications
- Maintains a complete CEMS maintenance log
- Assists contractors during audits and certification/recertification testing
- Checks the conditions of all analyzer shelters
- Informs responsible managers/supervisors of the CEMS status on at least a weekly basis

2 Facility and CEMS Description

2.1 Facility Description

OCSD's Reclamation Plant No. 1 consists of three (3) Internal Combustion Engines (ICEs) firing natural gas or digester gas. Individual CEMS will monitor emissions from each ICE exhaust stack.

2.1.1 Emission Limits

The following limits are excerpted from the air permit and SCAQMD Rule 1110.2.

NO_X 44.9 ppm @ 15% O_2
368 lb/day (total of all three ICEs)

CO 590ppm @ 15% O_2
1,321 lb/day (total of all three ICEs)

2.2 CEMS System Description

Each CEMS is a fully extractive system that is housed in an environmentally controlled shelter.

Each CEMS measures concentrations of oxides of nitrogen (NO_X), carbon monoxide (CO) and oxygen (O_2) from each IC Engine exhaust stack. All measurements are done on a real time basis. An additional NO_X analyzer is installed on the control equipment inlet for process monitoring and control. The system includes a programmable logic controller (PLC). The PLC communicates, via Ethernet, from the CEMS to the Data Acquisition System (DAHS) computer. The PLC will transmit one-minute averages. Contact closures are provided for alarms and system status.

Complete system operation, including calibration and sequencing is automatic. Operator attention is necessary only for periodic manual verification of accuracy and normal maintenance.

2.2.1 Analyzers Included in the CEMS

The following table summarizes the analyzer components of the CEMS. A brief description of each analyzer and other major equipment components is located in the following sections.

Table 2-1: CEMS Analyzers Summary Information

ICE Unit 1 CEMS

Analyzer	Manufacturer/Model	Range(s)	Serial Number
Stack NO_X/O_2	TEI 42i-LS	NO_X: 0-35/0-100 ppm O_2: 0-25%	0836634041
Stack CO	TEI 48i	0-80/0-760 ppm	0836634047
Inlet NO_X	TEI 42i-LS	0-100 ppm	0836634045

ICE Unit 2 CEMS

Analyzer	Manufacturer/Model	Range(s)	Serial Number
Stack NO_X/O_2	TEI 42i-LS	NO_X: 0-35/0-100 ppm O_2: 0-25%	0836624040
Stack CO	TEI 48i	0-80/0-760 ppm	0836634040
Inlet NO_X	TEI 42i-LS	0-100 ppm	0836634044

ICE Unit 3 CEMS

Analyzer	Manufacturer/Model	Range(s)	Serial Number
Stack NO_X/O_2	TEI 42i-LS	NO_X: 0-35/0-100 ppm O_2: 0-25%	0904434729
Stack CO	TEI 48i	0-80/0-760 ppm	09010027
Inlet NO_X	TEI 42i-LS	0-100 ppm	090434733

2.3 Sample System Overview

To ensure accuracy a clean, dry representative gas sample must be transported to the analyzers. Any moisture or particulate matter can cause damage to the gas analyzers so it must be removed from the sample. The following describes the function and operation of major system components arranged according to the normal flow of sample gas from sample probe to gas analyzers.

Refer to the CEMS sample system flow engineering diagrams located as Chapter 7 (drawing number 505041902). In the following sections tag names for major components are identified in **BOLD** typeface where applicable. Cross reference these tag names against the CEMS diagrams. Also refer to the CEMS diagrams for flow rate and pressure set points associated with several components.

2.3.1 Sample Probe

To ensure accuracy a clean, dry representative gas sample must be transported to the analyzers. Any moisture or particulate matter can cause damage to the gas analyzers so it must be removed from the sample. The following describes the function and operation of major system components arranged according to the normal flow of sample gas from sample probe to gas analyzers.

Refer to the CEMS sample system flow engineering diagrams (located with the Operation and Maintenance manual files). In the following sections tag names for major components are identified in **BOLD** typeface where applicable. Cross reference these tag names against the CEMS diagrams. Also refer to the CEMS diagrams for flow rate and pressure set points associated with several components.

2.3.2 Sample Probe

The Universal Analyzers Model 270S heated stack filter assembly and probe is designed for continuous extraction of gases with sample flow rates of up to 20 liters per minute. The filter assembly, which provides the first stage of sample conditioning, is mounted in a NEMA 4X fiberglass enclosure. The filter assembly is heated to 400°F.

Instrument air is used to pressurize an accumulator to a maximum of 125 psig. During a probe purge, a solenoid valve opens providing a substantial blast of air that loosens the particles on the filter surface and forces them back through the probe into the stack.

Calibration gas is injected into the chamber ahead of the filter. A back pressure check valve insures that calibration gas does not leak into the sample.

2.3.3 Sample Line

The sample lines transport the gas sample from the probes to the analyzers. The heated line maintains the sample gas above the dew point, preventing moisture in the sample from condensing and affecting the analyzers' response.

The line contains a 1/4" tube for calibration gas, a 3/8" tube for probe purging operation, and a 3/8" tube for the gas sample. The temperature is maintained using a type "K" thermocouple. The sample line also contains wires for the sample line heater; probe filter heater and probe filter temperature alarm. The heated sample line umbilical is covered with a PVC jacket.

2.3.4 Vacuum Gauge – VG1, VG2

This vacuum gauge (Stack and Inlet) provides an indication of the condition of upstream components. A high vacuum reading can indicate a blockage or restriction in the probe or sample line. Normal pressure readings should be less than 10 inches Hg.

2.3.5 Sample Pump – SP1, SP2

The sample pump (Stack and Inlet) is a positive-displacement type that utilizes a moving diaphragm. During normal operation, the pressure at the pump outlet is set at approximately 10 psig, using the back-pressure regulator.

When the CEMS enclosure is located a considerable distance from the sample point, restriction on the sample lines may induce a substantial vacuum at the pump inlet. Be alert for leaks that could affect accurate measurement, especially in cases where a long sample line run causes pump inlet vacuum greater than 5 inches Hg.

The pump shuts down automatically if the moisture sensor (**MS1, MS2**) detects moisture in the sample system tubing downstream of the sample gas cooler.

Note: *A fatal alarm may be triggered by the controller if any condition occurs that may adversely affect the performance of the CEMS equipment, or may otherwise damage components of the CEMS equipment. For example, the detection of excess moisture in the sample stream can cause damage to the individual analyzers.*

2.3.6 Sample Gas Cooler – GC1, GC2

The M&C Series ECM-2G electric gas cooler (Stack and Inlet) is a compressor cooler. With the ECM model the sample gas is passed through up to two Jet-Stream heat exchangers where it is cooled to +5°C. Temperature is measured by a sensor and regulated electronically. The heat energy emitted by the cooling system is dissipated via a cooling fin block with forced ventilation. Solids are trapped in the sample probe filter as well as in a downstream fine filter.

A thermocouple with temperature alarm signal output is included on the sample gas cooler and will be monitored via signal input to the PLC and DAHS. The cooler's dewpoint setpoint value is set at 37°F.

2.3.7 Cooler Drain Pumps – DP1/DP2, DP3/DP4

A two-head peristaltic pump (Stack and Inlet) continuously drains the condensation moisture traps. The pump motor is a fixed-speed drive rotating at 6 rpm. The pump requires 115V power.

2.3.8 Ammonia Scrubber – AS1

The ammonia (NH_3) scrubber protects the Stack NO_X analyzer reaction chamber by removing ammonia from the sample gas. Presence of NH_3 can cause a positive NO bias in the NO_X measurement. The scrubber also reduces ammonia salt buildup. The process depletes the scrubber media requiring periodic replacement. A hand valve (**HV4**) is used to shut off the drain from the ammonia scrubber.

2.3.9 Moisture Sensor – MS1, MS2

The moisture sensor (Stack and Inlet) monitors the sample gas stream at the sample gas cooler (**GC1, GC2**) outlet to detect any moisture, which could damage the gas analyzers. Any droplet of moisture across the conductivity sensor electrodes simulates a switch. The moisture sensor then sends a signal to the PLC causing the PLC to turn off the sample pump (**SP1, SP2**) and create an alarm to the DCS or data acquisition system. The moisture sensor is also connected to a relay board that automatically shuts off the sample pump (**SP1, SP2**), regardless of the PLC digital output, should moisture be detected downstream of the sample conditioner (**GC1, GC2**).

2.3.10 Filter – F1, F2

Sample gas flows through an in-line filter (Stack and Inlet), removing particulate that could damage downstream components. The filter has a replaceable filter element, which can trap particles as small as 2.0 micron.

2.3.11 Solenoid Valve and Trim Valve – SV8, SV10, TV1, TV2

This 3-way solenoid valve (Stack and Inlet) is used for performing local calibrations (direct calibration gas injections) to the analyzers, bypassing the probe and sample conditioning system.

The trim valve is used to adjust the flow rate of calibration gas during a local calibration sequence.

2.3.12 Flow Switch – FS1, FS2

Sample gas flows through a flow switch (Stack and Inlet) that sends a signal to the PLC when the sample flow rate falls below 3 liters per minute.

2.3.13 Total Sample Flow Meter – RM1, RM5

A flow meter (Stack and Inlet) indicates the sample flow rate at the sample pump outlet. The sample flow rate should be set using the back pressure regulator (**BPR1, BPR2**) to 4 to 5 liters per minute.

2.3.14 Analyzer Flow Meter – RM2, RM3, RM6

Sample gas flow for each analyzer is indicated and controlled by a flow meter. Adjust each analyzer flow meter to provide the required labeled flow rate (approximately 1.5 liters per minute).

2.3.15 Pressure Gauge – PG2, PG3

The pressure gauge (Stack and Inlet) monitors the sample gas pressure at the cooler outlet. The pressure gauge should read > 2 psig.

2.3.16 Back Pressure Regulator – BPR1, BPR2

The sample gas flows through the total sample flow meter (**RM1, RM5**). The gas flow then divides and flows through the analyzer sample flow meters. Excess sample gas is vented through a back pressure regulator. Adjust the back pressure regulator so as to maintain 4-5 liters per minute at the total sample flow meter (**RM1, RM5**).

2.4 Analytical Instruments

The CEMS measures NO_X, CO, and O_2. The following provides an overview on the theory of operation of each analyzer. Descriptions have been partially excerpted from manufacturers' manuals.

2.4.1 TEI Model 42i-LS NO_X and NO_X/O_2 Analyzer

The TEI Model 42i Low Source (LS) chemiluminescent analyzer is used to measure oxides of nitrogen. It is based on the principle that nitric oxide (NO) and ozone (O_3) react to produce a characteristic luminescence with intensity linearly proportional to the NO concentration. Infrared light emission results when the electronically excited NO_2 molecules decay to lower energy states.

Nitrogen dioxide (NO_2) must first be transformed into NO before it can be measured using the chemiluminescent reaction. NO_2 is converted to NO by a converter heated to about 625°C.

The gas sample enters the analyzer through the sample bulkhead. The sample flows through a particulate filter, a capillary, and then to the mode solenoid valve. The solenoid valve routes the sample either straight to the reaction chamber (NO mode), or through the NO_2-to-NO converter and then to the reaction chamber (NO_X mode).

Dry air enters the Model 42i-LS through the dry air bulkhead, through a flow sensor and then through a silent discharge ozonator. The ozonator generates the necessary ozone concentration needed for the chemiluminescent reaction. The ozone reacts with the NO in the ambient air sample to produce electronically excited NO_2 molecules. A photomultiplier tube (PMT) housed in a thermoelectric cooler detects the NO_2 luminescence.

The NO and NO_X concentrations calculated in the NO and NO_2 modes are stored in memory. The difference between the concentrations is used to calculate the NO_2 concentration. The Model 42i-LS outputs NO, NO_2 and NO_X concentrations to both the front panel display and the analog outputs.

A paramagnetic O_2 sensor bench is incorporated with the Stack NO_X analyzer for measurement of stack % O_2 content. The sensor measures the paramagnetic susceptibility of the sample gas by means of a magneto-dynamic measuring cell. Oxygen is virtually unique in being a paramagnetic gas; this means that it is attracted into a magnetic field.

In the measuring cell the oxygen concentration is detected by means of a dumb-bell mounted on a torque suspension in a strong, non-linear magnetic field. The higher the concentration of oxygen the greater this dumb-bell is deflected from its rest position. Around the dumb-bell is a coil of wire. A current is passed through this coil to return the dumb-bell to its original position. The current is measured and is proportional to the oxygen concentration.

The Inlet NO_X analyzer is the same make and model as the Stack NO_X analyzer but without the O_2 sensor bench.

2.4.2 TEI Model 48i CO Analyzer

The Model 48i operates on the principle that carbon monoxide (CO) absorbs infrared radiation at a wavelength of 4.6 microns. Because infrared absorption is a non-linear measurement technique, it is necessary to transform the basic analyzer signal into a linear output. The Model 48i uses an internally stored calibration curve to accurately linearize the instrument output over any range up to a concentration of 10,000 ppm.

The sample is drawn into the Model 48i through the sample bulkhead. The sample flows through the optical bench. Radiation from an infrared source is chopped and then passes through a gas filter alternating between CO and N_2. The radiation then passes through a narrow bandpass interference filter and enters the optical bench where absorption by the sample gas occurs. The infrared radiation then exits the optical bench and falls on an infrared detector.

The CO gas filer acts to produce a reference beam which cannot be further attenuated by CO in the sample cell. The N_2 side of the filter wheel is transparent to the infrared radiation and therefore produces a measurement beam which can be absorbed by CO in the cell. The chopped detector signal is modulated by the alternation between the two gas filters with an amplitude related to the concentration of CO in the sample cell. Other gases do not cause modulation of the detector signal since they absorb the reference and measure beams equally. Thus, the GFC system responds specifically to CO.

The Model 48i outputs the CO concentration to the front panel display, the analog outputs, and also makes the data available over the serial or Ethernet connection.

2.5 Instrument Air Subsystem

Instrument air is used for probe purging operation. The instrument air supply source is provided by plant resources. The air supply is controlled and regulated through the subassembly before transported for use by the CEMS probe.

2.5.1 Hand Valves – HV1, HV2, HV3

The hand valves are used to shut off the plant supplied instrument air source to the system to allow maintenance. ***Do not*** set **HV1** to the **OFF** position unless the system is in maintenance mode. **HV2** is set normally to the off position unless used for maintenance purposes. **HV3** is normally set to the off position unless it is being used to blow moisture out of the filter regulator bowl.

2.5.2 Pressure Gauge and Pressure Switch – PG1, PS1

The pressure gauge (**PG1**) and switch (**PS1**) is used to monitor the instrument air supply pressure. The switch provides a signal to the PLC when pressure falls below the set point. The pressure switch setpoint is typically set at 60 psig. **PG1** should read >90 psig.

2.5.3 Filter Regulator – FR1

Instrument air flows through a filter regulator removing particulate matter that could damage downstream components. The filter regulator also controls air pressure required for probe purge (blowback) procedures. The regulator reduces the air supply pressure to 80 psig. The filter regulator must be periodically drained to remove water by opening **HV3**.

2.6 Redundant Air Clean Up Panel

A secondary air clean up subassembly is included with the system in cases where the primary source of instrument grade air is not available. The air clean up assembly consists of a series of filters and scrubbers. The air is cleaned and dried prior to being used as an instrument air source

2.6.1 Hand Valves – HV4, HV5, HV6

The hand valves are used to shut off or bypass the instrument air supply from the redundant air clean up assembly. ***Do not set hand valve to the OFF*** position unless the system is in Maintenance Request. This condition applies whenever the redundant air clean up assembly is in use as the source of instrument air.

2.6.2 Particulate Filters – F1, F2, F3

The series of pre and post particulate filters are placed before and after the air dryers. The filters provide solid particle removal down to 0.5 microns. Designed for use in dry systems, the post filter provides efficient removal of desiccant dust and other solid contaminants downstream of various types of desiccant air dryers. These solid contaminants, if not removed, can damage sensitive downstream instruments and pneumatic controls.

2.6.3 Refrigerated Air Dryer – RAD1

The AirTak SRD refrigerated air dryer removes water and contaminants from the plant supplied instrument air source. The dryers supply clean, dry air with a low pressure dew point. Excess moisture is removed automatically through the system drain.

2.6.4 Coalescing Filter – CF1

The coalescing filter element has a 0.5-micron rated coalescing-type media that is efficient in removing oil aerosols and solid particles. The filter-removing element can be used when either petroleum or synthetic-base lubricant are present. The filter is installed after the particulate filter to prevent rapid buildup of contaminants and before the SO_2/NO_x scrubber to prevent contamination from aerosol.

2.6.5 Heatless Air Dryer – HAD1

The AirTak SHLD heatless air dryer consists of two identical cylindrical towers solidly packed with activated alumina desiccant. Synchronized valves and continuous two-minute cycles produce a constant supply of clean, dry air.

The process begins with inlet air flowing to the switching valves. The electric timer completes a circuit allowing inlet air to flow to and open the left purge valve. The inlet air flows past the lower shuttle valve to the right tower. The desiccant in the right tower adsorbs moisture from the air. The dry air then flows past the upper shuttle valve to the dryer outlet.

A small portion of the dried air flows through the adjustable purge orifice and expands to approximately atmospheric pressure. The expanded air flows through the desiccant in the left tower where it picks up moisture. This regenerates the left tower.

After 50 seconds, the timer causes the left purge valve to close. Within 10 seconds, the timer completes another circuit, causing the right purge valve to open. The left tower now dries the air while the right tower is regenerated. The cycle repeats every two minutes.

2.7 Calibration Gas Subassembly

Zero and span gas cylinders, used to calibrate the analyzers, are connected through flow regulators to a group of solenoid valves that discharge into a manifold. The manifold supplies a pressurized line that carries the calibration gases to an inlet connector on the primary filter, next to the sample probe. During calibration, the zero and span gases are filtered, cooled, and dried by the same apparatus that conditions the sample gas. This design routes calibration gas through all out-of-stack components and filters. This method assures that analyzer calibration and measurement functions are performed under identical supply conditions, which reduce variability and errors in measurement.

For maintenance and system checkout purposes calibration gas can also be directly injected to the analyzers bypassing the sample conditioning system by using the CEMS front panel controls.

The following components make up the calibration gas subsystem of the CEMS.

2.7.1 Calibration Gas Regulator – REG1 thru REG9

Each calibration gas cylinder is equipped with a regulator. Bottle contents need to be monitored closely to ensure that enough calibration gas remains to perform the required checks (daily calibration, quarter audits).

2.7.2 Calibration Gas Solenoid Valves

Calibration gas flow is controlled by normally-closed solenoid valves (**SV1** thru **SV4**). When activated to open, the valves allow flow of calibration gas. The solenoid valve timing and sequencing is controlled by the CEMS controller software.

SV8 and **SV10** are 3-way solenoid valves and used for performing local calibrations (direct calibration gas injections) to the analyzers, bypassing the probe and sample conditioning system. Associated trim valves (TV1, TV2) are used to adjust calibration gas flow rate during a local calibration sequence.

SV7 and **SV9** directs calibration gas through the probe for remote (at-the-probe) calibrations of the analyzers.

2.7.3 Calibration Flow Rotameter – RM4, RM7

The flow rotameter indicates flow rate at the calibration gas outlet to the probe. The flow rate should be set to 4-5 liters per minute.

2.8 Operator Interface Terminal

The Operator Interface Terminal (OIT), located inside the CEMS Main Analysis Enclosure, allows the operator access to a variety of system functions. The OIT is provided to monitor and control the system locally instead of having to use the Data Acquisition System (DAHS) computer, which is sometimes located remotely from the CEMS.

A Modicon Touchpanel OIT is used to view and control critical system operations. The OIT allows the operator to view data, change selected system setup parameters, view and acknowledge local alarms, control calibrations, and control probe blowback (purge) operations.

2.9 CEMS Controller

The CEMS system includes a series of intelligent input and output modules that are also known as a Programmable Logic Controller (PLC). These modules are packaged for harsh industrial environments and communicate with the DAHS or the plant's DCS. The controller is mounted inside of the gas analyzer cabinet for ease of connection and added protection.

Included in a typical system are analog-to-digital converters that take 4-20 mA signals from the analyzers and convert the signal into digital values. These digitized values are converted into engineering units within the controller. The digital input points are used to detect the presence of status conditions such as *in calibration*, or *analyzer fault*. The input points can also be used to detect process conditions such as online/offline, startup or shutdown.

The controller can run in a stand-alone mode (that is not connected to the DAHS or DCS). The controller continues to calibrate all analyzers in cases where the DAHS may be temporarily down. In addition, the controller has battery backup memory. Data for each channel can be stored in memory. This ensures that if the DAHS is down for any reason, no data is lost. When the DAHS returns to service, the available data from the controller can be retrieved. The data in the controller is stored on a "first in first out" (FIFO) basis.

The PLC automatically performs a system calibration at predetermined intervals to ensure accurate measurements.

2.10 Data Acquisition and Handling System

The Data Acquisition and Handling System (DAHS) consists of a desktop IBM compatible computer, associated hardware and the software. The PLC sends information to the DAHS via an Ethernet switch. The switch then communicates with the DAHS and the Plant DCS. All data is stored on the computer hard drive as minute averages.

A number of process-operating parameters are monitored by the PLC and logged by the DAHS. These include calibration control, alarms, analyzer status, and process status.

The DAHS provides the functions required to fully meet SCAQMD Rule 1110.2. The system also provides a configurable environment to fulfill all state and local regulations as defined by the site's air permit. Reports may be produced in either hard copy or electronic format.

Refer to the RKI Engineering PODS software user guide (under separate cover) for detailed information on using the DAHS program features.

[End of section. This document is formatted for double-sided printing.]

3 CEMS Routine Operation Procedures

3.1 General

This section contains start-up procedures for the CEMS following a shutdown period. It also contains procedures for a calibration (both automatic and manual modes) to be performed routinely or at operator discretion, to check and assure that the system is operating correctly and with consistent accuracy.

3.2 Component Check

The operational integrity of the system components is dependent upon the status indicators of the units being fully functional. Before beginning or restarting the system after a shutdown, check that all indicator light bulbs and displays are operational. Check all knobs, dials, rocker switches, etc. to ensure they are in good working order. Check flowmeters for cleanliness and visual clarity, and check tubing for any loose connections or deterioration. Check all printers and recorders to ensure a sufficient paper and ink/toner supply. Check the calibration gas cylinders to ensure that all connections have been made and are secure. Check bottle pressures and expiration dates. Be sure that all cylinders are open to supply the required gas.

Personnel who will operate the CEM system should take time to become familiar with the system components. Operator familiarity is necessary to be able to troubleshoot and identify minor problems that can become major and cause the system to be inoperable.

3.3 Temperature Control

Operation of the system components, particularly the electrical and instrumentation units must be in a controlled environment to ensure accurate and reliable operation. The cabinets which house the monitoring equipment are equipped with HVAC systems that will maintain the operating stability and temperature of the instruments. Technicians are required to check the thermostats daily. Desired temperatures of 70°F to 75°F should be maintained even when the equipment is not in operation.

3.4 Front Panel Switches and Indicators

A switch panel is provided in the analyzer rack so the operator can perform a variety of manual functions. Refer to CEMS engineering diagram 50419A01 (located in the CEMS Operation and Maintenance Manual) for details on switch and indicator locations.

SAMPLE LINE temperature – The display indicates the sample line temperature. Sample line temperature should be maintained at 250°F.

CAL REQ switch – The calibration request switch is used to initiate an unscheduled but automatically controlled calibration cycle. When the **CAL REQ** switch is pressed (it is a momentary switch) a signal is sent to the PLC which interrupts the current cycle and starts a calibration cycle. When the calibration cycle is completed, the PLC returns to normal automatic operation.

MAINT REQ switch – The maintenance request switch sends a signal to the PLC that the analyzer data is invalid due to maintenance or when a manual calibration is performed.

LOCAL / PROBE calibration switch – The local calibration / probe calibration switch allows the operator to perform a local calibration, injecting calibration gases directly into the analyzer and bypassing the probe. Local calibration is used in conjunction with the **MAINT REQ** switches.

Pressure gauge **PG2, PG3** – The pressure gauge indicates the current sample gas pressure at the cooler outlet. Pressure readings should be greater than 2 psig.

Sample flow rotameter **RM1, RM5** – The flow rotameter indicates the sample flow rate at the pump outlet. Sample flow rate should be 4-5 liters/minute.

Back pressure regulator **BPR1, BPR2** – Total flow rate is adjusted using this knob. Adjust the back pressure regulator to maintain a flow rate of 4-5 liters/minute at **RM1, RM5**.

Analyzer flow rotameters **RM2, RM3, RM6** – Sample gas flow for the analyzer is indicated and controlled by the flow rotameter. Adjust analyzer flow rotameter to provide the required labeled flow rate. Sample flow rate to each analyzer should be approximately 1.5 liters/minute.

Additional gauges are located on the separately mounted cabinet panels and include the following:

Pressure gauge **PG1** – The pressure gauge and associated switch (**PS1**) is used to monitor the instrument air supply pressure. The switch provides a signal to the PLC when pressure falls below the set point. Pressure readings should be greater than 80 psig. The setpoint for the pressure switch is 60 psi.

Calibration gas flow rotameter **RM4, RM7** – A flow rotameter indicates flow rate at the calibration gas outlet to the probe. The calibration gas flow rate should be set to 4-5 liters/minute.

Vacuum gauge **VG1, VG2** – This vacuum gauge provides an indication of the condition of upstream components. A high vacuum reading can indicate a blockage or restriction in the probe or sample line. Normal pressure readings should be less than 10” Hg.

Filter regulator **FR1** – The instrument air filter regulator removes particulate matter. The filter regulator also controls air pressure required for probe purge procedures. The regulator reduces the air supply pressure to 80 psig.

3.5 Initial Startup

The following procedure was performed during initial start-up of the CEMS or after a lengthy shutdown period.

3.5.1 Normal System Sampling Flow Verification

1. Place system in maintenance mode by toggling the **MAINT REQ** switch on the CEMS front panel to the up position or use the OIT Panel menu controls.
2. Verify total sample pressure gauge (**PG2, PG3**) reads 0 psig.
3. Verify instrument air pressure switch (**PS1**) is set to 60 psig.
4. Verify vacuum gauge (**VG1, VG2**) reads 0” Hg.
5. Place system in automatic operating mode by toggling the **MAINT REQ** switch on the CEMS front panel to the down position.
6. Adjust the back pressure regulator (**BPR1, BPR2**) to allow total flow of 4 liters/minute.
7. Adjust each analyzer flow rotameter to provide the required labeled flow rate (approximately 1.5 liters/minute).
8. Verify total sample flow rotameter (**RM1, RM5**) is between 4 -5 liters/minute.
9. Verify that vacuum gauge (**VG1, VG2**) indicates less than 5.0” Hg.
10. Perform leak check of system. Manually flow NO_X span gas (daily calibration gas). Verify O_2 analyzer is reading <0.1 % O_2. If in-leakage is found, check all Swagelok fittings with leak detection solution (*SNOOP* or similar).

System sampling has now been verified and the CEMS should operate automatically.

3.6 Shutdown and Storage

If possible the CEMS and DAHS should not be taken off-line at any time, whether a process shutdown is long-term or short-term. Temporary power might be needed to the CEMS and DAHS during a plant or process shutdown.

If the CEMS requires a shutdown and storage period use the following guidelines to ensure system integrity upon re-start.

Short Term Storage (one week or less):

1. Turn off the analyzers.
2. Turn off the printer.
3. Get advice from the local regulatory agency on whether the PLC or DAHS can be turned off during a short or long-term shutdown. Several agencies require that the data acquisition system remain in operation at all times.

   If shutting down the DAHS is allowed by the agency, ensure that the database has been backed up. Shut down the DAHS software per manufacturers’ procedures. Turn off power to the computer.

Note that the PLC has a rechargeable battery. If the battery is not kept charged the PLC may lose its programming. A method should be put in place to provide temporary power to the PLC to recharge the battery.

If the PLC or DAHS is to remain in operation then a temporary power source will need to be provided for these components.

4. Turn off circuit breakers in service panel keeping in mind the notes from Step 3.
5. Turn off all power supplied to the monitor enclosure.

Long Term Storage (greater than a week):

1. Turn off the analyzers.
2. Turn off the printer.
3. Get advice from the local regulatory agency on whether the PLC or DAHS can be turned off during a short or long-term shutdown. Several agencies require that the data acquisition system remain in operation at all times.

   If shutting down the DAHS is allowed by the agency, ensure that the database has been backed up. Shut down the DAHS software per manufacturers' procedures. Turn off power to the computer.

   Note that the PLC has a rechargeable battery. If the battery is not kept charged the PLC may lose its programming. A method should be put in place to provide temporary power to the PLC to recharge the battery.

   If the PLC or DAHS is to remain in operation then a temporary power source will need to be provided for these components.
4. Turn off circuit breakers in service panel keeping in mind the notes from Step 3.
5. Turn off all power supplied to the monitor enclosure.
6. Plug any open bulkhead fittings including input to desiccant tubes. Remove plugs before turning on analyzers.
7. Turn off calibration gas bottle regulators.
8. Close doors tightly (lock).
9. Turn off instrument air supply to monitor enclosure.
10. Ensure all drain traps are empty.

3.7 Routine Operation

The CEMS is designed to operate automatically with little operator attention. However, to assure optimal performance, follow the maintenance schedule in Chapter 8 and the routine operation procedures described below.

Perform the following procedures at least once a week to ensure accurate and reliable measurement.

1. Check flow rate of sample flow rotameter (**RM1, RM5**) and analyzer flow rotameters (**RM2, RM3, RM6**). Verify mid-scale readings, adjust if necessary. Large variations from required settings indicate a need for maintenance.
2. Check sample pressure (**PG2, PG3**). Verify pressure gauge reads >2 psig. Large variations from the required settings indicate a need for maintenance.

3. Check sample (probe) vacuum (**VG1, VG2**). The sample vacuum is not adjustable and is only an indication of the condition of upstream components. As the vacuum reads higher, that is an indication of probe or sample line restriction; it should be checked.
4. Verify that the sample conditioning unit (**GC1, GC2**) is operating properly at correct temperature (2°C).

3.8 Probe Purge

During a probe purge cycle (probe blowback), clean, dry, instrument air is injected back through the probe. The probe purge cycle is controlled by the PLC program and is typically set to be performed once a day for durations of up to 60 seconds. The operator can adjust the number of purges per day and the duration of the purge cycle.

3.9 CEMS Calibrations

Calibration tests are conducted each day as a part of the quality assurance program for CEMS equipment in accordance with state and federal regulations. Daily calibrations are required each day that the process operates. Tests are run for zero gas and span (high level) gas for each analyzer.

3.9.1 Automatic Calibrations

Analyzer calibration is performed automatically by the PLC once every 24 hours. The "autocal" time is specified in the calibration sequence, which can be viewed from the DAHS and adjusted when needed. When the controller starts the automatic calibration sequence, the automatic sampling sequence is suspended and reset. Data outputs from the PLC are held at the last valid reading until the calibration process is complete. Certified calibration gases are routed up through the sample line to the probe and back down the normal extraction gas sample path to the analyzers. Although each analyzer may be calibrated individually, the normal automatic calibration performed by the CEMS calibrates all analyzers simultaneously.

The gas analyzers automatic calibration, provided by the PLC's program, is divided into several sequential events. During calibration, the PLC energizes solenoid valves to allow calibration gas to flow to the sample probe and on to the instruments. The time intervals for purging and flowing of calibration gases can be altered to match the length of the sample line.

Calibration Gas 1 flows for a preset time interval. Then the PLC energizes Calibration Gas 2 and so forth until all appropriate gas bottles have been selected. The calibration gas injection phase is typically set for five minutes to allow time for the analyzer readings to stabilize. The calibration value is the final minute of data read in this injection phase.

In the final phases of the calibration sequence the sample line is purged of calibration gas (10 sec to 1 minute, adjustable). A settle time phase (one minute, adjustable) is initiated to allow the system to return to a steady state of normal flue gas readings before data collection is resumed. Upon completion of the calibration sequence the PLC resets the automatic calibration sequence and resumes normal automatic sampling.

A failed calibration is indicated by the DAHS whenever excessive drift in any analyzer is detected. Whenever a calibration has failed, troubleshooting procedures are initiated immediately. Per regulatory compliance specifications, data is considered invalid and the affected analyzer out-of-control until corrective actions have been completed and a successful re-calibration performed.

Technicians can use the front panel switches to manually initiate a calibration cycle at any time. When a manual calibration is initiated the PLC will utilize the sequence phases programmed for the automatic calibration.

A manual calibration check is performed after any maintenance has been completed to demonstrate the system is working within required specifications. A calibration is also performed as a general system check prior to any required periodic test such as a quarterly linearity or Cylinder Gas Audit (CGA) or an annual Relative Accuracy Test Audit (RATA).

3.9.2 Post Maintenance Calibration and Leak Check

To check the system out after any maintenance activities, put the system into maintenance mode by placing the **MAINT REQ** switch into the Up position or use the menu controls on the OIT panel. Record the system pressure (**PG2, PG3**) that is located next to the flow meters. Then flip the **LOCAL CAL / PROBE CAL** switch to the **LOCAL** position. Manually flow zero gas and while flowing, use the regulator to adjust the sample pressure to exactly what the normal sampling mode pressure had been. Adjust the zero and spans on all of the analyzers and shut off all gases. Return the **LOCAL CAL / PROBE CAL** switch to the **PROBE** (normal sampling) position. Manually flow calibration gas again through the whole system and check that the readings are close to the same. Any significant difference in the readings shows that the system is leaking in ambient air or calibration gas into the system. If leaking, check all fittings and calibration gas solenoid valves and repeat the above procedure.

Place the system back into normal sample mode by placing the **MAINT REQ** switch in the **OFF** or down position or use the menu controls on the OIT panel.

4 Data Recording and Reporting

4.1 Data Acquisition System

The Data Acquisition and Handling System (DAHS) provides automated data monitoring and management capabilities to the CEMS. The DAHS facilitates all of the data reporting requirements necessary to establish compliance with EPA and state operating permit emission limits.

The CEMS uses a Programmable Logic Controller (PLC) for system control and data gathering. The PLC transmits data from the analyzers to the DAHS. The DAHS polls the PLC for data to generate and store one (1) minute and (15) minute averages.

Analog signals of emission parameters are converted by the DAHS into emission measurement values in engineering units. After conversion of the signals, pollutant parameter values are calculated to the measurement units required for reporting per the facility's air permit and applicable regulatory rule. Depending on required report format, reporting units may be expressed as calculated values or raw engineering units.

The DAHS will indicate any occurrence of specification limit exceedances (calibration failure, excess emissions episodes) or CEM operational problems (system fault alarms). In the DAHS, necessary reports are generated in the required format for submittal to the applicable regulatory agencies.

Alarm reports are generated by the DAHS to call operator attention to excess emissions and system problems. Alarms and messages are triggered by analog and status signals to the DAHS and, in some cases, by operator entry via the PC keyboard. The DAHS records an alarm message at the time of the alarm to provide a real-time mechanism for alerting technicians to excess emissions and monitoring system problems. When alarm messages are received, appropriate technicians are notified and troubleshooting, maintenance and corrective actions are initiated. The alarm message provides for automated and also manually entered documentation of the CEM or process operating status during alarm conditions.

Data compiled by the DAHS include analyzer values, hourly averages, excess emissions, calibration data, alarm messages, reason codes, corrective action codes, and process data. The DAHS generates several reports which serve as the primary basis and substance of the emission reports required under EPA and state regulations.

In addition, a central CEM record file is kept at the facility. The file contains QAP check forms, audit results, corrective action forms, and calibration gas certificates of analysis. This central file also serves as an archive for all CEM records including maintenance logbooks, daily data summaries, maintenance request forms, fuel analysis reports, quarter audit and annual RATA reports, and fuel flowmeter accuracy results (as applicable).

Maintenance personnel maintain the log and enter descriptions of preventive and corrective actions performed on the monitoring system components. This record is also used to document the use of spare parts. A periodic review of the CEMS maintenance log provides a guide to possible problem trends with the CEM system and input as to the needs of the spare parts inventory.

Note: *In accordance with EPA requirements the DAHS is to remain in standard time. Do not adjust the DAHS clock to daylight savings time.*

4.2 SCAQMD Valid Data Requirements

The CEMS will be operated and data recorded during all periods of operation of the affected source including periods of start-up, shutdown, malfunction or emergency conditions, except for CEMS breakdowns and repairs. Calibration data shall be recorded during zero and span calibration checks, and zero and span adjustments.

A zero value data point is a data point gathered while the source is not operating and is within 5% of the span range from zero value.

All CEMS, at a minimum, shall generate and record data points once for each successive 15-minute period on the hour and at equally spaced intervals thereafter. Each CEMS will be capable of completing a minimum of one cycle of operation (sampling, analyzing, and data recording) for each successive 15-minute interval.

Raw data will be gathered from the monitors at equally spaced intervals. The facility will specify, within the test report for a Relative Accuracy Test Audit (RATA) of a CEMS, the frequency of data gathering in a 15-minute interval. This data gathering frequency shall remain the same throughout the period following a RATA until a subsequent RATA is conducted with a different specified frequency. The specified frequency shall be the frequency for data gathering to constitute continuous measurement.

All valid raw data points gathered from the monitors for a 15-minute interval will be used to compute a 15-minute average emissions data point. If only one valid data point is gathered within a 15-minute interval, that data point will be used as the 15-minute average emission data point. No invalid data points may be used to compute the 1-minute average emission data point. A valid 15-minute average emission data point must be further based on a minimum of one valid raw data point.

All NO_X concentration, volumetric flow, and NO_X emission rate data will be reduced to 1-hour averages. Valid hour averages will be equally computed based on four 15-minute average emission points equally spaced over each 1 hour period, commencing at 12:00 am, except for a maximum of four 1-hour maintenance periods in each day during which CEMS maintenance activities such as calibration, quality assurance, maintenance, or CEMS repair is conducted. During these 1-hour maintenance periods a valid hour average shall consist of at least two valid 15-minute average emission data points. A 1-hour maintenance period is defined when the operation of the CEMS is interrupted for CEMS maintenance activities at any time during any 1-hour period, and that period shall count towards the four 1-hour maintenance periods allowed regardless of the number of data points gathered. The CEMS shall be kept operational at all times unless the CEMS must be turned off for CEMS maintenance.

4.3 Electronic Reporting

The function of the Remote Terminal Unit required under RECLAIM Rule is to collect data daily from the DAHS, generate data files, and transmit the data electronically to the SCAQMD Central Station.

Each day the RTU is responsible for sending a data package to the Central Station. The packet includes NOx lb/hr data, valid data status bit, calibration status bit, off-line status bit, alternate status bit, and an out-of-control status bit.

In order to produce the daily data package the RTU polls the DAHS and performs calculations on the polled data. In any of the NO_X lb/hr data received from the DAHS is missing or invalid, it is necessary to fill in the missing data using the missing data substitution rules of RECLAIM Rule.

The data package transmission, via a modem line, uses the following conventions:

1. Up to four attempts are made to reach the SCAQMD, and if unsuccessful, retires are made every 15 minutes.
2. Xmodem protocol is used to send the data package to the SCAQMD host server, and a custom protocol is used to receive the response packet.
3. The response packet is checked, and if errors are detected, retransmission is attempted.
4. A communications log is kept which archives daily RECLAIM data packets and response packets, as well as operations and error messages as needed.

If the polling is unsuccessful all of the hourly data in that period is considered to be missing. The NO_X lb/day and status flags are computed, archived, and sent to the Central Station. The program waits until the next day to repeat the process.

A monthly emissions report is also required within fifteen calendar days of the close of each month. A quarterly database reconciliation report (DRR) is also required. The DRRs are required in two steps.

1. Quarters 1 thru 3 are required within 30 calendar days of the close of each quarter.
2. Quarter 4 is required within 60 calendar days of the close of 4^{th} quarter.

A DRR will also be required if QA/QC activities cause changes to emissions data previously submitted via the RTU. The monthly DRR is required within 15 days of the close of the month.

[End of section. This document is formatted for double-sided printing.]

5 Quality Control Activities

5.1 Introduction

Quality Control (QC) is the procedures, policies, and corrective actions necessary to ensure product quality. QC procedures are routine activities. These activities include but are not limited to daily calibrations and routine maintenance.

Quality control activities range from the correct installation of the CEM system to proper data handling procedures. Facility technicians will strive to keep the CEM systems in proper operation at a minimum of 95% of facility operating time.

Note: *The facility has chosen to comply with 40 CFR 60 performance specifications for on-going QA/QC purposes. Refer to the ST-220 CEMS Application Form under separate cover.*

5.2 Calibration Audit Gases

Calibration gases are used to verify the accuracy of the gas analyzers. Daily calibration gases are used to verify that the instruments are within the allowable error limits for a two-point (zero, mid span, or high span) audit on a daily basis. Quarterly calibration gases are used to verify that the instruments are within the allowable limits for a two point calibration (low and mid) for Part 60 Appendix F.

All gases used for daily calibrations must be certified with EPA Protocol standards. EPA Protocol gases must be vendor-certified to be within 1.0 percent accuracy (Protocol 1, sometimes referred to as RATA class) of the concentration specified on the cylinder label (tag value), using the uncertainty calculation procedure in section 2.1.8 of the "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards," September 1997, EPA-600/R-97/121. If a 1.0 percent accuracy gas is not available in the required percent of span range, a 2.0 percent (Protocol 2) certified gas may be use.

Alternately, zero air material may be used for the zero calibration level. Zero air material (used in daily calibrations) is defined in 40 CFR 72.2 as:

1. A calibration gas certified by the gas vendor not to contain concentrations of SO_2, NO_X, or THCs above 0.1 ppm, a CO concentration above 1 ppm, or a CO_2 concentration above 400 ppm.
2. Ambient air conditioned and purified by a CEMS for which the CEMS manufacturer or vendor certifies that the CEMS model produces conditioned gases that does not contain concentrations of SO_2, NO_X, or THCs above 0.1 ppm, a CO concentration above 1 ppm, or a CO_2 concentration above 400 ppm.
3. A multi-component mixture certified by the supplier of the mixture that the concentration of the component being zeroed is less than or equal to the applicable specified in condition 1 above and that the mixture’s other components do not interfere with the CEMS readings.

The maximum certification shelf life for single concentration calibration and audit gases is 36 months. For combined concentrations of gases (such as NO_X and CO in the same bottle) the maximum certification shelf life is equal to that of its most briefly certifiable component. If a certified gas is to be used after the certification period has ended, it must be re-certified. A gas standard may be re-certified if the gas pressure remaining in the cylinder is greater than 3.4 megapascals (500 psig). Facility personnel will maintain calibration gas bottle certificate records for a minimum of three years.

The gas cylinders are 2000 psig and must be changed at 150 psig to maintain correct gas concentrations. Cylinder regulators are set to between 15 and 20 psig. Calibration gases need to be reordered when the bottle pressure drops to 1000 psig. Normal daily calibrations will consume about 100 psig per week. Under normal usage rates, calibration cylinders should last more than three months. Any manual calibrations in addition to the required daily calibration will also increase gas consumption.

Check gas cylinder pressures on a daily basis. There must be sufficient gas in each cylinder to complete the calibration. The instrument could fail the calibration if the gas runs out during the calibration cycle. Calibration gas can be lost if the cylinder pressure is set too high (lifting the seat on the normally closed solenoid valve that controls gas flow), through leaking fittings, and through a leaking solenoid valve. Brass regulators should be used only on cylinders containing CO_2 or N_2. Stainless steel regulators must be used on cylinders containing NO_X and SO_2.

The cylinders will contain a known concentration of a single gas such as N_2 (used for zero or low span calibration), or blended gases such as CO_2, NO_X, SO_2, and N_2 (used for high span calibration). Refer to the manufacturer's certification sheet provided with each cylinder for the gas concentration, cylinder certification number, and Protocol statement. Even though the cylinders usually have a tag listing the gas concentrations, always use the values on the certification sheet for entry into the DAHS. Also, record cylinder changes, gas concentrations, expiration dates, and certification numbers in the CEMS maintenance log. Keep a copy of the certification sheet as part of the CEMS records.

Even EPA Protocol gas cylinders have been known to be in error. If an analyzer shows excessive drift after changing a cylinder, check the analyzer with the cylinder that was replaced, or another cylinder that is known to be accurate. Ensure the new gas values were entered correctly in the DAHS. If a cylinder is suspect, return it to the supplier or have it re-certified at an independent testing lab.

5.2.1 Safety Procedures for High Pressure Gas Cylinders

1. Avoid rough handling of cylinders. Do not drop or allow cylinders to strike each other.
2. The cylinders should always be secured in an approved rack system whenever the bottles are not being used.
3. Whenever possible, store cylinders in a dry enclosure to protect them from extremes of weather and ground moisture. Do not subject cylinders to temperatures higher than 125°F. Storage of calibration gas bottles requires a secure and safe installation as defined by federal and state regulations.
4. Do not allow any part of the cylinder to come in contact with an open flame. Do not allow an arc from an electric arc welder to strike any part of the gas cylinder.
5. Do not remove the valve protection cap until the cylinder has been secured and is ready for use. Do not tamper with any part of the cylinder valve.

6. Use a hand-truck to move cylinders, even for a short distance. Do not drag, roll or slide cylinders.
7. Do not place a cylinder where it may become part of an electric circuit.
8. Per the EPA, a compressed gas calibration standard should not be used when its gas pressure is below 1.03 megapascals (150 psig). NIST has found that some gas mixtures have exhibited a concentration change when the cylinder pressure has fallen below this value.
9. Do not store full and empty cylinders together.
10. Do not tamper with any part of the cylinder valve.

5.2.2 Calibration Gas Cylinder Change Out

To ensure successful daily calibrations of the CEMS analyzers, it is critical that the calibration gases be checked daily and replaced when low. Also periodically check expiration dates posted on the bottle certificate. Do not use calibration gases that have passed their expiration dates. Always order new calibration gas bottles well before needed. The lead time for ordering and having bottles shipped to the plant can be several weeks.

Using a gas cylinder whose contents are too low causes the gas certification to be invalid, thereby invalidating the calibration. The EPA specifies that a bottle should be changed out whenever the bottle pressure drops below 150 psig. It's recommended that the bottle be changed out whenever the pressure drops between 150 and 200 psig. Laboratory tests have indicated that a concentration shift away from the certified value can occur when the bottle pressure drops below 150 psig.

Use the following procedure as a general guide for replacing gas cylinder bottles.

1. Turn off the regulator for that cylinder and close the valve. Uncouple the hose from the cylinder, making sure there are no leaks from the cylinder.
2. Transport the empty cylinder to the designated pickup area for shipment back to the vendor. Be sure to replace the chain on the cylinder rack when done. Tear off the "In Service" segment of the stock tag, leaving the "Empty" segment attached.
3. Select a new cylinder from the full racks. Ensure that the new bottle is within the correct percent of span specification required for the analyzer and type of test (daily calibration or quarterly audit).
4. Install the new cylinder making sure the strap is secured around the cylinder. When connecting cylinders, be sure not to over-tighten and flatten the white seal inside the regulator connection. If this is damaged, replace it. Check for leaks on all connections using soap solution. Tear off the "Full" segment of the stock tag, leaving the "In Service" and "Empty" segments attached.
5. Enter the new cylinder value into the DAHS and save the change. Also enter the new value into the analyzer using the analyzer's front panel control menu.
6. Put the system into maintenance request mode and manually flow gas to the analyzer to ensure that the sampling system is processing the new cylinder. Re-zero and re-span the analyzer at this time if needed. Remove the system from maintenance request mode.
7. Perform a full, hands-off calibration in accordance with the regulations and check the results.
8. Check the cylinder out of stock so that proper stocking levels can be maintained.
9. Make an entry in the CEMS maintenance log book that the cylinder was changed, recording the old cylinder number and values and the new cylinder number and values. Note in the log book that a passing calibration was performed with the new bottle.

5.3 Daily Calibration Error Check

A two-point calibration error test of each analyzer is performed automatically once during each unit operating day. The CEMS include capabilities for both manual and automatic calibration of the analyzers.

The automatic calibration timer of the CEMS controller is set to perform a calibration of each analyzer every 24 hours. As allowed under SCAQME Rule 218.1, on days the process is not operating the automatic calibration will be turned off in order to conserve calibration gas. Automatic calibrations will be turned back on again a few days/hours before the process is due to operate. Automatic calibrations will be initiated on all process operating days.

During the system calibration, the responses of the individual analyzers are recorded by the DAHS. In addition, the controller is programmed to initiate a calibration shortly after (typically one hour but can be adjusted) the process comes on-line after a period of process shutdown.

A technician will check the DAHS calibration drift report daily to ensure that the recorded zero and span drift values are passing required specifications. If the values are failed, the technician will perform basic troubleshooting routines (check calibration gas bottles and connections, look for alarm messages) and perform a manual calibration. If the calibration problem persists and the technicians cannot resolve the issue, a CEMS service representative will be called to service or troubleshoot the instrument(s). CEMTEK Environmental contact information is located in the Preface to this document.

5.3.1 Conducting the Daily Calibration Error Test

The two-point calibration error test calculates the calibration error for two gas concentrations (SCAQMD Rule 218.1). These gas concentrations are (1) zero to 20 percent of span (zero-level) and (2) 80 to 100 percent of span (high- or span-level). Calibration gas concentration ranges for daily calibration error tests are shown in the following table(s). Calibration gases must be EPA Protocol certified.

Table 5-1: Daily Calibration Gas Specifications

O_2 Analyzer	Gas Concentration
Measurement Range = 0–25%	
Zero (0 to 20% of span)	0
High (80 to 100% of span)	20–25%

Stack CO Analyzer	Gas Concentration
Measurement Range = 0–80 ppm	
Zero (0 to 20% of span)	0
High (80 to 100% of span)	64 – 80 ppm
Measurement Range = 0–760 ppm	
Zero (0 to 20% of span)	0
High (80 to 100% of span)	80 – 100 ppm

Stack NO_X Analyzer	Gas Concentration
Measurement Range = 0–35 ppm	
Zero (0 to 20% of span)	0
High (80 to 100% of span)	28 – 35 ppm
Measurement Range = 0–100 ppm	
Zero (0 to 20% of span)	0
High (80 to 100% of span)	80 – 100 ppm

Inlet NO_X Analyzer	Gas Concentration
Measurement Range = 0–100 ppm	
Zero (0 to 20% of span)	0
High (80 to 100% of span)	80 – 100 ppm

Refer to the CEMS engineering drawing set specification (SP) page for further information on calibration gas bottle mixtures used in this configuration. The CEMS drawings are located in the CEMS Operation and Maintenance manual.

Important: *Do not use gas cylinders if the pressure has fallen below 150 psig.*

During calibration, the system controller flows calibration gases to the probe. The analyzers are challenged once with each of the two calibration gases. Each gas flows for approximately 10 minutes. The monitor response is recorded by the DAHS.

Do not make manual adjustments to the monitor settings until after taking measurements at both zero and high concentration levels for that day.

The DAHS compares the actual analyzer reading with the expected value of the calibration gas. If the analyzer drift exceeds the specification limits, the failure is "flagged" on the calibration report. The calibration error for each monitor is computed by the DAHS from the test results for each concentration level as follows:

Daily Drift for Pollutants ***40 CFR 60, Appendix B, PS-2, PS-4/4A***	
$$CE = \frac{\lvert R - A \rvert}{S} \times 100$$	CE = Calibration error as a percentage of instrument span R = Zero or high-level calibration gas value in ppm A = Actual monitor response to calibration gas in ppm S = Span of the instrument

The calibration error for O_2 monitor is computed by the DAHS from the test results for each concentration level as follows:

Daily Drift for Diluents ***40 CFR 60, Appendix B, PS-3***	
For alternate criteria use $$CE = \lvert R - A \rvert$$	CE = Calibration error as a percentage of O_2 R = Zero or high-level calibration gas value in percent (%) A = Actual monitor response to calibration gas in percent (%)

5.3.2 Additional Calibration Error Tests and Adjustments

Additional calibration error tests are performed whenever a daily calibration error test has failed; whenever a monitoring system is returned to service after repair or corrective maintenance, or after making certain calibration adjustments. Except for routine calibration adjustments, data from the monitor are considered invalid until successful completion of a calibration error test.

Routine calibration adjustments are permitted after any successful calibration error test. These routine adjustments can be done to bring monitor readings as close as possible to the calibration-gas reference values. An additional calibration error test is then required following routine calibration adjustments when the monitor's calibration has been physically adjusted to verify that the adjustments have been done correctly.

Additional calibration error tests are not required if the routine calibration adjustments are made automatically by the DAHS by means of a mathematical algorithm programmed into the software.

Additional (non-routine) calibration adjustments of a monitor are permitted before (but not during) linearity checks and RATAs. A calibration check, either the pre-programmed auto-calibration or a manual calibration initiated by a technician, will be performed prior to conducting any other QA audit (linearity, RATA). This is to ensure that the analyzers are in good general working condition before performing the audit.

5.3.3 Re-calibration Limits

Adjustments to the calibration should be performed, at a minimum, whenever the daily calibration error exceeds the criteria specified in 40 CFR 60, Appendix B Performance Specifications (warning level). The two-point calibration error test is then repeated after adjustments. The recommended recalibration criteria for the NO_X concentration monitor is CE >2.5% of span. For the O_2 monitor, the recommended recalibration criterion is $|R – A|$ >0.5% O_2. For CO the recommended recalibration criterion is CE > 5% of span (40 CFR 60, Performance Specification 4/4A).

These performance specification limits serve as a warning or maintenance limit that the monitor may be reaching the out-of-control limits. When the maintenance limit is exceeded facility technicians will need to take steps to troubleshoot and bring the calibration values back under the PS limit to ensure the monitor doesn't go out-of-control.

5.3.4 Out-of-Control Limits

Part 60 Appendix F has a two part out-of-control specification. Per EPA guidelines the affected analyzer at a minimum is to be recalibrated when the %drift error is 2 times the performance specification to avoid exceeding either of the out-of-control limits noted below.

An out-of-control period occurs when the daily calibration drift (zero or span) exceeds twice the applicable specification for five consecutive days.

If the daily calibration drift exceeds four times the applicable Performance Specification drift limits in a single day the CEMS is considered out-of-control.

The out-of-control period begins with the hour of completion of the fifth, consecutive, daily calibration drift check when the CD is in excess of two times the Performance Specification limit. Or, the out-of-control period begins with the hour of completion of the daily calibration drift check *preceding* the daily CD check that resulted in a CD in excess of four times the Performance Specification.

The out-of-control period ends with the completion of a passing calibration drift being within the corresponding CD limit of either two times or four times the Performance Specification limit.

Whenever a failed calibration, corrective action, and a successful re-calibration occur in the same hour, the system will not be considered to be out-of-control if two or more valid data points from that hour were recorded.

During the period the CEMS is out-of-control the CEMS data may not be used in calculating emission compliance nor be counted toward meeting minimum data availability.

The DAHS records the calibration error test results and displays the status (pass or fail) on the calibration report if the re-calibration (or out-of-control) criteria are exceeded. Re-calibration or corrective action is taken when the failure is identified.

Table 5-2: Excessive Calibration Error Criteria – Part 60

Analyzer	CD Specification Maintenance Level or Warning Level	Excessive CD 5 Consecutive Days (2 X PS) Analyzer Out-of-Control (Part 60 Appendix F)	Excessive CD 24 Hr. Criteria (4 X PS) Analyzer Out-of-Control (Part 60 Appendix F)
CO	5.0% span error (Part 60 PS-4/4A)	10.0% span error	20.0% span error
NO_X	2.5% span error (Part 60 PS-2)	5.0% span error	10.0% span error
O_2	0.5% O_2 difference (Part 60 PS-3)	1.0% O_2 difference	2.0% O_2 difference

During the period the CEMS is out-of-control; the CEMS data may not be used in calculating emission compliance nor be counted toward meeting minimum data availability.

The out-of-control period begins with the hour of the failed calibration error test and ends with the hour of the next satisfactory calibration error test after corrective action.

Whenever a failed calibration, corrective action, and a successful re-calibration occur in the same hour, the system will not be considered to be out-of-control if two or more valid data points from that hour were recorded.

6 Quality Assurance Activities

6.1 Introduction

Quality Assurance (QA) is a series of checks performed to ensure the QC procedures are functioning properly. The activities include but are not limited to quarterly and annual audits.

6.2 Quarterly Assessments

The following assessments will be performed during each calendar quarter that the unit combusts fuel. This requirement is in effect the calendar quarter following the calendar quarter in which the monitor or CEMS is certified.

6.3 Cylinder Gas Audit – Part 60

The Cylinder Gas Audit (CGA) is performed for each Stack NO_X, CO, and O_2 analyzer at least once during each unit operating quarter based on the requirements of 40 CFR 60, Appendix F. If applicable, the CGA is performed on both the low and high ranges. CGAs are conducted in three consecutive quarters. During the fourth quarter, the accuracy of the analyzer is evaluated by conducting a Relative Accuracy Test Audit. Use separate calibration gas cylinders for each concentration during the audit. Conduct the CGA no less than two months apart. If possible given the plant operating schedule, the CGA is conducted during process on-line conditions. If the process operating schedule is such that an on-line CGA cannot be performed before the end of the reporting quarter then a process off-line CGA will be conducted. The CGA is exempt in quarters with zero operating time.

6.3.1 Cylinder Gas Audit Procedure

A CGA test can typically be triggered through the DAHS controls. The PLC programming will control calibration gas valve(s) and timing sequencing for an automated test of each analyzer. The DAHS will perform all required calculations and provide a CGA report detailing test results. The technician will need to check that the correct calibration gases have been connected to the assigned regulators.

Separate calibration gas cylinders are used for the two required concentration levels during the audit. Three non-consecutive runs at each concentration level are performed. The calibration gases are introduced at the probe interface box and transported through the CEMS sampling system (normal sampling flow path).

Refer to the CEMS Engineering drawing SP (specification) page (located in the CEMS Operation and Maintenance manual) for information on calibration gases specified for this application and the regulator to be used for the CGA bottles. The following specifies the Part 60 requirement for CGA calibration gases.

The calibration gases required for the diluent (O_2) are actual concentration values and not based on percent of range.

Audit Point	***Pollutant Monitors % of span***	***O_2 % by volume***
Low level	20-30% of span	4-6% by volume
Mid Level	50-60% of span	8-12% by volume

The following summarizes the required calibration gas ranges.

Table 6-1: CGA Calibration Gas Specifications – Part 60

Stack NO_X Analyzer	**Gas Concentration**
Measurement Range = 0–35 ppm	
Audit Point 1: Low (20 to 30% of span)	7 – 10.5 ppm
Audit Point 2: Mid (50 to 60% of span)	17.5 – 21 ppm
Measurement Range = 0–100 ppm	
Audit Point 1: Low (20 to 30% of span)	20 – 30 ppm
Audit Point 2: Mid (50 to 60% of span)	50 – 60 ppm

CO Analyzer	**Gas Concentration**
Measurement Range = 0–80 ppm	
Audit Point 1: Low (20 to 30% of span)	16 – 24 ppm
Audit Point 2: Mid (50 to 60% of span)	40 – 48 ppm
Measurement Range = 0–760 ppm	
Audit Point 1: Low (20 to 30% of span)	152 – 228 ppm
Audit Point 2: Mid (50 to 60% of span)	380 – 456 ppm

O_2 Analyzer	**Gas Concentration**
Measurement Range = 0–25 %	
Audit Point 1: Low	4 – 6% by volume
Audit Point 2: Mid	8 – 12% by volume

Important: All calibration gases used for CGA testing must be EPA Protocol gases.

Important: Do not use gas cylinders if the pressure has fallen below 150 psig.

The accuracy values for each concentration should not exceed 15% as calculated in the following equation or 5 ppm difference:

Cylinder Gas Audit Accuracy ***40 CFR 60, Appendix F, Section 6.3***		
$$A = \frac{C_m - C_a}{C_a} x 100$$	A =	Percent accuracy of the CEM
	C_m =	The average monitor response to the specific audit gas (high or low) in units of concentration
	C_a =	Certified value of audit gas (value according to EPA Protocol certification) in units of concentration

6.3.2 Out-of-Control Period

An out-of-control period occurs when the CGA at any of the two concentrations exceeds the applicable specifications (>15% error or 5 ppm difference). The out-of-control period begins with the hour of the failed CGA and ends with the hour of a satisfactory CGA following the corrective action.

During the time the CEMS is out-of-control the CEMS data may not be used in calculating emission compliance nor be counted toward meeting minimum data availability.

6.4 Annual Relative Accuracy Test Audit

Perform the following assessments annually for NO_X, O_2 and CO. The tests to be completed within 12 months of the end of the calendar quarter in which the CEMS was last tested for certification/recertification purposes.

An independent testing contractor will conduct these RATAs. The Reference Test Method for the RATAs will be SCAQMD Method 100.1 for gas analyzers and SCAQMD Methods 1.1, 2.1, 3.1, and 4.1 for volumetric flow as outlined in the District's Source Test Manual (in lieu of Part 60, Appendix A Test Methods).

The Relative Accuracy Test Audits for the pollutant and diluent gas analyzers will be conducted simultaneously for each unit (that is, simultaneous testing of each unit's CO, NO_X, and O_2 monitors). During Relative Accuracy Testing, each unit will operate at its normal level and combusting its primary fuel.

Prior to the RATA ensure that all preventive maintenance has been performed on the CEMS equipment. Also perform the quarterly linearity check prior to the RATA to ensure proper linearization of the analyzers.

6.4.1 Sampling Strategies

Reference Method traverse points will be selected to ensure acquisition of representative pollutant and diluent sample concentrations, moisture content, temperature, and flue gas rate over the flue cross section. The reference test method that will be utilized in this program is SCAQMD Method 100.1. For mass emissions reporting requirements, SCAQMD Test Methods 1.1 thru 4.1 (moisture/stack flow) will be utilized as additional reference test methods.

Before the test, a site assessment is performed to locate sample points for obtaining representative measurements of pollutant concentrations. Checks will be performed to verify the absence of cyclonic flow and gas concentration stratification. These checks will be done in accordance with the SCAQMD's Source Test Manual, Chapter X, Section 13 and SCAQMD Rule 218. This requirement may be waived by the District if cyclonic flow and gas concentration stratification checks have previously been performed (that is performed at initial certification of the CEMS).

Each gas monitoring system RATA run will be a minimum of 30 minutes after the readings have stabilized (SCAQMD). For each run of a gas monitoring system RATA, all necessary pollutant and diluent concentration measurements, and moisture measurements (if applicable) will be made within a 60-minute period.

Before and after each test run, the entire reference method sampling system will be leak checked by evacuating the system to a minimum of 20 inch Hg vacuum, and plugging for a period of 5 minutes. The resultant loss of vacuum cannot exceed 1 inches Hg during this period.

A pre-test linearity check will be performed on each Reference Method analyzer. A zero gas (pure nitrogen), mid span and high span calibration gas will be introduced to each analyzer and its response will be recorded. The Reference Method analyzer linearity is acceptable if the monitor response is within 1% of the analyzer range.

A system bias check will be performed on each Reference Method analyzer by transporting the EPA Protocol gases used to zero and mid span (or high span) the analyzers to the sample system as close as practical to the probe inlet. This way the calibration gases will be exposed to the same elements as the sample and the monitor response is recorded. The analyzers responses for each calibration gas must agree within ±5% of instrument range. Changes/repairs are made to the system to compensate for any differences in the analyzer readings.

The system bias results will be used for the pretest calibration-drift values. Upon completion of the sample test run a posttest calibration-drift test will be performed. The results of the calibration drift test must be within ±3% or the test run is void; corrective actions will be taken and another test run will be performed in the advent of a failed calibration drift test or failed system bias test.

NO_X measurements will be performed in the NO_X mode of the analyzer. An NO_2 to NO converter check will be required if NO_2 constitutes 5% or more of the total NO_X in the sample stream, or the rule or permit condition requires "NO_X" monitoring. The NO_2 to NO converter must be at least 90% efficient. The converter will be high temperature (650°C) stainless steel, if no NH_3 is present. If NH_3 is present, then a low temperature (350°C) Molybdenum catalyst must be used in the converter. This check is done just prior to testing.

To correlate properly individual emission data and volumetric flowrate data with the reference method data, the beginning and end of each reference-method test-run (including exact time of day) will be annotated on the chart recorder or other permanent recording device.

6.4.2 Correlation of Data

Confirm that the monitoring system and reference-method test results are on a consistent moisture, pressure, temperature, and diluent concentration basis. Response times of the emission monitoring system will be compared with the reference method measurements to ensure comparison of simultaneous measurements.

For each RATA test run, the measurements from the monitors are compared against the corresponding reference method values. The paired data is tabulated in a table and relative accuracy results calculated.

A minimum of nine sets of paired monitor data and reference-method test data will be performed.

More than nine sets of paired data may be collected. All data, including any rejected runs will be reported. Runs may only be rejected due to unusual problems and/or occurrences during testing such as plant process problems, analyzer problems or a failed calibration or system bias check. Otherwise, all runs performed must be included in final results calculations of relative accuracy.

6.4.3 O_2 Relative Accuracy Test

SCAQMD Test Method 100.1, an instrumental test method, will be used proposed as the reference method for this QA/QC program. A portion of the sample stream flows to a paramagnetic or polargraphic analyzer for the determination of O_2 concentration. The O_2 RATA will be conducted simultaneously with the NO_X and CO RATAs. Each sample run will be no less 30 minutes with approximately 15 minutes between sampling runs for test CEMS calibration.

For each reference method determination, the flue gas will be sampled at a number of traverse points, which will be determined prior to testing. The differences between the reference-method sample and the O_2 monitor's readings will be evaluated from a minimum of nine (9) sets of paired monitor and reference-method test data. From these differences, the 95% confidence coefficient is calculated, and the relative accuracy determined. Any tests not included in the calculations for the determination of relative accuracy will be included in the final test report.

For SCAQMD reporting purposes, test results are acceptable if the O_2 relative accuracy does not exceed 10.0% of the mean value of the RM test data in terms of units of percent volume (semiannual). Alternately, for cases where the mean value of the reference method test data for O_2 concentration is less than 5.0 volume percent, the relative accuracy requirement may be met if the following is satisfied.

$$|d| + |cc| </= 1.0 \text{ volume percent}$$

where: d = average differences between the O_2 concentration and the corresponding reference method test data
cc = confidence coefficient

6.4.4 NO_X Relative Accuracy Test

SCAQMD Test Method 100.1, an instrumental test method, will be used as the reference method for this QA/QC program. This method is an instrumental analyzer procedure. A sample is continuously extracted from the effluent gas stream. A portion of the sample stream is conveyed to an instrumental chemiluminescent analyzer for the determination of NO_X concentration. Each sample run will be no less than 30 minutes with approximately 15 minutes between sampling runs for test CEMS calibration.

For each reference method determination, the flue gas is sampled at a number of traverse points that will be determined prior to testing. The difference between the reference method sample and the NO_X monitor's reading is evaluated from a minimum of nine sets of paired monitor and reference method test data. From these differences, the 95% confidence coefficient is calculated, and the relative accuracy determined. The diluent gas tests will be conducted concurrently with the pollutant gas tests. Any tests not included in the calculations for the determination of relative accuracy will be included in the final test report.

Results are acceptable if the relative accuracy is less than or equal to 20% of the mean value of the reference method in units of ppmv. Alternately, for cases where the mean value of the reference method test data is less than 5 ppmv, the NO_X concentration relative accuracy may be met if the following is satisfied.

$$|d| + |cc| </= 1.0 \text{ ppmv}$$

where: d = average differences between the NO_X concentration and the corresponding reference method test data
cc = confidence coefficient

For SCAQMD mass emissions reporting requirements, results are acceptable if the relative accuracy is less than or equal to 20% of the mean value of the reference method test data in units of lb/hr (semiannual). Alternately, for cases where the mean NO_X concentration obtained by reference test method is less than or equal to 5.0 ppm, or the mean stack gas velocity obtained by reference test method is less than 15 feet per second, the mass emission rate relative accuracy may be met if the following is satisfied.

$$|d| + |cc| </= (c * s * A) * cf$$

where: d = average difference between the NO_X concentration and the corresponding reference method test data
cc = confidence coefficient
A = stack cross-sectional area in the plane of measurement
C = 1.0 ppm or mean concentration obtained by reference method, whatever is greater
S = 2 feet per second or mean stack gas velocity obtained by reference test method, whichever is greater
cf = conversion factor to pounds per hour

6.4.5 CO Relative Accuracy

A relative accuracy test audit is performed on the CO monitor annually in accordance with SCAQMD Rule 218.1. SCAQMD Test Method 100.1, an instrumental test method, will be used as the reference method for this QA/QC program. A sample is continuously extracted from the effluent gas stream. A portion of the sample stream is conveyed to an ultraviolet (UV), nondispersive infrared (NDIR), or fluorescence analyzer for the determination of CO concentration. Each sample run will be no less than 30 minutes with approximately 15 minutes between sampling runs for test CEMS calibration.

For each reference method determination, the flue gas is sampled at a number of traverse points that will be determined prior to testing. The difference between the reference method sample and the CO monitor's reading will be evaluated from a minimum of nine sets of paired monitor and reference method test data. From these differences, the 95% confidence coefficient is calculated, and the relative accuracy determined. The diluent gas tests will be conducted with the pollutant gas tests. Any tests not included in the calculations for the determination of relative accuracy will be included in the final test report.

For SCAQMD Rule 218.1, results are acceptable if the relative accuracy is less than or equal to 20% of the mean value of the reference method or, the de-minimus concentration of 2.0 ppm CO, whichever is greater.

6.4.6 Flow Relative Accuracy Test

Stack volumetric flow is calculated by the data acquisition system using signal inputs from fuel flowmeters in conjunction with F-factors (calculated for digester gas fuel and EPA default value for natural gas fuel) and used for determining CO and NO_X mass emissions. The calculated volumetric flow values will be tested for relative accuracy using reference methods to determine stack flow.

SCAQMD Test Methods 1.1 thru 4.1 (moisture/stack flow) will be used as the reference method for this QA/QC program for performing a RATA on flow monitors (or fuel flowmeters used to calculate stack flow). The flow relative accuracy test will be conducted at the normal operating level. The test will be conducted simultaneously with the relative accuracy tests that will be conducted for the CO and NO_X monitoring systems.

An S-type Pitot tube and an inclined manometer will be used for testing. The velocity measurements will be recorded at traverse point locations in each stack/duct as calculated according to Method 1.1. The differences between the reference method sample and the flow monitor's readings will be evaluated from a minimum of nine (9) sets of paired monitor and reference method test data. From these differences, the 95% confidence coefficient is calculated, and the relative accuracy determined. The flow readings and the reference method readings will be compared on a scfh basis.

Results are acceptable if the relative accuracy is less than or equal to 15% of the mean value of the reference method test data or the de minimus value equivalent to a calculated volumetric flow rate based on 2 feet per second stack gas velocity for cases where the mean stack gas velocity obtained by the reference method test is less than 15 feet per second.

6.4.7 Relative Accuracy Calculations

The following equations will be used to calculate relative accuracy:

RATA, Arithmetic Mean		
$\bar{d} = \frac{1}{n}\sum_{i=1}^{n} d_i$	$\bar{d}$ =	Arithmetic mean
	n =	Number of data points
	$\sum_{i=1}^{n} d_i$ =	Algebraic sum of the individual differences, d_i
RATA, Standard Deviation		
$S_d = \sqrt{\frac{\sum_{i=1}^{n} d_i^2 - \frac{\left(\sum_{i=1}^{n} d_i\right)^2}{n}}{n-1}}$	S_d =	Standard Deviation
	n =	Number of data points
	$\sum_{i=1}^{n} d_i$ =	Algebraic sum of the individual differences, d_i
	$(\sum_{i=1}^{n} d_i)^2$ =	Algebraic sum of differences squared
RATA, Confidence Coefficient		
$cc = t_{0.025} \frac{S_d}{\sqrt{n}}$	cc =	Confidence Coefficient
	S_d =	Standard Deviation
	n =	Number of data points
	$T_{0.025}$ =	t value

Relative Accuracy		
$$RA = \frac{\lvert \bar{d} \rvert + \lvert cc \rvert}{\overline{RM}} x 100$$	RA =	Relative Accuracy
	$\overline{RM}$ =	Arithmetic mean of the reference method values
	$\lvert \bar{d} \rvert$ =	The absolute value of the mean difference between the reference method values and the corresponding CEMS values
	$\lvert cc \rvert$ =	Absolute value of the confidence coefficient

6.4.8 Out-of-Control Period

An out-of-control period occurs under any of the following conditions:

1. The relative accuracy of a pollutant concentration monitor or emission rate measurement system exceeds 20%.
2. The relative accuracy of flow monitoring system exceeds 15%.
2. Failure to conduct a relative accuracy test audit by the due date for a semi-annual assessment (annual if incentive program applies).

For the relative accuracy test audit, the out-of-control period begins with the hour of completion of the failed RATA and bias test and is over at the end of the hour of a passing RATA and bias test.

During the time the CEMS is out-of-control the CEMS data may not be used in calculating emission compliance nor be counted towards meeting minimum data availability.

6.5 Sampling System Bias Test

In accordance with SCAQMD Rule 218.1 (b)(4)(B), a sample system bias test is performed annually on all analyzers prior to the RATA.

The sampling system bias test is designed to ensure consistency between local (analyzer direct) and remote (at-the-probe) calibrations. The objective is to prove the integrity of both the sample handling system and the analyzers. The check serves as a leak test of the sampling system.

The CEM sampling system bias check is the difference between analyzer responses when calibration gas is injected through the sampling system and direct injection of the same calibration gas into the analyzer.

A zero concentration calibration gas will be injected into the CEMS through the calibration line to the valve box and the monitor response value will be recorded. The same procedure will be done for a calibration gas that closely approximates the effluent gas concentration. Both gases will be injected in such a manner that the calibration gas path follows that of the effluent gas from the CEMS valve box to the analyzers.

The same two gases will each be injected directly into the analyzer and the individual analyzer responses will be recorded.

From the two sets of injections the system bias will be calculated. The following equation will be utilized.

$$SB = ((P - A)/S) * 100$$

Where:

Where:	SB	=	system bias analyzer response
	P	=	analyzer response when the calibration gas is injected at the probe
	A	=	analyzer response when the calibration gas is injected at the analyzer
	S	=	span of the instrument

Results are acceptable if the system bias check is less than or equal to 5%.

7 Recertification and Diagnostic Tests

7.1 Introduction

All maintenance events will trigger the need to perform diagnostic testing and/or recertification events to ensure that the CEMS has been returned to optimum operating condition after the maintenance activity. The immediately following sections describe the types of test events that may be required after completion of certain types of maintenance activities.

7.2 Diagnostic Tests and Recertification Events

Diagnostic and recertification tests are those tests required to verify that a CEMS is operating accurately following certain preventive or corrective maintenance procedures. Provided that all required diagnostic tests and recertification tests are successfully completed, valid data collected beginning with the time of completing the required test(s) are considered valid. If a test is failed, then the data collected from the time of completing the preventive or corrective maintenance procedure that triggered the diagnostic test period to the time of the failed diagnostic test is considered invalid.

Results of each required diagnostic tests or recertification test event will be entered into the CEMS Maintenance Log. Entries in the Maintenance Log will be reviewed by responsible facility mangers/supervisors to ensure that the entries are complete and that all required tests have been completed.

Consistent with the requirements set forth in SCAQMD policy, the facility will recertify the CEMS or any system component, when necessary. Recertification is required whenever a replacement, modification, or change is made to the CEMS or system component (including the DAHS) that significantly affects the system's ability to measure or record mass emissions, or emission concentration. However, changes resulting from routine or normal corrective maintenance or QA activities do not require recertification. Similarly, software modifications in the automated DAHS do not require recertification when the modifications do not affect missing data substitution or calculation formulas.

SCAQMD policy specifies that for recertification, the same series of tests that were performed during the initial certification test program must be repeated unless otherwise approved by the District. The following tables list maintenance activities that would require either diagnostic tests or full recertification.

7.2.1 Diagnostic Tests and Recertification Summary Tables

The following tables list maintenance events and outline the appropriate tests to be performed for each event. The tables clarify which types of changes to a monitoring system may "significantly affect the ability of the system to accurately measure or record" emissions or flow rate and therefore require recertification testing or less stringent diagnostic testing.

The following tables do not address every situation that may arise and is not binding for situations that it does address. Contact the District concerning specific situations, particularly where an event occurs which is not listed in the tables.

The tables are divided into two types; Like Replacements only meaning all replacements are for like in all aspects, and UnLike Replacements meaning replacements are of different manufacturer, model or specification.

Table 7-1: Like Replacements Only

RECLAIM/NON-RECLAIM CEMS quality assessment tests following quality control activities [1]:

Quality Assessment→ Quality Control↓	CEMS Calibration [2]	Manual Transmitter Calibration	Linearity Test [3]	Interference (as applicable) [4]	NO_2/NO_X Converter Efficiency [5]	Sample System Bias [6]	Analytical RATA [7]	Stack Flow Rate RATA [7]	Response Time
Sample System Components									
Probe replacement	X								
Probe filter replacement	X								
Heated sample line replacement	X					X			X
Condenser replacement	X					X			X
Sample pump repair/replacement	X								
Sample filter replacement	X								
Hardware/Software Components									
CEM controller components replacement	X								
DAHS hardware replacement [9]									
DAHS software reloading	X								

Like Replacements Only - Continued

Quality Assessment→ Quality Control↓	CEMS Calibration [2]	Manual Transmitter Calibration	Linearity Test [3]	Interference (as applicable) [4]	NO_2/NO_X Converter Efficiency [5]	Sample System Bias [6]	Analytical RATA [7]	Stack Flow Rate RATA [7]	Response Time
Fuel Flow Metering System (as applicable)									
Primary element replacement [9]									
Transmitter replacement		X							
NO_X Analyzer (as applicable) [10]									
NO_2 converter replacement	X				X				
Photomultiplier tube (PMT) replacement	X								
PMT tube cleaning	X								
Analyzer replacement	X		X	X	X		X		X
Pre-certified analyzer (redundant backup)	X								
Analyzer vacuum pump repair/replacement	X								
Analyzer filter replacement	X								
Ozone generator replacement	X								
PC board replacement	X								
Thermo-electric temp. cont. board	X								
Optics cleaning/replacement	X								
Chopper belt/motor replacement	X								
Capillary replacement	X								

Like Replacements Only - Continued

Quality Assessment→ Quality Control↓	CEMS Calibration [2]	Manual Transmitter Calibration	Linearity Test [3]	Interference (as applicable) [4]	NO_2/NO_X Converter Efficiency [5]	Sample System Bias [6]	Analytical RATA [7]	Stack Flow Rate RATA [7]	Response Time
CO Analyzer (as applicable) [10]									
Analyzer replacement	X		X	X			X		X
Pre-certified analyzer (redundant backup)	X								
Bulb/lamp replacement	X								
PC board replacement	X								
Analog output trim	X								
Optics cleaning/replacement	X								
Optical bench alignment	X								
Electro-optic heater replacement	X								
Detector repair/replacement	X								
Chopper motor replacement	X								
Chopper bandpass filter(s) replacement	X								
O_2 Analyzer (as applicable) [10]									
Analyzer replacement	X		X				X	X [8]	X
Pre-certified analyzer (redundant backup)	X								
Linearizer circuit replacement	X		X						
ZrO_2 cell replacement	X								
PC board replacement/adjustment	X								
Source lamp replacement	X								
Photocell replacement	X								
Detector replacement	X								
Oven temp. adj. or replacement	X								

Notes:

1. Satisfactory completion of the indicated quality assessment activity will be sufficient demonstration of the CEMS ability to generate valid data. A change of any component listed on the original CEMS application by specific model and/or serial number for which specific details such as materials of construction or design are included requires formal notification to the District and will result in a response from the District.
2. CEMS calibration: A calibration performed in normal operating mode to confirm proper operation and establish new calibration correction factors or valid data generation.
3. Linearity test consists of conducting a cylinder gas audit (CGA) as described in 40 CFR 60, Appendix F, 40 CFR 75, or as defined in an SCAQMD approved QAP for the facility.
4. Applicable to systems where ammonia is present.
5. Can use any NIST traceable gas.
6. May not be applicable to dilution probe systems; consult SCAQMD.
7. As defined in 40 CFR 60, Appendix F.
8. If an analyzer is used for EPA F-factor calculation of stack flow rate (as described in EPA Method 19).
9. Refer to applicable sections of QAP or consult with SCAQMD for additional specific guidance.
10. 168-hour “burn-in” test is required for complete analyzer change out.

Table 7-2: Unlike Replacements Only

RECLAIM/NON-RECLAIM CEMS quality assessment tests following quality control activities [1]:

Quality Assessment→ / Quality Control↓	CEMS Calibration [2]	Manual Transmitter Calibration	Linearity Test [3]	Interference (as applicable) [4]	NO_2/NO_X Converter Efficiency [5]	Sample System Bias [6]	Analytical RATA [7]	Stack Flow Rate RATA [7]	Response Time
Sample System Components									
Probe relocation	X					X	X [8]		X
Probe replacement	X					X			X
Probe filter replacement	X					X			X
Heated sample line replacement	X					X			X
Condenser replacement	X					X			X
Sample pump repair/replacement	X					X			X
Sample filter replacement	X					X			X
Hardware/Software Components									
CEM controller components replacement	X								
DAHS hardware replacement	X								
DAHS software reloading	X								
Fuel Flow Metering System (as applicable)									
Flow computer								X	
Primary element replacement								X	
Transmitter replacement		X							

Unlike Replacements Only - Continued

Quality Assessment→ Quality Control↓	CEMS Calibration [2]	Manual Transmitter Calibration	Linearity Test [3]	Interference (as applicable) [4]	NO_2/NO_X Converter Efficiency [5]	Sample System Bias [6]	Analytical RATA [7]	Stack Flow Rate RATA [7]	Response Time
NO_X Analyzer (as applicable) [10]									
NO_2 converter replacement	X			X	X				
PMT tube replacement	X		X						
Analyzer replacement	X		X	X	X	X	X		X
Analyzer vacuum pump repair/replacement	X								
Analyzer filter replacement	X								
Ozone generator replacement	X								
Critical orifice/capillary replacement	X								
PC board replacement	X								
Thermo-electric temp. cont. board	X								
Optics replacement	X			X					
Chopper belt/motor replacement	X								
CO Analyzer (as applicable) [10]									
Analyzer replacement	X		X				X		X
Bulb/lamp replacement	X								
PC board replacement	X								
Analog output trim replacement	X		X						
Replace optical bench	X		X				X		
Optics replacement	X		X						
Electro-optic heater replacement	X								
Detector replacement	X		X						
Chopper motor replacement	X								
Chopper bandpass filter(s) replacement	X								

Unlike Replacements Only - Continued

Quality Assessment→ / Quality Control↓	CEMS Calibration [2]	Manual Transmitter Calibration	Linearity Test [3]	Interference (as applicable) [4]	NO_2/NO_X Converter Efficiency [5]	Sample System Bias [6]	Analytical RATA [7]	Stack Flow Rate RATA [7]	Response Time
O_2 Analyzer (as applicable) [10]									
Analyzer replacement	X		X				X	X [9]	X
Replace linearizer board	X		X						
Cell replacement	X		X						
PC board replacement	X								
Source lamp replacement	X								
Photocell replacement	X								
Detector replacement	X								
Oven temp. replacement	X								

Notes:

1. Satisfactory completion of the indicated quality assessment activity will be sufficient demonstration of the CEMS ability to generate valid data. A change of any component listed on the original CEMS application by specific model and/or serial number for which specific details such as materials of construction or design are included requires formal notification to the District and will result in a response from the District.
2. CEMS calibration: A calibration performed in normal operating mode to confirm proper operation and establish new calibration correction factors or valid data generation.
3. Linearity test consists of conducting a cylinder gas audit (CGA) as described in 40 CFR 60, Appendix F, 40 CFR 75, or as defined in an SCAQMD approved QAP for the facility.
4. Applicable to systems where ammonia is present.
5. Can use any NIST traceable gas.
6. May not be applicable to dilution probe systems; consult SCAQMD.
7. As defined in 40 CFR 60, Appendix F.
8. Stratification test must be done.
9. If an analyzer is used for EPA F-factor calculation of stack flow rate (as described in EPA Method 19).
10. 168-hour “burn-in” test is required for complete analyzer change out.

7.2.2 SCAQMD Recertification Procedures

The District will reevaluate the monitoring systems where changes to the basic process equipment or air pollution control equipment have been made, to determine the proper full span range of the monitors. A change to a monitor's full scale range will be implemented in accordance with procedures from the SCAQMD's Technical Guidance Document R-003 which specifies a 3-point linearity test.

Recertification of any existing CEMS must be completed within 90 days of the start-up of newly changed or modified equipment monitored by the CEMS. The facility shall calculate and report NO_X emission data for the period prior to the CEMS recertification through the DAHS according to the following:

a. For any CEMS, which is recertified within 90 days of start-up of the newly modified equipment, the emission data recorded by the CEMS prior to the recertification would be considered valid and will be used for calculating and reporting NO_X emissions for the corresponding measurement point.
b. For any CEMS, which is not certified within 90 days of start-up of the newly modified equipment, the 90^{th} percentile emission data (lb/day) for the previous 90 unit-operating days recorded by the CEMS prior to the recertification shall be used for calculating and reporting NO_X emissions for the corresponding measurement point.

RATAs required during a recertification test program must be submitted to the District within a 60 day window in order for the CEMS data to be considered valid from the last day of RATA testing.

7.2.3 Impact of Recertification Events on Data Acceptability

If a replacement, modification or change is such that the data collected by the previously certified monitoring system are no longer representative, such as after a change in flue gas handling system or unit operation that requires changing the span value of the analyzers, the facility must substitute data using initial missing data procedures. If changes results in significantly higher concentration or flow rate, substitute maximum potential values as approved by the State regulatory agency during the period following the replacement, modification or change up to the hour of successful completion of all recertification testing.

[End of section. This document is formatted for double-sided printing.]

8 Routine Preventive Maintenance

8.1 Introduction

The following sections describe a process of checks that must be followed to ensure reported data is reliable and the CEMS operates dependably. The following includes information about when checks and audits should be performed and when a situation indicates the need for corrective actions. It is essential the personnel conducting the checks and audits completely fill out every item on the appropriate forms. This includes the recording of any comments concerning the condition of the CEMS. Corrective actions should be initiated immediately upon identification of a problem or malfunction.

It is recommended that zero and span calibration drift checks be conducted immediately prior to any maintenance and a calibration must be performed after any maintenance. If the post-maintenance zero or calibration drift test shows excessive drift, correction action and recalibration must be conducted to bring the CEMS and its components within specifications. All corrective action activities must be documented.

As routine or non-routine maintenance is performed, consult the table(s) from Chapter 7 of this manual. The tables identify the type of maintenance event and resultant test specification that may be required to demonstrate compliance of the equipment after completion of the maintenance procedure.

8.2 Logbook Maintenance

A logbook and maintenance check sheets will 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. Maintenance records must be maintained and presented for inspection if asked for by a regulatory agent.

A record of all testing, maintenance, or repair activities performed on any monitoring system or component will be maintained in a location and format suitable for inspection. The logbook and/or maintenance/inspection log sheets will 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 recharacterizes a system’s ability to record and report emissions data must be recorded (for example, changing of temperature and pressure coefficients).
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.

8.3 Minimize Downtime during Routine Maintenance

The goal of this section is to minimize downtime and the impact on data availability during normal routine maintenance. Following the steps on routine preventative maintenance as well as any additional maintenance requirements on all equipment supplied with this 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 this system at all times. This is critical to plant owners and operators as too much time spent in downtime can affect data availability requirements.

While performing any maintenance activity, consult the Recertification/Diagnostic Test tables located in Chapter 7 of this QAP document. The tables specify types of maintenance activities and resultant diagnostic test routines required to demonstrate the component is operating within compliance specifications after completion of the maintenance procedure.

All maintenance activities, whether routine or non-routine, needs 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 to be logged in the appropriate CEMS logbook and/or maintenance check forms.

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 by using the **MAINT REQ** switch on the CEMS front panel to perform the work. A way to minimize downtime is to take advantage of planned or unplanned process trips, outages or overhauls. Maintain the DAHS in operational status at all times.

If the system is equipped with a back-up CEMS then perform service, calibration and a complete function and accuracy check of the back-up system before 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.

Hourly emission averages will be affected by spending excessive amounts of time in maintenance mode. This in turn affects data availability. Leave the system in maintenance mode for only as long as needed to perform the needed maintenance or repair activity. Return the system to normal sampling mode as soon as possible.

Frequency of maintenance depends on many variables such as geographic location (humidity and seasonal temperature fluctuations), fuel type, stack temperature and moisture content, etc. Consequently, scheduled maintenance intervals will vary from the general guidelines given in the CEMS Operation and Maintenance (O&M) manual and the individual component equipment manuals.

8.4 System Checks

The following sections provide a brief overview on general system checks used for troubleshooting proposes.

8.4.1 Calibration Failure

Technicians are responsible for checking the daily calibration report as soon as the calibration sequence has been completed for the day. The DAHS will output an alarm whenever a calibration result is out of specification. Calibration results are reviewed through the DAHS and can be printed out. Weekly upward or downward trends in calibration results may require checking and manual calibration of the analyzer before the analyzer becomes out-of-control. If a calibration failure occurs, data is considered out-of-control until a successful re-calibration has been performed.

If a calibration failure occurs, first check the gauge on the related calibration gas cylinder to see if the pressure is adequate (above 150 psig). If the gas pressure is adequate, manually perform a calibration. If calibration cannot be successfully completed by adjusting the analyzers, troubleshoot and perform maintenance as required on the analyzer.

Use the following as a guideline for performing troubleshooting after a calibration failure:

1. First check the value entered in the DAHS and the analyzer for the gas cylinder to that listed on the cylinder label. If the values do not agree, correct.
2. Next, check to see that the bottle supply valves are open, that the pressure regulator is set to 20 psig, and that the cylinder has more than 150 psig of gas remaining. If the cylinder level falls below 150 psig, the cylinder will need replacing.
3. If the calibration failure percentage is large, this may indicate a system or component failure in the analyzer; not simply analyzer drift. In this situation, follow the troubleshooting procedures detailed in the equipment manufacturers' manuals.
4. If the cylinder and the analyzer are set up correctly, and if the failure percentage is small, the analyzer should be re-zeroed and re-spanned following manufacturers' procedures.
5. All analyzer adjustments must be followed by a hands-off, full system calibration.
6. Check the calibration report to show that the adjustment or repair resulted in a passed calibration and that the out-of-control period has ended.
7. Log the corrective actions taken in the CEMS maintenance log book. Be sure to include:
    a. Date and time analyzer became out of control or out of service.
    b. Description of any testing, adjustment, repair, component replacement, or preventive maintenance performed.
    c. Analyzer readings before and after the adjustment.
    d. The follow up quality assurance activity that was performed to show that the adjustment or repair involved solved the problem (minimum, hands off calibration check).
    e. Date and time the analyzer was returned to service.

If a calibration failure requires a substantial readjustment of the zero calibration on an analyzer, and if subsequent automatic calibration indicates a widely drifting zero output, troubleshoot and service that analyzer following the procedures in the manufacturer's instruction manual.

8.4.2 Abnormal Measurement Output Voltage/Current

If output voltage/current range is not between the required range for each analyzer and calibration is completed successfully, refer to the analyzer manufacturer's instruction manuals for adjustment and/or repair information.

8.4.3 Water Contamination

When troubleshooting a sample failure alarm check for any water in the moisture sensor bowl or a high cooler temperature. To find the cause of the water contamination, proceed as follows:

a. Check to see that the temperature of the sample gas cooler (**GC1**) is at least 2°C (~35°F).
b. Remove, dry out, and replace the moisture sensor (**MS1**) filter elements.

8.4.4 Moisture Sensor Check

The moisture sensor (**MS1, MS2**) should be checked daily to ensure it is dry and clean. The moisture sensor protects the downstream analyzers from damage.

Place system in maintenance mode and turn off the sample pump.

Note: *Individual configurations differ, some pumps can be unplugged, and some are turned off by unplugging the moisture sensor related to the pump, some have toggle on/off switches. Others can be digitally turned off through the OIT or turned off by DAHS control. Know the system controls first.*

1. Carefully remove knurled nut at the base of the filter housing. The sensor is made of glass components. Support the moisture sensor so it does not drop and break.
2. Remove and inspect the sensor for cracks and moisture between the two contacts. If no moisture is present then the alarm should be off. You can check the sensitivity by simply dampening the sensor slightly. It should activate the alarm. If the system is running the pump will turn off.
3. If moisture is present you will need to dry the sensor and purge out the Teflon lines between the chiller outlet and the moisture sensor. Replace the filter if needed (see particulate filter replacement procedure).
4. To purge the lines remove the 1/4 inch Teflon line at impinger #2 outlet. Be careful not to drop the gasket, note the Teflon side of gasket faces the glass.
5. Next loosen and remove the 1/4 inch Teflon line at the moisture sensor outlet. Purge the Teflon line from the chiller to the moisture sensor outlet with dry instrument grade air or N_2 until all signs of moisture are gone.
6. Reinstall the line and the moisture sensor, make sure gaskets are installed properly and all fittings are tight. If moisture is getting past the sample gas cooler you should troubleshoot the cooler to find out the cause.

When checking is completed turn the sample pump back on. Verify flow and pressures are okay and there are no leaks in the lines. Take system out of maintenance and calibrate system.

8.4.5 Sample System Particulate Filter Check

Visually inspect particulate filter (**F1, F2**) on a daily basis. If filter shows buildup and flow levels are dropping, replace filter. Otherwise, the filter should be replaced on an annual basis.

Place system in maintenance mode and turn off sample pump.

> ***Note:*** *Individual configurations differ, some pumps can be unplugged, and some are turned off by unplugging the moisture sensor related to the pump, some have toggle on/off switches. Others can be digitally turned off through the OIT or turned off by DAHS control. Know the system controls first.*

1. Carefully remove knurled nut at the base of the filter housing. Support the moisture sensor so it does not drop and break.
2. Carefully remove the glass filter housing.
3. Carefully remove the knurled nut at the base of the filter element. The nut and filter element will drop out from its supporting housing bracket.
4. Clean the bracket with de-ionized water if needed and dry. Replace the filter element making sure it seats into the small lip on center.
5. Inspect the O-ring and replace if needed.
6. Inspect the small seal at the base of the knurled nut that supports the moisture sensor. Verify the Teflon side of the seal is facing up.
7. Reinstall in reverse order.

When the check is completed turn sample pump back on. Verify that flow and pressures are okay and there are no leaks in the lines. Take system out of maintenance and calibrate system.

8.4.6 Routine Maintenance for the Sample Probe

The probe has no moving parts. It does have a particulate filter and an electric heater. The electric heater can be checked by using a clamp-on AC amp meter to detect current on the power wires going from the analyzer cabinet into the sample line up to the probe. The probe also has a low temperature alarm contact that will detect an inoperable probe heater. The filter is manually checked as part of scheduled routine maintenance as described later.

Changing the Probe Filter:

> **Caution:** The probe and filter assembly may be hot and can cause burns when not handled with appropriate protection. Use heat resistance gloves when performing maintenance on the probe.

To change the filter in the Universal 270 probe, grasp the cap at the end of the filter body opposite the probe and turn counter clockwise. Removing the cover exposes the filter. Reach into the heated oven with pliers to pull out the old filter.

Inspect the O-rings located at each end of the filter to ensure they are still elastic and will seal the filter. Replace them if they are charred or deformed.

Replace the filter with a new one, again handling it with pliers. Insure it is pushed in the center of the oven so that it is in contact with the O-ring at the inside end of the filter. Screw the cap back on the filter body.

8.4.7 Routine Maintenance for the Sample Line

The sample line requires no maintenance. However, it is advisable to periodically inspect the sample line visually to detect any damage or wear due to rubbing, vibration, physical damage, etc. If the sample line is installed properly there should be no stress points that could cause the tubing to become kinked in any manner. Typical life of the sample line heat trace is approximately 10-12 years depending on the temperature maintained and ambient conditions. Sample line heat trace is not a serviceable item and thus would require replacement in its entirety.

8.4.8 Routine Maintenance for the Sample Conditioning Unit

The M&C ECM sample-conditioning unit (**GC1**) requires no particular routine maintenance. Depending on the quality of the ambient air the cooling fin block should be blown out with compressed air from time to time. In addition:

1. Insure sample pump is operating properly
2. Insure condensate pump is operating correctly

The operating temperature of the sample cooler is monitored and a signal input indicating a fault will be sent to the PLC if temperature set points have been exceeded. Troubleshooting procedures and corrective actions must be initiated whenever a sample cooler alarm has been activated.

8.4.9 Replacing Ammonia Scrubber

Check ammonia scrubber (**AS1**) on a quarterly basis. When deposits are visible 75% of the way up the length of the scrubber, scrubbing media needs to be replaced.

Place system in maintenance mode and turn off the sample pump.

> ***Note:*** *Individual configurations differ, some pumps can be unplugged, and some are turned off by unplugging the moisture sensor related to the pump, some have toggle on/off switches. Others can be digitally turned off through the OIT or turned off by DAHS control. Know the system controls first.*

1. Bleed off any liquid from ammonia scrubber through the drain located at the base of the scrubber into the drain manifold. Rubber gloves suggested for servicing scrubber.
2. Unscrew thumbscrew on the bottom of the housing.
3. Swing yoke to one side.
4. Hold the bottom cap plate and housing and twist slightly while pulling downward to remove it from its housing bracket.
5. Remove old media and dispose of properly. Housing, center rod, screens and spring may be cleaned with de-ionized water.
6. Replace bottom cap plate, screen and center rod into housing.
7. Fill with 135 cc Berl Saddles and 65 cc scrubbing media, make sure no material falls into the center rod.
8. Make sure the rod is centered so it fits back into housing bracket without forcing it. Inspect and clean O-rings.
9. Reassemble the top screen, spring and take the complete assembly and push it back up into its housing bracket O-rings; twist slightly to seal. Be careful not to crack the case housing.
10. Replace the yoke and tighten the thumbscrew finger tight. Do not over tighten.
11. Verify scrubber drain is closed.

After completion of the procedure take system out of maintenance. Check that flow rates are okay and no leaks detected. Calibrate system.

8.4.10 Instrument Air Filter Service Check

Use the following to service the instrument air filter (**FR1**). The filter regulator should be checked weekly (minimum). The DAHS will output an alarm if instrument air pressure drops below setpoint (approximately 60 psi). The filter assembly requires periodic cleaning and replacement, typically semiannual but the interval is dependent on site-specific operating conditions.

Place system in maintenance during service if applicable.

Note: *Systems differ; review system engineering drawings and operation first, verify set point. Use rubber gloves if filter is oily or wet.*

1. Turn off main instrument air supply valve (**HV1**).
2. Ensure that the auto-drain has cleared all moisture at bottom of the filter bowl.
3. Allow air to bleed off and the pressure gauge for the regulator reads zero psi.
4. Loosen any tubes attached to the bottom of the regulator drain.
5. Loosen the nut at the bottom of the filter bowl and remove it completely while supporting the bowl with your other hand.
6. Remove the bowl.
7. Grab the filter and filter retainer washer at the bottom and twist it slightly. The filter and retainer washer should drop down.

8. Inspect the O-ring in the retainer washer. Replace if needed.
9. Clean the filter housing and inspect the O-ring at the base of the filter housing were the top of the bowl seats. Replace O-ring if bad (O-ring can get stuck to the bowl).
10. Clean the filter bowl, filter retainer washer, and mounting nut.
11. Inspect the O-ring on the mounting nut. Replace O-ring if bad.
12. Clean all parts.

Reinstallation

1. Install O-rings, filter and filter retainer washer.
2. Verify O-rings are in place and install bowl and nut that secures the bowl. Hand tighten (note bowl is made of polycarbonate and can crack if over tightened). Once the O-rings are correctly seated tighten the nut to secure the bowl.
3. Once bowl drain is in place leave it slightly open.
4. Turn on **HV1** instrument air slowly and then close off drain as pressure builds. This allows pressure to build up slowly and any moisture to drain. Verify set point is O.K. and there are no leaks.

8.4.11 Peristaltic Pump Tubing Replacement

Operation of the sample cooler peristaltic drain pumps (**DP1/DP2, DP3/DP4**) should be checked daily, turning approximately 6 rpm. The tubing should be inspected annually for clogging or cracks and replaced as needed.

To inspect and replace the tubing place system in maintenance mode and turn off the sample pump.

> ***Note:*** *Individual configurations differ, some pumps can be unplugged, and some are turned off by unplugging the moisture sensor related to the pump, some have toggle on/off switches. Others can be digitally turned off through the OIT or turned off by DAHS control. Know the system controls first.*

A supplied tubing loading key will be required for assembly.

1. Turn off drain pump at the pump on/off switch.
2. Disconnect the inlet and outlet tubing of the pump from the chiller and exhaust manifold drain or at the slip fit connectors. Note pump rotation.
3. Remove the 4 wing nuts and washers.
4. Remove the first head (end bells), and or second head from the studs by pulling the head towards you away from the pump body.
5. Pull the head end bells apart. Hold the end bell containing the rotor with the tubing retainer grooves pointing down. Remove the old tubing. It may show signs of wear, small cracks or cuts.
6. Inspect the pump rollers to make sure they are rolling freely.

7. Replace the old tubing with Masterflex tubing the same diameter and length as the one you removed. Make a note on where the bend of the old tubing was located. It will be the part of the tube that will be placed around the rollers.
8. Place tubing in the right groove and against the first two rollers. Hold tubing with thumb. Near groove, insert smaller prong of loading key between the top of the rotor and tubing. Push key in as far as possible.
9. Push down and turn the key counterclockwise completely around the rotor. The key will push the tubing uniformly into the end bell assembly. Hold the second end of tubing. Remove the key.
10. Position the other end bell on top and press the end bells together. Be careful not to pinch the tubing. If end bells do not snap tightly together, reload tubing. If necessary, turnkey in slot on rotor shaft to adjust tubing.
11. With key in slot on rotor shaft, turn key to align tang on rotor shaft with slot in motor drive shaft. Point tubing retainer grooves up. Shift the pump head slightly until it snaps on the alignment pins (if present). Secure with the screws. Tighten with fingers only.
12. Do the same for pump head number two. Then reinstall the heads making sure the cam and the slot in each head line up so the pump will rotate freely and the wing nuts can be reinstalled and tightened up.
13. Turn the drain pump on, verify it turns in the right direction and is removing water.

14. After completion take the system out of maintenance and calibrate the system verifying no leaks in the system.

8.4.12 Sample Pump Diaphragm Replacement

The sample pump (**SP1, SP2**) should be checked annually. Rebuild pump as needed.

Place system in maintenance mode and turn off the sample pump.

Note: *Individual configurations differ, some pumps can be unplugged, and some are turned off by unplugging the moisture sensor related to the pump, some have toggle on/off switches. Others can be digitally turned off through the OIT or turned off by DAHS control. Know the system controls first.*

1. Remove the two 1.4 inch Swagelok nuts at the inlet and outlet to the pump. Do not mix up the two lines.
2. Use a 3/16 Allen wretch to loosen the 4 SST screws on the top of the pump head. Note the direction of flow arrows on the top of the pump head.
3. Remove the 5/32 Allen screw on top of the pump housing and replace the Teflon washer and the Teflon coated diaphragm. Inspect the Teflon coating on the plate-diaphragm and head parts for good condition.
4. The valve body can then be removed by unscrewing the two smaller screws. This part may be freed by gently tapping on these two screws after they have been loosened about three or four turns.

5. Carefully remove the valve body, the two disc-valves, and the gasket. Check all internal surfaces for any accumulation of dirt. The two disc-valves can be wiped clean and replaces as long as they appear unaffected by usage. The valve gasket should be inspected.
6. Replace the gasket and disc-valves, verify the Teflon coating is in good condition and the valve seats are clean and dry.
7. The service diaphragm is secured by a single screw in its center. Remove this screw with a 5/32" Allen wrench. The diaphragm and plate should lift off. Some adherence to the metal might occur if the diaphragm has been in use for a long period.
8. When replacing the service diaphragm, a Teflon washer should be inserted under the head of the diaphragm cap screw. This is added insurance against small gas leaks through screw heads. After tightening the screw, the excess Teflon should be trimmed away.

   When replacing the service diaphragm, be sure the four projecting studs of the base casting are properly located in the four outer holes provided in the diaphragm before the part is clamped in place. Be sure the diaphragm plate is firmly replaced with its center screw.
9. Reinstall the valve body into the head by setting the head onto the valve body and tighten the two screws. Make sure the discs seated correctly. Reinstall the head. Turn the pump on to verify suction and pressure.
10. Hook up the Swagelok tube and fittings. Take out of maintenance and calibrate system.

8.4.13 NO_X Converter Check

This check is performed to ensure that the majority of the NO_X component of the stack gas is able to be converted by the NO_X analyzer into NO to be measured. The NO_X converter element of a NO_X analyzer has a typical life span of 2,000 ppm hours, roughly about a 2-5 year lifespan. NO_X converter degradation is not easily detected during normal operation and daily calibrations. NO_X converter failure will be detected during a relative accuracy test audit, as the reference method NO_X measurement will not agree with the stack measurement. This procedure should be performed annually, before the RATA.

The NO_X converter efficiency check is performed in accordance with EPA Test Method 7E, section 8.2.4.1, section 12.7, and section 13.5.

1. Select a protocol gas cylinder having an NO_2 concentration that is 15-18 ppm, balanced in air for stainless steel converters. No other gases may be present in the cylinder. Alternately, use an NO_2 gas that is within 10% of expected NO_2 concentration in the exhaust stack. Note that NO_2 cylinders have a limited shelf life. Check the expiration date on the cylinder prior to use.
2. Perform a calibration check to ensure that the analyzer is not out-of-control. Make adjustments and re-check the calibration as necessary.
3. Place the system into maintenance mode. Directly inject the NO_2 gas to the analyzer and check cylinder regulator pressure to ensure that the flow rate is 2 liters per minute.
4. Flow the gas until stable readings are reached (approximately 10 minutes). If the resulting stable reading is 90-100% of the cylinder target value, the NO_X converter is converting the NO_2 properly. Any lesser amount of conversion indicates that the NO_X converter needs to be replaced. If the converter is replaced, perform a follow up converter check to ensure that the problem was resolved.
5. Note in the CEMS maintenance log book when the converter check was performed, results of the check, and if the converter was replaced.

NO_2 to NO Conversion Efficiency ***40 CFR 60, Appendix A, Method 7E, Equation 7E-7***	
$$Eff_{NO2} = \frac{C_{Dir}}{C_V} x 100$$	Eff_{NO2} = Percent converter efficiency C_{Dir} = Monitor response value to the direct NO2 gas injection C_V = Certified value of the NO_2 calibration gas

8.4.14 Analyzer Cabinet Temperature Control

The analyzer cabinet is equipped with HVAC to maintain ambient temperature at a stable level. The temperature inside the shelter should typically be controlled at 72°F and should not deviate by more than ±5 degrees in a 24 hour period. A stable temperature is needed to guard the equipment against analyzer drift resulting from ambient temperature fluctuations. A routine check of the HVAC controls should include:

1. Verification of correct temperature control. If unit is not functioning correctly, corrective action procedures must be immediately implemented.
2. Check condition of the conditioner’s filter on a monthly basis. Change as needed, usually every two months.

8.5 CEMS Preventive Maintenance Schedule

This section contains a suggested schedule for performing preventive maintenance. Maintenance schedules may vary depending upon site-specific conditions (that is, filters may need to be changed more often in a “dirty” environment or less often under “clean” conditions). For detailed maintenance, procedures refer to the manufacturer's instruction manuals and other technical data included separate cover.

Facility personnel shall normally maintain the CEM systems. In addition, service technicians and CEMS service representatives are available upon request.

The QA audits can also define other possible operation problems that need to be resolved. Operational problems necessitate immediate repair action by personnel. If the onsite maintenance personnel cannot resolve the problem, a CEMS representative will be summoned. All repairs will be documented in the operation and maintenance logbook.

Some items, such as filter checks, may not exhibit a failure condition until damage has occurred to other components. Initially, these items will 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 or equipment damage. This includes paying attention to any pressure or flow rate shifts (sudden or prolonged) in one direction and close observation of the visual indicators in the system. Be alert for both gradual and sudden changes in system operation.

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 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. Use simulated signal inputs to check contact closures on relays. Adjust temperature controllers, pressure settings, vacuum settings, flow rates, etc. above or below set points to check alarm triggers. Apply a spot of moisture to the moisture sensor to test the liquid/moisture alarm. All alarm conditions require quick attention and resolution.

Before beginning any maintenance or troubleshooting routines, call the control room to let them know that the system is being worked on and possibly affecting emissions data. Place the system into maintenance mode during any preventive or corrective maintenance activity. This action marks the data with the maintenance flag, which will prevent that data from being used in the hourly averages. Take the system out of maintenance mode immediately following any maintenance activity and let the control room know when the system has returned to normal operation.

Maintenance should be scheduled so as to not conflict with an auto-calibration and to maximize data collection and minimize monitor downtime. Always perform a full system hands off calibration after completion of any maintenance activity.

Always log the work done, with the date and the time period during which the analyzers or system was in maintenance. Include the date and time the analyzer was out-of-service, description of the maintenance or corrective action activity, or component replacement. Log the time the system was place back into service and initial the log entry.

Important Note: *In accordance with some local regulatory compliance requirements, certain types of maintenance events may trigger the need to perform diagnostic testing and/or recertification to ensure that the CEMS has been returned to optimum operating condition after the maintenance activity. A manual calibration is required after completion of most routine maintenance repair events. Major repair and/or complete replacement of an analyzer or other major equipment component may require partial or full recertification of the repaired/replaced instrument.*

General Warnings: *The technicians performing maintenance should be familiar with all safety warnings contained in the individual manufacturer's manuals. All maintenance must be performed in accordance with facility safety procedures.*

Most components need to be powered off before major maintenance to prevent potential electrical shock hazards. Maintenance performed on electrical equipment must be conducted in accordance with facility Lockout/Tagout (LO/TO) procedures

Some components can be damaged by small amounts of static electricity. Before performing any maintenance, use a properly grounded antistatic wrist strap to be worn while handling any instrument's internal components.

Some components such as the probe or heating elements on some analyzer types may be extremely hot to the touch. Wear protective heat-resistant gloves when handling.

Other components such as optical assemblies and capillaries in the analyzers are made of glass and must be handled carefully.

Be careful when using solvents or abrasive materials for cleaning to avoid damage to components. Check manufacturers' manuals for recommended cleaning materials and procedures.

8.5.1 Daily Preventive Maintenance

Perform the following checks and maintenance for each day that the CEMS is in operation. Make corrections and/or repairs as necessary. Record any corrective maintenance or troubleshooting procedures performed on the CEMS and any out-of-control periods in the CEMS Maintenance Logbook.

Unit Number ID:	
Date of Checks:	
Technician(s) Initials:	

Sample System Checks – Daily				
Item		**Tag**	**Set Point**	**Record Daily Value or Status**
Pressures	Instrument air	**PG1**	80-125 psig	
	Stack sample pressure	**PG2**	>2 psig (expected 5-15 psig)	
	Inlet sample pressure	**PG3**	>2 psig (expected 5-15 psig)	
	Stack probe vacuum	**VG1**	<10 inch Hg (expected <3” Hg)	
	Inlet probe vacuum	**VG2**	<10 inch Hg (expected <3” Hg)	
	Instrument air filter regulator	**FR1**	>80 psig (±10 psig)	
Flows	Stack total sample flow	**RM1**	4-5 lpm (DAHS will alarm at setpoint)	
	Inlet total sample flow	**RM5**	4-5 lpm (DAHS will alarm at setpoint)	
	Stack NO_X/O_2 analyzer flow	**RM2**	~1.5 lpm (expected 1.25 to 1.75 lpm)	
	CO analyzer flow	**RM3**	~1.5 lpm (expected 1.25 to 1.75 lpm)	
	Inlet NO_X analyzer flow	**RM6**	~1.5 lpm	
	Stack cal gas total flow	**RM4**	8-9 lpm	
	Inlet cal gas total flow	**RM7**	8-9 lpm	

Daily preventive maintenance checks continued.

Sample System Checks – Daily				
Item		**Tag**	**Set Point**	**Record Daily Value or Status**
Visual checks	Cabinet temperature	Check HVAC controls	72°F, ±5°F	
	Stack moisture sensor/filter	**MS1**	Clean and dry (DAHS will alarm "wet sample" if moisture detected)	
	Inlet moisture sensor/filter	**MS2**	Clean and dry (DAHS will alarm "wet sample" if moisture detected)	
	Stack sample cooler temp	**GC1**	Status indicators show okay. (DAHS will alarm on "cooler fault" signal input.)	
	Inlet sample cooler temp	**GC2**	Status indicators show okay. (DAHS will alarm on "cooler fault" signal input.)	
	Stack sample cooler drain pump	**DP1** and **DP2**	Turning approx. 6 rpm	
	Inlet sample cooler drain pump	**DP3** and **DP4**	Turning approx. 6 rpm	
	Stack sample line temp control	**TC1**	250°F, ±5°F. (DAHS will alarm at temp setpoints.)	
	Inlet sample line temp control	**TC1**	250°F, ±5°F. (DAHS will alarm at temp setpoints.)	

Daily preventive maintenance checks continued.

Additional Sample System Checks – Daily	
Item	**Value or Status (Completed, OK, Replaced)**
Visually inspect sample system particulate filter (**F1** and **F2**). If filter shows buildup (appears dirty) and flow levels are dropping, replace filter. Typical replacement is semiannual up to annual but is highly dependent on operating conditions.	
Check daily calibration gas bottle pressures: 0-2000 gauge = 200 Replace cylinder if high pressure is below set point. Order new cal gases when needed keeping in mind the lead time required for some cal gas mixtures.	
Refrigerated air dryer (**RAD1**) – Inspect for proper operation. Check control panel for alarms. Verify proper inlet and ambient air conditions.	

DAHS Checks – Daily	
Item	**Value or Status (Completed, OK, Replaced)**
Check DAHS for normal operation. Is system logging data?	
Check and archive alarms. Log reason codes and action codes for any alarm conditions.	
Check printer for normal operation.	
Check calibration drift report for all analyzers/monitors. Did all calibrations pass?	
Review all daily summary reports. Watch for and immediately report to supervisor any non-compliance/exceedance episodes. Initiate corrective actions as needed. Fill out downtime event forms as needed.	

Daily preventive maintenance checks continued.

Analyzer Checks – Daily	
Item	**Value or Status (Completed, OK, Replaced)**
Check all analyzer/monitor displays for error messages.	

Notes: Ensure system has been placed in Maintenance Mode before performing any maintenance or repair.

Non-Compliance Episodes:
Immediately report to the Environmental Person within 15-20 minutes any non-compliance/exceedance episodes. The SCAQMD must be informed within 1 hour of each episode. Ensure all events are logged along with time, duration, and corrective actions taken for each non-compliance episode.

Calibration Issues:

- Check results as soon as cal period finishes.
- If cal fails, recalibrate within 15 minutes (compliance: pass recalibration w/in 60 min of orig. cal hour is considered "good".
- Initiate a calibration after each new cal gas bottle.
- Initiate a calibration after each startup.
- Initiate a calibration after any maintenance/corrective action event to check operating condition of the analyzers.

8.5.2 Weekly Preventive Maintenance

Perform the following checks and maintenance for each week that the CEMS is in operation. Make corrections and/or repairs as necessary. Record any corrective maintenance or troubleshooting procedures performed on the CEMS and any out-of-control periods in the CEMS Maintenance Logbook.

Unit Number ID:	
Week Ending:	
Technician(s) Initials:	

Sample System Checks – Weekly	
Item	**Value or Status (Completed, OK, Replaced)**
Perform all daily checks.	
Watch for upward or downward trends in the daily calibrations for the prior week. Perform zero and span adjustment, if required.	
Check moisture sensor on Stack and Inlet (**MS1, MS2**) and tubing downstream of sample conditioner for moisture. Remove and dry as necessary. DAHS will alarm if moisture is detected. Check Stack and Inlet sample conditioner (**GC1, GC2**) for proper operating temperature. DAHS will alarm if a “cooler fault” signal is received	
Refrigerated air dryer (**RAD1**) – Assure drain is functioning properly.	
Refrigerated air dryer (**RAD1**) –Check the daily instrument air pressure readings at **PG1** and total sample system pressure readings at **PG2** and **PG3**. If the daily readings are not within expected parameters inspect the pre- and post-filters and replace if readings are out of range.	

Weekly checks continued

DAHS Checks – Weekly	
Item	**Value or Status (Completed, OK, Replaced)**
Check/change backup media if using CD, tape, or flash card; removable hard drive, etc.	
If enabled, verify that automatic backups have occurred for the week.	
Verify there is sufficient disk space for another week of data.	

Analyzer Checks – Weekly	
Item	**Value or Status (Completed, OK, Replaced)**
TEI 42i-LS NO_X Analyzer	
Perform zero and span adjustment if required.	

8.5.3 Monthly Preventive Maintenance

Perform the following checks and maintenance once each month that the CEMS is in operation. Make corrections and/or repairs as necessary. Record any corrective maintenance or troubleshooting procedures performed on the CEMS and any out-of-control periods in the CEMS Maintenance Logbook.

Unit Number ID:	
Date of Checks:	
Technician(s) Initials:	

Sample System Checks – Monthly	
Item	**Value or Status (Completed, OK, Replaced)**
Perform all daily and weekly checks.	
Check filter on cabinet HVAC system. Clean or replace as needed, usually every 2-3 months.	
Plan ahead for the upcoming CGA. Check CGA cal gas bottle pressures > 500 psig. Also check expiration dates. Order new gas bottles as needed keeping in mind the lead time may be several weeks.	
Refrigerated air dryer (**RAD1**) – Blow out entire unit with compressed air.	
Refrigerated air dryer (**RAD1**) – Blow condenser coils out with compressed air.	
Refrigerated air dryer (**RAD1**) – Inspect refrigeration compressor for overheating.	

8.5.4 Quarterly Preventive Maintenance

Perform the following checks and maintenance four times each year that the CEMS is in operation. Make corrections and/or repairs as necessary. Record any corrective maintenance or troubleshooting procedures performed on the CEMS and any out-of-control periods in the CEMS Maintenance Logbook.

Unit Number ID:	
Date of Checks:	
Technician(s) Initials:	

Sample System Checks – Quarterly	
Item	**Value or Status (Completed, OK, Replaced)**
Perform all daily, weekly, and monthly checks. Note that all routine maintenance is to be performed prior to the required quarterly audit test.	
If sample gas vacuum (**VG1, VG2**) shows an increase, perform probe maintenance. Replace the filter element and clean the filter chamber as necessary. Replace O-rings. Verify probe box heater is operating. If flow is low, check sample pump (**SP1, SP2**).	
Perform sample system leak check and flow balance procedure (Chapter 9).	
Check and replace ammonia scrubber media (**AS1**) as needed.	
Check system alarms, calibrate as needed.	
Perform general housekeeping duties inside cabinet. Dust/clean all equipment surfaces.	

Quarterly preventive maintenance checks continued.

Analyzer Checks – Quarterly	
Item	**Value or Status (Completed, OK, Replaced)**
For all analyzers: Visually check for obvious defects such as loose connectors, loose fittings, cracked or clogged Teflon lines, and excessive dust or dirt accumulation. Dirt accumulation inside the instruments can cause overheating or component failure and may provide conducting paths for electricity. Clean the inside of each instrument by vacuuming accessible areas and then using compressed air to blow out remaining dust. Use a soft paint brush or cloth to remove stubborn dirt. Clean all analyzer cooling fans. **CAUTION:** Observe all safety warnings from manufacturers' manuals.	
For stack mounted equipment: Check all seals and mounting hardware. Any deposits or build-up in the mounting flanges should be removed.	
TEI 42i-LS NO_X Analyzer	
Check pump diaphragm and Teflon wafer, rebuild as needed, usually annually.	
Inspect sample filter, replace if needed.	
Inspect capillaries for blockage (discoloration). The capillaries should be clear, if not replace.	
Inspect capillary O-rings for wear, replace if needed.	
Inspect ozone generator and scrubber.	
Inspect and clean the fan filter. Clean as needed by flushing with warm water and let dry. Or, use compressed air to blow out dust or use a hand vacuum.	

Quarterly checks continued

Analyzer Checks – Quarterly	
Item	**Value or Status (Completed, OK, Replaced)**
TEI Model 48i CO Monitor	
Check for leaks around the fittings.	
Check pump diaphragm, replace as needed (usually annually).	
Check that capillary is not blocked.	
If applicable, check for leaks around the optional valves.	
Inspect and clean the fan filter. After removing, flush with warm water and let dry or blow the filter clean with compressed air.	

QA Audits – Quarterly	
Perform quarterly CGA test and check DAHS results.	Completed On:

Notes:
Check which calendar quarter that any required annual RATA might be due. Fill out the QA Audit check forms in the Annual Preventive Maintenance tables when the required RATA has been completed. CGAs are not performed in the quarter in which an annual RATA is due.

Comments:

8.5.5 Semiannual Preventive Maintenance

Perform the following checks and maintenance twice each year that the CEMS is in operation. Make corrections and/or repairs as necessary. Record any corrective maintenance or troubleshooting procedures performed on the CEMS and any out-of-control periods in the CEMS Maintenance Logbook.

Unit Number ID:	
Date of Checks:	
Technician(s) Initials:	

Sample System Checks – Semiannual	
Item	**Value or Status (Completed, OK, Replaced)**
Perform all daily, weekly, monthly, and quarterly checks.	
Check and replace sample system filter (**F1, F2**) as needed.	
Check and replace instrument air filter (**FR1**) as needed.	
Check Stack and Inlet sample pumps (**SP1, SP2**); replace diaphragms and disks as needed.	
Check Stack and Inlet sample cooler peristaltic pump tubing (**DP1**/**DP2, DP3**/**DP4**), replace as needed.	
Refrigerated air dryer (**RAD1**) – Inspect entire assembly for loose connections, screws, panels, etc.	
Refrigerated air dryer (**RAD1**) – Inspect refrigeration circuit for signs of oil and refrigerant leakage.	
Refrigerated air dryer (**RAD1**) – Clean fan blades, casing, motors and internal components. Use light mixture of detergent. No oil based cleaning solvents should be used.	

Semiannual preventive maintenance checks continued.

Analyzer Checks – Semiannual	
Item	**Value or Status (Completed, OK, Replaced)**
TEI Model 48i CO Analyzer	
Check the optics. The mirrors should be cleaned any time the AGC intensity is below 20,000 Hz.	
Check calibration of the pressure and temperature transducers.	

8.5.6 Annual Preventive Maintenance

Perform the following checks and maintenance once each year that the CEMS is in operation. Make corrections and/or repairs as necessary. Record any corrective maintenance or troubleshooting procedures performed on the CEMS and any out-of-control periods in the CEMS Maintenance Logbook.

Unit Number ID:	
Date of Checks:	
Technician(s) Initials:	

Sample System Checks – Annual	
Item	**Value or Status (Completed, OK, Replaced)**
Perform all daily, weekly, monthly, quarterly, and semiannual checks. Note that all routine maintenance is to be performed prior to the required annual RATA.	
Perform probe maintenance.	
Inspect and clean Stack and Inlet thermoelectric cooler fan (**GC1, GC2**).	
Heatless air dryer (**HAD1**) – Disassemble and clean all parts except towers using warm water and soap. The towers cannot be cleaned and should be returned to manufacturer for repacking if contaminated. Dry parts and blow out internal passages in valve body, adapter, and main body using clean, dry compressed air. Prior to reassembly lubricate per specifications in manufacturer's manual.	
Refrigerated air dryer (**RAD1**) – Tighten all electrical connections. Look for broken, cracked, or bare wires.	
Refrigerated air dryer (**RAD1**) – Measure and record amperage. Verify that readings are within acceptable parameters as listed in the manufacturer's manual.	
Refrigerated air dryer (**RAD1**) – Clean the condenser coil with a mild detergent mixture and brush.	

Annual checks continued

Analyzer Checks – Annual	
Item	**Value or Status (Completed, OK, Replaced)**
TEI 42i-LS NO_X Analyzer	
Perform a NO_X converter check. Replace the converter if efficiency drops below 90% or every 3 threes.	
TEI Model 48i CO Analyzer	
Inspect the source control system. The wire wound resistor source has a finite life. The manufacturer recommends replacement after one year of continuous use. If the source is to be replaced on an as needed basis, replace when one of the following conditions hold: • No light output • If after cleaning the optics, the IR light intensities remain below 100,000 Hz	
Clean measuring cell; replace block and pipe cell windows and O-rings as needed.	

QA Audits – Annual	
Perform any required annual RATA.	All testing completed on:

[End of section. This document is formatted for double-sided printing.]

9 Corrective Maintenance and Troubleshooting

9.1 Introduction

This section contains information on performing troubleshooting and corrective maintenance. For detailed procedures refer to the manufacturer's instruction manuals and other technical data included under separate cover. The technician should be familiar with the material in these manuals before attempting any troubleshooting.

9.1.1 Troubleshooting the System

The following table outlines common problems that may be encountered with the CEMS sample conditioning system.

Table 9-1: Troubleshooting the Sampling System

Problem	Corrective Action
Power failure.	1. Check circuit breakers. 2. Check power wiring. 3. Check alarm system.
Heat-trace failure.	1. Check sample line temperature. 2. Check voltage/current for heated sample line 3. Check line for external damage.
Loss of sample (Flow switch tripped; pressure at the sample gas cooler outlet fell below 5 psig)	1. Check sample pump motor (**SP1, SP2**), wiring, diaphragm and seals. 2. Check sample vacuum (**VG1**, **VG2**). 3. Check setpoint at pressure (**PG2, PG3**) for 3 psi. 4. Check sample gas cooler (**GC1, GC2**). 5. Check moisture/conductivity sensor (**MS1, MS2**). 6. Adjust back pressure regulator (**BPR1, BPR2**). 7. Check gauges for sticking or fouling. 8. Check particulate filter (**F1, F2**) and sample line for blockage/leaks, proper connection. 9. Check analyzer vents for blockages. 10. Check flowmeters (**RM2, RM3,** and **RM6)** for correct flow setpoint and readjust, if necessary. 11. Remove, clean, repair or replace sample line components causing flow restrictions.

CEMS troubleshooting continued

Problem	Corrective Action
High Vacuum (Flow switch tripped; sample pressure before in-line sample system filter is above 15" Hg)	1. Check probe for blockage. 2. Check sample line for blockage. 3. Check sample system particulate filter (**F1, F2**) for blockage/leaks, proper connection. 4. Replace flow switch (**FS1, FS2**). Using ohmmeter, run switch up and down watching vacuum gauge or trip point; watch ohmmeter for contact closure.
Water in Line (Moisture sensor activates moisture alarm)	1. Check temperature alarm of sample gas cooler (**GC1, GC2**). 2. Check sample line heating. 3. Peristaltic drain pump (**DP1/DP2, DP3/DP4**) is inoperative. 4. Solid state conductivity sensor (**MS1**) needs replacing.
Instrument air loss (Instrument air pressure below 80 psig)	1. Check instrument air supply (**PG1**, **PS1**, and **FR1**). 2. Check for proper set points.
Calibration Gas Cylinder Pressure.	1. Check regulator gauges. 2. Install new cylinders.

9.1.2 CEMS Leak Check Procedure

This leak check procedure should be done once a quarter or whenever a leak is suspected.

a. Place system in maintenance mode by toggling the **MAINT REQ** switch on the CEMS front panel in the up position (Stack and Inlet as applicable).
b. Make sure sample pump (**SP1, SP2**) is on.
c. Disconnect the *Sample* tube from sample gas cooler (**GC1**).
d. Plug inlet side of sample gas cooler.
e. Verify that the sample flow meter (**RM1, RM5**) flow drops to zero.
f. If system fails the test. Troubleshoot and repair as required.

> **Note:** Leaks that occur downstream of the sample pump are not detected by this check. Use leak detection liquid if necessary.

Remember to place the system back into normal sampling mode by placing the **MAINT REQ** switch in the **OFF** position after completing any maintenance procedure.

9.1.3 Flow Balance Procedure

This procedure should be done after completing a leak check procedure. This procedure adjusts sample system and calibration system flow rates to match.

a. Place system in maintenance mode by toggling the **MAINT REQ** switch on the CEMS front panel to the up position (Stack and Inlet as applicable).
b. Adjust backpressure regulator (**BPR1, BPR2**) to achieve 4 liters per minute on total flow meter (**RM1, RM5**). Sample pressure gauge (**PG2**) should indicate between 5 and 10 psig.
c. Adjust analyzer flow meter (**RM2, RM3, RM6**) to 1.5 liter per minute.
d. Continue steps b. and c. until adjusted.
e. Vacuum gauge (**VG1, VG2**) should read less than 5 inches Hg.
f. Note values obtained in steps a-d.
g. Manually flow calibration gas 1 to probe.
h. Adjust low pressure on calibration gas bottle 1 regulator to achieve 20 psig as indicated by the regulator low pressure gauge.
i. Manually flow calibration gas 2 to probe. While calibration gas 2 is flowing adjust calibration gas 2 regulator to achieve the same values achieved on step f.
j. Do this for all remaining calibration gas bottles.
k. Return to normal sampling mode using the **MAINT REQ** switch (**OFF** position) and verify that the flow and pressure readings are the same as obtained in steps b through c. If not, repeat *Flow Balance Procedure*.

9.2 Sample Cooler

Use the following table for an overview of possible errors with the M&C ECM sample cooler.

Table 9-2: Sample Cooler Troubleshooting Overview

Error	Reason	Check/Repair
Condensate in the gas outlet	Ambient temperature <5°C Cooler overloaded Peristaltic pump doesn't work Tube of the peristaltic pump defective Cooling capacity too low (cooler is not overloaded) Motor protection switch released.	Heat up the components downstream. Keep the operational data. Change peristaltic pump. Change the tubing. Clean the fins of the condenser. Check the vent. Check the safety distance to other heated components. Secure sufficient ventilation. Thermal load caused by the sample gas response ambient is too high. Let the cooler cool down before restarting it.
Gas flow blocks up reading	Contamination of the sample gas path way.	Optimize the dust pre-separation upstream of the cooler. Clean the gas path ways and the cooling system.
Wrong temperature	Temperature sensor defective Temperature controller defective Leak in cooling agent circuit	Check the PT100-sensor. Check the temperature controller. Send the cooler for repair.
Cooler breakdown	Power supply interrupted	Check the power supply and reconnect. Pay attention to safety warnings.
Compressor does not work	Compressor defective Motor protection switch defective	Send the cooler for repair.

9.3 Troubleshooting the AirTak Heatless Air Dryer

Use the following table for general troubleshooting. Refer to the manufacturer's manual for detailed information.

Table 9-3: Heatless Air Dryer Troubleshooting

<table>
<tr><th>Problem</th><th>Probable Cause</th><th>Solution</th></tr>
<tr><td rowspan="7">Unit delivers wet air.</td><td>Improper operating conditions.</td><td>Make sure:
Inlet air is properly filtered.
Inlet air pressure is between 60 and 150 psig.
Inlet air temperature is between 35° and 100°F.
Outlet air flow is within specified range.</td></tr>
<tr><td>Improper purge flow adjustments.</td><td>Adjust purge flow.</td></tr>
<tr><td>Inoperative purge valve.</td><td>*Remove valve bodies then remove valve pares from adapter. Inspect valve parts and interior of adapter for contaminants. Disassemble all parts attached to main body. Clean all parts and reassemble as described in the manufacturer's manual. Do not disassemble towers.</td></tr>
<tr><td>Excessive desiccant loss.</td><td>*Remove towers being careful not to damage center tube. The spring on the center tube in the bottom of the towers should be fully compressed. If spring is loose, replace tower or return to factory for repacking. Disassemble and clean dryer per manufacturer's manual.</td></tr>
<tr><td>Disconnected tubing.</td><td>Make sure all tubing is firmly connected.</td></tr>
<tr><td>Timer motor failure.</td><td>**Remove cover. Plug in dryer electrical cord and observe rotation of cam adjusting knob. Cam should make one revolution every two minutes. Replace timer if no rotation is observed.</td></tr>
<tr><td>Timer cam adjustment or switch failure.</td><td>**Timer cams should be set as follows:<table><tr><th>Degrees</th><th>No. 1 Switch</th><th>No.2 Switch</th></tr><tr><td>0</td><td>ON</td><td></td></tr><tr><td>150</td><td>OFF</td><td></td></tr><tr><td>180</td><td></td><td>ON</td></tr><tr><td>330</td><td></td><td>Off</td></tr></table>Remove cover. Plug in dryer electrical cord and observe rotation of cam adjusting knob. The switches should actuate when the adjusting knob is at the positions given above. Use the red cam adjusting key supplied with the component to adjust the cams as described below:
Disconnect electrical power to dryer.
Insert the tab on the cam adjusting key into the notch in the no. 1 cam (grey section). The word Start on the key must face the adjusting knob. Turn the adjusting knob until the degree reading is "0".
Insert the tab on the cam adjusting key into the notch in the no. 1 can (red section). The word Stop on the key must face the adjusting knob. Turn the adjusting knob until the degree reading is 150.
Repeat the previous steps to obtain 180° setting for the grey section and 330° setting for the read section on the no. 2 cam
If the timer switches are not making and breaking per the chart above, replace the faulty switch.</td></tr>
</table>

Troubleshooting continued

Problem	Probable Cause	Solution
Unit delivers wet air – continued.	Solenoid coil burned out	Remove cover. Plug in dryer electrical cord and listen for solenoid actuation when the timer switches make and break. If the timer switches are making and breaking but the solenoids are not actuating, replace the solenoids.
Air blows at high volume from muffler	Improper purge flow adjustments.	Adjust purge flow.
	Inoperative purge valve.	*Remove valve bodies then remove valve pares from adapter. Inspect valve parts and interior of adapter for contaminants. Disassemble all parts attached to main body. Clean all parts and reassemble as described in the manufacturer's manual. Do not disassemble towers.
	Excessive desiccant loss.	*Remove towers being careful not to damage center tube. The spring on the center tube in the bottom of the towers should be fully compressed. If spring is loose, replace tower or return to factory for repacking. Disassemble and clean dryer per manufacturer's manual.

*Disconnect electrical power, shut off inlet pressure, and reduce pressure in dryer to zero before performing.
**Do not reach inside dryer with finger or tool when power is on.

9.4 Troubleshooting the AirTak Refrigerated Air Dryer

Use the following table for general troubleshooting. Refer to the manufacturer's manual for detailed information on operation and maintenance of the dryer.

Table 9-4: Refrigerated Air Dryer Troubleshooting

Problem	Cause
Dryer not running. Power ON light is ON.	Low voltage to the dryer. Compressor over-load open. Defective compressor start components. Compressor windings open.
Dryer not running. Power On light is OFF.	Switch not turned on. No power. Circuit breaker fuse improperly wired. On/Off switch defective.
High discharge pressure – above 125 psig.	Fan not operating. Dirty or blocked condenser. High ambient conditions. Excessive air load exceeding the capacity of the dryer.
High suction pressure – 30.5 to 32.5 normal.	Excessive air load exceeding the capacity of the dryer. HGV setting too high. High ambient temperature.
Low suction pressure – 30.5 to 32.5 normal.	Low or no air load. Fan not cycling at low load. HGV setting too low. Refrigerant leak (low on refrigerant). Low ambient temperature and fan not cycling.
Moisture in the air system downstream.	Dryer over loaded (air flow). Separator drain not functioning. Air bypass valve open. Refrigeration system not operating. Improper air piping.
High pressure drop in dryer air circuit.	Dryer over loaded (air flow). Heat exchanger clogged. Iced evaporator coil.
High temperature light ON – refrigerant compressor OFF.	Air inlet temperature too high. Refrigerant shortage. Blocked condenser.

9.5 Troubleshooting the NOX Analyzer

Refer to the TEI 42i-LS NO_X manual for detailed instructions on corrective maintenance procedures and troubleshooting procedures (located in the appendix section of the CEMS Operation and Maintenance manual CD). The following is only a brief overview.

Table 9-5: NO_X Analyzer General Troubleshooting

Malfunction	Cause	Solution
Does Not Start Up	No power	Check that the instrument is plugged into the proper source. Check fuse.
	Power Supply	Check voltages using a digital voltmeter.
	Digital electronics	Unplug power cord. Check that all boards are seated properly. Replace one board at a time with known good board.
No Output Signal (or very low output)	No sample reaching analyzer	Check input sample flow.
	Blocked Capillary	Unplug power cord. Clean or replace capillary.
	No ozone reaching the reaction chamber	Check the instrument control menu to see if the ozonator is on. If so, check dry air supply.
No output signal	Disconnected or defective input or high voltage supply	Unplug power cord. Check that cables are connected properly. Check resistance of cables.
	Analyzer not calibrated	Recalibrate
	Defective ±15 volt	Check supply voltages (diagnostics menu on analyzer).
Calibration Drift	Dryer to ozonator depleted	Replace
	Line voltage fluctuations	Check to see if line voltage is within specifications
	Defective pump	Rebuild pump.
	Unstable NO or NO_2 source	Replace.
	Clogged capillaries	Unplug power cord. Clean or replace capillary.
	Clogged sample air filter	Replace filter element.
Excessive noise	Defective or low sensitivity PMT	Unplug power cord. Remove PMT then install known good PMT. Plug in power cord and check performance.
	Defective input board	Replace board.
	Defective cooler	Check temperature (less than -2°C at T_{amb} = 25°C.

General troubleshooting guide - continued

Malfunction	Cause	Solution
Non-linear response	Incorrect calibration source	Verify accuracy of multipoint calibration source gas.
	Leak in sample probe line.	Check for variable dilution.
Excessive response time	Partially blocked sample capillary	Unplug power cord. Clean or replace capillary.
	Hang up/blockage in sample filter	Replace filter element.
Improper converter operation	Questionable calibration gas value	Verify accuracy.
	Converter temperature too high or too low	Temperature should be about 325°C.
	Low line voltage	Check that line voltage is within specifications.
	Molybdenum consumed	Replace molybdenum converter cartridge.

Table 9-6: NO_X Analyzer Alarm Messages

Alarm Message	Possible Cause	Action
Alarm – Cooler Temp	Check fan operation	Replace fan if not operation properly.
	Check fan filter	Clean or replace foam filter
Cooler reads 80ºC	Bad cooler	Replace cooler.
	Cooler does not hold set point of -3ºC	Replace cooler – thermoelectric module inside cooler failed.
	Cooler reads -20°C	Replace cooler – thermocouple bad.
Alarm – Internal Temp	Check fan operation	Replace fan if not operating properly.
	Check fan filter	Clean or replace foam filter.
Alarm – Chamber Temp	Chamber Temperature below set point of 50ºC	Check 10 K thermistor, replace if bad. Check temperature control board to insure the LEDs are coming on. If not, temperature control board could be defective.
Alarm – Conv. Temp	Converter temperature low	Molybdenum converter should be hot to touch, if not the heater may have failed. Check that converter temp. set point is approximately 325°C. Check that voltage to the heater is 115 VAC.

Alarm messages continued

Alarm Message	Possible Cause	Action
Alarm - Pressure	High pressure indication	Check the pump for a tear in the diaphragm, replace with pump repair kit if necessary. Check that capillaries are properly installed and O-ring are in good shape. Replace if necessary. Check flow system for leaks.
Alarm – Sample Flow	Sample flow low	Check sample capillary (15 mil) for blockage. Replace as necessary. If using sample particulate filter make sure it is not blocked. Disconnect sample particulate filter from the sample bulkhead, if flow increases replace the filter.
Alarm – Ozonator Flow	Ozone flow low.	Check ozone capillary (0.008 inch ID) for blockage. Replace as necessary.
Alarm – NO, NO_2, NO_X Conc.	Concentration has exceeded range limit	Check to insure range corresponds with expected value. If not select proper range.
	Concentration low	Check user-defined low set point, set to zero.

9.6 Troubleshooting the TEI Model 48i CO Analyzer

Refer to the TEI 48i CO manual for detailed instructions on corrective maintenance procedures and troubleshooting procedures (located in the appendix section of the CEMS Operation and Maintenance manual CD). The following is only a brief overview.

Table 9-7: CO Analyzer General Troubleshooting

Malfunction	Possible Cause	Action
Does not start (The light on power switch does not come on and the pump motor is not running.)	No power or wrong power configuration	Check the line to confirm that power is available and that it matches the voltage and frequency configuration of the instrument.
	Main fuse is blown or missing	Unplug the power cord, open the fuse drawer on the back panel, and check the fuses visually or with a multimeter.
	Bad switch or wiring connection	Unplug the power cord, disconnect the switch and check operation with a multimeter.
Pressure transducer does not hold calibration or is noisy	Pressure transducer defective	Replace pressure transducer
Run output noisy	Recorder noise	Replace or repair recorder
	Sample CO concentration varying	Run instrument on a span CO source – if quiet, there is no malfunction
	Foreign material in optical bench	Clean optical bench
Analyzer does not calibrate properly	System leak	Find and repair leak
	Pressure or temperature transducer out of calibration	Recalibrate pressure and temperature transducer
	Dirty system	Clean cells and flow components
	Leaky correlation wheel	Replace with a known good wheel.
Analog test ramp	Faulty recorder	Replace recorder
	D/A calibration off	Recalibrate the D/A with a DVM known to be in calibration.

Table 9-8: CO Analyzer Alarm Messages

Alarm Message	Possible Cause	Action
Alarm – Internal Temp	Check fan operation	Replace fan if not operating properly
	Check fan filter	Clean or replace foam filter.
Alarm – Chamber Temp	Chamber temperature below set point of 50°C	Check 10K thermistor, replace if bad. Check temperature control board to insure the LEDs are coming on. If not, temperature control board could be defective.
Alarm – Pressure	High pressure indication	Check the pump for a tear in the diaphragm, replace with pump repair kit if necessary. Check that capillaries are properly installed and O-rings are in good shape. Replace if necessary. Check flow system for leaks.
Alarm – Flow	Flow low	Check sample capillary (0.015 inch ID) for blockage. If using sample particulate filter make sure it is not blocked. Disconnect sample particulate filter from the sample bulkhead, if flow increases, replace the filter.
Alarm – Bias voltage	Defective measurement interface	Replace measurement interface board.
	Defective pre-amp board	Replace pre-amp board.
Alarm- AGC intensity	Pre-amp Gain not set properly	Check Gain adjustment
	Defective pre-amp board	Replace pre-amp board
Alarm – Motor Speed	Defective measurement interface board	Replace measurement interface board.
	Defective chopper motor or cable	Check chopper motor cable. Replace chopper motor.

Alarm messages continued

Alarm Message	Possible Cause	Action
Alarm – CO Conc.	Concentration has exceeded range limit	Check to insure range corresponds with expected value. If not select proper range.
	Concentration low	Check user-defined low set point, set to zero.
Alarm – Zero Check Alarm – Span Check Alarm – Zero Autocal Alarm – Span Autocal	Instrument out of calibration	Recalibrate instrument Check gas supply. Perform manual calibration.
Alarm – Motherboard Status Alarm – Interface Status Alarm – I/O Exp Status	Internal cables not connected properly. Board is defective	Check that all internal cables are connected properly. Recycle AC power to instrument. If still alarming, change board.

[End of section. Document is formatted for double-sided printing.]

10 Recommended Spare Parts

The spare parts listed in this section are required for the maintenance and repair of the system. Some parts should be kept on hand at all times to ensure system availability and reliability.

Call CEMTEK Environmental Parts Department at 1-888-400-0200 for current spare parts listing, part numbers, and pricing. The Parts Department fax number is 714-437-7177.

Parts can also be ordered through an online portal at www.cemtekparts.com. The portal includes a customized online parts ordering system tailored for each customer's unique set of equipment and parts. The site includes a searchable parts database and customer knowledge base which is updated on a regulator basis. In addition to ordering parts online, customers have the option to email the parts department, send an email to the CEMTEK service department, or request onsite service through the portal.

Consult with CEMTEK's Service Department at 1-888-400-0201 first (not the Parts Department) when a bad component is suspected after troubleshooting procedures. It's possible that a simple adjustment may "fix" the problem rather than a component replacement. If it's determined that a component does require replacement the Service Department will check warranty status and issue an RMA number for return and replacement of the component part(s).

Call the CEMTEK Service Department to check warranty status.

Consumable Parts
The consumable spare parts list 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 through the life of the system.

Basic Spare Parts
The basic spare parts list includes 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 through the life of the system.

Critical Spare Part
The critical spare parts list includes parts that will need to be replaced to maintain system accuracy and reliability in case of a major failure. These parts should be kept on hand to perform major repairs or maintenance through the life of the system.

In Depth Spare Parts
The complete spare parts list includes all parts used in the system.

[End of section. This document is formatted for double-sided printing.]

11 Emission Equations

11.1 Monitored Parameters

Monitored and calculated parameters include:

Stack O2%
Stack NOx, ppm
Stack NOx, ppm @ 15% O2
Stack CO, ppm
Stack CO, ppm @ 15% O2
Inlet NOx, ppm
Inlet NOx, ppm @ 15% O2
Natural gas fuel flow, dscfm
Digester gas fuel flow, dscfm
Total plant natural gas fuel flow, kdscfh
Total plant digester gas fuel flow, kdscfh
IC Engine load, MW
Stack flow (calculated), dscfm
NOx rate, lbs/day
Total plant NOx rate, lbs/day
CO rate, lbs/day
Total plant CO rate, lbs/day
NH3 (urea) slip, ppm @ 15%O2

11.2 Equations

The following lists a series of equations used for emissions calculations for SCAQMD Rule 218, 1110.1, and air permit reporting. The data acquisition system performs these calculations using signal inputs from each analyzer and from process parameter monitoring sources and utilizing standard defaults and conversion factors, as applicable.

Signal inputs from a fuel flowmeter will be used to calculate and report mass emissions (lbs/hr, lbs/day).

O_2 Correction			
$$C_{adj} = C_d \text{ x } \frac{20.9 - n\%O_2}{20.9 - \%O_2}$$			
Where:	$n\%O_2$	=	correction factor @ 15%O_2, per permit
	C_{adj}	=	Pollutant emissions in units of the standard (ppm @ 15% O_2)
	C_d	=	Dry pollutant concentration in ppm
	O_2	=	Oxygen concentration in percent measured at same point

This data is compiled into daily reports, which contain emissions data, excess emissions periods, calibration data and faults and warning messages.

Emission rates (lb/mmBtu) will be determined by the following equations (40 CFR 60, Appendix A, Method 19):

Oxygen-based F factor, dry basis (from EPA Method 19): When measurements are on a dry basis for both O_2 ($\%O_{2d}$) and pollutant (C_d) concentrations.			
$E = K \text{ x } C_d \text{ x } F_d \text{ x } [20.9 / (20.9 - \%O_{2d})]$			
Where:	E	=	Pollutant emission, lb/mmBtu
	K	=	Conversion factor NO_x conversion factor use 1.195 x 10^{-7} (lbs/dscf)/ppm NO_X CO conversion factor use 7.267 x 10^{-8} (lbs/dscf)/ppm CO
	C_d	=	Hourly average pollutant concentration, dry basis, ppm
	$O_2\%$	=	Oxygen content by volume (expressed as percent), dry or wet basis
	F_d	=	An O_2 based factor representing a ratio of the volume of dry flue gases generated to the higher heating value. (dscf/mmBtu) F factor for digester gas will be calculated based on fuel analysis. F factor for natural gas will use the EPA default value of 8710.

Fuel based F factors will be determined through fuel analysis for digester gas.

Determined F Factors		
$F_d = [(K_{hd}\%H) + (K_c\%C) + (K_n\%N) - (K_o\%O)] / [(GCV * K/Mw/1000000) * 100]$		
Where:		
F_d	=	Volume of combustion components per unit of heat content, scf/mmBtu
%H, %C,%N, %O	=	Concentrations of hydrogen, carbon, nitrogen, and oxygen from an ultimate analysis of fuel, weight percent
GCV	=	Gross calorific value of the fuel consistent with the ultimate analysis, Btu/scf
K	=	385.5 scf/lbmol
Mw	=	Molecular weight of fuel
K_{hd}	=	3.64 (scf/lb)/(%)
K_c	=	1.53 (scf/lb)/(%)
K_n	=	0.14 (scf/lb)/(%)
K_o	=	0.46 (scf/lb)/(%)

Fuel derived mass emissions calculation.

Fuel Derived Mass Emissions			
ER = E x HF			
Where:	ER	=	Emission Rate in lb/hr
	E	=	Pollutant emission in lb/mmBtu, O_2 based (using the EPA Method 19 equation referenced above)
	HF	=	Heat Flow in mmBtu/hr = (fuel flow in scf/hr x 1050 Btu/scf)/10^6

Heat input calculation

Heat Input			
$HI = (FF * GCV) / 10^6$			
Where:	HI	=	Heat input rate from fuel, mmBtu/hr
	FF	=	Fuel flow, scf/hr
	GCV	=	Gross caloric value of the fuel, Btu/scf

Lbs/day emissions

Mass Emissions, lb/day			
$$N_i = \sum_{i=1}^{24} M_i$$			
Where:	Ni	=	Mass emission rate of pollutant in lb/day for i engine
	Mi	=	Mass emission rate of pollutant lb/hr summed up in a 24 hr period

Total plant mass emissions

Total Mass Emissions			
$$T_i = \sum N_i$$			
Where:	Ti	=	Total plan mass emission rate in lb/day for i, day of month
	Ni	=	Mass emission rate of pollutant in lb/day for i engine.

Total plant mass emission rate lb/day for i day of the month using hourly emission data

$$X_i = \frac{\sum_{i=1}^{Last-day-of-month} T_i}{i}$$			
Where:	Xi	=	Total plant mass emission rate of pollutant in lb/day averaged over the number of days in a given calendar month
	Ti	=	Total mass emission rate of pollutant lb/day for i day of the month

Urea slip:
The NOx and urea react on a 1:2 basis. Therefore, the amount of urea is equal to 1/2 the amount of NOx reduced in the SCR. The simplified formula is:

NH3 (urea) slip = urea fed – (NOx in – NOx out) * 1/2

We intend to use the formula that solves for NH3 slip using mass flow molar values which requires the calculation or measurement of stack flow.

((9.21*NH3 Flow Rate / 60.0553) - ((Dry Gas Flow Rate/29) * ((Inlet NOx - Outlet NOx) / 2) / 10^6) * (10^6 / Dry Gas Volumetric Flow Rate / 29))

NH3 Flow Rate = gal/hr
Inlet NOx & Outlet NOx – ppmc @ 15% O2
Dry Gas Volumetric Flow Rate – lb/hr

dry gas volumetric flow = ((Fuel Flow * Fuel GCV) * Fuel F_Factor) * (20.9 | (20.9 – O2))

Ph20/Urea = 68.9 lb/ft3 or 9.21 lb/gal when Urea @ 32.5 %, 4 deg C

[End of section. This document is formatted for double-sided printing.]

Continuous Emissions Monitoring System (CEMS)

Quality Assurance Plan (QAP)

SCAQMD Rule 218.1 and SCAQMD Rul2 1110.2
40 CFR 60, Appendix F

Project Title: CEMS
Job Number: J-79-1A
Process Code: Plant 2=26

Date: September 2014
Revision: 3
CEMTEK Project No.: 50173, 50419

Prepared for:

Orange County Sanitation District – Reclamation Plant 2
IC Engine Units 1 thru 5
Huntington Beach, CA

SCAQMD Facility ID: 029110

Prepared by:

CEMTEK Environmental, Inc.
3041 S. Orange Ave
Santa Ana, CA 92707-4247
Phone: 714-437-7100
Fax: 714-437-7177
www.cemteks.com

[End of section. This document is formatted for double-sided printing.]

Preface

Notices:
Product names referenced in this manual are trademarks of their respective manufacturers.

The information in this document has been carefully compiled and edited. While this material is believed to be accurate, no responsibility is assumed for possible inaccuracies or omissions.

Cautions and Warnings:
Before performing any maintenance on the CEMS components refer to the manufacturers' manuals. Observe all manufacturers' cautions and warnings noted in the component manuals. Also read all safety labels that may be posted on equipment.

General Warnings: *The technicians performing maintenance should be familiar with all safety warnings contained in the individual manufacturer's manuals. All maintenance must be performed in accordance with facility safety procedures.*

Most components need to be powered off before major maintenance to prevent potential electrical shock hazards. Maintenance performed on electrical equipment must be conducted in accordance with facility Lockout/Tagout (LO/TO) procedures

Some components can be damaged by small amounts of static electricity. Before performing any maintenance, use a properly grounded antistatic wrist strap to be worn while handling any instrument's internal components.

Some components such as the probe or heating elements on some analyzer types may be extremely hot to the touch. Wear protective heat-resistant gloves when handling.

Other components such as optical assemblies and capillaries in the analyzers are made of glass and must be handled carefully.

Be careful when using solvents or abrasive materials for cleaning to avoid damage to components. Check manufacturers' manuals for recommended cleaning materials and procedures.

Revision Log:

Revision No.	Revision Date	Revised Sections	Notes
3	September 2014	All	Reformat to updated template. Revisions added for CEMS upgrade (Inlet NO_X analyzer). Supersedes previous versions of the QAP.

Contact Information

West Coast Office	East Coast Office
CEMTEK Environmental, Inc. 3042 S. Orange Ave. Santa Ana, CA 92707-4247 Ph.: 714-437-7100 Fax: 714-437-7177	CEMTEK Systems, Inc. 2012 South Wood Ave. Linden, New Jersey 07036 Ph.: 908-474-9630 Fax: 908-474-9413
For parts and service call: 1-888-400-0200 or order online at www.cemtekparts.com	
For 24-hour emergency service call: 1-888-400-0201	
Website: www.cemteks.com	

Additional Reference Material

Refer to the following manuals for additional information located under separate cover.

Code of Federal Regulations, Title 40, Part 60 (eCFR website): In the pull down list select Title 40 and then follow the links to Part 60
http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=%2Findex.tpl

Facility's Air Permit

DAHS User Guide

CEMS Operation and Maintenance Manual

EPA's Emission Measurement Center, use to download copies of EPA test methods: http://www.epa.gov/ttn/emc/

South Coast Air Quality Management District (SCAQMD) website:
http://www.aqmd.gov/

[End of section. This document is formatted for double-sided printing.]

Contents

Contents v
Tables viii
1 Quality Assurance Plan Overview 1-1
1.1 Introduction 1-1
1.2 Quality Assurance Plan Objective 1-1
1.3 Quality Audit Procedures Overview 1-2
1.4 Document Control 1-3
1.5 Facility Responsibilities 1-3
2 Facility and CEMS Description 2-1
2.1 Facility Description 2-1
2.1.1 Emission Limits 2-1
2.2 CEMS System Description 2-1
2.2.1 Analyzers Included in the CEMS 2-1
2.3 Sample System Overview 2-3
2.3.1 Sample Probe 2-3
2.3.2 Sample Probe 2-3
2.3.3 Sample Line 2-3
2.3.4 Vacuum Gauge – VG1, VG2 2-4
2.3.5 Sample Pump – SP1, SP2 2-4
2.3.6 Sample Gas Cooler – GC1, GC2 2-4
2.3.7 Cooler Drain Pumps – DP1/DP2, DP3/DP4 2-4
2.3.8 Ammonia Scrubber – AS1 2-5
2.3.9 Moisture Sensor – MS1, MS2 2-5
2.3.10 Filter – F1, F2 2-5
2.3.11 Solenoid Valve and Trim Valve – SV8, SV10, TV1, TV2 2-5
2.3.12 Flow Switch – FS1, FS2 2-5
2.3.13 Total Sample Flow Meter – RM1, RM5 2-5
2.3.14 Analyzer Flow Meter – RM2, RM3, RM6 2-5
2.3.15 Pressure Gauge – PG2, PG3 2-6
2.3.16 Back Pressure Regulator – BPR1, BPR2 2-6
2.4 Analytical Instruments 2-6
2.4.1 TEI Model 42i-LS NO_X and NO_X/O_2 Analyzer 2-6
2.4.2 TEI Model 48i CO Analyzer 2-7
2.5 Instrument Air Subsystem 2-7
2.5.1 Hand Valves – HV1, HV2, HV3 2-8
2.5.2 Pressure Gauge and Pressure Switch – PG1, PS1 2-8
2.5.3 Filter Regulator – FR1 2-8
2.6 Redundant Air Clean Up Panel 2-8
2.6.1 Hand Valves – HV4, HV5, HV6 2-8
2.6.2 Particulate Filters – F1, F2, F3 2-8
2.6.3 Refrigerated Air Dryer – RAD1 2-9
2.6.4 Coalescing Filter – CF1 2-9
2.6.5 Heatless Air Dryer – HAD1 2-9
2.7 Calibration Gas Subassembly 2-9

2.7.1 Calibration Gas Regulator – REG1 thru REG9 2-10
2.7.2 Calibration Gas Solenoid Valves....2-10
2.7.3 Calibration Flow Rotameter – RM4, RM7 2-10
2.8 Operator Interface Terminal....2-10
2.9 CEMS Controller 2-10
2.10 Data Acquisition and Handling System 2-11
3 CEMS Routine Operation Procedures....3-1
3.1 General....3-1
3.2 Component Check....3-1
3.3 Temperature Control 3-1
3.4 Front Panel Switches and Indicators....3-1
3.5 Initial Startup....3-2
3.5.1 Normal System Sampling Flow Verification 3-3
3.6 Shutdown and Storage....3-3
3.7 Routine Operation 3-4
3.8 Probe Purge....3-5
3.9 CEMS Calibrations 3-5
3.9.1 Automatic Calibrations....3-5
3.9.2 Post Maintenance Calibration and Leak Check 3-6
4 Data Recording and Reporting....4-1
4.1 Data Acquisition System 4-1
4.2 SCAQMD Valid Data Requirements 4-2
4.3 Electronic Reporting....4-3
5 Quality Control Activities 5-1
5.1 Introduction 5-1
5.2 Calibration Audit Gases....5-1
5.2.1 Safety Procedures for High Pressure Gas Cylinders....5-2
5.2.2 Calibration Gas Cylinder Change Out....5-3
5.3 Daily Calibration Error Check 5-4
5.3.1 Conducting the Daily Calibration Error Test 5-4
5.3.2 Additional Calibration Error Tests and Adjustments 5-6
5.3.3 Re-calibration Limits 5-7
5.3.4 Out-of-Control Limits 5-7
6 Quality Assurance Activities....6-1
6.1 Introduction 6-1
6.2 Quarterly Assessments 6-1
6.3 Cylinder Gas Audit – Part 60 6-1
6.3.1 Cylinder Gas Audit Procedure 6-1
6.3.2 Out-of-Control Period 6-3
6.4 Annual Relative Accuracy Test Audit 6-3
6.4.1 Sampling Strategies....6-4
6.4.2 Correlation of Data....6-5
6.4.3 O_2 Relative Accuracy Test....6-5
6.4.4 NO_X Relative Accuracy Test....6-6
6.4.5 CO Relative Accuracy 6-7
6.4.6 Flow Relative Accuracy Test....6-7
6.4.7 Relative Accuracy Calculations....6-8
6.4.8 Out-of-Control Period 6-9

6.5 Sampling System Bias Test 6-9
7 Recertification and Diagnostic Tests 7-1
7.1 Introduction 7-1
7.2 Diagnostic Tests and Recertification Events 7-1
7.2.1 Diagnostic Tests and Recertification Summary Tables 7-1
7.2.2 SCAQMD Recertification Procedures 7-9
7.2.3 Impact of Recertification Events on Data Acceptability 7-9
8 Routine Preventive Maintenance 8-1
8.1 Introduction 8-1
8.2 Logbook Maintenance 8-1
8.3 Minimize Downtime during Routine Maintenance 8-2
8.4 System Checks 8-2
8.4.1 Calibration Failure 8-3
8.4.2 Abnormal Measurement Output Voltage/Current 8-4
8.4.3 Water Contamination 8-4
8.4.4 Moisture Sensor Check 8-4
8.4.5 Sample System Particulate Filter Check 8-5
8.4.6 Routine Maintenance for the Sample Probe 8-5
8.4.7 Routine Maintenance for the Sample Line 8-6
8.4.8 Routine Maintenance for the Sample Conditioning Unit 8-6
8.4.9 Replacing Ammonia Scrubber 8-6
8.4.10 Instrument Air Filter Service Check 8-7
8.4.11 Peristaltic Pump Tubing Replacement 8-8
8.4.12 Sample Pump Diaphragm Replacement 8-9
8.4.13 NO_X Converter Check 8-10
8.4.14 Analyzer Cabinet Temperature Control 8-11
8.5 CEMS Preventive Maintenance Schedule 8-11
8.5.1 Daily Preventive Maintenance 8-14
8.5.2 Weekly Preventive Maintenance 8-18
8.5.3 Monthly Preventive Maintenance 8-20
8.5.4 Quarterly Preventive Maintenance 8-21
8.5.5 Semiannual Preventive Maintenance 8-24
8.5.6 Annual Preventive Maintenance 8-26
9 Corrective Maintenance and Troubleshooting 9-1
9.1 Introduction 9-1
9.1.1 Troubleshooting the System 9-1
9.1.2 CEMS Leak Check Procedure 9-2
9.1.3 Flow Balance Procedure 9-3
9.2 Sample Cooler 9-4
9.3 Troubleshooting the AirTak Heatless Air Dryer 9-5
9.4 Troubleshooting the AirTak Refrigerated Air Dryer 9-7
9.5 Troubleshooting the NOX Analyzer 9-8
9.6 Troubleshooting the TEI Model 48i CO Analyzer 9-11
10 Recommended Spare Parts 10-1
11 Emission Equations 11-1
11.1 Monitored Parameters 11-1
11.2 Equations 11-1

Tables

Table 2-1: CEMS Analyzers Summary Information 2-2
Table 5-1: Daily Calibration Gas Specifications....5-4
Table 5-2: Excessive Calibration Error Criteria – Part 60 5-8
Table 6-1: CGA Calibration Gas Specifications – Part 60 6-2
Table 7-1: Like Replacements Only....7-2
Table 7-2: Unlike Replacements Only....7-6
Table 9-1: Troubleshooting the Sampling System 9-1
Table 9-2: Sample Cooler Troubleshooting Overview 9-4
Table 9-3: Heatless Air Dryer Troubleshooting....9-5
Table 9-4: Refrigerated Air Dryer Troubleshooting 9-7
Table 9-5: NO_X Analyzer General Troubleshooting....9-8
Table 9-6: NO_X Analyzer Alarm Messages....9-9
Table 9-7: CO Analyzer General Troubleshooting....9-11
Table 9-8: CO Analyzer Alarm Messages 9-12

1 Quality Assurance Plan Overview

1.1 Introduction

This document is intended to satisfy the requirements of the South Coast Air Quality Management District (SCAQMD) Rule 218.1 and 1110.2. SCAQMD regulations require development of a quality control program. This document is in compliance with this requirement.

Note that the facility has chosen the 40 CFR 60, Appendix B and Appendix F option on the SCAQMD ST-220 CEMS Application Form (Item 14) for Non-RECLAIM CEMS. Appendix B details specifications required to certify the CEMS analyzers. Appendix F details on-going Quality Assurance/Quality Control procedures for the CEMS.

This Quality Assurance Plan (QAP) has been developed for the gas continuous emissions monitoring systems (CEMS) for the Orange County Sanitation District (OCSD) Reclamation Plant No. 2 located in Huntington Beach, CA.

1.2 Quality Assurance Plan Objective

The QAP establishes operational procedures that will ensure data and measurements are accurate and precise. At no time will non-quality assured data be reported as valid data.

The objective of the QAP is to establish a series of QA and QC activities that will provide a high level of confidence in the data reported by the CEMS. The QAP provides guidelines for implementing QA and QC activities needed to ensure that emission-monitoring data are complete, representative, and of known precision and accuracy.

Quality Control (QC): The procedures, policies, and corrective actions necessary to ensure product quality. QC procedures are routine activities. These activities include but are not limited to daily calibrations and routine preventive maintenance activities as defined by manufacturers of the various hardware components of the CEM system and by regulatory agencies.

QC procedures are specific maintenance activities necessary to optimize the CEMS performance and reliability. These activities include daily, weekly, monthly, quarterly, semiannual and annual checks and inspections. Corrective actions, such as corrective maintenance and recalibrations, are performed when the specification limits 40 CFR 60, Appendix F or SCAQMD Rule 218 are exceeded.

Quality Assurance (QA): A series of checks performed to ensure the QC procedures are functioning properly. Quality assurance is often used to define “external” activities (that is functions performed on a more occasional basis). The activities include but are not limited to required periodic quarterly and annual audits.

QA procedures consist of a series of checks and audits that are performed on the CEMS on a predetermined as well as an "as needed" basis. The resulting assessments activate QC measures and corrective actions. After the corrective actions are performed, the data quality is again assessed. The quality of the data will determine whether the corrective actions were successful or whether further actions are required.

This QAP only summarizes the QA/QC activities. Operation and Maintenance manuals from the analyzer manufacturers were used in the development of QC procedures. These documents are maintained at the facility and provide detailed procedures for calibration, troubleshooting, and repair for the CEM system major equipment components. These documents should be used as a major reference source whenever maintenance activities occur. The manufacturers' manuals are located as appendices in the CEMS Operation and Maintenance manual.

1.3 Quality Audit Procedures Overview

The following is a brief description of the type and frequency of QA/QC procedures, as outlined in SCAQMD Rule 218 and 40 CFR 60 Appendix F as applicable.

Daily Assessments:

- Two-point (Zero and Span) calibration drift tests for all pollutant concentration and diluent monitors.
- If an Out-of-control event occurs the appropriate maintenance and corrective action(s) will be performed and the daily assessment repeated for the affected monitor.
- Data recording and tabulation of all calibration error tests according to month, day, and magnitude.

Quarterly Assessments

- Quarterly two-point cylinder gas audit (CGA) for CO monitors (40 CFR 60, Appendix F, Section 5.1.2).
- If an Out-of-control event occurs the appropriate maintenance and corrective action(s) will be performed and the quarter assessment repeated for the affected monitor.

Annual QA Activities

- Annual Relative Accuracy Test Audit
- If an Out-of-control event occurs the appropriate maintenance and corrective action(s) will be performed and the annual assessment repeated for the affected monitor.

1.4 Document Control

This QAP is a controlled document. The QAP should be reviewed on an annual basis and updated when needed to reflect changes in regulatory requirements. It should also be updated if any changes in scheduled maintenance routines are indicated after experience in operating the system after a prolonged period of time. Maintenance schedules can vary depending upon site-specific conditions (example, filters may need to be changed more often in a “dirty” environments or less often under “clean” conditions) or as the system ages certain maintenance routines may have to be performed more often. The schedule of preventive maintenance routines outlined in Chapter 8 of this QAP are based on manufacturers’ recommendations and experience from the CEMTEK field service technicians. The maintenance schedule may need adjusting over time based on site-specific conditions.

When modifications to the QAP become necessary, responsible facility personnel will be designated to ensure that any required revisions are made to the QAP document, providing a copy of any revisions to all individuals or groups that need to be aware of such changes. The plant operating procedures, equipment operation and maintenance (O&M) manuals, and other documents that are referenced in this QAP are not controlled documents and therefore are not subject to this document revision procedures.

To ensure that all copies of the QAP are revised to contain current procedures, the following document control headers and footers are provided on each page:

Revision Number
Date of Revision
Section/Page Number

1.5 Facility Responsibilities

Certain individuals and groups at the facility will have designated responsibilities to ensure that QA/QC activities are performed as required by this QAP program. The following is a fairly typical organizational structure of responsibilities.

Environmental Affairs Group (as equivalent to individual facilities):

- Oversees the CEMS QA/QC program
- Reviews all plans and reports for accuracy
- Prepares certification/recertification applications and notifications
- Stays abreast of Federal, State and local regulation updates that may affect the CEMS programs and interprets as required
- Coordinates and schedules CEMS audits, diagnostic tests and certification/recertification tests as required
- Submits emission summary reports and certification/recertification test results to the regulatory agency(s) as required
- Supports and provides training in the administration and maintenance of the CEMS Data Acquisition and Handling System (DAHS)
- Reviews CEMS data for validity and makes any necessary corrections so the proper data will be entered in the quarterly reports

- Ensures records are maintained for out-of-control conditions
- Notifies the Plant Manager of any abnormal conditions that cannot be resolved within existing CEMS procedures in a reasonable amount of time
- Prepares emission summary reports for approval and submittal in a timely manner at the end of the reporting periods to allow review prior to submittal
- Maintains files of all plant CEMS data (hard copy and electronic), reports, calibration gas certificates
- Notifies appropriate plant personnel of scheduled CEMS audits and certification/recertification tests
- Arranges for support needed by contractors for relative accuracy test audits (RATAs) and certification/recertification tests
- Provides plant resources to assist contractors during RATAs and certification or recertification testing

Plant manager:

- Designates and manages manpower and other resources needed to properly maintain and operate the CEMS
- Reviews and approves all plant-specific CEMS plans, procedures, and reports

Maintenance managers and shift supervisors:

- Reviews CEMS calibration reports on a daily basis and responds to CEMS alarms
- Notifies the Plant Manager of any abnormal conditions so immediate action can be taken to return the system to normal operating conditions
- Notifies the environmental staff and maintenance technicians of CEMS malfunctions
- Ensures that a spare parts inventory is maintained based on manufacturers' recommendations and plant operating experience with the CEMS
- Ensures that the inventory of EPA Protocol calibration gases is well maintained
- Ensures that work requests for preventive maintenance and priority jobs on the CEMS are scheduled and completed in a timely manner

Maintenance and instrument technicians:

- Performs all maintenance (routine and corrective) to keep the CEMS running according to specifications
- Maintains a complete CEMS maintenance log
- Assists contractors during audits and certification/recertification testing
- Checks the conditions of all analyzer shelters
- Informs responsible managers/supervisors of the CEMS status on at least a weekly basis

2 Facility and CEMS Description

2.1 *Facility Description*

OCSD's Reclamation Plant No.2 consists of five (5) Internal Combustion Engines (ICEs) firing natural gas or digester gas. Individual CEMS will monitor emissions from each ICE exhaust stack.

2.1.1 Emission Limits

The following limits are excerpted from the air permit and SCAQMD Rule 1110.2.

NO_X 47.6 ppm @ 15% O_2
828 lb/day (total for all five ICEs)

CO 600ppm @ 15% O_2
2,644 lb/day (total for all five ICEs)

2.2 *CEMS System Description*

Each CEMS is a fully extractive system that is housed in an environmentally controlled shelter.

Each CEMS measures concentrations of oxides of nitrogen (NO_X), carbon monoxide (CO) and oxygen (O_2) from each IC Engine exhaust stack. All measurements are done on a real time basis. An additional NO_X analyzer is installed on the control equipment inlet for process monitoring and control. The system includes a programmable logic controller (PLC). The PLC communicates, via Ethernet, from the CEMS to the Data Acquisition System (DAHS) computer. The PLC will transmit one-minute averages. Contact closures are provided for alarms and system status.

Complete system operation, including calibration and sequencing is automatic. Operator attention is necessary only for periodic manual verification of accuracy and normal maintenance.

2.2.1 Analyzers Included in the CEMS

The following table summarizes the analyzer components of the CEMS. A brief description of each analyzer and other major equipment components is located in the following sections.

Table 2-1: CEMS Analyzers Summary Information

ICE Unit 1 CEMS

Analyzer	Manufacturer/Model	Range(s)	Serial Number
Stack NO_X/O_2	TEI 42i-LS	NO_X: 0-35/0-100 ppm O_2: 0-25%	0836634042
Stack CO	TEI 48i	0-80/0-760 ppm	0836634048
Inlet NO_X	TEI 42i-LS	0-100 ppm	0836634043

ICE Unit 2 CEMS

Analyzer	Manufacturer/Model	Range(s)	Serial Number
Stack NO_X/O_2	TEI 42i-LS	NO_X: 0-35/0-100 ppm O_2: 0-25%	0904434731
Stack CO	TEI 48i	0-80/0-760 ppm	09010026
Inlet NO_X	TEI 42i-LS	0-100 ppm	0904434734

ICE Unit 3 CEMS

Analyzer	Manufacturer/Model	Range(s)	Serial Number
Stack NO_X/O_2	TEI 42i-LS	NO_X: 0-35/0-100 ppm O_2: 0-25%	0904434730
Stack CO	TEI 48i	0-80/0-760 ppm	09010028
Inlet NO_X	TEI 42i-LS	0-100 ppm	0904434732

ICE Unit 4 CEMS

Analyzer	Manufacturer/Model	Range(s)	Serial Number
Stack NO_X/O_2	TEI 42i-LS	NO_X: 0-35/0-100 ppm O_2: 0-25%	0910435616
Stack CO	TEI 48i	0-80/0-760 ppm	09010030
Inlet NO_X	TEI 42i-LS	0-100 ppm	0910435618

ICE Unit 5 CEMS

Analyzer	Manufacturer/Model	Range(s)	Serial Number
Stack NO_X/O_2	TEI 42i-LS	NO_X: 0-35/0-100 ppm O_2: 0-25%	0910435617
Stack CO	TEI 48i	0-80/0-760 ppm	09010029
Inlet NO_X	TEI 42i-LS	0-100 ppm	0910435619

2.3 Sample System Overview

To ensure accuracy a clean, dry representative gas sample must be transported to the analyzers. Any moisture or particulate matter can cause damage to the gas analyzers so it must be removed from the sample. The following describes the function and operation of major system components arranged according to the normal flow of sample gas from sample probe to gas analyzers.

Refer to the CEMS sample system flow engineering diagrams located as Chapter 7 (drawing number 505041902). In the following sections tag names for major components are identified in **BOLD** typeface where applicable. Cross reference these tag names against the CEMS diagrams. Also refer to the CEMS diagrams for flow rate and pressure set points associated with several components.

2.3.1 Sample Probe

To ensure accuracy a clean, dry representative gas sample must be transported to the analyzers. Any moisture or particulate matter can cause damage to the gas analyzers so it must be removed from the sample. The following describes the function and operation of major system components arranged according to the normal flow of sample gas from sample probe to gas analyzers.

Refer to the CEMS sample system flow engineering diagrams (located with the Operation and Maintenance manual files). In the following sections tag names for major components are identified in **BOLD** typeface where applicable. Cross reference these tag names against the CEMS diagrams. Also refer to the CEMS diagrams for flow rate and pressure set points associated with several components.

2.3.2 Sample Probe

The Universal Analyzers Model 270S heated stack filter assembly and probe is designed for continuous extraction of gases with sample flow rates of up to 20 liters per minute. The filter assembly, which provides the first stage of sample conditioning, is mounted in a NEMA 4X fiberglass enclosure. The filter assembly is heated to 400°F.

Instrument air is used to pressurize an accumulator to a maximum of 125 psig. During a probe purge, a solenoid valve opens providing a substantial blast of air that loosens the particles on the filter surface and forces them back through the probe into the stack.

Calibration gas is injected into the chamber ahead of the filter. A back pressure check valve insures that calibration gas does not leak into the sample.

2.3.3 Sample Line

The sample lines transport the gas sample from the probes to the analyzers. The heated line maintains the sample gas above the dew point, preventing moisture in the sample from condensing and affecting the analyzers' response.

The line contains a 1/4” tube for calibration gas, a 3/8” tube for probe purging operation, and a 3/8” tube for the gas sample. The temperature is maintained using a type “K” thermocouple. The sample line also contains wires for the sample line heater; probe filter heater and probe filter temperature alarm. The heated sample line umbilical is covered with a PVC jacket.

2.3.4 Vacuum Gauge – VG1, VG2

This vacuum gauge (Stack and Inlet) provides an indication of the condition of upstream components. A high vacuum reading can indicate a blockage or restriction in the probe or sample line. Normal pressure readings should be less than 10 inches Hg.

2.3.5 Sample Pump – SP1, SP2

The sample pump (Stack and Inlet) is a positive-displacement type that utilizes a moving diaphragm. During normal operation, the pressure at the pump outlet is set at approximately 10 psig, using the back-pressure regulator.

When the CEMS enclosure is located a considerable distance from the sample point, restriction on the sample lines may induce a substantial vacuum at the pump inlet. Be alert for leaks that could affect accurate measurement, especially in cases where a long sample line run causes pump inlet vacuum greater than 5 inches Hg.

The pump shuts down automatically if the moisture sensor (**MS1, MS2**) detects moisture in the sample system tubing downstream of the sample gas cooler.

Note: *A fatal alarm may be triggered by the controller if any condition occurs that may adversely affect the performance of the CEMS equipment, or may otherwise damage components of the CEMS equipment. For example, the detection of excess moisture in the sample stream can cause damage to the individual analyzers.*

2.3.6 Sample Gas Cooler – GC1, GC2

The M&C Series ECM-2G electric gas cooler (Stack and Inlet) is a compressor cooler. With the ECM model the sample gas is passed through up to two Jet-Stream heat exchangers where it is cooled to +5°C. Temperature is measured by a sensor and regulated electronically. The heat energy emitted by the cooling system is dissipated via a cooling fin block with forced ventilation. Solids are trapped in the sample probe filter as well as in a downstream fine filter.

A thermocouple with temperature alarm signal output is included on the sample gas cooler and will be monitored via signal input to the PLC and DAHS. The cooler’s dewpoint setpoint value is set at 37°F.

2.3.7 Cooler Drain Pumps – DP1/DP2, DP3/DP4

A two-head peristaltic pump (Stack and Inlet) continuously drains the condensation moisture traps. The pump motor is a fixed-speed drive rotating at 6 rpm. The pump requires 115V power.

2.3.8 Ammonia Scrubber – AS1

The ammonia (NH_3) scrubber protects the Stack NO_X analyzer reaction chamber by removing ammonia from the sample gas. Presence of NH_3 can cause a positive NO bias in the NO_X measurement. The scrubber also reduces ammonia salt buildup. The process depletes the scrubber media requiring periodic replacement. A hand valve (**HV4**) is used to shut off the drain from the ammonia scrubber.

2.3.9 Moisture Sensor – MS1, MS2

The moisture sensor (Stack and Inlet) monitors the sample gas stream at the sample gas cooler (**GC1, GC2**) outlet to detect any moisture, which could damage the gas analyzers. Any droplet of moisture across the conductivity sensor electrodes simulates a switch. The moisture sensor then sends a signal to the PLC causing the PLC to turn off the sample pump (**SP1, SP2**) and create an alarm to the DCS or data acquisition system. The moisture sensor is also connected to a relay board that automatically shuts off the sample pump (**SP1, SP2**), regardless of the PLC digital output, should moisture be detected downstream of the sample conditioner (**GC1, GC2**).

2.3.10 Filter – F1, F2

Sample gas flows through an in-line filter (Stack and Inlet), removing particulate that could damage downstream components. The filter has a replaceable filter element, which can trap particles as small as 2.0 micron.

2.3.11 Solenoid Valve and Trim Valve – SV8, SV10, TV1, TV2

This 3-way solenoid valve (Stack and Inlet) is used for performing local calibrations (direct calibration gas injections) to the analyzers, bypassing the probe and sample conditioning system.

The trim valve is used to adjust the flow rate of calibration gas during a local calibration sequence.

2.3.12 Flow Switch – FS1, FS2

Sample gas flows through a flow switch (Stack and Inlet) that sends a signal to the PLC when the sample flow rate falls below 3 liters per minute.

2.3.13 Total Sample Flow Meter – RM1, RM5

A flow meter (Stack and Inlet) indicates the sample flow rate at the sample pump outlet. The sample flow rate should be set using the back pressure regulator (**BPR1, BPR2**) to 4 to 5 liters per minute.

2.3.14 Analyzer Flow Meter – RM2, RM3, RM6

Sample gas flow for each analyzer is indicated and controlled by a flow meter. Adjust each analyzer flow meter to provide the required labeled flow rate (approximately 1.5 liters per minute).

2.3.15 Pressure Gauge – PG2, PG3

The pressure gauge (Stack and Inlet) monitors the sample gas pressure at the cooler outlet. The pressure gauge should read > 2 psig.

2.3.16 Back Pressure Regulator – BPR1, BPR2

The sample gas flows through the total sample flow meter (**RM1, RM5**). The gas flow then divides and flows through the analyzer sample flow meters. Excess sample gas is vented through a back pressure regulator. Adjust the back pressure regulator so as to maintain 4-5 liters per minute at the total sample flow meter (**RM1, RM5**).

2.4 Analytical Instruments

The CEMS measures NO_X, CO, and O_2. The following provides an overview on the theory of operation of each analyzer. Descriptions have been partially excerpted from manufacturers' manuals.

2.4.1 TEI Model 42i-LS NO_X and NO_X/O_2 Analyzer

The TEI Model 42i Low Source (LS) chemiluminescent analyzer is used to measure oxides of nitrogen. It is based on the principle that nitric oxide (NO) and ozone (O_3) react to produce a characteristic luminescence with intensity linearly proportional to the NO concentration. Infrared light emission results when the electronically excited NO_2 molecules decay to lower energy states.

Nitrogen dioxide (NO_2) must first be transformed into NO before it can be measured using the chemiluminescent reaction. NO_2 is converted to NO by a converter heated to about 625°C.

The gas sample enters the analyzer through the sample bulkhead. The sample flows through a particulate filter, a capillary, and then to the mode solenoid valve. The solenoid valve routes the sample either straight to the reaction chamber (NO mode), or through the NO_2-to-NO converter and then to the reaction chamber (NO_X mode).

Dry air enters the Model 42i-LS through the dry air bulkhead, through a flow sensor and then through a silent discharge ozonator. The ozonator generates the necessary ozone concentration needed for the chemiluminescent reaction. The ozone reacts with the NO in the ambient air sample to produce electronically excited NO_2 molecules. A photomultiplier tube (PMT) housed in a thermoelectric cooler detects the NO_2 luminescence.

The NO and NO_X concentrations calculated in the NO and NO_2 modes are stored in memory. The difference between the concentrations is used to calculate the NO_2 concentration. The Model 42i-LS outputs NO, NO_2 and NO_X concentrations to both the front panel display and the analog outputs.

A paramagnetic O_2 sensor bench is incorporated with the Stack NO_X analyzer for measurement of stack % O_2 content. The sensor measures the paramagnetic susceptibility of the sample gas by means of a magneto-dynamic measuring cell. Oxygen is virtually unique in being a paramagnetic gas; this means that it is attracted into a magnetic field.

In the measuring cell the oxygen concentration is detected by means of a dumb-bell mounted on a torque suspension in a strong, non-linear magnetic field. The higher the concentration of oxygen the greater this dumb-bell is deflected from its rest position. Around the dumb-bell is a coil of wire. A current is passed through this coil to return the dumb-bell to its original position. The current is measured and is proportional to the oxygen concentration.

The Inlet NO_X analyzer is the same make and model as the Stack NO_X analyzer but without the O_2 sensor bench.

2.4.2 TEI Model 48i CO Analyzer

The Model 48i operates on the principle that carbon monoxide (CO) absorbs infrared radiation at a wavelength of 4.6 microns. Because infrared absorption is a non-linear measurement technique, it is necessary to transform the basic analyzer signal into a linear output. The Model 48i uses an internally stored calibration curve to accurately linearize the instrument output over any range up to a concentration of 10,000 ppm.

The sample is drawn into the Model 48i through the sample bulkhead. The sample flows through the optical bench. Radiation from an infrared source is chopped and then passes through a gas filter alternating between CO and N_2. The radiation then passes through a narrow bandpass interference filter and enters the optical bench where absorption by the sample gas occurs. The infrared radiation then exits the optical bench and falls on an infrared detector.

The CO gas filer acts to produce a reference beam which cannot be further attenuated by CO in the sample cell. The N_2 side of the filter wheel is transparent to the infrared radiation and therefore produces a measurement beam which can be absorbed by CO in the cell. The chopped detector signal is modulated by the alternation between the two gas filters with an amplitude related to the concentration of CO in the sample cell. Other gases do not cause modulation of the detector signal since they absorb the reference and measure beams equally. Thus, the GFC system responds specifically to CO.

The Model 48i outputs the CO concentration to the front panel display, the analog outputs, and also makes the data available over the serial or Ethernet connection.

2.5 Instrument Air Subsystem

Instrument air is used for probe purging operation. The instrument air supply source is provided by plant resources. The air supply is controlled and regulated through the subassembly before transported for use by the CEMS probe.

2.5.1 Hand Valves – HV1, HV2, HV3

The hand valves are used to shut off the plant supplied instrument air source to the system to allow maintenance. ***Do not*** set **HV1** to the **OFF** position unless the system is in maintenance mode. **HV2** is set normally to the off position unless used for maintenance purposes. **HV3** is normally set to the off position unless it is being used to blow moisture out of the filter regulator bowl.

2.5.2 Pressure Gauge and Pressure Switch – PG1, PS1

The pressure gauge (**PG1**) and switch (**PS1**) is used to monitor the instrument air supply pressure. The switch provides a signal to the PLC when pressure falls below the set point. The pressure switch setpoint is typically set at 60 psig. **PG1** should read >90 psig.

2.5.3 Filter Regulator – FR1

Instrument air flows through a filter regulator removing particulate matter that could damage downstream components. The filter regulator also controls air pressure required for probe purge (blowback) procedures. The regulator reduces the air supply pressure to 80 psig. The filter regulator must be periodically drained to remove water by opening **HV3**.

2.6 Redundant Air Clean Up Panel

A secondary air clean up subassembly is included with the system in cases where the primary source of instrument grade air is not available. The air clean up assembly consists of a series of filters and scrubbers. The air is cleaned and dried prior to being used as an instrument air source

2.6.1 Hand Valves – HV4, HV5, HV6

The hand valves are used to shut off or bypass the instrument air supply from the redundant air clean up assembly. ***Do not set hand valve to the OFF*** position unless the system is in Maintenance Request. This condition applies whenever the redundant air clean up assembly is in use as the source of instrument air.

2.6.2 Particulate Filters – F1, F2, F3

The series of pre and post particulate filters are placed before and after the air dryers. The filters provide solid particle removal down to 0.5 microns. Designed for use in dry systems, the post filter provides efficient removal of desiccant dust and other solid contaminants downstream of various types of desiccant air dryers. These solid contaminants, if not removed, can damage sensitive downstream instruments and pneumatic controls.

2.6.3 Refrigerated Air Dryer – RAD1

The AirTak SRD refrigerated air dryer removes water and contaminants from the plant supplied instrument air source. The dryers supply clean, dry air with a low pressure dew point. Excess moisture is removed automatically through the system drain.

2.6.4 Coalescing Filter – CF1

The coalescing filter element has a 0.5-micron rated coalescing-type media that is efficient in removing oil aerosols and solid particles. The filter-removing element can be used when either petroleum or synthetic-base lubricant are present. The filter is installed after the particulate filter to prevent rapid buildup of contaminants and before the SO_2/NO_x scrubber to prevent contamination from aerosol.

2.6.5 Heatless Air Dryer – HAD1

The AirTak SHLD heatless air dryer consists of two identical cylindrical towers solidly packed with activated alumina desiccant. Synchronized valves and continuous two-minute cycles produce a constant supply of clean, dry air.

The process begins with inlet air flowing to the switching valves. The electric timer completes a circuit allowing inlet air to flow to and open the left purge valve. The inlet air flows past the lower shuttle valve to the right tower. The desiccant in the right tower adsorbs moisture from the air. The dry air then flows past the upper shuttle valve to the dryer outlet.

A small portion of the dried air flows through the adjustable purge orifice and expands to approximately atmospheric pressure. The expanded air flows through the desiccant in the left tower where it picks up moisture. This regenerates the left tower.

After 50 seconds, the timer causes the left purge valve to close. Within 10 seconds, the timer completes another circuit, causing the right purge valve to open. The left tower now dries the air while the right tower is regenerated. The cycle repeats every two minutes.

2.7 Calibration Gas Subassembly

Zero and span gas cylinders, used to calibrate the analyzers, are connected through flow regulators to a group of solenoid valves that discharge into a manifold. The manifold supplies a pressurized line that carries the calibration gases to an inlet connector on the primary filter, next to the sample probe. During calibration, the zero and span gases are filtered, cooled, and dried by the same apparatus that conditions the sample gas. This design routes calibration gas through all out-of-stack components and filters. This method assures that analyzer calibration and measurement functions are performed under identical supply conditions, which reduce variability and errors in measurement.

For maintenance and system checkout purposes calibration gas can also be directly injected to the analyzers bypassing the sample conditioning system by using the CEMS front panel controls.

The following components make up the calibration gas subsystem of the CEMS.

2.7.1 Calibration Gas Regulator – REG1 thru REG9

Each calibration gas cylinder is equipped with a regulator. Bottle contents need to be monitored closely to ensure that enough calibration gas remains to perform the required checks (daily calibration, quarter audits).

2.7.2 Calibration Gas Solenoid Valves

Calibration gas flow is controlled by normally-closed solenoid valves (**SV1** thru **SV4**). When activated to open, the valves allow flow of calibration gas. The solenoid valve timing and sequencing is controlled by the CEMS controller software.

SV8 and **SV10** are 3-way solenoid valves and used for performing local calibrations (direct calibration gas injections) to the analyzers, bypassing the probe and sample conditioning system. Associated trim valves (TV1, TV2) are used to adjust calibration gas flow rate during a local calibration sequence.

SV7 and **SV9** directs calibration gas through the probe for remote (at-the-probe) calibrations of the analyzers.

2.7.3 Calibration Flow Rotameter – RM4, RM7

The flow rotameter indicates flow rate at the calibration gas outlet to the probe. The flow rate should be set to 4-5 liters per minute.

2.8 Operator Interface Terminal

The Operator Interface Terminal (OIT), located inside the CEMS Main Analysis Enclosure, allows the operator access to a variety of system functions. The OIT is provided to monitor and control the system locally instead of having to use the Data Acquisition System (DAHS) computer, which is sometimes located remotely from the CEMS.

A Modicon Touchpanel OIT is used to view and control critical system operations. The OIT allows the operator to view data, change selected system setup parameters, view and acknowledge local alarms, control calibrations, and control probe blowback (purge) operations.

2.9 CEMS Controller

The CEMS system includes a series of intelligent input and output modules that are also known as a Programmable Logic Controller (PLC). These modules are packaged for harsh industrial environments and communicate with the DAHS or the plant's DCS. The controller is mounted inside of the gas analyzer cabinet for ease of connection and added protection.

Included in a typical system are analog-to-digital converters that take 4-20 mA signals from the analyzers and convert the signal into digital values. These digitized values are converted into engineering units within the controller. The digital input points are used to detect the presence of status conditions such as *in calibration*, or *analyzer fault*. The input points can also be used to detect process conditions such as online/offline, startup or shutdown.

The controller can run in a stand-alone mode (that is not connected to the DAHS or DCS). The controller continues to calibrate all analyzers in cases where the DAHS may be temporarily down. In addition, the controller has battery backup memory. Data for each channel can be stored in memory. This ensures that if the DAHS is down for any reason, no data is lost. When the DAHS returns to service, the available data from the controller can be retrieved. The data in the controller is stored on a “first in first out” (FIFO) basis.

The PLC automatically performs a system calibration at predetermined intervals to ensure accurate measurements.

2.10 Data Acquisition and Handling System

The Data Acquisition and Handling System (DAHS) consists of a desktop IBM compatible computer, associated hardware and the software. The PLC sends information to the DAHS via an Ethernet switch. The switch then communicates with the DAHS and the Plant DCS. All data is stored on the computer hard drive as minute averages.

A number of process-operating parameters are monitored by the PLC and logged by the DAHS. These include calibration control, alarms, analyzer status, and process status.

The DAHS provides the functions required to fully meet SCAQMD Rule 1110.2. The system also provides a configurable environment to fulfill all state and local regulations as defined by the site's air permit. Reports may be produced in either hard copy or electronic format.

Refer to the RKI Engineering PODS software user guide (under separate cover) for detailed information on using the DAHS program features.

[End of section. This document is formatted for double-sided printing.]

3 CEMS Routine Operation Procedures

3.1 General

This section contains start-up procedures for the CEMS following a shutdown period. It also contains procedures for a calibration (both automatic and manual modes) to be performed routinely or at operator discretion, to check and assure that the system is operating correctly and with consistent accuracy.

3.2 Component Check

The operational integrity of the system components is dependent upon the status indicators of the units being fully functional. Before beginning or restarting the system after a shutdown, check that all indicator light bulbs and displays are operational. Check all knobs, dials, rocker switches, etc. to ensure they are in good working order. Check flowmeters for cleanliness and visual clarity, and check tubing for any loose connections or deterioration. Check all printers and recorders to ensure a sufficient paper and ink/toner supply. Check the calibration gas cylinders to ensure that all connections have been made and are secure. Check bottle pressures and expiration dates. Be sure that all cylinders are open to supply the required gas.

Personnel who will operate the CEM system should take time to become familiar with the system components. Operator familiarity is necessary to be able to troubleshoot and identify minor problems that can become major and cause the system to be inoperable.

3.3 Temperature Control

Operation of the system components, particularly the electrical and instrumentation units must be in a controlled environment to ensure accurate and reliable operation. The cabinets which house the monitoring equipment are equipped with HVAC systems that will maintain the operating stability and temperature of the instruments. Technicians are required to check the thermostats daily. Desired temperatures of 70°F to 75°F should be maintained even when the equipment is not in operation.

3.4 Front Panel Switches and Indicators

A switch panel is provided in the analyzer rack so the operator can perform a variety of manual functions. Refer to CEMS engineering diagram 50419A01 (located in the CEMS Operation and Maintenance Manual) for details on switch and indicator locations.

SAMPLE LINE temperature – The display indicates the sample line temperature. Sample line temperature should be maintained at 250°F.

CAL REQ switch – The calibration request switch is used to initiate an unscheduled but automatically controlled calibration cycle. When the **CAL REQ** switch is pressed (it is a momentary switch) a signal is sent to the PLC which interrupts the current cycle and starts a calibration cycle. When the calibration cycle is completed, the PLC returns to normal automatic operation.

MAINT REQ switch – The maintenance request switch sends a signal to the PLC that the analyzer data is invalid due to maintenance or when a manual calibration is performed.

LOCAL / PROBE calibration switch – The local calibration / probe calibration switch allows the operator to perform a local calibration, injecting calibration gases directly into the analyzer and bypassing the probe. Local calibration is used in conjunction with the **MAINT REQ** switches.

Pressure gauge **PG2, PG3** – The pressure gauge indicates the current sample gas pressure at the cooler outlet. Pressure readings should be greater than 2 psig.

Sample flow rotameter **RM1, RM5** – The flow rotameter indicates the sample flow rate at the pump outlet. Sample flow rate should be 4-5 liters/minute.

Back pressure regulator **BPR1, BPR2** – Total flow rate is adjusted using this knob. Adjust the back pressure regulator to maintain a flow rate of 4-5 liters/minute at **RM1, RM5**.

Analyzer flow rotameters **RM2, RM3, RM6** – Sample gas flow for the analyzer is indicated and controlled by the flow rotameter. Adjust analyzer flow rotameter to provide the required labeled flow rate. Sample flow rate to each analyzer should be approximately 1.5 liters/minute.

Additional gauges are located on the separately mounted cabinet panels and include the following:

Pressure gauge **PG1** – The pressure gauge and associated switch (**PS1**) is used to monitor the instrument air supply pressure. The switch provides a signal to the PLC when pressure falls below the set point. Pressure readings should be greater than 80 psig. The setpoint for the pressure switch is 60 psi.

Calibration gas flow rotameter **RM4, RM7** – A flow rotameter indicates flow rate at the calibration gas outlet to the probe. The calibration gas flow rate should be set to 4-5 liters/minute.

Vacuum gauge **VG1, VG2** – This vacuum gauge provides an indication of the condition of upstream components. A high vacuum reading can indicate a blockage or restriction in the probe or sample line. Normal pressure readings should be less than 10” Hg.

Filter regulator **FR1** – The instrument air filter regulator removes particulate matter. The filter regulator also controls air pressure required for probe purge procedures. The regulator reduces the air supply pressure to 80 psig.

3.5 Initial Startup

The following procedure was performed during initial start-up of the CEMS or after a lengthy shutdown period.

3.5.1 Normal System Sampling Flow Verification

1. Place system in maintenance mode by toggling the **MAINT REQ** switch on the CEMS front panel to the up position or use the OIT Panel menu controls.
2. Verify total sample pressure gauge (**PG2, PG3**) reads 0 psig.
3. Verify instrument air pressure switch (**PS1**) is set to 60 psig.
4. Verify vacuum gauge (**VG1, VG2**) reads 0" Hg.
5. Place system in automatic operating mode by toggling the **MAINT REQ** switch on the CEMS front panel to the down position.
6. Adjust the back pressure regulator (**BPR1, BPR2**) to allow total flow of 4 liters/minute.
7. Adjust each analyzer flow rotameter to provide the required labeled flow rate (approximately 1.5 liters/minute).
8. Verify total sample flow rotameter (**RM1, RM5**) is between 4 -5 liters/minute.
9. Verify that vacuum gauge (**VG1, VG2**) indicates less than 5.0" Hg.
10. Perform leak check of system. Manually flow NO_X span gas (daily calibration gas). Verify O_2 analyzer is reading <0.1 % O_2. If in-leakage is found, check all Swagelok fittings with leak detection solution (*SNOOP* or similar).

System sampling has now been verified and the CEMS should operate automatically.

3.6 Shutdown and Storage

If possible the CEMS and DAHS should not be taken off-line at any time, whether a process shutdown is long-term or short-term. Temporary power might be needed to the CEMS and DAHS during a plant or process shutdown.

If the CEMS requires a shutdown and storage period use the following guidelines to ensure system integrity upon re-start.

Short Term Storage (one week or less):

1. Turn off the analyzers.
2. Turn off the printer.
3. Get advice from the local regulatory agency on whether the PLC or DAHS can be turned off during a short or long-term shutdown. Several agencies require that the data acquisition system remain in operation at all times.

   If shutting down the DAHS is allowed by the agency, ensure that the database has been backed up. Shut down the DAHS software per manufacturers' procedures. Turn off power to the computer.

Note that the PLC has a rechargeable battery. If the battery is not kept charged the PLC may lose its programming. A method should be put in place to provide temporary power to the PLC to recharge the battery.

If the PLC or DAHS is to remain in operation then a temporary power source will need to be provided for these components.

4. Turn off circuit breakers in service panel keeping in mind the notes from Step 3.
5. Turn off all power supplied to the monitor enclosure.

Long Term Storage (greater than a week):

1. Turn off the analyzers.
2. Turn off the printer.
3. Get advice from the local regulatory agency on whether the PLC or DAHS can be turned off during a short or long-term shutdown. Several agencies require that the data acquisition system remain in operation at all times.

   If shutting down the DAHS is allowed by the agency, ensure that the database has been backed up. Shut down the DAHS software per manufacturers' procedures. Turn off power to the computer.

   Note that the PLC has a rechargeable battery. If the battery is not kept charged the PLC may lose its programming. A method should be put in place to provide temporary power to the PLC to recharge the battery.

   If the PLC or DAHS is to remain in operation then a temporary power source will need to be provided for these components.
4. Turn off circuit breakers in service panel keeping in mind the notes from Step 3.
5. Turn off all power supplied to the monitor enclosure.
6. Plug any open bulkhead fittings including input to desiccant tubes. Remove plugs before turning on analyzers.
7. Turn off calibration gas bottle regulators.
8. Close doors tightly (lock).
9. Turn off instrument air supply to monitor enclosure.
10. Ensure all drain traps are empty.

3.7 Routine Operation

The CEMS is designed to operate automatically with little operator attention. However, to assure optimal performance, follow the maintenance schedule in Chapter 8 and the routine operation procedures described below.

Perform the following procedures at least once a week to ensure accurate and reliable measurement.

1. Check flow rate of sample flow rotameter (**RM1, RM5**) and analyzer flow rotameters (**RM2, RM3, RM6**). Verify mid-scale readings, adjust if necessary. Large variations from required settings indicate a need for maintenance.
2. Check sample pressure (**PG2, PG3**). Verify pressure gauge reads >2 psig. Large variations from the required settings indicate a need for maintenance.

3. Check sample (probe) vacuum (**VG1, VG2**). The sample vacuum is not adjustable and is only an indication of the condition of upstream components. As the vacuum reads higher, that is an indication of probe or sample line restriction; it should be checked.
4. Verify that the sample conditioning unit (**GC1, GC2**) is operating properly at correct temperature (2°C).

3.8 Probe Purge

During a probe purge cycle (probe blowback), clean, dry, instrument air is injected back through the probe. The probe purge cycle is controlled by the PLC program and is typically set to be performed once a day for durations of up to 60 seconds. The operator can adjust the number of purges per day and the duration of the purge cycle.

3.9 CEMS Calibrations

Calibration tests are conducted each day as a part of the quality assurance program for CEMS equipment in accordance with state and federal regulations. Daily calibrations are required each day that the process operates. Tests are run for zero gas and span (high level) gas for each analyzer.

3.9.1 Automatic Calibrations

Analyzer calibration is performed automatically by the PLC once every 24 hours. The “autocal” time is specified in the calibration sequence, which can be viewed from the DAHS and adjusted when needed. When the controller starts the automatic calibration sequence, the automatic sampling sequence is suspended and reset. Data outputs from the PLC are held at the last valid reading until the calibration process is complete. Certified calibration gases are routed up through the sample line to the probe and back down the normal extraction gas sample path to the analyzers. Although each analyzer may be calibrated individually, the normal automatic calibration performed by the CEMS calibrates all analyzers simultaneously.

The gas analyzers automatic calibration, provided by the PLC's program, is divided into several sequential events. During calibration, the PLC energizes solenoid valves to allow calibration gas to flow to the sample probe and on to the instruments. The time intervals for purging and flowing of calibration gases can be altered to match the length of the sample line.

Calibration Gas 1 flows for a preset time interval. Then the PLC energizes Calibration Gas 2 and so forth until all appropriate gas bottles have been selected. The calibration gas injection phase is typically set for five minutes to allow time for the analyzer readings to stabilize. The calibration value is the final minute of data read in this injection phase.

In the final phases of the calibration sequence the sample line is purged of calibration gas (10 sec to 1 minute, adjustable). A settle time phase (one minute, adjustable) is initiated to allow the system to return to a steady state of normal flue gas readings before data collection is resumed. Upon completion of the calibration sequence the PLC resets the automatic calibration sequence and resumes normal automatic sampling.

A failed calibration is indicated by the DAHS whenever excessive drift in any analyzer is detected. Whenever a calibration has failed, troubleshooting procedures are initiated immediately. Per regulatory compliance specifications, data is considered invalid and the affected analyzer out-of-control until corrective actions have been completed and a successful re-calibration performed.

Technicians can use the front panel switches to manually initiate a calibration cycle at any time. When a manual calibration is initiated the PLC will utilize the sequence phases programmed for the automatic calibration.

A manual calibration check is performed after any maintenance has been completed to demonstrate the system is working within required specifications. A calibration is also performed as a general system check prior to any required periodic test such as a quarterly linearity or Cylinder Gas Audit (CGA) or an annual Relative Accuracy Test Audit (RATA).

3.9.2 Post Maintenance Calibration and Leak Check

To check the system out after any maintenance activities, put the system into maintenance mode by placing the **MAINT REQ** switch into the Up position or use the menu controls on the OIT panel. Record the system pressure (**PG2, PG3**) that is located next to the flow meters. Then flip the **LOCAL CAL / PROBE CAL** switch to the **LOCAL** position. Manually flow zero gas and while flowing, use the regulator to adjust the sample pressure to exactly what the normal sampling mode pressure had been. Adjust the zero and spans on all of the analyzers and shut off all gases. Return the **LOCAL CAL / PROBE CAL** switch to the **PROBE** (normal sampling) position. Manually flow calibration gas again through the whole system and check that the readings are close to the same. Any significant difference in the readings shows that the system is leaking in ambient air or calibration gas into the system. If leaking, check all fittings and calibration gas solenoid valves and repeat the above procedure.

Place the system back into normal sample mode by placing the **MAINT REQ** switch in the **OFF** or down position or use the menu controls on the OIT panel.

4 Data Recording and Reporting

4.1 Data Acquisition System

The Data Acquisition and Handling System (DAHS) provides automated data monitoring and management capabilities to the CEMS. The DAHS facilitates all of the data reporting requirements necessary to establish compliance with EPA and state operating permit emission limits.

The CEMS uses a Programmable Logic Controller (PLC) for system control and data gathering. The PLC transmits data from the analyzers to the DAHS. The DAHS polls the PLC for data to generate and store one (1) minute and (15) minute averages.

Analog signals of emission parameters are converted by the DAHS into emission measurement values in engineering units. After conversion of the signals, pollutant parameter values are calculated to the measurement units required for reporting per the facility's air permit and applicable regulatory rule. Depending on required report format, reporting units may be expressed as calculated values or raw engineering units.

The DAHS will indicate any occurrence of specification limit exceedances (calibration failure, excess emissions episodes) or CEM operational problems (system fault alarms). In the DAHS, necessary reports are generated in the required format for submittal to the applicable regulatory agencies.

Alarm reports are generated by the DAHS to call operator attention to excess emissions and system problems. Alarms and messages are triggered by analog and status signals to the DAHS and, in some cases, by operator entry via the PC keyboard. The DAHS records an alarm message at the time of the alarm to provide a real-time mechanism for alerting technicians to excess emissions and monitoring system problems. When alarm messages are received, appropriate technicians are notified and troubleshooting, maintenance and corrective actions are initiated. The alarm message provides for automated and also manually entered documentation of the CEM or process operating status during alarm conditions.

Data compiled by the DAHS include analyzer values, hourly averages, excess emissions, calibration data, alarm messages, reason codes, corrective action codes, and process data. The DAHS generates several reports which serve as the primary basis and substance of the emission reports required under EPA and state regulations.

In addition, a central CEM record file is kept at the facility. The file contains QAP check forms, audit results, corrective action forms, and calibration gas certificates of analysis. This central file also serves as an archive for all CEM records including maintenance logbooks, daily data summaries, maintenance request forms, fuel analysis reports, quarter audit and annual RATA reports, and fuel flowmeter accuracy results (as applicable).

Maintenance personnel maintain the log and enter descriptions of preventive and corrective actions performed on the monitoring system components. This record is also used to document the use of spare parts. A periodic review of the CEMS maintenance log provides a guide to possible problem trends with the CEM system and input as to the needs of the spare parts inventory.

Note: *In accordance with EPA requirements the DAHS is to remain in standard time. Do not adjust the DAHS clock to daylight savings time.*

4.2 SCAQMD Valid Data Requirements

The CEMS will be operated and data recorded during all periods of operation of the affected source including periods of start-up, shutdown, malfunction or emergency conditions, except for CEMS breakdowns and repairs. Calibration data shall be recorded during zero and span calibration checks, and zero and span adjustments.

A zero value data point is a data point gathered while the source is not operating and is within 5% of the span range from zero value.

All CEMS, at a minimum, shall generate and record data points once for each successive 15-minute period on the hour and at equally spaced intervals thereafter. Each CEMS will be capable of completing a minimum of one cycle of operation (sampling, analyzing, and data recording) for each successive 15-minute interval.

Raw data will be gathered from the monitors at equally spaced intervals. The facility will specify, within the test report for a Relative Accuracy Test Audit (RATA) of a CEMS, the frequency of data gathering in a 15-minute interval. This data gathering frequency shall remain the same throughout the period following a RATA until a subsequent RATA is conducted with a different specified frequency. The specified frequency shall be the frequency for data gathering to constitute continuous measurement.

All valid raw data points gathered from the monitors for a 15-minute interval will be used to compute a 15-minute average emissions data point. If only one valid data point is gathered within a 15-minute interval, that data point will be used as the 15-minute average emission data point. No invalid data points may be used to compute the 1-minute average emission data point. A valid 15-minute average emission data point must be further based on a minimum of one valid raw data point.

All NO_X concentration, volumetric flow, and NO_X emission rate data will be reduced to 1-hour averages. Valid hour averages will be equally computed based on four 15-minute average emission points equally spaced over each 1 hour period, commencing at 12:00 am, except for a maximum of four 1-hour maintenance periods in each day during which CEMS maintenance activities such as calibration, quality assurance, maintenance, or CEMS repair is conducted. During these 1-hour maintenance periods a valid hour average shall consist of at least two valid 15-minute average emission data points. A 1-hour maintenance period is defined when the operation of the CEMS is interrupted for CEMS maintenance activities at any time during any 1-hour period, and that period shall count towards the four 1-hour maintenance periods allowed regardless of the number of data points gathered. The CEMS shall be kept operational at all times unless the CEMS must be turned off for CEMS maintenance.

4.3 Electronic Reporting

The function of the Remote Terminal Unit required under RECLAIM Rule is to collect data daily from the DAHS, generate data files, and transmit the data electronically to the SCAQMD Central Station.

Each day the RTU is responsible for sending a data package to the Central Station. The packet includes NOx lb/hr data, valid data status bit, calibration status bit, off-line status bit, alternate status bit, and an out-of-control status bit.

In order to produce the daily data package the RTU polls the DAHS and performs calculations on the polled data. In any of the NO_X lb/hr data received from the DAHS is missing or invalid, it is necessary to fill in the missing data using the missing data substitution rules of RECLAIM Rule.

The data package transmission, via a modem line, uses the following conventions:

1. Up to four attempts are made to reach the SCAQMD, and if unsuccessful, retires are made every 15 minutes.
2. Xmodem protocol is used to send the data package to the SCAQMD host server, and a custom protocol is used to receive the response packet.
3. The response packet is checked, and if errors are detected, retransmission is attempted.
4. A communications log is kept which archives daily RECLAIM data packets and response packets, as well as operations and error messages as needed.

If the polling is unsuccessful all of the hourly data in that period is considered to be missing. The NO_X lb/day and status flags are computed, archived, and sent to the Central Station. The program waits until the next day to repeat the process.

A monthly emissions report is also required within fifteen calendar days of the close of each month. A quarterly database reconciliation report (DRR) is also required. The DRRs are required in two steps.

1. Quarters 1 thru 3 are required within 30 calendar days of the close of each quarter.
2. Quarter 4 is required within 60 calendar days of the close of 4th quarter.

A DRR will also be required if QA/QC activities cause changes to emissions data previously submitted via the RTU. The monthly DRR is required within 15 days of the close of the month.

[End of section. This document is formatted for double-sided printing.]

5 Quality Control Activities

5.1 Introduction

Quality Control (QC) is the procedures, policies, and corrective actions necessary to ensure product quality. QC procedures are routine activities. These activities include but are not limited to daily calibrations and routine maintenance.

Quality control activities range from the correct installation of the CEM system to proper data handling procedures. Facility technicians will strive to keep the CEM systems in proper operation at a minimum of 95% of facility operating time.

Note: The facility has chosen to comply with 40 CFR 60 performance specifications for on-going QA/QC purposes. Refer to the ST-220 CEMS Application Form under separate cover.

5.2 Calibration Audit Gases

Calibration gases are used to verify the accuracy of the gas analyzers. Daily calibration gases are used to verify that the instruments are within the allowable error limits for a two-point (zero, mid span, or high span) audit on a daily basis. Quarterly calibration gases are used to verify that the instruments are within the allowable limits for a two point calibration (low and mid) for Part 60 Appendix F.

All gases used for daily calibrations must be certified with EPA Protocol standards. EPA Protocol gases must be vendor-certified to be within 1.0 percent accuracy (Protocol 1, sometimes referred to as RATA class) of the concentration specified on the cylinder label (tag value), using the uncertainty calculation procedure in section 2.1.8 of the "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards," September 1997, EPA-600/R-97/121. If a 1.0 percent accuracy gas is not available in the required percent of span range, a 2.0 percent (Protocol 2) certified gas may be use.

Alternately, zero air material may be used for the zero calibration level. Zero air material (used in daily calibrations) is defined in 40 CFR 72.2 as:

1. A calibration gas certified by the gas vendor not to contain concentrations of SO_2, NO_X, or THCs above 0.1 ppm, a CO concentration above 1 ppm, or a CO_2 concentration above 400 ppm.
2. Ambient air conditioned and purified by a CEMS for which the CEMS manufacturer or vendor certifies that the CEMS model produces conditioned gases that does not contain concentrations of SO_2, NO_X, or THCs above 0.1 ppm, a CO concentration above 1 ppm, or a CO_2 concentration above 400 ppm.
3. A multi-component mixture certified by the supplier of the mixture that the concentration of the component being zeroed is less than or equal to the applicable specified in condition 1 above and that the mixture's other components do not interfere with the CEMS readings.

The maximum certification shelf life for single concentration calibration and audit gases is 36 months. For combined concentrations of gases (such as NO_X and CO in the same bottle) the maximum certification shelf life is equal to that of its most briefly certifiable component. If a certified gas is to be used after the certification period has ended, it must be re-certified. A gas standard may be re-certified if the gas pressure remaining in the cylinder is greater than 3.4 megapascals (500 psig). Facility personnel will maintain calibration gas bottle certificate records for a minimum of three years.

The gas cylinders are 2000 psig and must be changed at 150 psig to maintain correct gas concentrations. Cylinder regulators are set to between 15 and 20 psig. Calibration gases need to be reordered when the bottle pressure drops to 1000 psig. Normal daily calibrations will consume about 100 psig per week. Under normal usage rates, calibration cylinders should last more than three months. Any manual calibrations in addition to the required daily calibration will also increase gas consumption.

Check gas cylinder pressures on a daily basis. There must be sufficient gas in each cylinder to complete the calibration. The instrument could fail the calibration if the gas runs out during the calibration cycle. Calibration gas can be lost if the cylinder pressure is set too high (lifting the seat on the normally closed solenoid valve that controls gas flow), through leaking fittings, and through a leaking solenoid valve. Brass regulators should be used only on cylinders containing CO_2 or N_2. Stainless steel regulators must be used on cylinders containing NO_X and SO_2.

The cylinders will contain a known concentration of a single gas such as N_2 (used for zero or low span calibration), or blended gases such as CO_2, NO_X, SO_2, and N_2 (used for high span calibration). Refer to the manufacturer's certification sheet provided with each cylinder for the gas concentration, cylinder certification number, and Protocol statement. Even though the cylinders usually have a tag listing the gas concentrations, always use the values on the certification sheet for entry into the DAHS. Also, record cylinder changes, gas concentrations, expiration dates, and certification numbers in the CEMS maintenance log. Keep a copy of the certification sheet as part of the CEMS records.

Even EPA Protocol gas cylinders have been known to be in error. If an analyzer shows excessive drift after changing a cylinder, check the analyzer with the cylinder that was replaced, or another cylinder that is known to be accurate. Ensure the new gas values were entered correctly in the DAHS. If a cylinder is suspect, return it to the supplier or have it re-certified at an independent testing lab.

5.2.1 Safety Procedures for High Pressure Gas Cylinders

1. Avoid rough handling of cylinders. Do not drop or allow cylinders to strike each other.
2. The cylinders should always be secured in an approved rack system whenever the bottles are not being used.
3. Whenever possible, store cylinders in a dry enclosure to protect them from extremes of weather and ground moisture. Do not subject cylinders to temperatures higher than 125°F. Storage of calibration gas bottles requires a secure and safe installation as defined by federal and state regulations.
4. Do not allow any part of the cylinder to come in contact with an open flame. Do not allow an arc from an electric arc welder to strike any part of the gas cylinder.
5. Do not remove the valve protection cap until the cylinder has been secured and is ready for use. Do not tamper with any part of the cylinder valve.

6. Use a hand-truck to move cylinders, even for a short distance. Do not drag, roll or slide cylinders.
7. Do not place a cylinder where it may become part of an electric circuit.
8. Per the EPA, a compressed gas calibration standard should not be used when its gas pressure is below 1.03 megapascals (150 psig). NIST has found that some gas mixtures have exhibited a concentration change when the cylinder pressure has fallen below this value.
9. Do not store full and empty cylinders together.
10. Do not tamper with any part of the cylinder valve.

5.2.2 Calibration Gas Cylinder Change Out

To ensure successful daily calibrations of the CEMS analyzers, it is critical that the calibration gases be checked daily and replaced when low. Also periodically check expiration dates posted on the bottle certificate. Do not use calibration gases that have passed their expiration dates. Always order new calibration gas bottles well before needed. The lead time for ordering and having bottles shipped to the plant can be several weeks.

Using a gas cylinder whose contents are too low causes the gas certification to be invalid, thereby invalidating the calibration. The EPA specifies that a bottle should be changed out whenever the bottle pressure drops below 150 psig. It's recommended that the bottle be changed out whenever the pressure drops between 150 and 200 psig. Laboratory tests have indicated that a concentration shift away from the certified value can occur when the bottle pressure drops below 150 psig.

Use the following procedure as a general guide for replacing gas cylinder bottles.

1. Turn off the regulator for that cylinder and close the valve. Uncouple the hose from the cylinder, making sure there are no leaks from the cylinder.
2. Transport the empty cylinder to the designated pickup area for shipment back to the vendor. Be sure to replace the chain on the cylinder rack when done. Tear off the "In Service" segment of the stock tag, leaving the "Empty" segment attached.
3. Select a new cylinder from the full racks. Ensure that the new bottle is within the correct percent of span specification required for the analyzer and type of test (daily calibration or quarterly audit).
4. Install the new cylinder making sure the strap is secured around the cylinder. When connecting cylinders, be sure not to over-tighten and flatten the white seal inside the regulator connection. If this is damaged, replace it. Check for leaks on all connections using soap solution. Tear off the "Full" segment of the stock tag, leaving the "In Service" and "Empty" segments attached.
5. Enter the new cylinder value into the DAHS and save the change. Also enter the new value into the analyzer using the analyzer's front panel control menu.
6. Put the system into maintenance request mode and manually flow gas to the analyzer to ensure that the sampling system is processing the new cylinder. Re-zero and re-span the analyzer at this time if needed. Remove the system from maintenance request mode.
7. Perform a full, hands-off calibration in accordance with the regulations and check the results.
8. Check the cylinder out of stock so that proper stocking levels can be maintained.
9. Make an entry in the CEMS maintenance log book that the cylinder was changed, recording the old cylinder number and values and the new cylinder number and values. Note in the log book that a passing calibration was performed with the new bottle.

5.3 Daily Calibration Error Check

A two-point calibration error test of each analyzer is performed automatically once during each unit operating day. The CEMS include capabilities for both manual and automatic calibration of the analyzers.

The automatic calibration timer of the CEMS controller is set to perform a calibration of each analyzer every 24 hours. As allowed under SCAQME Rule 218.1, on days the process is not operating the automatic calibration will be turned off in order to conserve calibration gas. Automatic calibrations will be turned back on again a few days/hours before the process is due to operate. Automatic calibrations will be initiated on all process operating days.

During the system calibration, the responses of the individual analyzers are recorded by the DAHS. In addition, the controller is programmed to initiate a calibration shortly after (typically one hour but can be adjusted) the process comes on-line after a period of process shutdown.

A technician will check the DAHS calibration drift report daily to ensure that the recorded zero and span drift values are passing required specifications. If the values are failed, the technician will perform basic troubleshooting routines (check calibration gas bottles and connections, look for alarm messages) and perform a manual calibration. If the calibration problem persists and the technicians cannot resolve the issue, a CEMS service representative will be called to service or troubleshoot the instrument(s). CEMTEK Environmental contact information is located in the Preface to this document.

5.3.1 Conducting the Daily Calibration Error Test

The two-point calibration error test calculates the calibration error for two gas concentrations (SCAQMD Rule 218.1). These gas concentrations are (1) zero to 20 percent of span (zero-level) and (2) 80 to 100 percent of span (high- or span-level). Calibration gas concentration ranges for daily calibration error tests are shown in the following table(s). Calibration gases must be EPA Protocol certified.

Table 5-1: Daily Calibration Gas Specifications

O_2 Analyzer	Gas Concentration
Measurement Range = 0–25%	
Zero (0 to 20% of span)	0
High (80 to 100% of span)	20–25%

Stack CO Analyzer	Gas Concentration
Measurement Range = 0–80 ppm	
Zero (0 to 20% of span)	0
High (80 to 100% of span)	64 – 80 ppm
Measurement Range = 0–760 ppm	
Zero (0 to 20% of span)	0
High (80 to 100% of span)	80 – 100 ppm

Stack NO_X Analyzer	Gas Concentration
Measurement Range = 0–35 ppm	
Zero (0 to 20% of span)	0
High (80 to 100% of span)	28 – 35 ppm
Measurement Range = 0–100 ppm	
Zero (0 to 20% of span)	0
High (80 to 100% of span)	80 – 100 ppm

Inlet NO_X Analyzer	Gas Concentration
Measurement Range = 0–100 ppm	
Zero (0 to 20% of span)	0
High (80 to 100% of span)	80 – 100 ppm

Refer to the CEMS engineering drawing set specification (SP) page for further information on calibration gas bottle mixtures used in this configuration. The CEMS drawings are located in the CEMS Operation and Maintenance manual.

Important: *Do not use gas cylinders if the pressure has fallen below 150 psig.*

During calibration, the system controller flows calibration gases to the probe. The analyzers are challenged once with each of the two calibration gases. Each gas flows for approximately 10 minutes. The monitor response is recorded by the DAHS.

Do not make manual adjustments to the monitor settings until after taking measurements at both zero and high concentration levels for that day.

The DAHS compares the actual analyzer reading with the expected value of the calibration gas. If the analyzer drift exceeds the specification limits, the failure is "flagged" on the calibration report. The calibration error for each monitor is computed by the DAHS from the test results for each concentration level as follows:

Daily Drift for Pollutants ***40 CFR 60, Appendix B, PS-2, PS-4/4A***		
$$CE = \frac{\lvert R - A \rvert}{S} \times 100$$	CE =	Calibration error as a percentage of instrument span
	R =	Zero or high-level calibration gas value in ppm
	A =	Actual monitor response to calibration gas in ppm
	S =	Span of the instrument

The calibration error for O_2 monitor is computed by the DAHS from the test results for each concentration level as follows:

Daily Drift for Diluents ***40 CFR 60, Appendix B, PS-3***		
For alternate criteria use $$CE = \lvert R - A \rvert$$	CE =	Calibration error as a percentage of O_2
	R =	Zero or high-level calibration gas value in percent (%)
	A =	Actual monitor response to calibration gas in percent (%)

5.3.2 Additional Calibration Error Tests and Adjustments

Additional calibration error tests are performed whenever a daily calibration error test has failed; whenever a monitoring system is returned to service after repair or corrective maintenance, or after making certain calibration adjustments. Except for routine calibration adjustments, data from the monitor are considered invalid until successful completion of a calibration error test.

Routine calibration adjustments are permitted after any successful calibration error test. These routine adjustments can be done to bring monitor readings as close as possible to the calibration-gas reference values. An additional calibration error test is then required following routine calibration adjustments when the monitor's calibration has been physically adjusted to verify that the adjustments have been done correctly.

Additional calibration error tests are not required if the routine calibration adjustments are made automatically by the DAHS by means of a mathematical algorithm programmed into the software.

Additional (non-routine) calibration adjustments of a monitor are permitted before (but not during) linearity checks and RATAs. A calibration check, either the pre-programmed auto-calibration or a manual calibration initiated by a technician, will be performed prior to conducting any other QA audit (linearity, RATA). This is to ensure that the analyzers are in good general working condition before performing the audit.

5.3.3 Re-calibration Limits

Adjustments to the calibration should be performed, at a minimum, whenever the daily calibration error exceeds the criteria specified in 40 CFR 60, Appendix B Performance Specifications (warning level). The two-point calibration error test is then repeated after adjustments. The recommended recalibration criteria for the NO_X concentration monitor is CE >2.5% of span. For the O_2 monitor, the recommended recalibration criterion is $|R – A|$ >0.5% O_2. For CO the recommended recalibration criterion is CE > 5% of span (40 CFR 60, Performance Specification 4/4A).

These performance specification limits serve as a warning or maintenance limit that the monitor may be reaching the out-of-control limits. When the maintenance limit is exceeded facility technicians will need to take steps to troubleshoot and bring the calibration values back under the PS limit to ensure the monitor doesn't go out-of-control.

5.3.4 Out-of-Control Limits

Part 60 Appendix F has a two part out-of-control specification. Per EPA guidelines the affected analyzer at a minimum is to be recalibrated when the %drift error is 2 times the performance specification to avoid exceeding either of the out-of-control limits noted below.

An out-of-control period occurs when the daily calibration drift (zero or span) exceeds twice the applicable specification for five consecutive days.

If the daily calibration drift exceeds four times the applicable Performance Specification drift limits in a single day the CEMS is considered out-of-control.

The out-of-control period begins with the hour of completion of the fifth, consecutive, daily calibration drift check when the CD is in excess of two times the Performance Specification limit. Or, the out-of-control period begins with the hour of completion of the daily calibration drift check *preceding* the daily CD check that resulted in a CD in excess of four times the Performance Specification.

The out-of-control period ends with the completion of a passing calibration drift being within the corresponding CD limit of either two times or four times the Performance Specification limit.

Whenever a failed calibration, corrective action, and a successful re-calibration occur in the same hour, the system will not be considered to be out-of-control if two or more valid data points from that hour were recorded.

During the period the CEMS is out-of-control the CEMS data may not be used in calculating emission compliance nor be counted toward meeting minimum data availability.

The DAHS records the calibration error test results and displays the status (pass or fail) on the calibration report if the re-calibration (or out-of-control) criteria are exceeded. Re-calibration or corrective action is taken when the failure is identified.

Table 5-2: Excessive Calibration Error Criteria – Part 60

Analyzer	CD Specification Maintenance Level or Warning Level	Excessive CD 5 Consecutive Days (2 X PS) Analyzer Out-of-Control (Part 60 Appendix F)	Excessive CD 24 Hr. Criteria (4 X PS) Analyzer Out-of-Control (Part 60 Appendix F)
CO	5.0% span error (Part 60 PS-4/4A)	10.0% span error	20.0% span error
NO_X	2.5% span error (Part 60 PS-2)	5.0% span error	10.0% span error
O_2	0.5% O_2 difference (Part 60 PS-3)	1.0% O_2 difference	2.0% O_2 difference

During the period the CEMS is out-of-control; the CEMS data may not be used in calculating emission compliance nor be counted toward meeting minimum data availability.

The out-of-control period begins with the hour of the failed calibration error test and ends with the hour of the next satisfactory calibration error test after corrective action.

Whenever a failed calibration, corrective action, and a successful re-calibration occur in the same hour, the system will not be considered to be out-of-control if two or more valid data points from that hour were recorded.

6 Quality Assurance Activities

6.1 Introduction

Quality Assurance (QA) is a series of checks performed to ensure the QC procedures are functioning properly. The activities include but are not limited to quarterly and annual audits.

6.2 Quarterly Assessments

The following assessments will be performed during each calendar quarter that the unit combusts fuel. This requirement is in effect the calendar quarter following the calendar quarter in which the monitor or CEMS is certified.

6.3 Cylinder Gas Audit – Part 60

The Cylinder Gas Audit (CGA) is performed for each Stack NO_X, CO, and O_2 analyzer at least once during each unit operating quarter based on the requirements of 40 CFR 60, Appendix F. If applicable, the CGA is performed on both the low and high ranges. CGAs are conducted in three consecutive quarters. During the fourth quarter, the accuracy of the analyzer is evaluated by conducting a Relative Accuracy Test Audit. Use separate calibration gas cylinders for each concentration during the audit. Conduct the CGA no less than two months apart. If possible given the plant operating schedule, the CGA is conducted during process on-line conditions. If the process operating schedule is such that an on-line CGA cannot be performed before the end of the reporting quarter then a process off-line CGA will be conducted. The CGA is exempt in quarters with zero operating time.

6.3.1 Cylinder Gas Audit Procedure

A CGA test can typically be triggered through the DAHS controls. The PLC programming will control calibration gas valve(s) and timing sequencing for an automated test of each analyzer. The DAHS will perform all required calculations and provide a CGA report detailing test results. The technician will need to check that the correct calibration gases have been connected to the assigned regulators.

Separate calibration gas cylinders are used for the two required concentration levels during the audit. Three non-consecutive runs at each concentration level are performed. The calibration gases are introduced at the probe interface box and transported through the CEMS sampling system (normal sampling flow path).

Refer to the CEMS Engineering drawing SP (specification) page (located in the CEMS Operation and Maintenance manual) for information on calibration gases specified for this application and the regulator to be used for the CGA bottles. The following specifies the Part 60 requirement for CGA calibration gases.

The calibration gases required for the diluent (O_2) are actual concentration values and not based on percent of range.

Audit Point	***Pollutant Monitors % of span***	***O_2 % by volume***
Low level	20-30% of span	4-6% by volume
Mid Level	50-60% of span	8-12% by volume

The following summarizes the required calibration gas ranges.

Table 6-1: CGA Calibration Gas Specifications – Part 60

Stack NO_X Analyzer	Gas Concentration
Measurement Range = 0–35 ppm	
Audit Point 1: Low (20 to 30% of span)	7 – 10.5 ppm
Audit Point 2: Mid (50 to 60% of span)	17.5 – 21 ppm
Measurement Range = 0–100 ppm	
Audit Point 1: Low (20 to 30% of span)	20 – 30 ppm
Audit Point 2: Mid (50 to 60% of span)	50 – 60 ppm

CO Analyzer	Gas Concentration
Measurement Range = 0–80 ppm	
Audit Point 1: Low (20 to 30% of span)	16 – 24 ppm
Audit Point 2: Mid (50 to 60% of span)	40 – 48 ppm
Measurement Range = 0–760 ppm	
Audit Point 1: Low (20 to 30% of span)	152 – 228 ppm
Audit Point 2: Mid (50 to 60% of span)	380 – 456 ppm

O_2 Analyzer	Gas Concentration
Measurement Range = 0–25 %	
Audit Point 1: Low	4 – 6% by volume
Audit Point 2: Mid	8 – 12% by volume

Important: All calibration gases used for CGA testing must be EPA Protocol gases.

Important: Do not use gas cylinders if the pressure has fallen below 150 psig.

The accuracy values for each concentration should not exceed 15% as calculated in the following equation or 5 ppm difference:

Cylinder Gas Audit Accuracy ***40 CFR 60, Appendix F, Section 6.3***	
$$A = \frac{C_m - C_a}{C_a} x 100$$	A = Percent accuracy of the CEM C_m = The average monitor response to the specific audit gas (high or low) in units of concentration C_a = Certified value of audit gas (value according to EPA Protocol certification) in units of concentration

6.3.2 Out-of-Control Period

An out-of-control period occurs when the CGA at any of the two concentrations exceeds the applicable specifications (>15% error or 5 ppm difference). The out-of-control period begins with the hour of the failed CGA and ends with the hour of a satisfactory CGA following the corrective action.

During the time the CEMS is out-of-control the CEMS data may not be used in calculating emission compliance nor be counted toward meeting minimum data availability.

6.4 Annual Relative Accuracy Test Audit

Perform the following assessments annually for NO_X, O_2 and CO. The tests to be completed within 12 months of the end of the calendar quarter in which the CEMS was last tested for certification/recertification purposes.

An independent testing contractor will conduct these RATAs. The Reference Test Method for the RATAs will be SCAQMD Method 100.1 for gas analyzers and SCAQMD Methods 1.1, 2.1, 3.1, and 4.1 for volumetric flow as outlined in the District’s Source Test Manual (in lieu of Part 60, Appendix A Test Methods).

The Relative Accuracy Test Audits for the pollutant and diluent gas analyzers will be conducted simultaneously for each unit (that is, simultaneous testing of each unit's CO, NO_X, and O_2 monitors). During Relative Accuracy Testing, each unit will operate at its normal level and combusting its primary fuel.

Prior to the RATA ensure that all preventive maintenance has been performed on the CEMS equipment. Also perform the quarterly linearity check prior to the RATA to ensure proper linearization of the analyzers.

6.4.1 Sampling Strategies

Reference Method traverse points will be selected to ensure acquisition of representative pollutant and diluent sample concentrations, moisture content, temperature, and flue gas rate over the flue cross section. The reference test method that will be utilized in this program is SCAQMD Method 100.1. For mass emissions reporting requirements, SCAQMD Test Methods 1.1 thru 4.1 (moisture/stack flow) will be utilized as additional reference test methods.

Before the test, a site assessment is performed to locate sample points for obtaining representative measurements of pollutant concentrations. Checks will be performed to verify the absence of cyclonic flow and gas concentration stratification. These checks will be done in accordance with the SCAQMD's Source Test Manual, Chapter X, Section 13 and SCAQMD Rule 218. This requirement may be waived by the District if cyclonic flow and gas concentration stratification checks have previously been performed (that is performed at initial certification of the CEMS).

Each gas monitoring system RATA run will be a minimum of 30 minutes after the readings have stabilized (SCAQMD). For each run of a gas monitoring system RATA, all necessary pollutant and diluent concentration measurements, and moisture measurements (if applicable) will be made within a 60-minute period.

Before and after each test run, the entire reference method sampling system will be leak checked by evacuating the system to a minimum of 20 inch Hg vacuum, and plugging for a period of 5 minutes. The resultant loss of vacuum cannot exceed 1 inches Hg during this period.

A pre-test linearity check will be performed on each Reference Method analyzer. A zero gas (pure nitrogen), mid span and high span calibration gas will be introduced to each analyzer and its response will be recorded. The Reference Method analyzer linearity is acceptable if the monitor response is within 1% of the analyzer range.

A system bias check will be performed on each Reference Method analyzer by transporting the EPA Protocol gases used to zero and mid span (or high span) the analyzers to the sample system as close as practical to the probe inlet. This way the calibration gases will be exposed to the same elements as the sample and the monitor response is recorded. The analyzers responses for each calibration gas must agree within ±5% of instrument range. Changes/repairs are made to the system to compensate for any differences in the analyzer readings.

The system bias results will be used for the pretest calibration-drift values. Upon completion of the sample test run a posttest calibration-drift test will be performed. The results of the calibration drift test must be within ±3% or the test run is void; corrective actions will be taken and another test run will be performed in the advent of a failed calibration drift test or failed system bias test.

NO_X measurements will be performed in the NO_X mode of the analyzer. An NO_2 to NO converter check will be required if NO_2 constitutes 5% or more of the total NO_X in the sample stream, or the rule or permit condition requires "NO_X" monitoring. The NO_2 to NO converter must be at least 90% efficient. The converter will be high temperature (650°C) stainless steel, if no NH_3 is present. If NH_3 is present, then a low temperature (350°C) Molybdenum catalyst must be used in the converter. This check is done just prior to testing.

To correlate properly individual emission data and volumetric flowrate data with the reference method data, the beginning and end of each reference-method test-run (including exact time of day) will be annotated on the chart recorder or other permanent recording device.

6.4.2 Correlation of Data

Confirm that the monitoring system and reference-method test results are on a consistent moisture, pressure, temperature, and diluent concentration basis. Response times of the emission monitoring system will be compared with the reference method measurements to ensure comparison of simultaneous measurements.

For each RATA test run, the measurements from the monitors are compared against the corresponding reference method values. The paired data is tabulated in a table and relative accuracy results calculated.

A minimum of nine sets of paired monitor data and reference-method test data will be performed.

More than nine sets of paired data may be collected. All data, including any rejected runs will be reported. Runs may only be rejected due to unusual problems and/or occurrences during testing such as plant process problems, analyzer problems or a failed calibration or system bias check. Otherwise, all runs performed must be included in final results calculations of relative accuracy.

6.4.3 O_2 Relative Accuracy Test

SCAQMD Test Method 100.1, an instrumental test method, will be used proposed as the reference method for this QA/QC program. A portion of the sample stream flows to a paramagnetic or polargraphic analyzer for the determination of O_2 concentration. The O_2 RATA will be conducted simultaneously with the NO_X and CO RATAs. Each sample run will be no less 30 minutes with approximately 15 minutes between sampling runs for test CEMS calibration.

For each reference method determination, the flue gas will be sampled at a number of traverse points, which will be determined prior to testing. The differences between the reference-method sample and the O_2 monitor's readings will be evaluated from a minimum of nine (9) sets of paired monitor and reference-method test data. From these differences, the 95% confidence coefficient is calculated, and the relative accuracy determined. Any tests not included in the calculations for the determination of relative accuracy will be included in the final test report.

For SCAQMD reporting purposes, test results are acceptable if the O_2 relative accuracy does not exceed 10.0% of the mean value of the RM test data in terms of units of percent volume (semiannual). Alternately, for cases where the mean value of the reference method test data for O_2 concentration is less than 5.0 volume percent, the relative accuracy requirement may be met if the following is satisfied.

$$|d| + |cc| </= 1.0 \text{ volume percent}$$

where: d = average differences between the O_2 concentration and the corresponding reference method test data

cc = confidence coefficient

6.4.4 NO_X Relative Accuracy Test

SCAQMD Test Method 100.1, an instrumental test method, will be used as the reference method for this QA/QC program. This method is an instrumental analyzer procedure. A sample is continuously extracted from the effluent gas stream. A portion of the sample stream is conveyed to an instrumental chemiluminescent analyzer for the determination of NO_X concentration. Each sample run will be no less than 30 minutes with approximately 15 minutes between sampling runs for test CEMS calibration.

For each reference method determination, the flue gas is sampled at a number of traverse points that will be determined prior to testing. The difference between the reference method sample and the NO_X monitor's reading is evaluated from a minimum of nine sets of paired monitor and reference method test data. From these differences, the 95% confidence coefficient is calculated, and the relative accuracy determined. The diluent gas tests will be conducted concurrently with the pollutant gas tests. Any tests not included in the calculations for the determination of relative accuracy will be included in the final test report.

Results are acceptable if the relative accuracy is less than or equal to 20% of the mean value of the reference method in units of ppmv. Alternately, for cases where the mean value of the reference method test data is less than 5 ppmv, the NO_X concentration relative accuracy may be met if the following is satisfied.

$$|d| + |cc| </= 1.0 \text{ ppmv}$$

where: d = average differences between the NO_X concentration and the corresponding reference method test data

cc = confidence coefficient

For SCAQMD mass emissions reporting requirements, results are acceptable if the relative accuracy is less than or equal to 20% of the mean value of the reference method test data in units of lb/hr (semiannual). Alternately, for cases where the mean NO_X concentration obtained by reference test method is less than or equal to 5.0 ppm, or the mean stack gas velocity obtained by reference test method is less than 15 feet per second, the mass emission rate relative accuracy may be met if the following is satisfied.

$$|d| + |cc| </= (c * s * A) * cf$$

where: d = average difference between the NO_X concentration and the corresponding reference method test data
cc = confidence coefficient
A = stack cross-sectional area in the plane of measurement
C = 1.0 ppm or mean concentration obtained by reference method, whatever is greater
S = 2 feet per second or mean stack gas velocity obtained by reference test method, whichever is greater
cf = conversion factor to pounds per hour

6.4.5 CO Relative Accuracy

A relative accuracy test audit is performed on the CO monitor annually in accordance with SCAQMD Rule 218.1. SCAQMD Test Method 100.1, an instrumental test method, will be used as the reference method for this QA/QC program. A sample is continuously extracted from the effluent gas stream. A portion of the sample stream is conveyed to an ultraviolet (UV), nondispersive infrared (NDIR), or fluorescence analyzer for the determination of CO concentration. Each sample run will be no less than 30 minutes with approximately 15 minutes between sampling runs for test CEMS calibration.

For each reference method determination, the flue gas is sampled at a number of traverse points that will be determined prior to testing. The difference between the reference method sample and the CO monitor's reading will be evaluated from a minimum of nine sets of paired monitor and reference method test data. From these differences, the 95% confidence coefficient is calculated, and the relative accuracy determined. The diluent gas tests will be conducted with the pollutant gas tests. Any tests not included in the calculations for the determination of relative accuracy will be included in the final test report.

For SCAQMD Rule 218.1, results are acceptable if the relative accuracy is less than or equal to 20% of the mean value of the reference method or, the de-minimus concentration of 2.0 ppm CO, whichever is greater.

6.4.6 Flow Relative Accuracy Test

Stack volumetric flow is calculated by the data acquisition system using signal inputs from fuel flowmeters in conjunction with F-factors (calculated for digester gas fuel and EPA default value for natural gas fuel) and used for determining CO and NO_X mass emissions. The calculated volumetric flow values will be tested for relative accuracy using reference methods to determine stack flow.

SCAQMD Test Methods 1.1 thru 4.1 (moisture/stack flow) will be used as the reference method for this QA/QC program for performing a RATA on flow monitors (or fuel flowmeters used to calculate stack flow). The flow relative accuracy test will be conducted at the normal operating level. The test will be conducted simultaneously with the relative accuracy tests that will be conducted for the CO and NO_X monitoring systems.

An S-type Pitot tube and an inclined manometer will be used for testing. The velocity measurements will be recorded at traverse point locations in each stack/duct as calculated according to Method 1.1. The differences between the reference method sample and the flow monitor's readings will be evaluated from a minimum of nine (9) sets of paired monitor and reference method test data. From these differences, the 95% confidence coefficient is calculated, and the relative accuracy determined. The flow readings and the reference method readings will be compared on a scfh basis.

Results are acceptable if the relative accuracy is less than or equal to 15% of the mean value of the reference method test data or the de minimus value equivalent to a calculated volumetric flow rate based on 2 feet per second stack gas velocity for cases where the mean stack gas velocity obtained by the reference method test is less than 15 feet per second.

6.4.7 Relative Accuracy Calculations

The following equations will be used to calculate relative accuracy:

RATA, Arithmetic Mean	
$\bar{d} = \frac{1}{n}\sum_{i=1}^{n} d_i$	$\bar{d}$ = Arithmetic mean n = Number of data points $\sum_{i=1}^{n} d_i$ = Algebraic sum of the individual differences, d_i
RATA, Standard Deviation	
$S_d = \sqrt{\dfrac{\sum_{i=1}^{n} d_i^2 - \dfrac{\left(\sum_{i=1}^{n} d_i\right)^2}{n}}{n-1}}$	S_d = Standard Deviation n = Number of data points $\sum_{i=1}^{n} d_i$ = Algebraic sum of the individual differences, d_i $(\sum_{i=1}^{n} d_i)^2$ = Algebraic sum of differences squared
RATA, Confidence Coefficient	
$cc = t_{0.025} \frac{S_d}{\sqrt{n}}$	cc = Confidence Coefficient S_d = Standard Deviation n = Number of data points $T_{0.025}$ = t value

Relative Accuracy		
$$RA = \frac{\lvert \bar{d} \rvert + \lvert cc \rvert}{\overline{RM}} x\,100$$	RA =	Relative Accuracy
	$\overline{RM}$ =	Arithmetic mean of the reference method values
	$\lvert \bar{d} \rvert$ =	The absolute value of the mean difference between the reference method values and the corresponding CEMS values
	$\lvert cc \rvert$ =	Absolute value of the confidence coefficient

6.4.8 Out-of-Control Period

An out-of-control period occurs under any of the following conditions:

1. The relative accuracy of a pollutant concentration monitor or emission rate measurement system exceeds 20%.
2. The relative accuracy of flow monitoring system exceeds 15%.
2. Failure to conduct a relative accuracy test audit by the due date for a semi-annual assessment (annual if incentive program applies).

For the relative accuracy test audit, the out-of-control period begins with the hour of completion of the failed RATA and bias test and is over at the end of the hour of a passing RATA and bias test.

During the time the CEMS is out-of-control the CEMS data may not be used in calculating emission compliance nor be counted towards meeting minimum data availability.

6.5 Sampling System Bias Test

In accordance with SCAQMD Rule 218.1 (b)(4)(B), a sample system bias test is performed annually on all analyzers prior to the RATA.

The sampling system bias test is designed to ensure consistency between local (analyzer direct) and remote (at-the-probe) calibrations. The objective is to prove the integrity of both the sample handling system and the analyzers. The check serves as a leak test of the sampling system.

The CEM sampling system bias check is the difference between analyzer responses when calibration gas is injected through the sampling system and direct injection of the same calibration gas into the analyzer.

A zero concentration calibration gas will be injected into the CEMS through the calibration line to the valve box and the monitor response value will be recorded. The same procedure will be done for a calibration gas that closely approximates the effluent gas concentration. Both gases will be injected in such a manner that the calibration gas path follows that of the effluent gas from the CEMS valve box to the analyzers.

The same two gases will each be injected directly into the analyzer and the individual analyzer responses will be recorded.

From the two sets of injections the system bias will be calculated. The following equation will be utilized.

$$SB = ((P - A)/S) * 100$$

Where:

Where:	SB	=	system bias analyzer response
	P	=	analyzer response when the calibration gas is injected at the probe
	A	=	analyzer response when the calibration gas is injected at the analyzer
	S	=	span of the instrument

Results are acceptable if the system bias check is less than or equal to 5%.

7 Recertification and Diagnostic Tests

7.1 Introduction

All maintenance events will trigger the need to perform diagnostic testing and/or recertification events to ensure that the CEMS has been returned to optimum operating condition after the maintenance activity. The immediately following sections describe the types of test events that may be required after completion of certain types of maintenance activities.

7.2 Diagnostic Tests and Recertification Events

Diagnostic and recertification tests are those tests required to verify that a CEMS is operating accurately following certain preventive or corrective maintenance procedures. Provided that all required diagnostic tests and recertification tests are successfully completed, valid data collected beginning with the time of completing the required test(s) are considered valid. If a test is failed, then the data collected from the time of completing the preventive or corrective maintenance procedure that triggered the diagnostic test period to the time of the failed diagnostic test is considered invalid.

Results of each required diagnostic tests or recertification test event will be entered into the CEMS Maintenance Log. Entries in the Maintenance Log will be reviewed by responsible facility mangers/supervisors to ensure that the entries are complete and that all required tests have been completed.

Consistent with the requirements set forth in SCAQMD policy, the facility will recertify the CEMS or any system component, when necessary. Recertification is required whenever a replacement, modification, or change is made to the CEMS or system component (including the DAHS) that significantly affects the system's ability to measure or record mass emissions, or emission concentration. However, changes resulting from routine or normal corrective maintenance or QA activities do not require recertification. Similarly, software modifications in the automated DAHS do not require recertification when the modifications do not affect missing data substitution or calculation formulas.

SCAQMD policy specifies that for recertification, the same series of tests that were performed during the initial certification test program must be repeated unless otherwise approved by the District. The following tables list maintenance activities that would require either diagnostic tests or full recertification.

7.2.1 Diagnostic Tests and Recertification Summary Tables

The following tables list maintenance events and outline the appropriate tests to be performed for each event. The tables clarify which types of changes to a monitoring system may “significantly affect the ability of the system to accurately measure or record” emissions or flow rate and therefore require recertification testing or less stringent diagnostic testing.

The following tables do not address every situation that may arise and is not binding for situations that it does address. Contact the District concerning specific situations, particularly where an event occurs which is not listed in the tables.

The tables are divided into two types; Like Replacements only meaning all replacements are for like in all aspects, and UnLike Replacements meaning replacements are of different manufacturer, model or specification.

Table 7-1: Like Replacements Only

RECLAIM/NON-RECLAIM CEMS quality assessment tests following quality control activities [1]:

Quality Assessment→ / Quality Control↓	CEMS Calibration [2]	Manual Transmitter Calibration	Linearity Test [3]	Interference (as applicable) [4]	NO_2/NO_X Converter Efficiency [5]	Sample System Bias [6]	Analytical RATA [7]	Stack Flow Rate RATA [7]	Response Time
Sample System Components									
Probe replacement	X								
Probe filter replacement	X								
Heated sample line replacement	X					X			X
Condenser replacement	X					X			X
Sample pump repair/replacement	X								
Sample filter replacement	X								
Hardware/Software Components									
CEM controller components replacement	X								
DAHS hardware replacement [9]									
DAHS software reloading	X								

Like Replacements Only - Continued

Quality Assessment→ **Quality Control↓**	**CEMS Calibration [2]**	**Manual Transmitter Calibration**	**Linearity Test [3]**	**Interference (as applicable) [4]**	**NO_2/NO_X Converter Efficiency [5]**	**Sample System Bias [6]**	**Analytical RATA [7]**	**Stack Flow Rate RATA [7]**	**Response Time**
Fuel Flow Metering System (as applicable)									
Primary element replacement [9]									
Transmitter replacement		X							
NO_X Analyzer (as applicable) [10]									
NO_2 converter replacement	X				X				
Photomultiplier tube (PMT) replacement	X								
PMT tube cleaning	X								
Analyzer replacement	X		X	X	X		X		X
Pre-certified analyzer (redundant backup)	X								
Analyzer vacuum pump repair/replacement	X								
Analyzer filter replacement	X								
Ozone generator replacement	X								
PC board replacement	X								
Thermo-electric temp. cont. board	X								
Optics cleaning/replacement	X								
Chopper belt/motor replacement	X								
Capillary replacement	X								

Like Replacements Only - Continued

Quality Control↓ / Quality Assessment→	CEMS Calibration [2]	Manual Transmitter Calibration	Linearity Test [3]	Interference (as applicable) [4]	NO_2/NO_X Converter Efficiency [5]	Sample System Bias [6]	Analytical RATA [7]	Stack Flow Rate RATA [7]	Response Time
CO Analyzer (as applicable) [10]									
Analyzer replacement	X		X	X			X		X
Pre-certified analyzer (redundant backup)	X								
Bulb/lamp replacement	X								
PC board replacement	X								
Analog output trim	X								
Optics cleaning/replacement	X								
Optical bench alignment	X								
Electro-optic heater replacement	X								
Detector repair/replacement	X								
Chopper motor replacement	X								
Chopper bandpass filter(s) replacement	X								
O_2 Analyzer (as applicable) [10]									
Analyzer replacement	X		X				X	X [8]	X
Pre-certified analyzer (redundant backup)	X								
Linearizer circuit replacement	X		X						
ZrO_2 cell replacement	X								
PC board replacement/adjustment	X								
Source lamp replacement	X								
Photocell replacement	X								
Detector replacement	X								
Oven temp. adj. or replacement	X								

Notes:

1. Satisfactory completion of the indicated quality assessment activity will be sufficient demonstration of the CEMS ability to generate valid data. A change of any component listed on the original CEMS application by specific model and/or serial number for which specific details such as materials of construction or design are included requires formal notification to the District and will result in a response from the District.
2. CEMS calibration: A calibration performed in normal operating mode to confirm proper operation and establish new calibration correction factors or valid data generation.
3. Linearity test consists of conducting a cylinder gas audit (CGA) as described in 40 CFR 60, Appendix F, 40 CFR 75, or as defined in an SCAQMD approved QAP for the facility.
4. Applicable to systems where ammonia is present.
5. Can use any NIST traceable gas.
6. May not be applicable to dilution probe systems; consult SCAQMD.
7. As defined in 40 CFR 60, Appendix F.
8. If an analyzer is used for EPA F-factor calculation of stack flow rate (as described in EPA Method 19).
9. Refer to applicable sections of QAP or consult with SCAQMD for additional specific guidance.
10. 168-hour “burn-in” test is required for complete analyzer change out.

Table 7-2: Unlike Replacements Only

RECLAIM/NON-RECLAIM CEMS quality assessment tests following quality control activities [1]:

Quality Assessment→ / Quality Control↓	CEMS Calibration [2]	Manual Transmitter Calibration	Linearity Test [3]	Interference (as applicable) [4]	NO_2/NO_X Converter Efficiency [5]	Sample System Bias [6]	Analytical RATA [7]	Stack Flow Rate RATA [7]	Response Time
Sample System Components									
Probe relocation	X					X	X [8]		X
Probe replacement	X					X			X
Probe filter replacement	X					X			X
Heated sample line replacement	X					X			X
Condenser replacement	X					X			X
Sample pump repair/replacement	X					X			X
Sample filter replacement	X					X			X
Hardware/Software Components									
CEM controller components replacement	X								
DAHS hardware replacement	X								
DAHS software reloading	X								
Fuel Flow Metering System (as applicable)									
Flow computer								X	
Primary element replacement								X	
Transmitter replacement		X							

Unlike Replacements Only - Continued

Quality Assessment→ **Quality Control↓**	**CEMS Calibration** [2]	**Manual Transmitter Calibration**	**Linearity Test** [3]	**Interference (as applicable)** [4]	**NO_2/NO_X Converter Efficiency** [5]	**Sample System Bias** [6]	**Analytical RATA** [7]	**Stack Flow Rate RATA** [7]	**Response Time**
NO_X Analyzer (as applicable) [10]									
NO_2 converter replacement	X			X	X				
PMT tube replacement	X		X						
Analyzer replacement	X		X	X	X	X	X		X
Analyzer vacuum pump repair/replacement	X								
Analyzer filter replacement	X								
Ozone generator replacement	X								
Critical orifice/capillary replacement	X								
PC board replacement	X								
Thermo-electric temp. cont. board	X								
Optics replacement	X			X					
Chopper belt/motor replacement	X								
CO Analyzer (as applicable) [10]									
Analyzer replacement	X		X				X		X
Bulb/lamp replacement	X								
PC board replacement	X								
Analog output trim replacement	X		X						
Replace optical bench	X		X				X		
Optics replacement	X		X						
Electro-optic heater replacement	X								
Detector replacement	X		X						
Chopper motor replacement	X								
Chopper bandpass filter(s) replacement	X								

Unlike Replacements Only - Continued

Quality Assessment→ **Quality Control↓**	**CEMS Calibration** [2]	**Manual Transmitter Calibration**	**Linearity Test** [3]	**Interference (as applicable)** [4]	**NO_2/NO_X Converter Efficiency** [5]	**Sample System Bias** [6]	**Analytical RATA** [7]	**Stack Flow Rate RATA** [7]	**Response Time**
O_2 Analyzer (as applicable) [10]									
Analyzer replacement	X		X				X	X [9]	X
Replace linearizer board	X		X						
Cell replacement	X		X						
PC board replacement	X								
Source lamp replacement	X								
Photocell replacement	X								
Detector replacement	X								
Oven temp. replacement	X								

Notes:

1. Satisfactory completion of the indicated quality assessment activity will be sufficient demonstration of the CEMS ability to generate valid data. A change of any component listed on the original CEMS application by specific model and/or serial number for which specific details such as materials of construction or design are included requires formal notification to the District and will result in a response from the District.
2. CEMS calibration: A calibration performed in normal operating mode to confirm proper operation and establish new calibration correction factors or valid data generation.
3. Linearity test consists of conducting a cylinder gas audit (CGA) as described in 40 CFR 60, Appendix F, 40 CFR 75, or as defined in an SCAQMD approved QAP for the facility.
4. Applicable to systems where ammonia is present.
5. Can use any NIST traceable gas.
6. May not be applicable to dilution probe systems; consult SCAQMD.
7. As defined in 40 CFR 60, Appendix F.
8. Stratification test must be done.
9. If an analyzer is used for EPA F-factor calculation of stack flow rate (as described in EPA Method 19).
10. 168-hour “burn-in” test is required for complete analyzer change out.

7.2.2 SCAQMD Recertification Procedures

The District will reevaluate the monitoring systems where changes to the basic process equipment or air pollution control equipment have been made, to determine the proper full span range of the monitors. A change to a monitor's full scale range will be implemented in accordance with procedures from the SCAQMD's Technical Guidance Document R-003 which specifies a 3-point linearity test.

Recertification of any existing CEMS must be completed within 90 days of the start-up of newly changed or modified equipment monitored by the CEMS. The facility shall calculate and report NO_X emission data for the period prior to the CEMS recertification through the DAHS according to the following:

a. For any CEMS, which is recertified within 90 days of start-up of the newly modified equipment, the emission data recorded by the CEMS prior to the recertification would be considered valid and will be used for calculating and reporting NO_X emissions for the corresponding measurement point.
b. For any CEMS, which is not certified within 90 days of start-up of the newly modified equipment, the 90th percentile emission data (lb/day) for the previous 90 unit-operating days recorded by the CEMS prior to the recertification shall be used for calculating and reporting NO_X emissions for the corresponding measurement point.

RATAs required during a recertification test program must be submitted to the District within a 60 day window in order for the CEMS data to be considered valid from the last day of RATA testing.

7.2.3 Impact of Recertification Events on Data Acceptability

If a replacement, modification or change is such that the data collected by the previously certified monitoring system are no longer representative, such as after a change in flue gas handling system or unit operation that requires changing the span value of the analyzers, the facility must substitute data using initial missing data procedures. If changes results in significantly higher concentration or flow rate, substitute maximum potential values as approved by the State regulatory agency during the period following the replacement, modification or change up to the hour of successful completion of all recertification testing.

[End of section. This document is formatted for double-sided printing.]

8 Routine Preventive Maintenance

8.1 Introduction

The following sections describe a process of checks that must be followed to ensure reported data is reliable and the CEMS operates dependably. The following includes information about when checks and audits should be performed and when a situation indicates the need for corrective actions. It is essential the personnel conducting the checks and audits completely fill out every item on the appropriate forms. This includes the recording of any comments concerning the condition of the CEMS. Corrective actions should be initiated immediately upon identification of a problem or malfunction.

It is recommended that zero and span calibration drift checks be conducted immediately prior to any maintenance and a calibration must be performed after any maintenance. If the post-maintenance zero or calibration drift test shows excessive drift, correction action and recalibration must be conducted to bring the CEMS and its components within specifications. All corrective action activities must be documented.

As routine or non-routine maintenance is performed, consult the table(s) from Chapter 7 of this manual. The tables identify the type of maintenance event and resultant test specification that may be required to demonstrate compliance of the equipment after completion of the maintenance procedure.

8.2 Logbook Maintenance

A logbook and maintenance check sheets will 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. Maintenance records must be maintained and presented for inspection if asked for by a regulatory agent.

A record of all testing, maintenance, or repair activities performed on any monitoring system or component will be maintained in a location and format suitable for inspection. The logbook and/or maintenance/inspection log sheets will 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 recharacterizes a system’s ability to record and report emissions data must be recorded (for example, changing of temperature and pressure coefficients).
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.

8.3 Minimize Downtime during Routine Maintenance

The goal of this section is to minimize downtime and the impact on data availability during normal routine maintenance. Following the steps on routine preventative maintenance as well as any additional maintenance requirements on all equipment supplied with this 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 this system at all times. This is critical to plant owners and operators as too much time spent in downtime can affect data availability requirements.

While performing any maintenance activity, consult the Recertification/Diagnostic Test tables located in Chapter 7 of this QAP document. The tables specify types of maintenance activities and resultant diagnostic test routines required to demonstrate the component is operating within compliance specifications after completion of the maintenance procedure.

All maintenance activities, whether routine or non-routine, needs 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 to be logged in the appropriate CEMS logbook and/or maintenance check forms.

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 by using the **MAINT REQ** switch on the CEMS front panel to perform the work. A way to minimize downtime is to take advantage of planned or unplanned process trips, outages or overhauls. Maintain the DAHS in operational status at all times.

If the system is equipped with a back-up CEMS then perform service, calibration and a complete function and accuracy check of the back-up system before 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.

Hourly emission averages will be affected by spending excessive amounts of time in maintenance mode. This in turn affects data availability. Leave the system in maintenance mode for only as long as needed to perform the needed maintenance or repair activity. Return the system to normal sampling mode as soon as possible.

Frequency of maintenance depends on many variables such as geographic location (humidity and seasonal temperature fluctuations), fuel type, stack temperature and moisture content, etc. Consequently, scheduled maintenance intervals will vary from the general guidelines given in the CEMS Operation and Maintenance (O&M) manual and the individual component equipment manuals.

8.4 System Checks

The following sections provide a brief overview on general system checks used for troubleshooting proposes.

8.4.1 Calibration Failure

Technicians are responsible for checking the daily calibration report as soon as the calibration sequence has been completed for the day. The DAHS will output an alarm whenever a calibration result is out of specification. Calibration results are reviewed through the DAHS and can be printed out. Weekly upward or downward trends in calibration results may require checking and manual calibration of the analyzer before the analyzer becomes out-of-control. If a calibration failure occurs, data is considered out-of-control until a successful re-calibration has been performed.

If a calibration failure occurs, first check the gauge on the related calibration gas cylinder to see if the pressure is adequate (above 150 psig). If the gas pressure is adequate, manually perform a calibration. If calibration cannot be successfully completed by adjusting the analyzers, troubleshoot and perform maintenance as required on the analyzer.

Use the following as a guideline for performing troubleshooting after a calibration failure:

1. First check the value entered in the DAHS and the analyzer for the gas cylinder to that listed on the cylinder label. If the values do not agree, correct.
2. Next, check to see that the bottle supply valves are open, that the pressure regulator is set to 20 psig, and that the cylinder has more than 150 psig of gas remaining. If the cylinder level falls below 150 psig, the cylinder will need replacing.
3. If the calibration failure percentage is large, this may indicate a system or component failure in the analyzer; not simply analyzer drift. In this situation, follow the troubleshooting procedures detailed in the equipment manufacturers' manuals.
4. If the cylinder and the analyzer are set up correctly, and if the failure percentage is small, the analyzer should be re-zeroed and re-spanned following manufacturers' procedures.
5. All analyzer adjustments must be followed by a hands-off, full system calibration.
6. Check the calibration report to show that the adjustment or repair resulted in a passed calibration and that the out-of-control period has ended.
7. Log the corrective actions taken in the CEMS maintenance log book. Be sure to include:
   a. Date and time analyzer became out of control or out of service.
   b. Description of any testing, adjustment, repair, component replacement, or preventive maintenance performed.
   c. Analyzer readings before and after the adjustment.
   d. The follow up quality assurance activity that was performed to show that the adjustment or repair involved solved the problem (minimum, hands off calibration check).
   e. Date and time the analyzer was returned to service.

If a calibration failure requires a substantial readjustment of the zero calibration on an analyzer, and if subsequent automatic calibration indicates a widely drifting zero output, troubleshoot and service that analyzer following the procedures in the manufacturer's instruction manual.

8.4.2 Abnormal Measurement Output Voltage/Current

If output voltage/current range is not between the required range for each analyzer and calibration is completed successfully, refer to the analyzer manufacturer's instruction manuals for adjustment and/or repair information.

8.4.3 Water Contamination

When troubleshooting a sample failure alarm check for any water in the moisture sensor bowl or a high cooler temperature. To find the cause of the water contamination, proceed as follows:

a. Check to see that the temperature of the sample gas cooler (**GC1**) is at least 2°C (~35°F).
b. Remove, dry out, and replace the moisture sensor (**MS1**) filter elements.

8.4.4 Moisture Sensor Check

The moisture sensor (**MS1, MS2**) should be checked daily to ensure it is dry and clean. The moisture sensor protects the downstream analyzers from damage.

Place system in maintenance mode and turn off the sample pump.

Note: *Individual configurations differ, some pumps can be unplugged, and some are turned off by unplugging the moisture sensor related to the pump, some have toggle on/off switches. Others can be digitally turned off through the OIT or turned off by DAHS control. Know the system controls first.*

1. Carefully remove knurled nut at the base of the filter housing. The sensor is made of glass components. Support the moisture sensor so it does not drop and break.
2. Remove and inspect the sensor for cracks and moisture between the two contacts. If no moisture is present then the alarm should be off. You can check the sensitivity by simply dampening the sensor slightly. It should activate the alarm. If the system is running the pump will turn off.
3. If moisture is present you will need to dry the sensor and purge out the Teflon lines between the chiller outlet and the moisture sensor. Replace the filter if needed (see particulate filter replacement procedure).
4. To purge the lines remove the 1/4 inch Teflon line at impinger #2 outlet. Be careful not to drop the gasket, note the Teflon side of gasket faces the glass.
5. Next loosen and remove the 1/4 inch Teflon line at the moisture sensor outlet. Purge the Teflon line from the chiller to the moisture sensor outlet with dry instrument grade air or N_2 until all signs of moisture are gone.
6. Reinstall the line and the moisture sensor, make sure gaskets are installed properly and all fittings are tight. If moisture is getting past the sample gas cooler you should troubleshoot the cooler to find out the cause.

When checking is completed turn the sample pump back on. Verify flow and pressures are okay and there are no leaks in the lines. Take system out of maintenance and calibrate system.

8.4.5 Sample System Particulate Filter Check

Visually inspect particulate filter (**F1, F2**) on a daily basis. If filter shows buildup and flow levels are dropping, replace filter. Otherwise, the filter should be replaced on an annual basis.

Place system in maintenance mode and turn off sample pump.

Note: *Individual configurations differ, some pumps can be unplugged, and some are turned off by unplugging the moisture sensor related to the pump, some have toggle on/off switches. Others can be digitally turned off through the OIT or turned off by DAHS control. Know the system controls first.*

1. Carefully remove knurled nut at the base of the filter housing. Support the moisture sensor so it does not drop and break.
2. Carefully remove the glass filter housing.
3. Carefully remove the knurled nut at the base of the filter element. The nut and filter element will drop out from its supporting housing bracket.
4. Clean the bracket with de-ionized water if needed and dry. Replace the filter element making sure it seats into the small lip on center.
5. Inspect the O-ring and replace if needed.
6. Inspect the small seal at the base of the knurled nut that supports the moisture sensor. Verify the Teflon side of the seal is facing up.
7. Reinstall in reverse order.

When the check is completed turn sample pump back on. Verify that flow and pressures are okay and there are no leaks in the lines. Take system out of maintenance and calibrate system.

8.4.6 Routine Maintenance for the Sample Probe

The probe has no moving parts. It does have a particulate filter and an electric heater. The electric heater can be checked by using a clamp-on AC amp meter to detect current on the power wires going from the analyzer cabinet into the sample line up to the probe. The probe also has a low temperature alarm contact that will detect an inoperable probe heater. The filter is manually checked as part of scheduled routine maintenance as described later.

Changing the Probe Filter:

Caution: The probe and filter assembly may be hot and can cause burns when not handled with appropriate protection. Use heat resistance gloves when performing maintenance on the probe.

To change the filter in the Universal 270 probe, grasp the cap at the end of the filter body opposite the probe and turn counter clockwise. Removing the cover exposes the filter. Reach into the heated oven with pliers to pull out the old filter.

Inspect the O-rings located at each end of the filter to ensure they are still elastic and will seal the filter. Replace them if they are charred or deformed.

Replace the filter with a new one, again handling it with pliers. Insure it is pushed in the center of the oven so that it is in contact with the O-ring at the inside end of the filter. Screw the cap back on the filter body.

8.4.7 Routine Maintenance for the Sample Line

The sample line requires no maintenance. However, it is advisable to periodically inspect the sample line visually to detect any damage or wear due to rubbing, vibration, physical damage, etc. If the sample line is installed properly there should be no stress points that could cause the tubing to become kinked in any manner. Typical life of the sample line heat trace is approximately 10-12 years depending on the temperature maintained and ambient conditions. Sample line heat trace is not a serviceable item and thus would require replacement in its entirety.

8.4.8 Routine Maintenance for the Sample Conditioning Unit

The M&C ECM sample-conditioning unit (**GC1**) requires no particular routine maintenance. Depending on the quality of the ambient air the cooling fin block should be blown out with compressed air from time to time. In addition:

1. Insure sample pump is operating properly
2. Insure condensate pump is operating correctly

The operating temperature of the sample cooler is monitored and a signal input indicating a fault will be sent to the PLC if temperature set points have been exceeded. Troubleshooting procedures and corrective actions must be initiated whenever a sample cooler alarm has been activated.

8.4.9 Replacing Ammonia Scrubber

Check ammonia scrubber (**AS1**) on a quarterly basis. When deposits are visible 75% of the way up the length of the scrubber, scrubbing media needs to be replaced.

Place system in maintenance mode and turn off the sample pump.

> ***Note:*** *Individual configurations differ, some pumps can be unplugged, and some are turned off by unplugging the moisture sensor related to the pump, some have toggle on/off switches. Others can be digitally turned off through the OIT or turned off by DAHS control. Know the system controls first.*

1. Bleed off any liquid from ammonia scrubber through the drain located at the base of the scrubber into the drain manifold. Rubber gloves suggested for servicing scrubber.
2. Unscrew thumbscrew on the bottom of the housing.
3. Swing yoke to one side.
4. Hold the bottom cap plate and housing and twist slightly while pulling downward to remove it from its housing bracket.
5. Remove old media and dispose of properly. Housing, center rod, screens and spring may be cleaned with de-ionized water.
6. Replace bottom cap plate, screen and center rod into housing.
7. Fill with 135 cc Berl Saddles and 65 cc scrubbing media, make sure no material falls into the center rod.
8. Make sure the rod is centered so it fits back into housing bracket without forcing it. Inspect and clean O-rings.
9. Reassemble the top screen, spring and take the complete assembly and push it back up into its housing bracket O-rings; twist slightly to seal. Be careful not to crack the case housing.
10. Replace the yoke and tighten the thumbscrew finger tight. Do not over tighten.
11. Verify scrubber drain is closed.

After completion of the procedure take system out of maintenance. Check that flow rates are okay and no leaks detected. Calibrate system.

8.4.10 Instrument Air Filter Service Check

Use the following to service the instrument air filter (**FR1**). The filter regulator should be checked weekly (minimum). The DAHS will output an alarm if instrument air pressure drops below setpoint (approximately 60 psi). The filter assembly requires periodic cleaning and replacement, typically semiannual but the interval is dependent on site-specific operating conditions.

Place system in maintenance during service if applicable.

Note: *Systems differ; review system engineering drawings and operation first, verify set point. Use rubber gloves if filter is oily or wet.*

1. Turn off main instrument air supply valve (**HV1**).
2. Ensure that the auto-drain has cleared all moisture at bottom of the filter bowl.
3. Allow air to bleed off and the pressure gauge for the regulator reads zero psi.
4. Loosen any tubes attached to the bottom of the regulator drain.
5. Loosen the nut at the bottom of the filter bowl and remove it completely while supporting the bowl with your other hand.
6. Remove the bowl.
7. Grab the filter and filter retainer washer at the bottom and twist it slightly. The filter and retainer washer should drop down.

8. Inspect the O-ring in the retainer washer. Replace if needed.
9. Clean the filter housing and inspect the O-ring at the base of the filter housing were the top of the bowl seats. Replace O-ring if bad (O-ring can get stuck to the bowl).
10. Clean the filter bowl, filter retainer washer, and mounting nut.
11. Inspect the O-ring on the mounting nut. Replace O-ring if bad.
12. Clean all parts.

Reinstallation

1. Install O-rings, filter and filter retainer washer.
2. Verify O-rings are in place and install bowl and nut that secures the bowl. Hand tighten (note bowl is made of polycarbonate and can crack if over tightened). Once the O-rings are correctly seated tighten the nut to secure the bowl.
3. Once bowl drain is in place leave it slightly open.
4. Turn on **HV1** instrument air slowly and then close off drain as pressure builds. This allows pressure to build up slowly and any moisture to drain. Verify set point is O.K. and there are no leaks.

8.4.11 Peristaltic Pump Tubing Replacement

Operation of the sample cooler peristaltic drain pumps (**DP1/DP2, DP3/DP4**) should be checked daily, turning approximately 6 rpm. The tubing should be inspected annually for clogging or cracks and replaced as needed.

To inspect and replace the tubing place system in maintenance mode and turn off the sample pump.

> ***Note:*** *Individual configurations differ, some pumps can be unplugged, and some are turned off by unplugging the moisture sensor related to the pump, some have toggle on/off switches. Others can be digitally turned off through the OIT or turned off by DAHS control. Know the system controls first.*

A supplied tubing loading key will be required for assembly.

1. Turn off drain pump at the pump on/off switch.
2. Disconnect the inlet and outlet tubing of the pump from the chiller and exhaust manifold drain or at the slip fit connectors. Note pump rotation.
3. Remove the 4 wing nuts and washers.
4. Remove the first head (end bells), and or second head from the studs by pulling the head towards you away from the pump body.
5. Pull the head end bells apart. Hold the end bell containing the rotor with the tubing retainer grooves pointing down. Remove the old tubing. It may show signs of wear, small cracks or cuts.
6. Inspect the pump rollers to make sure they are rolling freely.

7. Replace the old tubing with Masterflex tubing the same diameter and length as the one you removed. Make a note on where the bend of the old tubing was located. It will be the part of the tube that will be placed around the rollers.
8. Place tubing in the right groove and against the first two rollers. Hold tubing with thumb. Near groove, insert smaller prong of loading key between the top of the rotor and tubing. Push key in as far as possible.
9. Push down and turn the key counterclockwise completely around the rotor. The key will push the tubing uniformly into the end bell assembly. Hold the second end of tubing. Remove the key.
10. Position the other end bell on top and press the end bells together. Be careful not to pinch the tubing. If end bells do not snap tightly together, reload tubing. If necessary, turnkey in slot on rotor shaft to adjust tubing.
11. With key in slot on rotor shaft, turn key to align tang on rotor shaft with slot in motor drive shaft. Point tubing retainer grooves up. Shift the pump head slightly until it snaps on the alignment pins (if present). Secure with the screws. Tighten with fingers only.
12. Do the same for pump head number two. Then reinstall the heads making sure the cam and the slot in each head line up so the pump will rotate freely and the wing nuts can be reinstalled and tightened up.
13. Turn the drain pump on, verify it turns in the right direction and is removing water.
14. After completion take the system out of maintenance and calibrate the system verifying no leaks in the system.

8.4.12 Sample Pump Diaphragm Replacement

The sample pump (**SP1, SP2**) should be checked annually. Rebuild pump as needed.

Place system in maintenance mode and turn off the sample pump.

Note: *Individual configurations differ, some pumps can be unplugged, and some are turned off by unplugging the moisture sensor related to the pump, some have toggle on/off switches. Others can be digitally turned off through the OIT or turned off by DAHS control. Know the system controls first.*

1. Remove the two 1.4 inch Swagelok nuts at the inlet and outlet to the pump. Do not mix up the two lines.
2. Use a 3/16 Allen wretch to loosen the 4 SST screws on the top of the pump head. Note the direction of flow arrows on the top of the pump head.
3. Remove the 5/32 Allen screw on top of the pump housing and replace the Teflon washer and the Teflon coated diaphragm. Inspect the Teflon coating on the plate-diaphragm and head parts for good condition.
4. The valve body can then be removed by unscrewing the two smaller screws. This part may be freed by gently tapping on these two screws after they have been loosened about three or four turns.

5. Carefully remove the valve body, the two disc-valves, and the gasket. Check all internal surfaces for any accumulation of dirt. The two disc-valves can be wiped clean and replaces as long as they appear unaffected by usage. The valve gasket should be inspected.
6. Replace the gasket and disc-valves, verify the Teflon coating is in good condition and the valve seats are clean and dry.
7. The service diaphragm is secured by a single screw in its center. Remove this screw with a 5/32" Allen wrench. The diaphragm and plate should lift off. Some adherence to the metal might occur if the diaphragm has been in use for a long period.
8. When replacing the service diaphragm, a Teflon washer should be inserted under the head of the diaphragm cap screw. This is added insurance against small gas leaks through screw heads. After tightening the screw, the excess Teflon should be trimmed away.

   When replacing the service diaphragm, be sure the four projecting studs of the base casting are properly located in the four outer holes provided in the diaphragm before the part is clamped in place. Be sure the diaphragm plate is firmly replaced with its center screw.
9. Reinstall the valve body into the head by setting the head onto the valve body and tighten the two screws. Make sure the discs seated correctly. Reinstall the head. Turn the pump on to verify suction and pressure.
10. Hook up the Swagelok tube and fittings. Take out of maintenance and calibrate system.

8.4.13 NO_X Converter Check

This check is performed to ensure that the majority of the NO_X component of the stack gas is able to be converted by the NO_X analyzer into NO to be measured. The NO_X converter element of a NO_X analyzer has a typical life span of 2,000 ppm hours, roughly about a 2-5 year lifespan. NO_X converter degradation is not easily detected during normal operation and daily calibrations. NO_X converter failure will be detected during a relative accuracy test audit, as the reference method NO_X measurement will not agree with the stack measurement. This procedure should be performed annually, before the RATA.

The NO_X converter efficiency check is performed in accordance with EPA Test Method 7E, section 8.2.4.1, section 12.7, and section 13.5.

1. Select a protocol gas cylinder having an NO_2 concentration that is 15-18 ppm, balanced in air for stainless steel converters. No other gases may be present in the cylinder. Alternately, use an NO_2 gas that is within 10% of expected NO_2 concentration in the exhaust stack. Note that NO_2 cylinders have a limited shelf life. Check the expiration date on the cylinder prior to use.
2. Perform a calibration check to ensure that the analyzer is not out-of-control. Make adjustments and re-check the calibration as necessary.
3. Place the system into maintenance mode. Directly inject the NO_2 gas to the analyzer and check cylinder regulator pressure to ensure that the flow rate is 2 liters per minute.
4. Flow the gas until stable readings are reached (approximately 10 minutes). If the resulting stable reading is 90-100% of the cylinder target value, the NO_X converter is converting the NO_2 properly. Any lesser amount of conversion indicates that the NO_X converter needs to be replaced. If the converter is replaced, perform a follow up converter check to ensure that the problem was resolved.
5. Note in the CEMS maintenance log book when the converter check was performed, results of the check, and if the converter was replaced.

NO_2 to NO Conversion Efficiency ***40 CFR 60, Appendix A, Method 7E, Equation 7E-7***	
$$Eff_{NO2} = \frac{C_{Dir}}{C_V} x\, 100$$	Eff_{NO2} = Percent converter efficiency C_{Dir} = Monitor response value to the direct NO2 gas injection C_V = Certified value of the NO_2 calibration gas

8.4.14 Analyzer Cabinet Temperature Control

The analyzer cabinet is equipped with HVAC to maintain ambient temperature at a stable level. The temperature inside the shelter should typically be controlled at 72°F and should not deviate by more than ±5 degrees in a 24 hour period. A stable temperature is needed to guard the equipment against analyzer drift resulting from ambient temperature fluctuations. A routine check of the HVAC controls should include:

1. Verification of correct temperature control. If unit is not functioning correctly, corrective action procedures must be immediately implemented.
2. Check condition of the conditioner's filter on a monthly basis. Change as needed, usually every two months.

8.5 CEMS Preventive Maintenance Schedule

This section contains a suggested schedule for performing preventive maintenance. Maintenance schedules may vary depending upon site-specific conditions (that is, filters may need to be changed more often in a "dirty" environment or less often under "clean" conditions). For detailed maintenance, procedures refer to the manufacturer's instruction manuals and other technical data included separate cover.

Facility personnel shall normally maintain the CEM systems. In addition, service technicians and CEMS service representatives are available upon request.

The QA audits can also define other possible operation problems that need to be resolved. Operational problems necessitate immediate repair action by personnel. If the onsite maintenance personnel cannot resolve the problem, a CEMS representative will be summoned. All repairs will be documented in the operation and maintenance logbook.

Some items, such as filter checks, may not exhibit a failure condition until damage has occurred to other components. Initially, these items will 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 or equipment damage. This includes paying attention to any pressure or flow rate shifts (sudden or prolonged) in one direction and close observation of the visual indicators in the system. Be alert for both gradual and sudden changes in system operation.

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 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. Use simulated signal inputs to check contact closures on relays. Adjust temperature controllers, pressure settings, vacuum settings, flow rates, etc. above or below set points to check alarm triggers. Apply a spot of moisture to the moisture sensor to test the liquid/moisture alarm. All alarm conditions require quick attention and resolution.

Before beginning any maintenance or troubleshooting routines, call the control room to let them know that the system is being worked on and possibly affecting emissions data. Place the system into maintenance mode during any preventive or corrective maintenance activity. This action marks the data with the maintenance flag, which will prevent that data from being used in the hourly averages. Take the system out of maintenance mode immediately following any maintenance activity and let the control room know when the system has returned to normal operation.

Maintenance should be scheduled so as to not conflict with an auto-calibration and to maximize data collection and minimize monitor downtime. Always perform a full system hands off calibration after completion of any maintenance activity.

Always log the work done, with the date and the time period during which the analyzers or system was in maintenance. Include the date and time the analyzer was out-of-service, description of the maintenance or corrective action activity, or component replacement. Log the time the system was place back into service and initial the log entry.

Important Note: *In accordance with some local regulatory compliance requirements, certain types of maintenance events may trigger the need to perform diagnostic testing and/or recertification to ensure that the CEMS has been returned to optimum operating condition after the maintenance activity. A manual calibration is required after completion of most routine maintenance repair events. Major repair and/or complete replacement of an analyzer or other major equipment component may require partial or full recertification of the repaired/replaced instrument.*

General Warnings: *The technicians performing maintenance should be familiar with all safety warnings contained in the individual manufacturer's manuals. All maintenance must be performed in accordance with facility safety procedures.*

Most components need to be powered off before major maintenance to prevent potential electrical shock hazards. Maintenance performed on electrical equipment must be conducted in accordance with facility Lockout/Tagout (LO/TO) procedures

Some components can be damaged by small amounts of static electricity. Before performing any maintenance, use a properly grounded antistatic wrist strap to be worn while handling any instrument's internal components.

Some components such as the probe or heating elements on some analyzer types may be extremely hot to the touch. Wear protective heat-resistant gloves when handling.

Other components such as optical assemblies and capillaries in the analyzers are made of glass and must be handled carefully.

Be careful when using solvents or abrasive materials for cleaning to avoid damage to components. Check manufacturers' manuals for recommended cleaning materials and procedures.

8.5.1 Daily Preventive Maintenance

Perform the following checks and maintenance for each day that the CEMS is in operation. Make corrections and/or repairs as necessary. Record any corrective maintenance or troubleshooting procedures performed on the CEMS and any out-of-control periods in the CEMS Maintenance Logbook.

Unit Number ID:	
Date of Checks:	
Technician(s) Initials:	

Sample System Checks – Daily				
Item		**Tag**	**Set Point**	**Record Daily Value or Status**
Pressures	Instrument air	**PG1**	80-125 psig	
	Stack sample pressure	**PG2**	>2 psig (expected 5-15 psig)	
	Inlet sample pressure	**PG3**	>2 psig (expected 5-15 psig)	
	Stack probe vacuum	**VG1**	<10 inch Hg (expected <3" Hg)	
	Inlet probe vacuum	**VG2**	<10 inch Hg (expected <3" Hg)	
	Instrument air filter regulator	**FR1**	>80 psig (±10 psig)	
Flows	Stack total sample flow	**RM1**	4-5 lpm (DAHS will alarm at setpoint)	
	Inlet total sample flow	**RM5**	4-5 lpm (DAHS will alarm at setpoint)	
	Stack NO_X/O_2 analyzer flow	**RM2**	~1.5 lpm (expected 1.25 to 1.75 lpm)	
	CO analyzer flow	**RM3**	~1.5 lpm (expected 1.25 to 1.75 lpm)	
	Inlet NO_X analyzer flow	**RM6**	~1.5 lpm	
	Stack cal gas total flow	**RM4**	8-9 lpm	
	Inlet cal gas total flow	**RM7**	8-9 lpm	

Daily preventive maintenance checks continued.

Sample System Checks – Daily				
Item		**Tag**	**Set Point**	**Record Daily Value or Status**
Visual checks	Cabinet temperature	Check HVAC controls	72°F, ±5°F	
	Stack moisture sensor/filter	**MS1**	Clean and dry (DAHS will alarm “wet sample” if moisture detected)	
	Inlet moisture sensor/filter	**MS2**	Clean and dry (DAHS will alarm “wet sample” if moisture detected)	
	Stack sample cooler temp	**GC1**	Status indicators show okay. (DAHS will alarm on “cooler fault” signal input.)	
	Inlet sample cooler temp	**GC2**	Status indicators show okay. (DAHS will alarm on “cooler fault” signal input.)	
	Stack sample cooler drain pump	**DP1** and **DP2**	Turning approx. 6 rpm	
	Inlet sample cooler drain pump	**DP3** and **DP4**	Turning approx. 6 rpm	
	Stack sample line temp control	**TC1**	250°F, ±5°F. (DAHS will alarm at temp setpoints.)	
	Inlet sample line temp control	**TC1**	250°F, ±5°F. (DAHS will alarm at temp setpoints.)	

Daily preventive maintenance checks continued.

Additional Sample System Checks – Daily	
Item	**Value or Status (Completed, OK, Replaced)**
Visually inspect sample system particulate filter (**F1** and **F2**). If filter shows buildup (appears dirty) and flow levels are dropping, replace filter. Typical replacement is semiannual up to annual but is highly dependent on operating conditions.	
Check daily calibration gas bottle pressures: 0-2000 gauge = 200 Replace cylinder if high pressure is below set point. Order new cal gases when needed keeping in mind the lead time required for some cal gas mixtures.	
Refrigerated air dryer (**RAD1**) – Inspect for proper operation. Check control panel for alarms. Verify proper inlet and ambient air conditions.	

DAHS Checks – Daily	
Item	**Value or Status (Completed, OK, Replaced)**
Check DAHS for normal operation. Is system logging data?	
Check and archive alarms. Log reason codes and action codes for any alarm conditions.	
Check printer for normal operation.	
Check calibration drift report for all analyzers/monitors. Did all calibrations pass?	
Review all daily summary reports. Watch for and immediately report to supervisor any non-compliance/exceedance episodes. Initiate corrective actions as needed. Fill out downtime event forms as needed.	

Daily preventive maintenance checks continued.

Analyzer Checks – Daily	
Item	**Value or Status (Completed, OK, Replaced)**
Check all analyzer/monitor displays for error messages.	

Notes: Ensure system has been placed in Maintenance Mode before performing any maintenance or repair.

Non-Compliance Episodes:
Immediately report to the Environmental Person within 15-20 minutes any non-compliance/exceedance episodes. The SCAQMD must be informed within 1 hour of each episode. Ensure all events are logged along with time, duration, and corrective actions taken for each non-compliance episode.

Calibration Issues:

- Check results as soon as cal period finishes.
- If cal fails, recalibrate within 15 minutes (compliance: pass recalibration w/in 60 min of orig. cal hour is considered “good”.
- Initiate a calibration after each new cal gas bottle.
- Initiate a calibration after each startup.
- Initiate a calibration after any maintenance/corrective action event to check operating condition of the analyzers.

8.5.2 Weekly Preventive Maintenance

Perform the following checks and maintenance for each week that the CEMS is in operation. Make corrections and/or repairs as necessary. Record any corrective maintenance or troubleshooting procedures performed on the CEMS and any out-of-control periods in the CEMS Maintenance Logbook.

Unit Number ID:	
Week Ending:	
Technician(s) Initials:	

Sample System Checks – Weekly	
Item	**Value or Status (Completed, OK, Replaced)**
Perform all daily checks.	
Watch for upward or downward trends in the daily calibrations for the prior week. Perform zero and span adjustment, if required.	
Check moisture sensor on Stack and Inlet (**MS1, MS2**) and tubing downstream of sample conditioner for moisture. Remove and dry as necessary. DAHS will alarm if moisture is detected. Check Stack and Inlet sample conditioner (**GC1, GC2**) for proper operating temperature. DAHS will alarm if a "cooler fault" signal is received	
Refrigerated air dryer (**RAD1**) – Assure drain is functioning properly.	
Refrigerated air dryer (**RAD1**) –Check the daily instrument air pressure readings at **PG1** and total sample system pressure readings at **PG2** and **PG3**. If the daily readings are not within expected parameters inspect the pre- and post-filters and replace if readings are out of range.	

Weekly checks continued

DAHS Checks – Weekly	
Item	**Value or Status (Completed, OK, Replaced)**
Check/change backup media if using CD, tape, or flash card; removable hard drive, etc.	
If enabled, verify that automatic backups have occurred for the week.	
Verify there is sufficient disk space for another week of data.	

Analyzer Checks – Weekly	
Item	**Value or Status (Completed, OK, Replaced)**
TEI 42i-LS NO_X Analyzer	
Perform zero and span adjustment if required.	

8.5.3 Monthly Preventive Maintenance

Perform the following checks and maintenance once each month that the CEMS is in operation. Make corrections and/or repairs as necessary. Record any corrective maintenance or troubleshooting procedures performed on the CEMS and any out-of-control periods in the CEMS Maintenance Logbook.

Unit Number ID:	
Date of Checks:	
Technician(s) Initials:	

Sample System Checks – Monthly	
Item	**Value or Status (Completed, OK, Replaced)**
Perform all daily and weekly checks.	
Check filter on cabinet HVAC system. Clean or replace as needed, usually every 2-3 months.	
Plan ahead for the upcoming CGA. Check CGA cal gas bottle pressures > 500 psig. Also check expiration dates. Order new gas bottles as needed keeping in mind the lead time may be several weeks.	
Refrigerated air dryer (**RAD1**) – Blow out entire unit with compressed air.	
Refrigerated air dryer (**RAD1**) – Blow condenser coils out with compressed air.	
Refrigerated air dryer (**RAD1**) – Inspect refrigeration compressor for overheating.	

8.5.4 Quarterly Preventive Maintenance

Perform the following checks and maintenance four times each year that the CEMS is in operation. Make corrections and/or repairs as necessary. Record any corrective maintenance or troubleshooting procedures performed on the CEMS and any out-of-control periods in the CEMS Maintenance Logbook.

Unit Number ID:	
Date of Checks:	
Technician(s) Initials:	

Sample System Checks – Quarterly	
Item	**Value or Status (Completed, OK, Replaced)**
Perform all daily, weekly, and monthly checks. Note that all routine maintenance is to be performed prior to the required quarterly audit test.	
If sample gas vacuum (**VG1, VG2**) shows an increase, perform probe maintenance. Replace the filter element and clean the filter chamber as necessary. Replace O-rings. Verify probe box heater is operating. If flow is low, check sample pump (**SP1, SP2**).	
Perform sample system leak check and flow balance procedure (Chapter 9).	
Check and replace ammonia scrubber media (**AS1**) as needed.	
Check system alarms, calibrate as needed.	
Perform general housekeeping duties inside cabinet. Dust/clean all equipment surfaces.	

Quarterly preventive maintenance checks continued.

Analyzer Checks – Quarterly	
Item	**Value or Status (Completed, OK, Replaced)**
For all analyzers: Visually check for obvious defects such as loose connectors, loose fittings, cracked or clogged Teflon lines, and excessive dust or dirt accumulation. Dirt accumulation inside the instruments can cause overheating or component failure and may provide conducting paths for electricity. Clean the inside of each instrument by vacuuming accessible areas and then using compressed air to blow out remaining dust. Use a soft paint brush or cloth to remove stubborn dirt. Clean all analyzer cooling fans. **CAUTION:** Observe all safety warnings from manufacturers' manuals.	
For stack mounted equipment: Check all seals and mounting hardware. Any deposits or build-up in the mounting flanges should be removed.	
TEI 42i-LS NO_X Analyzer	
Check pump diaphragm and Teflon wafer, rebuild as needed, usually annually.	
Inspect sample filter, replace if needed.	
Inspect capillaries for blockage (discoloration). The capillaries should be clear, if not replace.	
Inspect capillary O-rings for wear, replace if needed.	
Inspect ozone generator and scrubber.	
Inspect and clean the fan filter. Clean as needed by flushing with warm water and let dry. Or, use compressed air to blow out dust or use a hand vacuum.	

Quarterly checks continued

Analyzer Checks – Quarterly	
Item	**Value or Status (Completed, OK, Replaced)**
TEI Model 48i CO Monitor	
Check for leaks around the fittings.	
Check pump diaphragm, replace as needed (usually annually).	
Check that capillary is not blocked.	
If applicable, check for leaks around the optional valves.	
Inspect and clean the fan filter. After removing, flush with warm water and let dry or blow the filter clean with compressed air.	

QA Audits – Quarterly	
Perform quarterly CGA test and check DAHS results.	Completed On:

Notes:
Check which calendar quarter that any required annual RATA might be due. Fill out the QA Audit check forms in the Annual Preventive Maintenance tables when the required RATA has been completed. CGAs are not performed in the quarter in which an annual RATA is due.

Comments:

8.5.5 Semiannual Preventive Maintenance

Perform the following checks and maintenance twice each year that the CEMS is in operation. Make corrections and/or repairs as necessary. Record any corrective maintenance or troubleshooting procedures performed on the CEMS and any out-of-control periods in the CEMS Maintenance Logbook.

Unit Number ID:	
Date of Checks:	
Technician(s) Initials:	

Sample System Checks – Semiannual	
Item	**Value or Status (Completed, OK, Replaced)**
Perform all daily, weekly, monthly, and quarterly checks.	
Check and replace sample system filter (**F1, F2**) as needed.	
Check and replace instrument air filter (**FR1**) as needed.	
Check Stack and Inlet sample pumps (**SP1, SP2**); replace diaphragms and disks as needed.	
Check Stack and Inlet sample cooler peristaltic pump tubing (**DP1**/**DP2, DP3**/**DP4**), replace as needed.	
Refrigerated air dryer (**RAD1**) – Inspect entire assembly for loose connections, screws, panels, etc.	
Refrigerated air dryer (**RAD1**) – Inspect refrigeration circuit for signs of oil and refrigerant leakage.	
Refrigerated air dryer (**RAD1**) – Clean fan blades, casing, motors and internal components. Use light mixture of detergent. No oil based cleaning solvents should be used.	

Semiannual preventive maintenance checks continued.

Analyzer Checks – Semiannual	
Item	**Value or Status (Completed, OK, Replaced)**
TEI Model 48i CO Analyzer	
Check the optics. The mirrors should be cleaned any time the AGC intensity is below 20,000 Hz.	
Check calibration of the pressure and temperature transducers.	

8.5.6 Annual Preventive Maintenance

Perform the following checks and maintenance once each year that the CEMS is in operation. Make corrections and/or repairs as necessary. Record any corrective maintenance or troubleshooting procedures performed on the CEMS and any out-of-control periods in the CEMS Maintenance Logbook.

Unit Number ID:	
Date of Checks:	
Technician(s) Initials:	

Sample System Checks – Annual	
Item	**Value or Status (Completed, OK, Replaced)**
Perform all daily, weekly, monthly, quarterly, and semiannual checks. Note that all routine maintenance is to be performed prior to the required annual RATA.	
Perform probe maintenance.	
Inspect and clean Stack and Inlet thermoelectric cooler fan (**GC1, GC2**).	
Heatless air dryer (**HAD1**) – Disassemble and clean all parts except towers using warm water and soap. The towers cannot be cleaned and should be returned to manufacturer for repacking if contaminated. Dry parts and blow out internal passages in valve body, adapter, and main body using clean, dry compressed air. Prior to reassembly lubricate per specifications in manufacturer's manual.	
Refrigerated air dryer (**RAD1**) – Tighten all electrical connections. Look for broken, cracked, or bare wires.	
Refrigerated air dryer (**RAD1**) – Measure and record amperage. Verify that readings are within acceptable parameters as listed in the manufacturer's manual.	
Refrigerated air dryer (**RAD1**) – Clean the condenser coil with a mild detergent mixture and brush.	

Annual checks continued

Analyzer Checks – Annual	
Item	**Value or Status (Completed, OK, Replaced)**
TEI 42i-LS NO_X Analyzer	
Perform a NO_X converter check. Replace the converter if efficiency drops below 90% or every 3 threes.	
TEI Model 48i CO Analyzer	
Inspect the source control system. The wire wound resistor source has a finite life. The manufacturer recommends replacement after one year of continuous use. If the source is to be replaced on an as needed basis, replace when one of the following conditions hold: • No light output • If after cleaning the optics, the IR light intensities remain below 100,000 Hz	
Clean measuring cell; replace block and pipe cell windows and O-rings as needed.	

QA Audits – Annual	
Perform any required annual RATA.	All testing completed on:

[End of section. This document is formatted for double-sided printing.]

9 Corrective Maintenance and Troubleshooting

9.1 Introduction

This section contains information on performing troubleshooting and corrective maintenance. For detailed procedures refer to the manufacturer's instruction manuals and other technical data included under separate cover. The technician should be familiar with the material in these manuals before attempting any troubleshooting.

9.1.1 Troubleshooting the System

The following table outlines common problems that may be encountered with the CEMS sample conditioning system.

Table 9-1: Troubleshooting the Sampling System

Problem	Corrective Action
Power failure.	1. Check circuit breakers. 2. Check power wiring. 3. Check alarm system.
Heat-trace failure.	1. Check sample line temperature. 2. Check voltage/current for heated sample line 3. Check line for external damage.
Loss of sample (Flow switch tripped; pressure at the sample gas cooler outlet fell below 5 psig)	1. Check sample pump motor (**SP1, SP2**), wiring, diaphragm and seals. 2. Check sample vacuum (**VG1**, **VG2**). 3. Check setpoint at pressure (**PG2, PG3**) for 3 psi. 4. Check sample gas cooler (**GC1, GC2**). 5. Check moisture/conductivity sensor (**MS1, MS2**). 6. Adjust back pressure regulator (**BPR1, BPR2**). 7. Check gauges for sticking or fouling. 8. Check particulate filter (**F1, F2**) and sample line for blockage/leaks, proper connection. 9. Check analyzer vents for blockages. 10. Check flowmeters (**RM2, RM3,** and **RM6)** for correct flow setpoint and readjust, if necessary. 11. Remove, clean, repair or replace sample line components causing flow restrictions.

CEMS troubleshooting continued

Problem	Corrective Action
High Vacuum (Flow switch tripped; sample pressure before in-line sample system filter is above 15" Hg)	1. Check probe for blockage. 2. Check sample line for blockage. 3. Check sample system particulate filter (**F1, F2**) for blockage/leaks, proper connection. 4. Replace flow switch (**FS1, FS2**). Using ohmmeter, run switch up and down watching vacuum gauge or trip point; watch ohmmeter for contact closure.
Water in Line (Moisture sensor activates moisture alarm)	1. Check temperature alarm of sample gas cooler (**GC1, GC2**). 2. Check sample line heating. 3. Peristaltic drain pump (**DP1/DP2, DP3/DP4**) is inoperative. 4. Solid state conductivity sensor (**MS1**) needs replacing.
Instrument air loss (Instrument air pressure below 80 psig)	1. Check instrument air supply (**PG1**, **PS1**, and **FR1**). 2. Check for proper set points.
Calibration Gas Cylinder Pressure.	1. Check regulator gauges. 2. Install new cylinders.

9.1.2 CEMS Leak Check Procedure

This leak check procedure should be done once a quarter or whenever a leak is suspected.

a. Place system in maintenance mode by toggling the **MAINT REQ** switch on the CEMS front panel in the up position (Stack and Inlet as applicable).
b. Make sure sample pump (**SP1, SP2**) is on.
c. Disconnect the *Sample* tube from sample gas cooler (**GC1**).
d. Plug inlet side of sample gas cooler.
e. Verify that the sample flow meter (**RM1, RM5**) flow drops to zero.
f. If system fails the test. Troubleshoot and repair as required.

Note: Leaks that occur downstream of the sample pump are not detected by this check. Use leak detection liquid if necessary.

Remember to place the system back into normal sampling mode by placing the **MAINT REQ** switch in the **OFF** position after completing any maintenance procedure.

9.1.3 Flow Balance Procedure

This procedure should be done after completing a leak check procedure. This procedure adjusts sample system and calibration system flow rates to match.

a. Place system in maintenance mode by toggling the **MAINT REQ** switch on the CEMS front panel to the up position (Stack and Inlet as applicable).
b. Adjust backpressure regulator (**BPR1, BPR2**) to achieve 4 liters per minute on total flow meter (**RM1, RM5**). Sample pressure gauge (**PG2**) should indicate between 5 and 10 psig.
c. Adjust analyzer flow meter (**RM2, RM3, RM6**) to 1.5 liter per minute.
d. Continue steps b. and c. until adjusted.
e. Vacuum gauge (**VG1, VG2**) should read less than 5 inches Hg.
f. Note values obtained in steps a-d.
g. Manually flow calibration gas 1 to probe.
h. Adjust low pressure on calibration gas bottle 1 regulator to achieve 20 psig as indicated by the regulator low pressure gauge.
i. Manually flow calibration gas 2 to probe. While calibration gas 2 is flowing adjust calibration gas 2 regulator to achieve the same values achieved on step f.
j. Do this for all remaining calibration gas bottles.
k. Return to normal sampling mode using the **MAINT REQ** switch (**OFF** position) and verify that the flow and pressure readings are the same as obtained in steps b through c. If not, repeat *Flow Balance Procedure*.

9.2 Sample Cooler

Use the following table for an overview of possible errors with the M&C ECM sample cooler.

Table 9-2: Sample Cooler Troubleshooting Overview

Error	Reason	Check/Repair
Condensate in the gas outlet	Ambient temperature <5°C Cooler overloaded Peristaltic pump doesn't work Tube of the peristaltic pump defective Cooling capacity too low (cooler is not overloaded) Motor protection switch released.	Heat up the components downstream. Keep the operational data. Change peristaltic pump. Change the tubing. Clean the fins of the condenser. Check the vent. Check the safety distance to other heated components. Secure sufficient ventilation. Thermal load caused by the sample gas response ambient is too high. Let the cooler cool down before restarting it.
Gas flow blocks up reading	Contamination of the sample gas path way.	Optimize the dust pre-separation upstream of the cooler. Clean the gas path ways and the cooling system.
Wrong temperature	Temperature sensor defective Temperature controller defective Leak in cooling agent circuit	Check the PT100-sensor. Check the temperature controller. Send the cooler for repair.
Cooler breakdown	Power supply interrupted	Check the power supply and reconnect. Pay attention to safety warnings.
Compressor does not work	Compressor defective Motor protection switch defective	Send the cooler for repair.

9.3 Troubleshooting the AirTak Heatless Air Dryer

Use the following table for general troubleshooting. Refer to the manufacturer's manual for detailed information.

Table 9-3: Heatless Air Dryer Troubleshooting

Problem	Probable Cause	Solution
Unit delivers wet air.	Improper operating conditions.	Make sure: • Inlet air is properly filtered. • Inlet air pressure is between 60 and 150 psig. • Inlet air temperature is between 35° and 100°F. • Outlet air flow is within specified range.
	Improper purge flow adjustments.	Adjust purge flow.
	Inoperative purge valve.	*Remove valve bodies then remove valve pares from adapter. Inspect valve parts and interior of adapter for contaminants. Disassemble all parts attached to main body. Clean all parts and reassemble as described in the manufacturer's manual. Do not disassemble towers.
	Excessive desiccant loss.	*Remove towers being careful not to damage center tube. The spring on the center tube in the bottom of the towers should be fully compressed. If spring is loose, replace tower or return to factory for repacking. Disassemble and clean dryer per manufacturer's manual.
	Disconnected tubing.	Make sure all tubing is firmly connected.
	Timer motor failure.	**Remove cover. Plug in dryer electrical cord and observe rotation of cam adjusting knob. Cam should make one revolution every two minutes. Replace timer if no rotation is observed.
	Timer cam adjustment or switch failure.	**Timer cams should be set as follows: Degrees — No. 1 Switch — No.2 Switch 0 — ON — 150 — OFF — 180 — — ON 330 — — Off Remove cover. Plug in dryer electrical cord and observe rotation of cam adjusting knob. The switches should actuate when the adjusting knob is at the positions given above. Use the red cam adjusting key supplied with the component to adjust the cams as described below: • Disconnect electrical power to dryer. • Insert the tab on the cam adjusting key into the notch in the no. 1 cam (grey section). The word Start on the key must face the adjusting knob. Turn the adjusting knob until the degree reading is "0". • Insert the tab on the cam adjusting key into the notch in the no. 1 can (red section). The word Stop on the key must face the adjusting knob. Turn the adjusting knob until the degree reading is 150. • Repeat the previous steps to obtain 180° setting for the grey section and 330° setting for the read section on the no. 2 cam If the timer switches are not making and breaking per the chart above, replace the faulty switch.

Troubleshooting continued

Problem	Probable Cause	Solution
Unit delivers wet air – continued.	Solenoid coil burned out	Remove cover. Plug in dryer electrical cord and listen for solenoid actuation when the timer switches make and break. If the timer switches are making and breaking but the solenoids are not actuating, replace the solenoids.
Air blows at high volume from muffler	Improper purge flow adjustments.	Adjust purge flow.
	Inoperative purge valve.	*Remove valve bodies then remove valve pares from adapter. Inspect valve parts and interior of adapter for contaminants. Disassemble all parts attached to main body. Clean all parts and reassemble as described in the manufacturer's manual. Do not disassemble towers.
	Excessive desiccant loss.	*Remove towers being careful not to damage center tube. The spring on the center tube in the bottom of the towers should be fully compressed. If spring is loose, replace tower or return to factory for repacking. Disassemble and clean dryer per manufacturer's manual.

*Disconnect electrical power, shut off inlet pressure, and reduce pressure in dryer to zero before performing.
**Do not reach inside dryer with finger or tool when power is on.

9.4 Troubleshooting the AirTak Refrigerated Air Dryer

Use the following table for general troubleshooting. Refer to the manufacturer's manual for detailed information on operation and maintenance of the dryer.

Table 9-4: Refrigerated Air Dryer Troubleshooting

Problem	Cause
Dryer not running. Power ON light is ON.	Low voltage to the dryer. Compressor over-load open. Defective compressor start components. Compressor windings open.
Dryer not running. Power On light is OFF.	Switch not turned on. No power. Circuit breaker fuse improperly wired. On/Off switch defective.
High discharge pressure – above 125 psig.	Fan not operating. Dirty or blocked condenser. High ambient conditions. Excessive air load exceeding the capacity of the dryer.
High suction pressure – 30.5 to 32.5 normal.	Excessive air load exceeding the capacity of the dryer. HGV setting too high. High ambient temperature.
Low suction pressure – 30.5 to 32.5 normal.	Low or no air load. Fan not cycling at low load. HGV setting too low. Refrigerant leak (low on refrigerant). Low ambient temperature and fan not cycling.
Moisture in the air system downstream.	Dryer over loaded (air flow). Separator drain not functioning. Air bypass valve open. Refrigeration system not operating. Improper air piping.
High pressure drop in dryer air circuit.	Dryer over loaded (air flow). Heat exchanger clogged. Iced evaporator coil.
High temperature light ON – refrigerant compressor OFF.	Air inlet temperature too high. Refrigerant shortage. Blocked condenser.

9.5 Troubleshooting the NOX Analyzer

Refer to the TEI 42i-LS NO_X manual for detailed instructions on corrective maintenance procedures and troubleshooting procedures (located in the appendix section of the CEMS Operation and Maintenance manual CD). The following is only a brief overview.

Table 9-5: NO_X Analyzer General Troubleshooting

Malfunction	Cause	Solution
Does Not Start Up	No power	Check that the instrument is plugged into the proper source. Check fuse.
	Power Supply	Check voltages using a digital voltmeter.
	Digital electronics	Unplug power cord. Check that all boards are seated properly. Replace one board at a time with known good board.
No Output Signal (or very low output)	No sample reaching analyzer	Check input sample flow.
	Blocked Capillary	Unplug power cord. Clean or replace capillary.
	No ozone reaching the reaction chamber	Check the instrument control menu to see if the ozonator is on. If so, check dry air supply.
No output signal	Disconnected or defective input or high voltage supply	Unplug power cord. Check that cables are connected properly. Check resistance of cables.
	Analyzer not calibrated	Recalibrate
	Defective ±15 volt	Check supply voltages (diagnostics menu on analyzer).
Calibration Drift	Dryer to ozonator depleted	Replace
	Line voltage fluctuations	Check to see if line voltage is within specifications
	Defective pump	Rebuild pump.
	Unstable NO or NO_2 source	Replace.
	Clogged capillaries	Unplug power cord. Clean or replace capillary.
	Clogged sample air filter	Replace filter element.
Excessive noise	Defective or low sensitivity PMT	Unplug power cord. Remove PMT then install known good PMT. Plug in power cord and check performance.
	Defective input board	Replace board.
	Defective cooler	Check temperature (less than -2°C at T_{amb} = 25°C.

General troubleshooting guide - continued

Malfunction	Cause	Solution
Non-linear response	Incorrect calibration source	Verify accuracy of multipoint calibration source gas.
	Leak in sample probe line.	Check for variable dilution.
Excessive response time	Partially blocked sample capillary	Unplug power cord. Clean or replace capillary.
	Hang up/blockage in sample filter	Replace filter element.
Improper converter operation	Questionable calibration gas value	Verify accuracy.
	Converter temperature too high or too low	Temperature should be about 325°C.
	Low line voltage	Check that line voltage is within specifications.
	Molybdenum consumed	Replace molybdenum converter cartridge.

Table 9-6: NO_X Analyzer Alarm Messages

Alarm Message	Possible Cause	Action
Alarm – Cooler Temp	Check fan operation	Replace fan if not operation properly.
	Check fan filter	Clean or replace foam filter
Cooler reads 80ºC	Bad cooler	Replace cooler.
	Cooler does not hold set point of -3ºC	Replace cooler – thermoelectric module inside cooler failed.
	Cooler reads -20°C	Replace cooler – thermocouple bad.
Alarm – Internal Temp	Check fan operation	Replace fan if not operating properly.
	Check fan filter	Clean or replace foam filter.
Alarm – Chamber Temp	Chamber Temperature below set point of 50ºC	Check 10 K thermistor, replace if bad. Check temperature control board to insure the LEDs are coming on. If not, temperature control board could be defective.
Alarm – Conv. Temp	Converter temperature low	Molybdenum converter should be hot to touch, if not the heater may have failed. Check that converter temp. set point is approximately 325°C. Check that voltage to the heater is 115 VAC.

Alarm messages continued

Alarm Message	Possible Cause	Action
Alarm - Pressure	High pressure indication	Check the pump for a tear in the diaphragm, replace with pump repair kit if necessary. Check that capillaries are properly installed and O-ring are in good shape. Replace if necessary. Check flow system for leaks.
Alarm – Sample Flow	Sample flow low	Check sample capillary (15 mil) for blockage. Replace as necessary. If using sample particulate filter make sure it is not blocked. Disconnect sample particulate filter from the sample bulkhead, if flow increases replace the filter.
Alarm – Ozonator Flow	Ozone flow low.	Check ozone capillary (0.008 inch ID) for blockage. Replace as necessary.
Alarm – NO, NO_2, NO_X Conc.	Concentration has exceeded range limit	Check to insure range corresponds with expected value. If not select proper range.
	Concentration low	Check user-defined low set point, set to zero.

9.6 Troubleshooting the TEI Model 48i CO Analyzer

Refer to the TEI 48i CO manual for detailed instructions on corrective maintenance procedures and troubleshooting procedures (located in the appendix section of the CEMS Operation and Maintenance manual CD). The following is only a brief overview.

Table 9-7: CO Analyzer General Troubleshooting

Malfunction	Possible Cause	Action
Does not start (The light on power switch does not come on and the pump motor is not running.)	No power or wrong power configuration	Check the line to confirm that power is available and that it matches the voltage and frequency configuration of the instrument.
	Main fuse is blown or missing	Unplug the power cord, open the fuse drawer on the back panel, and check the fuses visually or with a multimeter.
	Bad switch or wiring connection	Unplug the power cord, disconnect the switch and check operation with a multimeter.
Pressure transducer does not hold calibration or is noisy	Pressure transducer defective	Replace pressure transducer
Run output noisy	Recorder noise	Replace or repair recorder
	Sample CO concentration varying	Run instrument on a span CO source – if quiet, there is no malfunction
	Foreign material in optical bench	Clean optical bench
Analyzer does not calibrate properly	System leak	Find and repair leak
	Pressure or temperature transducer out of calibration	Recalibrate pressure and temperature transducer
	Dirty system	Clean cells and flow components
	Leaky correlation wheel	Replace with a known good wheel.
Analog test ramp	Faulty recorder	Replace recorder
	D/A calibration off	Recalibrate the D/A with a DVM known to be in calibration.

Table 9-8: CO Analyzer Alarm Messages

Alarm Message	Possible Cause	Action
Alarm – Internal Temp	Check fan operation	Replace fan if not operating properly
	Check fan filter	Clean or replace foam filter.
Alarm – Chamber Temp	Chamber temperature below set point of 50°C	Check 10K thermistor, replace if bad. Check temperature control board to insure the LEDs are coming on. If not, temperature control board could be defective.
Alarm – Pressure	High pressure indication	Check the pump for a tear in the diaphragm, replace with pump repair kit if necessary. Check that capillaries are properly installed and O-rings are in good shape. Replace if necessary. Check flow system for leaks.
Alarm – Flow	Flow low	Check sample capillary (0.015 inch ID) for blockage. If using sample particulate filter make sure it is not blocked. Disconnect sample particulate filter from the sample bulkhead, if flow increases, replace the filter.
Alarm – Bias voltage	Defective measurement interface	Replace measurement interface board.
	Defective pre-amp board	Replace pre-amp board.
Alarm- AGC intensity	Pre-amp Gain not set properly	Check Gain adjustment
	Defective pre-amp board	Replace pre-amp board
Alarm – Motor Speed	Defective measurement interface board	Replace measurement interface board.
	Defective chopper motor or cable	Check chopper motor cable. Replace chopper motor.

Alarm messages continued

Alarm Message	Possible Cause	Action
Alarm – CO Conc.	Concentration has exceeded range limit	Check to insure range corresponds with expected value. If not select proper range.
	Concentration low	Check user-defined low set point, set to zero.
Alarm – Zero Check Alarm – Span Check Alarm – Zero Autocal Alarm – Span Autocal	Instrument out of calibration	Recalibrate instrument Check gas supply. Perform manual calibration.
Alarm – Motherboard Status Alarm – Interface Status Alarm – I/O Exp Status	Internal cables not connected properly. Board is defective	Check that all internal cables are connected properly. Recycle AC power to instrument. If still alarming, change board.

[End of section. Document is formatted for double-sided printing.]

10 Recommended Spare Parts

The spare parts listed in this section are required for the maintenance and repair of the system. Some parts should be kept on hand at all times to ensure system availability and reliability.

Call CEMTEK Environmental Parts Department at 1-888-400-0200 for current spare parts listing, part numbers, and pricing. The Parts Department fax number is 714-437-7177.

Parts can also be ordered through an online portal at www.cemtekparts.com. The portal includes a customized online parts ordering system tailored for each customer's unique set of equipment and parts. The site includes a searchable parts database and customer knowledge base which is updated on a regulator basis. In addition to ordering parts online, customers have the option to email the parts department, send an email to the CEMTEK service department, or request onsite service through the portal.

Consult with CEMTEK's Service Department at 1-888-400-0201 first (not the Parts Department) when a bad component is suspected after troubleshooting procedures. It's possible that a simple adjustment may "fix" the problem rather than a component replacement. If it's determined that a component does require replacement the Service Department will check warranty status and issue an RMA number for return and replacement of the component part(s).

Call the CEMTEK Service Department to check warranty status.

Consumable Parts
The consumable spare parts list 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 through the life of the system.

Basic Spare Parts
The basic spare parts list includes 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 through the life of the system.

Critical Spare Part
The critical spare parts list includes parts that will need to be replaced to maintain system accuracy and reliability in case of a major failure. These parts should be kept on hand to perform major repairs or maintenance through the life of the system.

In Depth Spare Parts
The complete spare parts list includes all parts used in the system.

[End of section. This document is formatted for double-sided printing.]

11 Emission Equations

11.1 Monitored Parameters

Monitored and calculated parameters include:

- Stack O2%
- Stack NOx, ppm
- Stack NOx, ppm @ 15% O2
- Stack CO, ppm
- Stack CO, ppm @ 15% O2
- Inlet NOx, ppm
- Inlet NOx, ppm @ 15% O2
- Natural gas fuel flow, dscfm
- Digester gas fuel flow, dscfm
- Total plant natural gas fuel flow, kdscfh
- Total plant digester gas fuel flow, kdscfh
- IC Engine load, MW
- Stack flow (calculated), dscfm
- NOx rate, lbs/day
- Total plant NOx rate, lbs/day
- CO rate, lbs/day
- Total plant CO rate, lbs/day
- NH3 (urea) slip, ppm @ 15%O2

11.2 Equations

The following lists a series of equations used for emissions calculations for SCAQMD Rule 218, 1110.1, and air permit reporting. The data acquisition system performs these calculations using signal inputs from each analyzer and from process parameter monitoring sources and utilizing standard defaults and conversion factors, as applicable.

Signal inputs from a fuel flowmeter will be used to calculate and report mass emissions (lbs/hr, lbs/day).

O_2 Correction			
$$C_{adj} = C_d \text{ x } \frac{20.9 - n\%O_2}{20.9 - \%O_2}$$			
Where:	$n\%O_2$	=	correction factor @ 15% O_2, per permit
	C_{adj}	=	Pollutant emissions in units of the standard (ppm @ 15% O_2)
	C_d	=	Dry pollutant concentration in ppm
	O_2	=	Oxygen concentration in percent measured at same point

This data is compiled into daily reports, which contain emissions data, excess emissions periods, calibration data and faults and warning messages.

Emission rates (lb/mmBtu) will be determined by the following equations (40 CFR 60, Appendix A, Method 19):

Oxygen-based F factor, dry basis (from EPA Method 19): When measurements are on a dry basis for both O_2 ($\%O_{2d}$) and pollutant (C_d) concentrations.		
$E = K \text{ x } C_d \text{ x } F_d \text{ x } [20.9 / (20.9 - \%O_{2d})]$		
Where: E	=	Pollutant emission, lb/mmBtu
K	=	Conversion factor NO_x conversion factor use 1.195×10^{-7} (lbs/dscf)/ppm NO_X CO conversion factor use 7.267×10^{-8} (lbs/dscf)/ppm CO
C_d	=	Hourly average pollutant concentration, dry basis, ppm
$O_2\%$	=	Oxygen content by volume (expressed as percent), dry or wet basis
F_d	=	An O_2 based factor representing a ratio of the volume of dry flue gases generated to the higher heating value. (dscf/mmBtu) F factor for digester gas will be calculated based on fuel analysis. F factor for natural gas will use the EPA default value of 8710.

Fuel based F factors will be determined through fuel analysis for digester gas.

Determined F Factors		
$F_d = [(K_{hd}\%H) + (K_c\%C) + (K_n\%N) - (K_o\%O)] / [(GCV * K/Mw/1000000) * 100]$		
Where:		
F_d	=	Volume of combustion components per unit of heat content, scf/mmBtu
%H, %C,%N, %O	=	Concentrations of hydrogen, carbon, nitrogen, and oxygen from an ultimate analysis of fuel, weight percent
GCV	=	Gross calorific value of the fuel consistent with the ultimate analysis, Btu/scf
K	=	385.5 scf/lbmol
Mw	=	Molecular weight of fuel
K_{hd}	=	3.64 (scf/lb)/(%)
K_c	=	1.53 (scf/lb)/(%)
K_n	=	0.14 (scf/lb)/(%)
K_o	=	0.46 (scf/lb)/(%)

Fuel derived mass emissions calculation.

Fuel Derived Mass Emissions			
ER = E x HF			
Where:	ER	=	Emission Rate in lb/hr
	E	=	Pollutant emission in lb/mmBtu, O_2 based (using the EPA Method 19 equation referenced above)
	HF	=	Heat Flow in mmBtu/hr = (fuel flow in scf/hr x 1050 Btu/scf)/10^6

Heat input calculation

Heat Input			
$HI = (FF * GCV) / 10^6$			
Where:	HI	=	Heat input rate from fuel, mmBtu/hr
	FF	=	Fuel flow, scf/hr
	GCV	=	Gross caloric value of the fuel, Btu/scf

Lbs/day emissions

Mass Emissions, lb/day			
$$N_i = \sum_{i=1}^{24} M_i$$			
Where:	Ni	=	Mass emission rate of pollutant in lb/day for i engine
	Mi	=	Mass emission rate of pollutant lb/hr summed up in a 24 hr period

Total plant mass emissions

Total Mass Emissions			
$$T_i = \sum N_i$$			
Where:	Ti	=	Total plan mass emission rate in lb/day for i, day of month
	Ni	=	Mass emission rate of pollutant in lb/day for i engine.

Total plant mass emission rate lb/day for i day of the month using hourly emission data

$$X_i = \frac{\sum_{i=1}^{Last-day-of-month} T_i}{i}$$			
Where:	Xi	=	Total plant mass emission rate of pollutant in lb/day averaged over the number of days in a given calendar month
	Ti	=	Total mass emission rate of pollutant lb/day for i day of the month

Urea slip:
The NOx and urea react on a 1:2 basis. Therefore, the amount of urea is equal to 1/2 the amount of NOx reduced in the SCR. The simplified formula is:

NH3 (urea) slip = urea fed – (NOx in – NOx out) * 1/2

We intend to use the formula that solves for NH3 slip using mass flow molar values which requires the calculation or measurement of stack flow.

((9.21*NH3 Flow Rate / 60.0553) - ((Dry Gas Flow Rate/29) * ((Inlet NOx - Outlet NOx) / 2) / 10^6) * (10^6 / Dry Gas Volumetric Flow Rate / 29))

NH3 Flow Rate = gal/hr
Inlet NOx & Outlet NOx – ppmc @ 15% O2
Dry Gas Volumetric Flow Rate – lb/hr

dry gas volumetric flow = ((Fuel Flow * Fuel GCV) * Fuel F_Factor) * (20.9 | (20.9 – O2))

Ph20/Urea = 68.9 lb/ft3 or 9.21 lb/gal when Urea @ 32.5 %, 4 deg C

[End of section. This document is formatted for double-sided printing.]

Exhibit “B”

BID PRICE FORM

EXHIBIT B - BID PRICE FORM

CENTRAL GENERATION CEMS MAINTENANCE SERVICES

Pricing per Scope of Work emailed on 9/22/2022

Quantities listed below represent the estimated quantites requiring service (per Scope of Work, Exhibit A). OC SAN does not guarantee usage.
Submit total amounts for all schedules as follows:

Work Description	Unit Cost Per Service$	Estimated 5-year Contract Quantity	Extended Cost
Monthly Maintenance Services	$ 8,100.00	40	324000
Quarterly Maintenance Services *(Includes Monthly service requirements as outlined in QAP)*	$ 15,500.00	10	155000
Semi-annual Maintenance Services *(Includes Quarterly, and Monthly service requirements as outlined in QAP)*	$ 16,300.00	5	81500
Annual Maintenance Services *(Includes Semi-annual, Quarterly, and Monthly service requirements as outlined in QAP)*	$ 21,400.00	5	107000
Total annual lump sum cost of CEMS Maintenance in accordance with Scope of Work / Technical Specifications.		60	$ 667,500.00

*OC SAN DOES NOT GUARANTEE USAGE ON THIS CONTRACT.