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Environmental Technology Verification Program

Advanced Monitoring Systems Center

Test/QA Plan for Field Demonstration of Mercury Continuous Emission Monitors at the TSCA Incinerator

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Approval of Joint DOE/ETV Test/QA plan for

Field Demonstration of Mercury Continuous Emission Monitors at the TSCA Incinerator

Revision 3

June 2002

Name______________________**Signature**________________________

Company_________________________________

Date________________

1.0 PROJECT DESCRIPTION

1.1 Introduction

Most U.S. Department of Energy (DOE) sites rely on incineration and other forms of thermal treatment such as high temperature vitrification and lower temperature calcination to treat a wide variety of mixed wastes. Mercury and mercury containing compounds are often present in the mixed waste matrices stored in the DOE complex and mercury emissions from thermal treatment processes pose unique challenges for air pollution control technologies. Monitoring methods for mercury vapors are required to ensure that mercury is not being released, particularly from processes operating at elevated temperatures. Increasingly strict regulatory standards and growing public concerns are causing operators of mixed waste treatment facilities to control air emissions to unprecedented low levels, and to provide continuing assurance through monitoring that emissions controls are effective.

In September 1999, the U.S. Environmental Protection Agency (EPA) finalized the Hazardous Waste Combustor (HWC) Maximum Achievable Control Technology (MACT) Rule. The MACT Rule will limit heavy metal releases in stack emissions from hazardous waste combustors. Mercury is one of the contaminants of concern under the new MACT standards. The emission limits are being lowered and the MACT Rule includes provisions for the use of continuous emission monitors (CEMs).

While the use of continuous emissions monitors will not directly improve pollutant emission control, it will satisfy regulatory requirements, verify emission compliance, provide data to optimize emissions control, provide evidence that demonstrates the degree of emission controls achieved, and increase public confidence in the safety and technical credibility of the incineration process. In some cases, the implementation of a suitable CEM will enable the operator of the incinerator to operate closer to the emission standard than they could otherwise with feed rate control. This is an incentive for the operator to employ CEM technology as a more verifiable means of monitoring compliance with the regulation.

The Toxic Substances Control Act (TSCA) Incinerator (TSCAI) at the East Tennessee Technology Park (ETTP) in Oak Ridge, Tennessee provides a unique venue for mercury CEM performance testing. The TSCAI holds federal and state permits and agreements to incinerate mixed waste, which consists of low-level radioactive and Resource Conservation and Recovery Act (RCRA) hazardous (mixed) wastes contaminated with polychlorinated biphenyls (PCBs). It is the only operational incinerator in the United States that can process PCB containing hazardous and radioactive waste.

The TSCAI has encountered considerable public scrutiny in recent years about the nature of the materials being handled at the facility and potential impacts of incinerator emissions on local public health. One of the primary concerns expressed by public policy makers was the absence of continuous emission monitoring systems for measuring hazardous metals, semi-volatile organic compounds, and other toxic pollutants. The TSCAI facility currently monitors O_2, CO, CO_2, and radionuclide emissions as required by permit. A developmental system for monitoring metals emissions is also in use. Although evidence has showed that the incinerator performs well within its permitted operating limits, the concerned parties have pushed for more use of advanced monitoring technologies. The Governor of Tennessee has recommended that the state regulatory agency include permit provisions requiring the facility to use the best available monitoring technologies.

In order to stay on the forefront of emissions monitoring technology, the TSCAI staff has been closely following the development and field testing of advanced CEM technologies. DOE has designated the TSCAI as a primary testing unit for advanced monitoring technologies. A field study evaluating the performance of three candidate multi-metals monitoring techniques was completed at the TSCAI in 1997. The results showed that none of the CEMs produced data of sufficient quality for compliance monitoring at a level that would be acceptable to EPA. In FY98-99, a two-month evaluation of a mercury CEM was performed at the TSCAI.[1] This effort demonstrated that the incinerator was a useful test site in determining the feasibility of using a CEM to measure total mercury in a saturated flue gas. Three commercial particulate matter (PM) CEMs were field tested in 1999-2000.[2] As a result of this evaluation, a recommendation was made to deploy a beta gauge type monitor for measuring PM emissions from the TSCAI. Given this background, a full-scale evaluation of mercury CEMs at the TSCAI will certainly provide valuable information to DOE, EPA and stakeholders.[3]

Functional and performance requirements for CEMs are driven primarily by EPA performance specifications, which generally include requirements for (a) "continuous" operation, (b) calibration requirements, (c) providing measurement results that compare within specified relative accuracy limits to applicable EPA-approved reference methods, and (d) downtime and maintenance limits. EPA has published draft Performance Specification 12 (PS-12) as a guide for assessing acceptability of mercury CEMs upon installation and use.[4]

EPA's Environmental Technology Verification (ETV) program recently completed a pilot-scale Phase I verification test of continuous emission monitors for mercury at the Rotary Kiln Incinerator Simulator (RKIS) within EPA's Incineration Research Laboratory in Research Triangle Park (RTP), North Carolina.[5] The objective of the ETV test was to quantify the performance of commercial-ready mercury CEMs, by comparison to reference mercury measurements, and by challenges with mercury standard gases and interferences, under controlled conditions in a pilot-scale combustion facility. Four commercial mercury CEMs were tested, and ETV verification reports on those CEMs are publicly available at http://www.epa.gov/etv/verifrpt.htm#07). The ETV Phase 1 verification test provides a basis for establishing the testing methodology and selection of CEMs for field performance testing at the TSCAI. Furthermore, the testing to be done under this test/QA plan will serve as part of Phase 2 of mercury CEM testing in ETV. The role of ETV in this test will include strengthening contacts with CEM vendors, assisting in study planning, and providing additional quality assurance activities. CEM vendors who participate in testing at the TSCAI can receive ETV verification of their CEM by authorizing an ETV Vendor's Agreement prior to test initiation.

1.2 Test Objective

The primary objective of this field evaluation is to support EPA, DOE, industry, CEM vendors, and the public in gathering information that will be useful in assessing the performance of mercury CEMs as the debate continues on the regulatory implementation of mercury CEMs for compliance monitoring. To that end, the test will be conducted in a manner that satisfies the requirements of the ETV program, so that verification reports on the test CEMs may be prepared as part of the Phase 2 testing within ETV. A secondary objective is to compare the performance of mercury CEMs in a full-scale incinerator environment so that the results can be used to select CEMs for deployment at DOE facilities. (The ETV program also plans to conduct another performance verification of mercury CEMs at a coal-fired power plant).

The mercury CEMs will be challenged by stack gases generated from the thermal treatment of a variety of actual wastes in the TSCAI. Depending on the levels of mercury that are present in the waste, mercury may be injected into the incinerator combustion chambers to adjust the concentration level in the stack for testing purposes. CEM responses will be compared to reference mercury measurements of total, oxidized, and elemental mercury. Mercury standard gases will be used to challenge the CEMs for calibration purposes, and the stability of the standards themselves will be evaluated. The project will identify issues associated with moving mercury CEMs out of the pilot-scale test arena and into an operating facility environment.

1.3 Scope of Work

The overall objective of the demonstration is to provide quantitative verification of the performance of the mercury CEMs in a field installation setting while monitoring emissions from the TSCAI that were generated from the treatment of actual wastes. Since mercury CEMs are a relatively new group of instruments, performance expectations and procedures to assess their performance are not fully established. EPA has published draft PS-12 as a proposed description of how to assess the acceptability of mercury CEMs.[2] However, draft PS-12 is patterned after performance specifications for CEMs for other pollutants, such as SO_2 and nitrogen oxides (e.g., NO_2), and as a result includes requirements which may be inappropriate or currently not feasible.

As a result of such factors, and because PS-12 is a draft document subject to revision, it is not necessary to adopt PS-12 procedures as the basis for this demonstration. Instead, the final set of performance parameters that will be addressed by this test rely heavily on key monitoring characteristics identified in the ETV program verification test[1] and meet the spirit of quantitative and qualitative performance requirements raised in PS-12.

The basis for establishing the quantitative performance of the tested technologies will be a standard method of measurement, consisting of the Ontario Hydro (OH) method,[6] currently recognized as the most suitable procedure to determine total, oxidized, and elemental mercury in source emissions.

The TSCAI employs a wet off-gas cleaning system for scrubbing particulate matter and acid gases from the combustion off-gas. The gas cleaning system should remove oxidized mercury and particulate-bound mercury at a fairly high efficiency. Elemental mercury, on the other hand, is expected to pass through the off-gas system virtually untouched. No attempt has ever been made, however, to quantify the presence of oxidized mercury in the TSCAI flue gas. For this reason, preliminary reference method testing is planned prior to installation of the mercury CEMs to determine the extent of mercury speciation in the flue gas.

The mercury CEM field demonstration will be conducted in accordance with the TSCAI burn schedule. The mercury CEMs performance parameters that will be addressed by this demonstration include:

- Zero drift
- Calibration drift
- Relative accuracy
- Correlation with reference method
- Precision
- Sampling system bias
- Calibration error

- Response time

Calibration and zero drift, response time, sampling system bias, and calibration error will be assessed for elemental mercury only, using commercial compressed gas standards of elemental mercury. Relative accuracy, correlation with the reference method, and precision (i.e., repeatability at stable test conditions) will be assessed for total, oxidized, and elemental mercury in the stack gas emissions. Interference response will not be assessed in the TSCAI field test. The extensive flue gas scrubbing at the TSCAI makes spiking of added interferants into the flue gas impractical. The alternative approach of using calibration gases introduced at the analyzer to simulate flue gas interferants, as described by PS-12,[4] was also discouraged in discussions with EPA and ETV staff as poorly representing actual flue gas conditions. Although the field demonstration is not expected to go beyond three months of actual monitoring of stack emissions, the reliability, availability, and maintainability of the CEMs over the course of the field test will be documented and assessed. Vendor representatives are expected to be present during installation of the CEMs to oversee installation and train technical support staff in the routine operation and maintenance of the CEMs. The vendors will also be expected to be present during initial and final weeks of CEM monitoring performance testing to ensure optimal operation of the CEMs for comparison with reference samples and calibration gas standards. Otherwise, routine daily operation and maintenance of the CEMs, as well as data logging, will be administered by a dedicated on-site technician.

1.4 Organization, Responsibilities, and Communication

This section provides a detailed outline for the organization and responsibilities of all participants in the mercury CEMs field demonstration. Section 1.4.1 presents the overall project organization. Section 1.4.2 details responsibilities of individual team members. Section 1.4.3 discusses the communication mechanism to be employed during the project execution.

1.4.1 Overall Project Organization

The evaluation of mercury CEMs at the TSCAI will be conducted jointly by Shaw Environmental and Infrastructure (Shaw E&I) under subcontract to Bechtel Jacobs Company LLC (BJC) and by the Hemispheric Center for Environmental Technology at Florida International University (FIU-HCET). Funding will be provided by DOE's TRU & Mixed Waste Focus Area (TMFA), the Characterization, Monitoring and Sensor Technology Crosscutting Program (CMST-CP), and FIU-HCET. EPA's ETV program is an independent collaborator with DOE in this effort. Figure 1.1 identifies principal members of the project team and the lines of authority.

1.4.2 Individual Organization Responsibilities

1.4.2.1 DOE TRU & Mixed Waste Focus Area (TMFA)

DOE Office of Science and Technology TMFA is responsible for

- Providing overall direction to the project team;
- Providing a portion of the financing of the program;
- Reviewing the draft test/QA plan; and
- Reviewing the draft mercury CEM data report.

1.4.2.2 DOE Oak Ridge Operations Office (ORO)

DOE ORO is responsible for

- Supporting the research and development needs at the TSCAI;
- Reviewing the draft test/QA plan; and
- Reviewing the draft mercury CEM data report.

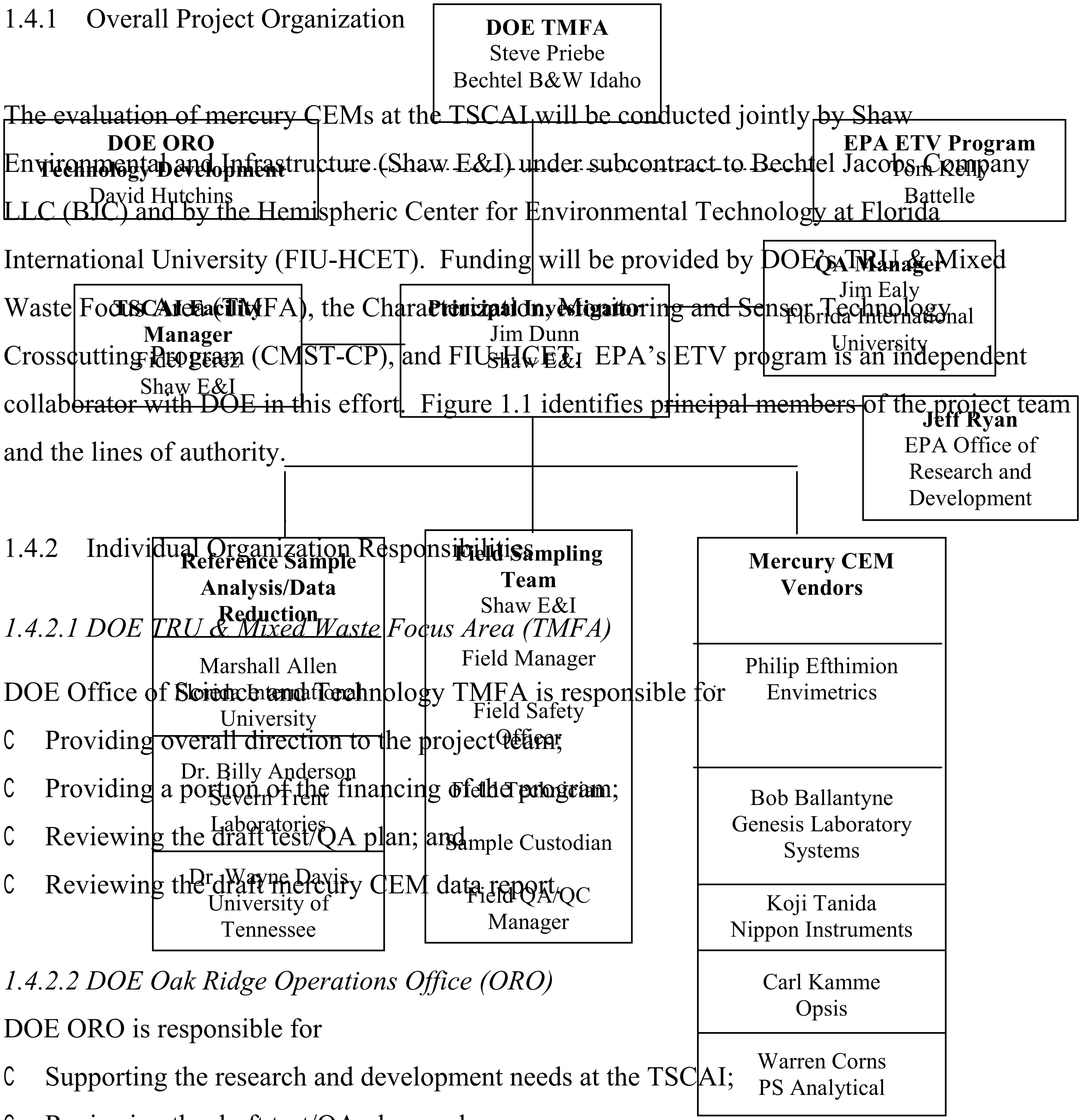


Figure 1.1. Organization chart for mercury CEM demonstration project at TSCAI

1.4.2.3 Shaw E&I

(a) Project Lead

Shaw E&I, who operates and maintains the TSCAI under subcontract to BJC, has the overall responsibility for project coordination, CEM installation and decommissioning, reference method testing and day-to-day operation and maintenance of the mercury CEMs. Shaw E&I has identified the Principal Investigator, Mr. Jim Dunn, who is responsible for ensuring that the quality, schedule, and budget goals established for this field test are met. More specifically, Mr. Dunn will

- Coordinate all test participants including DOE, TSCAI facility, mercury CEM vendors, FIU-HCET and subcontractors, and serve as the primary point of contact for all parties involved;
- Define scope of the field evaluation and establish budget for the test;
- Share responsibility with FIU-HCET for preparation of the draft test/QA plan and data report;
- Provide Battelle with hard and electronic copies of the data report and copies of all raw reference method and facility operation data;
- Assemble trained technical staff to conduct reference method sampling for the verification;
- Provide input on facility operating conditions and procedures for the field evaluation test;
- Assure that the test/QA plan is being followed during the field evaluation - more specifically, assure that test procedures and data acquisition and analysis are conducted according to this test/QA plan, and work directly with the field team to ensure that sampling, sample analysis, and data reduction are performed accurately, efficiently, and as scheduled;
- Respond to any issues raised in assessment reports and audits, including instituting corrective actions as necessary;
- Revise the draft test/QA plan and data report in response to reviewers' comments; and
- Be responsible for distribution of final test/QA plan and data report.

(b) TSCAI Operation

Under subcontract to BJC, Shaw E&I is responsible for managing and operating the TSCAI facility. They are also responsible for planning the tests, carrying out the scope of testing as defined in the approved test/QA plan, evaluating test data and reporting test data. Shaw E&I will be responsible for the preparation, operation, and management of the TSCAI facility in a manner that will accommodate all data collection needs of the project and for specific measurements during the tests. The TSCAI Facility Manager, Mr. Fidel Perez, has final authority on all process operations at the TSCAI facility, including

- Assembling trained technical staff to operate the facility;
- Ensuring the facility is fully functional during the time of the field evaluation;
- Overseeing technical staff in facility operation during testing;
- Ensuring that operating conditions and procedures for the facility are recorded during the test; and
- Reviewing and approving all data and records related to facility operation.

1.4.2.4 Field Sampling Team

(a) Field Manager

The Field Manager, Mr. Randy Moore, will have the following responsibilities:

- Assume overall on-site responsibility for field sampling and analysis activities, including set up, sampling, sample recovery, sample custody, data reduction, and data validation;
- Provide a TSCAI trained technician to support operation, maintenance and repair of the mercury CEMs throughout the field test;
- Coordinate the set up, operation, and breakdown of the OH sampling trains at each sampling location;
- Verify that each location's OH sampling train has been properly prepared by the sample recovery team;
- Monitor the overall progress of the on-site sampling and analytical activities and maintaining a daily written log of all events which occurred on-site;
- Resolve problems and implement any plan deviations that are approved;
- Review daily field data sheets;
- Discuss any information that may invalidate results and require retesting with the Principal Investigator; and

- Prepare daily summaries of all site activities.

(b) Field Safety Officer

The Field Safety Officer, Ms. Missie Smith, is responsible for:

- Providing Health and Safety training to test participants; and
- Performing site safety inspections and daily safety briefings with the field team.

(c) Field Technicians

The Field Technicians are responsible for:

- Coordinating reference method sampling with monitor operation;
- Sending run sheets for data reduction at the end of each run to the Field Manager;
- Informing the Field Manager of any sampling problems which would require suspension of other simultaneous sampling activities;
- Informing the Field Manager of any port-change or leak-check problems;
- Informing the Field Manager of any deviations from the test/QA plan prior to implementing the deviations;
- Reviewing the run results to check for problems which would require a retest; and
- Maintaining an individual daily log of all sampling activities and events.

(d) Sample Custodian

The Sample Custodian will have overall responsibility for OH reference method samples including recovery, storage, custody, and shipment to Severn Trent Laboratories. He/she is responsible for:

- The set up of the sample recovery area, including recovery equipment, reagents, dust free sample storage area, and a pre-cleaned glassware inventory;
- Procuring, cleaning, and labeling sample containers in accordance with the requirements of the OH method;
- Performing daily processing of all required information on sample tracking, custody, and lab analysis request forms and maintaining a central file of completed forms and custody information;

- Performing sample recovery and train preparation in accordance with sampling procedures;
- Ensuring that all samples are stored in accordance with storage and any holding time requirements until ready for shipping;
- Immediately informing the Field Manager and Field QA/QC Manager of any problems which may invalidate a sample;
- Accepting custody of all samples at the completion of the program for delivery to the laboratory; and
- Maintaining a detailed log book of all sample recovery and custody activities.

(e) Field QA/QC Manager

Specific responsibilities of the QA Manager include:

- Reviewing test/QA plan;
- Preparing internal QC procedures to establish the performance of the measurement systems;

- Performing on-site audits on operating and analytical system; and
- Reporting all QA/QC activities and data to the Field Manager.

1.4.2.5 FIU-HCET

FIU-HCET is responsible for:

- Providing a portion of the financing of the program;
- Contributing to the development of the test/QA plan;
- Procurement of mercury standards, analysis of OH reference method samples, data acquisition system procurement, and other miscellaneous support materials;
- Conducting a technical systems audit at least once during the field demonstration;
- Performing an audit of at least 10% of the evaluation data;
- Preparing and distributing an assessment report for each audit;
- Verifying implementation of any necessary corrective actions; and
- Sharing responsibility with the Principal Investigator for preparation of the data report.

Points of contact at FIU-HCET are Mr. Marshall Allen and Mr. Jim Ealy.

1.4.2.6 Severn-Trent Laboratories

The analytical laboratory for samples from the Ontario Hydro method will be Severn-Trent Labs (STL), of Knoxville, Tennessee. STL's activities will be led by Mr. Billy Anderson. The responsibilities of the analytical laboratory are as follows:

- Establish a system to maintain chain-of-custody and accurate sample identification for OH samples;
- Perform sample analyses according to OH method procedures, as modified in STL's standard operating procedures and related documentation;
- Perform required laboratory QA procedures, as established prior to the test in STL's standard operating procedures and related documentation;
- Report analytical results in an organized format, with sufficient supporting documentation to allow review of data quality;
- Cooperate with Battelle and EPA in a brief on-site audit of procedures at STL;
- Review portions of the test reports, to assure the accuracy of descriptions of the laboratory procedures and results.

1.4.2.7 University of Tennessee

Dr. Wayne Davis at the Department of Civil and Environmental Engineering at the University of Tennessee, Knoxville, Tennessee, will be responsible for:

- Performing statistical calculations specified in this test/QA plan on data collected during the field test; and
- Providing results of statistical calculations and associated discussions for the data report.

1.4.2.8 EPA ETV Program

The involvement of the EPA ETV program in this test will include Battelle, EPA's partner in the ETV Advanced Monitoring Systems (AMS) Center, as well as EPA staff. Battelle's involvement in this field evaluation will be primarily in an advisory role, based on experience gained in the ETV Phase 1 CEM tests, and in providing additional QA to meet ETV requirements. Dr. Thomas J. Kelly, the Verification Testing Leader in the AMS Center, will be the primary point of contact for ETV in this study. Battelle's responsibilities include

- Assisting in securing the participation of CEM vendors, by offering ETV verification as an incentive to participate;
- Providing input on mercury CEM technology for this field evaluation;
- Providing input to the draft test/QA plan, and coordinating the review of the plan as required by ETV;
- Providing information gathered in Phase I mercury CEM verification test, such as lessons learned and recommendations for improvement in test methodology;
- Performing technical systems and performance evaluation audits as specified in this test/QA plan; and
- Preparing an ETV verification report based on the data report, for each CEM covered by an ETV Vendor Agreement.

EPA involvement through the ETV program will include:

- Reviewing the draft test/QA plan;
- Reviewing the draft verification reports;
- Approving the final verification reports and verification statements;
- At EPA's discretion, performing an external technical systems audit during the field test.

1.4.2.9 Mercury CEM Vendors

Mercury CEM vendors will be responsible for

- Providing field-ready mercury CEMs for evaluation;
- Reviewing the draft test/QA plan;

- Participating in required safety training at the test facility prior to installation of their CEM;
- Providing data link to data logger for recording mercury CEM data;
- Training a dedicated site technician in CEM operation and maintenance and documenting that training has been completed;
- Providing field technician(s) to support CEM installation and ensure reliable CEM operation during the monitoring performance test weeks;
- Validating CEM data collected during the monitoring performance test weeks; and
- Reviewing the draft data report for their respective CEM.

Those CEM vendors who choose to undergo ETV verification based on the study data will have the following additional responsibilities:

- Sign an ETV Vendor Agreement and pay a verification fee to formalize participation in the ETV program;
- Review the draft verification report and verification statement for their CEM.

1.4.2.10 EPA Office of Research and Development

Mr. Jeff Ryan of the EPA Office of Research and Development will provide the following technical assistance:

- Suggest possible modifications to the OH method for handling mercury chemistry issues that arise in the presence of chlorine;
- Loan a mercury analyzer to the project for performing audits of mercury calibration gases; and
- Conducting calibration drift checks of the CEMs using mercuric chloride standards.

1.4.3 Communications

Any issues that will have a direct impact on the project quality, completeness of the data, or financial implications must be reviewed and approved by the Principal Investigator. Every effort should be made to resolve all issues prior to the field test and fully document the solutions in the approved test/QA plan. However, field test conditions may not always remain as planned and decisions are necessary to maintain progress in a timely and cost effective manner.

Routine telephone conference calls and emails will be the primary communication tools among the test participants. Monthly DOE progress reports will be issued internally through the existing reporting mechanism. The monthly reports will consist of progress, financial status, and discussion of issues raised during the test.

Communication within the field team will be facilitated by short distance wireless radios for on-site activities at the TSCAI. These will ensure that personnel assigned to various locations at the site can be in immediate contact with each other without using the plant communication system.

2.0 TSCA INCINERATOR FACILITY

The TSCAI facility is designed and permitted for receiving, sorting, storing, preparing, and thermally destroying low-level radioactive and RCRA mixed waste contaminated with PCBs. These wastes are treated in a rotary kiln incinerator with a secondary combustion chamber and off-gas treatment system for cleaning combustion effluent gases. The TSCAI facility includes various support buildings, an unloading and storage area, a tank farm, an incinerator area, concrete collection sumps, and carbon adsorbers. A schematic of the TSCAI facility is shown in Fig. 2.1.

In general, the TSCAI Facility treats a wide range of waste categories, including oils, solvents and chemicals, aqueous liquids, solids, and sludges. Solid and non-pumpable sludge materials are typically received and stored in metal containers and are repackaged into combustible containers prior to feeding. A hydraulic ram feeds containerized solids and sludges to the rotary kiln. Aqueous wastes are injected into the kiln through a lance. High heat-of-combustion liquids are burned in either the rotary kiln or a secondary combustion chamber with gas burners. Both solids and waste liquids are permitted for treatment in the primary combustion chamber, but only organic liquids may be treated in the secondary combustion chamber.

Ash residue from the wet ash removal system is collected and handled through hazardous and radioactive waste storage facilities. Selected residues are sent to a commercial landfill facility. Kiln off-gas flows to the secondary combustion chamber. The off-gas from the secondary combustion chamber then passes through a four-stage treatment system that includes a quench chamber and scrubber treatment system for cooling, removal of particulate matter and neutralization of acidic by-products. An induced-draft fan forces flue gases through the stack. Liquid wastes generated by the scrubber systems are treated by the Central Neutralization Facility (CNF), an adjacent on-site waste water treatment plant. Solid-type waste, such as scrubber sludge, is collected in drums for off-site disposal.

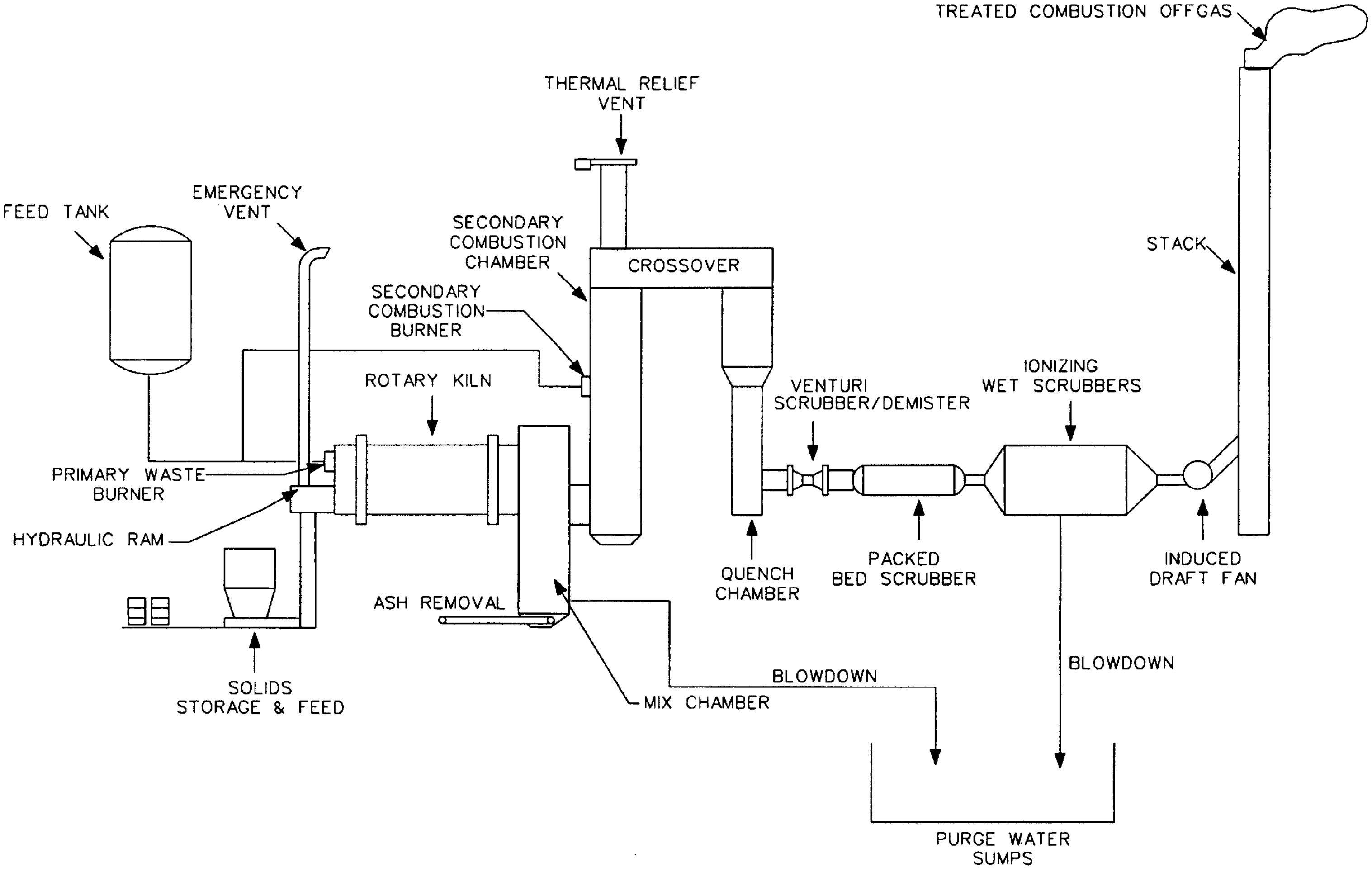


Figure 2.2. Schematic of the TSCA Incinerator and off-gas cleaning system.

2.1 Facility Description

2.1.1 Incineration Process

The rotary kiln receives and thermally processes boxes of solid and non-pumpable sludge wastes fed by the ram feeder and liquid and aqueous wastes injected by a burner and lance, respectively, at the kiln faceplate. Additionally, the kiln receives natural gas fired by an auxiliary burner to maintain a minimum combustion temperature and ensure stable combustion of liquids. Steam is used to atomize wastes fed through the burners and controlled at a ratio to the waste pressure. The normal operating temperature inside the kiln is maintained at approximately 1600EF. Residue is discharged from the kiln, and hot gases pass through a mixing chamber to the secondary combustion chamber and on to the process gas cleaning system. An induced-draft fan maintains sub-atmospheric pressures in both the kiln and the solid feed system to minimize the release of vapors from the feed system and combustion gases from the kiln. The kiln shell is made of carbon steel with a refractory lining.

The second stage of the incineration process is the mixing chamber, which separates the primary combustion chamber (rotary kiln) and the secondary combustion chamber. The mixing chamber is a carbon steel chamber lined with refractory brick. The chamber collects the flue gases and ash discharged from the rotary kiln, reduces the gas velocity to allow particulates to drop out of the gas into the ash handling system, and passes the hot flue gases into the secondary combustion system. An ash handling system conveys ash and residue from a water-filled trough beneath the mixing chamber to the ash hopper for subsequent disposal. Water in the ash trough provides a seal against air leakage into the system. The ash water removal pump removes suspended ash and solids from the ash trough at the bottom of the mixing chamber and discharges to the purge water sumps.

The secondary combustion system receives hot process gases from the mixing chamber and secondary liquid wastes fired by a waste burner. Natural gas is fired by an auxiliary burner. The cross-sectional area of the entrance to the secondary combustion chamber is reduced to rapidly increase gas velocity and, in conjunction with the burners downstream, to provide turbulence and mixing of the kiln gas. Also, while it normally accepts secondary liquid wastes pumped from the secondary liquid waste feed tank, the secondary combustion chamber can accept wastes pumped from the primary liquid waste feed tanks, from the fuel oil tank, or directly from a tanker. The normal operating temperature in the secondary combustion chamber is maintained above 2200EF. All three secondary combustion chamber sections are refractory lined.

A thermal relief vent at the outlet of the secondary combustion chamber can vent combustion gases to the atmosphere in the event of an induced-draft fan shutdown or an interruption of the water feed to the quench chamber in the off-gas cleaning system. This prevents damage to the scrubber system during an interruption of quenching and prevents backward flow from the incinerator during shutdown of the induced-draft fan. When the thermal relief vent is used, all waste material and fuel feeds to the incinerator are automatically discontinued except for the fuel to the secondary auxiliary burner.

After secondary combustion in the incineration process, the off-gases from the secondary combustion chamber pass through the refractory-lined duct into the off-gas cleaning system. This is a wet system that reduces both acidic gaseous and particulate emissions to the atmosphere to comply with TSCA and RCRA regulations and with state emission standards.

2.1.2 Off-Gas Cleaning System

The quench chamber receives and cools the hot flue gas from the secondary combustion chamber. The quench system is equipped with a refractory lining, a process water system, a sump, a recycle water system, and an emergency water backup system. The quench chamber normally receives the hot flue gas at about 2200EF, containing particulates, sulfur dioxide (SO_2), hydrofluoric acid (HF), and hydrochloric acid (HCl), and cools and saturates the flue gas to the adiabatic saturation temperature with a series of internal sprays of fresh and recirculated water. The water spray systems are the process water system and the recycle water system. Both water systems have spray nozzles with strainers on the supply lines to prevent line clogging. Excess water from the fresh process water spray header flows by gravity to the quench chamber recycle tanks and continues to the recycle water system. Recirculating pumps recycle this water back to the quench chamber. The pH of the recycle water is controlled with 20% caustic solution from the caustic solution storage tank. The quench chamber has an acid-resistant refractory lining suitable to withstand the process gas temperature and composition and the process scrubbing water composition.

The saturated gas stream from the quench chamber flows through a fire-retardant fiber-reinforced polyester (FRP) duct to the inlet of the venturi scrubber. All of the air pollution control devices downstream of the quench chamber, excepting the induced-draft fan, are manufactured of FRP materials.

The venturi scrubber receives the cooled and water-saturated flue gas, removes particulates of 1 µm and larger, and removes a portion of the HCl. The scrubber consists of converging and diverging cones with an automatic variable throat to maintain a pressure drop and an integral sump. The recirculating water system serving the quench chamber supplies the scrub solution through a nozzle upstream of the throat. The recycle water flows back to the quench sump. The pH of the recycle water is controlled by using 20% caustic solution from the caustic solution storage tank.

The mist eliminator between the venturi scrubber and the packed-bed scrubber removes the entrained water from the saturated flue gas and minimizes interference with the cross-flow liquid/gas flow in the packed-bed scrubber. The mist eliminator is preceded by a dispersion plate that distributes the flow more evenly. From the mist eliminator, effluents flow by gravity to the quench tank.

The packed-bed scrubber removes additional soluble and reactive acid gases such as HCl, HF, and SO_2. The scrubber is a horizontal cross-flow scrubber, contains 3 ft of irrigated packing, and has an entrainment separator following the packed bed. Recirculated scrubber water irrigates the packing. The water recycle system serving the ionizing wet scrubber provides the recycle water. The pH of the recycle water is controlled with 20% caustic solution from the caustic solution storage tank. The packed-bed scrubber has an integral sump. Water flows from the sump to the ionizing wet scrubber sumps. Effluents from the packed-bed scrubber flow through an inlet transition section to the ionizing wet scrubber. The inlet transition provides a gradual transition from the sampling duct to the ionizing wet scrubber to minimize turbulence.

The ionizing wet scrubbers remove the fine particulates of less than 1 µm from the flue gas stream with high efficiency. Key features of each of the two-stage, horizontal cross-flow scrubbers are (l) an ionizer module, (2) a packed-bed section for removing charged particles, (3) a recirculating water system, and (4) an integral sump.

From the flow control damper section at the outlet of the ionizing wet scrubber, the flue gas stream passes to the Hastelloy C22 induced-draft fan. The induced-draft fan pulls the combustion and flue gases through the incineration and process gas cleaning systems at subatmospheric pressure. Instrumentation and controls for the induced-draft fan measure gas inlet and outlet pressure, fan drive motor power, and vibration. Gas pressure and temperature in other parts of the system that would be affected by the loss of fan operation are also monitored. Loss of fan operation shuts off all waste feed streams and the auxiliary fuel to the rotary kiln. The induced-draft fan inlet damper varies stack gas velocity. The fan discharges the water-saturated flue gas to the stack. A short FRP duct section carries the gas stream from the fan outlet to the stack inlet.

The stack receives the water-saturated flue gas and vents it to the atmosphere. It is 100 ft high and 54 in. inside diameter, with a gas velocity of approximately 20 feet per second (fps). The stack is equipped with several sample ports for flue gas sampling, a continuous emission monitoring system for measuring carbon monoxide (CO), carbon dioxide (CO_2), and oxygen (O_2), continuous sampling systems for radionuclides and metals, and access platforms. The combustion gas velocity is also monitored through the monitoring of the induced-draft fan current and pressure drop across the fan.

2.1.3 Process Data Collection

The combustion process and off-gas cleaning systems are monitored by instrumentation for process control and data collection. Operational parameters are automatically monitored and logged by the incinerator Supervisory Control and Data Acquisition (SCADA) system.

2.2 General Facility Operating Conditions

Typical TSCAI stack gas characteristics at the sampling locations under normal incinerator operations are summarized in Table 2.1.

Table 2.1. TSCA Incinerator stack gas characteristics

Parameter	Condition	Units
Temperature	175 – 185	°F
Static Pressure	- 0.25	inches H_20
Flow Rate	8,000 – 9,000	dscf
	17,000 – 19,000	acfm
Velocity	18 – 20	fps
O_2	9 – 11	%
CO_2	5 – 8	%
CO	<10	ppmv
Moisture	45 – 55	%
PM Loading (front-half)	0.002 – 0.030	gr/dscf @ 7% O_2
	5 – 70	mg/dscm @ 7% O_2

Waste feed and operating temperature constraints for the TSCAI are summarized in Table 2.2.

Table 2.2. Waste feed and operating temperature constraints for the TSCA Incinerator

Parameter	Units	Primary organic	Secondary organic	Aqueous	Bulk solids	Total
Feed rate min.	lb/h	170	130	NA [a]	NA	NA
Feed rate max.	lb/h	826	630	380	650 [b]	NA
Heat content min.	Btu/lb	7000	10000	NA	NA	NA
Btu feed rate max.	Btu/h	8,800,000	8,800,000	NA	8,900,000	NA
PCB feed rate max.	lb/h	450	450	450	300	450
Viscosity max.	cP	100	100	NA	NA	NA
Ash liquid total	lb/h	NA	NA	NA	NA	44
Chlorine total	lb/h	NA	NA	NA	NA	260
Fluorine total	lb/h	NA	NA	NA	NA	20
Sulfur total	lb/h	NA	NA	NA	NA	88
Antimony total	lb/h	NA	NA	NA	NA	168
Arsenic total	lb/h	NA	NA	NA	NA	0.322
Barium total	lb/h	NA	NA	NA	NA	168
Beryllium total	lb/h	NA	NA	NA	NA	0.00175 [c]
Cadmium total	lb/h	NA	NA	NA	NA	0.78
Chromium total	lb/h	NA	NA	NA	NA	0.118
Lead total	lb/h	NA	NA	NA	NA	2.625 [c]
Mercury total	lb/h	NA	NA	NA	NA	0.02 [c]
Nickel total	lb/h	NA	NA	NA	NA	168
Selenium total	lb/h	NA	NA	NA	NA	168
Silver total	lb/h	NA	NA	NA	NA	168
Thallium total	lb/h	NA	NA	NA	NA	280

Parameter	Units	Kiln	SCC	NA
Min. Temperature, RCRA wastes	EF	1572	1878	NA
Min. Temperature, TSCA wastes	EF	1572	2200	NA

[a] NA = not applicable.

[b] 950 lb/h with no liquid feed.

[c] Hourly rates are administrative limits; permit limits are based on daily totals.

3.0 TEST PROTOCOL

The mercury CEM demonstration project is expected to cover about a one-year period from start to finish as seen in Table 3.1. Test planning and site preparation will take place over a period of three to four months. Field testing, involving the installation and testing of the mercury CEMs, will be conducted over about a three-month period at the TSCAI Facility. The CEMs will go through a start-up and shakedown period, followed by the Initial Monitoring Performance (MP) Test during the first month of field activities. The CEMs will operate for a period of six to nine weeks with minimal attention to perform routine inspections, maintenance, and calibration tasks. The Final MP Test will take place during the last week of the field test. All field activities will be concluded with removal of the CEMs from the facility. The final phase of the project consists of reduction of the data and report preparation. The primary project activities are described in further detail in the following sections.

3.1 Mercury CEMs Selection

CEMs for mercury are typically designed for determining total and/or chemically speciated mercury in combustion source emissions. Total mercury is the sum of mercury in all phases and chemical forms in the combustion gas, including elemental mercury (Hg^o) and oxidized mercury (primarily mercuric chloride ($HgCl_2$)) vapors, and particulate-phase mercury. Most commercial mercury CEMs do not measure particulate-phase mercury; instead they filter out particulate matter, and measure the total of the vapor-phase mercury species. Commercial CEMs may provide chemical speciation data, i.e., the total and elemental (or oxidized and elemental) fractions of the mercury vapor species are reported separately. This separation is commonly accomplished by a difference measurement, in which oxidized mercury is intermittently or continuously chemically or thermally reduced to elemental mercury for detection.

Table 3.1. Schedule for TSCAI mercury CEM field evaluation

Month	Project Activity	
Test Planning and Site Preparation		
NA	Procure mercury calibration gases Prepare specification for data acquisition system and procure the system Establish facility interfaces with mercury CEMs Review, revise, and approve test/QA plan Set up data acquisition system	
	CEM Field Activities	**Data Analysis and Reporting**
1	Set up/install mercury CEMs CEMs startup/shakedown Initial MP Test Unattended CEMs operation	Sample analysis – Initial MP Test
2	Unattended CEMs operation	Data reduction – Initial MP Test Evaluate Initial MP Test results Adjust test/QA plan for Final MP Test
3	Unattended CEMs operation Final MP Test Decommission CEMs	
4		Sample analysis – Final MP Test Evaluate Final MP Test results
5		Prepare data report
6		Issue draft data report
7		Prepare draft ETV verification reports based upon draft data report
8		Distribute data report for internal review, and distribute verification reports for vendor and EPA QA review
9		Address/respond to data report comments, and revise ETV verification reports in light of review comments
10		Distribute ETV verification reports for stakeholder and EPA peer review
11		Finalize data report and ETV verification reports based upon review comments
12		Issue final data report and submit ETV verification reports for EPA approval

The commercial mercury CEMs also use a variety of final analytical approaches to detect mercury. Cold vapor atomic absorption spectroscopy (CVAAS), cold vapor atomic fluorescence spectroscopy (CVAFS), and differential optical absorption spectroscopy (DOAS) are all used, but can detect only elemental mercury, and so require the speciation approaches outlined above to determine oxidized mercury. Atomic emission spectroscopy (AES) is used in at least one commercial CEM, and has the advantage that in principle all forms of mercury, including particulate mercury, are converted to elemental mercury and detected equally. This approach provides a true total mercury measurement, but does not provide any information on speciation.

The CEMs tested according to this plan may be verified for their measurement of any and all of the applicable mercury components listed above. For example, a monitor that determines total vapor phase mercury and elemental mercury, and by difference determines oxidized mercury, may be evaluated for measurements of all three components. In the United States, emission regulations on combustion sources are expected to address only total mercury. However, there are valuable non-regulatory uses of mercury speciation data, and therefore speciation capabilities of the CEMs will be evaluated if the degree of speciation is great enough to produce quantifiable measurements of various forms of mercury.

Selection of the mercury CEMs to be tested at the TSCAI will be a joint effort by the TSCAI facility staff, TMFA, CMST-CP, ETV stakeholders, and Battelle ETV personnel. As required by ETV, an open invitation to participate will be made to all mercury CEM vendors. Efforts will be made before the test to establish that the CEMs that may participate are suited for application on a wet stack to assure that they have a chance to succeed in the testing. Since mercury CEMs employ more than one analytical technique for measuring mercury, efforts will also be made to involve at least one monitor from each analytical technique in the test program. The CEMs should be commercial-ready monitors that could be readily applied to solving problems in the DOE complex and in other mercury-emitting facilities. Developmental instruments may be considered for inclusion if there is facility space available to accommodate them, but development instruments will not receive ETV verification.

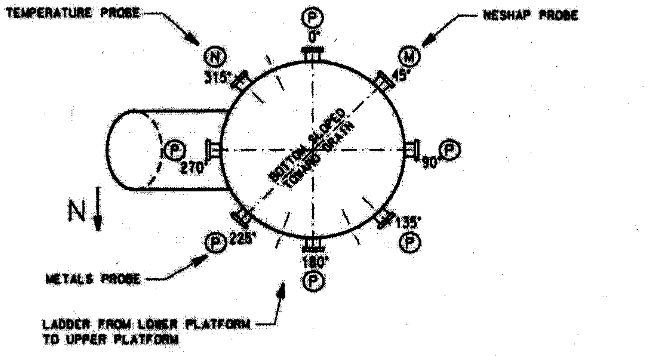
3.2 Preliminary Reference Method Testing

An existing tube furnace test apparatus in the Shaw E&I Technology Development Laboratory will be used to generate a simulated stack gas containing controlled amounts of elemental and oxidized mercury under non-chlorinated and chlorinated conditions. The simulated stack gas will be sampled using an OH method sampling train and OH train samples will be submitted to the analytical laboratory for analysis. This exercise will be useful in evaluating suggested modifications to the OH method based on recommendations from the EPA Office of Research and Development. It will also provide an opportunity for the ETV program to conduct an audit of the Field Sampling Team and analytical laboratory performing the OH method protocol.

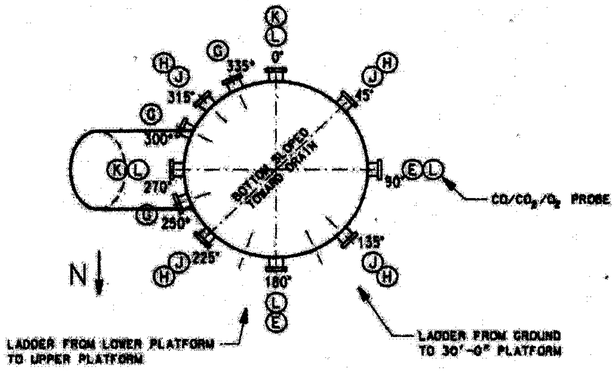
3.3 Equipment Setup and CEM Installation

The mercury CEM instrument cabinets will be housed in the TSCAI Test Bed Mobile Laboratory Trailer. Approximately four to six instrument cabinets can be comfortably placed inside the trailer. Should additional space be needed to accommodate more CEMs, a second trailer may be installed at the site. A dedicated data acquisition system will be procured and placed inside the trailer for logging signals from the mercury CEMs. The data logger will also be connected to the facility SCADA system through an Ethernet link for collecting and logging important process parameters on the CEMs data logger.

The TSCAI stack (53.75 in. ID) has two stack-sampling platforms used for sampling and monitoring emissions from the air pollution control system. The location of the sampling ports and platforms is schematically represented in Figs. 3.1 and 3.2. Both platforms are accessible by ladders from the ground. The lower platform is approximately 30 ft from the ground. One port at this location is dedicated to a probe that extracts stack gas analyzed for carbon monoxide (CO), carbon dioxide (CO_2), and oxygen (O_2) by the facility CEMs. Other ports at this level are used for experimental CEM testing and compliance testing for gaseous pollutants. The upper platform is



PLAN VIEW UPPER PLATFORM ELEVATION 51'-½" FROM GROUND



PLAN VIEW LOWER PLATFORM ELEVATION 30'-0" FROM GROUND

MARK	SIZE	QUANTITY	DESCRIPTION
E	4"	2	FLANGED SAMPLE PORT
G	8"	3	FLANGED SAMPLE PORT
H	6"	4	FLANGED SAMPLE PORT
J	4"	4	FLANGED SAMPLE PORT
K	4"	2	FLANGED SAMPLE PORT (SQUARE FACED)
L	2"	4	THREADED INSTRUMENT PORT
N	4"	1	FLANGED SAMPLE PORT
M	4"	1	FLANGED SAMPLE PORT
P	4"	6	FLANGED SAMPLE PORT

TSCA Incinerator Stack Sampling Port Details

Figure 3.1.

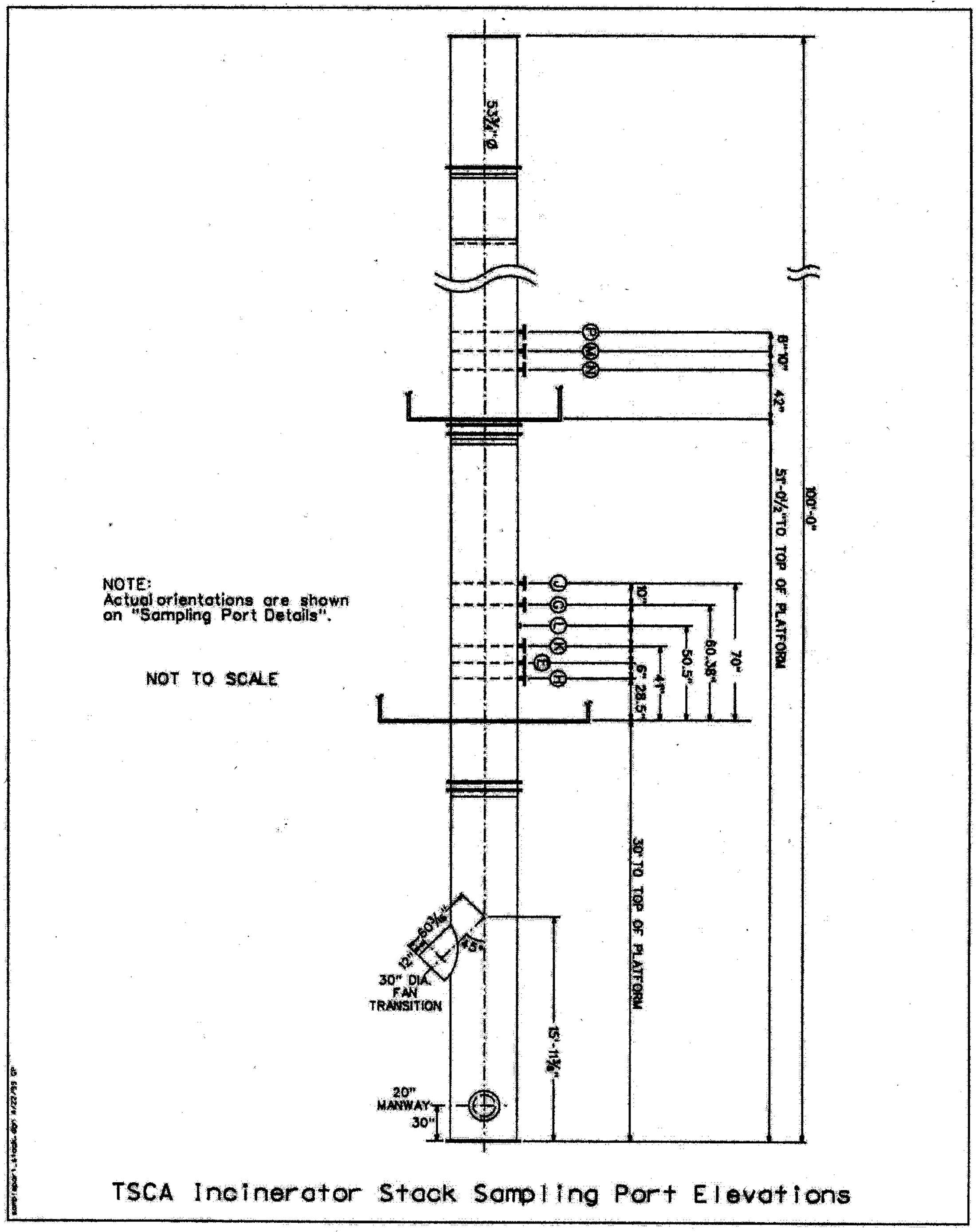

53¾" Ø
100'-0"
8" 10"
42"
51'-0½" TO TOP OF PLATFORM
P
M
N
J
G
L
K
E
H
10"
70"
60.38"
50.5"
41"
6" 28.5"
NOTE:
Actual orientations are shown on "Sampling Port Details".
NOT TO SCALE
30' TO TOP OF PLATFORM
12"
45°
30" DIA. FAN TRANSITION
15'-11¾"
20" MANWAY
30"
TSCA Incinerator Stack Sampling Port Elevations

Figure 3.2.

approximately 50 ft from ground level and contains ports for a continuous radionuclide sampling system, a continuous metals sampling system, reference methods requiring traverses, and experimental CEM testing. A detailed listing of specifications relative to installing a CEM on the TSCAI stack is shown in Appendix A.

Each of the mercury CEMs will have their own dedicated sampling port on the stack. Vendor-supplied extractive sampling probes, installed in ports at the lower stack platform, will be connected to the analyzers by means of 100-ft long heated Teflon sample lines. As most commercial mercury CEMs do not measure particulate-bound mercury, there is no need to locate the analyzers in close proximity to the flue gas extraction location. Furthermore, placing the CEMs outside of the radiation area boundary, which surrounds the TSCAI, avoids the need for radiation worker training for vendor representatives and the need to regularly enter the radiation area for accessing the analyzer cabinet. Trained and experienced site personnel will install the vendor-supplied extractive probes and run the heated Teflon sample lines to the CEM cabinets located in the Test Bed Trailer. The project is prepared to provide each of the vendors a 100-ft long heated Teflon sample line based on a technical specification that will be provided to the vendors for their review and approval. If they so choose, the vendors may provide their own heated sample line if they have special requirements or use a patented system.

Previous testing of PM CEMs at the TSCAI demonstrated very good correlation between duplicate EPA Method 5i sampling trains placed at the upper platform and PM CEMs sampling from ports at the lower platform. Cyclonic flow and flue gas velocity measurements taken at the lower platform to justify the vertical separation of the reference method trains and the CEMs demonstrated the absence of cyclonic flow for PM measurements and revealed a relatively flat velocity profile. The flue gas velocity was only moderately higher in the region directly in the path of gas flow from the induced-draft fan transition duct. This data provides evidence that the use of the lower and upper platforms for locating the CEM probes and the reference method trains, respectively, is suitable for comparison measurements of mercury emissions.

Vendor representatives will be present to oversee the installation of the mercury CEMs; Shaw E&I field technicians will perform the hands-on installation of the probes in the stack. TSCAI maintenance staff will support setup and installation of the field hardware.

3.4 Start-up/Shakedown

Vendor representatives will be on-hand to start-up the CEMs. The vendor representatives should plan to spend about one week in shaking down the CEMs and training a dedicated Shaw E&I field technician in the operation, calibration, and servicing of the units. The use of mercury calibration gas standards will be introduced during the shakedown period and a baseline response from the CEMs using the mercury standards will be obtained while the vendors are present. Routine calibrations will be performed to insure proper setup and operation of the CEMs and to train the dedicated field technician in calibration procedures. The vendors will be provided adequate time during the shakedown period to troubleshoot any problems that occur before proceeding to the Initial MP Test.

3.5 CEM Monitoring Performance Test Schedule

Monitoring Performance (MP) tests utilizing mercury calibration gas standards and OH reference method measurements will be conducted immediately following the shakedown period and at the end of the field study, respectively. The schedule for the two-week-long MP tests is shown in Table 3.2. The initial and final MP tests will follow the same testing format. An additional factor for evaluation in the final week of tests is determination of whether the CEM response has changed, drifted, or shifted over time between the initial and final test periods. It is recommended that the vendor representatives be present to oversee operation of their CEM and to validate their CEM response during these two weeks of testing.

Table 3.2. Weekly schedule for MP tests

Day	CEM Monitoring Performance Parameter
1	Challenge with Hg^o standard/zero gas (Calibration/Zero Drift)
	Flue gas sampling (Relative Accuracy, Correlation, Precision)
2	Challenge with Hg^o standard/zero gas (Calibration/Zero Drift)
	Flue gas sampling (Relative Accuracy, Correlation, Precision)
3	Challenge with HgE standard/zero gas (Calibration/Zero Drift)
	Flue gas sampling (Relative Accuracy, Correlation, Precision)
4	Challenge with Hg^o standard/zero gas (Calibration/Zero Drift)
	Flue gas sampling (Relative Accuracy, Correlation, Precision)
5	Challenge with Hg^o standard/zero gas (Calibration/Zero Drift, Response Time, Sampling System Bias, Calibration Error)

3.6 CEM Monitoring Performance Test Procedures

The TSCAI will be operated continuously during the entire MP test period, and will not be shut down overnight. Such continuous round-the-clock operation is the standard mode of operation for the TSCAI. The TSCAI is normally operated for a three-month campaign to treat liquid and solid wastes, and then the unit is shut down for approximately three months to perform scheduled maintenance tasks and to repackage solid wastes in preparation for the next operating campaign. This three-month burn/three-month shutdown rotational cycle maximizes the time that waste is being treated when the incinerator is operating.

At the beginning of each test day the CEMs undergoing testing will be supplied with zero gas and then with a commercial compressed gas standard containing elemental mercury. The response to each gas will be recorded on each test day to assess the zero and calibration drift of the CEMs. On one test day in each week of testing, the rise and fall times of the CEMs will be determined to assess response time by recording their readings as the mercury calibration gas is first turned on, and later turned off. Also on one day in each week of testing, the mercury calibration gas standards will be delivered first directly to the CEM's mercury analyzer, and then through the CEM's sample interface, to assess sampling system bias and calibration error introduced by the interface itself.

After the CEMs have been challenged with the calibration gas standards, the CEMs will extract flue gas from the stack in preparation for conducting reference method measurements. Waste feeds will be fed to the TSCAI for at least 30 min before initiating reference method sampling. The mercury CEMs will begin recording data as soon as they are brought on-line. However, the reference method sampling will start no sooner than a time previously agreed upon with the CEM vendors. The CEM vendors will be given at least 15 minutes notice prior to initiation of reference method sampling.

OH method sampling will be performed while burning liquid, solid, and/or a combination of liquid and solid wastes. Testing will be done at a low and high mercury stack concentration, approximately 10 µg/dscm and 60 µg/dscm, respectively. Mercury stack concentrations will be varied by varying the waste feed rate, by injecting mercury solutions into the waste feeds, or by a combination of both. Injection of mercury is an alternative that will be used as necessary depending on the levels of mercury in the wastes. The waste feeds to be used for the test will be selected based on availability and will not be determined until the time of testing draws near. There will, however, be an attempt to select liquid wastes that will generate a steady, constant level of mercury in the stack as well as solid wastes, which produce intermittent spikes of mercury due to the batch-wise nature of solid waste feeds.

Reference method measurements will be made using paired sampling trains located at the upper sampling platform, while the CEM probes are extracting flue gas from ports at the lower platform. The reference method sampling time will be approximately three hours with the low mercury levels and approximately one hour with the higher mercury levels. A total of 10 test runs using paired sampling trains will be conducted during each MP Test. A summary of the reference method sampling events planned for the MP Test is provided in Table 3.3. To ensure that the reference method and CEM data sets are indeed parallel and comparable for each period, the CEM vendors will be notified of the start and stop times of each reference method period so that average analyte concentrations corresponding directly to the reference method measurement period can be reported.

Table 3.3. Sampling requirements for paired train Ontario Hydro testing

Day	Stack Mercury Concentration (µg/dscm)	No. of Test Runs	Sample Time (hr)
1	10	2	3
2	10	2	3
3	60	3	1
4	60	3	1

The OH sampling trains will sample isokinetically and traverse the stack at points determined by EPA Method 1. The CEMs undergoing testing will sample at a single (fixed) point in the stack. Each CEM will operate with an extraction probe provided by the vendor. Each CEM probe will be connected to its respective analyzer by means of a 100-ft long heated sample line maintained at a temperature specified by the vendor.

3.7 Unattended Operation

At the conclusion of the initial week of monitoring performance testing, it is expected that the vendor representatives will leave the site and that the trained Field Technician will assume routine operation, calibration, and maintenance of the CEMs. The CEMs will be challenged with the mercury calibration gas standards during this period to confirm that the CEMs are continuing to respond properly. Calibration and zero drift checks will be made as often as possible, while assuring that sufficient calibration gas is available to complete the final week of testing. Routine maintenance checks will be made according to a documented schedule and checklist determined by each CEM vendor.

Should problems arise with the CEMs, the Field Technician will first attempt to troubleshoot the problem either alone or with instructions from the vendor through telephone conversations, facsimile transmittal, or e-mail communication. If the Field Technician is unsuccessful in resolving the problem, then the vendor representative will be requested to visit the site to investigate and resolve the problem.

Information will be recorded to document the reliability and performance of the CEMs during the unattended operational period. The information recorded may include the extent of operational downtime; the support and maintenance requirements, including labor hours and costs; the expendable supplies required; the extent of CEM drift or adjustments needed; and the effort required from the manufacturer to resolve any problems.

4.0 DATA GENERATION AND CALCULATIONS

Measurement results from both the reference method and the mercury CEMs to be evaluated are to be reported in units of Fg/dscm at 7% O_2 (i.e., Fg/m^3 on a dry basis, corrected to 20EC and 7% O_2). The following paragraphs describe how the data will be generated and what calculations will be made to assess the performance of the CEMs. A summary of the data requirements is provided in Table 4.1.

Table 4.1. Data requirements for the mercury CEM performance evaluation tests

Performance Parameter	Objective	Comparison Based On
Relative Accuracy	Determine degree of quantitative agreement with reference method	Reference method results
Correlation	Determine degree of correlation with reference method	Reference method results
Precision	Determine repeatability of successive measurements at fixed mercury levels	Repetitive measurements under constant facility conditions
Cal/Zero Drift	Determine stability of zero gas and span gas response	Zero Gas and Hg^o Standards
Relative Cal/Zero Drift	Determine relative response to zero gas and span gas over successive days	Zero Gas and Hg^o Standards
Sampling System Bias	Determine effect of the CEM's sample interface on response to zero gas and Hg^o standard	Response to Zero Gas and Hg^o Standards at analyzer *vs*. through sample interface
Calibration Error	Determine effect of the CEM's sample interface on response to zero gas and Hg^o standard	Response to Zero Gas and Hg^o Standards through sample interface
Response Time	Estimate rise and fall times of the CEMs	CEM results at start/stop of Hg addition

4.1 Calibration and Zero Drift

Calibration and zero drift will be determined based on challenging the CEMs with zero gas and with a compressed gas standard of elemental mercury on each test day in each week of the performance evaluation test. Calibration and zero drift checks will also be done periodically during the unattended operational period between the initial and final weeks of MP testing. Calibration drift (CD) describes the difference in the mercury CEM's output readings from the established reference value after a stated period of operation during which no unscheduled maintenance, repair or adjustment took place.

$$CD = \frac{\left(R_{CEM} - R_V\right)}{R_V} \times 100$$

Where

R_{CEM} = CEM response, and

R_V = Reference value of the high level calibration standard.

Zero drift (ZD) represents the difference in the mercury CEM's output readings for zero input after a stated period of operation during which no unscheduled maintenance, repair or adjustment took place.

$$ZD = \frac{\left(R_{CEM} - R_V\right)}{R_{EM}} \times 100$$

Where

R_{CEM} = CEM response for zero input,

R_V = Reference response for zero input, and

R_{EM} = emission limit.

4.2 Relative Calibration and Zero Drift

Since mercury calibration gas standards have not been widely used, their absolute quantitation for assessing accuracy of mercury CEMs has not been universally accepted at this time. Section 5.2 describes the validation procedure that will be used to test the stability of the mercury calibration gas standards. Depending on the stability of the mercury standards, it may not be appropriate to use them as absolute calibration standards. With this in mind, an alternative method of evaluating calibration and zero drift in a relative sense may also be used, rather than as deviations from an absolute standard. That is, calibration and zero drift will be reported in terms of the mean, relative standard deviation, and range (maximum and minimum) of the readings obtained from the CEM in the daily sampling of the same Hg^o standard gas, and of zero gas. The relative standard deviation (RSD) will be calculated as

$$RSD = \frac{SD}{\overline{X}} \times 100$$

where $\overline{X}$ is the mean, and SD the standard deviation, of the daily readings on standard or zero gas. This calculation, along with the range of the data, will indicate the variation in zero and standard readings from (e.g.) day to day, week to week, and from the start of the verification test to the end.

4.3 Relative Accuracy

Relative accuracy (RA) will be verified by comparing the CEM results against the reference results, for each parameter that the CEM measures. The OH method results will be reviewed before performing statistical calculations to identify individual outliers from the full set of reference method results. The OH results will be screened for precision of results from co-located sampling trains. OH test results which are identified as outliers will be reported, but may not be used for performance evaluation. The intent of this approach is to provide a valid set of reference data for evaluation purposes, while also illustrating the degree of variability of the reference method. Identification of outliers will be based on basic statistical tests such as a t-test comparison of means, or a Q-test evaluation of divergent results. In any case where rejection of a reference result is suggested, effort will be made to find a cause for the divergent result.

The RA of the CEMs with respect to the reference method will be calculated using:

$$RA = \frac{\bar{d} + \frac{t_{0.975}}{\sqrt{n}} SD}{\bar{R}_{RM}}$$

Where

$\bar{d}$ = arithmetic mean of the difference, d, of the paired CEMs and the reference method results,

$\bar{R}_{RM}$ = arithmetic mean of the reference method result,

n = number of data points,

$t_{0.975}$ = the t-value at the 97.5% confidence with n-1 degrees of freedom, and

SD = Standard deviation of the paired CEMs and the reference results.

Relative accuracy will be calculated separately for each parameter measured by each CEM. Depending on the number of OH reference method samples that are available for determining RA, the RA procedure specified in PS-12 may be used to exclude up to three of the results from the RA calculation. The impact of the number of data points (n) on the RA value will be discussed in the data report.

4.4 Correlation with Reference Method

Correlation of the CEM with the OH method will be calculated using the same data used to assess relative accuracy. Correlation will be calculated for each parameter measured by the CEM. The coefficient of determination (r^2) will be calculated to determine the degree of correlation of each CEM with the reference method results. Coefficient of determination is the square of the correlation coefficient (r). The coefficient of determination will be calculated for each parameter measured by each CEM to be evaluated.

4.5 Precision

Precision of the CEMs will be assessed based on the individual measurements performed by each CEM over the duration of applicable OH method sampling runs. For example, if a CEM provides an updated measurement every 5 minutes, then over a one-hour sampling run a total of 12 readings would be obtained. The average and standard deviation of those readings will be calculated to assess precision. This procedure will be applied to all applicable Ontario Hydro method sampling intervals during times of stable incinerator operation.

Precision (P) of the CEMs to be evaluated will be determined by calculating the percent relative standard deviation (RSD) of a series of CEM measurements made during stable operation of the TSCAI, with mercury injected at a constant level into the combustion zone. During each reference method sampling run, all readings from each CEM will be recorded. RSD is the ratio of standard deviation of those readings over the mean of the readings.

Where

$$P = RSD = \frac{SD}{\overline{X}} \times 100$$

SD = standard deviation of the readings from the CEM, and

$\overline{X}$ = mean of the CEM readings.

Precision will be calculated for each CEM using data from every reference method sampling run. The calculated precision values include all sources of variability (e.g., TSCAI fluctuations, instability in mercury injection, etc.), and not just the CEM variability. Any known variability of the test facility and the CEMs will be reported with the calculated precision. All CEM data from the periods of precision testing will be reviewed to determine whether the consensus of the CEM data indicates a variation in the test facility itself.

4.6 Sampling System Bias

The sampling system bias test will be performed as part of the calibration/zero drift test procedure, in each week of performance evaluation testing. Sampling system bias (B) reflects the difference in CEM response when sampling mercury standard gas through the CEM's entire sample interface, compared to that when sampling the same gas directly at the CEM's pollutant analyzer, i.e.:

$$B = \frac{R_i - R_d}{R_d} \times 100$$

where

R_i = CEM's reading when the standard gas is supplied at the sampling inlet, and

R_d = CEM's reading when the standard is supplied directly to the analyzer.

4.7 Calibration Error

Another way to express sampling system bias is by means of the Calibration Error. Calibration error (CE) is used to determine the difference between the concentration measured by the CEM and the known concentration generated by a calibration source when the entire CEM (including the sample interface) is challenged.

Where

$$CE = \frac{d}{R_v} \times 100$$

d = difference of the paired data points from the CEM and the reference method, and

R_V = reference concentration value.

4.8 Response Time

The response time refers to the time interval between the start of a step change in mercury input and the time when the CEM reading has reached 95% of the final value. Both rise time and fall time will be determined. CEM response times will be obtained in conjunction with a calibration/zero drift check or sampling system bias check, by starting or stopping delivery of the mercury standard gas to the CEM analyzer or sampling interface, recording all readings until stable readings are obtained, and then estimating the 95% response time. For those CEMs, whose measurement process is not truly continuous, the estimation process will require interpolating between successive readings.

4.9 Data Availability

No additional test activities will be required to determine the data availability achieved by the CEMs. Data availability will be assessed by comparing the data recovered from each CEM to the amount of data that would be recovered upon completion of all portions of these test procedures.

4.10 Maintenance

Setup and maintenance needs will be documented qualitatively, both through observation and through communication with the vendors during the test. Factors to be noted include the frequency of scheduled maintenance activities, the downtime of the CEM, and the number of staff operating or maintaining it during the evaluation tests.

5.0 MATERIALS AND EQUIPMENT

5.1 High Purity Nitrogen/Air

The high purity gases used for zeroing of the CEMs will be commercial ultra-high purity (UHP, i.e., minimum 99.999% purity) air or nitrogen.

5.2 Mercury Standard Gases

Compressed gas standards containing elemental mercury (HgE) will be obtained from Spectra Gases for use in assessing drift of the CEMs. These will consist of HgE in a nitrogen matrix, at levels of about 1 ppb (8 $\mu g/m^3$) and 5 ppb (40 $\mu g/m^3$). Multiple cylinders of uniform concentration will be obtained to meet the gas consumption rates of the CEMs during the tests. Spectra Gases determines the concentrations of the gas standards using a Seefelder analyzer maintained at Spectra Gases under laboratory conditions.

Due to uncertainties with respect to compressed gas standard stability and instrumentation drift, a procedure has been developed to audit the stability of the compressed gas standards prior to the beginning of the test program, during the program and at the end of the program. The objective of the audit process will be to identify any drift in the stability of the compressed gas standards independently of the drift that may also occur within the actual CEMs to be used. The procedure consists of the following tasks:

- Spectra Gases will provide the cylinders of compressed gas standards. These will be analyzed at Spectra Gases using their standard procedure that employs the technique of using a calibrated Seefelder analyzer.
- Upon receipt of all compressed gas cylinders at the TSCAI site, the response of all cylinders will be measured by an independent Seefelder mercury analyzer and the ratio of the response of each cylinder will then be compared to the ratio of the values of the concentrations

provided by Spectra Gases. The intent of this step is to ensure that all cylinder concentrations are in the same relative proportion as the values provided by the gas supplier. This will also establish a control that can be repeated periodically to insure that the standards remain stable, or that if they do not, that the rate of degradation has been established.

C Each cylinder will be taken out of service at a predetermined final cylinder pressure with sufficient gas remaining to conduct the following tests:

  - Analysis of the cylinder by the independent analyzer at the date that the cylinder is taken out of service—this will determine the cylinder concentration at the end of its service.
  - If a cylinder is taken out of service early in the test program (i.e., after the Initial MP Test), it will then remain at the site until a shipment of cylinders is ready to be made back to Spectra Gases. Prior to shipment, cylinders stored for extended periods of time will again be analyzed by the independent analyzer.
  - Upon return to Spectra Gases, each cylinder's final response and calibration value will be determined using Spectra's Seefelder instrument.

C Data analysis will be conducted on all cylinder response values obtained to determine the stability of the gases, and to determine the degradation rate, if any, that has occurred during the test program.

This procedure ensures that the degradation rate can be quantified both as a function of time and as a function of quantity of gas remaining in the cylinder. The information will be used to factor out any effects of calibration gas stability from the analyses associated with CEMs response, drift and other required performance analyses.

The compressed gas cylinders will be located inside the trailer near the CEM instrument cabinets for ease of access while performing calibrations and to keep the cylinders at room temperature while in use to ensure uniform gas concentration throughout the test. It may be necessary to place one or two cylinders on the lower sampling platform while conducting the sampling system bias and calibration error checks in order to conserve the gas. Cylinders may be stored outdoors for periods of time before testing begins or while waiting for return shipment to Spectra Gases.

5.3 Mercury Injection for Adjusting Mercury Levels in Waste Feeds

The mercury solutions used to inject mercury into the waste feed lines for reaching target concentrations of mercury in the stack will be aqueous solutions of mercury II acetate. The solutions will be injected into the waste feed lines downstream of the mass flow meters and upstream of the waste feed cut-off valves. A dedicated pumping system will control and record the injection rate of the solution into the waste feed line. In terms of performance testing, while mercury injection solution concentrations and feed rates aid in establishing the appropriate flue gas mercury concentrations, the actual flue gas mercury content will be determined by the OH reference method sampling, and not by calculation of the injected mercury.

5.4 Mercury Spiking Standard for Reference Method Performance Evaluation

A NIST-traceable aqueous mercury standard, obtained from a commercial supplier, will be used as the spiking solution in the performance evaluation of the reference method.

5.5 Sampling Trains Handling and Tracking Protocol

The Shaw E&I Field Sampling Team will supply the glassware, probes, heater boxes, meter boxes, and other associated equipment for performance of the OH method sampling. Severn Trent Laboratories will supply the chemical reagents and materials that are used in the OH sampling train impingers. Multiple trains will be prepared each day so that as many as six trains (i.e., three sampling runs with two trains each) may be sampled in a single day, in addition to at least one blank train. Sampling train preparation, sampling, sample recovery, and cleaning of used trains will be the responsibility of the Field Sampling Team.

The Field Sampling Team will recover samples from OH method trains will in a laboratory facility adjacent to the TSCAI site. Containers for collecting and storing samples will be purchased and labeled for tracking by Severn Trent Laboratories and subsequently supplied to the Field Sampling Team. Request for Analysis/Chain of Custody (RFA/COC) forms afford the necessary documentation to record sample possession from the time of collection by the Field Sampling Team through analysis by the laboratory. Specifications for the analysis of these samples and special instructions to the laboratory are also included on the RFA/COCs. The Field Sampling Team will track the samples using a numbering system provided by the analytical laboratory for numbering and tracking samples. The original RFA/COC form will remain with the sample at all times.

Samples will be packaged and delivered by the Field Sampling Team to Severn Trent Laboratories, located within a 30 minute driving distance of the TSCAI site. RFA/COC forms and samples will be directly delivered to laboratory personnel, who will review and confirm the samples in the presence of Field Sampling Team personnel prior to acceptance by the laboratory.

5.6 Analysis Equipment

Laboratory equipment for sample recovery and analysis will be provided by Severn Trent Laboratories. This will include all chemicals and solutions for rinsing train components and recovering impinger samples, as well as cold vapor atomic absorption (CVAA) spectroscopy equipment for mercury determination.

5.7 Miscellaneous Materials and Equipment

Various other materials, equipment, and support services will be needed to complete the field test. These include calibration gas regulators, heated sample lines, tubing, telephone connection in the laboratory trailer, photography, and report publication services.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

6.1 Equipment Calibrations

6.1.1 TSCA Incinerator Monitoring Equipment

The TSCAI equipment that provides measurements for operation of the incinerator, verification of permit compliance, and determination of the reference method results requires compliance level calibration procedures. Such measurements include waste feed rates, combustion chamber temperatures, off-gas scrubber liquid flows, and stack O_2, CO, and CO_2 content. Calibration procedures along with calibration schedules must be in place and followed during the field test. Calibration results will be made available if requested for auditing purposes.

6.1.2 Reference Method

Most measurements for determining the results of the reference method will be taken using equipment provided by the Field Sampling Team. (O_2, and CO_2 measurements may be taken from the facility CEMs.) The reference method sampling must be performed according to the QA/QC requirements stated in the ASTM draft Ontario Hydro standard test method. Examples of such requirements include use of blank sampling trains and blank sampling materials, such as filters and reagent solution blanks. QA/QC activities will be recorded.

6.1.3 Analytical Laboratory

Severn Trent Laboratories, conducting the analysis of samples from the reference method by cold-vapor atomic absorption spectroscopy (CVAAS) as required by the OH method, will be required to include the calibration records for the mercury analysis equipment with the analytical results. Calibration approaches for the mercury analysis will be as specified in sections 8.9 and 12.2 of the OH method, and calibrations will be documented in the same way as are Severn-Trent's continuing calibration procedures.

6.2 Audits

6.2.1 Technical Systems Audits

The purpose of the Technical Systems Audits (TSA) is to verify that the field evaluation test is being performed in accordance with this test/QA plan and that all QA/QC procedures are being implemented. More specifically, the actual procedures for data acquisition and handling, such as sampling and analysis methods used, will be audited against the procedures stated in the test/QA plan. At least one TSA audit will be conducted during this field test. FIU-HCET is responsible for the TSA audit and preparing the TSA finding report, which will be reported to the Battelle QA Manager.

Battelle QA staff will also conduct an on-site Technical Systems Audit, in addition to any Technical Systems Audit carried out by FIU-HCET. This TSA may be coordinated in time with FIU's TSA, and may involve review by Battelle QA staff of the QA activities conducted by FIU. In addition, EPA QA staff may conduct a separate TSA, at their own discretion.

6.2.2 Performance Evaluation Audit

A performance evaluation (PE) audit will be conducted to ensure that OH reference method sampling equipment and TSCAI stack monitoring instrumentation used for producing reference method results provide quality measurements. Table 6.1 shows the key measurements that may be audited. As can be seen from Table 6.1, the audit will be conducted by comparing data from the reference method sampling train or TSCAI to that from an independent analyzer or monitor, operated simultaneously and sampled at the same point in the duct.

Table 6.1. Summary of performance evaluation audits

Parameter	Audit Method	Expected Tolerance
O_2	Compare to independent O_2 measurement, operated simultaneously and sampled at the same point of the duct	±1% O_2

CO_2	Compare to independent CO_2 measurement, operated simultaneously and sampled at the same point of the duct	±10% of CO_2 reading
Temperature	Compare to independent temperature measurement, operated simultaneously and sampled at the same point of the duct	±2% absolute temperature
Barometric Pressure	Compare to independent pressure measurement, operated simultaneously and sampled at the same point	±0.5 inch of H_2O
Flue Gas Differential Pressure	Compare to independent pressure measurement, operated simultaneously and sampled at the same point of the duct	±0.5 inch of H_2O
OH Gas Flow Rate	Compare to independent flow measurement, operated simultaneously on the same flow	5%
Mass (H2O)	Check balance with calibrated weights	±1% or 0.5 g, whichever is larger
OH Method	Spike one sampling train in each week of OH sampling using a NIST-traceable mercury solution	± 10%

This audit will be the responsibility of Battelle staff. Battelle will supply the staff and equipment needed to make the independent audit measurements. If agreement outside the indicated tolerance is found, the test will be repeated. Further failure to achieve agreement will result in use of a different independent measurement device. If adequate agreement between independent measurements cannot be reached, the affected reference data will be flagged in the data analysis and reports.

6.2.3 Data Quality Audit

A minimum of 10% of the data acquired in the field evaluation tests will be audited by tracking the data from initial acquisition, through reduction and statistical calculations, and to final reporting. FIU-HCET will perform this audit. Battelle will also conduct a comparable audit in the preparation of the draft ETV verification reports.

6.2.4 Audit Reports

All Battelle audits will be documented in accordance with Section 3.3.4 of the Quality Management Plan for the AMS center.[7] An audit report will include the following sections:

- Identification of any adverse findings or potential problems;
- Space for response to adverse findings or potential problems;
- Possible recommendations for resolving problems;
- Citation of any noteworthy practices that may be of use to others; and
- Confirmation that corrective actions (if necessary) have been implemented and are effective.

Audit reports will be distributed to the FIU-HCET and ETV QA Managers and the Principal Investigator. Amendments and deviations to the test/QA plan will be documented by the FIU-HCET QA Manager and distributed to the ETV QA Manager. The Principal Investigator or their designee will approve test/QA plan amendments and deviations. Should major problems arise during the project, real-time communication between the Principal Investigator and the FIU-HCET and ETV QA Managers will be necessary to determine potential project impacts and corrective actions for problem resolution.

6.2.5 Corrective Action

The process for corrective actions in this test is designed to meet the requirements of the Quality Management Plan for the ETV AMS Center.[7] FIU-HCET is responsible for determining if any immediate (by noon of the following workday) corrective action should be taken for each negative finding or potential problem identified in the audits. If serious quality problems exist, the FIU-HCET QA Manager is authorized to stop work. Battelle QA staff will communicate directly with FIU-HCET staff concerning any findings from Battelle or EPA audits. The Principal Investigator has the ultimate responsibility for providing a response to the findings and implementing any necessary corrective action. The FIU-HCET assigned QA Manager will follow-up on corrective actions. Battelle will be responsible for providing to EPA an audit assessment report within 10 working days after the Battelle QA manager has verified that corrective actions have been taken.

7.0 DATA ANALYSIS AND REPORTING

7.1 Data Acquisition

Data gathered during the field evaluation can be divided into three categories: reference method data, mercury CEMs data, and process operational data, such as combustion source conditions, test temperatures, the times of test activities, etc. Table 7.1 lists the types of data to be recorded, recording frequency, and responsible party.

Mercury CEM response data will be recorded by a dedicated data logger procured specifically for this project. The CEM vendors will be responsible for reviewing and validating their respective CEM response data at the end of each RA test day. The vendors must include all individual readings of all tests conducted on that day.

Other data will be recorded either in laboratory record books or in standard data sheets provided by Shaw E&I and Severn Trent Laboratories. These records will be reviewed on a daily basis to determine the validity of the sampling runs and resolve any inconsistencies. All written records must be in ink. Any corrections to notebook entries, or changes in recorded data, must be made with a single line through the original entry. The correction is then to be entered, initialed, and dated by the person making the correction. The majority of the data will be input to validated computer spreadsheets.

In all cases, strict confidentiality of data from each vendor’s CEM, and strict separation of data from different CEMs, will be maintained. Separate files (including manual records, printouts, and/or electronic data files) will be kept for each CEM.

Table 7.1. Summary of Data Recording Process

Data to be Recorded	Responsible Party	Where Recorded	Recording Frequency	Disposition of Data
Dates and times of test events	Shaw E&I	Laboratory record books	Start and end of each test, and every time a test parameter is changed	Used to organize/check test results; Manually incorporated in data spread sheets as necessary
Operating parameters such as waste feed rates, combustion chamber temperatures, flue gas composition, etc.	Shaw E&I	SCADA data logger	Continuous at set acquisition rate	Used to organize/check test results; Manually incorporated in data spreadsheets as necessary
Mercury gas standards	Shaw E&I and FIU-HCET	Laboratory record books	When received from manufacturer	Manually entered into spreadsheets
Mercury CEM readings				
- digital display - printout	Vendor	Data sheets provided by Shaw E&I	At specified points during each test	Used to validate the electronic record
- electronic output	Shaw E&I	Dedicated data logger	Continuously at specified acquisition rate through each test	Electronically transferred to spreadsheets
Reference method sampling data	Shaw E&I	Laboratory record books, data sheets, or data acquisition system, as appropriate	Throughout reference method sampling	Used to organize/check test results; manually incorporated in data spreadsheets as necessary
Reference method sample analysis, chain of custody and results	Shaw E&I and Severn Trent Laboratories	Laboratory record books, data sheets, or data acquisition system, as appropriate	Throughout sample handling and analysis process	Transferred to spreadsheets

7.2 Data Validation

Records generated in this test will receive a one-over-one review within two weeks after generation, and before those records are used to calculate, evaluate, or report verification results. Those records may include (e.g.) laboratory record books; operating data from the TSCAI; data from the CEMs; or reference analytical results. The person doing this review will document it by adding his initials and the date to a hard copy of the record, and returning that record to the person who generated or is storing it.

All data acquired during the field evaluation will be reviewed against a set of established criteria to provide a level of assurance of its validity prior to use. FIU-HCET will be responsible for data validation. All measurement data will be validated based on process conditions during sampling or testing, adherence to prescribed sampling, testing and QA procedures, consistency with expected and/or reference results, and other test-specific acceptance criteria. The data will be labeled as valid or invalid based on how well it meets these criteria. The QC criteria for data validation include consistency, duplicate sample calibrations, tests for outliers, transmittal error, and uncertainty analysis.

Data validation will be conducted by the following means:

- Field checks of raw and reduced data;
- Standard analytical laboratory QC checks, including those specifically called for by the OH method;
- QA audits on overall testing and sampling procedures;
- Comparing summary tables with raw data;
- Comparing actual results with expected results;
- Determine consistency of results among multiple measurements at the same location;
- Review of all input to spreadsheets;
- Verify calculation results; and
- Draft and final report review.

Any data that become invalid through data validation will be discussed in the data report in conjunction with the reason for disqualifying the data. Examples of such reasons include suspected sample contamination, and that drift data exceeded acceptance criteria.

7.3 Reporting

Data from the CEMs collected during calibrations, comparisons with reference method measurements, and routine unattended operation between the MP Tests will be evaluated using the parameters in Section 4.0 to assess the performance of each of the monitoring systems. After the data have been assimilated, each of the vendors will have an opportunity to review and comment on the results of their respective monitor's performance. A final draft data report will be prepared and distributed for comment/peer review prior to publication.

The data report will be a single report meeting the DOE TMFA reporting requirements and will include all test results of all CEMs evaluated. Data and result interpretations will be presented. The report will contain, at a minimum, the following sections: description of the TSCAI, description of the mercury CEMs evaluated, description of the reference method, technical approach and test protocol, operational and maintenance requirements, tests results including calibration results and statistical calculation results, and conclusions.

Battelle ETV staff will also produce an independent set of verification reports, using the draft data report as a starting point. Separate verification reports will be prepared, each addressing a CEM provided by one commercial vendor. Each verification report will present the test procedures and test data, as well as the results of the statistical evaluation of those data. The draft verification reports will be submitted to EPA QA staff and the CEM vendors for review, at the same time that the draft data report is distributed for review. The verification reports and draft data report will be revised, based on all review comments received. The ETV verification reports will then undergo a second round of review by EPA peer reviewers and AMS Center stakeholders. Following revisions based on those reviews, the ETV verification reports and verification statements will be submitted to EPA for final approval.

8.0 HEALTH AND SAFETY

All participants in this test (i.e., Shaw E&I, FIU, Battelle and EPA staff, and vendor representatives) will adhere to the health and safety requirements of the TSCAI facility. All parties involved in the test will participate in Safety Tailgate Meetings each morning. Vendor representatives will spend the majority of their time on site in the CEM Testbed trailer where the mercury CEM analyzers will be housed. Since the analytical instruments will be set up outside the radiation area, it is not anticipated that the vendors will have a need to perform any hands-on work inside the radiation area. Trained IT technicians will perform hands-on installation of instrument probes at the stack. Should there be a need for a vendor representative to perform hands-on work inside the radiation area, then they will be required to comply with the training requirements for hands-on work in the area (i.e., 24-hr HAZWOPER and Radiation Worker II).

9.0 BIBLIOGRAPHY

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4. Proposed Performance Specification 12 for Total Mercury Emission Monitoring Systems, U.S. EPA, Washington, D.C., April 19, 1996.
5. Test/QA plan for Pilot-Scale Verification of Continuous Emission Monitors for Mercury, U.S. EPA Environmental Technology Verification Program, prepared by Battelle, Columbus, Ohio, November 30, 2000.
6. Standard Test Method for Elemental, Oxidized, Particle-Bound, and Total Mercury in Flue Gas Generated From Coal-Fired Stationary Sources (Ontario Hydro Method), American Society for Testing and Materials, Draft Method, September 3, 2001.
7. Quality Management Plan for the ETV Advanced Monitoring Systems Center, Version 3.0, Battelle, Columbus, Ohio, December 12, 2001.

APPENDIX A

CEM INSTALLATION SPECIFICATIONS

AFFILIATION					
Company	Shaw E&I	**Contact**	Jim Dunn		
Address	**PO Box 4699**				
	Highway 58, Blair Road				
	Bldg. K-1435S, Rm 1				
	Oak Ridge, TN 37831-7345				
Phone	865-241-3737	**Fax**	865-576-5380	**E-mail**	dunnje@ettp.net
APPLICATION					
Location	Oak Ridge, Tennessee				
Name of Plant	East Tennessee Technology Park (formerly K-25)				
Name of Facility	Toxic Substances Control Act (TSCA) Incinerator				
Address	Same as above				
Type of Process	Incineration of RCRA hazardous, low level radioactive, PCB waste				
Type of Gas Cleaning System		**Wet Scrubber**			
Water Additives in Wet Scrubber System		**20% NaOH**			
SAMPLING POINT LOCATION					
Vertical Stack		**Material**	Fiber Reinforced Plastic		
Height (ft)	100	**Inside Diameter (in.)**	53.75		
Outside Diameter (in.)	54.5	**Wall Thickness (in.)**	0.375		
Mounting Location	Outdoor platforms	**Mounting Flanges**	4" and 6" ID, 150-lb, 8 bolt ANSI flanges		
Lower Platform		**Elevation (ft)**	30		
Stack Diameters Downstream From Flow Disturbance			4		
Stack Diameters Upstream From Flow Disturbance			15.6		
Upper Platform		**Elevation (ft)**	51		
Stack Diameters Downstream From Flow Disturbance			8		
Stack Diameters Upstream From Flow Disturbance			11		
Accessibility	Vertical ladder; mobile crane can access platforms if needed				

GAS STREAM COMPOSITION/PARAMETERS			
	Minimum	**Typical**	**Maximum**
Water Vapor (%)	45	48	52
CO (ppm @7%O2)		< 3	
CO2 (% dry)		6.6	
O2 (% dry)		9.8	
NOx (ppm dry)		50	
SOx (ppm dry)		< 15	
HCl (ppm dry)		< 50	
PM (mg/dscm @7% O2)	1	10	80
Static Pressure (in. H2O)		-0.25	
Temperature (ºF)	172	178	182
Gas Velocity (ft/sec)	17	19	21
Gas Flow (acfm)		18,000	
EXTERNAL ENVIRONMENTAL CONDITIONS			
Temperature (ºF)	0	70	100
Humidity (%)	40	85	100
Special Conditions (dusty, corrosive, explosion proof area, etc.)			None
UTILITIES			
Plant Air (psig)	95	**Steam (psig)**	90
Nitrogen (psig)	45	**Water (psig)**	100
Power (V)	110, 220, 480 3-phase		