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Environmental Technology Verification Program

Advanced Monitoring Systems Center

Test/QA Plan for Verification of Continuous Emission Monitors (CEMs) and Sorbent-Based Samplers for Mercury at a Coal-Fired Power Plant

TEST/QA PLAN

for

Verification of Continuous Emission Monitors (CEMs) and Sorbent-Based Samplers for Mercury at a Coal-Fired Power Plant

May 18, 2006

Prepared by

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ETV Advanced Monitoring Systems Center

Test/QA Plan

for

Verification of Continuous Emission Monitors (CEMs) and Sorbent-Based Samplers for Mercury at a Coal-Fired Power Plant

Version 2

May 18, 2006

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SECTION A
PROJECT MANAGEMENT

A4 VERIFICATION TEST ORGANIZATION

The verification test will be conducted under the auspices of the U.S. Environmental Protection Agency (EPA) through the Environmental Technology Verification (ETV) Program. It will be performed by Battelle, which is managing the ETV Advanced Monitoring Systems (AMS) Center through a cooperative agreement with EPA. The scope of the AMS Center covers verification of monitoring technologies for contaminants and natural species in air, water, and soil. This verification of mercury monitoring instruments is co-funded by the Illinois Clean Coal Institute (ICCI) under Project No. 04-1/3.2D-1.

The day to day operations of this verification test will be coordinated and supervised by Battelle personnel, with the participation of the vendors who will be having the performance of their mercury continuous emission monitors (CEMs) or sorbent-based samplers (SBSs) verified. The testing will occur at the Northern Indiana Public Service Company (NIPSCO) R.M. Schahfer Generating Station, in Wheatfield, Indiana (NIPSCO is a NiSource company). Staff from the Schahfer plant will support this test by helping to install the CEMs and SBSs to be tested, providing electrical and compressed air utilities, and overseeing operation of the CEMs and SBSs during periods of routine operation. Each CEM or SBS vendor will install their respective instrument, operate it through portions of the test (unless they give written consent for Battelle staff to operate it), and repair or maintain their CEM or SBS during the test. Reference mercury measurements will be carried out by ARCADIS Inc., under subcontract from Battelle, using ASTM D 6784-02, the "Ontario Hydro" (OH) method.[1] If feasible based on scheduling with other programs, ARCADIS staff may also conduct selected mercury CEM challenge procedures as described in the conceptual Instrumental Analyzer Procedure developed by EPA.[2] Quality assurance (QA) oversight will be provided by the Battelle Quality Manager, and also by the EPA AMS Center Quality Manager at her discretion. The organization chart in Figure 1

identifies the responsibilities of the organizations and individuals primarily associated with the verification test. Roles and responsibilities are defined further below.

A4.1 Battelle

Dr. Thomas Kelly is the AMS Center Verification Testing Leader for this test. In this role, Dr. Kelly will have overall responsibility for ensuring that the technical, schedule, and cost goals established for the verification test are met. Specifically, he will:

- Assemble a team of qualified technical staff to conduct the verification test.
- Direct the team (Battelle, Arcadis, and Schahfer facility staff) in performing the verification test in accordance with this test/QA plan.
- Ensure that all quality procedures specified in the test/QA plan and in the AMS Center Quality Management Plan[3] (QMP) are followed.
- Manage the subcontract under which Arcadis conducts the reference mercury sampling and analyses.
- Prepare the draft and final test/QA plan, verification reports, and verification statements.
- Revise the draft test/QA plan, verification reports, and verification statements in response to reviewers' comments.
- Respond to any issues raised in assessment reports and audits, including instituting corrective action as necessary.
- Serve as the primary point of contact for vendor representatives.
- Coordinate distribution of the final test/QA plan, verification reports, and statements.
- Establish a budget for the verification test and manage staff to ensure the budget is not exceeded.
- Ensure that confidentiality of sensitive vendor information is maintained.

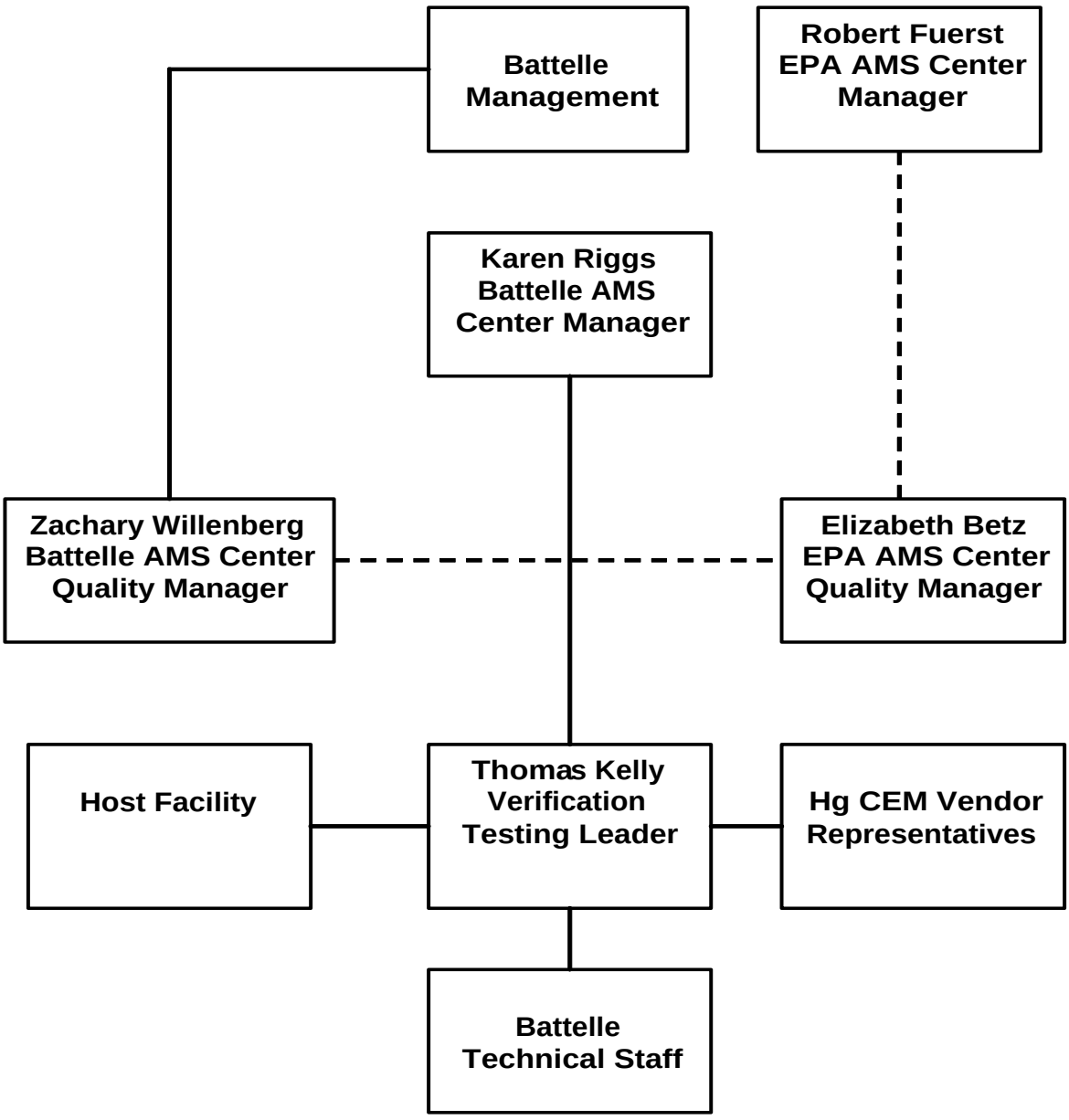

Figure 1. Organization Chart

Ms. Amy Dindal is Battelle's manager for the AMS Center. Ms. Dindal will

- Review the draft and final test/QA plan.
- Review the draft and final verification reports and verification statements.
- Ensure that necessary Battelle resources, including staff and facilities, are committed to the verification test.
- Ensure that confidentiality of sensitive vendor information is maintained.
- Support Dr. Kelly in responding to any issues raised in assessment reports and audits.
- Maintain communication with EPA's technical and quality managers.
- Issue a stop work order if Battelle or EPA QA staff discovers adverse findings that will compromise test results.

Battelle Technical Staff will oversee the testing of the mercury CEMs and SBSs during the verification test. Battelle staff will be on-site at the Schahfer facility during much of the verification test, and will be in daily communication with facility personnel, and with CEM/SBS vendors as needed. The responsibilities of the technical staff will be to:

- Become familiar with the operation and maintenance of the mercury CEMs and SBSs through instruction by the vendors.
- Assure that verification testing is performed as described in the test/QA plan.
- Communicate and coordinate with Schahfer facility staff in the installation, operation, testing, and removal of the CEMs and SBSs.
- Communicate and coordinate with the CEM/SBS vendors on installation, operation, maintenance, data acquisition, and removal of the CEMs and SBSs.
- Communicate with ARCADIS and Schahfer facility staff on the planning, performance, and reporting of the reference mercury sampling and analysis.
- Record qualitative observations about the maintenance and operation of the mercury CEMs and SBSs during testing.

- Assure that the data from each mercury CEM, and sample information from each SBS, are recorded and transmitted to the Verification Testing Leader on at least a weekly basis.
- Provide input on test procedures, CEM/SBS operation and maintenance, and field conditions for the draft verification reports.

Mr. Zachary Willenberg is Battelle's Quality Manager for the AMS Center. Mr. Willenberg will:

- Review the draft and final test/QA plan.
- Conduct a technical systems audit once during the verification test, or designate other QA staff to conduct the audit.
- Audit at least 10% of the verification data.
- Prepare and distribute an assessment report for each audit.
- Verify implementation of any necessary corrective action.
- Request that Battelle's AMS Center Manager issue a stop work order if audits indicate that data quality is being compromised.
- Provide a summary of the QA/QC activities and results for the verification reports.
- Review the draft and final verification reports and verification statements.
- Assume overall responsibility for ensuring that the test/QA plan is followed.

A4.2 Mercury CEM and SBS Vendors

The responsibilities of the CEM and SBS vendors are as follows:

- Review and provide comments on the draft test/QA plan.
- Accept (by signature of a company representative) the EPA-approved test/QA plan prior to test initiation (see page 4).
- Provide a CEM or SBS, complete with flue gas sampling inlet, for evaluation during the verification test.

- In the case of a CEM, carry out the initial certification procedures called for in 40 CFR Part 75,[4] coordinating with Battelle staff on the sequence and schedule for those procedures.
- In the case of an SBS, provide appropriate sorbent traps pre-spiked with mercury as required by 40 CFR Part 75 Appendix K,[4] as well as subsequent mercury analysis on the collected sorbent trap samples.
- Provide all other equipment/supplies/reagents/consumables needed to operate their CEMs or SBSs for the duration of the verification test.
- Supply a representative to install and maintain their technology, and to operate it in portions of the test specified in this test/QA plan, or provide written consent and instructions for Battelle staff to carry out these activities.
- Provide written instructions for routine operation of their CEMs or SBSs, including a daily checklist of diagnostic and/or maintenance activities.
- Provide maintenance and repair support for their CEMs or SBSs, on-site if necessary, throughout the duration of the verification test.
- Review and provide comments on the draft verification report and statement for their respective CEMs or SBSs.

A4.3 EPA

EPA's responsibilities in the AMS Center are based primarily on the requirements stated in the "Environmental Technology Verification Program Quality Management Plan" (EPA QMP).[5] The roles of specific EPA staff are as follows:

Ms. Elizabeth Betz is EPA's AMS Center Quality Manager. For the verification test, Ms. Betz will:

- Review the draft test/QA plan.
- Perform at her option one external technical system audit during the test.

- Notify the EPA AMS Center Manager of the need for a stop work order if the external audit indicates that data quality is being compromised.
- Prepare and distribute an assessment report summarizing results of her audit.
- Review the raft verification reports and statements.

Mr. Robert Fuerst is EPA's manager for the AMS Center. Mr. Fuerst will:

- Review the draft test/QA plan.
- Approve the final test/QA plan.
- Review the draft verification reports and statements.
- Oversee the EPA review process for the verification reports and statements.
- Coordinate the submission of verification reports and statements for final EPA approval.

Mr. Jeffrey Ryan of EPA's Office of Research and Development (ORD) will serve as a technical advisor in planning the test. Also, if feasible relative to the requirements and schedule of other research programs, Mr. Ryan may direct ARCADIS staff in carrying out selected CEM test procedures specified in the conceptual Instrumental Analyzer Procedure (IRM),[2] at the start of the field period. Mr. Ryan's responsibilities will be:

- Review and comment on the draft test/QA plan.
- Assure that ARCADIS staff are fluent in any IRM procedures to be carried out on the CEMs undergoing verification.
- Direct ARCADIS staff to conduct any such procedures on CEMs suitably equipped with sample flow control to be testable under the conceptual procedure.
- At his discretion, review the draft verification reports.

In addition, representatives of EPA's Office of Air Quality Planning and Standards (OAQPS) will serve as reviewers of all verification reports resulting from this test.

A4.4 Host Facility

The responsibilities of personnel from the Schahfer Generating Station, which is the host facility for this test, include the following:

- Provide information on the Schahfer plant for inclusion in the test/QA plan, and review and comment on the draft plan.
- Assist Battelle and CEM/SBS vendor staff in the installation, operation, testing, and removal of the CEMs and SBSs at the Schahfer facility, including connection of CEM and SBS flue gas sampling inlets to the facility stack.
- Assist ARCADIS and Battelle staff in the planning and performance of test procedures and reference mercury sampling and analysis.
- Support the test by providing space and needed utilities (e.g., electricity, air, water) for the CEMs and SBSs during testing.
- Provide daily oversight of the CEMs during periods of routine operation, checking diagnostic indicators and contacting Battelle if faults in CEM operation are observed.
- Record observations about the maintenance and operation of the mercury CEMs and SBSs during the test period.
- Provide information on plant operating conditions and stack gas conditions during the verification test (e.g., coal feed rate; steam production rate; stack gas temperature, opacity, SO_2, NO_x; records of any upsets or alterations in plant operating conditions)
- At the option of facility staff, review the draft verification reports and statements.

A4.5 ARCADIS

The responsibilities of ARCADIS in this test are as follows:

- Conduct a pre-test visit to the host facility, to plan for the OH reference method field efforts.

- Provide equipment and personnel to carry out two separate periods of OH sampling at the stack of the Schahfer plant, each period consisting of 12 sampling runs of at least two hours duration each, using paired OH trains.
- Recover collected samples of vapor-phase mercury from the OH trains, and transfer the recovered samples for mercury analysis.
- Conduct mercury analysis on flue gas samples and QA samples using the OH method,[1] with appropriate documentation of any modifications to that method.
- Calculate the OH reference mercury results in terms of flue gas mercury concentrations as specified in the OH method,[1] and provide a data package to Battelle that includes all sampling data sheets, analysis records, calibration data, and QA information, and that presents the mercury sample analysis results, QA results, and calculated flue gas mercury concentrations.
- Review that portion of the verification reports that describes the OH method sampling and analysis.

A5 BACKGROUND

The ETV Program's AMS Center conducts third-party performance testing of commercially available technologies that detect or monitor natural species or contaminants in air, water, and soil. Stakeholder committees of buyers and users of such technologies recommend technology categories, and technologies within those categories, as priorities for testing. Mercury CEMs were identified as a priority technology category through the AMS Center stakeholder process, and some CEMs have been tested previously under the AMS Center, though not at a coal-fired power plant. Verification reports from the previous tests are available at http://www.epa.gov/etv/verifications/vcenter1-11.html.

On March 15, 2005, EPA issued the Clean Air Mercury Rule (CAMR),[6] setting up a cap-and-trade emissions control program for mercury from utility power plants. Furthermore, the CAMR identifies sorbent-based mercury sampling systems, that collect an integrated sample of stack gas mercury over time periods from a few hours to many days, as acceptable technologies

for monitoring mercury emissions. Performance specifications for mercury CEMs and SBSs are established in the Code of Federal Regulations, Part 75.[4]

The purpose of this test/QA plan is to specify procedures for a verification test applicable to both mercury CEMs and SBSs, to be carried out at a coal-fired power plant. In performing the verification test, Battelle will follow the technical and QA procedures specified in this test/QA plan and will comply with the data quality requirements in the AMS Center QMP.[3]

A6 VERIFICATION TEST DESCRIPTION AND SCHEDULE

A6.1 Summary of Technology Categories

A6.1.1 Mercury CEMs

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.

Commercial mercury CEMs also may 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 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

potentially provides a true total mercury measurement, but does not provide any information on speciation.

EPA's Part 75 requirements for mercury CEMs[4] call for assessment of the performance of newly installed mercury CEMs only for their determination of vapor-phase (as opposed to particulate phase) mercury. Consequently, the CEMs tested under this plan will be verified for their measurement of vapor-phase elemental, oxidized, and/or total mercury (as appropriate for each CEM). For example, a monitor that determines total vapor phase mercury and elemental mercury, and by difference determines oxidized mercury, will 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, provided elemental and oxidized mercury in flue gas are determined well enough by the OH reference method to provide a valid basis for comparison.

EPA's conceptual Instrumental Analyzer Procedure [2] sets forth evaluation procedures that may be used to assess the performance of installed CEMs, without the need for comparison to mercury reference method results (i.e., from the OH method). That approach offers the opportunity to avoid the expense of the reference method sampling and analysis, while providing valuable information on CEM response to realistic mercury challenges. The procedures are applicable to any CEM for which the sample flow or dilution ratio is accurately known. In this verification of mercury CEMs, IRM test procedures may be conducted on each CEM for which the sampling approach meets this requirement, if coordination with the schedules of other ongoing programs can be achieved.

A6.1.2 Sorbent-Based Mercury Samplers

SBS systems do not directly monitor mercury, but rather provide a valid long-term integrated sample by collecting mercury from flue gas extracted from the stack. The mercury is collected onto multiple beds of a selective sorbent contained within a glass trap through which the flue gas is sampled. The SBS systems are designed to extract sample gas from the stack at a

rate proportional to the stack gas flow rate, provided a continuous indication of the total flow rate is available from the facility's data system. The SBS consists of a sampling probe connected to the stack, and a sampling module for control of the sampling process. Typically two simultaneous samples are collected in each sampling interval, using paired sorbent traps. After sampling, the collected mercury is removed from the traps for analysis by a laboratory analytical method such as CVAAS. Instrumentation for rapidly thermally desorbing the collected mercury from the traps, either in the laboratory or at the field site, is becoming available. For this verification it will be the responsibility of each SBS vendor to provide analysis of the collected sorbent trap samples from their respective SBS systems by their choice of an appropriate analytical laboratory or a thermal desorption approach.

The SBS systems are intended to collect the total vapor-phase mercury present, and thus SBS performance will be verified only for that measurement, i.e., no comparison of speciation will be made.

A6.2 Verification Schedule

As shown in Table 1, the field test of mercury CEMs/SBSs is planned to begin in late May 2006 with installation at the host facility, and to extend into July 2006. The evaluation will conclude, and the CEMs and SBSs will be removed from the host facility, in approximately mid-July. An overall summary report will be provided to the ICCI describing the test and data collection efforts conducted under ICCI support. A separate ETV verification report will then be drafted for each participating CEM and SBS, and each report will be reviewed by the respective CEM/SBS vendor and subsequently by peer reviewers, including ICCI and Schahfer facility staff, at their discretion. The final reports will be submitted to EPA for final signature, and the final reports will be provided to ICCI and made publicly available on the EPA/ETV web site.

Table 1. Planned Verification Schedule

Month	Test Activity	
	CEM Field Activities	**Data Analysis and Reporting**
May 2006	Set up/install mercury CEMs and SBSs CEM/SBS shakedown	Begin preparation of ETV report template
June	First OH[a] reference sampling period Routine operation (Conduct conceptual Instrumental Analyzer Procedure tests)[b]	Begin analysis of OH samples and SBS traps from first OH period Review and summarize operator observations from study (Compile conceptual Instrumental Analyzer Procedure test results)[b]
July	Second OH reference sampling period Remove CEMs/SBSs from host facility	Complete summary of operator observations Complete analysis of OH and SBS first period samples Begin analysis of OH samples and SBS traps from second OH period Submit summary report to ICCI
August		Complete analysis of OH and SBS second period samples Receive and organize CEM/SBS mercury results Draft report sections on OH/CEM and OH/SBS comparisons Final OH sampling/analysis data package delivered Internal review of draft reports
September		Vendor review of draft reports Revision of draft reports
October		Peer review of draft reports
November		Final revision of draft reports Submission of final reports for EPA approval

a. Ontario Hydro
b: Tentative

Table 2 shows the activities planned for each week of the field period in May, June, and July 2006; this planned schedule is subject to change due to occurrences in the field. The period of testing of the CEMs at the facility will be approximately 5 weeks. Sampling for flue gas mercury using the OH reference method will take place during the first and fifth weeks of that period, and the second to fourth weeks will be used for routine monitoring by the CEMs. Each participating SBS will be operated either during the first or fifth week of the field test (but not in both weeks), to obtain samples for direct comparison with the OH method results.

Table 2. Planned Weekly Test Activities During the Field Period

Week of (Planned Month and Day, 2005)	Test Activities
May 15	Battelle trailer arrives at Schahfer facility
May 22	Electric power and other utilities for Battelle trailer and CEMs established at Schahfer facility
May 29	CEMs equipment arrives at site
June 5	Installation of CEMs and first SBS; conduct trial operations
June 12	First OH reference method sampling period
June 19	Routine CEM operation
June 26	Routine CEM operation
July 3	Routine CEM operation; second SBS installed at site
July 10	Second OH reference method sampling period Remove CEMs/SBS from host facility

If performance of conceptual Instrumental Analyzer Procedure procedures is feasible, those procedures will likely be carried out in the week of June 5, at the start of the field test period. In substantial portions of the field period, the CEMs will routinely sample stack gas mercury, to allow assessment of operational factors and data completeness in continuous operation. During the two OH reference method sampling periods, the CEM and SBS vendors may operate their own instruments. However, during routine operational periods Battelle or host facility staff will operate the instruments.

A6.3 Test Facility

The host facility for the mercury CEM/SBS verification will be the Schahfer Generating Station, located near Wheatfield, Indiana, approximately 20 miles south of Valparaiso, Indiana. The Schahfer plant consists of four units (designated 14, 15, 17, and 18), with a total rated capacity of about 1,000 MW. The CEM/SBS verification is planned to be conducted at Unit 17, however Unit 18 is a twin of Unit 17 and could be used in the event of unavailability of Unit 17. Unit 17 of the Schahfer plant burns pulverized Illinois subbituminous coal, and has an electrostatic precipitator (ESP) and a wet flue gas desulfurization (FGD) unit.

Flue gas from Unit 17 feeds into a stack which is a free standing concrete chimney with an internal liner. The elevation of the top of the stack is 1,164 feet, and grade elevation is 665 feet, so the height of the stack is 499 feet above grade. Emission test ports and penetrations in the concrete chimney and liner for the continuous opacity monitor and the SO_2 and NO_x CEMs are located at a platform approximately 8 feet wide that encircles the outside of the stack at elevation 1,035 feet (370 feet above grade). This platform can be accessed from the ground by an elevator of three-person capacity. The stack diameter at this platform level is 22 feet 6 inches, so the total flow area is 397.6 square feet. The last flow disturbance is at the FGD connection to the stack liner at about elevation 793 feet (128 feet above grade). Thus the emission test ports are over 10 stack diameters downstream from the last flow disturbance and nearly 6 diameters upstream from the stack exit. Data for SO_2 and NO_x show no stratification in the stack gas at the 370 foot

platform level. The stack gas is at slight positive pressure relative to atmospheric pressure at this point in the stack.

Four available emission test ports are located about 4 feet above the platform at the 370 foot level, at 90º intervals around the circumference of the stack, and are standard 4 inch ports with #125 flanges. These four ports will be the sampling points for all mercury CEMs/SBSs and OH reference method sampling in this verification. One port will be used for the OH method, and the other three for Hg CEMs/SBSs. Each CEM/SBS will sample at a single point in the stack, and the OH method will likewise sample at a corresponding single point, i.e., no traversing will be done. The fixed sampling point for the OH method and for each CEM/SBS will be at one meter inside the inner liner of the stack at each respective port location. The total distance through the wall of the stack (i.e., from each port flange to the inner wall of the liner) is approximately 4 feet 5 inches, so each CEM/SBS vendor will need to provide a sampling probe at least 7 feet 8 inches long to extend through the wall and one meter into the stack gas flow. Exact dimensions will be provided to participating CEM/SBS vendors so that they can prepare a probe of the correct dimensions.

The mercury analysis portion of any CEM undergoing testing will be located at ground level near the stack, in a trailer to be provided by Battelle. As a result, CEM vendors will be required to provide a suitable sampling probe for filtering and conditioning the stack gas, and any needed sampling lines (at least 450 feet in length) to connect their CEM to their sampling probe at the stack. This requirement is consistent with the expected CEM configuration, if a Hg CEM were to be installed permanently at the Schahfer facility.

Any SBSs undergoing testing will be located on the platform 370 feet above grade. SBS vendors will also be required to provide a suitable sampling probe for appropriately filtering and conditioning stack gas for sorbent trap sampling. If feasible, an electronic signal (e.g., 4-20 mA output) indicating the stack gas flow rate will be provided to each SBS for use in controlling the sampler flow rate.

Table 3 summarizes the flue gas characteristics at the Schahfer Unit 17 stack, showing the typical values of key parameters and constituents. As noted above, stack gas pressure is slightly positive at the sampling ports to be used in this study. Total vapor-phase mercury levels in the stack are expected to be about 1 microgram per dry standard cubic meter (μg/dscm), with a preponderance of elemental mercury, based on recent measurements.

Table 3. Typical Stack Gas Characteristics at the Schahfer Generating Station

Parameter	Typical Value
Temperature (ºF)	130
Moisture (%)	15
CO_2 (%)	11.5
NO_x (ppm)	120
SO_2 (ppm)	150
Particulate matter (grs/acf)	0.000579
Total mercury vapor (μg/dscm)	1

A7 QUALITY OBJECTIVES

This verification test will evaluate the performance of CEMs and SBSs for determining mercury in the flue gas of a coal-fired power plant. This evaluation will include a comparison of results to those of the OH reference method for flue gas mercury.[1] The quality of the reference measurements will be assured by adherence to the requirements of the OH method, including the QA/QC requirements and acceptance criteria for solution and field blanks, spiked samples, replicate precision, measurement accuracy, and continuing calibration standards.[1] In addition, all OH reference measurements will be made with paired trains, and the percent relative standard deviation (%RSD) of each data pair must be ≤10% (at mercury levels >1.0 μg/dscm), or ≤20% (at

mercury levels ≤1.0 μg/dscm). Data not meeting this criterion will be excluded from comparison to the CEM/SBS results.

These QA/QC requirements will be augmented by a Technical Systems Audit (TSA), and by independent performance evaluation (PE) audit comparisons. These additional QA procedures will be carried out by Battelle. The PE audit will involve comparisons to an instrument or calibration standard that is different from those used as the basis for the reference mercury measurements. These comparisons are meant to independently confirm that the reference measurements are being performed correctly and provide accurate results. The planned audit procedures are described in Section C1. The EPA Quality Manager also may conduct an independent TSA, at her discretion.

A8 SPECIAL TRAINING/CERTIFICATION

Documentation of training related to technology testing, field testing, data analysis, and reporting is maintained for all Battelle technical staff in training files at their respective locations. Documentation of the expertise and experience of ARCADIS staff in OH reference method sampling and analysis is similarly available. The Battelle Quality Manager may verify the presence of appropriate training records prior to the start of testing. If Battelle or Schahfer facility staff operate and/or maintain a CEM or SBS during the verification test, the CEM/SBS vendor will be required to train those staff prior to the start of testing. Battelle will document this training with a consent form, signed by the vendor, that states which specific Battelle/Schahfer staff have been trained on the respective CEM/SBS. Battelle technical staff will have a minimum of a bachelor's degree in science/engineering or have equivalent work experience.

A9 DOCUMENTATION AND RECORDS

The records for this verification test will be contained in the test/QA plan, chain-of-custody forms, laboratory record books (LRB), data collection forms, electronic files (both raw data and spreadsheets), and the final verification report. All of these records will be maintained in the Verification Testing Leader's office during the test and will be transferred to permanent

storage at Battelle's Records Management Office at the conclusion of the verification test. All Battelle LRBs are stored indefinitely, either by the Verification Testing Leader or Battelle's Records Management Office. EPA will be notified before disposal of any files. The documentation and results of the OH reference measurements made by ARCADIS will be submitted to Battelle after completion of all sample analyses, review of the OH data, and calculation of flue gas mercury concentrations. Section B10 further details the data recording practices and responsibilities.

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

SECTION B
MEASUREMENT AND DATA ACQUISITION

B1 EXPERIMENTAL DESIGN

This test/QA plan addresses verification of CEMs or SBSs for flue gas mercury by evaluating the accuracy of mercury measurements, the linearity and stability of CEM response to zero and span gases, and the ease of use, reliability, and maintenance needs of each CEM/SBS. Specifically, both mercury CEMs and SBSs will be evaluated for the following performance parameters:

- Relative Accuracy
- Data Completeness
- Operational factors such as ease of use, maintenance and data output needs, power and other consumables use, reliability, and operational costs.

Mercury CEMs will also be evaluated relative to the following performance criteria based on the Part 75 requirements:[4]

- Linearity
- 7-Day Calibration Error
- Cycle Time

Relative accuracy will be determined for each CEM and SBS by comparison of flue gas vapor phase mercury results to simultaneous results from a reference method of mercury measurement, in this case the OH method.[1] For CEMs that speciate the vapor-phase mercury (e.g., that determine elemental and total mercury, and infer oxidized mercury by difference), relative accuracy will be determined for each mercury fraction. Linearity will be determined by comparison of CEM readings to known elemental mercury concentrations, when mercury standards are supplied to the CEM and pass through the CEM's inlet filter at a flow rate that exceeds the inlet flow of the CEM. Calibration error will be evaluated by similar comparison of CEM readings on mercury standard and zero gases performed once each day over a consecutive

seven-day period. Cycle time will be evaluated in terms of the time response of a CEM when switching between stack gas and a zero gas or upscale elemental mercury standard gas supplied at the CEM's inlet. Data completeness will be assessed as the percentage of maximum data return that is achieved by each CEM or SBS over the test period. Operational factors will be evaluated by means of operator observations, and records of needed maintenance, vendor activities, and expendables use.

Testing for CEM linearity, 7-day calibration error, and cycle time will rely upon mercury calibration sources internal to each CEM. To the extent possible, test procedures for CEM linearity, 7-day calibration error, and cycle time will be carried out prior to the OH method sampling conducted to assess relative accuracy, as is recommended in 40 CFR Part 75.[4] However, should the test schedule not allow that sequence of testing, Battelle will coordinate with the CEM vendors to reach agreement on an acceptable schedule of testing.

Additional tests may be done on each CEM by ARCADIS staff, provided suitable coordination with other ongoing EPA test programs can be achieved. One such test would be a system integrity check, performed by supplying an oxidized vapor-phase mercury standard through the CEM's inlet filter at a flow rate that exceeds the inlet flow of the CEM. Evaluation of dynamic spiking capabilities appropriate to the IRM procedures[2] may also be conducted.

B1.1 Test Procedures

The following sections describe the test procedures that will be used to evaluate each of the performance parameters listed above.

B1.1.1 Relative Accuracy

The relative accuracy of each CEM and SBS will be evaluated by comparison of their Hg results to simultaneous results obtained by sampling of stack gas with the OH method. In each of two separate weeks of the field test period, ARCADIS will conduct a series of 12 OH runs, each of at least two hours in duration, using paired OH trains. The elemental, oxidized, and/or total

vapor-phase mercury determined by the reference method will be compared to corresponding results from each CEM and SBS, averaged over the period of each OH run.

To assure comparability of the CEM/SBS and OH results, each reference method sampling run will start no sooner than a time previously agreed upon with the CEM/SBS vendors. The vendors will be given at least 15 minutes notice prior to the start of each reference sampling run. However, there will be no obligation to delay the start of a reference method run because of a lack of readiness on the part of a CEM/SBS vendor. No more than three OH test runs will be conducted on any single day; it is expected that two runs per day will be the norm. Vendors will be notified at the end of each test day of the exact start and stop times of each OH run, so that they can report average concentrations that correspond directly to the OH reference sampling periods.

Each CEM/SBS will sample at a single point, non-isokinetically, one meter into the stack gas flow from the inner wall of the stack. OH method sampling will also be conducted at a corresponding single point, isokinetically, at one meter from the stack wall. Although traversing of the OH sampling probe is called for by the OH method,[1] the single-point OH sampling planned here was chosen after consultation with EPA and ARCADIS staff, because of the large size of the stack (and consequent difficulty of properly traversing), the limited number of sampling ports, and the observed lack of stratification of NO_x and SO_2, as noted in Section A6.3. .

The OH trains will be dismantled for sample recovery in the field by ARCADIS staff, and all collected sample fractions will be logged and stored for transfer to the analytical laboratory. All sample handling, QA/QC activities, and mercury analyses will be conducted by ARCADIS, adhering to the requirements of the OH method.[1] Only the vapor phase mercury fractions (as opposed to particulate mercury) will be analyzed. Subsequent to mercury analysis, ARCADIS will review the data, and report final mercury results from all trains in units of micrograms per dry standard cubic meter (μg/dscm), corrected to 7% O_2. The results from the paired OH trains will be subjected to the data acceptance criteria noted above in Section A7. Results from paired

trains meeting those criteria will then be averaged together, to produce the final reference data used for comparison to the CEM results.

B1.1.2 Linearity

Linearity of CEM response will be evaluated by challenging the CEM with low, medium, and high concentration elemental mercury standard gases (i.e., 20 to 30%, 50 to 60%, and 80 to 100% of the full scale of the CEM, respectively), using a calibration source provided by the respective CEM vendor. These standards will be supplied to the CEM in non-repetitive triplicate, through the CEM's inlet filter at a rate that exceeds the CEM's inlet flow rate. Each challenge will be maintained long enough to achieve a stable response on the CEM being tested, before moving to the next challenge gas. The response of each CEM to each challenge will be recorded, and compared to the known Hg level of the standards, as described in Section B1.2.2.

B1.1.3 7-Day Calibration Error

At approximately 24-hour intervals over seven consecutive days, each CEM will be challenged with zero gas and a relatively high elemental mercury standard (i.e., 80 to 100% of the full scale of the CEM) using a calibration source provided by the respective CEM vendor. These challenge gases will be supplied to the CEM through the CEM's inlet filter at a rate that exceeds the CEM's inlet flow rate. Each such challenge will be maintained long enough to achieve a stable response on the CEM being tested. The CEM must record the test data in such a way that any adjustments to CEM response made automatically can be determined and recorded.

B1.1.4 Cycle Time

Cycle time of each CEM will be determined by monitoring CEM readings while switching from sampling of zero gas to sampling of stack gas, and from sampling a high level (80 to 100% of scale) elemental mercury standard to sampling stack gas. The former procedure will determine the upscale response time, and the latter the downscale response time. In each case the response time will be determined as the elapsed time needed to achieve 95 percent of the change from one stable CEM reading to the next.

B1.1.5 Data Completeness

No additional test procedures will be carried out specifically to address data completeness. This parameter will be assessed based on the overall data return achieved by each CEM/SBS.

B1.1.6 Operational Factors

Operational factors such as maintenance needs, data output, consumables use, ease of use, etc., will be evaluated based on observations recorded by Battelle and facility staff, and in some cases by information from the CEM/SBS vendors. A separate laboratory record book will be maintained at the host facility for each CEM/SBS undergoing testing, and will be used to enter daily observations on these factors. Examples of information to be recorded in the record books include the daily status of diagnostic indicators for a CEM; use or replacement of any consumables; the effort or cost associated with maintenance or repair; vendor effort (e.g., time on site) for repair or maintenance; the duration and causes of any CEM/SBS down time or data acquisition failure; and operator observations about ease of use of the CEM. These observations will be summarized to aid in describing CEM/SBS performance in the verification report on each CEM.

B1.1.7 Other Possible Tests

B1.1.7.1 System Integrity Check

If a reference source of oxidized mercury is available, the CEMs will be challenged with that source as a check on the efficiency of sampling and conversion of oxidized mercury. This test will be performed by supplying the oxidized mercury challenge gas to the CEM through the CEM's inlet filter at a rate that exceeds the CEM's inlet flow rate. The difference between the challenge mercury concentration and the CEM's reading will be calculated as a percentage of the CEM's span value.

B1.1.7.2 Dynamic Spiking

If dynamic spiking experiments can be scheduled, calculations of dynamic spiking performance may include the spike recovery percentage, the relative standard deviation (RSD) of replicate spike recovery percentages at each spike concentration, and the absolute differences

between the delivered spike concentration and the average CEM reading at each concentration. These calculations will be made using the equations specified in Section 12 of the conceptual Instrumental Analyzer Procedure.[2] The target criteria noted for these results in Section 13.5 of the procedure are 100 (±5) or 100 (±10) percent spike recovery, ≤ 5 percent RSD for replicate spike recoveries at each spike concentration, and differences between the spike and CEM readings of ≤ 0.2 μg/m^3.

B1.2 Statistical Analysis

The statistical methods and calculations used for evaluation of the quantitative performance parameters are described in the following sections. Several performance parameters will be evaluated only for the CEMs, and not for the SBSs.

B1.2.1 Relative Accuracy

The relative accuracy (RA) of the Hg CEMs/SBSs with respect to the OH reference method results will be assessed as a percentage, using Equation 1:

$$RA = \frac{\left|\overline{d}\right| + t_{n-1}^{\alpha}\frac{S_d}{\sqrt{n}}}{\overline{x}} \times 100\% \qquad (1)$$

where *d* refers to the difference between the OH reference mercury concentration and the average CEM/SBS reading over the OH sampling period, and *x* corresponds to the OH reference mercury concentration. S_d denotes the sample standard deviation of the differences, while t^{α}_{n-1} is the t value for the 100(1 - α)th percentile of the distribution with n-1 degrees of freedom. The RA will be determined for an α value of 0.025 (i.e., 97.5% confidence level, one-tailed). Relative accuracy will be calculated separately for each component of vapor-phase mercury that is measured by the respective CEM/SBS (i.e., elemental, oxidized, or total), and will be calculated separately for the two different periods of OH reference method sampling. All paired OH data meeting the PS-12A quality criteria will be eligible for inclusion in the calculation of relative accuracy. However, for

each of the OH sampling periods, if more than nine OH results meet the acceptance criteria, then selected OH results may be omitted from the calculation, provided that at least nine results are included in the calculation. If nine or fewer OH results meet the acceptance criteria in an OH sampling period, then all acceptable results must be used in the calculation (none can be omitted).

B1.2.2 Linearity

The linearity of CEM response will be assessed by comparing the CEM responses to the elemental mercury standard concentrations, using Equation A-4, from 40 CFR Part 75, Appendix A:

$$LE = \frac{|R-A|}{R} \times 100 \qquad (2)$$

where LE is the linearity error at each concentration, R is the reference mercury concentration supplied to the CEM, and A is the average of the triplicate CEM readings at each concentration.

B1.2.3 7-Day Calibration Error

The assessment of calibration error is based on the difference between the CEM responses and the mercury content of the standard gas. Calibration error will be calculated from the CEM responses to both the zero and upscale mercury concentrations for each of the seven consecutive days of this test. Specifically, calibration error will be calculated using Equation A-5 from 40 CFR Part 75, Appendix A:

$$CE = \frac{|R-A|}{S} \times 100 \qquad (3)$$

where CE is the calibration error as a percentage of the CEM span value, R is the reference mercury concentration supplied to the CEM, A is the CEM response to the reference gas, and S is the span value of the instrument. For this verification, a span value of 10 micrograms per standard cubic meter is assumed, consistent with Section 2.1.7 of 40 CFR Part 75.[4]

B1.2.4 Cycle Time

The upscale and downscale cycle times (essentially the rise and fall times) of CEM response will be determined as the elapsed time needed to achieve 95% of the final stable reading after switching from zero gas to stack gas, and from a high mercury standard to stack gas,

respectively. The slower (i.e., longer) of the two response times will be reported as the cycle time of the CEM.

B1.2.5 Data Completeness

Data completeness will be calculated as the percentage of the total possible data return over the entire field period that is achieved by each CEM/SBS. For a CEM, this calculation will use the total hours of data recorded from each CEM, divided by the total hours of data in the entire field period. The "field period" is defined to begin at the start of the first OH method run or mercury gas challenge, whichever comes first, and to end at the completion of the last OH method run or mercury gas challenge, whichever comes last. Only hours in which the CEM monitored stack gas or a challenge gas for at least half the hour will be included in the calculation. (Only hours in which Schahfer Unit 17 is operating will be included in the denominator of the calculation, i.e., an outage of the unit used for the verification will not be included in the test period for this calculation.) No distinction will be made in this calculation between data recorded during a specific test activity (e.g., data recorded for comparison to OH reference method data) and that recorded during routine stack gas monitoring during the field period. The causes of any substantial incompleteness of data return will be established from operator observations or vendor records, and noted in the discussion of data completeness results.

The SBSs will be operated only during the periods of OH reference method sampling. As a result, data completeness for the SBSs will be based on the fraction of total OH sampling periods that each SBS was sampling.

B1.3 Reporting

The statistical comparisons described above will be conducted separately for each of the CEMs/SBSs being tested, and information on the operational parameters will be compiled and reported. The data for each CEM/SBS will be kept separate from data for all other CEMs/SBSs, and no intercomparison of the CEM/SBs data will be performed at any time. A separate

verification report will be prepared for each CEM/SBS tested, that presents the test procedures and test data, as well as the results of the statistical evaluation of those data.

Operational aspects of the CEMs/SBSs will be recorded by testing staff at the time of observation during the field test, and summarized in the verification report. For example, descriptions of the data-acquisition procedures, use of vendor-supplied proprietary software, consumables used, repairs and maintenance needed, and the nature of any problems will be presented in the report. Each verification report will briefly describe the ETV program, the AMS Center, the host facility and its operating conditions, and the procedures used in verification testing. The results of the verification test will be stated quantitatively, without comparison to any other CEM/SBS tested, or comment on the acceptability of the technology's performance. Each draft verification report will first be subjected to review by the respective CEM/SBS vendor, then revised and subjected to a review by EPA, ICCI, NiSource/Schahfer, and/or other peer reviewers. The peer review comments will be addressed in further revisions of the report, and the peer review comments and responses will be tabulated to document the peer review process. The reporting and review process will be conducted according to the requirements of the AMS Center QMP.[3]

B2 REFERENCE SAMPLE COLLECTION

The collection of reference samples will be conducted by ARCADIS, under subcontract to Battelle, according to the requirements of the Ontario Hydro method, ASTM D 6784-02,[1] as described above (Section B1.1.1). The use of paired trains, the recovery of samples, the preparation of calibration and QA samples, the analysis of samples for mercury, and the reporting of results will be carried out according to the ASTM method. Section B5 describes the QA/QC requirements of the OH method. In addition, independent audits of sampling procedures will be carried out by Battelle as part of the Technical Systems Audit procedure (Section C1.2)

B3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

All reference samples will be in the custody of ARCADIS from sample collection through sample recovery and analysis. Recovered samples may be carried by ARCADIS staff to their laboratory for analysis, rather than shipped back to the laboratory from the field. Sample custody will be documented throughout collection, recovery, and analysis of the reference samples, using standard forms used by ARCADIS for this purpose. Each chain-of-custody form will be signed by the person relinquishing samples once that person has verified that the chain-of-custody form is accurate. Upon receipt at the laboratory, chain-of-custody forms will be signed by the person receiving the samples once that person has verified that all samples identified on the chain-of-custody forms are present in the shipping container. Any discrepancies will be noted on the form and the sample receiver will immediately contact the ARCADIS sampling leader to report missing, broken, or compromised samples. Copies of all chain-of-custody forms will be delivered to Battelle's Verification Testing Leader upon request, and maintained with the test records.

B4 LABORATORY REFERENCE METHODS

The OH method[1] includes the requirement for mercury analysis by atomic absorption or atomic fluorescence techniques. The OH method also includes the calibration requirements for the mercury analysis. All such analyses will be performed by ARCADIS technical staff. ARCADIS is responsible for providing the analytical instrumentation, calibrating that instrumentation according to OH method requirements, performing method QA/QC (see Section B5), and maintaining calibration records for any instrumentation used. ARCADIS will be required to provide Battelle with documentation on calibration and quality control of the reference analyses, upon request.

B5 QUALITY CONTROL REQUIREMENTS

As described in Section A7, reference mercury measurements will be subject to the data quality criteria in Table 4. The reference analytical procedure will be maintained to meet these

requirements. If analytical performance strays outside the required tolerances, the relevant QC samples will be prepared and analyzed again. If problems persist, the reference instrument will be recalibrated, and/or affected samples will be reanalyzed. Reference sample results not meeting these requirements will be excluded from comparison to the mercury CEM/SBS results.

Table 4. Ontario Hydro Reference Method Quality Control Requirements and Data Acceptance Criteria

QC Parameter[a]	Addressed By	Required Performance
Continued Hg calibration	Run check standard every 10 samples	Check standard result within 10% of expected value
Replicate Hg precision	Analyze every sample twice, every 10th sample three times	Results within 10% of one another
Measurement accuracy	Analyze independently prepared standard	Results within 10% of expected value
Measurement accuracy	Analyze spiked samples after every 10 samples	Results within 10% of expected value
Measurement accuracy	Analyze Hg standard from independent source[b]	Results within 15% of expected value
Solution blanks	Analyze reagent solution every time new batch is prepared	if blank <10% of sample Hg or <10 x LOD, subtract blank from samples; if blank >10% of sample Hg, data must be flagged
Field blanks	Analyze samples recovered from complete blank trains	if blank >30% of sample Hg, data must be flagged
Minimum precision of reference Hg data	Comparison of results from duplicate OH sampling trains	≤10%RSD (at >1.0 μg/dscm) ≤20%RSD (at ≤1.0 μg/dscm)

a: Ontario Hydro Method (ASTM D 6784-02) requirement, unless otherwise noted.
b: This standard will be provided as part of the Performance Evaluation audit (Section C.1.1).

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

The equipment used for the reference sampling and analysis will be tested, inspected, and maintained as per the standard operating procedures of ARCADIS, so as to meet the performance requirements established in the OH reference method for mercury measurement.[1] If Battelle or host facility staff operate and maintain the mercury CEMs/SBSs undergoing testing, those activities will be done as directed by the vendor. Otherwise, operation and maintenance of the CEMs/SBSs will be the responsibility of the CEM/SBS vendors.

B7 INSTRUMENT CALIBRATION AND FREQUENCY

The instrument to be used by ARCADIS for the reference mercury analyses is a Perkin Elmer FIMSTM-100, a compact atomic absorption spectrometer that uses flow injection techniques for automated mercury analysis. The FIMSTM-100 uses a high-performance single-beam optical system with a low pressure mercury lamp and solar-blind detector. The FIMSTM-100 is controlled from a personal computer using WinLab32 for AATM software, a Microsoft Windows-based program that includes analytical checks and quality control functions for GLP, GALP, and regulatory compliance, data editing, reformatting, and transfer. FIMS provides detection limits of <0.01 μg/L. The FIMSTM-100 will be calibrated per the standard operating procedures of ARCADIS, which adhere exactly to the calibration requirements stated in section 13.4.1 of the OH reference method.[1] The mercury CEMs undergoing testing will be calibrated initially by the respective CEM vendors at the time of installation at the host facility. In the event that recalibration is necessary, that recalibration will be carried out by the CEM vendor, or by Battelle staff under the direction of the vendor. All calibrations performed will be documented by Battelle or host facility staff in the project record book dedicated to the respective CEM.

B8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

All materials, supplies, and consumables will be ordered by the Verification Test Coordinator or designee. Where possible, Battelle will rely on sources of materials and

consumables that have been used previously as part of ETV verification testing without problems. Battelle will also rely on previous experience or recommendations from EPA advisors, host facility staff, or CEM/SBS vendors.

B9 NON-DIRECT MEASUREMENTS

Data published previously in the scientific literature will not be used during this verification test.

B10 DATA MANAGEMENT

Various types of data will be acquired and recorded electronically or manually by Battelle, vendor, and host facility staff during this verification test. Table 5 summarizes the types of data to be recorded. All maintenance activities, repairs, calibrations, and operator observations relevant to the operation of the mercury CEMs/SBSs will be documented by Battelle or host facility staff in laboratory record books. A separate record book will be provided for each participating CEM/SBS. Results from the laboratory reference method will be compiled by ARCADIS staff in electronic format, and submitted to Battelle in the form of a sampling and analysis report at the conclusion of reference mercury analyses.

Records received by or generated by any Battelle or host facility staff during the verification test will be reviewed by a Battelle staff member within two weeks of receipt or generation, respectively, before the records are used to calculate, evaluate, or report verification results. If a Battelle staff member generated the record, this review will be performed by a Battelle technical staff member involved in the verification test, but not the staff member who originally received or generated the record. The review will be documented by the person performing the review by adding his/her initials and date to the hard copy of the record being reviewed. In addition, any calculations performed by Battelle or ARCADIS staff will be spot-checked by Battelle technical staff to ensure that calculations are performed correctly. Calculations to be checked include any statistical calculations described in this test/QA plan. The

Table 5. Summary of Data Recording Process

Data to Be Recorded	Where Recorded	How Often Recorded	By Whom	Disposition of Data
Dates, times, and details of test events, CEM/SBS maintenance, down time, etc.	ETV test notebooks	Start/end of test procedure, and at each change of a test parameter or change of CEM/SBS status	Battelle or Host Facility	Used to organize/check test results; manually incorporated in data spreadsheets as necessary
CEM calibration information	ETV test notebooks, or electronically	At CEM calibration or re-calibration	Vendor, Battelle, or Host Facility	Incorporated in verification report as necessary
CEM mercury readings	Recorded electronically by each monitor and then downloaded to computer at the close of each day.	Recorded continuously.	CEM vendor, for transfer to Battelle	Converted to spreadsheet for statistical analysis and comparisons
SBS mercury results	Obtained by susbequent analysis of mercury sorbent samples collected in the field	For each SBS sample	SBS vendor or analytical laboratory	Converted to spreadsheet for statistical analysis and comparisons
Reference method procedures, calibrations, QA, etc.	Laboratory record books, or data recording forms	Throughout sampling and analysis processes	ARCADIS	Retained as documentation of reference method performance
Reference method Hg analysis results	Electronically from Hg analytical method	Every sample analysis	ARCADIS	Converted to spreadsheets for calculation of flue gas Hg results, and statistical analysis and comparisons

data obtained from this verification test will be compiled and reported independently for each mercury CEM/SBS. Results for CEMs/SBSs from different vendors will not be compared with each other.

Among the QA activities conducted by Battelle QA staff will be an audit of data quality. This audit will consist of a review by the Battelle Quality Manager of at least 10% of the test data. During the course of any such audit, the Battelle Quality Manager will inform the technical staff of any findings and any immediate corrective action that should be taken. If serious data qualityproblems exist, the Battelle Quality Manager will notify the AMS Center Manager, who is authorized to stop work. Once the assessment report has been prepared, the Verification Testing Leader will ensure that a response is provided for each adverse finding or potential problem, and will implement any necessary follow-up corrective action. The Battelle Quality Manager will ensure that follow-up corrective action has been taken.

SECTION C
ASSESSMENT AND OVERSIGHT

C1 ASSESSMENTS AND RESPONSE ACTIONS

Every effort will be made in this verification test to anticipate and resolve potential problems before the quality of performance is compromised. One of the major objectives of this test/QA plan is to establish mechanisms necessary to ensure this. Internal quality control measures described in this test/QA plan, which is peer reviewed by a panel of outside experts, implemented by the technical staff and monitored by the Verification Testing Leader, will give information on data quality on a day-to-day basis. The responsibility for interpreting the results of these checks and resolving any potential problems resides with the Verification Testing Leader. Technical staff have the responsibility to identify problems that could affect data quality or the ability to use the data. Any problems that are identified will be reported to the Verification Testing Leader, who will work to resolve any issues. Action will be taken to control the problem, identify a solution to the problem, and minimize losses and correct data, where possible. Independent of any EPA QA activities, Battelle will be responsible for ensuring that the following audits are conducted as part of this verification test.

C1.1 Performance Evaluation Audits

A Performance Evaluation (PE) audit will be conducted to assess the quality of the OH method reference measurements made in this verification test. In the PE audit, key aspects of the reference measurement will be checked by comparison with an independent instrument, or an independent NIST-traceable standard. Table 6 shows those aspects of the OH sampling procedure to be audited, with the audit procedures and acceptable tolerances for the audit comparisons. If the PE audit results do not meet the tolerances shown, they will be repeated. If the outlying results persist, a change in reference instrument and a repeat of the PE audit may be considered. This audit will be performed once during the verification test, and will be the responsibility of the Verification Testing Leader or his designee.

Table 6. Methods and Tolerances for PE Audit of OH Method Sampling Procedures

OH Method Parameter	PE Audit Method	Acceptable Tolerance
Gas sample flow rate	Compare to independent flow measurement device	5%
Stack gas temperature	Compare to independent temperature measurement device	2% absolute temperature
Impinger weights	Check balance used with certified weights	Greater of 1% or 0.5 g

The audit standard for the PE audit of OH sampling flow will be a BIOS® DryCal DC-2 electronic piston flow meter, which is a portable NIST-traceable primary flow standard. Stack gas temperature will be audited by measuring the thermocouple voltage reading from the OH train with an independent certified thermocouple meter. Calibrated weights from Battelle's Instrumentation Laboratory will be used to audit the weighing of OH impingers.

A PE audit of the OH train mercury recovery and analysis will also be performed by spiking two blank OH trains with NIST-traceable mercury solutions, provided by Battelle. In each case, impingers 1 (KCl), 4 (H_2O_2/HNO_3), and 5 ($KMnO_4/H_2SO_4$) of a blank OH train will be spiked. One such train will be spiked in the first period of OH reference sampling at the host facility, and the second will be spiked during the final week of OH reference sampling. The spiked trains will be recovered and analyzed in the same manner as for all other OH trains, and the analytical results for the spiked impingers will be compared to the spike amount. The target criterion for this PE audit is agreement of the analytical result within 25% of the spiked amount of mercury.

C1.2 Technical Systems Audits

The Battelle Quality Manager will perform a technical systems audit (TSA) at least once during this verification test. The purpose of this audit is to ensure that the verification test is being performed in accordance with the AMS Center QMP,[3] this test/QA plan, published reference methods, and any Standard Operating Procedures (SOPs) used by ARCADIS. In the

TSA, the Battelle Quality Manager or a designee may review the reference methods used, compare actual test procedures to those specified or referenced in this plan, and review data acquisition and handling procedures. In the TSA, the QA manager will tour the test site and CEM/SBS locations; observe the OH method sampling and sample recovery; inspect documentation of OH sample chain of custody; and review CEM/SBS-specific record books. He will also check CEM/SBS data acquisition procedures, and may confer with the CEM/SBS vendors and host facility personnel. He may also visit the ARCADIS laboratories where the mercury analysis is conducted, to review procedures and adherence to this plan and applicable SOP's. A TSA report will be prepared, including a statement of findings and the actions taken to address any adverse findings. The EPA AMS Center Quality Manager will receive a copy of Battelle's TSA report. At EPA's discretion, EPA QA staff may also conduct an independent on-site TSA during the verification test. The TSA findings will be communicated to technical staff at the time of the audit and documented in a TSA report.

C1.3 Data Quality Audits

The Battelle Quality Manager will audit at least 10% of the verification data acquired in the verification test. The Battelle Quality Manager will trace the data from initial acquisition, through reduction and statistical comparisons, to final reporting. All calculations performed on the data undergoing the audit will be checked.

C1.4 QA/QC Reporting

Each assessment and audit will be documented in accordance with Section 3.3.4 of the AMS Center QMP.[3] The results of the technical systems audit will be submitted to EPA. Assessment reports will include the following:

- Identification of any adverse findings or potential problems
- Response to adverse findings or potential problems
- Recommendations for resolving problems
- Confirmation that solutions have been implemented and are effective
- Citation of any noteworthy practices that may be of use to others.

C2 REPORTS TO MANAGEMENT

The Battelle Quality Manager, during the course of any assessment or audit, will identify to the technical staff performing experimental activities any immediate corrective action that should be taken. If serious quality problems exist, the Battelle Quality Manager will notify the AMS Center Manager, who is authorized to stop work. Once the assessment report has been prepared, the Verification Testing Leader will ensure that a response is provided for each adverse finding or potential problem and will implement any necessary follow-up corrective action. The Battelle Quality Manager will ensure that follow-up corrective action has been taken. The test/QA plan and final report are reviewed by EPA AMS Center QA staff and EPA AMS Center program management staff. Upon final review and approval, both documents will then be posted on the ETV website (www.epa.gov/etv).

SECTION D
DATA VALIDATION AND USABILITY

D1 DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

The key data review requirements for the verification test are stated in Section B10 of this test/QA plan. The QA audits described within Section C of this document, including the audit of data quality, are designed to assure the quality of the data.

D2 VALIDATION AND VERIFICATION METHODS

Section C of this test/QA plan provides a description of the validation safeguards employed for this verification test. Data validation and verification efforts include the collection of QC samples as required in the OH method,[1] and the performance of TSA and PE audits as described in Section C.

D3 RECONCILIATION WITH USER REQUIREMENTS

This test/QA plan and the resulting ETV verification report(s) will be subjected to review by the CEM/SBS vendors, EPA, and expert peer reviewers, and optionally by representatives of NiSource, the Schahfer plant, and ICCI. These reviews will assure that this test/QA plan and the resulting report(s) meet the needs of potential users and permitters of Hg CEMs/SBSs. The final report(s) will be submitted to EPA in Word Perfect and Adobe pdf format and subsequently posted on the ETV website.

SECTION E
REFERENCES

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3. Quality Management Plan for the ETV Advanced Monitoring Systems Center, Version 5.0, U.S. EPA Environmental Technology Verification Program, Battelle, Columbus, Ohio, March 2004.

4. Code of Federal Regulations, 40 CFR part 75, including Appendices A through K, July 2005

5. Environmental Technology Verification Program Quality Management Plan, EPA/600/R-03/021, U.S. Environmental Protection Agency, Cincinnati, Ohio, December 2002

6. Clean Air Mercury Rule, U.S. Environmental Protection Agency, March 15, 2005, available at http://www.epa.gov/air/mercuryrule/rule.htm.