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TECHNICAL ASSISTANCE DOCUMENT: TECHNIQUES TO DETERMINE A COMPANY'S ABILITY TO CONDUCT A QUALITY STACK TEST

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TECHNICAL ASSISTANCE DOCUMENT: TECHNIQUES TO DETERMINE A COMPANY'S ABILITY TO CONDUCT A QUALITY STACK TEST

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ABSTRACT

Techniques are described to determine a company's ability to conduct quality stack testing both before testing begins and during the actual testing. The techniques described are intended for use by industrial and governmental agencies that conduct or contract for stack testing. The techniques suggested apply to stack testing methods in general, that is, they are not limited to EPA Reference Test Methods alone.

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TECHNIQUES TO DETERMINE A COMPANY'S ABILITY TO CONDUCT A QUALITY STACK TEST

INTRODUCTION

This document has four parts. Part I identifies features generally found in companies with a history of conducting valid stack tests, i.e., tests that meet all the associated legal and technical requirements including the issuance of a clear and complete final report. Companies that conduct stack testing can use the information in Part I to upgrade stack testing knowledge and operating procedures of their staff. Individuals who contract for or monitor stack tests will increase their knowledge of techniques that can be used to validate the test results.

Part II contains a set of questions that can either be mailed to the company being evaluated for their response or can be asked in a phone conversation discussing the test. These questions, which are based on the points discussed in Part I, are intended to allow a reasonable decision to be made about the ability of a company to conduct the stack testing required when a specific test is eminent. If the user wants merely to classify laboratories into categories such as "likely capable," "most likely capable," and "likely not capable," and does not have a specific test in mind, these questions will not give an accurate assessment of a company's technical abilities unless a specific source sampling situation is presented to the company.

If extensive stack sampling is anticipated, it may be useful and cost-effective to visit those laboratories identified as likely able to conduct the testing. Part III suggests things to look for during this

visit, e.g., the quality of the equipment, the completeness of test reports and records, and the knowledge of the personnel about their work.

Part IV suggests some straightforward and simple techniques to determine if the personnel supplied for the stack test are properly trained and their equipment is properly calibrated and in good repair. It also suggests some techniques to determine the accuracy and adequacy of their sample recovery and analysis procedures.

The approach described in this document is not limited to USEPA methods and is flexible enough to balance the degree of certainty the user requires with the resources available for the testing.

PART I

APPLICABLE FEATURES FOUND IN COMPANIES WITH A HISTORY OF CONDUCTING VALID STACK TESTING

A source test company can be organized in many ways and still meet the requirements necessary for valid stack testing. The organizational structure will certainly be affected by the type of testing done, the geographical area covered and the size of the company. Some companies find it efficient to separate field activities (equipment maintenance, calibration, performance of the stack testing, etc.) from laboratory activities (analysis, filter weighing, etc.). Other companies find it more convenient to combine field and laboratory activities under one individual.

An effective quality assurance program should allow the company's performance to be monitored so that erroneous results are identified and corrected before they are reported. Although many techniques are available to ensure a viable quality assurance program, the sophistication of the program actually installed must be determined by balancing the degree of data quality desired with the amount of resources (funds, personnel) available.

The cost of an adequate quality assurance program can range from as little as 2% up to 25% of the total cost of the testing program depending on the purpose of the program and the methods utilized. For example, sophisticated methods generally require a higher level of personnel training and more extensive equipment maintenance and calibration than less sophisticated methods. A company that conducts testing only within easy driving distance of its laboratory and uses only one or two test methods will likely have lower quality assurance costs than one that conducts testing over a larger geographical area and uses sophisticated test methods.

Regardless of the organizational structure chosen or the size and sophistication of the quality assurance program, certain characteristics are desirable to assure that good quality, useful data are obtained. The most desirable characteristics are listed below by subject area.

ORGANIZATION

There is a detailed organizational structure which clearly delineates each person's duties and responsibilities so that someone outside the organization can determine who is responsible for each activity.

There are effective methods for communication between individuals in different parts of the organization to ensure that all objectives of the test are met.

One individual is assigned the overall responsibility for quality assurance (or quality control) with direct access to management, e.g., without having to go through the stack test project manager.

PERSONNEL EXPERIENCE/TRAINING

There is an established training program that company personnel must complete before being qualified to perform their assigned tasks without constant supervision. This program should be under the direction of a specific person or persons and a written record of training accomplishments kept for each individual. Ideally, the proficiency of technical personnel should be periodically reviewed in some planned manner and the results documented.

Current periodicals such as the Journal of the Air Pollution Control Association, Pollution Engineering, Industrial Research, Environmental Science and Technology, Analytical Chemistry, etc., are circulated among the staff with encouragement to read them.

Personnel are encouraged to participate in certification/audit programs, workshops, conferences and training courses and the results documented.

GENERAL OPERATING PROCEDURES

Established step-by-step instructions are available in writing for personnel who routinely perform the activities of sampling, shipping, storage, and analysis.

The history of a sample (sample identification, chain-of-custody, analysis and sampling methods used, calibration curves, quality control/assurance procedures used, calculations, record-keeping, etc.) is clearly documented, dated, and maintained in an organized manner so as to be easily followed by someone who did not actually collect or analyze the sample.

The company has a reliable, effective communication system for use in those stack tests that require the sampling and/or monitoring of several process points simultaneously. (Walkie-Talkies have greater range and location flexibility than either sound-powered-phones or a field intercom system. FM type Walkie-Talkies are preferred over CB types in situations where powerful mobile CB units can prevent effective communication between low powered CB Walkie-Talkies or where personnel will not be visible to each other.)

A record is kept on the receipt of chemicals, reagents, and gas cylinders with an indication of their expected shelf life and the date of receipt recorded on the actual container if at all possible.

SAMPLING AND ANALYSIS

Operational checks are specified to verify the proper assembly of sampling equipment and to ensure sufficient spare equipment is shipped to the test site to allow completion of the test in a timely manner. Spare glassware, equipment, filters, dry gas meter and other equipment that can break or change calibration should be available at the test site.

Calibration procedures and schedules are established for all important sampling and analysis equipment and stored in a permanent file.

When equipment is calibrated, a logbook entry is made that contains the name of the person doing the calibration, the date of the calibration, and the calibration factor determined.

Calibration and reference standards are traceable to USEPA, NBS SRM, or other recognized standards such as ACS, wherever possible.

Calibration records are maintained in an organized file for a reasonable amount of time, e.g., two years.

Standardized Reference Test Methods (EPA, ASTM, ASME, etc.) are used whenever available and other methods used are clearly written and contain all necessary documentation to fully describe the modified or special test method and the testing results.

All chemical solutions used in sampling are checked to assure proper makeup and are properly stored to prevent contamination or deterioration.

A reagent blank is routinely carried through all sampling procedures, whenever appropriate. All glassware is properly cleaned and stored between tests.

DATA REDUCTION AND VALIDATION

An effective quality assurance program will ensure that all samples are subjected to data validation techniques that are adequate for the intent of the sampling results and compatible

with the type of sample (routine, nonroutine). For example, for routine samples (similar samples collected and analyzed more often than every 4 to 6 weeks) quality control charts such as those described in the Quality Assurance Handbook* may be appropriate. The basic idea of control charts is to determine the normal limits (precision) associated with the sampling results (based on the past performance of the laboratory) so that sample data that fall outside these limits can be scrutinized to determine the source of the imprecision (error). Standard samples or control samples are generally used to establish these limits and the longer a specific control chart is used, the easier it becomes to identify erroneous data.

When used in conjunction with the Method of Standard Additions, control charts can be very effective in identifying erroneous results, particularly those associated with the analysis of the sample. Errors resulting from mistakes made in the field, however, may not be identified by this approach since many sources do not emit a constant level of pollutant over long periods of time. For best results the standards should be carried through the entire analytical procedure when utilizing this approach.

Control charts may not be cost-effective on samples collected at infrequent intervals and thus the use of Standard Additions or control samples may be adequate. This latter method alone will tend to identify incorrectly prepared standards and other laboratory errors but will not identify errors caused by mistakes made during sample collection.

Whenever possible, a spiked or synthetic sample should accompany samples sent to another company for analysis to document the performance of the contracting company. A method to validate that sample integrity was maintained during transport should also be used. Companies that contract out work should have an in-place, functioning standard procedure for documenting the accuracy of the contractor's results and an established criterion for selecting the contracting company.

* Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III - Stationary Source Specific Methods, EPA-600/4-77-027b, Research Triangle Park, NC (1977).

Some examples of good data reduction and validation practices are:

All laboratory and field data sheets are complete, dated and signed by the analyst/operator and checked or reviewed by management personnel. Data sheets should be filled out in ink (and not pencil).

Standard written procedures, forms, etc., are used to perform necessary computations, data reductions, and validations.

The company has a specific policy for reporting data including the number of significant figures and detection limits.

Preventive maintenance schedules are established for each important physical (electrical, electronic, mechanical) portion of equipment which could affect the validity of the results or cause delays at the test site.

There is an established, closed-loop system to ensure that corrective actions are taken when problems or out-of-control conditions are detected and reported.

Problems that have been discovered and corrected are recorded in a consistent manner stating the deficiency, the corrective action taken, and the date of the action.

Independent, duplicate checks are frequently made of the key aspects of the sampling and measurement systems.

Blind samples are periodically introduced into the analytical system for purposes of quality control.

The company participates in external performance audits that are relevant to the test methodology it uses (e.g., dry gas meter calibration surveys and performance surveys for Methods 6 and 7

conducted by the Source Branch, Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina).

RECORDKEEPING

A field logbook or "events log" is maintained in ink by the sampling team for recording field measurements and other pertinent observations. This may consist only of a binder containing all the data sheets necessary for recording the test data, but many companies find it beneficial to have logbooks for the sampling operator, the recovery team and the analyst.

Samples are labelled in a permanent manner with an identification number, the date, time, and sampling location; the name of the testor; the sample liquid level at the time of collection and any required preservation techniques; light- or temperature-sensitivity; allowable holding time.

The analyst keeps a record of samples submitted, date received and analyzed, sample storage techniques used and analyses done, including procedures used and the person responsible.

Standardized forms are used whenever practical to ensure that all required data are collected and recorded. Examples of how forms can be used to simplify compiling the final report, while at the same time ensuring that all objectives of the test are met, are described below.

1. Presurvey Forms. In most cases adequate pre-test planning requires that a staff member familiar with the requirements of the test method, either visit the test site or talk to the appropriate plant personnel via phone to determine the equipment needed for the test. The use of a presurvey form can ensure that all the equipment/personnel needs for the test program are fulfilled before the test team leaves their

laboratory. This will yield considerable cost savings and improved data quality. Based on their workload and type of testing done, some companies may find it best to use one form for all methods while others may find it more effective to use different forms for different pollutants, methods, sources, etc. Regardless, a good presurvey form would at least address the following points.

- objective of the test (research, compliance, equipment performance, etc.) and desired test and report date
- names of contact personnel at plant, their telephone numbers and their availability and function during the testing
- plant operating schedule (batch, cyclical, continuous) and shutdowns anticipated
- sketch of sampling location(s), number of points to be sampled at each location, size of test ports, clearance around ports, availability of electrical power, and its location with respect to test site.
- velocity profile(s), stack temperature, pollutant concentration(s) expected and how and when determined
- major components in the stack gas (%H_2O, %CO, %CO_2, etc.), any hazardous materials likely present, concentration of pollutant that will be encountered.
- test method(s) to be used and special calibrations or equipment required (e.g., special probes, reagents, etc.)
- physical layout of sampling site, availability of parking space, and a list of the equipment required to put the sampling train in place (ladder, pulley, electrical cords, electrical outlet adapter, monorail), and availability of ice, chemicals, gas samples, etc., needed for the test
- location and phone number of first aid station and hospital, required plant procedures and safety practices.
- minimum number of samples to be collected, what process points are to be monitored during test and at what interval the data should be recorded

- identification and physical description of test sample recovery facility
- location and phone numbers of nearest motels and map of area

2. Test Plan/Accomplishment Form. This form can be included as part of the presurvey form, but for simplicity it may be better to have a separate form that is completed after the presurvey has been done. It should be consulted by those responsible for calibrating, packaging and shipping the equipment to the test site and also be supplied to the testing crew at the test site for reference. At a minimum this form should contain the following information:

   - number/type of equipment required for test (including spare parts) and testing schedule planned or required
   - specific test procedure(s) to be used with copies attached
   - what pretest/post-test equipment maintenance and calibration are required in the laboratory and at the site, date done and values obtained
   - how samples are to be shipped, stored, labelled, analyzed, etc., and what, if any, sample stability problems might be encountered

3. Equipment Shipment/Transport Forms. If desired, this form can be included in the Test Design form described above. It should contain the following information with apropriate means to certify that the required equipment and other materials have been packaged for shipment.

   - type/number of items required and packaged
   - calibrations done/calibration factors obtained
   - method of shipment/number of boxes
   - what field calibrations should be done
   - all necessary data forms and testing procedures required for the test

4. Shipping Labels for Equipment. Labels that clearly identify the contents of each box greatly facilitate sample set up in the field. They also help ensure that all required equipment is sent to the test site.

5. Field Testing Form. This form, which is completed in ink by field personnel, should contain all pertinent information about the sampling and process operating conditions encountered. Items that should be addressed on this form are:

   - sampling equipment serial number/calibration factor
   - stack velocity profile, temperature, sampling point location
   - names of persons conducting the test and their specific functions (sampling, sample clean-up, process monitoring, etc.)
   - plant name, date of test, special instructions to analyst, etc.
   - how samples were stored, shipped, etc.
   - any field tests done to ascertain the accuracy of equipment calibration.
   - description of process and control device design and operating conditions and any problems encountered

6. Sample ID Forms (Labels). All samples should be tagged immediately after collection with a label that identifies all pertinent sample data such as sample number, plant name, project number, date collected, type sample, special storage/transport conditions, sample volume, name of person taking sample.

7. Sample Analysis Form. This form, which is completed by the analyst and may be only a laboratory notebook, should contain the following pertinent information:

- analytical method used
- analytical equipment calibration/standardization done
- integrity of the samples as received and date received
- how results were calculated
- any special conditions that occurred that might have affected the quality of the data
- analyst(s) name, date of analysis.

8. Final Report Format. Issuance of a clear, complete final report in a timely manner (e.g., 4-6 weeks) is the sign of a well-managed testing company. The longer it takes to issue a final report after the testing/analysis is completed, the more likely that significant errors of omission will occur. If the company is unable to issue final reports routinely in a timely manner, it could indicate that their staff or facilities are inadequate. The procedures used in the testing and analysis should be well documented in the final report. At a minimum, discussions of field sampling methods, analytical procedures, sample handling logs and quality control checks should be included.

NOTE: Appendix A contains a checklist that summarizes the information that could be contained on these standardized forms.

PART II
QUESTIONNAIRE

This section contains a set of questions that can be completed by the companies under consideration or filled out by the evaluator via a phone conversation with the company. If mailed, the questionnaire should be accompanied by detailed information on the facility and pollutant(s) to be measured, so that the respondees can provide specific information on their ability to perform the desired testing. Questions that do not apply to the testing under consideration should be crossed out by the evaluator before sending it to the company.
If the size or importance of the test warrants it, reference or audit samples could also accompany the questionnaire. The number of samples to be collected, the process parameters to be measured and similar information should be given if available.

Table II-1 is an example of the type of information that should accompany the questionnaire. For example, if two points are to be sampled simultaneously or if very cyclical (batch) processes are to be tested, the questionnaire should include this information.

QUESTIONNAIRE
(Write N/A if question does not apply and explain answers where appropriate)

Date _____

I. Name of Company _____

Address _____

Phone No. _____

Responsible person: Source Testing _____ Ext. _____

Analysis _____ Ext. _____

QA/QC _____ Ext. _____

TABLE II-1
The following facilities will be tested

PROCESS	CONTROL EQUIPMENT	EMISSIONS OR COMPOUNDS TO BE MEASURED	REQUIRED OR DESIRED TEST METHODS TO BE USED (IF KNOWN)

Please respond to testing the above facilities and compounds for the purpose of _____.

_ Compliance - Federal

_ Compliance - State

_ Compliance - Local

_ Engineering evaluation

_ Control equipment vendor's guarantee

Special instructions about the testing, process cycle, etc., that you should consider in your response are:

_____

_____

II. EXPERIENCE/TRAINING

1. How long has your company been doing source testing? _____
2. Categorize your source test projects:
   a) _____% Compliance
   b) _____% Government _____% Industry

3. Indicate name, education/training/experience of staff that would do the testing using Table II-2 and/or by inclusion of resumes.
4. Which of the following training/educational programs are required and/or available for your employees:

	Professional		Technician	
	Req.	Avail.	Req.	Avail.
In-place training program	____	____	____	____
Classroom	____	____	____	____
"Hands-On"	____	____	____	____
Certification/audit programs	____	____	____	____
Conferences	____	____	____	____
Workshops	____	____	____	____
Proficiency tests	____	____	____	____
Circulation of journals	____	____	____	____
Other: (describe briefly)	____	____	____	____

5. Is your analytical laboratory accredited by any associations or state or federal agencies whose accreditation is pertinent to the testing under consideration? If yes, please describe briefly.

TABLE II-2. EDUCATION/TRAINING/EXPERIENCE OF PROPOSED STAFF

INDIVIDUAL'S NAME AND DEGREE	POSITION OR TITLE	YEARS EXPERIENCE	APPROPRIATE NUMBER OF COMPLETE TESTS SUPERVISED/ PERFORMED IN LAST		INDIVIDUAL WILL PERFORM FOLLOWING TEST METHOD/ MEASUREMENTS IN PROPOSED WORK
			12 MON.	3 MON.	

NOTE: If more than one person may perform a specific procedure or you are not able at this time to specify the personnel most likely to be sent to the test site, please describe the qualification of all personnel who might be sent.

III. 1. Identify parameters that you would monitor and record for the process and control equipment listed in Table II-1.

2. Are your personnel trained to monitor these parameters during the test? Yes _____ No _____

3. List QA/QC procedures you will use to document the quality of the test results.

4. Will you subcontract any of the proposed work?
Yes _____ No _____

If yes, describe how you will select the subcontractor and verify the validity of their results.

5. List any specific QA/QC procedures that you intend to use in the proposed work.

IV. FACILITIES

1. Do you have a special laboratory or area designated for source test analysis? Yes _____ No _____

2. Is there a reference file available that contains pertinent reference books on Reference Test Methods for ASTM, EPA, etc.? Yes _____ No _____

3. Do you have a sample storage area that can be locked?
   Yes _____ No _____
   Can it be refrigerated? Yes _____ No _____
   Can it be heated? Yes _____ No _____

4. Do you have a mobile laboratory with capabilities to perform analysis at the field site? Yes _____ No _____. If appropriate for this proposed work, include sketch and/or description with response.

V. GENERAL OPERATING PROCEDURES

1. Do you have established step-by-step procedures readily available to those personnel who routinely perform the following activities?

	Yes	No
Sampling	___	___
Shipping	___	___
Storage	___	___
Analysis	___	___

2. Is there a document control system to assure that these procedures are current and complete? Yes _____ No _____

3. Do you have established, written chain-of-custody procedures for samples? Yes _____ No _____

4. Is there an inspection procedure which you follow to determine if procurements meet quality control and acceptance requirements when received? Yes _____ No _____
If yes, describe briefly.

5. Do you maintain a log of incoming items such as chemicals, reagents, and other materials with an indication of their expected shelf life?
Yes _____ No _____
Do you require that the expiration date be recorded on the container? Yes _____ No _____

6. Do you frequently perform consecutive source test projects without returning equipment or personnel to the base laboratory? Yes _____ No _____
If yes, do you have procedures available that would be used to field check the calibration and accuracy of the equipment when it cannot be returned to the laboratory for this purpose?
Yes _____ No _____

7. What is the normal time lapse (in months) between testing and issuance of a report for a compliance test _____ and for a test done for noncompliance purposes _____.

VI. SAMPLING

1. Do you normally perform a site pre-survey via telephone or site visit as appropriate? Yes _____ No _____

2. Indicate the calibration equipment to which you have access, the size or capacity of the equipment and its location, e.g., on-site, via purchase order/contract, etc.?

		Location
Calibrated Dry Gas Meter	_____	_____
Wet test meter	_____	_____
Wind tunnel	_____	_____
NBS traceable weights	_____	_____
Other	_____	_____

3. Do you have written calibration procedures and schedules for all important sampling equipment? Yes _____ No _____

4. How often are the following calibrated:

Dry gas meter and orifice _____
Nozzles _____
Pitot tubes _____
Temperature measuring device _____
Barometers _____
Flowmeters _____

VII. DATA REDUCTION AND VALIDATION

1. Do you have standard written procedures or programs for the computations, data reductions, and validations usually done in your laboratory? Yes _____ No _____

2. Do you use the Method of Standard Additions to check for matrix effects in the chemical analysis of samples where applicable? Yes _____ No _____

3. Are chart papers and tapes retained as a part of the permanent record? Yes _____ No _____

4. Are quality control charts routinely used in your laboratory for any of the proposed measurements? Yes _____ No _____

VIII. PREVENTIVE MAINTENANCE

1. Are preventive maintenance schedules established and documented for each important piece of sampling and analysis equipment? Yes _____ No _____

2. Are written records of maintenance actions that affect data quality filed in an organized system? Yes _____ No _____

IX. AUDITS

1. Does your company participate in the following external audits conducted by the Source Branch, Environmental Monitoring Systems Laboratory, US EPA, Research Triangle Park, NC?

	Yes	No
Dry gas meter calibration survey	___	___
Performance survey for Method 6(SO)	___	___
Performance survey for Method 7(NO)	___	___

2. What other audits does your laboratory participate in?

X. REFERENCES

Name at least three of your clients that can be called for references about your previous sampling and analysis work in the areas of the proposed work.

Compound Measured	Company Name	Person to Contact	Phone No.

XI. GUARANTEE

Will you quarantee that your procedures and equipment will meet the specifications outlined in the test plan? Yes _____ No _____

PART III
TEST COMPANY VISIT

This visit to the test company's office is intended to give the evaluator a more comprehensive knowledge of their ability to conduct a quality stack test. It is intended to check questionnaire responses that are unclear and to ensure capabilities in areas that are critical to the conduct of the stack testing being considered. During this visit the evaluator can interview laboratory and field personnel to determine their capabilities, experience, knowledge about the test method, etc. The evaluator can also also examine: conditions of the sampling equipment, calibration logbooks, calibration schedule, quality and completeness of randomly selected field test reports, overall size of the facility (work area size, equipment location, lighting, cleanliness, ventilation, sample/solvent storage), and the existence of sample chain-of-custody procedures.

For the visit to be cost-effective, the individual conducting the visit should have prior actual field testing experience and preferably extensive laboratory experience with source testing methods. If a single, one-time only test is planned, and the cost of the visit is 15-20% of the total cost of the test, this visit will likely not be cost-effective unless they are the only one available and the test results will be used in litigation, obtaining a permit to operate, etc.

A surprise visit should be avoided to ensure that the appropriate personnel, equipment, and records are available. As an alternate to the visit, simply having the company submit copies of some test reports for inspection will yield the information desired by the evaluator.

LABORATORY VISIT

I. EXPERIENCE/TRAINING/KNOWLEDGE

Select specific individuals in the organization who would be involved in conducting the testing and interview them to determine their level of experience and knowledge about the job responsibilities. Some examples follow:

A. Identify the quality assurance/control officer named in the questionnaire. Ask him for a copy of the written policy directive for quality assurance. If no written plan is available, have him briefly describe the procedures they would use for the specific testing under consideration.
Comments:

B. Talk to the person(s) responsible for training and have him briefly describe training procedures. In your judgement:

1) Is there an active training program? Yes _____ No _____
Are the individual elements of the program clearly defined? Yes _____ No _____
Comments:

2) Ask to review the records of employee training accomplishments, particularly for those personnel who will be involved in the proposed testing.
Are the records well-organized? Yes _____ No _____
Are there records of recent accomplishments, including continuing education? Yes _____ No _____
Comments:

3) Many accrediting associations or agencies require periodic analysis of known samples. If the laboratory is participating in such programs, ask to examine the results, particularly if they relate to the testing under consideration.

C. Ask the person who normally performs the pre-survey to briefly describe presurvey procedures and examine a completed pre-survey form if at all possible.
Comments:

D. If applicable, ask a member of the sampling crew to show you a copy of the written sampling procedures for the specific test methods that will be used.
Are they easily located? _____
Step-by-step? _____
Concise? _____
Clear? _____
Comments:

E. Ask an analyst to show you a copy of written analysis procedures for the specific methods under consideration.
Are they easily located? _____
Step-by-step? _____
Concise? _____
Clear? _____
Updated? _____
Comments:

II. EQUIPMENT INSPECTION

A. Ask a member of the sampling team to show you the equipment typically used for a particular test method or for the methods that will be used in the testing.
Is the equipment as specified in the test method? _____
Quickly located? _____
Clean? _____
In good repair? _____
Recently calibrated (check logbook)? _____
Comments:

B. Review the calibration procedures and records for selected pieces of equipment. Are deficiencies, corrective actions and dates clearly documented? Yes _____ No _____

C. Examine field communication systems to determine condition and applicability for use in the sampling situation anticipated.

III. Recordkeeping/Report Writing

A. Ask to see final reports for at least three field tests and record the following:

	Report 1	Report 2	Report 3
Type Test	_____	_____	_____
Date of testing	_____	_____	_____
Date report issued	_____	_____	_____

B. Select at least one of these reports and determine its completeness, clarity, etc., using the report itself and the background file. For example, most test reports should address the following points:

_____ Date of test
_____ Objective of test
_____ Process points monitored and interval at which data were recorded
_____ Physical layout of sampling site
_____ Plant operating schedule during test
_____ Pollutant concentrations found
_____ Stack velocity, profile, temperature, gas composition
_____ Names, functions of persons conducting the test and analyzing the samples
_____ Sampling equipment ID number/calibration factor
_____ Specific test procedure(s) used in sampling and analysis
_____ Pre-test/post-test equipment maintenance/calibration, standardization done
_____ How samples were shipped, stored, labelled, and their condition upon receipt, etc.
_____ Calculation methods used
_____ Any special conditions that occurred that might have affected the quality or validity of the data

IV. Data Reduction and Validation

A. Ask a staff member for a copy of procedures, forms, etc., for data reduction.

Are they step-by-step? Yes _____ No _____
Easy-to-follow? Yes _____ No _____

B. Are the statistical techniques used to validate data (control charts, duplicate sample analysis, method of standard additions or control samples, internal audits, external audits) adequate for the testing under consideration? Yes ___ No ___

V. Preventive Maintenance

1. Select a major piece of equipment used in testing and ask to see the maintenance history of the equipment. Is it well organized and the action taken to correct problems clearly documented?

Part IV
Field Performance Evaluation

Stack testing is a highly-technical field in which proficiency comes about primarily through hands-on experience. Although the assembled equipment may look sophisticated, most stack testing equipment is made from inexpensive, readily-available equipment. Further, many test methods utilize identical equipment, e.g., the EPA Reference Method 5 (particulate) meter box (control console) is also used in EPA Reference Methods 8, 12, 13A, 13B, 14, and 17.

Spot-checking the reliability of a testing company's equipment can be done, frequently, inexpensively and in a straightforward manner by someone without extensive field experience. The use of audit samples and devices, where appropriate, and careful observation of test personnel actions supplemented by conversations with them can also be effective tools in evaluating a test company's ability to conduct a valid stack test.

Some procedures and equipment that can be used in the field evaluation are described here. All field calibration checks should give a value within three percent of the stated value unless a different specification is given. If stack testing is done at a certain site on a frequent basis, appropriate auditing equipment could be stored at each site to minimize the chance the equipment will be damaged during shipment to the test site.

The following field-equipment evaluation procedures are designed to help evaluate EPA Reference Method equipment and similar equipment used in ASTM and ASME test methods. However, these procedures can be used to design a similar evaluation for any other method. Many of these procedures could also be used when visiting the company's laboratory facilities.

I. Equipment Checks

A. Nozzle. A sharp-edged, accurately calibrated nozzle is mandatory when a test method requires isokinetic sampling. For highest accuracy, the nozzle should be perfectly round. However, acceptable limits are met when three measurements of the nozzle I.D. differ by less than 0.004 inches (0.1 mm). Prior to the test, the roundness and I.D. of the nozzle can be verified using a micrometer (or dial caliper). A visual inspection will indicate the overall condition of the nozzle with respect to corrosion, nicks, dirt, etc. Another check that can be done is to require the contractor to wash the nozzle before use, collect the wash, and return it to the laboratory with the samples to serve as a field blank. This will also ensure that the nozzle is clean before testing is initiated.

B. Probe. A check of the probe heating-system calibration cannot be done in the field, but it is possible to inspect the probe to ascertain that it is properly constructed and is the correct length; that the heater is working; and that the probe liner is clean and free of cracks. As with the nozzle, the probe can be washed before use and the wash used as a field blank. This can be particularly useful when a metal liner is being used. By requiring the test team to do this, the evaluator will also get an idea about the proficiency of the test team, their capability to adequately recover sample from a probe and the cleanliness of their equipment.

C. Filter Temperature Control. Accurate temperature control can be a critical parameter when the regulation requires a specific minimum or maximum filter temperature. An inexpensive, calibrated dial type thermometer can be used to verify the accuracy of the filter temperature box heating system. This dial thermometer can be inserted through the filter entrance or exit holes in the filter box and the temperature monitored to ensure that the proper temperature range is maintained during sampling. Portable thermocouples are also available for this purpose. Care should be taken to be sure that the thermometer is not placed too near the heater strip or a false temperature reading may result.

D. Pitot Tube Calibration. The "S" type pitot tube is generally used to measure the velocity at each sampling point to establish

stack volumetric flow rate and the required sampling rate. Since it is usually used in the presence of a thermocouple and nozzle, it is important that this latter equipment not affect the pitot tube calibration coefficient. A simple way to check this in a stack with constant flow rates and flow patterns is to measure the velocity head at three points in the stack first without the nozzle and thermocouple attached and then with them attached. The average velocity head for the two situations should agree within three percent.

Alternately, the evaluator can require that the testing company measure the velocity head using their "S" pitot and a regular ASME L type pitot tube supplied by the evaluator. After correcting for the different calibration factors, the two pitot tubes should yield velocity heads that agree within three percent. For best results, the evaluator should also supply a differential pressure gauge for use with his pitot tube to verify the accuracy of the tester's differential pressure gauge.

E. Differential Pressure Gauge. The pressure gauges should first be checked to be sure that they are appropriate for the test. For example, a 0 to 25 inch H_2O Magnehelic gauge (0-62 cm) is not appropriate if the pressure differential to be measured is less than one inch (2.5 cm). A Magnehelic that has been dropped or is dirty or corroded may no longer be accurate, but most testing crews do not routinely check the accuracy of these pressure gauges. However, as shown below, checking the accuracy and applicability of these gauges is quite simple.

The relative accuracy of the two pressure gauges normally found in a meter box (one for the pitot tube and one for the orifice) can be checked by setting a sampling rate in the meter box that is suitable for both gauges and measuring the pressure differential across the limiting orifice using first one and then the other gauge.

If there is a difference, this will only tell you that at least one of the gauges is inaccurate, but not which one. To determine the defective gauge, it is better to bring a portable inclined manometer (0-10 inches H_2O; 0-25 cm H_2O) to the test site and use it to check the accuracy of the tester's differential pressure gauge.

F. Volume Measuring Device. Some stack sampling methods use a calibrated rotameter and a stopwatch to determine the volume of gas sampled, but most employ a dry gas meter for this purpose. Volume meters can be checked for accuracy at the test site in several ways. For example, the evaluator can connect his own reference (calibrated) dry gas meter (DGM) to the meter box inlet using an appropriate fitting and compare the volume measured by the reference meter to that measured by the one in the meter box.

Alternately, a critical orifice such as that described by Mitchell, (Pollution Engineering, 13, 45-47, June 1981)* can be used to establish the accuracy of the volume meter and the overall integrity of the meter box.

A third method is to set the meter box orifice pressure gauge (ΔH) to the box's $\Delta H@$ and see if the average flow rate is between 0.73 and 0.77 cfm for a 5-minute sample after correcting the volume to standard temperature and pressure. If it is not in this range, then one more of the following situations exists:

1. The orifice calibration is incorrect.
2. The DGM calibration is incorrect.
3. There is a leak between the DGM and the limiting orifice or between the orifice taps and the orifice differential pressure gauge.
4. The orifice pressure gauge is out of calibration.

* A correction to the article was published in the Letters to the Editor section in the September 1981 issue of Pollution Engineering. In the corrections the parameter, θ, was printed as C through a typesetting error.

G. Barometer. If an accurate barometric pressure is required for the test, it is well to bring a calibrated aneroid barometer to the test site to check the tester's unit. Alternately, it may be possible to use a mercury barometer located in a laboratory at the test site. Sometimes a National Weather Service station is nearby and the barometric pressure of the station can be used to check the accuracy of the tester's equipment. If this is done, it is important to get the actual pressure at the Weather Service Station and correct it to the elevation of the sampling port, not to sea level.

H. Filter. The filter holder should be essentially leak free at 15 inches Hg (38 cm Hg). Assembling the filter holder with the appropriate filter and leak checking it before placing it in the sampling train can be a very cost effective, time-saving procedure. By observing the test team during filter assembly and filter recovery the evaulator can determine the cleanliness of the filter and filter holder; determine that the proper filter is being used; confirm that the filter is not torn by the filter holder and that filter material is not left in the gasket. If desired an unused filter can be taken by the evaluator and returned to his own laboratory to check its tare weight. However, if this is done, the filters must be reweighed after conditioning it at a temperature and relative humidity identical to those used in taring the filter.

I. Impinger Design/Condition. The impingers used should meet the requirements of the test method, particularly if a gas sample is being collected by impingement. At times, it may be necessary to substitute a Greenburg-Smith impinger for a modified Greenburg-Smith impinger (orifice tip removed) but this should not affect the collection efficiency; substitution may affect collection efficiency. A visual inspection will also show the general cleanliness of the tester's glassware. If desired, the impingers can be rinsed before use and the rinse used as a field blank. (This test will only be useful if the impinger contents will be analyzed.)

J. Stack Temperature. Analogous to the filter heating box, a calibrated dial thermometer or portable thermocouple can be used to check the accuracy of the tester's stack temperature measurement.

K. Nomograph/Calculator. Frequently a nomograph or calculator is used to select the appropriate nozzle size and required sampling rate. Nomographs are light and if properly constructed, accurate and easy to use. The evaluator can carry either a nomograph or calculator to the test site and confirm the accuracy of the tester's device and calculations. Alternately, the evaluator can supply the tester with a theoretical situation and ask him to calculate the nozzle size and sampling rate.

II. Audit Sample

If appropriate, an audit sample procured commercially or prepared by the evaluator should be given to the test team for analysis. For example, an aqueous sulfuric acid sample can serve to verify the accuracy of a sulfate analysis. A lecture-size cylinder containing CO_2 and O_2 in nitrogen can be used to determine the accuracy of an Orsat analysis when this analysis will be used to correct the emission rate to 12% CO_2 or to calculate excess air. Alternately, ambient air can be used to check the proficiency of the analyst since the oxygen content of air should be 20.5 ± 0.3.

III. Other Procedures

A. Before allowing testing to begin, ask the test supervisor to show you any special instructions he was given about the objectives of the test. If he seems unfamiliar with the test design, testing should not be initiated until this situation is corrected.

Before the testing starts, it is also useful to discuss the action(s) the test team supervisor should take if the plant goes down or sampling must be stopped because a thunderstorm approaches, or someone is injured, etc. For example, if the plant suffers an upset in the middle of a sampling run or the filter plugs up, should the sampling continue, should it stop until the situation is corrected or should the entire test be terminated.

B. By talking with the appropriate personnel assure that they know what to do and what data they should record.

C. Examine the equipment as it is being assembled to be sure it is adequate and properly designed to conduct the test. Ask questions if you are not sure that a piece of equipment is suitable. Also check the date of calibration for each piece of equipment to see that it meets reasonable QA/QC procedures.

D. Check to see that the test team conducts all mandatory leak checks and that they correct any leaks that exceed the allowable rate. The efficiency with which these leaks are corrected can give the observer a reliable assessment of the test team's knowledge of their equipment and how it works.

E. Periodically, check to see that the test team is recording the required data in a permanent, accurate, and timely manner.

F. Observe the probe exit (if appropriate) to be sure that condensation is not occuring in the probe. Place your hand near the probe sheath to see if the heating system is operating.

G. If critical for measurement accuracy, periodically check all equipment to be sure that it is level. This is particularly true of manometers and rotameters.

H. Observe the proficiency of test personnel as they carry out their duties. For example, see if the samples are being recovered carefully and quantitatively and that each sample is identified promptly concerning date, type, sample number, etc.

I. Examine the color of particulate samples and see if the particulate is symmetrically distributed on the filter. If the filter and particulate are yellow or charcoal black and the probe and filter were heated above 100°C during testing, this could indicate a cracked glass probe liner. If the particulate deposit on a flat filter is not symmetrically distributed but rather seems to flow towards or away from one edge, this could indicate that the filter was not properly placed in the filter holder.

APPENDIX A

PERTINENT INFORMATION

THAT SHOULD BE CONTAINED ON THE STANDARD FORMS

APPENDIX A

Check to see that the standardized forms address the following points:

1. Presurvey form

_____ Objective
_____ Desired test date
_____ Desired report date
_____ Contact personnel and phone numbers
_____ Plant operating schedule/anticipated shutdowns
_____ Sketch of sampling location/points
_____ Velocity profile
_____ Pollutant concentration expected
_____ Composition of stack gas/hazardous materials
_____ Test methods
_____ Special calibrations or equipment required
_____ Physical layout of sampling site, size of test ports
_____ Equipment required to put sampling train in place
_____ Minimum number of samples to be collected
_____ Process points to be monitored and interval of data recording
_____ Identification and physical description of sample recovery facility
_____ Map of area, motels, etc.
_____ Availability and location of electrical power

2. Test Design/Accomplishment Form (May be included in Presurvey Form)

_____ Number/type of equipment required for test
_____ Specific test procedure(s) to be used.
_____ Pre test/post-test equipment maintenance and calibration
_____ How samples are to be shipped, stored, labelled, analyzed, etc.
_____ Sample stability problems

3. Equipment Shipment/Transport Forms (May be included in Test Design Form)

_____ Type/number of items required and packaged

_____ Calibrations done/calibration factors

_____ Method of shipment

_____ Number of boxes

_____ Field calibrations to be done by test crew

4. Shipping labels for Equipment

_____ Clear identification of contents

_____ Destination

5. Field Testing Form

_____ Sampling equipment ID number/calibration factor

_____ Stack velocity, profile, temperature

_____ Name/function of persons conducting the test

Plant name/date of test

_____ Special instructions to analyst

_____ How samples were stored, shipped, etc.

_____ Field calibrations

6. Sample Analysis Form (may be a laboratory notebook)

_____ Analytical method used

_____ Equipment calibration/standardization done

_____ Integrity of samples as received

_____ Calculation methods with at least one sample of each type of calculation

_____ Any special conditions that occurred that might have affected the quality or validity of the data

_____ Analyst(s) name, date of analysis

7. Sample ID Forms (Labels)

_____ Sample number
_____ Plant name
_____ Project number
_____ Date collected
_____ Sample type
_____ Special storage/transport conditions
_____ Sample volume
_____ Name or initials of person taking sample

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE TECHNIQUES TO DETERMINE A COMPANY'S ABILITY TO CONDUCT A QUALITY STACK TEST		5. REPORT DATE 6. PERFORMING ORGANIZATION CODE
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15. SUPPLEMENTARY NOTES

TECHNICAL ASSISTANCE DOCUMENT

16. ABSTRACT

Techniques to determine a testing company's ability to conduct a quality stack test for compliance or process engineering purposes are presented. The document has four sections. The first identifies characteristics commonly associated with laboratories that have a history of performing high quality stack tests. The second part suggests questions that can be asked of candidate companies during the selection process and presents process information that should be given to them so that they may be evaluated fairly. The third part presents techniques the evaluator can use at a company's laboratory during a pretest selection visit. The last part presents techniques that can be used during and after the actual test to determine the performance of the testing company and to estimate the quality of their test results.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Stack Testing Quality Assurance Techniques		

18. DISTRIBUTION STATEMENT RELEASE TO PUBLIC	19. SECURITY CLASS (This Report) Unclassified 20. SECURITY CLASS (This page) Unclassified	21. NO. OF PAGES 22. PRICE

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