TITLE 45
LEGISLATIVE RULE

DIVISION OF ENVIRONMENTAL PROTECTION
OFFICE OF AIR QUALITY

SERIES 2
TO PREVENT AND CONTROL PARTICULATE AIR
POLLUTION FROM COMBUSTION OF FUEL IN INDIRECT HEAT EXCHANGERS

§45-2-1. General.

1.1. Scope. -- Series 2 establishes emission limitations for smoke and particulate matter which are discharged from fuel burning units. The Appendix to this rule incorporates the compliance determination methods and procedures.

1.2. Authority.– W. Va. Code §§22-5-1 et seq.

1.3. Filing Date. – June 2, 2000

1.4. Effective Date. – August 31, 2000

1.5. Former Rules. – This legislative rule amends 45CSR2 - 'To Prevent and Control Particulate Air Pollution From Combustion of Fuel in Indirect Heat Exchangers"' which was filed on April 28, 1995 and became effective on May 1, 1995.

[***Note:*** *The 4/28/95 legislative rule repealed 45CSR2A - "TP-2 - Compliance Test Procedures for Rule 2 - 'To Prevent and Control Particulate Air Pollution From Combustion of Fuel in Indirect Heat Exchangers'" which was filed on September 16, 1988 and became effective on July 14, 1989, and replaced this rule with 45CSR2 Appendix – Compliance Test Procedures for 45CSR2. As a result of EPA's approval action published on August 11, 2002 (68 FR 47473), the provisions of the 45CSR2 Appendix replace the provisions of 45CSR-2A - TP-2 as part of the West Virginia SIP, effective 10/10/2003.]*

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45CSR2 Appendix – Compliance Test Procedures for 45CSR2

Section 1. General.

Scope. – It is the intent and purpose of this Appendix to establish stack testing procedures for

determination of compliance with the weight emission standards as set forth in 45CSR2 -- "To Prevent and Control Particulate Air Pollution From Combustion of Fuel in Indirect Heat Exchangers". To this end, it is the intent of the Division of Environmental Protection Office of Air Quality to adopt by reference, certain of the Reference Methods and other test methods set forth in 40 CFR, Part 60, Appendix A [as of July 1, 1994]. These methods set forth acceptable stack testing, calibration, and laboratory procedures including appropriate apparatus with
provisions for certain minor exceptions as delineated in Section 6 of this Appendix.

Section 2. (Reserved).

Section 3. Symbols.

3.1. Ab = (Sd) x (Va), Ab is the estimate of the wight of residue, prior to use, in the acetone wash volume used (grams)

3.2. An = cross-sectional area of the sample nozzle (ft^2)

3.3. As = cross-sectional area of the sample plane (ft^2)

3.4. ASTM = American Society for Testing and Materials

3.5. B = percent moisture in the sampled gas, by volume, on a wet basis, divided by 100

3.6. BE = the boiler thermal efficiency (percent)

3.7. C = 453.592 grams/pound

3.8. ˚C = degrees Centigrade

3.9. cfm = cubic feet per minute

3.10. CEM = continuous emission monitoring equipment

3.11. CO = carbon monoxide

3.12. CO_2 = carbon dioxide

3.13. d = diameter of nozzle (inches)

3.14. DGR = dry gas meter reading: the sample gas volume meter reading at meter conditions (cubic

feet)

3.15. $_{\Delta}$DGR = difference between two consecutive DGR's, the volume sampled at each sampling point (cubic feet)

3.16. EA = excess air fraction

3.17. F-factor = a factor representing a ratio of the dry flue gases generated to the calorific value of the fuel combusted (dscf/10^6 Btu)

3.18. Fi = quantity of each fuel fired in a fuel burning unit during the total test run period (in appropriate units)

3.19. $^{\circ}$F = degrees Fahrenheit

3.20. Fp = combined correction factor for units and pitot tube deviation

3.21. ft^3 = cubic feet

3.22. ft/min = feet per minute

3.23. gm = grams

3.24. hbd = average enthalpy of steam/water leaving boiler as blowdown (Btu/lbm)

3.25. hi = average enthalpy of steam or other working fluid entering the boiler of the fuel burning unit (Btu/lbm)

3.26. ho = average enthalpy of steam or other working fluid leaving the boiler of the fuel burning unit (Btu/lbm)

3.27. $_{\Delta}$H = pitot tube differential reading (inches H_2O)

3.28. $_{\Delta}$Hp = indicated differential pressure when the test pitot tube is used at the calibration point

3.29. $_{\Delta}$Hs = indicated differential pressure when the standard pitot tube is used at the calibration point

3.30. Hg = mercury

3.31. HI = heat input per fuel burning unit(s) (10^6 Btu per hour)

3.32. H_2S = hydrogen sulfide

3.33. HVf = higher heating value of the fuel on an as fired basis (in Btu/lbm)

3.34. HVi = average Btu value of each fuel used on an as fired basis, in appropriate units (Btu/lbm, Btu/gal, etc.)

3.35. in. Hg = inches of mercury, pressure

3.36. ISKo = overall isokinetic factor, ratio of total actual sample volume (Qm) to the total isokinetic sample volume (Qo), both volumes adjusted to standard conditions

3.37. ISKp = point isokinetic factor, ratio of the actual sample volume to the isokinetic sample volume

3.38. %ISK = 100 (ISKo - 1)

3.39. Kp = coefficient of deviation of the Type S pitot tube used in sampling, determined by calibration

3.40. Ks = coefficient of deviation for a standard pitot tube

3.41. ibf = pounds force

3.42. lbm = pounds mass

3.43. Ma = particulate matter obtained from the evaporation of the acetone washings (grams)

3.44. Mbd = average mass flow rate of blowdown (lbm/hr)

3.45. Mf = particulate matter collected by filter(s) (grams)

3.46. Mg = molecular weight of gas sample on wet basis

3.47. mf = average mass flow rate of steam through the boiler (lbm/hr)

3.48. mg = milligram

3.49. ml = milliliter

3.50. Mn = Mf + Ma - Ab (grams), indicated weight of particulate matter collected by the sampling train

3.51. n = number of items in a set of related items

3.52. N_2 = nitrogen

3.53. O_2 = oxygen

3.54. E = sum of all extraction times at all points sampled per run (min.)

3.55. Pb = atmospheric pressure (in. Hg)

3.56. Pf = ash fraction of the non-metered fuel on an as fired basis

3.57. Pm = absolute pressure of gas at meter (in. Hg)

3.58. Pm = average absolute pressure of the sampled gas at meter conditions for the test run (in. Hg)

3.59. Ps = absolute pressure of gas in stack at sampling plane

3.60. qm = actual sample volume for each sample point adjusted to 68˚F and 29.92 in. Hg (ft^3)

3.61. Qm = sum of all qm for each test run (ft^3)

3.62. qo = volume of sampled gas for each point if isokinetic conditions were maintained, adjusted to 68˚F and 29.92 in. Hg (ft^3)

3.63. Qo = sum of all qo for each test run (ft^3)

3.64. Sd = residue found in acetone blank (gm/ml)

3.65. = pi, 3.1416

3.66. Δt = elapsed time at each sampling point (minutes)

3.67. Tf = temperature of the primary out-of-stack filter holder, when used (˚F)

3.68. Tm = temperature of gas sample at volume meter for each point (˚F)

3.69. Tm = average temperature of gas sample at volume meter for test run (˚F)

3.70. Ts = stack gas temperature (˚F)

3.71. Va = volume of acetone wash (ml)

3.72. Vac = vacuum (inches of mercury)

3.73. Vm = sum of all $^{\Delta}$DGR for the test run (ft^3)

3.74. Vmstd = Vm corrected to standard conditions

3.75. w = 1 / (1 - B), ratio of wet gas volume to dry gas volume

3.76. W = Wc + Wd (grams), amount of H_2O removed from the sampled gas

3.77. Wc = amount of water collected in the condenser or impingers (grams)

3.78. Wd = amount of water collected by the drying agent in the absorber (grams)

3.79. % = percent

Section 4. Adoption of Test Methods.

4.1. For determining compliance with the mass emission rates as delineated in 45CSR2 -- "To Prevent and Control Particulate Air Pollution From Combustion of Fuel in Indirect Heat Exchangers", a person shall utilize those Reference Methods, in particular Method 5, 5B, except as modified by subsection 4.1.a. of this section, or 17, as contained in 40 CFR, Part 60, Appendix A with the following amendments:

4.1.a. Primary filter media shall be maintained at, or about, stack temperature. The temperature of the primary filter media shall not exceed that of the stack except that in cases where sampling follows a wet scrubbing device the temperature of the primary filter, initial filter tare, and oven temperature may be adjusted to a maintained temperature of up to 250 ˚F.

4.1.b. The result of each compliance test is to be the arithmetic average of three (3)complete sampling runs conducted within a seven (7) day period.

4.1.c. A complete sampling run shall be one complete determination of the total particulate matter emission rate through the test stack for which:

c.1. the minimum total sampling time is two (2) hours; and

c.2. the minimum total sample volume is sixty (60) cubic feet adjusted to 68˚F and 29.92 inches of Hg. Smaller sampling volumes and shorter sampling times may be approved by the

Director on a case-by-case basis when necessitated by process variables or other factors.

4.1.d. Any and all references in 40 CFR, Part 60, Appendix A, to the "Administrator" is amended to be the "Director".

In carrying out these methods for the purpose of determining mass emission rates, it is understood that other Reference Methods contained in 40 CFR, Part 60, Appendix A are integral parts of Methods 5, 5B, and 17 in particular, but not inclusive, Methods 1, 2, 3, and 4.

Section 5. Unit Load and Fuel Quality Requirements.

5.1. All compliance test runs, which are to be included in the test result for a unit or a specified number of units, shall be conducted while the unit or group of units is operated at or above the normal maximum operating load for the specified unit or group of units; while fuel or combinations of fuel representative of normal operation are being burned; and under such other relevant conditions as the Director may specify based on representative performance of the specified units.

Section 6. Minor Exceptions.

6.1. In the interest of practicality, the Director or his designee may allow minor exceptions, not related to test site safety, to the specifications of these methods, if the Director or his designee concludes that in a particular case, the granting of such exception would not invalidate the test results. If such exceptions are granted, alternate specifications may be prescribed.

6.2. If an exception as described above is granted, the scope of the exception and any alternative specification prescribed shall be recorded in a letter of exception signed by the authorizing official. A copy of such letter of exception shall be attached to the test report.

Section 7. Pretest and Post Test General Requirements.

7.1. The owner/operator required to conduct tests and his test consultants shall become familiar with the requirements of 45CSR2 -- "To Prevent and Control Particulate Air Pollution From Combustion of Fuel in Indirect Heat Exchangers", Reference Methods as contained in 40 CFR, Part 60, Appendix A, and the requirements as delineated in this Appendix, including all forms, equations, and definitions. Questions of interpretation, applicability, or exception, shall be resolved with the Director or his designee prior to conducting the test.

7.2. When a compliance test conducted in accordance with this Appendix is required, the owner or operator of the affected unit(s) shall be notified in writing by the Director or his designee. The notice shall prescribe the following:

7.2.a. the unit(s) to be tested;

7.2.b. the identification number to be assigned to the test;

7.2.c. the date by which the test is to be completed and the test report submitted; and

7.2.d. the person, if other than the Director, to whom the test report is to be submitted, and with whom questions concerning the test procedure may be resolved. Test report forms for filing the results of the compliance test are available from the Division of Environmental Protection on request.

7.3. At least thirty (30) days prior to each compliance test, or within such other time period as requested and approved by the Director, a test protocol shall be furnished to the Director for his review and approval and shall include as a minimum, the following information:

7.3.a. Identification and description of the unit(s) that are to be tested.

7.3.b. A discussion of the manner in which the unit(s) shall be operated during the test periods with respect to operating loads, representativeness of fuel(s) fired, operating temperatures, and other factors which may affect emissions.

7.3.c. A description or listing of unit and control equipment data that shall be monitored and recorded during the test runs.

7.3.d. A description of test methods and equipment that shall be employed with requests for approval of any variances to test method procedures or sampling equipment designs set forth under this Appendix.

7.3.e. A drawing of the stack or duct sections where samples shall be taken showing distances to upstream and downstream gas flow disturbances or bends and changes in duct or stack cross sections.

7.3.f. A drawing of the test plane(s) showing dimensions and number and location of sampling (traverse) points.

7.3.g. The sampling time at each traverse point and total sampling time for each test run. If the sampling time per traverse point is to be less than five (5) minutes, comments shall be included concerning the variability of gas flow and temperatures during the shorter sampling time and how the sampling rate shall be monitored and adjusted to maintain isokinetic conditions.

7.3.h. The minimum volume (SCF) of gas that shall be sampled per test run.

7.3.i. The name of the person to contact concerning the scheduled tests and affiliation of personnel who shall conduct the tests.

7.3.j. A copy of the last individual stack registration approved by the Director in accordance with Sub-Section 4.1 (b) of 45CSR2.

7.3.k. A statement concerning where the laboratory analyses are to be conducted and a description of the chain of custody for collected samples.

7.3.l. The anticipated date that subject testing is to be performed.

7.4. Notification of the actual dates upon which compliance testing will be conducted shall be provided to the Director, in writing, no later than fifteen (15) days prior to the date of the first test run, or within such other time period as requested and approved by the Director, so that he may, at his option, have an observer present during the test runs and sample analyses. Such notification may be submitted with the test protocol, however, the actual date of initial testing shall not be less than thirty (30) days from date of protocol submittal. Within constraints imposed by available facilities, copies of test field data sheets, laboratory sheets, unit operating logs and similar relevant data collected during the test runs shall be provided to the West Virginia Division of Environmental Protection observer upon request at the conclusion of the tests. Any such data or other information so made available shall be treated as confidential upon request by the operator and shall not be made available to the public. The owner/operator shall place the word "confidential" upon all such information which is gathered and retained by the West Virginia Division of Environmental Protection. If facilities and circumstances allow, the West Virginia Division of Environmental Protection test observer shall, at his option, observe the laboratory analyses.

7.5. A compliance test report providing the information summarized below and any additional information that the Director may require shall be submitted to the Director within sixty (60) days, or within such other time period as requested and approved by the Director, of the completion of the compliance testing.

7.5.a. General Information

a.1. Plant name and location

a.2. Units/stacks tested

a.3. Name and address of company performing the tests

a.4. Test dates and times

7.5.b. Report Certification

The following persons shall certify that the test report contains true and accurate information:

b.1. Test team supervisor

b.2. Reviewer of test report (if applicable)

b.3. If test is performed by source owner, the report shall also be certified by facility owner/operator.

7.5.c. Test Summary

c.1. Description of emissions sources/stacks tested

c.2. Purpose of test

c.3. Pollutants measured

c.4. Operating data

4.A. Unit(s) configuration and air pollution control equipment flow diagrams.

4.B. Summary of operating parameters including steam or electrical production rates and other relevant parameters measured and recorded and/or calculated for test periods shall be attached to the report.

4.C. Pertinent control equipment and operating data recorded and/or calculated for the test period should be attached to the report. As each boiler operation and associated control equipment normally presents a unique case, pertinent data shall be determined on a case-by-case basis.

4.D. Description of any unusual or non-typical operating mode, fuels, soot blowing, blowdown, etc. occurring or used during the tests.

7.5.d. Test Results

d.1. Mass emission test results with emissions reported in units of the applicable standard and in pounds per hour.

d.2. Visible emissions test results, if applicable, as measured by observer or transmissometer. If observed by personnel from test company or plant, evidence of observer's certification shall be attached to the report.

d.3. Description of collected samples (if such information is deemed to be useful).

d.4. Description and discussion of real or apparent errors involved in test or process measurements, analysis, etc.

7.5.e. Test Procedures

e.1. Description of test equipment including drawing of sampling train.

e.2. Description of test procedures employed with detailed documentation of any deviations from methods required by this Appendix.

e.3. Description of analytical procedures employed with detailed documentation of any deviations from methods required by this Appendix.

e.4. Dimensioned drawing of sampling port location showing distances to upstream and downstream gas flow disturbances.

e.5. Cross-sectional drawing of sampling plane showing location and numbers or other designations of sampling points.

7.5.f. Appendix

f.1. Copies of original field data sheets from test runs.

f.2. Copies of original log sheets, strip charts and other process or control equipment data recorded during tests. These attachments shall be certified by a responsible plant official. As each boiler operation and associated control equipment normally presents a unique case, pertinent data shall be determined on a case-by-case basis.

f.3. Laboratory report including chain of custody.

f.4. Description of test equipment calibration procedures and calibration results for test equipment used.

f.5. Description of calibration performed on devices recording important

operating data during the tests.

f.6. Copies of strip charts or other original outputs from continuous emission monitoring (CEM) equipment on the tested source and description of CEM system calibration and operation prior to and/or during tests.

f.7. Originals of any visible emission readings taken during test period.

f.8. Copies of relevant correspondence such as West Virginia Division of Environmental Protection letters approving test method variances.

f.9. Names and titles of persons involved in the test including sampling team members, company personnel, and outside observers.

7.6. Subject to the provisions of Section 6 of this Appendix, Minor Exceptions, a complete sampling run is one complete determination of the total particulate matter emission rate through the test stack for which:

7.6.a. the composite particulate matter sample is extracted from the duct or stack at a location and from the number of sampling points prescribed in Method 1 of 40 CFR, Part 60, Appendix A [as of July 1, 1994];

7.6.b. the sampling equipment and its method of operation for collection of particulate sample meets the criteria and requirements prescribed in Method 5, 5B or Method 17 of 40 CFR, part 60, Appendix A [as of July 1, 1994];

7.6.c. the overall sampling rate is within +/- 10% of the overall isokinetic sampling rate, as calculated in Method 5, 5B or Method 17 of 40 CFR, Part 60, Appendix A [as of July 1, 1994]; whichever is applicable;

7.6.d. the stack gas components data is determined as prescribed by Methods 3 and 4 of 40 CFR, Part 60, Appendix A, [as of July 1, 1994];

7.6.e. the other provisions of this Appendix are met and sufficient heat input and fuel quality data is provided to verify that the requirements of Section 8 are met; and

7.6.f. sufficient data and commentary is provided with the submitted test report forms to allow the Director or his designee to evaluate the reported test results and the conditions under which they were obtained.

Section 8. Heat Input Data Measurements.

8.1. General.

8.1.a. The data measurements required to determine the total heat input to the fuel burning unit(s) vented by the test stack during the test run period depends on the computational method applicable.

This Appendix prescribes three (3) computational methods:

Method 1H -- Fuel Use Basis

Method 2H -- Steam Balance Basis

Method 3H -- Flue Gas Analysis Basis

The test supervisor is to submit data on the heat input(s) based on the Fuel Use Basis (Method 1H) whenever coal scales or other fuel meters, as appropriate, are available.

If the appropriate fuel metering device(s) are not available, Method 2H -- Steam Balance Basis is to be used.

For all test runs also submit data on the heat input(s) based on Method 3H -- Flue Gas Analysis Basis, in addition to the data required by Method 1H or 2H, whichever is applicable.

8.1.b. The following Sub-Sections detail the specific data required for each method and the means of obtaining these data.

8.2. Fuel Use Method (1H).

8.2.a. This computational method requires:

a.1. The measured amount of all fuel(s) fired in the fuel burning units during each test run period, as determined by continuous coal scales or equivalent and/or oil flow and/or gas meter(s). When gas is fired, the temperature and pressure of the gas meter(s) are needed.

a.2. The average moisture, ash, sulfur, volatile matter, and Btu value(s) of fuels fired in the fuel burning units during the test run period is to be determined and reported as follows:

2.A. For coal:

A.1. Obtain a representative sample of the coal fired in

each fuel burning unit during the test run period. This sample is to be obtained in accordance with the Commercial Sampling Procedure of ASTM: Method D 2234-76 or its latest revision. Consult this ASTM standard for details of the required procedures. Sampling and analysis of coal entering bunkers or silos feeding the fuel burning unit to be tested is also acceptable provided that ASTM requirements are met and that such sampling/analysis properly represents the quality of the coal burned during the test periods.

A.2. Prepare the reduced gross sample, obtained above, for laboratory analysis in accordance with ASTM: Method D 2013-72, "Preparing Coal Samples for Analysis" or its later revision. Consult this ASTM standard for details of the required procedure. In this ASTM method, further amplification is given to the methods of reducing the gross sample to a laboratory sample and preparing the laboratory analysis. The laboratory sample is so prepared that 100% of the coal sample shall pass through a No. 60 (250 micron) sieve. The final product is thoroughly mixed prior to extracting analytical samples.

A.3. Extract an analytical sample from the laboratory sample and determine the moisture, ash, and volatile matter content of this sample in accordance with ASTM Method D 3173-73 or ASTM Method D 2961-87 (Moisture), ASTM D3174-82 (Ash), and ASTM D175-82 (Volatile Matter) or their latest revisions. Consult these ASTM standards for details of the required procedures. In these ASTM methods, procedures are prescribed for determining the moisture, ash, and volatile content of the sample.

A.4. Extract another analytical sample from the laboratory sample and determine the Btu content of the sample in accordance with ASTM: Method D2015-77 "Gross Calorific Value of Solid Fuel by the Adiabatic Bomb Calorimeter" or its latest revision. Consult this ASTM standard for details of the required procedure.

A.5. Extract another analytical sample from the laboratory sample and determine total sulfur content of the sample in accordance with ASTM Method D 3177-75 "Test for Total Sulfur in the Analysis Sample of Coal and Coke" or ASTM Method D 4239-85 or their latest revisions. Consult these ASTM standards for details of the required procedures.

A.6. Send a sealed and marked one pint sample of the laboratory sample representative of the gross sample, to the Director with the test report. If drying was used in reducing the gross sample to the laboratory sample, indicate the percent loss of moisture during this process. For each container provide the test identification number assigned by the West Virginia Division of Environmental Protection in accordance with Sub-Section 7.2.b of this Appendix and the test run number.

2.B. For Fuel Oils: Determine the supplier's name and address, and the specifications for the oil supplied. Use the supplier's specifications when available for the ash

content and Btu value of the oil.

When such specifications are not available, determine the grade of oil fired, by referring to any Standard Engineering Handbook. As such the Handbook and appropriate edition should be properly identified, for inclusion as part of any results submitted to the agency for the ash, sulfur and Btu values. Send an eight ounce, sealed and marked, sample of the oil fired during the test to the Director with the test report.

2.C. For Natural Gas:

Determine the supplier's name and address, and the specification of the natural gas supplied. Use the supplier's specification for the Btu value of the fuel. Ash may be considered negligible.

2.D. Other Fuels:

Determine the name and address of the supplier(s) or producer(s) of any other materials fired during the test run period.

Determine the source(s) of the fuel(s). Use the supplier(s)'/producer(s)' specifications for the ash, sulfur, and Btu value. When such specifications are not available, resolve with the Director or his designee, the method which shall be used to determine these values, prior to conducting the test. Submit an appropriate small sample of the fuel fired, if other than a gas, to the Director in a sealed and marked sample container.

8.3. Steam Balance Method (2H).

This method requires a materials balance and inlet and outlet water/steam or other media pressure and temperature data during the test run period, for the boiler(s) of the fuel burning unit(s) vented by the test stack.

8.3.a. Measure the mass flow rate of all water/steam or other media flowing through each boiler, including blowdown.

8.3.b. Measure the inlet and outlet pressure and temperature of each water/steam circuit, including blowdown.

8.3.c. Construct a flow diagram of the water/steam or other media flow circuit(s) on Form THI-II (2H). Record the measured data on this form, indicating the data points on the diagram.

8.3.d. Determine the boiler manufacturer's name and address, and the boiler type and model number. From the manufacturer's specification, determine the boiler(s) thermal efficiencies. If

such specifications are not available, describe in detail the basis and method of selecting the value used.

8.4. Flue Gas Analysis Method (3H).

8.4.a. This method involves determining the heat input for the boiler(s) of the fuel burning unit(s) vented by the test stack utilizing:

a.1. appropriate F-factors as contained in 40 CFR, Part 60, Subpart D [as of July 1, 1994]; and

a.2. total volume of stack gas discharged through the stack during the test run; and

a.3. the average excess air discharged [O_2% or CO_2%] through the test stack during the test run period.

8.4.b. Appropriate F-factors are to be obtained from 40 CFR, Part 60, Subpart D [as of July 1, 1994], unless carbon content of fly ash or bottom ash exceeds five (5) percent on a per weight basis. In these cases, consult the Director or his designee prior to conducting the test to determine and resolve a suitable F-factor adjustment.

8.4.c. Total Volume of Stack Gas.

The total volume of stack gas is determined from:

c.1. volume meter readings obtained during subject test run and recorded on Form TD: Test Run Data Sheet for each test run.

8.4.d. Stack Excess Air.

d.1. For low nitrogen content fuel(s) (coal, fuel oil, natural gas), the stack excess air can be computed from the data obtained from the Orsat analysis and recorded on Form TOA Laboratory Data Sheet (Orsat) for each test run. If blast furnace gas, producer gas, or other fuel(s) of high nitrogen content are used, consult the Director or his designee prior to conducting the test to determine and resolve a suitable method of determining the excess air when such fuel(s) is burned.

Section 9. Computations and Data Analysis.

This section prescribes the computational method to be used in computing the particulate matter stack emission rate for the test and evaluating the supporting test data. Perform the computations and

analysis prescribed in this section for the data obtained from each test run which is to be part of the submitted test results. Record the measured data and the appropriate computations on the designated test report forms, which may be obtained from the Director upon request. Submit sufficient commentary with the test report data to fully describe the conditions under which the data was obtained and any factors which might affect the evaluation of the test results.

9.1. Particulate Matter Sample Weight Determination. (Form TLP -- Laboratory Data Sheet (Particulate)).

Mf = particulate matter (grams) collected by the primary filter, including any prefilter if used

Ma = particulate matter (grams) obtained from the evaporation of the acetone washings of the internal sampling train surfaces exposed to the particulate sample prior
to the primary filter

Ab = particulate matter residue (grams) in the volume (Va) of acetone wash used for Ma above, as determined by the acetone blank analysis [i.e. , Ab = (Sd)(Va); where Sd equals the residue found in the acetone blank analysis in gm/ml, and Va equals the volume of acetone used in the acetone wash for Ma above]

Mn = Mf + Ma - Ab = the indicated weight of particulate matter collected, in grams

9.2. Moisture Determination. (Form TLH: Laboratory Data Sheet -- Moisture; Forms TD; Test Run Data Sheet).

Record all measured and calculated data on the appropriate forms. Compute and record the following:

Vm = (ft[3]) the sum of all $_{\Delta}$DGR for the run, where $_{\Delta}$DGR is equal to the indicated amount of gas sampled at each point during the extraction interval

Tm = (˚F) average temperature of the dry gas meter during the test run. Tm = average dry gas meter temperatures (˚F) at each sampling point.

Pm = (in. Hg) average absolute pressure at the dry gas meter during the test run. Pm = the average absolute pressure at the dry gas meter for each sample point,
where, Pm = Pb - Vac; Pb = barometric pressure, Vac = meter vacuum.

Wc = amount of water collected in condenser or impingers (grams)

Wd = amount of water collected by the drying agent used after the condenser or impingers (grams)

W = Wc + Wd (grams)

B = percent moisture in the sampled gas by volume on a wet basis, divided by 100

$$B = W \Big/ \left| \frac{374\ Pm\ Vm}{Tm + 460} + W \right|$$

w = moisture correction factor; ratio of the volume of wet sample gas to the volume of dry sample gas

$$W = 1/ (1 - B)$$

9.3. Sample Gas Density and Excess Air Determination. (Form TOA -- Laboratory Data Sheet (Orsat)).

9.3.a. Gas Density.

a.1. Record the Orsat analysis for all three runs on Form TOA (Laboratory Data Sheet) on lines 1 through 9. Compute and record the average value of CO_2, O_2, CO and N_2 for each run on line 10 or the value of these components of the composite sample, if obtained (optional), on line 11.

a.2. Transcribe the values of w (moisture correction factor) from Form TLH to Form TOA in blocks 12 for each run. Transcribe the values of B, the percent water (wet basis) from Form TLH to Form TOA in column 13, line 14, for each run.

a.3. Correct the average component volumetric percentages, dry basis (line 10), to volumetric fractions (wet basis), by dividing by 100w and enter these values on line 14 for each test run.

a.4. Multiply each of these volumetric fractions (wet basis -- line 14) by the corresponding molecular weights on line 15 and enter the values on line 16.

a.5. Enter the sum of the values on line 16 for each run in the appropriate box on line 17, the apparent molecular weight of the wet gas (Mg).

a.6. Determine the wet gas density for each run by dividing the molecular weight for the run (on line 17) by the number 29 and enter this quotient in the appropriate

box on line 18.

9.3.b. Excess Air.

Compute and record the excess air fraction for each run using the average dry gas analysis from line 10 and the formula shown on line 20. Record excess air fraction (EA) in the appropriate box on line 19.

Note: The excess air fraction equation present on line 20 of Form TOA is not applicable when producer gas, blast furnace gas or other fuels high in nitrogen content are used.

9.4. Actual Sample Gas Volume Determination. (Form TD: Test Run Data Sheet).

9.4.a. For each point sampled during the run compute the actual volume drown through the sampling nozzle adjusted to standard conditions of 68˚F and 29.92 inches of Hg as indicated below:

qm = Actual sample volume (in cubic feet) drawn through the sampling nozzle for each sampled point adjusted to 68˚F and 29.92 inches of Hg.

$$qm = (_{\Delta}DGR)(w) \times \frac{528}{(Tm + 460)} \times \frac{Pm}{29.92}$$

where:

$_{\Delta}$DGR, w, Tm, and Pm are defined in Sub-Section 9.2 of this Section and are recorded on Form TD.

9.4.b. Record the computed values of qm for each sampled point on the appropriate line of the column labeled qm on Form TD. Sum the values of qm for all points included in the run and enter this value (Qm) in the block so labeled.

9.5. Isokinetic Sample Volume Determination. (Form TD: Test Run Data Sheet).

9.5.a. For each point samples during the run, compute the volume of sample gas (adjusted to 68˚F and 29.92 inches of Hg) that would have been drawn through the sampling nozzle if isokinetic conditions were maintained, as indicated below:

qo = Isokinetic sample volume, the volume of sampled gas (in cubic feet) for each sampled point, if isokinetic conditions were maintained, adjusted to standard conditions of 68˚F and 29.92 inches of Hg. For conditions where static pressure in the duct or stack being tested is more than 20 in. H_2O, consult

with Director or his designee.

$$qo = 60(528)\,(Fp)\,(An)\left(\frac{\Delta H}{Ts + 460}\right)^{.5} \times \Delta t$$

where:
Fp = combined correction factor for units and Pitot tube deviation:

Standard tube = 2.90 (units) x 1.00 (deviation) = 2.90
Type S tube = 2.90 (units) x 0.83* (deviation) = 2.41

* The deviation for the Type S tube may vary for different sampling configurations and should be determined by calibration against a standard pitot tube for each Pitobe arrangement per Method 2 of 40 CFR, Part 60, Appendix A [as of July 1, 1994].

An = the cross-sectional area of the sampling nozzle in (ft^2)
ΔH = Pitot tube differential reading** in inches of H_2

** If the particular pitot tube differential indicator used is calibrated to give a reading of the square root of ΔH ($\sqrt{\Delta H}$), change the heading of the "ΔH" column on Form TD to $\sqrt{\Delta H}$ and modify your computations for qo as appropriate.

Ts = Average stack gas temperature (in ˚F) at each sampled point during the extraction time at that point.

Δt = elapsed time at each sampling point (minutes)

9.5.b. Record the computed values of qo for each sampled point on the appropriate line of the column labeled qo on Form TD. Sum the values of qo for all points included in the run and enter this value (Qo) in the block so designated.

9.6. Fractional Isokinetic Rate Determination. (Form TD: Test Run Data Sheet).

9.6.a. For each point sampled during the run, compute the point isokinetic factor (ISKp), which indicates the average degree of deviation from isokinetic conditions during the sampling (extraction) time at that point. ISKp is computed as follows:

ISKp = the point isokinetic factor, the ratio of the actual sample volume to the isokinetic sample volume, both volumes adjusted to standard conditions of 68˚F and 29.92 inches of

Hg

$$ISKp = \left| \frac{qm}{qo} \right|$$

where:

qm is defined in Sub-Section 9.4 and qo is defined in Sub-Section 9.5 of this Appendix, both values are recorded for each point on Form TD.

9.6.b. Record the computed value of ISKp for each sampled point on the appropriate line of the column labeled ISKp on Form TD. The value of ISKp for each sampled point should not vary greatly from the overall isokinetic factor (ISKo).

9.6.c. For each run, compute the overall isokinetic factor (ISKo), which indicates the overall degree of deviation from isokinetic conditions during the run, and which is used in the weight emission rate computations of the next section. ISKo is computed as follows:

ISKo = the overall isokinetic factor, the ratio of the total actual sample volume to the total isokinetic sample volume, both volumes adjusted to standard conditions of 68˚F and 29.92 inches of Hg.

$$ISKo = \left| \frac{Qm}{Qo} \right|$$

where,

Qm is defined in Sub-Section 9.4 and Qo is defined in Sub-Section 9.5 of this Appendix, both values are recorded for each run on Form TD.

9.6.d. Record the computed value of ISKo for each run in the block so designated on Form TD. If the value of ISKo is outside the range of 0.9 to 1.10, reject the run result.

9.6.e. Compute the value %ISK as follows: retain the sign and record on Form TR-II: Summary of Test Run Results.

%ISK = 100 ISKo - 1

9.7. Particulate Matter Emission Rate Determination. (Form TD: Test Run Data Sheet, Form TR-II: Summary of Test Run Results).

The particulate matter emission rate for each run is computed from the following equation:

$$M(P)n = \frac{Mn}{C} \times \frac{As}{An} \times \frac{60}{\theta} \times \frac{1}{ISKo}$$

where,

M(P)n = the particulate matter emission rate (in pounds per hour) for the test run

Mn = Mf + Ma - Ab indicated weight of particulate matter (in grams) collected by the sampling train.

C = 453.592 grams/pound

As = the cross-sectional area of the sampling plane (ft^2)

An = the cross-sectional area of the sampling nozzle (ft^2)

60 = 60 minutes per hour

θ = the sum of all extraction times at all points sampled per run (the sum of $_{\Delta}$t's). The total sampling time, not including movement time from port to port.

ISKo = Qm/Qo = the overall isokinetic factor for the run. The ratio of total actual volume sampled to the total isokinetic volume, both values adjusted to 68˚F and 29.92 inches of Hg on a wet basis.

The values of Mn, As, An, θ and ISKo for each run are recorded on Form TD: Test Run Data Sheet.

Record the value of M(P)n for each test run on Form TR-II: Summary of Test Run Results.

9.8. If more than one sampling plane was required to evaluate the total stack emission rate, perform the computation specified in 9.7 of this Appendix for each sampling plane, then sum the values of M(P)n for all sampling planes used. Record the total emission rate for each run (all sampling planes) on Form TR-II as above, then compute the average stack emission rate for the test. Note the number and designations of the sampling planes used under comments. If more than one sampling train was used simultaneously to sample the required number of sampling points at one sampling plane, the values of Mn, Qm, and Qo are the sum total values for all
the sampling trains used for the one sampling plane.

9.9. Heat Input Determinations. (Forms THI-II: Heat Input Data Sheets: Form TOA; Laboratory Data Sheet (Orsat); Form TR-II: Summary of Test Run Results).

9.9.a. This Sub-Section prescribes three (3) methods of computing the total heat input to the (similar) fuel burning unit(s) vented by the test stack:

Method 1H -- Fuel Use Basis
Method 2H -- Steam Balance Basis
Method 3H -- Flue Gas Analysis Basis

Submit data and computations on the appropriate forms.

9.9.b. Summarize the results of the selected computational methods on Form TR-II: Summary of Test Run Results for each run. Record the type units tested (see definitions for type), the total number of similar units associated with the test run results, the two values of the total heat input for all the units associated with the test run results, as computed by the two selected methods, the total design heat input and the total maximum normal operating load for the units associated with the test result (see definitions for the heat input terms).

9.10. Method 1H -- Fuel Use Basis.

9.10.a. From the data obtained in accordance with Sub-Section 8.2, Heat Input Data Measurements, compute the heat input for each fuel burning unit for which this method is to be used, as follows:

$$HI = \frac{60}{\theta} \sum_{i=1}^{n} \frac{(Fi \times HVi)}{10^6}$$

where:

HI = Heat input per fuel burning unit(s) in 10^6 Btu per hour

Fi = The quantity of each fuel fired in this fuel burning unit during the total test run period (θ) in appropriate dimension units (e.g., pounds, gallons, SMCF)

HVi = The average Btu value of each fuel used, in appropriate dimensional units related to the Fi units (e.g., Btu/lb, Btu/gal, Btu/SMCF), on an as fired basis

θ = The total test run period in minutes. The sum of all extraction intervals ($_{\Delta}t$)

n = The number of different fuels fired in the fuel burning unit during the test run period

NOTE = When more than one fuel burning unit is vented by the test stack, sum the individual heat input values for all units of the same type vented by the test stack to obtain the total heat input for the test.

9.10.b. Record the values used in the computations, and the results on Form THI-II (1H)

9.11. Method 2H -- Steam Balance Basis.

9.11.a. From the data obtained in accordance with Sub-Section 8.3 of this Appendix, compute the heat input for each fuel burning unit for which this method is to be used, as follows:

$$HI = \frac{mf\ (ho - hi) + Mbd\ (hbd)}{10^4\ (BE)}$$

where:

HI = Heat input per fuel burning unit in 10^6 Btu per hour

ho = Average enthalpy of steam/water or other media leaving the boiler of the fuel burning unit in Btu/lbm

hi = Average enthalpy of steam/water or other media entering the boiler of the fuel burning unit in Btu/lb

mf = Average mass flow rate of steam/water or other media through the boiler in lbm/hour

Mbd = Average mass flow rate of blowdown in lbm/hour

hbd = Average enthalpy of steam/water or other media leaving the boiler as blowdown in Btu/lbm

BE = The boiler thermal efficiency (percent)

NOTE: The enthalpy values for the above equation can be determined from the inlet and outlet temperatures and pressures of the steam/water or other media flowing through the boiler using appropriate steam tables.

9.11.b. Record the steam flow, temperatures, pressures, and enthalpy values on the steam/water or other media circuit flow diagram required on Form THI-II (2H). Also record the necessary calculations and results on Form THI-II (2H) or attached sheet(s). Sum the heat input values of all fuel burning units of the same type vented by the test stack.

9.12. Method 3H -- Flue Gas Analysis Basis:

9.12.a. From data obtained in accordance with Sub-Section 8.4 of this Appendix, compute the heat input for each fuel burning unit for which this method is to be used, as follows:

$$HI = \frac{V_{mstd} \times \frac{As}{An} \times \frac{20.9 - \%O_2}{20.9}}{\text{F-factor} \times \frac{\theta}{60}}$$

where:

HI = Heat input per fuel burning unit in 10^6 Btu per hour

V_{mstd} = Volume of gas sample measured by the dry gas meter during run corrected to standard conditions of 68˚F and 29.92 inches Hg.

As = Cross-sectional area of the sampling plane (ft^2)

An = Cross-sectional area of the sampling nozzle (ft^2)

$\%O_2$ = Percent oxygen content by volume as taken from Orsat analysis on Form TOA

F-factor = a factor representing a ration of the dry flue gases generated to the calorific value of the fuel combusted (dscf / 10^6 Btu), See 40 CFR, Part 60, Subpart D

θ = Sum of all extraction time at all points sampled per run (minutes)

9.12.b. Record V_{mstd}, $\%O_2$, F-factor, and ~ on Form THI-II (3H). Record calculations.