NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

NEW JERSEY ADMINISTRATIVE CODE

TITLE 7, CHAPTER 27B

SAMPLING AND ANALYTICAL PROCEDURES

SUBCHAPTER 1. SAMPLING AND ANALYTICAL PROCEDURES FOR

DETERMINING EMISSIONS OF PARTICLES FROM MANUFACTURING

PROCESSES AND FROM COMBUSTION OF FUELS

Adopted:	
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7:27B-1.1   Definitions

The following words and terms, when used in this subchapter, shall have the following meanings, unless the context clearly indicates otherwise. Terms not defined in this section are intended to be used as defined in the New Jersey Air Pollution Control Act, N.J.S.A. 26:2C-1 et seq., and Chapter 27 in Title 7 of the New Jersey Administrative Code, or are used in their common engineering or scientific sense. Symbols and nomenclature are defined in Appendix 6.

"Bureau" means the Bureau of Air Pollution Control.

"Department" means the Department of Environmental Protection.

"Equivalent diameter" means the diameter of a circular cross section having the same area as a noncircular cross section.

"Performance test" or "test" means a series of test runs used for the purpose of determining emissions of air contaminants to the outdoor atmosphere.

"Run" or "test run" means a single integrated measurement or procedure used for the purpose of collecting a sample of air contaminants emitted to the outdoor atmosphere during a specified time interval.

"Sample collector" means any device used to selectively separate and collect a sample of a specified contaminant from a gas stream, including, but not limited to, thimbles, filters, impingers, bubblers, cyclones, condensers and absorbers.

"Sampling location" means the specific position at which a sampling port is located in a stack or chimney.

"Sampling port" means an opening in a stack or chimney into which sampling or measuring devices may be inserted or through which a sample is extracted.

"Sampling rate" means the volume rate which stack gases are drawn through a sampling train.

"Sampling train" means a combination of entrapment devices, instruments, and auxiliary apparatus arranged in a prescribed sequence to selectively separate and collect samples of specified air contaminants.

"Sampling velocity" means the linear velocity at which stack gases are drawn through the nozzle of a sampling train.

"Stack gas velocity" means the linear velocity (in the direction of gas flow) at which stack gases pass the sampling train nozzle.

"Standard conditions" means 70 degrees Fahrenheit and one atmosphere pressure (14.7 psia or 760 mm Hg).

"Traverse point" means a predetermined point at which a sample or measurement is obtained inside a stack or chimney.

7:27B-1.2   Acceptable Test Methods

(a)   Because of size and/or inertial effects on the particles to measured, they are to be collected under isokinetic conditions to ensure that the sample is representative. With isokinetic sampling, that portion of the gas stream from which the particles are entrapped is made to enter the sampling nozzle in the same direction and at the same velocity as the gas stream in the stack or chimney being sampled. The sample weight is determined gravimetrically after removal of uncombined water.

(b)   Performance tests shall be conducted in accordance with test methods set forth hereinafter. Alternate test procedures, equipment and/or materials of construction may be used subject to prior approval and/or conditions prescribed by the Department. The Department may itself employ such alternates when warranted by test conditions or other circumstances.

7:27B-1.3   Operating Conditions During the Test

Insofar as practical, the source operation will be tested while operating at normal, routine conditions and, as necessary, at other conditions including, but not limited to, design, maximum and fluctuating rates and during sootblowing. For test purposes, sootblowing operation will be preceded by a time interval of non-sootblowing which is equal to the normal non-sootblowing time period as determined by inspection of plant records or other sources of information available to personnel of the Department.

7:27B-1.4   Sampling Facilities to be Provided by the Person Responsible for Emissions

(a)   The owner or operator of the source operation to be tested shall be responsible for providing the following testing facilities upon request by the Bureau.

1.   Sampling ports installed at locations specified by the Bureau and of a size large enough to accommodate the sampling equipment.

2.   Safe sampling platform(s) and safe access thereto conforming with laws and regulations concerning safe construction and safe practice (Reference 1).

3.   Utilities as needed for sampling and testing equipment. This may include electrical power and water.

4.   Any other facilities exclusive of instrumentation and sensing devices as may be necessary for the Bureau to accurately determine the emission of particles from the source operation.

5.   Facilities as necessary for representative sampling of fuel and determination of the amount being burned during the test run.

6.   The facilities installed may be either permanent or temporary, at the discretion of the person responsible for their provision.

7:27B-1.5   Sampling Train

The sampling train normally used by the Department is shown on page 1 of Appendix 1 and shall consist of the following:

(a)   A sampling nozzle (A)* made of stainless steel (316) and having a sharp, tapered leading edge. Its internal diameter shall be of an appropriate size to permit a sampling rate that is as close as possible to 0.75 CFM at isokinetic conditions;

(b)   A glass-lined stainless steel probe (B)* with a heating system capable of maintaining the temperature of the sample gas passing through it sufficiently high to prevent condensation of water from occurring and a temperature sensor (T_1)* to indicate the sample gas temperature.

(c)   A high-vacuum hose (C)* with a smooth, inert inner wall and with a heating system capable of maintaining the temperature of the sample gas passing through it sufficiently high to prevent condensation of water from occurring, and a temperature sensor (T_2)* to indicate the sample gas temperature. In lieu of this hose, direct coupling of the probe (B)* and the glass cyclone and filter assembly $(D_1$ and $D_2)$* may be used.

(d)   A sample collector consisting of a glass cyclone (D_1)* followed by a glass fiber filter (Reeve-Angel 934AH**, MSA 1106BH** or approved equivalent) in a glass holder (D_2). The cyclone and filter assembly shall have a heating system (D)* capable of maintaining the temperature of the sample gas passing through it sufficiently high to prevent condensation of water from occurring, and a temperature sensor (T_3)* to indicate the sample gas temperature. The use of the cyclone is optional when it is not necessary to prevent the filter from being overloaded by large particles.

(e)   A condenser system (E)* consisting of a Greenburg-Smith impinger (E_1)* containing 100 ml. distilled water followed by a modified Greenburg-Smith impinger (E_2) *(dry) for mist knockout, both immersed in an ice bath.

(f)   A drying tube (F)* containing Drierite** or silica gel.

(g)   A hose (G)* capable of holding a vacuum of at least 15 inches of mercury.

(h)   A leak-free pump (H)* with coarse (H_1)* and fine (H_2)* flow control adjusters and vacuum gauge (P)*.

(i)   A dry gas test meter (I)* accurate within two percent and temperature sensors (T_4)* to indicate the sample gas inlet and outlet temperatures.

(j)   An orifice meter (J)* with an inclined manometer (M_2)* as described in APCO Publication APTD-0581 (Reference 2).

(k)   A thermocouple (K)* attached to the probe (B)* with its sensing portion adjacent to the sampling nozzle (A)* and equipped with a temperature sensor (T_5) to indicate the stack gas temperature.

(l)   An "S" type pitot tube (L)* attached to the probe (B)* with its sensing portion adjacent to the nozzle and equipped with a differential pressure gauge (M_1)* (inclined manometer or equivalent)

to measure velocity head to within ten percent of the minimum value as determined during the preliminary traverse.

(m)   All glassware (cyclone, filter holder and impingers) should be interconnected with glass fittings having ball joints.

NOTES:

1.   When tests are performed to determine actual or potential emission rates, all outlets will be sampled simultaneously. When tests are performed to determine the efficiency of air pollution control apparatus, each inlet to and outlet from the control apparatus must be sampled simultaneously.

2.   All measuring devices including, but not limited to, pitot tubes, meters, gauges and thermocouples shall be properly calibrated and maintained to provide accurate data.

*See Appendix 1.

**Trade name.

7:27B-1.6   Performance Test Principle

For purposes of measuring emissions in accordance with applicable provisions of the rules of the Bureau of Air Pollution Control, particles shall be drawn by isokinetic procedures from the stack or chimney and the weight of the particles determined gravimetrically after removal of uncombined water. The measured emission weight shall be the combined weight of all particles collected and analyzed in accordance with this sampling and analytical procedure.

7:27B-1.7   General Testing Requirements

All tests shall be conducted in accordance with the following:

(a)   The sampling location and number of traverse points shall be determined by EPA Method 1 (Reference 3) or ASME Power Test Code PTC-27 (Reference 4), or Western Precipitation Bulletin WP-50 (Reference 5), or ASTM Standard D2928 (Reference 6).

(b)   Determination of stack gas velocity shall be by EPA Method 2 (Reference 3) or ASME Power Test Code PTC-27 (Reference 4), or Western Precipitation Bulletin WP-50 (Reference 5), or ASTM Standard D2928 (Reference 6).

(c)   Unless otherwise specified by the Department, each performance test consists of not less than three separate and valid one-hour test runs.

(d)   For the purpose of determining compliance with any applicable standard, the results of each valid test run (see Section 1.14 of this Subchapter) shall be considered.

7:27B-1.8   Required Test Data

Test data to be determined and reported for each test run must include the following (see Appendix 5 for recommended reporting form):

(a)   Average dry gas meter temperature (degrees Fahrenheit) during each test run.

(b)   Average stack temperature (degrees Fahrenheit) during each test run.

(c)   The root mean square value of differential pressures (inches of water) of all traverse points in the stack during each test run.

(d)   Average differential pressure (inches of water) across the orifice meter during each test run.

(e)   Equivalent diameter (inches) of the stack cross-sectional area at sampling location.

(f)   Weight (grams) of total solid particles collected (see subsection 1.12(a)6) during each test run.

(g)   Percent of moisture by volume in stack gas during each test run, as determined by the procedure described in EPA Method 5 (Reference 3).

(h)   Volume of gas (cubic feet) sampled at meter conditions during each test run.

(i)   Source gas emission rate (standard cubic feet per minute) less dilution gas.

(j)   The potential emission rate (pounds per hour) during each test run, when necessary.

(k)   Emission rate to the atmosphere (pounds per hour) during each test run.

(l)   Percentage of CO_2, CO, O_2 and N_2 by Orsat analysis of the stack gas being sampled.

(m)   Molecular weight (M_s) of the stack gas. Sample may be obtained by EPA Method 3 (Reference 3) and calculated by the formula in subsection 1.13(f).

(n)   When necessary, heat content, type, quantity and heat input rate (millions of BTU per hour) of fuel burned during the test run.

NOTE:

Field notes, laboratory notes and calculations must be included with test reports submitted to the Department.

7:27B-1.9   **Preparation for Sampling**

(a)   Each filter is assigned a control number for identification. The filter is dried in an oven at 220-230 degrees Fahrenheit, cooled in a desiccator to room temperature and then weighed on an analytical type balance to the nearest 0.1 mg. The cycle shall be repeated as many times as necessary to attain a constant weight, which is then recorded. The filter is then placed in a Pyrex** glass filter holder with the openings sealed with clean rubber stoppers.

(b)   The internal surfaces of the nozzles, probe, hose, cyclone, impingers and all connecting glassware shall be cleaned and dried. The openings shall be sealed with clean rubber stoppers.

(c)   The drying tube shall be filled with sufficient Drierite** or silica gel to remove the moisture from the gas stream being sampled. Normally, 200-300 grams will serve the purpose. The drying tube plus the desiccant is weighed to the nearest gram, sealed immediately with clean rubber stoppers and marked for identification. The total weight is recorded.

(d)   Assemble the sampling train (after selecting the proper sampling nozzle) in accordance with the drawing (Appendix 1).

(e)   Place 100 ml. of distilled water in the Greenburg-Smith impinger (E_1). Place crushed ice around the impinger(s) prior to the start of the test run and add more ice as necessary during the test runs.

(f)   Check the sampling train for leaks before each run by plugging the nozzle and pulling a 15-inch mercury vacuum. A leakage rate of no more than 0.02 CFM is acceptable.

(g)   Activate the heating systems of the probe, hose, cyclone and filter so that the internal gas is at the proper temperature (subsections 1.5 (b), (c) and (d)).

**Trade name.

7:27B-1.10   **Sampling**

(a)   To begin sampling, position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Record the dry gas meter volume at the beginning of the test run. Immediately start the vacuum pump and adjust the flow to isokinetic conditions. Sampling time should be equal for each point.

(b)   Stack temperature, meter temperatures and differential pressures (as measured by the pitot tube and the orifice meter) during sampling shall be recorded for each sample point.

(c)   At the conclusion of the test run, turn off the pump and record the final dry gas meter volume. After deactivating the heating systems, remove the probe and nozzle from the stack and handle in accordance with the sample recovery procedure described below (Section 1.11).

(d)   When necessary, a representative sample of the fuel being burned during the test run will be taken. The sample will be placed into an appropriate container which is to be sealed and marked for identification.

7:27B-1.11   Sample Recovery

(a)   Exercise care in removing the sample to avoid loss of collected sample or gain of extraneous particles.

(b)   Remove the filter holder (D$_2$) *, reseal the openings with clean rubber stoppers and complete marking for identification.

(c)   Remove the drying tube (F)*, reseal the openings with clean rubber stoppers and complete marking for identification.

(d)   Remove the impingers (E$_1$ and E$_2$)*, reseal the openings with clean rubber stoppers and complete marking for identification.

(e)   Wash all sample-exposed surfaces between the nozzle and the glass fiber filter holder, including the cyclone and the flask, with acetone. Use a razor blade, brush or rubber policeman to dislodge adhering particles. Place all loose particles and acetone wash in a clean sample bottle, seal and label for identification.

(f)   Place about 100 ml. of acetone from the same container used for the wash in a separate clean sample bottle, seal and label for identification (acetone blank).

*See Appendix 1.

7:27B-1.12   Analysis

(a)   Record the data required on the laboratory report form (see Appendix 2 for recommended report form). Handle each sample as follows:

1.   Transfer the filter and any loose particles from the glass holder (D$_2$)* to a tared weighing dish, dry and desiccate to a constant weight (as in preparation). Report results to nearest 0.1 mg.

2.   Wash the glass holder (D$_2$) * (for filter) with acetone and add to the acetone wash sample bottle (subsection 1.11(e)).

3.   Measure the volume of water in the impingers to the nearest 1.0 ml. and record.

4.   Measure the volume of the acetone wash (subsection 1.11(e)) in ml., then evaporate to dryness at 70 degrees Fahrenheit and one atmosphere in a tared beaker, heat to 220-230 degrees Fahrenheit, desiccate at room temperature and weigh to a constant weight. After adjusting for the blank, the results are reported to the nearest 0.1 mg.

5.   Weigh the drying tube to the nearest gram after removing the seals and record the weight. Each gram of increased weight equals one ml. of volume equivalent of water. This volume plus the volume collected in the impingers (subsection 1.11(d)) represents the total moisture in the gas sampled and is used to determine the percent moisture in the stack gas.

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6. The total weight of particles collected is the sum of the weights of particles as determined in subsections 1.12(a)1 and 1.12(a)4.

  (b) For a liquid fuel:

    1. Determine the higher heating value (BTU per pound) by ASTM Standard D240 (Reference 7).

    2. Determine the sulfur content (percent by weight) by ASTM Standard D1552 (Reference 8).

    3. Determine the viscosity (Saybolt Universal Seconds at 100 degrees Fahrenheit) by ASTM Standard D88 (Reference 9)

  (c) For a solid fuel:

    1. Determine the higher heating value (BTU per pound) by ASTM Standard D271 (Reference 10).

    2. Determine the sulfur content (percent by weight) by ASTM Standard D271 (Reference 10).

*See Appendix 1.

7:27B-1.13   Calculations

  (a) Percent moisture by volume in stack gas is determined by the formula:

$$\text{Percent moisture} = \frac{V_v}{V_v + V_m} \times 100$$

$$\text{Where}: V_v = 0.00267 \times \frac{V_w (T_m + 460)}{\left(P_b + \dfrac{\Delta H}{13.6} \right)}$$

  (b) Average flue gas velocity ($\hat{a}_s$) for a test run is calculated by equation 3 of Appendix 4, using average Ts and ΔP.

  (c) The average percent isokinetic sampling rate for a test run is calculated by equation 7 of Appendix 3, using $\hat{a}_s$ and arithmetic averages for Ts, Tm and ΔH.

  (d) Emission rate (E) for a test run is calculated by equation 8 of Appendix 4, using $\hat{a}_s$ and arithmetic averages for Ts, Tm and ΔH.

  (e) Heat input rate is calculated in millions of BTU per hour by multiplying the higher heating value of the fuel by the fuel combustion rate (in consistent units) and dividing the product by 1,000,000.

(f)   Molecular weight of the stack gas is calculated from Orsat data and moisture content by the formula:

$M_s = (1-Q) \times [(44 \times \% \ CO_2**) + (28 \times \% \ CO**) + (32 \times \% \ O_2**) + (28 \times \% \ N_2**)] + 18 \times Q$

**Percent expressed as decimal fraction.

(g)   Specific gravity of flue gas (Gd) equals the ratio of the molecular weight of the stack gas to the molecular weight of air (28.95), **where:**

$$G_d = \frac{M_s}{28.95}$$

7:27B-1.14   Validation of Test

Any test run during which the average percent isokinetic sampling rate (Appendix 3) is less than 90 percent or greater than 110 percent shall not be valid.

REFERENCES

(1)   New Jersey Administrative Code, Title 5, Chapters 115, 116 and 180, are available from the Department of Labor and Industry, Bureau of Engineering and Safety, Post Office Box 709, Trenton, New Jersey 08625. (Chapter 115 is $1.00, Chapter 116 is free, Chapter 180 is $0.50).

(2)   APCO Publication No. APTD-0581-"Construction Details of Isokinetic Source-Sampling Equipment", is available from the Office of Technical Information and Publications, Air Pollution Control Office, US Environmental Protection Agency, PO Box 12055, Research Triangle Park, North Carolina 27709. (Free).

(3)   "Federal Register", Volume 36, Number 247, Part II, December 23, 1971, is available from the Superintendent of Documents, US Government Printing Office, Washington, DC 20402, and includes the following Environmental Protection Agency (EPA) test methods:

      Method 1 – "Sample and Velocity Traverses for Stationary Sources."

      Method 2 – "Determination of Stack Gas Velocity and Volumetric flow Rate (Type S Pitot Tube)."

      Method 3 – "Gas analysis for Carbon Dioxide, Excess Air, and dry molecular Weight>"

      Method 5 – "Determination of Particulate Emissions from Stationary Sources."

(4)   Power Test Code PTC-27:   "Determining Dust Concentration in a Gas Stream", is available from the American Society of Mechanical Engineers (ASME), United Engineering Center, 345 East 47th Street, New York, New York 10017. (Price $5.00.)

(5)   Western Precipitation Bulletin WP-50, "Methods for Determination of Velocity, Volume, Dust and Mist Content of Gases", Western Precipitation Division, Joy Manufacturing Company, 1000 West Ninth Street, Los Angeles, California 90015. (Price $1.00.)

(6)   ASTM Standard D2928, "Sampling Stacks for Particulate Matter", is available from the American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pennsylvania 19013. Price $1.75 each.)

(7)   ASTM Standard D240, "Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter", is available from the American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pennsylvania 19013. (Price $1.75 each.)

(8)   ASTM Standard D1552, "Sulfur in Petroleum Products (High Temperature Method)", is available from the American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pennsylvania 19013. (Price $1.75 each.)

(9)   ASTM Standard D88, "Saybolt Viscosity", is available from the American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pennsylvania 19013. (Price $1.75 each.)

(10)   ASTM Standard D271, "Laboratory Sampling and Analysis of Coal and Coke", is available from the American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pennsylvania 19013. (Price $1.75 each.)

OTHER USEFUL REFERENCES

(11)   Power Test Code PTC-21-1941: "Dust Separating Apparatus", is available from the American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pennsylvania 19013. (Price $4.00.)

(12)   APCO Publication No. PB209-022, "Maintenance, Calibration, and Operation of Isokinetic Source-Sampling Equipment", is available from the National Technical Information Service, US Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161. (Price $4.00.)

APPENDIX 1

The original Appendix 1 has not been reproduced here. The sample train generally employed for this method is as described in EPA Method 5, which can be downloaded from the EPA Emission Measurement Center (www.epa.gov/ttn/emc/promgate.html), with in-line thermocouples before and after the filter to monitor the sample gas temperature. The filter temperature is limited to being sufficiently hot to prevent condensation of water on the filter (generally 10-15°F above stack temperature) not to exceed 225°F. A post-test leak check conducted consistent with the procedures detailed for the pre-test leak check (7:27B-1.9(f)) is mandatory.

APPENDIX 2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR POLLUTION CONTROL
TECHNICAL SERVICES SECTION
LABORATORY REPORT – STACK SAMPLING

NAME OF COMPANY_____

LOCATION OF STACK_____

STACK DESIGNATION_____(NJ NO._____)

ANALYSIS REQUIRED_____

SAMPLES COLLECTED BY_____DATE(S)_____

SAMPLES DELIVERED TO LAB BY_____DATE_____

SAMPLES RECEIVED AT LAB BY_____DATE_____

A.S. NO.	FIELD NO.	RUN NO.	RESULT OF ANALYSIS	UNIT

Report to be forwarded to_____

Analysis by _____

LABORATORY ANALYSIS SUMMARY

COMPANY_____

STACK LOCATION_____

STACK DESIGNATION_____(NJ NO._____)

RUN NUMBER_____RUN DATE_____

DATA

(A)　　Filter Sample Net Wt.　　　　　　　　　　_____ grams

(B)　　Acetone Wash Volume　　　　　　　　　_____ml.

(C)　　Total Wash Particulate Wt.　　　　　　　_____grams

(D)　　Acetone Blank Volume　　　　　　　　　_____ml.

(E)　　Blank Residue Wt.　　　　　　　　　　　_____grams

(F)　　Wt. H_2O Adsorbed by Desiccant　　　　_____grams

(G)　　Net Condensate Volume in Impingers　　　_____ml.

CALCULATIONS*

(H)　　Acetone Wash Residue Wt. = E x B/D　　　_____grams

(I)　　Adjusted Acetone Wash Particulate Wt. = C – H　　_____grams

(J)　　Total Sample Wt. = A + I　　　　　　　　_____grams

(K)　　Total Water in Sample Gas = F + G　　　　_____grams

ORSAT

%CO2 = _____　　　　　%CO = _____　　　　%O2 = _____　　　　%N_2 = _____

*Calculation nomenclature refers to values corresponding to letters on left side of page. This nomenclature is for purposes of this page only.

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR POLLUTION CONTROL
TECHNICAL SERVICES SECTION

DERIVATION OF ISOKINETIC SAMPLING RATE FORUMLA

NOMENCLATURE: (SEE APPENDIX 6)

DERIVATION:

1. Isokinetic Sampling $= \dfrac{Un}{Us} \times 100\%$

2. $Un \text{ (ft./ sec.)} = \dfrac{Vt \text{ (cu. ft.)}}{An \text{ (sq. ft.) x t (min.) x 60 (sec./min.)}}$

3. $An \text{ (sq. ft.)} = \dfrac{A \times (Dn)^2 \text{ (sq. in.)}}{4 \times 144 \text{ (sq. in./sq. ft.)}} = 0.005454 \, (Dn)^2$

    Substitute 3 for An in 2 to obtain 4

4. $Un = \dfrac{Vt}{0.005454 \, (Dn)^2 \times t \times 60} = \dfrac{3.0558 \, Vt}{(Dn)^2 \times t}$

5. $Vt = \dfrac{Vm \times (Ts + 460) \times (Pb + \Delta H/13.6)}{(Tm + 460) \times (1-Q) \times Ps}$

    Substitute 5 for Vt in 4 to obtain 6.

6. $Un = \dfrac{3.0558 \times Vm \times (Ts + 460) \times (Pb + \Delta H/13.6)}{(Dn)^2 \times (Tm + 460) \times (1-Q) \times t \times Ps}$

    Substitute 6 for Un in 1 to obtain 7

7. %Isokinetic Sampling $= \dfrac{3.0558 \times Vm \times (Ts + 460) \times 100 \, (Pb + \Delta H/13.6)}{(Dn)^2 \times (Tm + 460) \times (1-Q) \times t \times Us \times Ps}$

    $= \dfrac{305.58 \times Vm \times (Ts + 460) \times (Pb + \Delta H/13.6)}{(Dn)^2 \times (Tm + 460) \times (1-Q) \times t \times Us \times Ps}$

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR POLLUTION CONTROL
TECHNICAL SERVICES SECTION

<u>% ISOKINETIC SAMPLING CALCULATIONS</u>

COMPANY	
STREET	
CITY	
STACK	
NJ NO.	INLET OUTLET

FIELD & LAB. DATA	RUN 1	RUN 2	RUN3	RUN 4	RUN 5
DATE					
T_s (^{o}F) (Avg.)					
V_m (CF) Avg.)					
T_m (^{o}F)					
D_n (inches)					
t (minutes)					
Q (decimal fraction)					
âs (ft./sec.)					
% Isokinetic Sampling					

CALCULATIONS BY:_____

DATE:_____

**NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR POLLUTION CONTROL
TECHNICAL SERVICES SECTION**

<u>DERIVATION OF EMISSION RATE FORMULA</u>

<u>NOMENCLATURE:</u>   (SEE APPENDIX 6)

<u>DERIVATION:</u>

1. $E \text{ (lbs/hr)} = G \, \dfrac{\text{(grs.)}}{\text{(cu. ft.)}} \times Vo\dfrac{\text{(cu.ft.)}}{\text{(min.)}} \times \dfrac{60 \text{ (min.)}}{\text{(hr.)}} \times \dfrac{\text{lb.}}{7000 \text{ grs.}}$

To convert from grams to grains (per cubic foot):

2. $G = Wt \text{ (gms.)} \times \dfrac{1}{Vt \text{(cu. ft.)}} \times 15.43 \, \dfrac{\text{(grs.)}}{\text{(gm.)}}$

3. $Vo = A \text{ (sq. ft.)} \times Us \, \dfrac{\text{(ft.)}}{\text{(sec.)}} \times 60 \, \dfrac{\text{(sec.)}}{\text{(min.)}}$

Where,

$$Us = 2.9 \, Cp \sqrt{\Delta P \, (Ts+460) \times \dfrac{1}{Gd} \times \dfrac{29.92}{Ps}}$$

Substitute 2 for G and 3 for Vo in 1 to obtain 4:

4. $E = \dfrac{60}{7000} \times 15.43 \times 60 \times \dfrac{Wt}{Vt} \times A \times Us = 7.9354 \, \dfrac{Wt}{Vt} \times A \times Us$

5. $A \text{ (sq. ft.)} = \dfrac{A \times D^2 \text{ (sq. in)}}{4 \times 144 \, \dfrac{\text{(sq. in.)}}{\text{(sq. ft.)}}} = 0.005454 \, D^2$

Substitute 5 for A in 4 to obtain 6:

6. $E = 0.04328 \, \dfrac{Wt}{Vt} \times D^2 \times Us$

To convert meter conditions to flue conditions

7. $Vt = Vm \text{ (cu. ft.)} \times \dfrac{(Ts + 460)}{(Tm + 460)} \times \dfrac{1}{(1-Q)} \times \dfrac{(Pb + \Delta H/13.6)}{Ps}$

Substitute 7 for Vt in 6 to obtain 8:

8. $E = \dfrac{0.04328 \times Wt \times D^2 \times Us \times (Tm + 460) \times (1-Q) \times Ps}{Vm \times (Ts + 460) \times (Pb + \Delta H/13.6)}$

APPENDIX 5

**NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR POLLUTION CONTROL
TECHNICAL SERVICES SECTION**

PRELIMINARY STACK TEST DATA

COMPANY			SUBCHAPTER	
STREET		CITY		
STACK		NJ NO.		
DATE		DATA COLLECTED BY:		
ORIFICE CALIBRATION (ΔH)		ESTIMATED METER TEMP (^{o}F)		
DRY BULB TEMP (^{o}F)		WET BULB TEMP (^{o}F)		
Pb		Pst	ESTIMATED PERCENT MOISTURE	
Ps		Pm (=Pb)	Ps/Pm	
NOMOGRAPH CORRECTION FACTOR			PITOT FACTOR	
MAXIMUM ΔP		MINIMUM ΔP	ACTUAL STACK TEMP (^{o}F)	
PROBE TIP DIAM (inches)			EQUIV. STACK DIAM (inches)	

DISTANCE FROM SAMPLING PORT TO TRAVERSE POINT FOR CIRCULAR DUCTS												
PT. NO.	1	2	3	4	5	6	7	8	9	10	11	12
DIST. (inches)												

REVIEWED BY	DATE

EMISSION CALCULATION REPORT

COMPANY	
STREET	
CITY	
STACK	
NJ NO.	INLET OUTLET

FIELD & LAB DATA	**RUN 1**	**RUN 2**	**RUN 3**	**RUN 4**	**RUN 5**
DATE					
Tm (^{o}F) (Avg.)					
Ts (^{o}F) (Avg.)					
ΔP (inches water)					
D (inches)					
Wt (grams)					
Q (decimal fraction)					
Vm (cubic feet)					
E (LB/HR) (TOTAL)					
ALLOWABLE EMISSIONS (LBS/HR) BASED UPON POTENTIAL EMISSION RATE					
ALLOWABLE EMISSIONS (LBS/HR) BASED UPON SOURCE GAS EMITTED					
HEAT INPUT RATE (MILLIONS OF BTU/HR)					
MAXIMUM ALLOWABLE EMISSSION RATE (LB/HR)					

CALCULATIONS BY:_____

DATE:_____

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR POLLUTION CONTROL
TECHNICAL SERVICES SECTION

SAMPLING DATA

DATE		RUN		(INLET)	(OUTLET)

COMPANY	
STACK		NJ NO.	

DESICCANT		IMPINGER	FILTER	WASH-OUT BOTTLE	

TEST STARTED	(AM) (PM)	TEST FINISHED	(AM) (PM)

ACTUAL SAMPLING TIME (MINUTES)

NOZZLE DIAM. (INCHES)

PORT	POINT	ΔP	ΔH	Ts	TM in	TM out	

STACK DATA	
AVG. Ts (^{o}F)	
$\overline{\Delta P}$ (in.H_2O)	
A (ft.^{2})	
Pst (in.H_2O)	
Ps (in. Hg)	
Gd	

METER DATA	
FINISH (CF)	
START (CF)	
Vm (CF)	
AVG. Tm (^{o}F)	
AVG. ΔH (in.H_2O)	

Pb (in. Hg)	

AVG. VELOCITY (fps)		ACFM		@	^{o}F	SCFM		@	70°F
COMPLETED BY			REVIEWED BY				DATE		

APPENDIX 6

**NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR POLLUTION CONTROL
TECHNICAL SERVICES SECTION**

<u>NOMENCLATURE</u>

A = Internal cross sectional area of flue at sampling location expressed in square feet.

ACFM = Actual cubic feet per minute at stack conditions of temperature and pressure.

An = Cross sectional area of sampling nozzle orifice expressed in square feet.

CF = Cubic feet.

CFM = Cubic feet per minute.

Cp = Pitot tube correction factor

D = Internal diameter of flue in inches

Dn = Internal diameter of sampling nozzle in inches.

E = Emission rate in pounds per hour

fps = Velocity in feet per second.

G = Particulate concentration in grains per cubic feet.

Gd = Specific gravity of flue gas referred to that of air at flue gas temperature and pressure.

ΔH = Orifice draft gauge reading in equivalent inches of water.

Ms = Molecular weight of stack gas (wet basis)

mg = Milligram

ml = Milliliter

mm Hg = Millimeter of mercury

ΔP = Velocity head draft gauge reading in equivalent inches of water.

$\overline{\Delta P}$ = Root mean square value of differential pressures of all traverse points in the stack (inches of water)

Pb = Barometric pressure in inches of mercury absolute

Pm = Absolute pressure at meter in inches of mercury.

Ps = Absolute pressure in flue, derived by the algebraic sum of barometric and static pressures and expressed in inches of mercury.

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Pst = Static pressure in flue expressed in inches of mercury gauge.

psia = Pounds per square inch absolute

Q = Moisture in flue gas (decimal fraction by volume)

SCFM = Cubic feet per minute at 70°F and one atmosphere pressure (14.7 psia or 760 mm Hg) or standard cubic feet per minute.

t = Duration of sampling time in minutes

Tm = Temperature at meter in degrees F

Ts = Flue gas temperature in degrees F

Un = Sample nozzle gas velocity in feet per second

Us = Flue gas velocity at the point where measured in feet per second

$\overline{Us}$ = Average flue gas velocity for a test run

Vm = Total volume of gas sampled as measured by meter in cubic feet

Vo = Volume rate of flue gas in cubic feet per minute

Vt = Total volume of gas sampled in cubic feet and converted to flue conditions

Vv = Total volume of water in sample gas in cubic feet converted to meter conditions (vapor state)

Vw = Total volume of water in sample gas in cubic centimeters (condensate plus water adsorbed in desiccant)

Wt = Weight of particulate sample collected in grams