

CHAPTER 27B

SAMPLING AND ANALYTICAL PROCEDURES

Authority

N.J.S.A. 13:1D-5, 13:1D-9, 26:2C-8.

Source and Effective Date

R.1974 d.360, effective December 30, 1974.
See: 7 N.J.R. 48(a).

Executive Order No. 66(1978) Expiration Date

Chapter 27B, Sampling and Analytical Procedures, is exempt from Executive Order No. 66(1978).

Chapter Historical Note

All provisions of this chapter became effective December 30, 1974 as R.1974 d.360. See: 7 N.J.R. 48(a). Subchapters 2 and 3 and revisions to the original rules became effective March 20, 1975 as R.1975 d.76. See: 7 N.J.R. 144(a). Revisions which consolidated the prior text of Subchapter 3 (making it Reserved) with Subchapter 1 became effective June 21, 1986 as R.1986 d.121. See: 8 N.J.R. 223(a). Subchapter 4 became effective January 21, 1985 (operative July 1, 1985) as R.1985 d.3. See: 16 N.J.R. 2894(a), 17 N.J.R. 184(a). New Subchapter 3 became effective September 8, 1986 (operative October 10, 1986) as R.1986 d.377. See: 17 N.J.R. 2194(a), 18 N.J.R. 1800(a).

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SUBCHAPTER 1. SAMPLING AND ANALYTICAL PROCEDURES FOR DETERMINING EMISSIONS OF PARTICLES FROM MANUFACTURING PROCESSES AND FROM COMBUSTION OF FUELS

Authority

Unless otherwise expressly noted, all provisions of this Subchapter were adopted pursuant to authority of N.J.S.A. 26:2C-1 et seq. and were filed and became effective on December 30, 1974, as R.1974 d.360. See: 7 N.J.R. 48(a). Revisions to the original rules were filed and became effective on May 20, 1975, as R.1975 d.136. See: 7 N.J.R. 261(d). Further revisions were filed on April 21, 1976, as R.1976 d.121 to become effective on June 21, 1976. See: 8 N.J.R. 223(a).

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.

“Equipment 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 at 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 be 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, the sootblowing operation will be preceded by a time interval of nonsootblowing which is equal to the normal nonsootblowing 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

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

1. 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;
2. 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 (T₁) * to indicate the sample gas temperature;
3. A high-vacuum hose (C) * with a smooth, inert inner wall and with a heating system capable of maintain-

ing the temperature of the sample gas passing through it sufficiently high to prevent condensation of water from occurring, and a temperature sensor (T₂) * to indicate the sample gas temperature. In lieu of this hose, direct coupling of the probe (B) * and the glass cyclone and filter assembly (D₁ and D₂) * may be used;

4. A sample collector consisting of a glass cyclone (D₁) * followed by a glass fiber filter (Reeve-Angel 934AH **, MSA 1106BH ** or approved equivalent) in a glass holder (D₂) *. 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 (T₃) * 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;

5. A condenser system (E) * consisting of a Greenburg-Smith impinger (E₁) * containing 100 ml. distilled water followed by a modified Greenburg-Smith impinger (E₂) * (dry) for mist knockout, both immersed in an ice bath;

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

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

8. A leak-free pump (H) * with coarse (H₁) * and fine (H₂) * flow control adjusters and vacuum gauge (P) *;

9. A dry gas test meter (I) * accurate within two per cent and temperature sensors (T₄) * to indicate the sample gas inlet and outlet temperatures;

10. An orifice meter (J) * with an inclined manometer (M₂) * as described in APCO Publication APTD-0581 (Reference 2);

11. A thermocouple (K) * attached to the probe (B) * its sensing portion adjacent to the sampling nozzle (A) * and equipped with a temperature sensor (T₅) to indicate the stack gas temperature;

12. 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 (M₁) * (inclined manometer or equivalent) to measure velocity head to within ten percent of the minimum value as determined during the preliminary traverse;

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

(b) 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.

(c) 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

(a) All tests shall be conducted in accordance with the following:

1. The sampling location and number of traverse points shall be determined by E.P.A. 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).

2. Determination of stack gas velocity shall be by E.P.A. 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).

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

4. For the purpose of determining compliance with any applicable standard, the results of each valid test run (see Section 14 of this Subchapter) shall be considered.

7:27B-1.8 Required test data

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

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

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

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

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

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

6. Weight (grams) of total solid particles collected (see N.J.A.C. 7:27B-1.12(a)5.) during each test run;

7. Per cent of moisture by volume in stack gas during each test run, as determined by the procedure described in E.P.A. Method 5 (Reference 3);

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

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

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

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

12. Percentage of CO₂, CO, O₂ and N₂ by Orsat analysis of the stack gas being sampled;

13. Molecular weight (M_s) of the stack gas. Sample may be obtained by E.P.A. Method 3 (Reference 3) and calculated by the formula in N.J.A.C. 7:27B-1.13(f);

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

(b) 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 (N.J.A.C. 7:27B-1.5(b) through (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 11 of this Subchapter).

(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 (N.J.A.C. 7:27B-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 (N.J.A.C. 7:27B-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 (N.J.A.C. 7:27B-1.11(d)) represents the total moisture in the gas sampled and is used to determine the per cent moisture in the stack gas.

6. The total weight of particles collected is the sum of the weights of particles as determined in paragraphs 1 and 4 of this subsection.

(b) Rules for a liquid fuel are:

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

2. Determine the sulfur content (per cent 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) Rules for a solid fuel are:

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

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

* See Appendix 1.

7:27B-1.13 Calculations

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

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

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

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

(c) The average per cent isokinetic sampling rate for a test run is calculated by equation 7 of Appendix 3, using $\bar{U}_s$ and arithmetic averages for T_s , T_m and ΔH .

(d) Emission rate (E) for a test run is calculated by equation 8 of Appendix 4, using $\bar{U}_s$ and arithmetic averages for T_s , T_m 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:

(g) Specific gravity of flue gas (G_d) equals the ratio of the molecular weight of the stack gas to the molecular weight of air (28.95).

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

$$28.95$$

7:27B-1.14 Validation of test

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

References

New Jersey Administrative Code, Title 12, 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, U.S. Environmental Protection Agency, P.O. 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, U.S. Government Printing Office, Washington, D.C. 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 Concentrations 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 19103. (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 19103. (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 19103. (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 19103. (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 19103. (Price: \$1.75 each.)

OTHER USEFUL REFERENCES

(11) Power Test Code PTC-21-1941: "Dust Separating Apparatus", is available from the American Society of Mechanical Engineers (ASME), United Engineering Center, 345 East 47th Street, New York, New York 10017. (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, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161. (Price: \$4.00.)

SUBCHAPTER 2. PROCEDURES FOR THE VISUAL DETERMINATION OF THE OPACITY (PER CENT) AND THE SHADE OR APPEARANCE (RINGELMANN NUMBER) OF EMISSIONS FROM SOURCES

Authority

Unless otherwise expressly noted, all provisions of this Subchapter were adopted pursuant to authority of N.J.S.A. 26:2C-8 and were filed and became effective on March 20, 1975, as R.1975 d.76. See: 7 N.J.R. 144(a). Revisions to the original rules were filed on April 21, 1976, as R.1976 d.121 to become effective on June 21, 1976. See: 8 N.J.R. 223(a).

7:27B-2.1 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.

"Bureau" means the Bureau of Air Pollution Control.

"Department" means the Department of Environmental Protection.

"Opacity" means the property of a substance which renders it partially or wholly obstructive to the transmission of visible light expressed as the percentage to which the light is obstructed.

"Ringelmann number" means a number used to describe the density of smoke as determined from the Ringelmann smoke chart.

"Ringelmann smoke chart" means the "Ringelmann scale for grading the density of smoke" as published by the United States Bureau of Mines or any chart, recorder, indicator or device which is approved by the Department as the equivalent of the Ringelmann scale for the measurement of smoke density.

7:27B-2.2 Acceptable observation methods

Observations shall be conducted in accordance with methods set forth hereinafter. Alternate methods and/or procedures, including the use of auxiliary equipment and instruments, may be used subject to prior approval by the Department. The Department may itself employ such alternates

when warranted by observation conditions or other circumstances.

7:27B-2.3 Observation principle

For purposes of observing emissions in accordance with applicable provisions of the rules of the bureau, opacity (per cent) and shade or appearance (Ringelmann number) shall be determined visually by a certified observer. Opacity (per cent) is applicable to all plumes regardless of color. Shade or appearance (Ringelmann number) is applicable to gray and black plumes only. The resultant observation shall be the aggregate of individual readings.

7:27B-2.4 General observation requirements

(a) The observer shall stand at a distance sufficient to provide a clear view of the emissions.

(b) The observer shall be located so that:

1. For per cent opacity readings, the sun shall be oriented in the 140 degree sector to the observer's back.
2. For Ringelmann number readings, the sun should be oriented in the 140 degree sector to the observer's back; however, where conditions do not permit, the sun need not be to the observer's back.

(c) Observations shall be directed to the point of the greatest per cent opacity or greatest Ringelmann number in the plume.

(d) Consistent with the requirements of subsections (a) and (b) of this Section, the observer shall make observations using a line of vision as close to 90 degrees as possible to the direction of the plume at the point specified in subsection (c) of this Section.

(e) The observer shall not look continuously at the plume, but shall observe the plume momentarily at 15-second intervals, except where consecutive second standards are prescribed (that is, N.J.A.C. 7:27-3.4 and 3.5).

(f) Rules for plumes which contain visible water ("steam" plumes) are:

1. Where visible water is present within the plume at the point of discharge of the outdoor atmosphere ("attached" plume), observations shall be made beyond the transition point after which water is no longer visible in the plume.
2. Where water vapor in the plume condenses and becomes visible at a distance after the point of discharge to the outdoor atmosphere ("detached" plume), observations should be made before the transition point where water vapor becomes visible in the plume.

7:27B-2.5 Required observation data

Data to be determined and reported for each observation must include the information required to complete the

plume observation record (form AIR-14, Appendix 1) as well as information showing the sun's orientation to the observer's back and the plume characteristics when observing a plume containing visible water set forth in N.J.A.C. 7:27B-2.4(f).

7:27B-2.6 Certification

(a) To be certified, an observer must satisfactorily complete a training course, approved by the Department, in observing and recording opacity and shade or appearance of visible plumes. Certification may be made by the Department or by any person approved by the Department for such purpose. An observer must have been certified (or recertified) within a period of approximately six months immediately preceding the observation.

(b) To be certified, an observer must demonstrate the ability to assign opacity readings in five percent increments and Ringelmann number readings in $\frac{1}{4}$ scale increments. Certification tests shall consist of no less than 25 plume observations in each plume category. Errors must not exceed 15 per cent ($\frac{3}{4}$ Ringelmann number) on any one reading in each category, and the average error must not exceed 5.5 per cent in each category. Substantially equivalent performance standards for observer certification may be approved by the Department.

References

Federal Register, Volume 39, Number 219, November 12, 1974, EPA Method 9, Visual Determination of the Opacity of Emissions from Stationary Sources, is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Editor's Note: In addition to the above text, an Appendix 1, Plume Observation Record, was filed with these rules but is not reproduced herein. Further information regarding this Appendix may be obtained by contacting the Bureau of Air Pollution Control, Department of Environmental Protection, Post Office Box 2807, Trenton, New Jersey 08625.

SUBCHAPTER 3. AIR TEST METHOD 3: SAMPLING AND ANALYTICAL PROCEDURES FOR THE DETERMINATION OF VOLATILE ORGANIC COMPOUNDS FROM SOURCE OPERATIONS

7:27B-3.1 Definitions

The following words and terms, when used in this subchapter, have the following meanings, unless the context clearly indicates otherwise.

"Aliquot" means a representative portion of a sample.

"ASTM" means the American Society for Testing and Materials.

"Atm" means atmosphere.

"Batch cycle" means the total elapsed time per batch in any single manufacturing process vessel, including all phases of the operation during which the vessel contains process materials, excluding time waiting for removal from the vessel.

"Calibration gas" means a gas of known composition and concentration, certified to within $\pm$ two percent by the manufacturer or, if laboratory blended, an independent analysis has been performed.

"Carrier gas" means nitrogen or helium containing less than two ppm of equivalent carbon or methane.

"Combustion gas" means air which contains less than two ppm of equivalent carbon or methane and is used to support the combustion of VOC in the sample gas.

"Condenser" means a system for determining the moisture content of the source gas and consisting of: a probe, two Greenburg-Smith impingers (one standard type containing 100 mls of distilled water and one dry modified type, both immersed in an ice bath), a drying tube containing a suitable desiccant, a pump, and a dry gas meter with a thermometer all connected in series. The condenser collects the moisture in a measured amount of source gas.

"Cutback asphalt" means any paving asphalt which has been liquified by blending with petroleum solvents, or produced directly from the distillation of petroleum and having vaporization properties similar to the blended and liquified asphalt.

"Department" means the New Jersey Department of Environmental Protection.

"Dilution gas" means air or nitrogen containing less than two ppm of equivalent carbon or methane.

"Direct analysis" means the continuous or semi-continuous on-site sampling and immediate analysis of the source sample.

"Emulsified asphalt" means asphalt which has been liquified by mixing with water and an emulsifying agent.

"Fuel gas" means hydrogen or a mixture of hydrogen and an inert gas which contains less than one ppm of equivalent carbon or methane.

"Gas chromatograph-flame ionization detector (GC-FID)" means a gas chromatograph instrument equipped with a flame ionization detector and a suitable column to separate the VOC. The flame ionization detector must have a heating system capable of preventing any condensation of the sample gas. The flame ionization detector must be capable of meeting or exceeding by demonstration the manufacturer's specifications.

"Gasoline" means any petroleum distillate or petroleum distillate/oxygenate blend having a Reid vapor pressure of four pounds per square inch (207 millimeters of mercury) absolute or greater and used as an automotive fuel.

"Gas sampling valve" means a two-position heated valve used to purge the sample loop with the source gas and to insert the loop containing the source gas sample into the carrier gas stream leading to the chromatograph. Both loop and valve must be heated to a temperature that will prevent any condensation of the sample gas.

"Isokinetic sampling" means drawing a gas sample through a nozzle into a sampling train at the same velocity as that in the stack or duct.

"Laboratory standard calibrations gases" means three gas mixtures each containing known concentrations of each of the VOC in the source gas (except trace components) in the same matrix, if possible, as will be sampled. One mixture is to have greater than, one mixture is to be approximately equal to, and one mixture is to have less than the expected concentration of VOC in the source gas. These gases can be certified to $\pm$ two percent by the manufacturer or produced locally by approved techniques if the concentration is confirmed by an independent analysis. The standards must be stable in the matrix and container over their period of use.

"LFL" means lower explosive limit.

"Modified particulate train" means a sampling train capable of collecting organic emissions at an isokinetic sampling rate.

"Needle valve" means a fine adjustment valve used to control the source gas sampling rate and constructed of corrosion-resistant material.

"Organic substance" means any chemical compound or mixture of chemical compounds of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbonates, metallic carbides, and ammonium carbonate.

"Ppm" means part per million by volume.

"Partial pressure" means the pressure exerted by a specified component in a mixture of gases.

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

"Petroleum solvent dry cleaning" means a process used for the cleaning of textiles and fabric products in which articles are washed in a solution of organic material produced by petroleum distillation that exists as a liquid under standard conditions, and then dried by exposure to a heated air stream.

"Probe" means glass, stainless steel or Teflon tubing as required by source gas conditions and equipped with a filter, if necessary. The probe and filter must have a heating or dilution system capable of preventing any condensation of the sample gas.

"Psia" means pounds per square inch absolute.

"Pump" means a leakless Teflon-coated diaphragm pump or equivalent with an appropriate capacity and a heating or dilution system capable of preventing any condensation of the sample.

"Pure component standards" means a gas mixture consisting of only one VOC in an inert gas. A separate mixture is required for each VOC suspected in the source gas.

"Recorder/Integrator" means a strip chart recorder and an optional integrator to calculate the results.

"Reid vapor pressure" or "RVP" means the absolute vapor pressure of a petroleum product in pounds per square inch (kilopascals) at 100 degrees Fahrenheit ($^{\circ}$ F) (37.8 degrees Celsius ($^{\circ}$ C)) as measured by "Method 1-Dry RVP Measurement Method" or "Method 2-Herzog Semi-Automatic Method" promulgated at 40 CFR 80, Appendix E; or any other test method approved in advance in writing by the Department and the EPA.

"Rigid sampling container" means a leak-free sampling container large enough to hold a gas sampling bag and capable of being evacuated to a pressure of 20 inches water without collapsing.

"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.

"Sample line" means glass, Teflon or stainless steel tubing with Teflon or stainless steel fittings, heated if necessary to prevent condensation.

"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 at 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.

"SCFH" means standard cubic feet per hour on a wet basis unless otherwise specified in the text.

"SCFM" means standard cubic feet per minute on a wet basis unless otherwise specified in the text.

"Solvent recovery dryer" means a class of dry cleaning dryers that employs a condenser to liquify and recover solvent vapors evaporated in a closed-loop, recirculating stream of heated air.

"Source operation" or "Source" means any process or any identifiable part thereof that emits or can reasonably be anticipated to emit any air contaminant either directly or indirectly into the outdoor atmosphere.

"Standard conditions" means 70 degrees Fahrenheit (°F) (21.1 degrees Celsius (°C)) and one atmosphere pressure (14.7 pounds per square inch absolute or 760 millimeters of mercury).

"Std" means standard.

"Surface coating formulation" means the material used to form a protective, functional, or decorative film including, but not limited to any architectural coating, paint, varnish, ink, or adhesive, applied to or impregnated into a substrate.

"Temperature sensor" means a thermometer, potentiometer with thermocouple, or other temperature sensing device calibrated with an approved standard.

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

"Test Run" or "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.

"Transfer operation" means the moving of any substance from any storage tank, manufacturing process vessel, or delivery vessel into any receiving vessel.

"Vapor" means the gaseous form of substances which, under standard conditions, are in the solid or liquid state and which can be changed to these states by either increasing the pressure or decreasing the temperature.

"Vapor pressure" means the pressure of the vapor phase of a substance, or the sum of the partial pressures of the vapor phases of individual substances in a mixture of substances, when in equilibrium with the non-vapor phase of the substance or substances.

"Velocity Meter" means an "S" type Pitot tube with a manometer or other appropriate gas flow measuring device.

"Volatile organic compound" or "VOC" means any compound of carbon (other than carbon monoxide, carbon dioxide, carbonic acid, metallic carbonates, metallic carbides, and ammonium carbonate) which participates in atmospheric photochemical reactions. For the purpose of determining compliance with emission limits or content standards, VOC shall be measured by test methods in the approved SIP (such as N.J.A.C. 7:27B-3) or 40 CFR Part 60, Appendix A, as applicable, or which have been approved in writing by the Department and are acceptable to EPA. This term does not include the compounds which EPA has excluded from its definition of VOC in the list set forth at 40 CFR 51.100(s)(1), which is incorporated by reference herein, together with all amendments and supplements. The list at 40 CFR 51.100(s)(1) currently includes the compounds and the classes of perfluorocarbons set forth below:

methane
ethane
methylene chloride (dichloromethane)
1,1,1-trichloroethane (methyl chloroform)
trichlorofluoromethane (CFC-11)
dichlorodifluoromethane (CFC-12)
trifluoromethane (HFC-23)
1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113)
1,2-dichloro-1,1,2,2-tetrafluoroethane (CFC-114)
chloropentafluoroethane (CFC-115)
chlorodifluoromethane (HCFC-22)
2,2-dichloro-1,1,1-trifluoroethane (HCFC-123)
2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124)
1,1-dichloro-1-fluoroethane (HCFC-141b)
1-chloro-1,1-difluoroethane (HCFC-142b)
pentafluoroethane (HFC-125)
1,1,2,2-tetrafluoroethane (HFC-134)
1,1,1,2-tetrafluoroethane (HFC-134a)
1,1,1-trifluoroethane (HFC-143a)
1,1-difluoroethane (HFC-152a)
parachlorobenzotrifluoride (PCBTF)

cyclic, branched or linear completely methylated siloxanes

Classes of perfluorocarbons:

cyclic, branched, or linear, completely fluorinated alkanes
cyclic, branched, or linear, completely fluorinated ethers with no unsaturations
cyclic, branched, or linear, completely fluorinated tertiary amines with no unsaturations

sulfur containing perfluorocarbons with no unsaturations and with sulfur bonds only to carbon and fluorine

If there is any conflict between the list at 40 CFR 51.100(s)(1) and the list set forth above, the list at 40 CFR 51.100(s)(1) shall control.

"Zero gas" means air or gas which contains less than 1 ppm of equivalent carbon or methane.

Amended by R.1992 d.102, effective March 2, 1992 (operative March 28, 1992).

See: 23 N.J.R. 1858(b), 24 N.J.R. 792(a).

New definition for "ASTM" and "volatile organic compounds (VOC)"; amended others to comport with "VOS" to "VOC" changes. Amended by R.1994 d.313, effective June 20, 1994 (operative July 26, 1994).

See: 25 N.J.R. 3339(a), 26 N.J.R. 2600(a).

Administrative Correction.

See: N.J.R. 1406(a).

7:27B-3.2 Sampling and analytical protocol: acceptable test methods

(a) When N.J.A.C. 7:27-8, 7:27-16, 7:27-17, or 7:27-23 requires a source emissions test, the applicant shall submit a written protocol to the Department at least 30 days prior to the date of the test, to the following address:

Chief, Bureau of Technical Services
Division of Environmental Quality
Department of Environmental Protection
CN 411
380 Scotch Road
Trenton, New Jersey 08625-0411

(b) The written protocol shall include a detailed description of the following:

1. Sampling location;
2. Sampling equipment;
3. Sampling and analytical procedures for the tests;
4. Data reporting forms; and
5. Quality assurance procedures.

(c) Any alternative test method, analytical method, instrumentation, source, test period, or data reporting forms shall be submitted in writing with the test protocol for approval at the discretion of the Department at least 30 days prior to the test, to the address set forth in (a) above.

(d) Any changes from the procedures and methods set forth in the protocol may be approved verbally prior to the test at the discretion of the Department; however, the applicant shall note the request and the Department's response in the final test report submitted by the applicant to the Department.

(e) Any Departmental approval pursuant to (c) or (d) above shall be confirmed in writing by the Department.

(f) The Department may itself employ such alternative procedures when warranted by test conditions or other circumstances.

(g) The applicant shall give notice to the Department at least 48 hours prior to the test in order to afford the opportunity for a Departmental observer(s) to be present.

(h) Performance tests shall be conducted in accordance with test methods set forth hereinafter.

(i) For determining the quality and quantity of VOC from source operations, the prescribed test procedures shall be as follows:

1. For a single known VOC: Procedures for the Direct Measurement of VOC Using a Flame Ionization Detector or a Photoionization Detector or a Non-Dispersive Infrared Analyzer (N.J.A.C. 7:27B-3.7).

2. For a mixture of known VOC in known proportion: Procedures for the Direct Measurement of VOC Using a Flame Ionization Detector, a Photoionization Detector or a Non-Dispersive Infrared Analyzer (N.J.A.C. 7:27B-3.7).

3. For a mixture of known VOC in unknown proportions: Procedures for the Direct Measurement of VOC Using a Gas Chromatograph with a Flame Ionization Detector or other suitable detector (N.J.A.C. 7:27B-3.8).

4. For a mixture containing unknown VOC: A procedure has not been included in the test methods, but an analysis using a gas chromatograph with a mass spectrometer will be required and conducted in accordance with established procedures by a qualified operator. Prior to any such test, the Department must receive and approve a written protocol from the operator.

5. For a known or unknown VOC in a stack where condensation is present, isokinetic sampling will be required. A procedure has not been included in these test methods, but sampling using an approved modified particulate train will be required, which shall be submitted for Departmental review pursuant to N.J.A.C. 7:27B-3.2(c), (d), and (e).

(j) Whenever a direct analysis at the source is not possible, the samples shall be taken in accordance with the procedure described at N.J.A.C. 7:27B-3.9.

(k) Whenever a volume flow rate must be determined to establish mass emission rates of VOC or for any other reason, the methods prescribed in N.J.A.C. 7:27B-1, AIR TEST METHOD 1 (N.J.A.C. 7:27B-3.18 Reference 1), or other flow determining method which shall be submitted for Departmental review pursuant to N.J.A.C. 7:27B-3.2(c), (d), and (e).

Amended by R.1992 d.102, effective March 2, 1992 (operative March 28, 1992).

See: 23 N.J.R. 1858(b), 24 N.J.R. 792(a).

"VOS" replaced by "VOC".

7:27B-3.3 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.

7:27B-3.4 Sampling facilities

(a) The following sampling facilities shall be provided by the party responsible for the emissions:

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

2. Safe sampling platforms and safe access thereto conforming with laws and regulations concerning safe construction and safe practice (N.J.A.C. 7:27B-3.18, Reference 2);

3. Utilities as needed for sampling and testing equipment, which may include electrical power and water;

4. Any other facilities exclusive of instrumentation and sensing devices as may be necessary for the Department to accurately determine the emissions of VOC from the source operation;

5. Facilities, as necessary, for representative sampling of raw materials and for the determination of the amount of raw materials being used during the test run; and

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

Amended by R.1992 d.102, effective March 2, 1992 (operative March 28, 1992).

See: 23 N.J.R. 1858(b), 24 N.J.R. 792(a).

"VOS" replaced by "VOC".

7:27B-3.5 Source operations and applicable test methods

The following chart sets forth the applicable test methods, shown by section designation, for the various source operations that are regulated by N.J.A.C. 7:27-8, 7:27-16, 7:27-17, and 7:27-23:

Applicable Test Methods

Source Operation	Vapor Pressure	Efficiency of Control Apparatus	Leaks From Source	Emissions From Source	VOC Content	Leak Tightness of Delivery Vessel	Recovered Solvent Flow Rate
Storage of VOC	3.6	3.7 3.8 3.9	3.14				
Transfer Operations	3.6	3.16	3.15	3.11		3.13	
Open Top Tanks and Surface Cleaners	3.6	3.7 3.8 3.9		3.7 3.8 3.9			
Surface Coating Operations		3.7 3.8 3.9		3.7 3.8 3.9	3.10		
Source Operations Other than Storage Tanks, Open Top Tanks and Surface Outers	3.6	3.7 3.8 3.9	3.14	3.7 3.8 3.9			
Cutback and Emulsified Asphalt					3.12		
Petroleum Solvent Dry Cleaners				3.7 3.8 3.9	3.17		3.17

Amended by R.1992 d.102, effective March 2, 1992 (operative March 28, 1992).

See: 23 N.J.R. 1858(b), 24 N.J.R. 792(a).

Reference to N.J.A.C. 7:27-23 added; "VOS" replaced by "VOC".

7:27B-3.6 Procedures for the determinations of vapor pressures of a single known VOC or mixtures of known and/or unknown VOC

(a) The vapor pressure of a single known volatile organic substance shall be determined as follows:

1. The vapor pressure of certain single known VOC may be found in the following, or other sources which shall be submitted to the Department for review, pursuant to N.J.A.C. 7:27B-3.2(c), (d), and (e), and may be used provided the vapor pressure was measured and the VOC was certified by the manufacturer or by the National Bureau of Standards as being of or equivalent to research grade.

i. Weast, R.C., "Handbook of Chemistry and Physics," Section D, Chemical Rubber Co., Cleveland, Ohio;

ii. Perry, J.H., "Chemical Engineers" Handbook, Section 3, McGraw-Hill, New York;

iii. Lange, N.A., "Handbook of Chemistry," McGraw-Hill, New York;

iv. Boublik, T.; Grued, V.; and Hala, E., "The Vapor Pressure of Pure Substances," Elsevier Scientific Publishing, New York;

v. Jordan, T.E., "Vapor Pressure of Organic Compounds" Interscience Publishers, New York.

2. In the absence of the referenced data above, the vapor pressure of the single VOC may be determined by the following methods:

i. "Method 1-Dry RVP Measurement Method" or "Method 2-Herzog Semi-Automatic Method" promulgated at 40 CFR 80, Appendix E; or any other test Method approved in advance in writing by the Department and the EPA, (N.J.A.C. 7:27B-3.18, Reference 3). This method may be used only if the sensitivity of the pressure measuring device is sufficient for the vapor pressure level. The results must be converted to and reported as the true vapor pressure at standard conditions (N.J.A.C. 7:27B-3.18, Reference 5); or

ii. ASTM Designation D2879-75, "Standard Method of Test for Vapor Pressure—Temperature Relationship and Initial Decomposition Temperature of Liquids by Isoteniscope" (N.J.A.C. 7:27B-3.18, Reference 4).

(b) The vapor pressures of mixtures of known VOC in known proportions shall be determined as follows:

1. Data on partial pressure for certain mixtures of VOC are published in the International Critical Tables and in scientific journals. The vapor pressure of a mixture which has been reported in such sources will be acceptable provided the source is documented by a reprint which shall be submitted for review by the Department, pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

2. The vapor pressure may also be determined by the method set forth in (a)2i above. The Reid method is applicable to volatile crude oil and volatile nonviscous petroleum products and other mixtures of VOC. For petroleum and petroleum distillates, refer to American Petroleum Institute (API) Bulletin 2517, "Selecting the Proper Nomograph" (N.J.A.C. 7:27B-3.18, Reference 5).

The Reid vapor pressure can be converted to true vapor pressure at standard conditions. For mixtures other than petroleum and petroleum distillates, the resulting Reid vapor pressure may be converted to true vapor pressure at standard conditions using Table 1.

TABLE 1
CONVERSION OF REID VAPOR PRESSURES
TO TRUE VAPOR PRESSURES

Reid Vapor Pressure Psia	True Vapor Pressure Psia
1	0.5
2	1.1
3	1.7
4	2.3
5	2.9
6	3.6
7	4.2
8	4.8
9	5.5
10	6.1
11	6.7
12	7.4
13	8.0
14	8.6
14.7	9.0

NOTE: Straight-line interpolation is to be used for intermediate values. Applicable for VOC other than petroleum and petroleum distillates.

(c) The vapor pressure of mixtures of known and/or unknown VOC shall be determined as follows:

1. The method set forth in (a)2i above;
2. ASTM Designation D2551-80, "Standard Method of Test of Vapor Pressure of Petroleum Products (Micro-method)" (N.J.A.C. 7:27B-3.18, Reference 6); or
3. The method set forth in (a)2ii above.

Amended by R.1992 d.102, effective March 2, 1992 (operative March 28, 1992).

See: 23 N.J.R. 1858(b), 24 N.J.R. 792(a).

Measurement methods changed at (a)2i; "VOS" changed to "VOC".

7:27B-3.7 Procedures for the direct measurement of volatile organic compounds using a flame ionization detector (FID), a photoionization detector (PID) or a non-dispersive infrared analyzer (NDIR)

(a) The method in this section is applicable for the determination of the concentration and the mass emission rate of a known VOC or a mixture of known VOC in known proportions in systems with constant emissions and flow rates. For the same circumstances as described above, the procedures specified in N.J.A.C. 7:27B-3.8 or 3.9 may be used in place of this method. Any other alternative test method shall be submitted to the Department for review, pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

(b) This method is based upon the following principles:

1. The flame ionization method is based upon ionization produced when the organic vapor in the sample is combusted in a hydrogen flame. The ions and electrons formed in the flame enter an electrode gap, decrease the gap resistance, and thus permit a current flow in an external circuit. The resulting current is proportional to the instantaneous concentration of the organic vapor.

2. The photoionization method is based upon ionization produced when an organic vapor in the sample is exposed to a high intensity ultraviolet source. The ions and electrons formed enter an electrode gap, decrease the gap resistance, and thus permit a current flow in an external circuit. The resulting current is proportional to the instantaneous concentration of the organic vapor.

3. The non-dispersive infrared method is based upon absorption of infrared energy when a band of infrared energy containing the proper frequencies is alternately passed through an absorption cell containing the organic vapor and a reference cell. The difference in absorption between the reference cell and the absorption cell containing the organic vapor is proportional to the instantaneous concentration of the organic vapor.

(c) The following is a summary of this method:

1. The instrument is calibrated with standard gas mixtures to establish the instrument response to the VOC being analyzed. A representative sample of the source gas is drawn into the instrument under conditions which prevent any condensation of the source gas and which remove particulate matter. The response is recorded at specified intervals during the test period, and the true concentration of the VOC is calculated from previously determined response factors. The total gas flow rate, moisture content, and the average molecular weight of the gas are determined during the sampling period, and the mass emission rate of the VOC is calculated and reported as pounds per hour.

2. For the purposes of this procedure, three separate test runs will be conducted, each of which shall extend for one hour or a batch cycle whichever is longer. Any alternative test period shall be submitted to the Department for review, pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

(d) The following is a list of equipment used in this method:

1. Probe;
2. Sample line;
3. Temperature sensor;
4. Pump;

5. Detector: a total hydrocarbon analysis instrument having a flame ionization, a photoionization or a non-dispersive infrared detector and a sampling system capable of preventing any condensation of the sample gas. The detector must be capable of meeting or exceeding the manufacturer's specifications by demonstration, preferably by the manufacturer, and the other specifications listed below:

i. Linearity: the instrument response to the VOC being measured shall not deviate from linearity by more than five percent of the full scale value of the range being used.

ii. Zero drift: less than three percent of full scale per test period or one hour, whichever is shorter.

iii. Span drift: less than three percent of full scale per test period or one hour whichever is shorter.

iv. Response time: equal to or less than 30 seconds for 95 percent full scale.

6. Recorder/Integrator:

7. Gas cylinder supplies as follows:

i. Laboratory standard calibration gases;

ii. Field standard: a known concentration of methane used to check instrument response in the field;

iii. Fuel gas;

iv. Combustion gas; and

v. Zero gas;

8. Velocity meter;

9. Condensor; and

10. Dilution system (if necessary): a system supplied by the instrument manufacturer or one similar to that specified in N.J.A.C. 7:27B-3.9(e)4, capable of producing dilution ratios which will prevent any condensation of the sample gas and capable of bringing the sample concentration within the linear range of the detector.

(e) The procedure for this section shall be as follows:

1. A presampling survey of the source operation shall be conducted to establish certain basic information including but not limited to: sampling location; stack temperature and pressure; stack gas moisture content; approximate particulate concentrations; composition of the gases; and the identification and approximate concentrations of the VOC to be analyzed. It may be necessary to take samples for analysis to acquire any information that is not readily available.

2. The instrument shall be calibrated as follows:

i. The instrument shall be operated according to the manufacturer's instructions;

ii. Adjust the analyzer to the zero reading by using zero gas; and

iii. Introduce three laboratory standard calibration gases separately recording the response for each. Plot the response versus the concentration. No response should deviate from the best fit line through the three points by more than five percent. If linearity cannot be obtained over the concentration range expected, the sample should be diluted to a concentration level where linearity can be obtained.

iv. Introduce a sample of the field standard and record the response.

3. The sampling and analysis shall be conducted as follows:

i. Assemble and connect any sampling probe, filter, and heating or dilution system to the instrument. All connections shall be tight and leak-free;

ii. Adjust the heating or dilution system to prevent any condensation of the sample gas;

iii. Analyze a sample of the field standard and adjust the instrument to the reading determined during calibration. If a dilution system must be used, record the response of the field standard with the dilution system in place and determine a new calibration curve at the same conditions used in the field;

iv. The probe should be positioned at least two feet into the stack or at the centroid of the stack. The sample port location should be in accordance with N.J.A.C. 7:27B-1, Air Test Method 1, (N.J.A.C. 7:27B-3.18, Reference 1);

v. Activate the system and adjust as necessary to achieve the manufacturer's recommended operating conditions. Record the instrument response using a continuous recording device if available; if a continuous reading device is not available, take a reading at intervals of no less than one minute. Note any non-representative operations or occurrences during the testing and omit those corresponding analyzer readings from the calculations;

vi. For the purposes of this procedure, three separate and valid test runs will be conducted, each of which shall extend for one hour or a batch cycle whichever is longer. Any alternative test period shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e);

vii. During the test period, determine the stack gas velocity, temperature, moisture content, average gas molecular weight, and volumetric flow rates in accordance with the methods prescribed in N.J.A.C. 7:27B-1 AIR TEST METHOD 1 (N.J.A.C. 7:27B-3.18, Reference 1) or other flow determining method which shall be submitted to the Department for review, pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e). See Appendix A

for the required reporting form. (Any alternative reporting form shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c) and (e).)

viii. At the conclusion of each test run, note the time and introduce the field standard gas and determine and record its response. The net response must agree within five percent of the pretest response for the test to be valid.

(f) The calculations shall be performed as follows:

1. Establish the molecular weight of each VOC and calculate a weighted average molecular weight if more than one VOC is present.

2. Calculate the total gas flow rate from the source in SCFM (70°F and 1 atm) including the contribution of the VOC and any moisture present.

3. Determine the response factor (RF) of the lab standard from the following equation.

$$RF = \frac{C \text{ ppm (std)}}{\text{Response (Meter Reading)}}$$

4. Calculate the concentration of VOC as the standard as follows:

$$C (\text{VOC as std.}) = \text{Instrument Response} \times RF$$

5. Calculate the emission rate in lbs/hr. expressed as the laboratory standard calibration gas.

$$\frac{\text{lbs. VOC}}{\text{hr}} = \frac{\text{Avg. C ppm (VOC as std.)} \times \text{SCFM} \times \text{MW(std.)} \times 60(\text{min/hr})}{387 \times 10^6}$$

Where:

C ppm (std) = the concentration in ppm of the standard mixture.

Avg. C ppm (VOC as std.) = average parts per million of VOC over the test period as laboratory standard calibration gas.

MW (std) = molecular weight of laboratory calibration standard (pounds per pound-mol).

SCFM = cubic feet per minute at 70°F and 1 atm emitted from the source operation.

387 = molar volume at standard conditions in cubic feet per pound-mol.

RF = response factor for VOC.

NOTE: This formula is based upon the assumption that both the standards and the sample have been passed through the same sampling system and are diluted by the same amount.

(g) The test report shall include the following information submitted on the required reporting forms in Appendix B (any alternative reporting form shall be submitted to the Department for review prior to use pursuant to N.J.A.C. 7:27B-3.2(c) and (e)):

1. A dimensioned sketch of the sampling location;
2. All data used to determine the volume flow rate;
3. The composition of the gas and its average molecular weight;
4. A sketch and/or description of the sampling system used;
5. The identity, concentration and means of verification for each standard used;
6. A description of the analysis instrument and the conditions of operation;
7. Sufficient details of the calculations to allow the results to be reproduced independently;
8. The emission rate measured in lbs/hr of each VOC for each test;
9. Operating conditions of the source operation; and
10. An explanation for any unusual procedures or results.

Amended by R.1992 d.102, effective March 2, 1992 (operative March 28, 1992).

See: 23 N.J.R. 1858(b), 24 N.J.R. 792(a).

"VOS" changed to "VOC".

7:27B-3.8 Procedures for the direct measurement of volatile organic compounds using a gas chromatograph (GC) with a flame ionization detector (FID) or other suitable detector

(a) The method in this section is applicable for the determination of the concentrations and the mass emission rates of any known VOC in unknown proportions in systems with constant emissions and flow rates. For the same circumstances as described above, the procedure specified in N.J.A.C. 7:27B-3.9 may be used in place of this method. Any other alternative test method shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

(b) This method is based upon the following principles:

1. Gas chromatography, whereby VOC are separated by passing an inert gas stream containing a known volume of the sample gas or a standard gas through a column containing a suitable stationary phase and/or a solid support; and

2. Ionization produced when each VOC in the gas sample as eluted from the gas chromatograph is combusted in a hydrogen flame. The ions and electrons formed in the flame enter an electrode gap, decrease the gas resistance, and thus permit a current flow in an external circuit. The resulting current is proportional to the instantaneous concentration of the VOC. Any alternative detector shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

(c) The following is a summary of this method:

1. The GC-FID is calibrated with standard gas mixtures containing each VOC being measured to establish the calibration curves and retention times. A representative sample is drawn into the gas sampling loop under conditions which prevent any condensation of the sample gas and which remove particulate matter. The sample is injected into the GC, the responses and retention times of the individual VOC are recorded on a strip chart recorder, and the peak areas of each VOC are measured. The peaks are identified from the established retention times. The concentration of each VOC is determined by referring to the calibration curve. The total gas flow rate, moisture content, and the average molecular weight of the gas are determined during the sampling period, and the mass emission rate of the VOC is calculated and reported as pounds per hour.

2. For the purposes of this procedure, three separate test runs will be conducted, each of which shall extend for one hour or a batch cycle whichever is longer. Any alternative test period shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

3. In situations where safety considerations, location, or number of sample points prohibit direct analysis at the VOC source, the samples are collected in accordance with the method prescribed in N.J.A.C. 7:27B-3.9 and transported to the GC-FID for analysis.

(d) The following is a list of equipment used in this method:

1. Probe;
2. Sample line;
3. Temperature sensor;
4. Pump;
5. Gas sampling valve;
6. Needle valve;
7. Gas chromatograph-flame ionization detector (GC-FID);
8. Recorder/Integrator;
9. Gas cylinder supplies as follows:
 - i. Laboratory standard calibration gases;

- ii. Pure components standard;
 - iii. Fuel gas;
 - iv. Combustion gas; and
 - v. Carrier gas.
10. Velocity meter;
11. Condensor; and
12. Dilution system (if necessary): a system as described in N.J.A.C. 7:27B-3.9.(e)4, capable of producing dilution ratios which will prevent any condensation of the sample gas and capable of bringing the sample concentration within the linear range of the GC detector.

(c) The procedure for this section shall be as follows:

1. A presampling survey of the source operation(s) shall be conducted to establish certain basic information including but not limited to: sampling location; stack temperature and pressure; stack gas moisture content; approximate particulate concentration; composition of the gases; and the identification and approximate concentrations of the VOC to be analyzed. It may be necessary to take samples for analysis to acquire any information that is not readily available.

2. The instruction shall be calibrated as follows:

i. The instruction shall be operated according to the manufacturer's instructions;

ii. The operating parameters of the instruction such as column selections, temperatures, carrier gas flow rate, and chart speed shall be established for the VOC to be measured and verified in the laboratory prior to actual sampling. The conditions selected should produce baseline separation of the individual VOC peaks, if possible, but in no case should the height of the valley between the two peaks measured from the baseline to the lowest point in the valley be greater than 30 percent of the height of the shorter of the two peaks. More than one set of conditions may be necessary for complete resolution;

iii. The instrument operating conditions shall be recorded on the chart and maintained throughout the calibration and sample gas analyses. The operating conditions to be recorded are sample loop temperature, column temperature, carrier gas flow rate, and chart speed. Attenuator setting shall be adjusted as required and recorded on the chart to indicate the time and amount of adjustment;

iv. Purge the sample loop with one of the calibration gas mixtures and record the concentration;

v. Activate the sampling valve to inject the sample and mark the injection point on the chart;

vi. Measure the distance on the chart from the injection point to the time at which the peak maximum

occurs for the calibration mixture. This distance divided by the chart speed will provide the retention time for each compound;

vii. Calculate the sample peak areas by multiplying the height times the width at half height and adjust each peak area by the attenuator setting as required. An integrator may be used to calculate peak areas;

viii. Repeat steps iv through vii for each calibration gas until two consecutive analyses agree within five percent. The corresponding peak areas for each VOC shall then be averaged;

ix. Plot the areas of each peak versus the concentration on suitable graph paper. If any point should deviate from a straight line by more than five percent, the calibration shall be repeated. If a straight line is not obtained, less concentrated standards or a smaller sample must be used to bring the response within the linear range of the detector; and

x. Draw a straight line through the points to establish a calibration curve for each VOC. Calculate the unknown VOC concentrations from their peak areas by reading from the appropriate calibration curve or by multiplying the peak area by the slope of the calibration curve. Extrapolation beyond the calibrated range is not acceptable.

xi. The instrument calibration shall be checked just prior to each test. The calibration gas shall be introduced through the sampling system in a manner similar to the introduction of the source gas.

3. The sampling and analysis shall be conducted as follows:

i. Assemble and connect any sampling probe, sample line, filter and heating or dilution system to the GC-FID. All connections shall be tight.

ii. Turn on the GC and source gas sampling systems and adjust conditions to prevent any condensation of the sample gas;

iii. If a dilution system is used, run three field standards through the dilution system and the instrument and record each response. The response shall not deviate from linearity by more than five percent;

iv. The probe shall be positioned at least two feet into the stack or at the centroid of the stack. The sample port location shall be in accordance with N.J.A.C. 7:27B-1, AIR TEST METHOD 1 (N.J.A.C. 7:27B-3.18, Reference 1);

v. After thoroughly purging the gas sampling loop with source gas, analyze a sample of the source gas maintaining the same instrument operating conditions used during the calibration procedures. Calculate the concentrations of the components by referring to the calibration curve; and

vi. Repeat the analysis at uniform intervals as many times as practical during the test run. No less than three sample analyses per test run shall be acceptable;

vii. For the purposes of this procedure three separate and valid test runs will be conducted, each of which shall extend for one hour or a batch cycle whichever is longer. Any alternative test period shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

viii. During the test period, determine the stack gas velocity, temperature, moisture content, average gas molecular weight, and volumetric flow rates in accordance with the methods prescribed in N.J.A.C. 7:27B-1, AIR TEST METHOD 1 (N.J.A.C. 7:27B-3.18, Reference 1), or other flow determining method submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e). See Appendix A for the required reporting form. (Any alternative reporting forms shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c) and (e).)

ix. At the conclusion of each test run introduce the calibration gas in a manner similar to the introduction of the source gas and determine the response. The net response must agree to within $\pm$ five percent of the pretest response for the test to be valid.

(f) The calculations shall be performed as follows:

1. Establish the molecular weight of each VOC.
2. Calculate the total gas flow rate from the source operation(s) in SCFM (70°F and 1 atm) including the contribution of the VOC and any moisture present.
3. Record the individual concentrations (C ppm) and determine the average concentration (C) of each VOC in ppm (avg. C ppm) for each test run from the calibration curves.
4. Calculate the emission rate in lbs/hr of each VOC as follows:

$$\frac{\text{lbs VOC}}{\text{hr}} = \frac{\text{Avg. C ppm(VOC)} \times \text{MW(VOC)} \times \text{SCFM}}{387 \times 10^6}$$

Where:

Avg. C ppm(VOC) = average parts per million of VOC over the test period.

MW (VOC) = molecular weight of VOC (pounds per pound-mol).

SCFM = cubic feet per minute at 70°F and 1 atm emitted from the source operation.

387 = molar volume at standard conditions in cubic feet per pound-mol.

NOTE: This formula is based upon the assumption that both the standards and the sample have been passed through the same sampling system and diluted by the same amount.

5. Calculate the total emission rate in lbs/hr of the VOC by totaling the individual VOC calculated in (f)4 above.

(g) The test report shall include the following information submitted on the required reporting form in Appendix C (any alternative reporting form shall be submitted to the Department for review pursuant to N.J.A.C. 7:27-3.2(c) and (e)):

1. A dimensioned sketch of the sampling location;
2. All data used to determine the volume flow rates;
3. The composition of the gas and its average molecular weight;
4. A sketch and/or description of the sampling system used;
5. The identity, concentration, and means of verification for each standard used;
6. A description of the analysis instrument and the conditions of operation;
7. Copies of the chromatograms for each standard and each test run identified as to time taken and pertinent instrument and dilution conditions;
8. Sufficient details of the calculations to allow the results to be reproduced independently;
9. The emission rate measured in lbs/hr of each VOC for each test;
10. Operating conditions of the source operations; and
11. An explanation for any unusual procedures or results.

Amended by R.1992 d.102, effective March 2, 1992 (operative March 28, 1992).

See: 23 N.J.R. 1858(b), 24 N.J.R. 792(a).

"VOS" replaced by "VOC".

7:27B-3.9 Procedures for the sampling and remote analysis of known volatile organic compounds using a gas chromatograph (GC) with a flame ionization detector (FID) or other suitable detector

(a) The method in this section is applicable for the determination of the concentration and the mass emission rates of known VOC from a source where it is not practical to conduct a direct analysis at the source or in systems where the flow rates are not constant. For the same circumstances as described above, any other alternative test method shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

(b) This method is based upon the following principles:

1. The reduction of the moisture and VOC levels in the source gas by condensation or dilution;

2. Collecting the resulting dry sample gas in a Tedlar or equivalent bag;

3. Gas chromatography whereby each VOC is separated by passing an inert gas stream containing a known volume of the sample gas or standard gas through a column containing a stationary phase and/or a solid support; and

4. Ionization produced when each VOC in the sample gas as eluted from the gas chromatograph is combusted in a hydrogen flame. The ions and electrons formed in the flame enter an electrode gap, decrease the gap resistance, and thus permit a current flow in an external circuit. The resulting current is proportional to the instantaneous concentration of the VOC. Any alternative detector shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

(c) The following is a summary of this method:

1. A representative sample from the source is drawn at a constant rate through a heated sample line to a series of condensers in an ice bath where the moisture and condensable VOC are removed, or to a dilution system which reduces the concentration of the source gas by a known amount with hydrocarbon-free air. The dry sample gas is collected in a Tedlar or equivalent sampling bag which, along with any collected condensate, is transported to the GC-FID for analysis.

2. The GC-FID is calibrated with standard gas mixtures of each VOC being measured to establish the calibration curve and retention times. Representative portions of any condensate and the bag sample are injected separately into the calibrated GC-FID. The responses and retention times of the individual VOC are recorded on a strip chart recorder and the peak areas of each VOC are measured. The peaks are identified from the established retention times. The concentration of each VOC is determined by referring to the calibration curve. The total gas flow rate, moisture content, and the average molecular weight of the gas are determined during the sample period, and the mass emission rate of the VOC is calculated and reported as pounds per hour.

3. For the purposes of this procedure, three separate test runs will be conducted, each of which shall extend for one hour or a batch cycle whichever is longer. Any alternative test period shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

(d) The following is a list of equipment used in this method:

1. Probe;

2. Sample line;

3. Temperature sensor;

4. Pump;

5. Gas sampling valve;

6. Needle valve;

7. Condensation trap: three midget impingers (two with 10 ml of distilled water and one dry) in an ice bath;

8. Gas meter: a dry gas meter to measure the volume of the gas sample collected;

9. Sample bag: a Tedlar or equivalent bag with a volume at least 50 percent greater than the expected sample size and equipped with a hose connection and shut-off valve to collect and store the sample;

10. Gas chromatograph—flame ionization detector (GC-FID);

11. Recorder/Integrator;

12. Gas cylinder supplies, including the following:

i. Laboratory standard calibrations gases;

ii. Pure component standards;

iii. Fuel gas;

iv. Combustion gas; and

v. Carrier gas.

13. Velometer;

14. Condensor (water);

15. Condensor (VOC): a system as specified in (e)3 below for collecting condensible VOC and moisture from the source gas consisting of: a probe, three midget impingers (two containing ten ml. of distilled water and one dry, all three immersed in an ice bath), a pump, and a dry gas meter all connected in series;

16. Dilution system (if circumstances require): a system as specified in (e)4 below, capable of producing dilution ratios which will prevent any condensation of the sample gas and capable of bringing the sample concentration within the linear range of the detector;

17. Rotameters: flowmeters constructed of glass, stainless steel or Teflon of appropriate size used to measure the gas flow rate. The meters must be heated, if necessary, and calibrated with the gas to be measured. A calibration may be made with another gas and then corrected accordingly;

18. Charcoal tube: a drying tube filled with activated charcoal with glass wool plugs in both ends to absorb organic vapors from the vented sample gas and to prevent the release of VOC into the work area;

19. Dilution gas; and

20. Sparger module: a sparge-desorb module to strip VOC from the impinger condensate and trap the VOC on a suitable adsorbant.

(e) The procedure for this section shall be as follows:

1. A presampling survey of the source operation(s) must be conducted to establish certain basic information including but not limited to: sampling location, stack temperature and pressure, stack gas moisture content, approximate particulate concentration, composition of the gases, and the identification and approximate concentrations of the VOC to be analyzed. It may be necessary to take samples for analysis to acquire any information that is not readily available;

2. The instrument shall be calibrated as follows:

i. The instrument shall be operated according to the manufacturer's instruction;

ii. The operating parameters of the instrument such as column selections, temperatures, carrier gas flow rate, and chart speed must be established for the VOC to be measured, and verified in the laboratory prior to the actual sampling. The conditions selected should produce baseline separation of the individual VOC peaks, if possible, but in no case should the height of the valley between the peaks measured from the baseline to the lowest point in the valley be greater than 30 percent of the height of the shorter of the two peaks. More than one set of conditions may be necessary for complete resolution;

iii. The instrument operating conditions shall be recorded on the chart and maintained throughout the calibration and sample gas analyses. The operating conditions are sample loop temperature, column temperature, carrier gas flow rate, and chart speed. Attenuator settings shall be adjusted as required and recorded on the chart to indicate the time and amount of adjustment;

iv. Purge the sample loop with one of the calibration gas mixtures and record the concentration;

v. Activate the sampling valve to inject the sample and mark the injection point on the chart;

vi. Measure the distance on the chart from the injection point to the time at which the peak maximum occurs for the calibration mixture. This distance divided by the chart speed will provide the retention time for each compound; and

vii. Calculate the sample peak areas by multiplying the height times the width at half height and adjust each peak area by the attenuator setting as required. An integrator may be used to calculate peak areas.

viii. Repeat steps iv through vii for each calibration gas until two consecutive analyses agree within five percent. The corresponding peak areas for each VOC shall then be averaged.

ix. Plot the areas of each peak versus the concentrations on suitable graph paper. If any point should deviate from a straight line by more than five percent, the calibration shall be repeated. If a straight line is not obtained, less concentration standards or a smaller sample must be used to bring the response within the linear range of the detector.

x. Draw a straight line through the points to establish a calibration curve for each VOC. Calculate the unknown VOC concentrations from their peak areas by reading from appropriate calibration curve or by multiplying the peak area by the slope of the calibration curve. Extrapolation beyond the calibrated range is not acceptable.

xi. The instrument calibration shall be checked just prior to each test. The calibration gas shall be introduced through the sampling system in a manner similar to the introduction of the source gas.

3. Sampling shall be conducted as follows when using a condensor system:

i. Each bag shall be tested for contamination by filling with nitrogen or air and allowing it to stand for 24 hours. The gases shall be analyzed by gas chromatograph at high sensitivity. Any bag found to be contaminated shall be discarded.

ii. Each bag shall be checked for leaks by pressurizing it to two to four inches of water and allow to stand overnight. A deflated bag indicates a leak.

iii. Connect the probe to a condensor, sample bag, pump, and a dry gas meter as shown. See Appendix C. See Appendix D for the required reporting form. (Any alternative reporting form shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c) and (e));

iv. Conduct a leak check according to the following procedure:

(1) Insert a clean, leak-free sample bag in the rigid container and prepare the container for a leak check. If the sampling container is truly rigid, the following leak-check shall be performed:

(A) Adjust the three-way valves to allow the evacuation of the rigid container;

(B) Plug the end of the probe and pull a vacuum of 15 inches mercury across the sampling train; and

(C) Monitor the flow meter and gas meter for flow movement. Any leak equal to or greater than four percent of the sampling rate is unacceptable;

(D) If an unacceptable leak exists, it shall be corrected and the leak check procedure repeated. If a leak occurred, the sample bag will have to be reevacuated prior to sampling. This is done by realigning the three-way valves so that a vacuum can be applied directly to the sample bag.

(2) If the sampling container cannot hold a vacuum of 15 inches mercury, then the following leak check procedures shall be used:

(A) Adjust the three-way valves to prevent any flow from entering the sample bag and with a water manometer in the line, pull a vacuum of 5–10 cm water (2–4 in. water) on the rigid container and then seal the container in such a way as to monitor the container pressure. Allow to stand for ten minutes. Any displacement in the water manometer indicates a leak. Refer to (1)(D), above if a leak occurs.

(B) After successfully leak checking the rigid container, adjust the three-way valves to by-pass the rigid container; and repeat steps (1)(B) and (1)(C), above.

v. Turn on the probe heating system and adjust to a temperature to prevent any condensation of the sample gas;

vi. The probe should be positioned at least two feet into the stack or at the centroid of the stack. The sample port location shall be in accordance with N.J.A.C. 7:27B-3.18, Reference 1. Record the initial meter volume;

vii. Purge the system by aligning the three-way valves on the rigid container so that a vacuum can be pulled directly on the impingers. The three-way valves shall be located close to the rigid container to avoid dilution air from entering the sample bag;

viii. Turn on the pump and adjust the flow so that a minimum of 20 liters of sample gas will be collected during the test period;

ix. Purge the system for five minutes, then realign the three-way valves on the rigid container so that the sample bag will be on the stream with the source gas. Continue to sample in this manner for the remainder of the test run;

x. Record the temperatures and pressures at five-minute intervals during the test period. See Appendix E for the required reporting form. (Any alternative reporting form shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c) and (e).)

xi. Record the final meter volume at the conclusion of the test run. Remove the probe from the stack and perform a leak check as previously described. The test shall be voided if the leak rate is equal to or greater

than four percent of the sampling rate as determined on the first post test leak check attempt;

xii. Rinse the probe, all connecting lines through the impingers and the impingers with an appropriate solvent. The rinse solution and impinger collect shall be placed in an opaque leak-proof container for later analysis. The container should be filled to minimize loss of VOC in the headspace;

xiii. The sample bag must be protected from heat and sunlight to prevent reactions between sample components and should be analyzed within 24 hours unless it can be shown that significant sample degradation does not occur;

xiv. For the purposes of this procedure, three separate and valid test runs will be conducted, each of which shall extend for one hour or a batch cycle whichever is longer. Any alternative test period shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e);

xv. During the test period, determine the stack gas velocity, temperature, moisture content, average gas molecular weight and volumetric flow rate in accordance with the methods prescribed in N.J.A.C. 7:27B-1 AIR TEST METHOD 1 (N.J.A.C. 7:27B-3.18, Reference 1), or other alternative method, which shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e). See Appendix A for the required reporting form. (Any alternative reporting form shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c) and (e).)

xvi. At the conclusion of each test run introduce the calibration gas in a manner similar to the introduction of the source gas and determine the response. The net response must agree to within $\pm$ five percent of the pretest response for the test to be valid.

4. Sampling shall be conducted as follows when using a dilution system:

i. Each bag shall be tested for contamination by filling with nitrogen or air and allowing it to stand for 24 hours. The gas shall be analyzed by gas chromatograph at high sensitivity. Any bag found to be contaminated shall be discarded.

ii. Each bag shall be checked for leaks by pressurizing it to two to four inches of water and allow to stand overnight. A deflated bag indicates a leak.

iii. Connect the probe to a dilution system, sample bag, pump, and a dry gas meter in series as shown. See Appendix C. See Appendix D for the required reporting form. (Any alternative reporting form shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c) and (e).)

iv. Conduct a leak check according to the procedure outlined in (e)3ii above;

v. Turn on the probe heating system and adjust to a temperature which will prevent condensation;

vi. The probe shall be positioned at least two feet into the stack or at the centroid of the stack. The sample port location should be in accordance with N.J.A.C. 7:27B-1, AIR TEST METHOD 1 (N.J.A.C. 7:27B-3.18, Reference 1);

vii. Purge the system by aligning the three-way valves on the rigid container so a vacuum can be pulled directly on the dilution system. The three-way valves shall be located close to the rigid container to avoid dilution air from entering the sample bag;

viii. Turn on the pump and adjust the flow to give the desired dilution rate and to ensure that a minimum of 20 liters of sample gas will be collected during the test period;

ix. Before sampling, verify that the system is working properly by introducing a calibration gas into the system and collect an audit sample maintaining the same operation conditions to be used during sampling. Transport this sample to the GC for immediate analysis, if possible; otherwise repeat the audit at the end of the tests and transport the audit samples to the laboratory along with the test samples. The audit results should be within five percent of the calibration gas concentration; if not, correct the problem and repeat the audit. In cases where immediate analysis is not possible, the audit results may be used to determine a correction factor;

x. Purge the system for five minutes. Then realign the three-way valves on the rigid container so the sample bag will be on stream with the source gas. Continue to sample maintaining the same dilution rate used for the audit test for the remainder of the test run;

xi. Record the temperatures and pressures at five-minute intervals during the test period. See Appendix E for required reporting form. (Any alternative reporting form shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c) and (e).)

xii. Record the final meter volume at the conclusion of the test run. Remove the probe from the stack and perform a leak check as previously described. The test shall be voided if the leak rate is equal or greater than four percent of the sampling rate as determined on the first post test leak check attempt; and

xiii. Remove the sample bag from the rigid container. Visually inspect the sample bag. If any condensation is observed, the test run shall be voided and a new run must be conducted using a greater dilution ratio;

xiv. The sample bag must be protected from heat and sunlight to prevent reactions between sample components and should be analyzed within 24 hours unless it can be shown that significant sample degradation does not occur;

xv. For the purpose of this procedure, three separate and valid test runs shall be conducted, each of which shall extend for one hour or a batch cycle, whichever is longer. Any alternative test period shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e);

xvi. During the test period, determine the stock gas velocity, temperature, moisture content, average gas molecular weight, and volumetric flow rate in accordance with the methods prescribed in N.J.A.C. 7:27B-1 AIR TEST METHOD 1 (N.J.A.C. 7:27B-3.18, Reference 1), or other appropriate flow determining method which shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e). See the required reporting form at Appendix A. (Any alternative reporting form shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c) and (e).)

5. The bag sample shall be analyzed as follows:

i. Turn on the GC and adjust the sample valve and those conditions which will prevent any condensation of the sample gas;

ii. After thoroughly purging the gas sampling loop with source gas, analyze an aliquot of the bag sample maintaining the same instrument operating conditions used during the calibration procedures; and

iii. Analyze each sample until two consecutive analyses agree within five percent. Average the corresponding peak areas for each compound. Calculate the concentrations of the components by referring to the calibration curves.

6. The condensation trap shall be analyzed as follows:

i. Connect the sparge and trap module to the GC injection system and set the valve, desorb temperature, and the inert gas flow rate as per manufacturer's specifications;

ii. Mix the condensate solution to obtain a representative sample and fill the sparger to the recommended volume;

iii. Sparge the sample into an appropriate trap for a minimum of 10 minutes with an inert gas. Thermally desorb the VOC from the trap onto the GC column and analyze the VOC employing the same instrument conditions used during the calibration procedures. Measure the area under each VOC peak. Save the sparged solution;

iv. Analyze each sample until two consecutive analyses agree within five percent. Average the corresponding peak areas for each component and calculate the concentrations of the components by referring to the calibration curves;

v. Combine the sparged solutions and analyze by either extracting with a solvent or by re-sparging an aliquot as a check on the sparge efficiency; and

vi. Inject an appropriate aliquot of the rinse solution into the GC, employing the same instrument conditions used during the calibration procedures. Measure the area under each peak, eliminating the solvent area.

(f) The calculations shall be performed as follows:

1. Establish the molecular weight of each VOC from the literature.

2. Calculate the total gas flow rate from the source operations in SCFM (70°F and 1 atm) including the VOC and any moisture present.

i. If impingers are used calculate the SCFM on a dry basis.

ii. If a dilution system is used with no impingers calculate the SCFM on a wet basis.

3. All flow meter readings must be corrected for temperature, pressure and specific gas density if necessary.

4. Bag Sample: Determine the concentration (C) of each VOC in ppm (C_{ppm} VOC) by using the calibration curves developed in (e)2x above and the area of each VOC. If the sample is collected using a dilution system, the concentrations shall be corrected by the dilution factor (D_f) as determined by the following formula:

$$D_f = \frac{\text{ml/min dilution gas} + \text{ml/min source gas}}{\text{ml/min source gas}}$$

5. Condensate and rinse: Convert the calibration curves used in (e)2x above from ppm vs. area to microgram (ugm) vs. area. Determine the concentration (C) of each VOC in the condensate and rinse in ppm (C_{ppm} VOC) in the vapor phase from the VOC peak areas and the calibration curves using the following formula:

$$C_{\text{ppm VOC}} = \frac{(\text{Area}) (\text{slope}) \times V_c \times 24.1}{V_j \times \text{MW (VOC)} \times V_g}$$

Where:

Area = area of VOC peak (area units).

Slope = slope of calibration curve (ugm/area unit).

V_c = Condensate Volume (milliliters).

V_j = injection volume (milliliters).

V_g = volume of gas sampled (liters).

MW VOC = molecular weight of VOC (gram per gram mol).

24.1 = molar volume at standard conditions in liters per gram mol.

6. Determine the total concentration (C) of each VOC in the source gas in ppm (C_{ppm}) by summing the results of each VOC from 4 and 5 above;

7. Calculate the emission rate in lbs/hr of each VOC as follows:

$$\frac{\text{lbs VOC}}{\text{hr}} = \frac{C_{\text{ppm(VOC)}} \times \text{SCFM} \times \text{MW (VOC)} \times 60 \text{ min/hr}}{387 \times 10^6}$$

Where:

C_{ppm} (VOC) = sum of bag sample and condensate concentrations in part per million of each VOC.

MW (VOC) = molecular weight of VOC (pounds per pound-mol).

SCFM = cubic feet minute at 70°F and 1 atm emitted from the source operation (dry if impingers used; wet if no impingers used).

387 = molar volume at standard conditions in cubic feet per pound-mol.

8. Calculate the total emission rate of VOC in lb/hr by totaling the emission rates of each individual VOC as calculated in 6 above.

(g) The test report shall include the following information submitted on the required reporting forms listed in Appendices D and E (any alternative reporting forms shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c) and (e)):

1. A dimensioned sketch of the sampling location;
2. All data used to determine the volume flow rate;
3. The composition of the gas and its average molecular weight;
4. A sketch and/or description of the sampling system used;
5. The identity, concentration and means of verification for each standard used;
6. A description of the analysis instrument and the conditions of operations;
7. Copies of the chromatograms for each standard and each test run identified as to time taken and pertinent instrument and dilution conditions;
8. Sufficient details of the calculations to allow the results to be reproduced independently;
9. The emission rate measured in lbs/hr of each VOC for each test;
10. Operating conditions of the source operation; and
11. An explanation for any unusual procedures or results.

7:27B-3.10 Procedures for the determination of volatile organic compounds in surface coating formulations

(a) The method in this section is applicable for the determination of the VOC contained in formulations used in surface coating operations. Any alternative test method shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

(b) This method is based upon the determination of the amount of VOC and water, if present, in a surface coating formulation, the density of the surface coating formulation, and the density of the volatile fraction of the surface quality.

(c) The procedure for this section shall be as follows:

1. Completely fill a container with a representative sample of the surface coating formulation to be analyzed. Seal the container so that the VOC present will not escape; and

2. Classify each surface coating material as follows:

- i. Class I: General solvent type paints (oil base), varnishes and lacquers including clear and pigmented varnishes and lacquers and coatings not clearly belonging to Class II; or

- ii. Class II: Water-thinned coatings including emulsions, latex paints and colored enamels.

(d) The coating samples shall be analyzed as follows:

1. Class I surface coatings shall be analyzed as follows:

- i. Determine the density of the formulation using the procedure specified in ASTM Designation D 1475-60, "Standard Method for Test for Density of Paint, Varnish, Lacquer, and Related Products" (N.J.A.C. 7:27B-3.18, Reference 7);

- ii. Determine the VOC content by using the procedure specified in ASTM Designation D 2369-81, "Standard Method of Test for Volatile Content of Coatings" (N.J.A.C. 7:27B-3.18, Reference 8);

- iii. Calculate the VOC content in $\frac{\text{kg}}{\text{L}}$ as follows:

$$\text{VOC } \frac{\text{kg}}{\text{L}} = \frac{W_1 - W_2 (\text{DM}) \times \text{kg} \times 1000 \text{ ml}}{S \times 1000 \text{ gm} \times \text{L}}$$

Where:

W_1 = weight of dish + sample (gm)

W_2 = weight of dish + sample after heating (gm)

DM = density of coating (gm/ml)

S = sample weight (gm)

L = liters

- iv. Sources included in a mathematical combination regulated by N.J.A.C. 7:27-16.5(a) shall be analyzed as follows:

- (1) Separate the volatile fraction from the solids either by high speed centrifuge, ASTM D2698-73, "Standard Test Method for the Determination of the Pigment Content of Solvent Reducible Paints by High Speed Centrifuging" (N.J.A.C. 7:27B-3.18, Reference 12), or by distillation, ASTM D95-83, "Standard Test Method for Determining Water in Petroleum and Bituminous Materials by Distillation" (N.J.A.C. 7:27B-3.18, Reference 13). ASTM D95-83 shall be modified by not adding the required solvent and continuing the distillation until the sample is dry. Measure the volume V and the weight W of the volatile fraction (see Appendix I);

- (2) Calculate the density of the VOC fraction in gm/ml as follows:

$$D(\text{voc}) = \frac{W}{V}$$

Where:

W = weight of the volatile fraction

V = volume of the volatile fraction

- (3) Convert density VOC from gm/ml to lb/gal as follows:

$$D(\text{voc}) \text{ lb/gal} = 8.345 D(\text{VOC}) \text{ gm/ml}$$

2. Class II surface coatings shall be analyzed as follows:

- i. Determine the density of the formulation using the procedure specified in ASTM Designation D 1475-60, "Standard Method for Test for Density of Paint, Varnish, Lacquer, and Related Products" (N.J.A.C. 7:27B-3.18, Reference 7);

- ii. Determine the water content of the formulation using the procedure specified in ASTM D4017-81, "Standard Test Method for Water in Paints and Paint Materials" by Karl Fisher (N.J.A.C. 7:27B-3.18, Reference 9);

- iii. Determine the VOC content by using the procedure specified in ASTM Designation D2369-81, "Standard Method of Test for Volatile Content of Coatings" (N.J.A.C. 7:27B-3.18, Reference 8);

- iv. Calculate the VOC content in kg VOC per liter of coating less water as follows:

$$\text{VOC } \frac{\text{kg}}{\text{L}} = \frac{(W_1 - W_2 - 0.1 \text{ PS})}{(1 - .01 P D_m)} \frac{D_m \times \text{kg} \times 1000 \text{ ml}}{S \times 1000 \text{ gm} \times \text{L}}$$

Where:

W_1 = weight of dish + sample (gm)

W_2 = weight of dish + sample after heating (gm)

P = percentage of water (%)

D_m = density of coating (gm/ml)

D_H = density of water (gm/ml)

S = sample weight (gm)

L = liter

Convert VOC content from kg/l to lb/gal as follows:

$$\text{cVOC } \frac{\text{lb}}{\text{gal}} = \frac{\text{cVOC kg} \times 8.345}{\text{L}}$$

v. Sources included in a mathematical combination shall be analyzed as follows:

(1) Separate the volatile fraction (including water if present) from the solids either by high speed centrifuge, using ASTM D2698-73, "Standard Test Method for the Determination of Pigment, Content of Solvent Reducibly Paints by High Speed Centrifuging" (N.J.A.C. 7:27B-3.18, Reference 12), or by distillation, ASTM D95-83, "Standard Test Method for Determining Water in Petroleum and Bituminous and Materials by Distillation" (N.J.A.C. 7:27B-3.18, Reference 13). ASTM D95-83 shall be modified by not adding the required solvent and continuing the distillation until the sample is dry and by purging the distillation apparatus with 5-10 CC/min air or nitrogen. Measure the volume V (mix) and the weight W (mix) of the volatile fraction. See Appendix I.

(2) Calculate the density of the volatile fraction in gm/ml.

$$D(\text{mix}) = \frac{W(\text{mix})}{V(\text{mix})}$$

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Where:

W(mix) = weight of the volatile fraction

V(mix) = volume of the volatile fraction

(3) Calculate the density of the VOC in gm/ml.

$$D(\text{VOC}) \text{ gm/ml} = \frac{(1 - P) W(\text{mix}) D(w) D(\text{mix})}{D(w) W(\text{mix}) P W(\text{mix}) D(\text{mix})}$$

Where:

P = percentage of water (%)

W(mix) = weight of the volatile fraction (gm)

D(mix) = density of the volatile fraction (gm/ml)

D(w) = density of water (gm/ml)

(4) Convert density of the volatile mixture from gm/ml to lb/gal as follows:

$$D(\text{mix}) \text{ lb/gal} = 8.345 D(\text{mix}) \text{ gm/ml}$$

Amended by R.1992 d.102, effective March 2, 1992 (operative March 28, 1992).

See: 23 N.J.R. 1858(b), 23 N.J.R. 2119(a), 24 N.J.R. 792(a).
"VOS" replaced by "VOC".

7:27B-3.11 Procedures for the determination of volatile organic compounds emitted from transfer operations using a flame ionization detector (FID) or non-dispersive infrared analyzer (NDIR)

(a) The procedure in this section is applicable for the determination of the mass emission of VOC rates from the transfer or loading of gasoline. Any alternative test method

shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

(b) This method is based upon one of the following two principles:

1. Flame Ionization, which involves ionization produced when the VOC in the sample is combusted in a hydrogen flame. The ions and electrons formed in the flame enter an electrode gap, decrease the gap resistance, and thus permit a current flow in an external circuit. The resulting current is proportional to the instantaneous concentration of the VOC; or

2. Non-Dispersive Infra-Red, which involves absorption of infrared energy when a band of infrared energy containing the proper frequencies is alternately passed through an absorption cell containing the organic vapor and a reference cell. The difference in absorption between the reference cell and the absorption cell containing the organic vapor is proportional to the instantaneous concentration of the organic vapor.

(c) The following is a summary of this method:

1. The instrument is calibrated with a propane or butane calibration gas to establish the response of the instrument. A representative sample of the VOC is drawn into the detector and the instrument response is recorded on a strip chart recorder. The total gas flow rate and the volume of gasoline pumped are determined for each five minute period. The mass emission rate of VOC is calculated as propane and the results are summed for each five minute period and reported as either percent control efficiency or pounds of VOC per 10,000 gallons of gasoline transferred.

2. For the purpose of this procedure, three separate test runs will be conducted. Each test run shall be conducted over a period of time during which at least 10,000 gallons of gasoline are transferred but in no case shall the test period be less than one hour in duration unless an alternative period shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

3. During each test run, all flanges, valves, connections and fittings shall be tested for leaks using the test procedures outlined in N.J.A.C. 7:27B-3.15.

(d) The following is a list of equipment used in this method:

1. Probe;
2. Temperature sensor;
3. Pump;
4. Flow meter: an appropriate flow measuring device as specified in EPA Method 2A or if testing a vapor incinerator Method 2B (N.J.A.C. 7:27B-3.18, Reference 16);

5. Needle valve;

6. Detector, as set forth below:

i. Flame ionization detector: the instrument shall be capable of meeting manufacturer's specifications by demonstration and those specifications listed in ii below;

ii. Non-Dispersive Infra-Red detector: the specifications are as follows:

(1) Linearity: the instrument response to propane or butane shall not deviate from linearity by more than five percent of the full scale value of the range being used;

(2) Zero drift: less than five percent of full scale per test period or one hour whichever is less;

(3) Span drift: less than five percent of full scale per test period or one hour whichever is less; and

(4) Response time: less than or equal to 30 seconds for 95 percent full scale.

7. Gas supplies:

i. Calibration gases: three manufacturer's certified propane mixture in the range of 1,000; 10,000; and 100,000 ppm and a propane standard for leak determination as specified in N.J.A.C. 7:27B-3.15;

ii. Zero gas;

iii. Fuel gas; and

iv. Combustion gas.

8. Sample line: Teflon or stainless steel tubing with Teflon or stainless steel fittings.

(e) The procedure for this section shall be as follows:

1. Calibrate and install a pressure measurement device (liquid manometer, magnehelic gauge, or equivalent instrument), capable of measuring up to 500 mm of water gauge pressure with ± 2.5 mm of water precision.

2. Connect the pressure measurement device to a pressure tap in the terminal's vapor collection system, located as closely as possible to the connection with the gasoline tank truck.

3. During the performance test, record the pressure every five minutes while a gasoline tank truck is being loaded, and record the highest instantaneous pressure that occurs during each loading. Every loading position shall be tested at least once during the performance test.

4. For the determination of volume at the exhaust vent, the following EPA reference methods shall be used (N.J.A.C. 7:27B-3.18, Reference 16):

i. Method 2B for combustion vapor processing systems; or

ii. Method 2A for all other vapor processing systems.

5. For the determination of VOC concentration at the exhaust vent, procedures outlined in N.J.A.C. 7:27B-3.7 shall be used. The calibration gas shall be either propane or butane.

6. Immediately prior to a performance test all potential sources of vapor leakage in the terminal's vapor collection system equipment shall be monitored for leaks using the procedures outlined in N.J.A.C. 7:27B-3.15. The monitoring shall be conducted only while a gasoline tank truck is being loaded. A reading of 100 percent lower explosive limit or greater of propane shall be considered a leak. All leaks shall be repaired prior to conducting the performance test.

i. All testing equipment shall be prepared and installed as specified in the appropriate test methods.

7. The volume of gasoline dispensed during the performance test period at all loading racks whose vapor emissions are controlled by the processing system being tested shall be determined. This volume may be determined from terminal records or from gasoline dispensing meters at each loading rack.

8. An emission testing interval shall consist of each five-minute period during the performance test. For each interval:

i. The reading from each measurement instrument shall be recorded; and

ii. The volume discharged and the average VOC concentration in the exhaust vent shall be determined, as specified in the appropriate test method. The average VOC concentration shall correspond to the volume measurement and shall be adjusted by the sampling system response time.

9. Unless specified by the Department, each performance test shall consist of not less than three separate and valid test runs. Each test run shall be conducted over a period of time during which at least 10,000 gallons of gasoline are transferred but in no case shall the test period be less than one hour in duration.

10. To determine the efficiency of a control device, simultaneous tests shall be conducted on the vapor in the gaseous stream displaced from the receiving vessel upstream of any vapor control system and at the exhaust vent of the control system.

(f) The calculations shall be performed as follows:

1. Calculate the mass emitted during each testing interval as follows:

$$\frac{\text{lbs VOC}}{\text{Less interval}} = \frac{\text{C ppm (as std)} \times 5 \text{ min}}{\times \text{SCFM} \times \text{MW (std)}} \times 387 \times 10^6$$

Where:

Cppm (as std) = parts per million of VOC as standard (propane or butane).

MW (std) = molecular weight of standard (propane or butane).

SCFM = Cubic feet per minute at 70°F and 1 atm emitted by the source.

387 = molar volume at standard conditions in cubic feet per pound-mol.

2. Calculate the total VOC emitted during the test period by summing the lbs. VOC per each test interval as calculated in 1 above.

3. Calculate the efficiency of the emission control system as follows:

$$\% \text{ Efficiency} = \frac{(\text{lbs/test inlet} - \text{lbs/test outlet}) \times 100}{(\text{lbs/test inlet})}$$

4. Calculate the total emission rate of the VOC in lbs per 10,000 gallons of gasoline transferred as follows:

$$\frac{\text{lbs VOC}}{10,000 \text{ gallons}} = \frac{\text{lbs VOC} \times 10,000}{\text{gallons of gasoline transferred}}$$

(g) The test report shall include the following information submitted on the required reporting form found in Appendix B (any alternative reporting form shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c) and (e)):

1. A dimensioned sketch of the sampling location;
2. All flow rate data;
3. A sketch and/or description of the sampling system used;
4. The identity, concentration and means of verification for each standard used;
5. A description of the analysis instrument and the conditions of operation;
6. Sufficient details of the calculations to allow the results to be reproduced independently;
7. The emissions in lbs/10,000 gallons of gasoline transferred for each test;
8. The percent efficiency of the control device, if required;
9. Concentration of VOC in gas displaced from delivery vessel, volume percent, if required;
10. Operating conditions of the source operation; and
11. An explanation for any unusual procedures or results.

Amended by R.1992 d.102, effective March 2, 1992 (operative March 28, 1992).

See: 23 N.J.R. 1858(b), 24 N.J.R. 792(a).
"VOS" replaced by "VOC".

7:27B-3.12 Procedures for the determination of volatile organic compounds in cutback and emulsified asphalts

(a) The method in this section is applicable for the determination of VOC in cutback or emulsified asphalts. For the same circumstances as described above, any alternative test method shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

(b) This method is based upon the separation by distillation of the more volatile organic constituents from cutback and emulsified asphalts. A representative sample of the cutback or emulsified asphalt is subjected to distillation at a controlled rate to a temperature of 347°F (175°C) and the weight and volume of the resulting distillate excluding water is determined.

(c) The procedure for this section shall be as follows:

1. Obtain a representative sample of the cutback or emulsified asphalt.

2. Analyze the sample as follows:

i. Distill at 347°F (175°C) a measured weight to the nearest 0.1 gm using the distillation apparatus described in ASTM Designation D 402-76 "Distillation of Cut-Back Asphaltic (Bituminous) Products" (N.J.A.C. 7:27B-3.18, Reference 10);

ii. Determine the specific gravity of the Cut-Back or Emulsified Asphalt by ASTM Designation D-70-76 "Specific Gravity of Semi-Solid Bituminous Materials" (N.J.A.C. 7:27B-3.18, Reference 11); and

iii. Collect and measure to the nearest .5 ml the volume of the distillate excluding any water present.

3. The calculations shall be performed as follows:

i. Calculate the sample volume from the sample weight and its density using the following formula:

$$\text{volume of sample (cc)} = \frac{\text{sample grams}}{\text{density gms/cc}}$$

ii. Calculate and report the VOC distillate as a volume percent of the total sample using the following formula:

$$\text{Volume \%} = \frac{\text{Volume VOC distillate} \times 100}{\text{Volume Sample}}$$

Amended by R.1992 d.102, effective March 2, 1992 (operative March 28, 1992).

See: 23 N.J.R. 1858(b), 24 N.J.R. 792(a).
"VOS" replaced by "VOC".

7:27B-3.13 Procedures for the determination of leak tightness of gasoline delivery vessels

(a) The method in this section is applicable for the determination of the leak tightness of gasoline delivery vessels. For the same circumstances as described above, any alternative test method shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

(b) This method is based upon the application of a pressure/vacuum to the compartment(s) of a gasoline delivery vessel and the measurement of the change in pressure/vacuum over a period of time.

(c) The following is a list of equipment used in this method:

1. Pressure source: pump or compressed gas cylinder of air or inert gas sufficient to pressurize the delivery vessel to 25 inches of water (47 millimeters of mercury);

2. Regulator: low pressure regulator for controlling the pressurization of the delivery vessel;

3. Vacuum source: vacuum pump capable of evacuating the delivery vessel to 10 inches of water (19 millimeters of mercury)

4. Manometer: liquid manometer, or equivalent, capable of measuring up to 25 inches of water (47 millimeters of mercury) with ± 0.1 inch water (02 millimeters of mercury) precision;

5. Test cap for vapor recovery hose fittings: a cap shall be equipped with a tap for the manometer connection and shall be equipped with a shut-off valve for connection to the pressure/vacuum source; and

6. Pressure/vacuum relief valves: the test apparatus shall be equipped with an in-line pressure/vacuum relief valve set to activate at 28 inches of water (53 millimeters of mercury) above atmospheric pressure and 12 inches of water (23 millimeters of mercury) below atmospheric pressure. The valves shall have a flow capacity greater than or equal to the pressurizing or evacuating pump rates.

(d) The following pretest conditions shall be met:

1. The delivery vessel shall be purged of gasoline vapors and tested empty; and

2. The delivery vessel shall be tested where it will be protected from the sun.

(e) The procedure for this section shall be as follows:

1. The dome covers are to be opened and then closed;

2. Connect static electrical ground connections to the delivery vessel. Attach the delivery and vapor hoses, remove the delivery elbows, and plug the liquid delivery fittings;

3. Attach the test cap to the vapor recovery line of the delivery vessel;

4. Connect the compartments of the delivery vessel internally to each other (if connecting the compartments internally is not possible, each compartment shall be tested separately);

5. Connect the pressure/vacuum supply hose and the pressure/vacuum relief valve to the shut-off valve. Attach the pressure source to the hose. Attach a manometer to the pressure tap;

6. Open the shut-off valve in the vapor recovery hose cap. Applying air pressure slowly, pressurize the delivery vessel to 18 inches of water (34 millimeters of mercury);

7. Close the shut-off valve and allow the pressure in the delivery vessel to stabilize. Adjust the pressure, if necessary, to maintain 18 inches of water (34 millimeters of mercury). When the pressure stabilizes, record the time and initial pressure; and

8. At the end of five minutes, record the final pressure.

9. Repeat steps 6 through 8 above until the pressure for two consecutive runs agrees to within ± 12.5 mm water.

10. Disconnect the pressure source from the pressure/vacuum supply hose, and slowly open the shut-off valve to bring the tank to atmospheric pressure;

11. Connect the vacuum source to the pressure/vacuum supply hose;

12. Slowly evacuate the tank to six inches of water (11 millimeters of mercury);

13. Close the shut-off valve and allow the pressure in the delivery vessel to stabilize. Adjust the pressure, if necessary, to maintain six inches of water (11 millimeters of mercury) vacuum. When the pressure stabilizes, record the time and initial pressure; and

14. At the end of five minutes, record the time and final pressure.

15. Repeat steps 6 through 14 for each compartment if these were not interconnected.

16. Alternate methods for purging and pressurizing shall be submitted for review by the Department pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e). See Appendix G for the required reporting form (any alternative reporting form shall be submitted to the Department for review, pursuant to N.J.A.C. 7:27B-3.2(c) and (e)).

7:27B-3.14 Procedures for the direct detection of fugitive volatile organic compound leaks

(a) The method in this section is applicable for the detection of fugitive VOC leaks. Any alternative test method shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

(b) This method is based upon the detection of VOC leaks from individual sources by a portable instrument. The instrument detector type is not specified but shall meet the performance criteria of (d)4 below. This procedure is intended to locate and classify leaks only and shall not be used to measure mass emission rates from individual sources.

(c) The following is a summary of this method:

1. The detector is calibrated with a standard gas mixture to establish the response of the instrument. A representative sample of fugitive emissions is drawn into the instrument. The response is read directly from the instrument meter.

2. For purposes of this procedure a single test shall be sufficient to establish the presence of a leak.

(d) The following is a list of equipment used in this method:

1. Probe: glass, stainless steel, or Teflon tubing as required by source gas conditions and equipped with 0.4 inch (one centimeter) tip spacer;

2. Pump: a leakless Teflon-coated diaphragm pump capable of maintaining an appropriate flow to the detector;

3. Dilutor: (if circumstances require) capable of diluting the sample gas into the range of the instrument such that concentration levels of 10,000 ppm can be measured. The dilutor tip shall be equipped with a 0.4 inch (one centimeter) spacer;

4. Monitoring instrument, as set forth below:

- i. The monitoring instrument shall be certified as safe for operation in explosive atmospheres;

- ii. The monitoring instrument detector shall be capable of measuring the leak concentration specified in the appropriate section in N.J.A.C. 7:27-16. Detector types which meet this requirement include but are not limited to catalytic oxidation, flame ionization, infra-red absorption, and photoionization; and

- iii. The instrument shall be readable to within five percent of the specified leak concentration and shall have a response time less than or equal to of 30 seconds for 95 percent of scale;

5. Standard calibration gas—8,000 ppmv Hexane or Methane in air.

(e) The procedure for this section shall be as follows:

1. A presampling survey shall be conducted to locate components where potential leaks could occur;

2. Calibration shall be conducted as follows:

- i. The instrument should be operated according to the manufacturer's directions;

- ii. Adjust the analyzer to zero by using ambient air; and

- iii. Introduce the 8,000 ppm calibration gas into the instrument sample probe. Adjust the instrument meter readout and chart recorder to correspond to the calibration value. If necessary, use a dilution system to bring the calibration gas into the instrument range.

3. Sampling and analyses shall be conducted as follows:

- i. Place the instrument probe with the 0.4 inch (one centimeter) spacer at the surface of the component interface where leakage is suspected. Move the probe along the interface periphery while observing the instrument readout. If an increased meter reading is observed, slowly probe the interface where leakage is indicated until the maximum meter reading is obtained. Leave the probe at the maximum reading location for approximately two times the instrument response time. If the concentration reading is in excess of the range of the instrument, add the dilution assembly and sample as above using a correction factor to convert the measurements to the undiluted bases. Record the date, time and identity of the leaking components. See Appendix F for the required reporting form. (Any alternative form shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c) and (e).)

Amended by R.1992 d.102, effective March 2, 1992 (operative March 28, 1992).

See: 23 N.J.R. 1858(b), 24 N.J.R. 792(a).
"VOS" replaced by "VOC".

7:27B-3.15 Procedures for the direct detection of fugitive volatile organic compound leaks from gasoline tank trucks and vapor collection systems using a combustible gas detector

(a) The method in this section is applicable for the detection of fugitive VOC leaks from gasoline tank trucks and vapor collection systems. For the same circumstances as described above, any alternative test method shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

(b) This method is based upon the detection of VOC leaks from individual sources by a portable instrument. The instrument detector type is not specified but must meet the performance criteria of N.J.A.C. 7:27B-3.14(d)4. This procedure is intended to locate and classify leaks only and shall not be used as a measure of mass emission rates from individual sources.

(c) The following is a summary of this method:

1. The detector is calibrated with a standard gas mixture to establish the response of the instrument. A representative sample of the fugitive emissions is drawn into the instrument. The response is read directly from the instrument meter.

2. For purposes of this procedure a single test shall be sufficient to establish the presence of a leak.

(d) The following is a list of equipment used in this method:

1. Probe: glass, stainless steel, or Teflon tubing as required by source gas conditions and equipped with a 1.0 inch (2.54 centimeter) tip spacer;

2. Pump: a leakless Teflon-coated diaphragm pump or other suitable pump capable of maintaining an appropriate flow to the detector;

3. Monitoring instrument as set forth below:

i. The monitoring instrument shall be certified as safe for operation in explosive atmosphere;

ii. The monitoring instrument detector shall be capable of measuring the leak concentration specified in the appropriate section of N.J.A.C. 7:27-16. Detector types meeting this requirement include but are not limited to catalytic oxidation, flame ionization, infra-red absorption, and photoionization; and

iii. The instrument shall be readable to within five percent of the specified leak concentration and shall have a response time of 30 seconds or less;

4. Standard calibration gas—at least 50 percent but less than 100 percent LEL of propane in air.

(e) The procedure for this section shall be as follows:

1. A presampling survey shall be conducted to locate components where potential leaks could occur;

2. Calibration shall be conducted as follows:

i. The instrument shall be operated according to the manufacturer's directions;

ii. Adjust the analyzer to zero according to the manufacturer's instructions; and

iii. Introduce the standard calibration gas into the instrument sample probe. Adjust the instrument meter readout to obtain the correct response. If unable to obtain the correct response within $\pm$ five percent the instrument is unacceptable for use.

3. Sampling and Analysis shall be conducted as follows:

i. All leak testing shall be done during a loading operation;

ii. Place the instrument probe with the 1.0 inch (2.54 centimeters) spacer at the surface of the component interface where leakage could occur. Move the probe along the interface periphery while observing the instrument readout. If an increased meter reading is observed, slowly probe the interface where leakage is indicated until the maximum reading is obtained. Leave the probe at the maximum reading location for approximately two times the instrument response time. If the concentration reading is in excess of the range of the instrument, add the dilution assembly and sample as above using a correction factor to convert the measurements to the undiluted basis. Record the date, time, amount, and identity of the leaking components. See Appendix F for the required reporting form. (Any alternative reporting form shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c) and (e).)

Amended by R.1992 d.102, effective March 2, 1992 (operative March 28, 1992).

See: 23 N.J.R. 1858(b), 24 N.J.R. 792(a).

"Substances" replaced by "compounds".

7:27B-3.16 Procedures for determining the efficiency of gasoline vapor recovery systems at service stations

(a) The method for this section is applicable for the determination of the efficiency of vapor recovery systems controlling gasoline vapors emitted during the filling of underground storage tanks. For the same circumstances as described above, any alternative method shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c), (d) and (e).

(b) This method is based upon the amount of gasoline vapor discharged from the atmospheric vent(s) of underground storage tank(s) being filled. The procedure is intended for all control systems which have a vapor recovery line connecting the underground storage tank to the tank truck.

(c) The following is a summary of this method:

1. A positive displacement meter is mounted on each atmospheric vent pipe to determine the amount of vapor displaced during the filling of underground storage tanks. The efficiency of the vapor recovery system is determined by comparing the amount of vapor emitted from the atmospheric vents with the total amount of gasoline transferred to the underground storage tanks.

2. For the purpose of this procedure, a single test shall be sufficient to establish the efficiency of the vapor recovery system.

(d) The following is a list of equipment used in this method:

1. Gas meter device: a positive displacement meter with a capacity of 3000 SCFH and a pressure drop of 0.05 inches of water at an air flow of 30 SCFH. This meter shall be designed to read (in 0.1 cubic foot increments) only the amount of positive vapors displaced and shall allow for any negative in-breathing. The meter shall be equipped with taps for a thermocouple and a pressure sensor;

2. Coupling for atmospheric vent pipe: a coupling to connect the gas metering device to the atmospheric vent pipe. Coupling shall be sized for a minimum pressure drop;

3. Thermocouples: temperature sensing devices to measure the temperature of the vapors emitted at the gas metering device and ambient temperature; and

4. Manometer: liquid manometer or other equivalent pressure sensing device capable of measuring zero to ten inches of water at the gas metering device.

5. Leak detection equipment standards shall be as follows:

- i. The leak detection equipment shall be certified as safe for operation in explosive atmospheres;
- ii. The monitoring instrument detector shall be capable of measuring the leak definition concentration specified in the appropriate section in N.J.A.C. 7:27-16. Detector types meeting this requirement include but are not limited to catalytic oxidation, flame oxidation, infrared absorption and photoionization; and
- iii. The instrument shall be readable to within five percent of the specific leak concentration and shall have a response time of 30 seconds or less.

(e) The procedure for this section shall be as follows:

1. Mount the positive displacement meter to the top of the atmospheric vent of the storage tank(s). If the vent has restriction, remove the restriction before mounting the meter;
2. Connect the manometer and thermocouple to the taps on the meter;
3. Connect tank truck fuel and vapor return hoses to the underground storage tanks in accordance with procedures outlined by the manufacturer;
4. Check the tank truck and all vapor return line connections with a leak detection instrument for a tight seal before and during the test;
5. Record the initial reading of the gas meter(s);
6. Start the transfer of gasoline to the storage tank(s) in accordance with facilities' established normal procedures;
7. Record temperature, pressure, and gas meter readings at two minute intervals;
8. Record at the start and the end of the test the barometric pressure and ambient temperature;
9. Disconnect the tank truck hoses from the storage tank in accordance with the procedures outlined by the facility when the transfer has been completed;
10. Continue to record temperature, pressure, and gas meter readings at the underground storage tank vent(s) at two-minute intervals for a period of ten minutes after the completion of the gasoline transfer;
11. Record the final reading of the gas meter;
12. Record the total volume of gasoline that was transferred; and
13. Disconnect the positive displacement meter from the atmospheric vent.

(f) Calculate the efficiency of the vapor recovery system using the following equation:

$$E = 1 - \frac{V_v (7.481) (T_s + 460) (P_b)}{V_T (T_v + 460) (29.92)} \times 100$$

Where:

E = Percent efficiency of the vapor recovery system at standard conditions.

V_v = Volume of displaced vapors vented from the atmospheric vent in actual cubic feet (ACF).

V_T = Volume of gasoline transferred to storage tanks in gallons.

T_v = Temperature of vapors vented from atmospheric vent in degrees Fahrenheit.

T_s = Standard temperature (70°F).

P_b = Average barometric pressure during test in inches of mercury.

7.481 = Conversion factor of gallons per cubic foot (Gal/ft³).

29.92 = Standard pressure in inches of mercury.

(g) The test report shall include the following information submitted on the required reporting forms listed in Appendix H. (Any alternative report form shall be submitted to the Department for review pursuant to N.J.A.C. 7:27B-3.2(c) and (e)):

1. A dimensioned sketch of the sampling location detailing number of storage tanks, type of fill pipe; and type of vapor recovery system;
2. The total amount of each type of gasoline transferred;
3. The size of the storage tank(s) into which the gasoline was transferred;
4. The total amount of gasoline present in the storage tank(s) prior to transfer;
5. Pressure/vacuum test date listed on the tank truck; and
6. Identification of the tank truck.

7:27B-3.17 Procedures for the determination of volatile organic compounds emitted from petroleum solvent dry cleaning operations

(a) The method in this section is applicable for the determination of the final recovered solvent flow rate at the completion of the recovery cycle, and the VOC content in all filtration waste. For the same circumstances as described above, any alternative method shall be submitted to the Department for review, pursuant to N.J.A.C. 7:27B-3.2(c), (d), and (e).

(b) This method is based upon:

1. The determination of the volume of the recovered solvent; and
2. The separation and weight determination of the solvent.

(c) The following is a summary of this method:

1. The recovered solvent is diverted to a graduated cylinder at the end of the recovery cycle. The volume of solvent recovered during a one minute period is measured and recorded.
2. The recovered solvent is separated from other filtration waste and weighed.

(d) The procedure for this section shall be as follows:

1. Recovered solvent shall be determined as follows:
 - i. The flow rate of the recovered solvent is measured at the outlet of the solvent-water separator;
 - ii. The flow rate of the recovered solvent is measured at the end of the solvent recovery phase;
 - iii. Divert the flow of the recovered solvent to a graduated cylinder;
 - iv. Record the volume of recovered solvent to the nearest milliliter, after a one minute interval;
 - v. Record the type of articles cleaned and the length of the recovery cycle; and
 - vi. Repeat steps i-v over three cleaning cycles.
2. The solvent content in filtration waste shall be determined as follows:
 - i. Collect three one-kilogram samples of still and filtration waste in air-tight containers which are impervious to petroleum solvents;
 - ii. Record the total mass of articles in kilograms cleaned since the last still boil-down or filter change;
 - iii. Record the total mass of still and filter water in kilograms produced since the last waste removal;
 - iv. Determine the solvent content of the still and filter water using the procedure specified in ASTM D322-80, "Standard Test Method for Gasoline Diluent in Used Gasoline Engine Oils by Distillation" (N.J.A.C. 7:27B-3.18, Reference 15); and
 - v. Report the results as mass of VOC per mass of dry weight of articles dry cleaned in kilograms per kilogram.

Amended by R.1992 d.102, effective March 2, 1992 (operative March 28, 1992).

See: 23 N.J.R. 1858(b), 24 N.J.R. 792(a).

"VOS" replaced by "VOC".

7:27B-3.18 Test methods and sources incorporated by reference

(a) The following sources and test methods are incorporated by reference in this subchapter:

1. New Jersey Administrative Code Title 7, Chapter 27B-1, AIR TEST METHOD 1 is available from New Jersey Department of Environmental Protection, John Fitch Plaza, CN 027, Trenton, New Jersey 08625. (Free)

2. Code of Federal Regulations, Title 29, Chapter XVII, Parts 1910 and 1926 are available from the Occupational Safety and Health Administration, U.S. Department of Labor, 1515 Broadway, New York, New York 10036.

3. Code of Federal Regulations, Title 40, Part 80, Appendix E—"Method 1—Dry RVP Measurement Method" and "Method 2—Herzog Semi-Automatic Method" are available from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

4. ASTM Designation D2879-75, Standard Method for Test for Vapor Pressure—Temperature Relationship and Initial Decomposition Temperature of Liquids by Isoteniscope, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 (\$4.00).

5. API (American Petroleum Institute) Bulletin 2517, Selecting the Proper Nomograph, 156 William Street, New York, New York 10038.

6. ASTM Designation D2551-80, Standard Method of Test for Vapor Pressure of Petroleum Products (micro-method), American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 (\$4.00).

7. ASTM Designation D1475-60, Standard Method of Test for Density of Paint, Varnish, Lacquer, and Related Products, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 (\$4.00).

8. ASTM Designation D2369-81, Standard Method of Test for Volatile Content of Coatings, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 (\$4.00).

9. ASTM Designation D4017-81, Standard Test Method for Water in Paints and Paint Materials by Karl Fischer Titration Method, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103. (\$4.00)

10. ASTM Designation D402-76, Standard Test Method for Distillation of Cut-Back Asphaltic (Bituminous) Products, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 (\$4.00).

11. ASTM Designation D-70-76, Standard Test Method for Specific Gravity of Semi-Solid Bituminous Materials, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 (\$4.00).

12. ASTM Designation D2698-73, Standard Test Method for the Determination of the Pigment Content of Solvent Reducible Paints by High Speed Centrifuging, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 (\$4.00).

13. ASTM Designation D95-83, Standard Method for Determining Water in Petroleum and Bituminous Materials by Distillation, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 (\$4.00).

14. Method 2-1 California Air Resources Board, Test Procedures for Determining the Efficiency of Gasoline Vapor Recovery Systems at Service Stations. Available from State of California, Air Resources Board, 1102 Q Street, Sacramento, California 95812.

15. ASTM Designation D322-80, Standard Test Method for Gasoline Diluent in Used Gasoline Engine Oils by Distillation, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 (\$4.00).

16. Code of Federal Regulations, Title 40, Part 60—Reference Methods 2A and 2B are available from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

Amended by R.1992 d.102, effective March 2, 1992 (operative March 28, 1992).

See: 23 N.J.R. 1858(b), 24 N.J.R. 792(a).

Repealed and replaced (a)3 regarding vapor pressure measurement methods.

Editor's Note: In addition to the above text, Appendices A through H were filed with these rules, but not reproduced herein. Further information regarding these Appendices may be obtained by contacting:

Bureau of Technical Services
Division of Environmental Quality
Department/of Environmental Protection
CN 411 (380 Scotch Road)
Trenton, New Jersey 08625-0411

SUBCHAPTER 4. AIR TEST METHOD 4: TESTING PROCEDURES FOR MOTOR VEHICLES

Authority

N.J.S.A. 13:1D-5, 13:1D-9, 26:2C-8, 26:2C-8.1,
26:2C-8.2 and 26:2C-8.5.

Source and Effective Date

R.1985 d.3, effective January 21, 1985 (operative July 1, 1985).
See: 16 N.J.R. 2894, 17 N.J.R. 184(a).

Executive Order 66(1978) Expiration Date

Pursuant to the requirements and criteria of Executive order 66(1978), this subchapter expires on June 30, 1989.

7:27B-4.1 Definitions

The following words and terms, when used in this Subchapter, shall have the following meanings, unless the context clearly indicates otherwise.

"Autobus" includes all motor vehicles used for the transportation of passengers for hire.

"Carbon monoxide (CO)" means a colorless, odorless, tasteless gas at standard conditions having a molecular composition of one carbon atom and one oxygen atom.

"Chassis dynamometer" means a device constructed in such a manner as to simulate highway driving conditions on a stationary motor vehicle.

"Commissioner" means the Commissioner of the Department of Environmental Protection.

"Crankcase emissions" means substances emitted into the atmosphere from any portion of the engine crankcase ventilation or lubrication system.

"Department" means the Department of Environmental Protection.

"Diesel-powered motor vehicle" means a vehicle which is self-propelled by a compression ignition type of internal combustion engine and which is designed primarily for transporting persons or property on public streets or highways; for purposes of this Subchapter, passenger automobiles and motorcycles are excluded.

"Emission control apparatus" means any device employed by the vehicle manufacturer which prevents or controls the emission of any air contaminant, including associated components which monitor the function and maintenance of these devices.

"Exhaust emissions" means substances emitted into the atmosphere from any opening downstream from the exhausted ports of a motor vehicle engine.

"Exhaust leak" means any condition of the exhaust system which permits exhaust emissions to escape into the atmosphere at any point between the exhaust ports of a motor vehicle engine and the outlet of the engine exhaust pipe.

"Gasoline-fueled motor vehicle" means any motor vehicle equipped to be powered by a hydrocarbon fuel other than diesel fuel, but including alcohol fuels and hydrocarbon-alcohol fuel blends.

"Heavy-duty motor vehicle" means any motor vehicle designed primarily for transportation of persons or property and registered as exceeding 6,000 pounds gross weight.

"Hydrocarbons (HC)" means compounds whose molecules consist of atoms of hydrogen and carbon only.

"Idle mode" means the vehicle test mode of the prescribed inspection test procedure, consisting of a non-loaded, throttled engine speed at the revolutions per minute specified by the manufacturer.

"Inspector" means any person authorized by the State of New Jersey to enforce N.J.A.C. 7:27-14.2.

"Light-duty motor vehicle" means any motor vehicle designed primarily for transportation of persons or property and registered at 6,000 pounds gross weight or less.

"Motor vehicle" means all vehicles propelled otherwise than by muscular power, excepting motorized bicycles and such vehicles as run only upon rails or tracks.

"Motor vehicle safety specialist" means any person employed by the New Jersey Division of Motor Vehicles to enforce motor vehicle safety and emission test standards.

"Motorized bicycle" means a pedal bicycle having a helper motor characterized in that either the maximum piston displacement is less than 50 cubic centimeters, or said motor is rated at no more than 1.5 brake horsepower and said bicycle is capable of a maximum speed of no more than 25 miles per hour on a flat surface.

"MPH" means miles per hour.

"Opacity" means the property of a substance which renders it partially or wholly obstructive to the transmission of visible light expressed as the percentage to which the light is obstructed.

"Operating mode" means a procedure for operating a diesel-powered motor vehicle or a diesel-powered engine during measurement of smoke opacity in the exhaust emissions.

"Prescribed inspection test procedure" means a method prescribed by the Department for testing exhaust emissions from light and heavy-duty motor vehicles.

"RPM" means revolutions per minute.

"Smoke" means small gasborne and airborne particles, exclusive of water vapor, arising from a process of combustion in sufficient number to be observable.

"Smokemeter" means a device constructed in such a manner as to measure smoke opacity by light obstruction between a light source and photoelectric cell which will indicate the percent of opacity of smoke at a point approximately six inches from the engine exhaust outlet. The device shall be of design meeting "Specifications For A Smoke Opacity Meter" dated April 30, 1981, and on file with the Commissioner and approved for use in accordance with manufacturer's recommended procedures for calibration, mounting and maintenance.

7:27B-4.2 General instructions for all tests

(a) The inspector shall insure prior to each test that the test equipment is calibrated by checking and, if necessary, adjusting zero and span settings.

(b) All measurements are to be made after the engine is at normal operating temperature.

(c) Any vehicle found to exhibit an exhaust leak shall have said leak repaired before an approved test can be performed.

(d) Standard application of the smoke opacity test procedures is required on exhaust outlets on vehicles equipped with dual, adjacent exhaust outlets.

7:27B-4.3 Smoke opacity testing procedures for diesel-powered motor vehicles subject to the inspection rules and regulations of the New Jersey Division of Motor Vehicles

(a) The smoke opacity testing procedures for diesel-powered motor vehicles subject to self-inspection authorized by the Division of Motor Vehicles at the premises or places of business of the owner or lessee to determine compliance with N.J.A.C. 7:27-14.2(a), are as follows:

1. The vehicle driven on chassis dynamometer with simulated load by power absorption procedure requires that the smokemeter be firmly positioned on the exhaust outlet and that the vehicle be positioned on the chassis dynamometer before the inspector proceeds with the following steps:

- i. With vehicle on a chassis dynamometer under no power absorption, select a gear ratio which will produce a maximum vehicle speed of 45-60 MPH at governed engine RPM;

- ii. With engine running at governed engine RPM, apply power absorption load to the dynamometer until such loading reduces the engine RPM to 80 percent of the governed speed, the peak smoke opacity measured over a period of five to ten seconds with the engine under such loading shall be the smoke opacity.

2. The vehicle driven in low gear with simulated load by braking action procedure requires that the smokemeter be firmly positioned on the exhaust outlet before proceeding with the following steps:

- i. Select a gear ratio which will produce a maximum speed of 10-15 MPH, at governed engine RPM, drive vehicle at 10-15 MPH at governed engine RPM;

- ii. Load the engine by applying brakes until engine RPM is lugged down to 80 percent of the governed engine RPM, the peak smoke opacity measured over a period of 5-10 seconds with the engine under such brake loading shall be the smoke opacity.

7:27B-4.4 Smoke opacity testing procedure for diesel-powered autobuses subject to the inspection rules and regulations of the New Jersey Department of Transportation

(a) The smoke opacity testing procedure for diesel-powered autobuses subject to the inspection rules and regulations of the Department of Transportation to determine compliance with N.J.A.C. 7:27-14.2(b) shall be the following:

1. Position smokemeter against exhaust outlet using extension pole and magnet so that the optical axis of the sensor head is perpendicular to the smoke plume;
2. With engine at normal operating temperature, depress accelerator pedal slowly to obtain a fast idle (1200-1300 RPM);
3. Accelerate the engine from fast idle to maximum governed RPM by depressing the accelerator pedal as rapidly as possible;
4. As governed RPM is reached, release the accelerator pedal to allow engine to coast down to fast idle (1200-1300 RPM);
5. Repeat steps 3 and 4; (NOTE: Steps 3, 4, and 5 are to purge the engine.)
6. After the engine purge, repeat steps 3 and 4 three times in succession. After each successive measurement, record peak opacity reading and reset smokemeter. The average of the three peak smoke opacity measurements obtained with the smokemeter shall be the test result as measured using the standing acceleration test procedure.

7:27B-4.5 Exhaust emission testing procedure for gasoline-fueled motor vehicles subject to inspection by the State of New Jersey

(a) The exhaust emission testing procedure for gasoline-fueled motor vehicles to determine compliance with N.J.A.C. 7:27-15.2(b), and 15.4(a) and (b) shall be the following:

1. The smoke test shall be performed as follows:
 - i. Place the vehicle in neutral gear with all accessories off and the handbrake secured;
 - ii. Accelerate the engine and observe for visible continuous smoke in the exhaust emissions and crankcase emissions;
 - iii. Visible smoke in the exhaust emissions or crankcase emissions for a period in excess of three consecutive seconds shall be a cause for rejection.
2. The emission test at idle mode shall be performed as follows:
 - i. Engines shall be at normal operating temperature and not overheating (as indicated by gauge warning light or boiling radiator) with all accessories off;

- ii. With engine operating in the idle mode and transmission in neutral, the sample probe shall be inserted at least six inches into the exhaust outlet;

- iii. Record exhaust concentrations measured as percent carbon monoxide and parts per million hydrocarbons after stabilized readings are obtained or at the end of 30 seconds, whichever occurs first;

- iv. These exhaust concentrations shall be the inspection test results.

7:27B-4.6 Gasoline-fueled motor vehicle emission control apparatus compliance examination procedure

(a) The examination of the motor vehicle emission control apparatus of all post-1974 model year gasoline-fueled motor vehicles under 8501 pounds to determine compliance with N.J.A.C. 7:27-15.4(c), when conducted during annual inspection and random roadside inspection, shall consist of the following three examinations:

1. A visual check to determine the presence of properly installed catalytic converters on motor vehicles designed and marketed by the vehicle manufacturer with catalytic converters as original equipment. The absence of such properly installed catalytic converters, shall be cause for vehicle rejection. Rejected vehicles shall be required to be properly equipped with new or used replacement catalytic converters certified according to U.S. Environmental Protection Agency procedures and subsequently reexamined. The reexamination shall consist of a visual check to document proper installation of a replacement catalytic converter.

2. (Reserved)

3. An examination consisting of a visual inspection for the presence of, or malfunction of the fuel filler neck inlet restrictor on motor vehicles designed and marketed by the vehicle manufacturer for operation with unleaded fuel only. Rejected vehicles shall be required to be properly equipped with new or used replacement catalytic converters certified according to U.S. Environmental Protection Agency procedures and a new fuel filler neck inlet restrictor. Reexamination shall consist of a visual check to document proper installation of a replacement catalytic converter and fuel filler neck inlet restrictor.

- i. The fuel filler neck inlet restrictor examination shall be conducted in the following manner:

- (1) Attempt to insert a dowel, with a diameter equivalent to that of a standard leaded fuel rump nozzle, into the fuel filler neck;

- (2) The absence of the fuel filler neck inlet restrictor is verified if the dowel can be inserted and shall be cause for vehicle rejection;

(b) Inspection of gasoline-fueled motor vehicles for (a) above shall be implemented by model year and registered weight in accordance with the following schedule:

Date	Model Year	Registered Weight
December 1, 1985	1985 and later	Under 6001 pounds
May 1, 1986	1982 and later	Under 6001 pounds
July 1, 1986	1982 and later	Under 8501 pounds
January 1, 1987	1979 and later	Under 8501 pounds
May 1, 1987	1975 and later	Under 8501 pounds

New Rule, R.1985 d.331, effective July 1, 1985 (operative December 2, 1985).

See: 17 N.J.R. 781(a), 17 N.J.R. 1649(a).

Old rule "Light-duty gasoline fueled motor vehicle emission control apparatus compliance examination procedure" was repealed and this new section adopted except for (a)2 which is still pending.

Public Notice: The Department has decided not to adopt the proposed Plumbtesmo test procedure.

See: 18 N.J.R. 1714(b).

7:27B-4.7 Gasoline-fueled motor vehicle exhaust lead determination procedure

(a) An examination using lead test paper to determine the presence of lead in the vehicle exhaust shall be performed on the following vehicles:

1. All post-1974 model year gasoline-fueled motor vehicles weighing less than 8501 pounds which are designed and marketed by the vehicle manufacturer for operation with unleaded fuel only and which are determined during annual inspection and random roadside inspection to have improperly functioning or improperly maintained emission control apparatus as determined according to the inspection test procedure established at N.J.A.C. 7:27B-4.6.

2. One percent of all post-1974 model year gasoline-fueled motor vehicles weighing less than 8501 pounds which are designed and marketed by the vehicle manufacturer for operation with unleaded fuel only and which are determined during annual inspection and random roadside inspection to have properly functioning and properly maintained emission control apparatus as determined according to the inspection test procedure established at N.J.A.C. 7:27B-4.6.

(b) The lead test paper examination shall be conducted in the following manner:

1. Remove test paper from package and moisten with distilled water;
2. Wipe a small section of the tailpipe with a cloth;
3. Attach moistened paper onto the cleaned surface of the tailpipe with a clip; and
4. Remove paper.
5. The presence of lead in the vehicle exhaust is indicated by the lead paper changing to a pink or red color.

(c) The test result for vehicles examined according to the inspection test procedures established at (b) above shall be recorded by the New Jersey Division of Motor Vehicles and forwarded monthly to the Department of Environmental Protection.

(d) The presence of lead in the vehicle exhaust, if determined solely according to the inspection test procedure established at (b) above shall not be cause for vehicle rejection.

(e) This section shall not apply to vehicle examinations performed by private inspection centers licensed by the Division of Motor Vehicles.

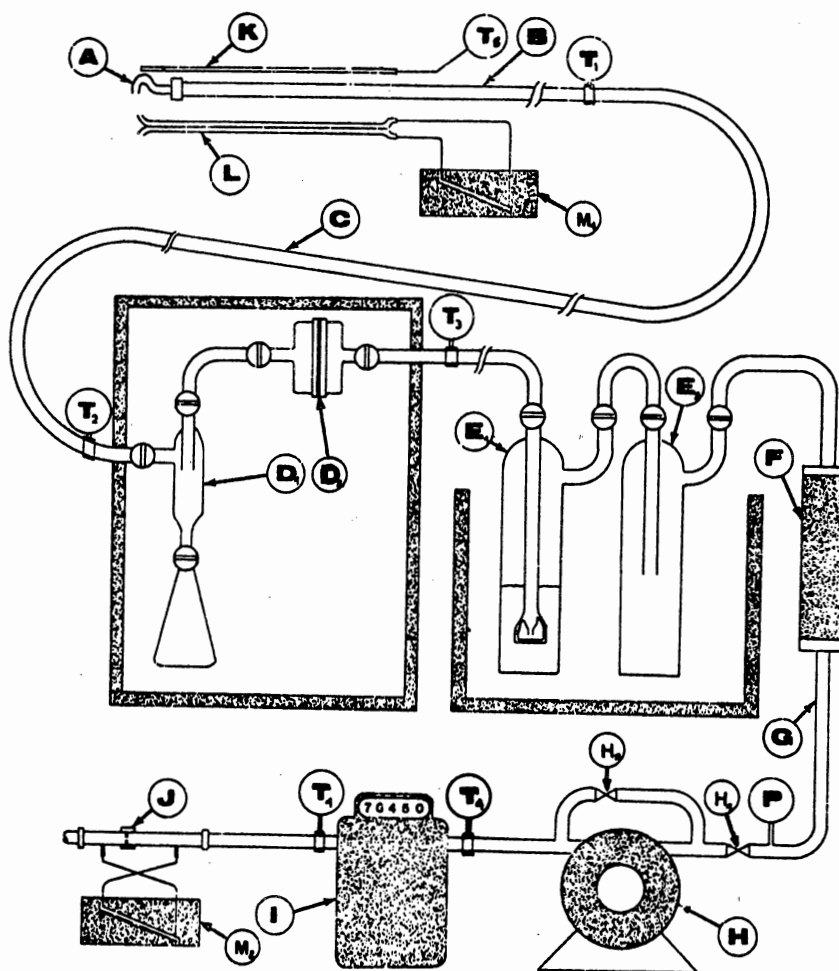
(f) This section shall expire on October 1, 1986.

New Rule, R.1985 d.331, effective July 1, 1985 (operative December 2, 1985).

See: 17 N.J.R. 781(a), 17 N.J.R. 1649(a).

APPENDIX 1

THE SAMPLING TRAIN



THE SAMPLING TRAIN

- A. SAMPLING NOZZLE
- B. PROBE
- C. VACUUM HOSE
- D. HEATING SYSTEM
- D₁ CYCLONE ASSEMBLY
- D₂ FILTER ASSEMBLY
- E. CONDENSER SYSTEM
- E₁ GREENBERG-SMITH IMPINGER
- E₂ MODIFIED GREENBERG-SMITH IMPINGER
- F. DRYING TUBE
- G. VACUUM HOSE
- H. VACUUM PUMP
- H₁ COARSE FLOW CONTROL ADJUSTER
- H₂ FINE FLOW CONTROL ADJUSTER
- I. DRY GAS METER
- J. ORIFICE METER
- K. THERMOCOUPLE
- L. "S" TYPE PITOT TUBE
- M. INCLINED MANOMETER
- P. VACUUM GAUGE
- T. TEMPERATURE INDICATOR

NOTE: All glassware (cyclone, filter holder and impingers)
is interconnected with glass fittings having ball joints.

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

SAMPLES RECEIVED AT LAB BY _____ DATE _____

[illegible]

Analysis by _____

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR POLLUTION CONTROL
TECHNICAL SERVICES SECTIONLABORATORY ANALYSIS SUMMARY

Company _____

Stack Location _____

Stack Designation _____ (N.J. 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. H₂O Adsorbed by Desiccant _____ grams
(G) Net Condensate Volume in Impingers _____ ml.

CALCULATIONS*

(H) Acetone Wash Residue Wt. = $E \times B \div D$ _____ 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 = _____ % N₂ = _____

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

APPENDIX 3

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR POLLUTION CONTROL
TECHNICAL SERVICES SECTIONDERIVATION OF % ISOKINETIC SAMPLING RATE FORMULANOMENCLATURE: (SEE APPENDIX 6)DERIVATION:

$$1. \% \text{ Isokinetic Sampling} = \frac{U_n}{U_s} \times 100\%$$

$$2. U_n \left(\frac{\text{ft.}}{\text{sec.}} \right) = \frac{V_t \left(\frac{\text{cu. ft.}}{\text{min.}} \right)}{A_n \left(\frac{\text{sq. ft.}}{\text{min.}} \right) \times t \left(\frac{\text{min.}}{\text{min.}} \right) \times 60 \left(\frac{\text{sec.}}{\text{min.}} \right)}$$

$$3. A_n \left(\frac{\text{sq. ft.}}{\text{min.}} \right) = \frac{\pi \times (D_n)^2 \left(\frac{\text{sq. in.}}{\text{sq. in./sq. ft.}} \right)}{4 \times 144 \left(\frac{\text{sq. in.}}{\text{sq. in./sq. ft.}} \right)} = 0.005454 (D_n)^2$$

Substitute 3 for A_n in 2 to obtain 4

$$4. U_n = \frac{V_t}{0.005454 (D_n)^2 \times t \times 60} = \frac{3.0558 V_t}{(D_n)^2 \times t}$$

$$5. V_t = \frac{V_m \times (T_s + 460) \times (P_b + \Delta H/13.6)}{(T_m + 460) \times (1-Q) \times P_s}$$

Substitute 5 for V_t in 4 to obtain 6

$$6. U_n = \frac{3.0558 \times V_m \times (T_s + 460) \times (P_b + \Delta H/13.6)}{(D_n)^2 \times (T_m + 460) \times (1-Q) \times t \times P_s}$$

Substitute 6 for U_n in 1 to obtain 7

$$7. \% \text{ Isokinetic Sampling} = \frac{3.0558 \times V_m \times (T_s + 460) \times 100 (P_b + \Delta H/13.6)}{(D_n)^2 \times (T_m + 460) \times (1-Q) \times t \times U_s \times P_s}$$

$$= \frac{305.58 \times V_m \times (T_s + 460) \times (P_b + \Delta H/13.6)}{(D_n)^2 \times (T_m + 460) \times (1-Q) \times t \times U_s \times P_s}$$

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

§ ISOKINETIC SAMPLING CALCULATIONS

COMPANY		
STREET		
CITY		
STACK		
N.J. NO.	INLET	OUTLET

FIELD & LAB. DATA	RUN 1	RUN 2	RUN 3	RUN 4	RUN 5
DATE					
T_g ($^{\circ}\text{F}$) (Avg.)					
V_m (CF) (Avg.)					
T_m ($^{\circ}\text{F}$)					
D_n (inches)					
t (minutes)					
Q (decimal fraction)					
U_g (ft./sec.)					
§ ISOKINETIC SAMPLING					

CALCULATIONS BY: _____

DATE: _____

APPENDIX 4

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR POLLUTION CONTROL
TECHNICAL SERVICES SECTIONDERIVATION OF EMISSION RATE FORMULANOMENCLATURE: (SEE APPENDIX 6)DERIVATION:

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

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

$$2. G = W_t \text{ (gms.)} \times \frac{1}{V_t (\text{cu. ft.})} \times 15.43 \frac{(\text{grs.})}{(\text{gm.})}$$

$$3. V_o = A \text{ (sq. ft.)} \times U_s \frac{(\text{ft.})}{(\text{sec.})} \times 60 \frac{(\text{sec.})}{(\text{min.})}$$

Where,

$$U_s = 2.9 C_p \sqrt{\Delta P (T_s + 460)} \times \frac{1}{G_d} \times \frac{29.92}{P_s}$$

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

$$4. E = \frac{60}{7000} \times 15.43 \times 60 \times \frac{W_t}{V_t} \times A \times U_s = 7.9354 \frac{W_t}{V_t} \times A \times U_s$$

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

Substitute 5 for A in 4 to obtain 6:

$$6. E = 0.04328 \frac{W_t}{V_t} \times D^2 \times U_s$$

To convert meter conditions to flue conditions:

$$7. V_t = V_m (\text{cu. ft.}) \times \frac{(T_s + 460)}{(T_m + 460)} \times \frac{1}{(1-Q)} \times \frac{(P_b + \Delta H/13.6)}{P_s}$$

Substitute 7 for V_t in 6 to obtain 8:

$$8. E = \frac{0.04328 \times W_t \times D^2 \times U_s \times (T_m + 460) \times (1-Q) \times P_s}{V_m \times (T_s + 460) \times (P_b + \Delta H/13.6)}$$

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

COMPANY			
STREET			
CITY			
STACK			
N.J. NO.	INLET	OUTLET	

FIELD & LAB. DATA	RUN 1	RUN 2	RUN 3	RUN 4	RUN 5
DATE					
T _m (°F) (Avg.)					
T _s (°F) (Avg.)					
ΔP (inches water)					
D (inches)					
W _t (grams)					
Q (decimal fraction)					
V _m (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 EMISSION RATE (LB/HR)					

CALCULATIONS BY: _____

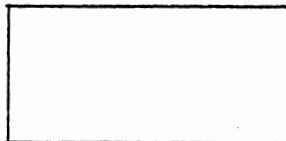
DATE: _____

APPENDIX 5

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR POLLUTION CONTROL
TECHNICAL SERVICES SECTIONPRELIMINARY STACK TEST DATA

COMPANY			SUBCHAPTER
STREET			CITY
STACK			N.J. NO.
DATE			DATA COLLECTED BY:
ORIFICE CALIBRATION (ΔH)			ESTIMATED METER TEMP ($^{\circ}F$)
DRY BULB TEMP ($^{\circ}F$)			WET BULB TEMP ($^{\circ}F$)
P_b		P_{st}^*	ESTIMATED PERCENT MOISTURE
P_s		$P_m (= P_b)$	P_s/P_m
NOMOGRAPH CORRECTION FACTOR			PITOT FACTOR
MAXIMUM ΔP		MINIMUM ΔP	ACTUAL STACK TEMP ($^{\circ}F$)
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
-------------	------

*Record in inches of H_2O as read

SAMPLING DATA

5-15-95

APPENDIX 6

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

- 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
- A_n = Cross sectional area of sampling nozzle orifice expressed in square feet
- CF = Cubic feet
- CFM = Cubic feet per minute
- C_p = Pitot tube correction factor
- D = Internal diameter of flue in inches
- D_n = 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
- G_d = 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
- M_s = 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)
- P_b = Barometric pressure in inches of mercury absolute
- P_m = Absolute pressure at meter in inches of mercury

- P_s = Absolute pressure in flue, derived by the algebraic sum of barometric and static pressures and expressed in inches of mercury
- P_{st} = 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
- T_m = Temperature at meter in degrees F
- T_s = Flue gas temperature in degrees F
- U_n = Sample nozzle gas velocity in feet per second
- U_s = Flue gas velocity at the point where measured in feet per second
- $\overline{U_s}$ = Average flue gas velocity for a test run
- V_m = Total volume of gas sampled as measured by meter in cubic feet
- V_o = Volume rate of flue gas in cubic feet per minute
- V_t = Total volume of gas sampled in cubic feet and converted to flue conditions
- V_v = Total volume of water in sample gas in cubic feet converted to meter conditions (vapor state)
- V_w = Total volume of water in sample gas in cubic centimeters (condensate plus water adsorbed in desiccant)
- W_t = Weight of particulate sample collected in grams

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