Method 203A--Visual Determination of Opacity of Emissions from Stationary Sources for Time-Averaged Regulations

Method 203A is virtually identical to EPA's Method 9 except for the data-reduction procedures, which provide for averaging times other than 6 minutes. That is, using Method 203A with a 6-minute averaging time would be the same as following EPA Method 9. Additionally, Method 203A provides procedures for fugitive dust applications. The certification procedures provided in section 3 are virtually identical to Method 9 and are provided here, in full, for clarity and convenience. A sample visible emission observation form and instructions for its use are appended to this method.

1. **APPLICABILITY AND PRINCIPLE**

1.1 **Applicability**. This method is applicable for the determination of the opacity of emissions from sources of visible emissions for time-averaged regulations. A time-averaged regulation is any regulation that requires averaging visible emission data to determine the opacity of visible emissions over a specific time period.

1.2 **Principle**. The opacity of emissions from sources of visible emissions is determined visually by an observer qualified according to the procedures of section 3.

2. Procedures

An observer qualified in accordance with section 3 of this method shall use the following procedures for visually determining the opacity of emissions.

2.1 Procedures for Emissions from Stationary Sources. These procedures are applicable for visually determining the opacity of stack emissions by a qualified observer. The qualified observer should do the following:

2.1.1 Position. Stand at a distance sufficient to provide a clear view of the emissions with the sun oriented in the 140-degree sector to the observer's back. Consistent with maintaining the above requirement as much as possible, make opacity observations from a position such that the line of vision is approximately perpendicular to the plume direction, and when observing opacity of emissions from rectangular outlets (e.g., roof monitors, open baghouses, noncircular stacks), approximately perpendicular to the longer axis of the outlet. Do not include more than one plume in the line of sight at a time when multiple plumes are involved and, in any case, make opacity observations with the line of sight perpendicular to the longer axis of such a set of multiple stacks (e.g., stub stacks on baghouses).

2.1.2 Field Records. Record the name of the plant, emission location, type of facility, observer's name and affiliation, a sketch of the observer's position relative to the source, and the date on a field data sheet. A sample visible emission observation form is included in appendix 1 of Method 203A. Record the time, estimated distance to the emission location, approximate wind direction, estimated wind speed, description of the sky condition (presence and color of clouds), and plume background on the field

data sheet at the time opacity readings are initiated and completed.

2.1.3 Observations. Make opacity observations at the point of greatest opacity in that portion of the plume where condensed water vapor is not present.

Do not look continuously at the plume but, instead, observe the plume momentarily at 15-second intervals.

2.1.3.1 Attached Steam Plumes. When condensed water vapor is present within the plume as it emerges from the emission outlet, make opacity observations beyond the point in the plume at which condensed water vapor is no longer visible. Record the approximate distance from the emission outlet to the point in the plume at which the observations are made.

2.1.3.2 Detached Steam Plumes. When water vapor in the plume condenses and becomes visible at a distinct distance from the emission outlet, evaluate the opacity of emissions at the emission outlet prior to the condensation of water vapor and the formation of the steam plume.

2.2 Procedures for Fugitive Process Dust Emissions. These procedures are applicable for the determination of the opacity of fugitive emissions by a qualified observer. The qualified observer should do the following:

2.2.1 Position. Stand at a position at least 5 meters from the fugitive source in order to provide a clear view of the emissions with the sun oriented in the 140-degree sector to the

back. Consistent as much as possible with maintaining the above requirements, make opacity observations from a position such that the line of vision is approximately perpendicular to the plume and wind direction. As much as possible, if multiple plumes are involved, do not include more than one plume in the line of sight at one time.

2.2.2 Field Records. Record the name of the plant or site, fugitive source location, source type [pile, stack industrial process unit, incinerator, open burning operation, activity, material handling (transfer, loading, sorting, etc.)], method of control used, if any, observer's name, certification date and affiliation, a sketch of the observer's position relative to the fugitive source, and date on a field data sheet, such as the sample visible emission observation form included in appendix 1. Also, record the time, estimated distance to the fugitive source location, approximate wind direction, estimated wind speed, description of the sky condition (presence and color of clouds), observer's position relative to the fugitive source, and color of the plume and type of background on the visible emission observation form when opacity readings are initiated and completed. For roads, storage piles, parking lots, record a description of the surface conditions (presence of moisture).

2.2.3 Observations. Make opacity observations, to the extent possible, using a contrasting background that is perpendicular to the line of vision. For roads, storage piles, and parking lots,

make opacity observations approximately 1 meter above the surface from which the plume is generated. For other fugitive sources, make opacity observations at the point of greatest opacity in that portion of the plume where condensed water vapor is not present. For intermittent sources, the initial observation should begin immediately after a plume has been created above the surface involved. Do not look continuously at the plume but, instead, observe the plume momentarily at 15-second intervals.

2.3 Recording Observations. Record the opacity observations to the nearest 5 percent every 15 seconds on an observational record sheet such as the visible emission observation form included in appendix 1. Each momentary observation recorded represents the average opacity of emissions for a 15-second period. The overall length of time for which observations are recorded shall be appropriate to the averaging time specified in the State regulation.

2.4 Data Reduction for Time-Averaged Regulations. A set of observations is composed of an appropriate number of consecutive observations determined by the averaging time specified. Divide the recorded observations into sets of appropriate time lengths for the specified averaging time. Sets must consist of consecutive observations; however, observations immediately preceding and following interrupted observations shall be deemed consecutive. Sets need not be consecutive in time and in no case shall two sets overlap, resulting in multiple violations. For each set of

observations, calculate the appropriate average opacity.

3. Qualification and Testing

3.1 Certification Requirements. To receive certification as a qualified observer, a candidate must be tested and demonstrate the ability to assign opacity readings in 5 percent increments to 25 different black plumes and 25 different white plumes, with an error not to exceed 15 percent opacity on any one reading and an average error not to exceed 7.5 percent opacity in each category. Candidates shall be tested according to the procedures described in paragraph 3.2. Any smoke generator used pursuant to paragraph 3.2 shall be equipped with a smoke meter which meets the requirements of paragraph 3.3. Certification tests that do not meet the requirements of paragraphs 3.2 and 3.3 are not valid.

The certification shall be valid for a period of 6 months, and after each 6-month period, the qualification procedures must be repeated by an observer in order to retain certification.

3.2 Certification Procedure. The certification test consists of showing the candidate a complete run of 50 plumes, 25 black plumes and 25 white plumes, generated by a smoke generator. Plumes shall be presented in random order within each set of 25 black and 25 white plumes. The candidate assigns an opacity value to each plume and records the observation on a suitable form. At the completion of each run of 50 readings, the score of the candidate is determined. If a candidate fails to qualify, the complete run of 50 readings must be repeated in any retest. The smoke test may

be administered as part of a smoke school or training program, and may be preceded by training or familiarization runs of the smoke generator during which candidates are shown black and white plumes of known opacity.

3.3 Smoke Generator Specifications. Any smoke generator used for the purpose of paragraph 3.2 shall be equipped with a smoke meter installed to measure opacity across the diameter of the smoke generator stack. The smoke meter output shall display in-stack opacity, based upon a path length equal to the stack exit diameter on a full 0 to 100 percent chart recorder scale. The smoke meter optical design and performance shall meet the specifications shown in Table 1. The smoke meter shall be calibrated as prescribed in paragraph 3.3.1 prior to conducting each smoke reading test. At the completion of each test, the zero and span drift, shall be checked, and if the drift exceeds $\pm$1 percent opacity, the condition shall be corrected prior to conducting any subsequent test runs. The smoke meter shall be demonstrated at the time of installation to meet the specifications listed in Table 1. This demonstration shall be repeated following any subsequent repair or replacement of the photocell or associated electronic circuitry including the chart recorder or output meter, or every 6 months, whichever occurs first.

3.3.1 Calibration. The smoke meter is calibrated after allowing a minimum of 30 minutes warm-up by alternately producing simulated opacity of 0 percent and 100 percent. When stable

response at 0 percent or 100 percent is noted, the smoke meter is adjusted to produce an output of 0 percent or 100 percent, as appropriate. This calibration shall be repeated until stable 0 percent and 100 percent readings are produced without adjustment. Simulated 0 percent and 100 percent opacity values may be produced by alternately switching the power to the light source on and off while the smoke generator is not producing smoke.

3.3.2 Smoke Meter Evaluation. The smoke meter design and performance are to be evaluated as follows:

3.3.2.1 Light Source. Verify from manufacturer's data and from voltage measurements made at the lamp, as installed, that the lamp is operated within $\pm$5 percent of the nominal rated voltage.

3.3.2.2 Spectral Response of Photocell. Verify from manufacturer's data that the photocell has a photopic response; i.e., the spectral sensitivity of the cell shall closely approximate the standard spectral-luminosity curve for photopic vision which is referenced in (b) of Table 1.

3.3.2.3 Angle of View. Check construction geometry to ensure that the total angle of view of the smoke plume, as seen by the photocell, does not exceed 15 degrees. Calculate the total angle of view as follows:

$$N_V = 2 \tan^{-1} d/2L,$$

where:

N_V = total angle of view;

d = the photocell diameter + the diameter

of the limiting aperture; and

L = distance from the photocell to the limiting aperture.

The limiting aperture is the point in the path between the photocell and the smoke plume where the angle of view is most restricted. In smoke generator smoke meters, this is normally an orifice plate.

3.3.2.4 Angle of Projection. Check construction geometry to ensure that the total angle of projection of the lamp on the smoke plume does not exceed 15 degrees. Calculate the total angle of projection as follows:

$$N_p = 2 \tan^{-1} d/2L$$

where:

N_p = total angle of projection;

d = the sum of the length of the lamp filament + the diameter of the limiting aperture; and

L = the distance from the lamp to the limiting aperture.

3.3.2.5 Calibration Error. Using neutral-density filters of known opacity, check the error between the actual response and the theoretical linear response of the smoke meter. This check is accomplished by first calibrating the smoke meter according to 3.3.1 and then inserting a series of three neutral-density filters of nominal opacity of 20, 50, and 75 percent in the smoke meter path length. Use filters calibrated within $\pm$2 percent. Care should be taken when inserting the filters to prevent stray light

from affecting the meter. Make a total of five nonconsecutive readings for each filter. The maximum opacity error on any one reading shall be ±3 percent.

3.3.2.6 Zero and Span Drift. Determine the zero and span drift by calibrating and operating the smoke generator in a normal manner over a 1-hour period. The drift is measured by checking the zero and span at the end of this period.

3.3.2.7 Response Time. Determine the response time by producing the series of five simulated 0 percent and 100 percent opacity values and observing the time required to reach stable response. Opacity values of 0 percent and 100 percent may be simulated by alternately switching the power to the light source off and on while the smoke generator is not operating.

4. References

1. U. S. Environmental Protection Agency. Standards of Performance for New Stationary Sources; appendix A; Method 9 for Visual Determination of the Opacity of Emissions from Stationary Sources. Final Rule. 39 FR 219. Washington, DC. U. S. Government Printing Office. November 12, 1974.

2. Office of Air and Radiation. "Quality Assurance Guideline for Visible Emission Training Programs." EPA-600/S4-83-011. Quality Assurance Division. Research Triangle Park, N.C. May 1982.

3. "Method 9 - Visible Determination of the Opacity of Emissions from Stationary Sources." February 1984. Quality

Assurance Handbook for Air Pollution Measurement Systems. Volume III, section 3.1.2. Stationary Source Specific Methods. EPA-600-4-77-027b. August 1977. Office of Research and Development Publications, 26 West Clair Street, Cincinnati, Oh.

4. Office of Air Quality Planning and Standards. "Opacity Error for Averaging and Nonaveraging Data Reduction and Reporting Techniques." Final Report-SR-1-6-85. Emission Measurement Branch, Research Triangle Park, N.C. June 1985.

5. The U. S. Environmental Protection Agency. Preparation, Adoption, and Submittal of State Implementation Plans. Methods for Measurement of PM_{10} Emissions from Stationary Sources. Final Rule. FEDERAL REGISTER. Washington, DC. U. S. Government Printing Office. Volumes 55. No. 74. pps. 14246-14279. April 17, 1990.

TABLE 1. SMOKE METER DESIGN AND PERFORMANCE SPECIFICATIONS

	Parameter	Specification
a.	Light source	Incandescent lamp operated at nominal rated voltage.
b.	Spectral response of photocell	Photopic (daylight spectral response of the human eye -- Reference 4.1 of section 4).
c.	Angle of view	15 degrees maximum total angle.
d.	Angle of projection ...	15 degrees maximum total angle.
e.	Calibration error	$\pm$3-percent opacity, maximum.
f.	Zero and span drift ...	$\pm$1-percent opacity, 30 minutes.
g.	Response time	$\leq$ 5 seconds.