Visible Emissions Training Program

SMOKE SCHOOL

PENN STATE

Visible Emissions Training

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Course Objectives

- Understand sources of visible emissions and the factors that make plumes visible.
- Learn what opacity is, and the procedures to visually measure opacity.
- Learn how to distinguish between smoke (particle) plumes and steam plumes.
- Learn what is expected of a certified smoke reader.
- Prepare you to take the field test to become a certified smoke reader.

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Introduction

- Air pollution
- Particle sizes
- Effect on humans – interaction of particles with the human body

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Air Pollutant Types

- Particulate
  - Smoke
  - Soot
  - Flyash
  - Dust
  - Fumes
  - Mist

(Always visible)

- Gaseous
  - Gases
  - Vapors

E.g., Sulfur dioxide (SO_2) is clear but appears blue when it reacts with the atmosphere;

Nitrous oxides (NOx) gas forms a brownish haze (smog).

(Not always visible)

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Particles

- Particle size expressed in ***microns*** or ***micrometers***
  (1 μm = 1/1,000,000 m = 0.00003937 inches)
- Diameters of various particles
- EPA definitions and terminology
- Interaction of particles with the ***human body***
- Interaction of particles with ***light***
- Microscopic images: Sizes and shapes of various air-borne particles

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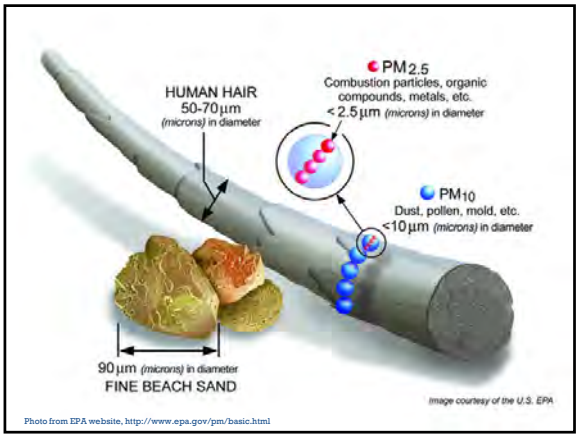

Photo from EPA website, http://www.epa.gov/pm/basic.html

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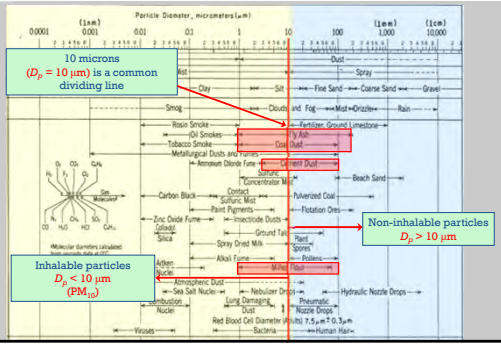
Particle Diameter in Microns (µm)



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Why 10 µm Particle Size is Important

- Particles < 10 µm are ***inhalable*** (can enter the lungs), and are potentially problematic for human health.
- Particles > 10 µm do not get inhaled into the lungs, but get trapped in the nose or throat.
- EPA is concerned with particles less than 10 µm ("***coarse particles***"), because of their potential effect on the lungs.
- EPA labels these coarse particles as **PM_{10} ("Particulate Matter less than 10 microns")**, and lists them among the 7 CAPs (Criteria Air Pollutants) for which the EPA issues NAAQS (National Ambient Air Quality Standards) for healthy air.

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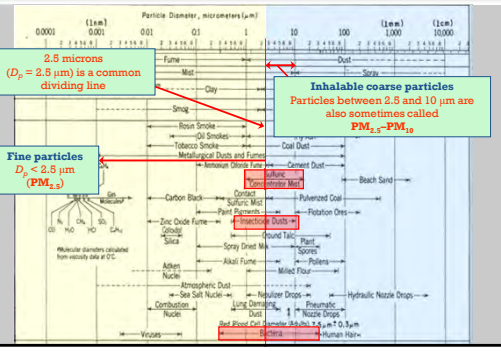
Particle Diameter in Microns (µm)



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Why 2.5 µm Particle Size is Important

- Particles < 2.5 µm are ***respirable*** – can penetrate deep into the lungs, and are potentially more problematic for human health than PM_{10}.
- EPA is most concerned with these small particles ("***fine particles***"), because of their effect on the lungs.
- EPA labels these small particles as **$PM_{2.5}$ ("Particulate Matter less than 2.5 microns"** or **"*fines*")**, and lists them among the 7 CAPs (Criteria Air Pollutants) for which the EPA issues NAAQS (National Ambient Air Quality Standards) for healthy air.

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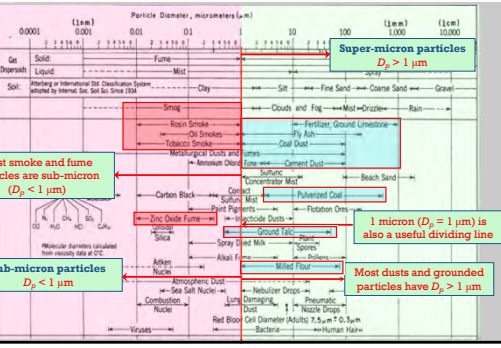
Particle Diameter in Microns (µm)



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Why 1 µm Particle Size is Important

- Combustion (burning) produces mostly ***submicron*** particles (D_p <1 µm).
- Natural processes and grinding produce mostly ***supermicron*** particles (D_p >1 µm).
- Particles < 1 µm can penetrate *really deep* into the lungs, all the way into the alveoli, and are potentially very problematic for human health.
- Particles near 1 µm interact most with *visible light*, since light waves are around 1 µm, and these particles may lead to significant opacity and visibility reduction.

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How Small of a Particle Can We See?

- Estimates vary, but range from D_p = 20 to 100 μm as the smallest object a healthy naked human eye can see.
- **On average, most people can distinguish objects down to about 70 μm, about the size of a single strand of hair.**
- However, if the object is a *glowing particle* or a particle that *scatters* light and is seen by the eye as a source of light (e.g. bubbles, transparent particles that scatter sunlight, etc.), a healthy human eye can see down to about D_p = 10 μm.
- Many air pollution particles scatter light, so 10 μm is a useful benchmark: **The naked eye can see individual air pollution particles down to about 10 μm**.
- However, we can see *clouds* of smaller (even submicron!) particles because of blockage and scattering of light.

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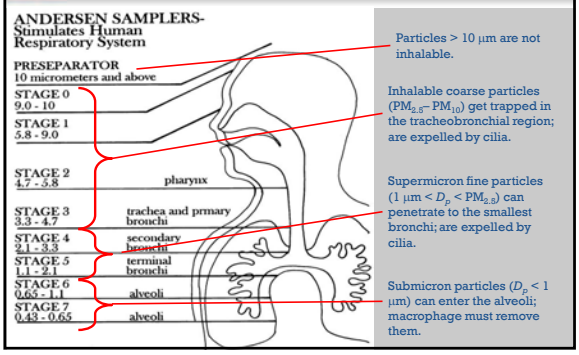
How Particles of Various Sizes Penetrate into the Human Respiratory System



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Sources of Visible Emissions

- Residential sources
- Natural sources
- Accidents
- Industrial sources

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Meteorology

The effect of wind, weather, and temperature conditions on the behavior of particle plumes

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Wind, and its Interaction with Particle Plumes

- Variation of wind speed with elevation
- Variation of wind speed during the day
- Estimating wind speed – The Beaufort scale
- The undesirable effect of wind on plumes near buildings

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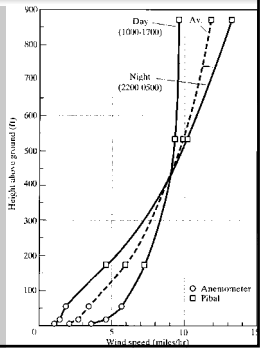
Variation of Wind Speed During the Day

- Solar radiation affects wind conditions.
- Wind generally varies between night and day.



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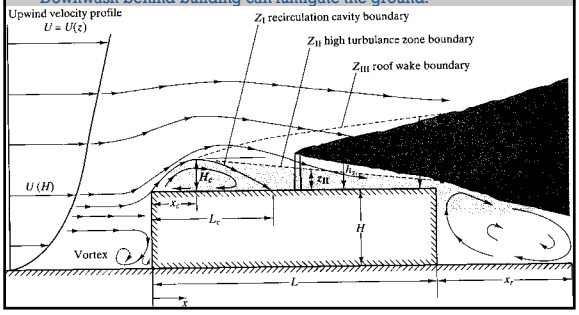
The Effect of Wind on Plumes Near Buildings

- Smoke from plume can get sucked into ventilation inlets.
- Downwash behind building can fumigate the ground.



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How to Avoid This Kind of Problem

- **Taller stack** – source of smoke is higher up, hopefully out of the way
  - More expensive and not always possible
- **Location of stack** – may be able to locate it so that interaction with wind and building is less severe
  - Also not always possible; wind is not always in the same direction
- **Hotter stack** – sends smoke up higher and out of the way
  - More expensive since wasting more energy

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Temperature

- Buoyancy of plumes
- Lapse rate
- Atmospheric stability
- Diurnal temperature variations

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Buoyancy of Plumes

- Hot plumes rise rapidly, but waste energy.
- Cool plumes save energy, but do not rise well.
- Bottom line – ***Must compromise between energy savings and plume buoyancy***.
- Taller stacks help.

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Lapse Rate

- The negative of the temperature gradient with elevation is called the lapse rate

  Lapse rate = - dT/dz = - (change in T)/(change in z)
- The standard (normal or average) lapse rate is about 6.5 °C per kilometer, i.e., T drops by about 6.5 °C for every 1 km of elevation.
- In English units, T drops by about 19°F for every 1 mile of elevation.

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Dry Adiabatic Lapse Rate

- The dry adiabatic lapse rate corresponds to a neutrally stable atmosphere.
- In other words, mixing is neither promoted nor inhibited.

Dry adiabatic lapse rate = 9.8°C/km

Dry adiabatic lapse rate = 28°F/mile

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Atmospheric Stability

- Stability of the atmosphere is determined by comparing actual lapse rate to dry adiabatic lapse rate.
  - Actual lapse rate > dry adiabatic lapse rate
    - Atmosphere is *unstable* – mixing is enhanced (*superadiabatic*).
  - Actual lapse rate = dry adiabatic lapse rate
    - Atmosphere is *neutrally stable* – mixing is neither inhibited nor enhanced (*adiabatic*).
  - Actual lapse rate < dry adiabatic lapse rate
    - Atmosphere is *stable* – mixing is inhibited (*subadiabatic*).

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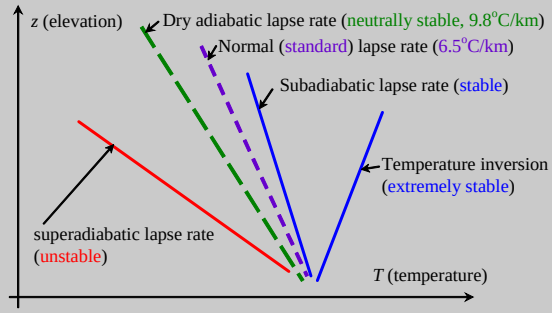
Atmospheric Stability (cont.)



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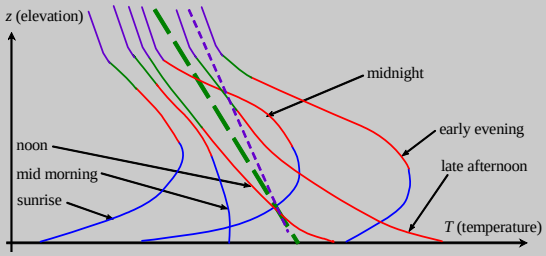
Diurnal Temperature Variations

Change in temperature profile throughout a 24-hour period



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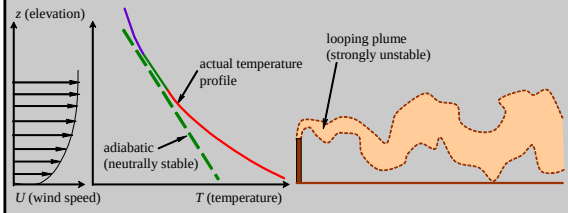
Atmospheric Stability (cont.)

Superadiabatic conditions (very unstable – **looping plume**)



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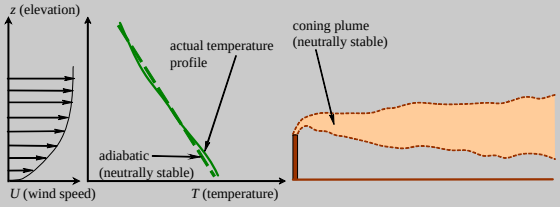
Atmospheric Stability (cont.)

Nearly adiabatic conditions (neutrally stable – **coning plume**)



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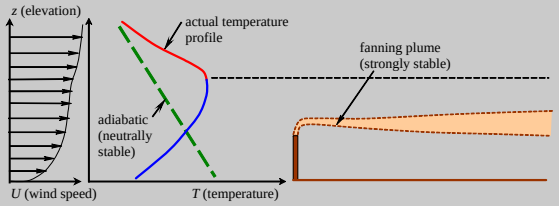
Atmospheric Stability (cont.)

Ground-based temperature inversion and short stack (very stable – **fanning plume**)



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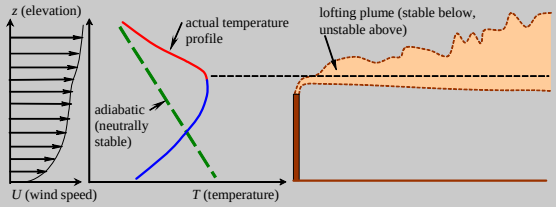
Atmospheric Stability (cont.)

Ground-based temperature inversion and tall stack (stable below, unstable above – **lofting plume**)



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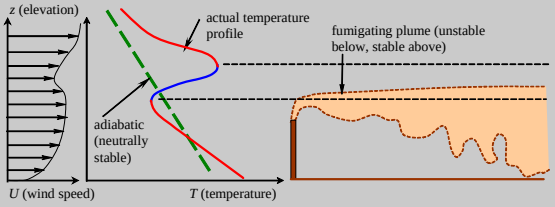
Atmospheric Stability (cont.)

Elevated temperature inversion and short stack (unstable below, stable above – **fumigating plume**)



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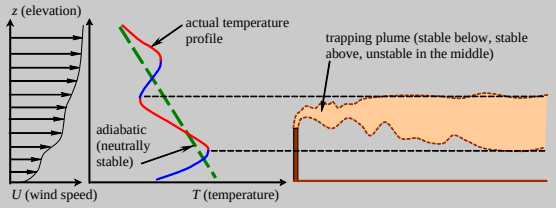
Atmospheric Stability (cont.)

Ground-based and elevated temperature inversions (stable below, stable above – **trapping plume**)



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Take a Quiz! Name that Plume!

Photographs of plumes in various atmospheric stability conditions

Name that plume:

- Lofting?
- Trapping?
- Looping?
- Coning?
- Fumigating?
- Fanning?

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Opacity

- What is opacity?
- Why is it important?
- How do we measure it?
- Factors affecting opacity measurement

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What is Opacity?

- Opacity is the fraction of light that does not pass through a plume.
  - The light is either absorbed or scattered away by particles in the plume.
  - The higher the opacity, the darker the background sky, looking through the plume.

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Why is Opacity Important?

- Visible emissions contain small particles, which:
  - Reduce visibility
  - May penetrate the lungs and cause damage
  - May be sites for adsorption and condensation of other chemicals
- Opacity is limited by federal, state, and local regulations. Fines can result if not in compliance.
- Change in opacity may indicate the process has changed, and may warrant a stack test.
- Inspection of opacity can be done remotely – inspection does not require access to plant property.

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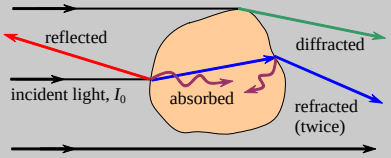
Light Interacting with Particles

- Scattering (three components)
  - Reflection
  - Refraction
  - Diffraction



- Attenuation (one component)
  - Absorption
  - Absorbed light is "lost", i.e., transformed into internal energy in the particle – the particle heats up slightly due to absorbed light.

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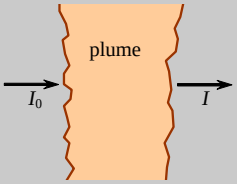
Definition of Transmissivity and Opacity

- I_0 = intensity of incoming light
- I = intensity of light that passes through the plume
- **Transmissivity, T**, is the fraction of light that passes through the plume
- **Opacity, O**, is the fraction of light that does not pass through the plume (it is either absorbed or scattered away)



$$T = I / I_0$$

$$O = 1 - T = 1 - I / I_0$$

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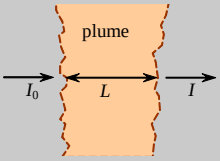
Definition of Transmissivity and Opacity

- If all particles are spherical and of the same diameter, D_p, one can derive an equation for the opacity

$$\text{Opacity} = 1 - \frac{I}{I_0} = 1 - \exp\left(-c\frac{\pi D_p^{\,2}}{4}kL\right)$$

Where

- c is the particle concentration
- k is an extinction coefficient
- L is the optical path length
- D_p is the particle diameter



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How Does One Measure Opacity?

- Electronic transmissometer in a stack
- Remote plume opacity monitor
- Photographic methods with sophisticated image processing
- Visual measurement using Ringelmann Scale
- Visual measurement using EPA Reference Method 9
- Visual measurement using EPA Reference Method 22

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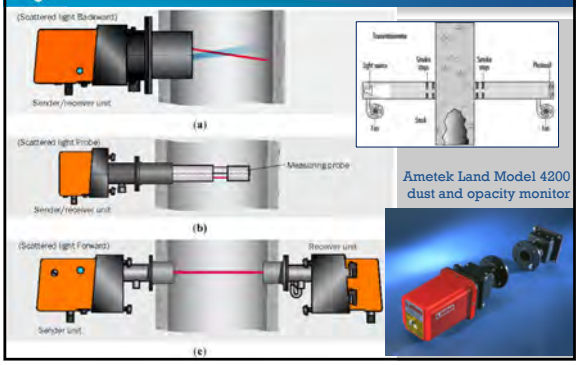
Opacity Measurement with an In-Stack Transmissometer



Ametek Land Model 4200 dust and opacity monitor

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You can not look at a photograph with your eyes and accurately determine opacity!

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You can calculate opacity using computer analysis of calibrated digital images (see Method Alt–082 in Appendices)

Algorithms compare in-plume data with background data

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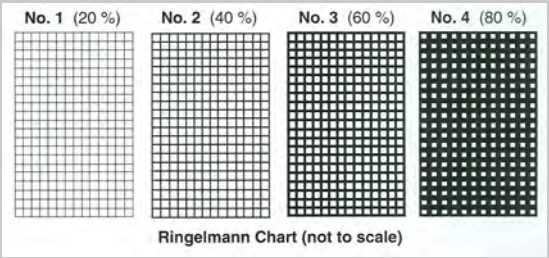
Ringelmann Scale

Early visual measurements of opacity were made with the Ringelmann scale (still used in some states – not PA)



Ringelmann Chart (not to scale)

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Factors Affecting Visual Measurement of Opacity

- Effect of looking through a plume at an angle
- Effect of sun position on observed opacity:
  - Contrast
  - Scattering intensity

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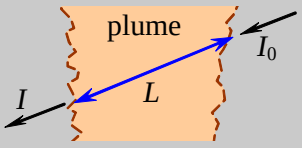
Effect of Looking Through Plume at an Angle

- All else being equal, the ***optical path length***, *L*, *increases* when opacity is measured through the plume at an angle which is not perpendicular to the plume.



$$\text{Opacity} = 1 - \frac{I}{I_0} = 1 - \exp\left(-c\frac{\pi D_p^{\,2}}{4}kL\right)$$

Recall *L* in this equation for opacity

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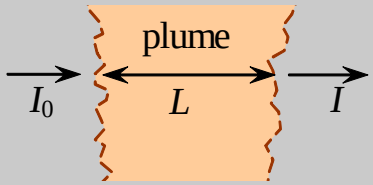
Effect of Looking Through Plume at an Angle (cont.)

- To avoid this error, the plume should be viewed from a position approximately perpendicular to the plume.



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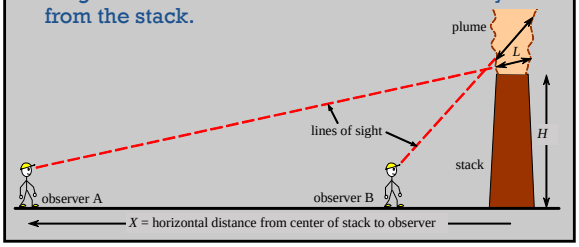
Effect of Looking Through Plume at an Angle (cont.)

- For example, an observer usually has to look up to see a plume.
- The error in opacity reading due to optical path length decreases the further one moves away from the stack.



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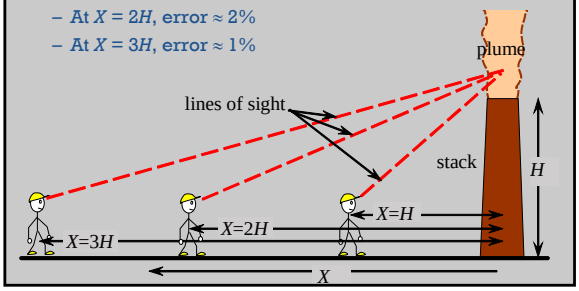
Effect of Looking Through Plume at an Angle (cont.)

- Error due to standing too close:
  - At $X = H$, error ≈ 8%
  - At $X = 2H$, error ≈ 2%
  - At $X = 3H$, error ≈ 1%



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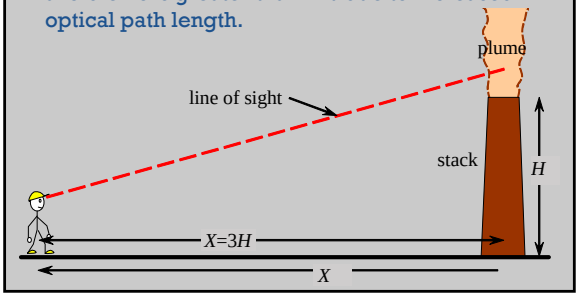
Effect of Looking Through Plume at an Angle (cont.)

- Bottom line: Stand at least 3 stack heights away to avoid errors greater than 1% due to increased optical path length.



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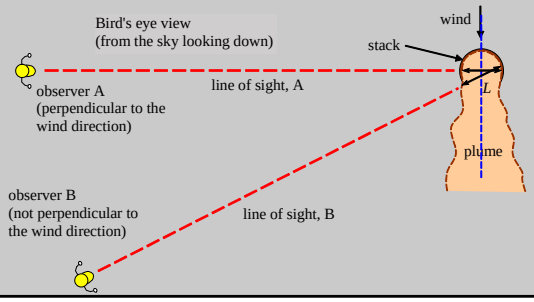
Effect of Wind Direction on Plume Opacity

- As another example, consider the wind interacting with a plume.



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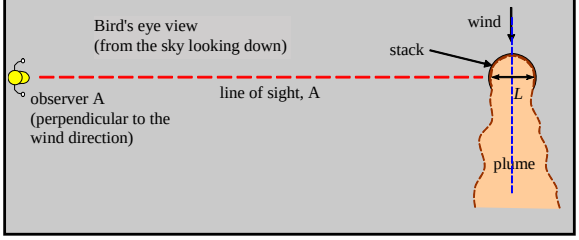
Effect of Wind Direction on Plume Opacity

- The error in opacity reading due to optical path length is minimized if the line of sight is perpendicular to the wind.



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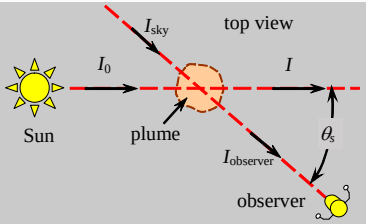
Effect of Sun Position on Observed Opacity

- θ_s is the scattering angle from the forward direction.
- $I_{observer}$ is the intensity of light that the observer actually *sees*, looking at the plume.
- I_{sky} is the intensity of the surrounding (background) sky light (scattered Sun light). Thus,

$$O_{observed} = 1 - I_{observer} / I_{sky}$$



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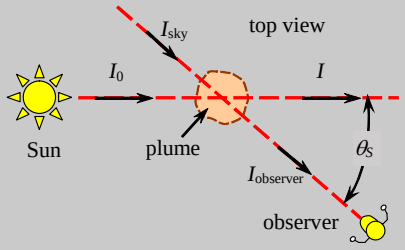
Effect of Sun Position on Observed Opacity

- The opacity seen by the observer (in contrast to the background sky light) is a *strong function* of angle θ_s
- Angle θ_s affects both contrast and scattering.



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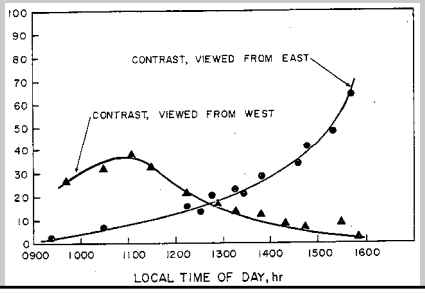
Effect of Sun Position on Contrast Between Plume and Sky

- White plume: Apparent contrast greatly affected by sun position.



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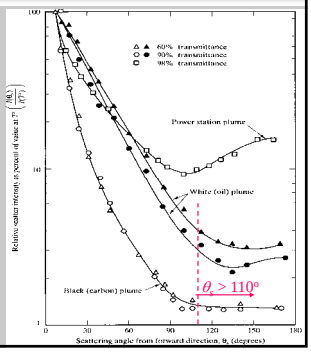
Effect of Sun Position on Scatter Intensity

- Scatter intensity is a very strong function of θ_s.
- However, for θ_s greater than about 110°, scatter intensity is relatively flat.



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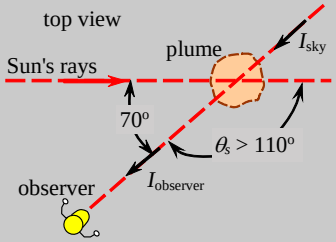
Effect of Sun Position on Scatter Intensity

- To avoid opacity errors due to scatter intensity, scatter angle θ_s should always be greater than about 110°.



- Specifically, to ensure that θ_s = 110° from any direction, the Sun must be within a *140° cone* to the observer's back.

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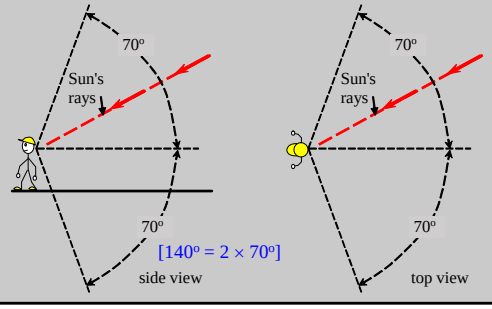
Very Important Point in this Seminar!

- When taking visual opacity readings, the sun must always be ***at your back;*** specifically, ***in a 140° cone*** from the back of your head.



59

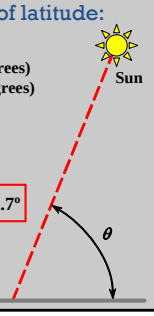
Maximum Sun Angle Calculation

- You can calculate the sun angle at an equinox or solstice – it is a simple function of latitude:

$\theta_{\text{Fall or Spring Equinox}}$ = 90 - latitude (degrees)
$\theta_{\text{Winter Solstice}}$ = 90 - 23.5 - latitude (degrees)
$\theta_{\text{Summer Solstice}}$ = 90 + 23.5 - latitude (degrees)

Example: State College, PA latitude = 40.8°, so the maximum sun angle ever encountered is at the summer solstice,

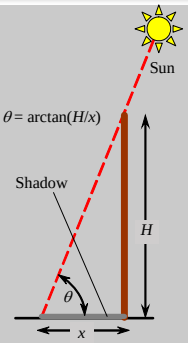
$\theta_{\text{Summer Solstice}}$ = 90° + 23.5° – 40.8° = 72.7°



60

Sun Angle Measurement in Central PA

- On June 20 or 21 (longest day of the year) sometime between noon to 1:00 p.m., the sun is the highest it ever gets.
- We used a shadow and some trigonometry to measure the sun angle.
- We measured approximately 71 degrees as the maximum sun angle on June 20, 2008 at 1:00 (agrees pretty well).



61

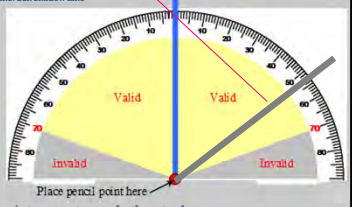
Sun Shadow Line

Valid reading if shadow falls in yellow highlighted region

Chart provided in the Appendix and on line: Sun Shadow Line

Point towards stack

A simple way to ensure that the sun is within the 140° sector to your back.

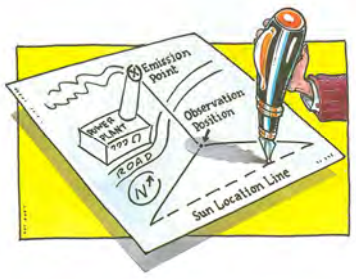


Instructions:
- Hold paper horizontally and point arrow towards the stack
- Hold a pencil vertically and place the point of the pencil at the indicated location
- Sketch the position of the pencil's shadow on the protractor region
- The shadow must lie in the valid range

62

Sun Location Line

Alternate method from California booklet



63

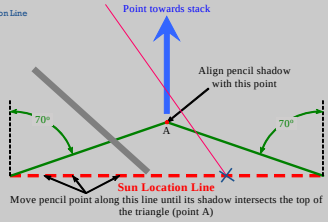
Sun Location Line

Valid reading if mark lies along the sun location line

Chart provided in the appendix: Sun Location Line

Point towards stack

Another simple way to see if the sun is within the 140° sector to your back.



Instructions:
- Hold paper horizontally and point arrow towards the stack
- Hold a pencil vertically and place the point of the pencil along the sun location line
- Move the pencil tip along the sun location line until its shadow intersects the top of the triangle
- Mark the location of the pencil tip
- The reading is valid if the mark lies *along* the sun location line

64

Question

What should I do if I can not stand 90° to the wind and *also* keep the sun at my back? (Which is more important?)

Answer:

It is more important to ***keep the sun at your back*** than to look 90° to the wind.

sun location is more critical than wind direction

(If possible, try again later; you may be able to satisfy both criteria at some later time in the day.)

65

Control of Visible Emissions

CONTROL

66

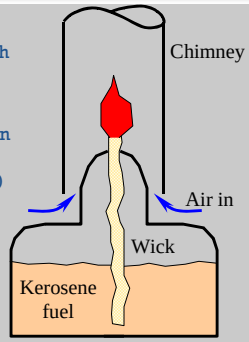
The Three T's of Good Combustion

- The three T's of good combustion and minimal visible emissions:
  - Temperature
  - Time
  - Turbulence

67

The Three T's Applied to a Kerosene Lamp

- Temperature
  - Chimney must be hot enough (cold chimney collects soot)
- Time
  - Flame must have time to burn (tall wick does not allow enough time for fuel to burn)
- Turbulence
  - There must be adequate mixing (poor mixing produces soot)



68

Theoretical Combustion of Coal

(Constituents in mols)

Fuel Assay		Air		Products
.635 C		O_2		.635 CO_2
.041 H_2				.191 H_2O
.015 S	+ .596		→	.015 SO_2
.075 O_2		3.76 N_2		2.241 N_2
.150 H_2O				.084 Ash
.084 Ash				

69

Actual Combustion of Coal

(constituents in mols, *X* = excess air)

Fuel Assay		Air		Products
.635 C		O_2		CO_2, CO, O_2
.041 H_2				H_2O, N_2
.015 S				SO_2, H_2S
.075 O_2	+ .596 (1+*X*)		→	NO, NO_2, NH_3
.150 H_2O		3.76 N_2		C_XH_Y
.084 Ash				Flyash (oxides Al, Fe, Ca, …)

70

Emissions from Coal

- Sulfur – forms SO_2 (blue), H_2S, and odors
  - SO_2: Pungent odor
  - H_2S: Rotten egg smell
- Fly ash – light brown to black
- Soot and smoke – black

71

Remedies for Visible Emissions from Coal

- Coal specification – Reduce sulfur content of coal assay
- Air flow – Add proper amount of excess air (too little produces soot; too much chills flame and disturbs fuel bed)
- Draft – Control the gas velocity over coal bed
- Cleaners – Improve performance of ESP, baghouse, scrubber, etc.
- Firing rate – Control fuel bed thickness; remove coal clinkers that block air ports

72

Theoretical Combustion of Oil

(constituents in mols)

Fuel Assay (#2 Fuel Oil)		Air		Products
.864 C .127 H_2 .004 S .001 O_2 .001 N_2 .003 Ash	+ .931	O_2 3.76 N_2	→	.864 CO_2 .127 H_2O .004 SO_2 3.502 N_2 .003 Ash

73

Actual Combustion of Oil

(constituents in mols, *X* = excess air)

Fuel Assay (#2 Fuel Oil)		Air		Products
.864 C .127 H_2 .004 S .001 O_2 .001 N_2 .003 Ash	+ .931 (1+*X*)	O_2 3.76 N_2	→	CO_2, CO H_2O, O_2 N_2, NO, NO_2 Ash, SO_2, H_2S Aldehydes Organic Acids Alcohols C_XH_Y

74

Emissions from Oil

- Sulfur – forms SO_2 (blue), H_2S, and odors:
  - SO_2: Pungent Odor
  - H_2S: Rotten Egg Smell

(However, modern diesel fuel is ultra-low sulfur)

- Soot and smoke – black or white

75

Sources of Visible Emissions from Oil

- Too much air (hydroxylation)
  - White emission
  - Forms aldehydes, alcohols, peroxides, and odors
- Too little air (cracking)
  - Black emission
  - Forms light hydrocarbons and soot

76

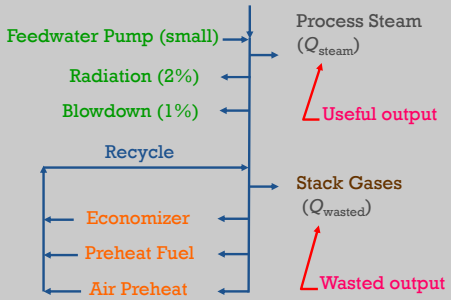
Remedies for Visible Emissions from Oil

- Atomizer – If not adjusted, get wrong drop size, wrong flame length
- Draft – Affects the three T's (temperature, time, and turbulence)
- Drop size – Small drops lead to a short flame, faster vaporization
- Swirl – Add swirl to control flame length
- Control air/fuel ratio and gas velocity – Affects the 3 T's, especially time and temperature

77

Boiler Energy Balance

Combustion Heat ($Q_{combustion}$) = *f* (Fuel, Air Flow)



78

Boiler Efficiency

Efficiency is always defined as the useful output divided by the required input.

For a steam boiler,

Useful output (process steam)

$$\eta = \frac{Q_{steam}}{Q_{combustion}} = \frac{Q_{combustion} - Q_{wasted}}{Q_{combustion}}$$

Required input (heat from the fuel)

79

Extra Fuel Cost for 5% Loss in Boiler Efficiency

A 100 BHP* boiler: 3450 lbm/hr steam or 3.35 million Btu/hr

Type of Fuel	Coal	Natural Gas	#2 Fuel Oil
Fuel Cost	\$3.2 per 10^6 BTU	\$4.0 per 10^6 BTU	\$18 per 10^6 BTU
Extra Yearly Cost (5% loss)	\$6,300	\$7,800	\$35,000

*BHP = **boiler horsepower**, defined as the amount of energy required to produce 34.5 pounds of steam per hour at a pressure and temperature of 0 Psig and 212 °F, with feedwater at 0 Psig and 212 °F. 100 BHP is equal to 1316 hp (mechanical horsepower - used for cars).

80

Combustion Efficiency from Coal

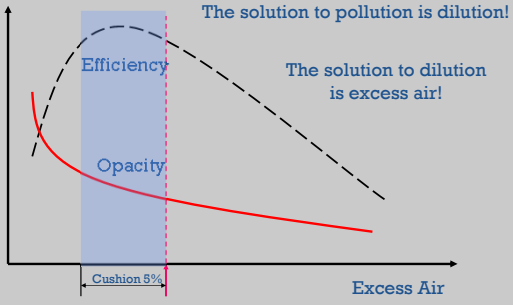
Effect of increasing excess air

Effect of increasing stack temperature

O_2 %	CO_2 %	Excess Air %	Stack Temperature (F) 250	300	350	400	450	500
5.0	14.2	30.3	89.0	87.5	85.9	84.3	82.8	81.2
6.0	13.3	38.8	88.5	86.9	85.3	83.6	81.9	80.2
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
10.0	9.7	88.1	85.9	83.7	81.6	79.4	77.1	74.9
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
14.0	6.2	193.8	80.3	76.9	73.6	70.2	66.8	63.4
15.0	5.3	242.0	77.7	73.8	70.0	66.1	62.1	58.2

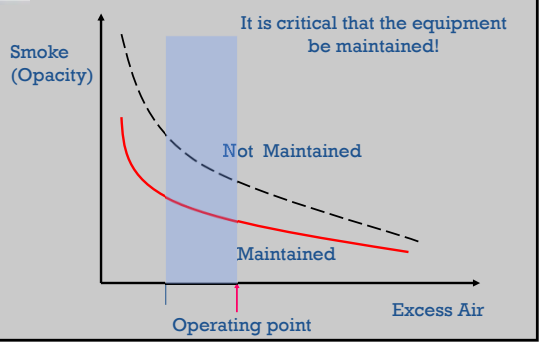
81

Combustion Efficiency



82

Combustion Efficiency



83

Steam Plumes

- Steam plumes are not regulated by the EPA or DEP
- The main problem with steam is that it is in the way of the smoke/particle plumes we want to read
- We must learn to recognize steam plumes so we do not mistake them for smoke/particle plumes

84

Reading Opacity with Steam Plumes

We must read outside of the steam!

85

Characteristics of Steam Plumes

- Relatively sharp boundaries or edges
- Very white, like clouds
- End abruptly (compared to particle plumes which can extend for miles – just slowly dissipate)

86

Media Often Misleads the Public

- TV reports, books, newspapers, magazines, and brochures often show *steam plumes* to illustrate *smoke plumes*!
- Why?
  - They (and the public) usually do not know the difference.
  - Steam plumes look more impressive (especially with the sun in back of the plume).
  - Smoke stack emissions have been cleaned up so much that it is hard to find good smoke plume pictures anymore.

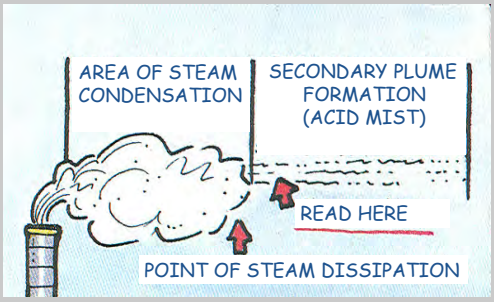
87

Secondary (Complex) Plumes

Secondary plumes consist of materials that leave stacks as vapors and condense in the atmosphere. Secondary plumes may accompany particle plumes. It is uncertain whether the opacity of secondary plumes is subject to regulation.

88

Secondary (Complex) Plumes



89

Visible Emissions Legislation – Federal

Several pieces of legislation, at both the federal and state levels, are relevant to visible emissions:

- Federal
  - Congress
    - Clean Air Act Amendments of 1990, Title 5 - Permits
  - Environmental Protection Agency (EPA)
    - Reference Method 9 of 1974 – Opacity of Visible Emissions
    - Reference Method 22 of 1982 – Opacity of Fugitive Emissions

90

Visible Emissions Legislation – State

Several pieces of legislation, at both the federal and state levels, are relevant to visible emissions:

- State
  - Pennsylvania Department of Environmental Protection (DEP)
    - Title 25, Section 123.41 – Visible Emissions

91

Clean Air Act Amendments of 1990 Title 5 – Permits

- All current emitters of *hazardous air pollutants* (HAPs) and all new emitters must secure an *operating permit*.
- The permit must contain provisions for *enforcing* emission limitations, inspection, entry, monitoring, certification, scheduling, and reporting of compliance.
- Monitored data must be collected continuously and *reported* semiannually to the compliance agency.
- Any construction, reconstruction, or modification of a major HAP source must meet *maximum achievable control technology* (MACT) standards *before* these activities begin.

92

Some facilities must use Continuous Opacity Monitoring Systems (COMS)

- Requirements for using COMS vary between states.
- EPA Method 203 (still referenced by many state regulations) has been rewritten as **Procedure 3 – Quality Assurance Requirements for Continuous Opacity Monitoring Systems at Stationary Sources.**
- Procedure 3 will apply to COMS used to demonstrate continuous compliance with opacity standards in EPA issued or approved regulations.
- The rule requires daily instrument and status indicator checks, quarterly performance audits, annual zero alignment audits and corrective action for malfunctioning COMS.

93

EPA Reference Method 9 of 1974 – Opacity of Visible Emissions

- EPA Reference Method 9 is
  - The primary method used for visual measurement of opacity
  - What we teach in this visible emissions training course

You will be tested and certified in *EPA Reference Method 9*.

94

EPA Reference Method 22 of 1982 – Opacity of Fugitive Emissions

- EPA Reference Method 22 is an alternate method which is sometimes used for visual assessment of *fugitive emissions.*
  - Must look on all sides and tops of buildings or other facilities for fugitive emissions.
  - We teach the details of Method 22 in this visible emissions training course, but you will *not* be tested or certified in Method 22.

95

Specifics for Pennsylvania

- The compliance agency for the Commonwealth of Pennsylvania is the *Department of Environmental Protection (DEP).*
  - DEP *interprets* and *enforces* Federal Title 5 regulations, and *issues permits*.
  - DEP permits require that there be a certified visible emissions reader *on site* at each plant.
  - The most important regulation from DEP regarding visible emissions is *Title 25, Section 123.41 – Visible Emissions*.

96

Pennsylvania Title 25 Regulations (Other States may be Different)

Section 123.41 – Limitations for point source emissions

No person shall cause, suffer, or permit the emission into the outdoor atmosphere of visible air contaminants in such a manner that the opacity of the emission is:

1. Equal to or greater than 20% for a period or periods aggregating more than 3 minutes in any one hour; or
2. Equal to or greater than 60% at any time

97

Pennsylvania Title 25 Regulations (cont.)

Section 123.41. Limitations in simple language

Opacity must stay *below* **20**%, except for up to *3 minutes* per hour.

Opacity must *always* stay *below* **60**%.

98

Pennsylvania Title 25 Regulations (cont.)

Section 123.2 – Fugitive particulate matter

No person shall cause, suffer, or permit fugitive particulate matter to be emitted into the outdoor atmosphere from any source or sources … if such emissions are:

1. Either visible, at any time, at the point such emissions pass outside the person's property, irrespective of the concentration of particulate matter in such emissions; or
2. Not visible at the point such emissions pass outside the person's property and the average concentration, above background, of three samples, of such emissions at any point outside the person's property, exceeds 150 particles per cubic centimeter.

99

Pennsylvania Title 25 Regulations (cont.)

Section 123.2 – Limitations in simple language

No visible fugitive particle emissions can pass outside the company's property line. (Opacity must be zero beyond the property line.)

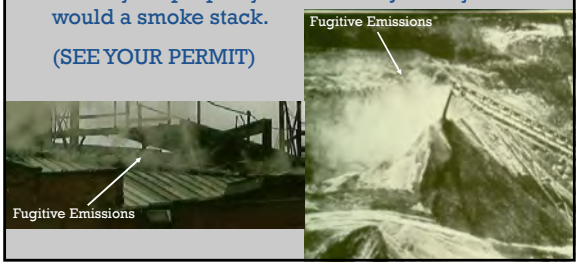
Furthermore, even if the opacity *is* zero outside the property line, the average particle concentration cannot exceed **150** particles per cubic centimeter above background concentration.

100

Be Aware: 40 CFR Part 60, Subpart OOO – Standards of Performance for Nonmetallic Mineral Processing Plants

Some of you may have to take readings for individual sources of **fugitive emissions** within your property boundaries just as you would a smoke stack.

(SEE YOUR PERMIT)



101

Pennsylvania Title 25 Regulations (cont.)

Section 123.45 – Alternative Opacity Limitation (AOL)

- In some cases, sources can comply with *mass* emission standards, but not *visible* (opacity) emission standards.
- The AOL accommodates such cases.
- AOL cases decided on an individual basis by DEP – the regional DEP office should be consulted.

102

Pennsylvania Title 25 Regulations (cont.)

Section 123.45 – Alternative Opacity Limitation (AOL) (cont.)

To be eligible for AOL:

- The source must comply with *mass* emission standards.
- The operator must attempt to minimize opacity "*within the bounds of good engineering and economic practice*."
- DEP will state the AOL level in the permit.

103

EPA Reference Method 9

[See Appendix of your handout for a copy of EPA Reference Method 9.]

Source: *Federal Register*, Vol. **39**, No. 219, Tuesday, November 12, 1974.

104

EPA Reference Method 9

Title: ***Visual Determination of the Opacity of Emissions from Stationary Sources***

Contents:

- Introduction
- Section 1. Principle and Applicability
- Section 2. Procedures
- Section 3. Qualifications and Testing

105

EPA Reference Method 9 (cont.)

Introduction:

Method 9 contains:

- Procedures for the training and certification of observers.
- Procedures to be used in the field for determination of plume opacity.

106

EPA Reference Method 9 (cont.)

Black plume studies:

- 100% of readings by qualified observers were read with a positive error of less than 7.5% opacity.

White plume studies:

- 99% of readings by qualified observers were read with a positive error of less than 7.5% opacity.

107

EPA Reference Method 9 (cont.)

Section 1 – Principle and Applicability

Principle:

- Opacity can be determined *visually* by a qualified observer.

Applicability:

- Applicable for determination of opacity from stationary sources.
- Applicable for qualifying observers to read opacities (i.e., lets you become "*certified smoke readers*").

108

EPA Reference Method 9 (cont.)

Section 2 – Procedures, Observer Position

- Observer shall stand ... with *the sun oriented in the 140° sector to his back.*
- His [observer's] line of vision is approximately *perpendicular to the plume direction.*
- When observing opacity of emissions from *rectangular outlets* (e.g., roof monitors, open baghouses, noncircular stacks), observer's line of vision is approximately *perpendicular to the longer axis of the outlet.*

109

EPA Reference Method 9 (cont.)

Section 2 – Procedures (cont.)

Field records – Observer shall record:

- Name of plant
- Type of facility
- Approximate wind direction and speed
- Observer's name and affiliation
- Description of plume background
- Date and time
- Emission location
- Estimated distance to emission location
- Description of the sky condition (presence and color of clouds)

110

See Back of Handout for Forms

Forms and references also posted on our website:
http://visible-emissions.outreach.psu.edu/

- Description of source
- Summary of data
- Record of opacity data
- Sun shadow line

111

Sample Form

Sample of a filled-in form:

Description of Source.

Description of Source

Page 1 of 1

General information:	
Test or observation number	1
Observation date	19 January 1980
Hours of observation	8:35 a.m. to 10:47 a.m.
Observer information:	
Observer name	Robert Jennings Heinsohn
Observer affiliation	Private consultant
Observer Method 9 certification date	24 November 1979
Name of Method 9 certifying agency	Penn State University
Company, facility, and source information:	
Company name	Penn State University
Company location or address	University Park, PA, on Burrowes St.
Type of facility	Steam generator, power plant
Specific information about source	Traveling grate stoker coal burner
Source ID number	17936-P
Control device(s) (In use? – Y or N)	Cyclones (Y)
Point of emission	Stack exit
Height of discharge point (ft)	194 ft
Stack diameter (ft)	Approx. 7 ft
Observer location and plume direction:	
Distance from observer to emission point (ft)	About 1 and ½ blocks (see sketch)
Height of observer location (ft)	Ground level
Description of observer location	On sidewalk (see sketch)
Prominent direction of plume (e.g., NE to SW)	W to E

112

Sample Form

Sample of a filled-in form (continued)

Notice the sketch at the bottom:

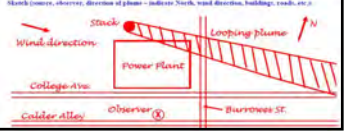
- Observer location
- Street names
- Compass

Description of Source

Page 1 of 1

General information:	
Test or observation number	1
Observation date	19 January 1980
Hours of observation	8:35 a.m. to 10:47 a.m.
Observer information:	
Observer name	Robert Jennings Heinsohn
Observer affiliation	Private consultant
Observer Method 9 certification date	24 November 1979
Name of Method 9 certifying agency	Penn State University
Company, facility, and source information:	
Company name	Penn State University
Company location or address	University Park, PA, on Burrowes St.
Type of facility	Steam generator, power plant
Specific information about source	Traveling grate stoker coal burner
Source ID number	17936-P
Control device(s) (In use? – Y or N)	Cyclones (Y)
Point of emission	Stack exit
Height of discharge point (ft)	194 ft
Stack diameter (ft)	Approx. 7 ft
Observer location and plume direction:	
Distance from observer to emission point (ft)	About 1 and ½ blocks (see sketch)
Height of observer location (ft)	Ground level
Description of observer location	On sidewalk (see sketch)
Prominent direction of plume (e.g., NE to SW)	W to E

Sketch (source, observer, direction of plume – indicate North, wind direction, buildings, roads, etc.):



113

Sample Form

Sample of a filled-in form:

Summary of Data.

Summary of Data

Page 1 of 1

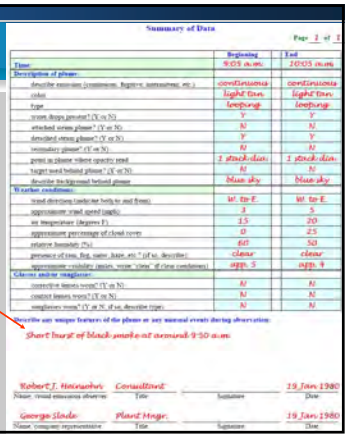
	Beginning	End
Time:	9:05 a.m.	10:05 a.m.
Description of plume:		
describe emission (continuous, fugitive, intermittent, etc.)	continuous	continuous
color	light tan	light tan
type	looping	looping
water drops present? (Y or N)	Y	Y
attached steam plume? (Y or N)	N	N
detached steam plume? (Y or N)	Y	Y
secondary plume? (Y or N)	N	N
point in plume where opacity read	1 stack dia.	1 stack dia.
target used behind plume? (Y or N)	N	N
describe background behind plume	blue sky	blue sky
Weather conditions:		
wind direction (indicate both to and from)	W. to E.	W. to E.
approximate wind speed (mph)	3	5
air temperature (degrees F)	15	20
approximate percentage of cloud cover	0	25
relative humidity (%)	60	50
presence of rain, fog, snow, haze, etc.* (if so, describe)	clear	clear
approximate visibility (miles; write "clear" if clear conditions)	app. 5	app. 4
Glasses and/or sunglasses:		
corrective lenses worn? (Y or N)	N	N
contact lenses worn? (Y or N)	N	N
sunglasses worn? (Y or N; if so, describe type)	N	N

114

Sample Form

Sample of a filled-in form (continued)

- This test was for one hour.
- Notice the comment about the burst of black smoke – will discuss more about this later.



115

Sample Form

Sample of a filled-in form:

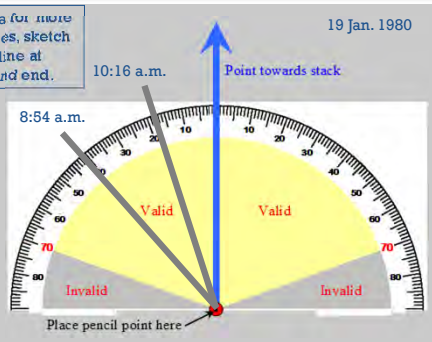
Record of Opacity Data

(one hour of data).

116

Sun Shadow Line

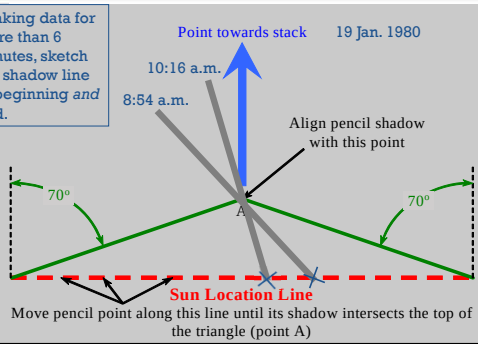
- If taking data for more than 6 minutes, sketch the shadow line at beginning *and* end.



117

Sun Location Line

- If taking data for more than 6 minutes, sketch the shadow line at beginning *and* end.



118

EPA Reference Method 9 (cont.)

Section 2 – Procedures (cont.)

Observations:

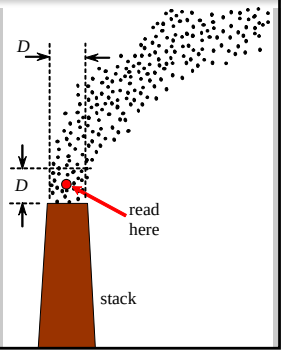
- Opacity observations shall be made at the point of greatest opacity in that portion of the plume where condensed water vapor is not present (no "steam").
- Observer shall not look continuously at the plume, but instead shall observe the plume momentarily at 15-second intervals.

119

Where in the Plume Should I Take the Opacity Readings?

Particle plumes

- Read at the point of *maximum opacity*.
- For a typical stack the maximum occurs *within one stack diameter* from the stack exit in the *center of the plume.*

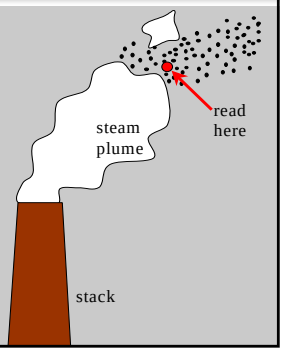


120

Where in the Plume Should I Take the Opacity Readings? (cont.)

Attached steam plumes

- Opacity observations shall be made beyond the point in the plume at which condensed water vapor is no longer visible.

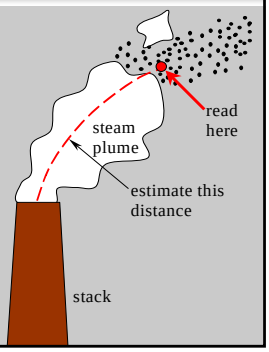


121

Where in the Plume Should I Take the Opacity Readings? (cont.)

Attached steam plumes

- Observer shall record the approximate distance from the emission outlet to the point in the plume at which the observations are made.

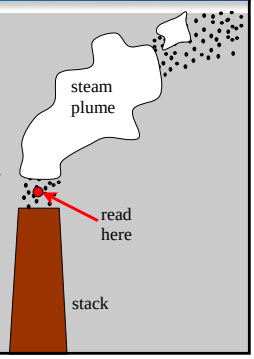


122

Where in the Plume Should I Take the Opacity Readings? (cont.)

Detached steam plumes

- Opacity…should be evaluated at the emission outlet prior to the condensation of water vapor and the formation of the steam plume.



123

EPA Reference Method 9 (cont.)

Section 2 – Procedures (cont.)

Recording observations:

- Opacity observations shall be recorded to the *nearest 5 percent* at *15-second intervals* on an observational record sheet.
- A *minimum of 24 observations* shall be recorded [6 minutes].

124

EPA Reference Method 9 (cont.)

Section 2 – Procedures (cont.)

Data reduction:

- Opacity shall be determined as an average of *24 consecutive observations* recorded at *15-second intervals.*
- Divide the observations recorded on the record sheet into *sets of 24 consecutive observations.*
- Sets need not be consecutive in time, and *cannot overlap*.

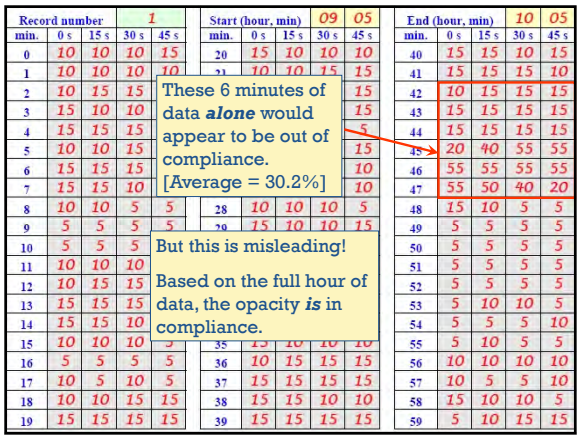
125

Sample – One Hour of Opacity Data

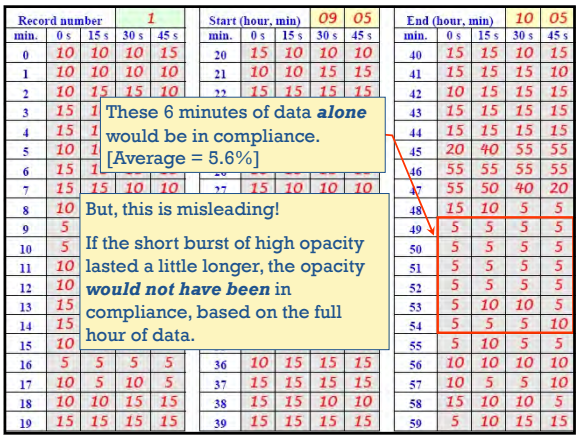
Record number					1				Start (hour, min)					09	05		End (hour, min)					10	05	
min.	0 s	15 s	30 s	45 s					min.	0 s	15 s	30 s	45 s				min.	0 s	15 s	30 s	45 s			
0	10	10	10	15					20	15	10	10	10				40	15	15	10	15			
1	10	10	10	10					21	10	10	15	15				41	15	15	15	10			
2	10	15	15	10					22	15	15	15	15				42	10	15	15	15			
3	15	10	10	15					23	10	10	15	15				43	15	15	15	15			
4	15	15	15	10					24	10	15	10	5				44	15	15	15	15			
5	10	10	15	15					25	5	10	15	15				45	20	40	55	55			
6	15	15	15	15					26	15	10	15	10				46	55	55	55	55			
7	15	15	10	10					27	15	10	10	10				47	55	50	40	20			
8	10	10	5	5					28	10	10	10	5				48	15	10	5	5			
9	5	5	5	5					29	15	10	10	15				49	5	5	5	5			
10	5	5	5	10					30	15	15	15	15				50	5	5	5	5			
11	10	10	10	10					31	15	15	15	15				51	5	5	5	5			
12	10	15	15	15					32	15	10	10	15				52	5	5	5	5			
13	15	15	15	15					33	10	10	15	15				53	5	10	10	5			
14	15	15	10	10					34	15	15	15	10				54	5	5	5	10			
15	10	10	10	5					35	15	10	10	10				55	5	10	5	5			
16	5	5	5	5					36	10	15	15	15				56	10	10	10	10			
17	10	5	10	5					37	15	15	15	15				57	10	5	5	10			
18	10	10	15	15					38	15	15	10	10				58	15	10	10	5			
19	15	15	15	15					39	15	15	15	15				59	5	10	15	15			

Data for one hour - in compliance

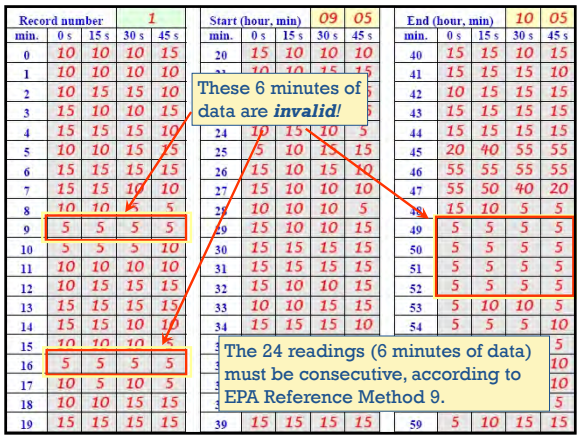
126



127



128



129

EPA Reference Method 9 (cont.)

Section 3 – Qualifications and Testing

Certification requirements:

- Candidate must … 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* [white and black plumes].
- The *certification shall be valid for…6 months*, at which time the qualification procedure must be repeated … to retain certification.

130

EPA Reference Method 9 (cont.)

Section 3 – Qualifications and Testing (cont.)

Certification procedure:

- The certification test consists of … 50 plumes: *25 black plumes* and *25 white plumes*.
- Plumes within each set of 25 black and 25 white runs shall be presented *in random order*.
- If the candidate fails to qualify, *the complete run of 50 readings* must be repeated in any retest.

131

EPA Reference Method 9 (cont.)

Section 3 – Qualifications and Testing (cont.)

Smoke generator specifications:

- The rest of Method 9 deals with the *smoke generator equipment* and *performance specifications*.
- Our smoke generator is calibrated and checked regularly according to the regulations set forth in Method 9.

132

Special Note: Method 9 in Pennsylvania

Pennsylvania uses EPA Method 203B which is a variation on Method 9

Readings every 15 seconds, but no 6-minute average

Opacity must stay *below* **20**%, except for up to **3 minutes** per hour.

(In any hour no more than twelve readings equal to or above 20% opacity)

Opacity must ***always*** stay *below* **60**%.

133

Question

Can EPA Method 9 be used to measure opacity of ***fugitive emissions***?

What about ***intermittent sources***?

Answer:

Method 9 can be used for both fugitive emissions and intermittent sources

- The observer may be required to record data for sequences less than 6 minutes (EPA Method 203A).
- The observer may be required to record instantaneous opacity (EPA Method 203C) for intermittent sources.
- In all cases, the DEP permit and/or the regional DEP office should be consulted.

134

EPA Reference Method 22

[See Appendix of your handout for a copy of EPA Reference Method 22.]

Source: 2004 CFR (Code of Federal Regulations) Title 40, Volume 7, Chapter 1, Part 60, Appendix A-7, Pages 476-480.

135

EPA Reference Method 22

Title: *Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Flares*

Scope and Applicability:

- Determine the frequency of fugitive emissions from stationary sources
- Determine the frequency of visible smoke emissions from flares

136

What are Fugitive Emissions?

Emissions NOT emitted from stack or duct:

- Escape capture by exhaust hoods.
- Emitted during material transfer.
- Emitted from buildings housing material, handling or processing equipment.
- Emitted directly from process equipment.

137

EPA Reference Method 22 (cont.)

Summary of Method:

- This method determines the amount of time that visible fugitive emissions occur during the operation period (i.e., the *accumulated emission time* or *fraction of total time*).
- This method does not require the use of instrumentation or that the numerical opacity of emissions be determined.

138

EPA Reference Method 22 (cont.)

Who can perform a Method 22 analysis:

- An individual who is able to determine whether a visible emission has occurred (hopefully everyone here today!)
- Method 9 certification is not required, however:
  - Must understand effects on visible emissions of background contrast and ambient lighting.
  - Must understand effects of observer position relative to lighting and wind.
  - Must recognize and distinguish the presence of uncombined water (steam).
  - Must distinguish extent of flare flame (read beyond).

139

Equipment Required

- **Two stopwatches**: accumulative type with unit divisions of at less than or equal to 0.5 seconds.
- **Light meter** capable of measuring illuminance in the 50 to 200 lux range (Required for indoor observations only.)

140

Method 22 Procedure

- Survey affected facility, building, or structure housing process to determine observation location consistent with requirements of permit (i.e., outside observation of emissions escaping building/structure or inside observation from affected process or unit.)
- Select position that enables a clear view of any (all) potential emission point(s). Recommended distance for observation is greater than 15 feet and less than 0.25 miles.
- Avoid interference (e.g., road dust) which prevents a clear view of affected facility.
- Do not make observations looking into sun!

141

Method 22 Procedure (cont.)

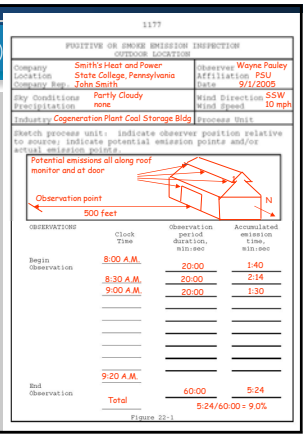
- For indoor locations an illumination greater than 100 lux (100 foot candles) is necessary.
- Using one stopwatch determine total observation period – this is specified by your permit.
- During observation period continuously watch emission source. Using second stopwatch record accumulated emission time of visible emissions.
- Take a rest break every 15 to 20 minutes of not less than 5 minutes and not more than 10 minutes.
- Extended continuous observations require two observers.

142

Method 22 (Outdoors)

Conclusion:
This source had an ***Accumulated Emission Time*** of 5 minutes and 24 seconds during an ***Observation Period*** of one hour (9% of the time).

This is an example of a source that is in compliance if the permit allows visible emissions for up to 6 minutes per hour or 10 percent of the time.


1177

FUGITIVE OR SMOKE EMISSION INSPECTION
OUTDOOR LOCATION

Company	Smith's Heat and Power	Observer	Wayne Pauley
Location	State College, Pennsylvania	Affiliation	PSU
Company Rep.	John Smith	Date	9/1/2005
Sky Conditions	Partly Cloudy	Wind Direction	SSW
Precipitation	none	Wind Speed	10 mph
Industry	Cogeneration Plant Coal Storage Bldg	Process Unit	

Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin Observation	8:00 A.M.	20:00	1:40
	8:30 A.M.	20:00	2:14
	9:00 A.M.	20:00	1:30
	9:20 A.M.		
End Observation	Total	60:00	5:24

5:24/60:00 = 9.0%

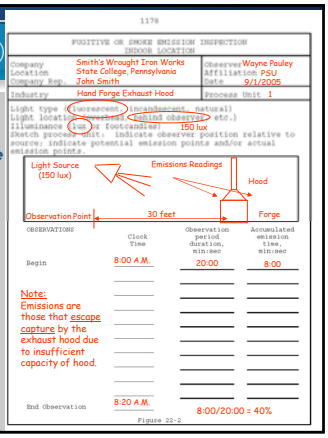
Figure 22-1

143

Method 22 (Indoors)

Conclusion:
This source had an ***Accumulated Emission Time*** of 8 minutes during an ***Observation Period*** of 20 minutes (40% of the time).

This source is NOT in compliance if the permit allows visible emissions for up to 6 minutes per hour or 10 percent of the time. Since it is clearly out of compliance there is no need to take a full hour of data.


1178

FUGITIVE OR SMOKE EMISSION INSPECTION
INDOOR LOCATION

Company	Smith's Wrought Iron Works	Observer	Wayne Pauley
Location	State College, Pennsylvania	Affiliation	PSU
Company Rep.	John Smith	Date	9/1/2005
Industry	Hand Forge Exhaust Hood	Process Unit	1

Light type (fluorescent / incandescent / natural)
Light location (overhead / behind observer / etc.)
Illuminance (lux / lx or footcandles) 150 lux
Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin	8:00 A.M.	20:00	8:00
End Observation	8:20 A.M.		

Note: Emissions are those that escape capture by the exhaust hood due to insufficient capacity of hood.

8:00/20:00 = 40%

Figure 22-2

144

For Method 22 you can use photographic documentation in lieu of sketches (see Method Alt–109 in Appendices)

Approved alternate use of photographs for:

1. Sky condition,
2. Observer's location relative to the source,
3. Observer's location relative to the sun,
4. Sketch of process unit being observed,
5. Potential emissions points, and
6. Actual emission points.

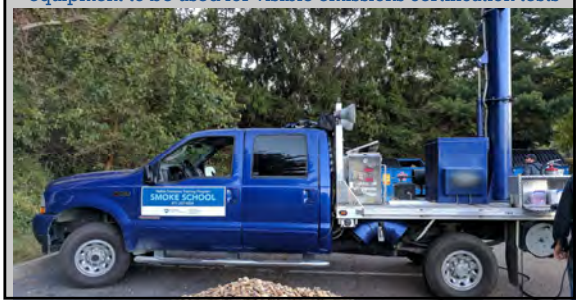
All digital photographic documentation must:

1. have proper field of view and depth of field to distinguish the process unit and potential and actual emission points,
2. be taken from the point of view of the observer, and
3. be taken within a reasonable time (15 minutes) of the observation to show sky condition and sun location.

145

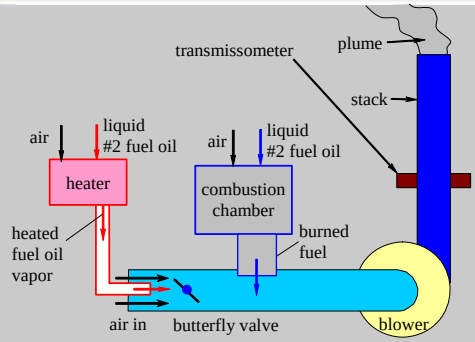
Penn State's Visible Emissions Equipment

Description and photographs of the smoke generating equipment to be used for visible emissions certification tests



146

Schematic Diagram of Smoke Generator



147

Description of Smoke Generator

White plume:

- ***#2 fuel oil*** – not burned, just *vaporized*.
- Fuel oil vapor *condenses* before it goes up the stack – forms white drops.

148

Description of Smoke Generator

Black plume:

- **Fuel oil** – burned, but not completely (*incomplete combustion*).
- Combustion products (*soot*) – form black particles.

149

Description of Smoke Generator

Stack:

- Stack is 15 feet tall, ***H = 15 ft*** (4.6 m).
- Stack is 1.0 foot in diameter, ***D = 1.0 ft*** (0.30 m).

150

Description of Associated Equipment

Electronics:

- A ***transmissometer*** in the stack monitors opacity.
- A ***computer*** records the opacity readings.
- Electronics with feedback loops – sets and monitors the desired opacity

151

Certification Field Test

What to expect

In this session, we will discuss:

- Practice runs and forms
- Certification test and forms
- Some hints about taking the field test
- Sample test results

152

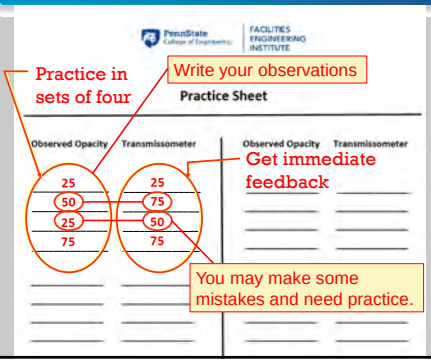
Practice Runs and Forms

Coarse calibration runs:

- Stand in an ***appropriate place*** (sun location and wind direction).
- ***Calibrate your eyeballs*** at 25%, 50%, and 75% opacity for both white and black plumes.
- Burn these opacities into your memory!
- Practice in sets of four, then check yourself.
- Read ***when horn sounds*** (staring at plume leads to confusion).

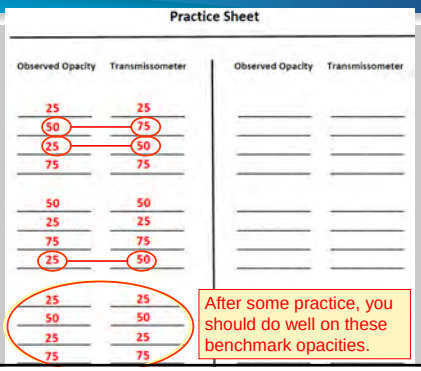
153

Practice Run Form (on back of test form)



154

Practice Run Form (benchmark calibration)



155

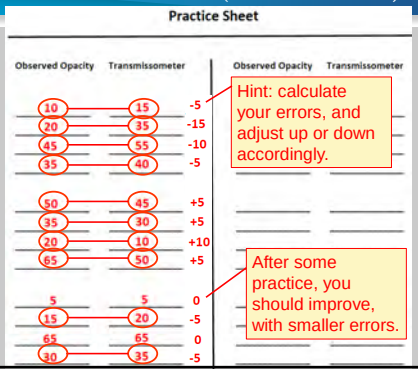
Practice Runs and Forms

Fine calibration runs:

- ***Remember your benchmarks at 25%, 50%, and 75% opacity!***
- Once you are comfortable with these benchmarks, practice the finer divisions of opacity (5%, 10%, 15%, 20%, ...) ***to nearest 5%.***
- Practice in sets of four, then check yourself.
- Read ***when horn sounds*** (staring at plume leads to confusion).

156

Practice Run Form (fine calibration)



157

Certification Test and Forms

Test preparation:

- Make sure you are still standing (or sitting) in an appropriate location (sun location and wind direction may have changed).
- ***Recalibrate your eyeballs at 25%, 50%, and 75% opacity prior to test.***

158

Certification Test and Forms (cont.)

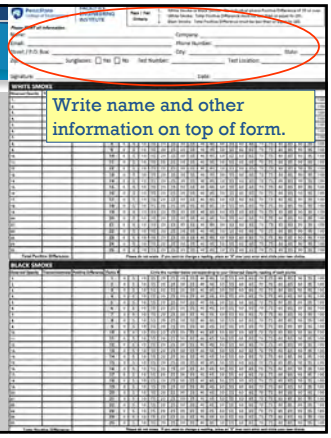
Test preparation (cont.):

- You will be given a computerized test form, a clipboard, and a pen or pencil.
- Fill in name and other information on the top of the form.

159

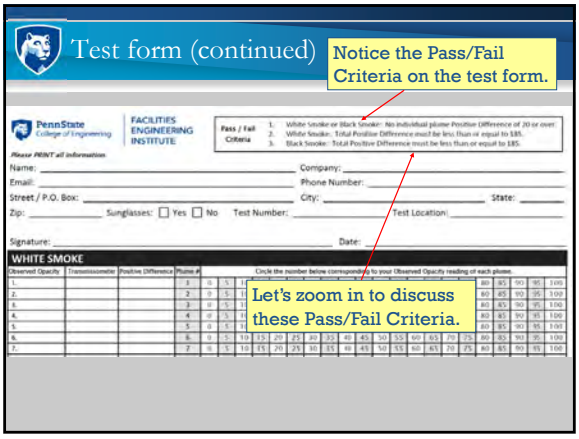
Test form

- This is the test form you will receive.
- Notice 25 white and 25 black tests on same form; you must pass both on the same test form to be certified.
- Later we will show some examples.



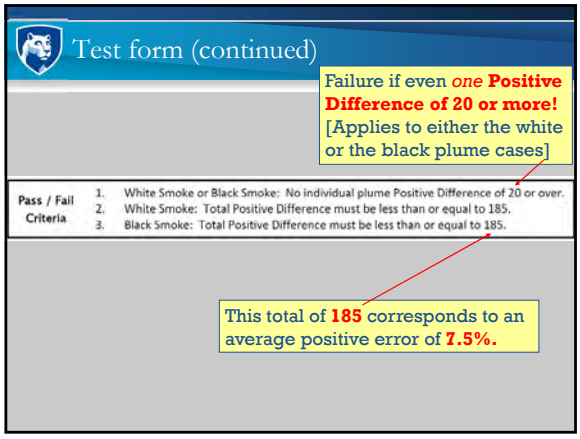
160

Test form (continued)



161

Test form (continued)



162

Test form (continued)

Write your observed opacity here

After each reading, circle your observed opacity

WHITE SMOKE

Observed Opacity	Transmissometer	Positive Difference	Plume #	Circle the number below correspon								
1. 5			1	0	5	10	15	20	25	30	35	40
2. 5			2	0	5	10	15	20	25	30	35	40
3. 25			3	0	5	10	15	20	25	30	35	40
4. 35			4	0	5	10	15	20	25	30	35	40
5. 20			5	0	5	10	15	20	25	30	35	40
6. 40			6	0	5	10	15	20	25	30	35	40

… Etc. ..

You will write 25 white plume readings and 25 black plume readings. All 50 readings equal one complete certification test.

163

Test form (continued)

When the full test (both white and black) is done, you will be given the (actual) **Transmissometer** opacity

For each reading, calculate the **Positive Difference** defined as |Observed – Transmissometer|

Example: 5-10=-5, but |5-10|=5

WHITE SMOKE

Observed Opacity	Transmissometer	Positive Difference	Plume #	Circle the number below correspon								
1. 5	5	0	1	0	5	10	15	20	25	30	35	40
2. 5	10	5	2	0	5	10	15	20	25	30	35	40
3. 25	15	10	3	0	5	10	15	20	25	30	35	40
4. 35	25	10	4	0	5	10	15	20	25	30	35	40
5. 20	15	5	5	0	5	10	15	20	25	30	35	40
6. 40	30	10	6	0	5	10	15	20	25	30	35	40

Example: 40-30=10, and |40-30|=10

164

Certification Test and Forms

During the test:

- No talking or cheating.
- 25 white plumes and 25 black plumes – read at sound of horn.
- Write **Observed Opacity** and also circle the value on the form to closest 5% (0%, 5%, 10%, 15%, 20%, 25%, 30%, …).
- Remember your eyeball calibration values of 25%, 50%, and 75%!

165

Some Hints About the Certification Test

General hints:

- Will go up and down opacity scale somewhat randomly for both black plume and white plume.
- Will concentrate on opacities at ***lower end of scale*** (below 50%).
- Expect to see a ***random pattern*** like this: (10%, 30%, 0%, 20%, 5%, 15%, 25%, 10%, …).
- Do *not* expect a ***predictable pattern*** like this: (0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, …).

166

Some Hints About the Certification Test

White plumes:

- You may use a ***target***. Examples – tree limbs, electrical wires, etc.
- Remember when the target disappears (25%, 50%, 75%) during calibration of your eyeballs.
- I found it easier to use a target for the white plumes.
- The white plumes were harder for me than were the black plumes (you may be different).

167

Some Hints about the Certification Test

Black plumes:

- You may use a ***target***.
- I found it easier *not* to use a target for the black plumes.
- The black plumes were easier for me than were the white plumes (you may be different).

168

Some Hints about the Certification Test

The test:

- Each test takes about ***one hour***.
- You must pass both white and black plumes in the *same* test.
- Failure or success has nothing to do with your ***intelligence*** – it is a function of how well you can ***calibrate your eyeballs***.
- If you fail, don't get frustrated – ***try, try, try again***. You will have several opportunities, today and tomorrow if needed.

169

Sample Certification Test Results

Example certification tests:

- We show some example failed tests and explain why each student failed the test.
- We explain how to "adjust" yourself in order to improve your chance of passing.
- Finally, we show an example of a passing certification test.

170

Example Student A

Did Student A pass?

NO. This student had *one* Positive Difference of 20 or more.
That *one* reading failed this student, even though the Total Positive Difference was 140, much less than the cut-off value of 185.

	Observed Opacity	Transmissometer	Positive Difference	Plume #
1.	5	5	0	1
2.	25	10	15	2
3.	35	15	20	3
4.	40	25	15	4
5.	20	15	5	5
6.	40	30	10	6
7.	45	35	10	7
8.	50	40	10	8
9.	55	50	5	9
10.	40	35	5	10
11.	65	65	0	11
12.	75	75	0	12
13.	0	0	0	13
14.	15	10	5	14
15.	10	5	5	15
16.	25	25	0	16
17.	0	0	0	17
18.	20	15	5	18
19.	40	35	5	19
20.	35	25	10	20
21.	50	45	5	21
22.	60	55	5	22
23.	10	10	0	23
24.	5	5	0	24
25.	20	15	5	25
	Total Positive Difference:		140	

171

Example Student B

Did Student B pass?

NO. This student had four Positive Differences of 15, but **no Positive Differences of 20 or more**.

However, this student had a **Total Positive Difference of 195**.
This Total Positive Difference exceeds the cut-off value of 185.

	Observed Opacity	Transmissometer	Positive Difference	Plume #
1.	5	5	0	1
2.	25	10	15	2
3.	25	15	10	3
4.	40	25	15	4
5.	30	15	15	5
6.	45	30	15	6
7.	45	35	10	7
8.	50	40	10	8
9.	55	50	5	9
10.	40	35	5	10
11.	65	65	0	11
12.	75	75	0	12
13.	0	0	0	13
14.	20	10	10	14
15.	10	5	5	15
16.	35	25	10	16
17.	0	0	0	17
18.	25	15	10	18
19.	45	35	10	19
20.	35	25	10	20
21.	55	45	10	21
22.	65	55	10	22
23.	15	10	5	23
24.	10	5	5	24
25.	25	15	10	25
	Total Positive Difference:		195	

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Example Student B

Where did Student B go wrong?

Look at the *Difference*, not the Positive Difference, and write + or – beside each one.

Example: 35-25=10 (+)

Notice that *all* of the Differences are positive!

	Observed Opacity	Transmissometer	Positive Difference	Plume #
1.	5	5	0	1
2.	25	10	15 +	2
3.	25	15	10 +	3
4.	40	25	15 +	4
5.	30	15	15 +	5
6.	45	30	15 +	6
7.	45	35	10 +	7
8.	50	40	10 +	8
9.	55	50	5 +	9
10.	40	35	5 +	10
11.	65	65	0	11
12.	75	75	0	12
13.	0	0	0	13
14.	20	10	10 +	14
15.	10	5	5 +	15
16.	35	25	10 +	16
17.	0	0	0	17
18.	25	15	10 +	18
19.	45	35	10 +	19
20.	35	25	10 +	20
21.	55	45	10 +	21
22.	65	55	10 +	22
23.	15	10	5 +	23
24.	10	5	5 +	24
25.	25	15	10 +	25
	Total Positive Difference:		195	

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Example Student B

How can Student B adjust in order to pass?

Recommendation:
This student should force himself to write a *lower* reading, since he tends to read high. This should hopefully be enough adjustment to pass the next time.

	Observed Opacity	Transmissometer	Positive Difference	Plume #
1.	5	5	0	1
2.	25	10	15 +	2
3.	25	15	10 +	3
4.	40	25	15 +	4
5.	30	15	15 +	5
6.	45	30	15 +	6
7.	45	35	10 +	7
8.	50	40	10 +	8
9.	55	50	5 +	9
10.	40	35	5 +	10
11.	65	65	0	11
12.	75	75	0	12
13.	0	0	0	13
14.	20	10	10 +	14
15.	10	5	5 +	15
16.	35	25	10 +	16
17.	0	0	0	17
18.	25	15	10 +	18
19.	45	35	10 +	19
20.	35	25	10 +	20
21.	55	45	10 +	21
22.	65	55	10 +	22
23.	15	10	5 +	23
24.	10	5	5 +	24
25.	25	15	10 +	25
	Total Positive Difference:		195	

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Example Student C

	Observed Opacity	Transmissometer	Positive Difference		Plume #
1.	5	10	5	-	1
2.	5	5	0		2
3.	10	15	5	-	3
4.	30	25	5	+	4
5.	20	15	5	+	5
6.	10	10	0		6
7.	15	5	10	+	7
8.	30	25	5	-	8
9.	15	20	5		9
10.	10	15	5	-	10
11.	45	35	10	+	11
12.	65	75	10	-	12
13.	0	0	0		13
14.	25	30	5	-	14
15.	40	35	5	+	15
16.	45	40	5	+	16
17.	50	50	0		17
18.	30	35	5	-	18
19.	55	65	10	-	19
20.	70	75	5	-	20
21.	55	45	10	+	21
22.	60	55	5	+	22
23.	15	10	5	+	23
24.	5	5	0		24
25.	20	15	5	+	25
		Total Positive Difference:	125		

Did Student C pass?

YES! This student had

- Fairly balanced + and - Differences
- No Positive Differences of 20 or more
- Total Positive Difference less than or equal to 185

However, this is only ***one*** of the ***two*** (black and white) plumes! [Must pass ***both*** on the ***same*** test form]

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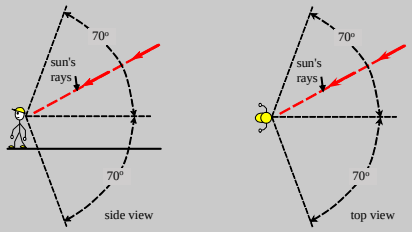
Review Question

Where should the sun be during opacity readings?

Answer: The sun should always be ***at your back***. Specifically, ***in a 140° cone*** from the back of your head.



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Review Question

What should I do if I can not stand 90° to the wind and *also* keep the sun at my back?
(Which is more important?)

Answer: It is more important to keep ***the sun at your back*** than to look 90° to the wind.

- Sun location is more critical than wind direction.
- (If possible, try again later; you may be able to satisfy both criteria at some later time in the day.)

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Review Question

Can I wear ***eyeglasses*** when taking opacity readings? What about ***sunglasses***?

Answer: If you normally wear **corrective eyeglasses**, wear them during the test *and* during opacity readings at work.

- Use common sense about wearing sunglasses:
  - If you wear sunglasses during the certification test, you should also wear them during actual opacity readings.
  - Automatic photo-gray lenses may impede proper calibration of your eyes. We do not recommend that you wear them unless you have no other option.

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Review Question

Can EPA Method 9 be used to measure opacity of ***fugitive emissions***? What about ***intermittent sources***?

Answer: Method 9 can be used for both fugitive emissions and intermittent sources.

- The observer may be required to record data for sequences less than 6 minutes (EPA Method 203A).
- The observer may be required to record instantaneous opacity (EPA Method 203C) for intermittent sources.
- In all cases, the DEP permit and/or the regional DEP office should be consulted.

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Review Question

What determines a violation of DEP opacity regulations?

Answer: According to PA Title 25:

- If the opacity is greater than or equal to 20% for more than 3 minutes per hour, this is a violation.
- If the opacity is greater than or equal to 60% at any time, this is a violation.
- Refer to EPA Method 203B (modified Method 9)

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Appendices

GOVERNMENT DOCUMENTS

STATE AND REGIONAL REGULATIONS AS WELL AS OTHER GUIDANCE[1]

FORMS[2]

[1] FOR INSTRUCTIONAL PURPOSES ONLY. While every attempt has been made to accurately summarize current regulations, ALWAYS CONSULT YOUR PERMIT and REFER TO OFFICIAL LEGAL REFERENCE SOURCES when complying with State and Federal EPA Title V Requirements.

[2] Your company may have its own forms. If not, feel free to copy and use these. You may also modify or customize them as necessary. These forms are also posted on our website, www.outreach.psu.edu/visible-emissions.

EPA Reference Method 9

Method 9 – Visual Determination of the Opacity of Emissions from Stationary Sources

Source: Federal Register, Vol 39, No. 219, Tuesday, November 12, 1974 [https://www.epa.gov/emc/method-9-visual-opacity]

Many stationary sources discharge visible emissions into the atmosphere; these emissions are usually in the shape of a plume. This method involves the determination of plume opacity by qualified observers. The method includes procedures for the training and certification of observers, and procedures to be used in the field for determination of plume opacity. The appearance of a plume as viewed by an observer depends upon a number of variables, some of which may be controllable and some of which may not be controllable in the field. Variables which can be controlled to an extent to which they no longer exert a significant influence upon plume appearance include: Angle of the observer with respect to the plume; angle of the observer with respect to the sun; point of observation of attached and detached steam plume; and angle of the observer with respect to a plume emitted from a rectangular stack with a large length to width ratio. The method includes specific criteria applicable to these variables.

Other variables which may not be controllable in the field are luminescence and color contrast between the plume and the background against which the plume is viewed. These variables exert an influence upon the appearance of a plume as viewed by an observer, and can affect the ability of the observer to accurately assign opacity values to the observed plume. Studies of the theory of plume opacity and field studies have demonstrated that a plume is most visible and presents the greatest apparent opacity when viewed against a contrasting background. It follows from this, and is confirmed by field trials, that the opacity of a plume, viewed under conditions where a contrasting background is present can be assigned with the greatest degree of accuracy. However, the potential for a positive error is also the greatest when a plume is viewed under such contrasting conditions. Under conditions presenting a less contrasting background, the apparent opacity of a plume is less and approaches zero as the color and luminescence contrast decrease toward zero. As a result, significant negative bias and negative errors can be made when a plume is viewed under less contrasting conditions. A negative bias decreases rather than increases the possibility that a plant operator will be cited for a violation of opacity standards due to observer error.

Studies have been undertaken to determine the magnitude of positive errors which can be made by qualified observers while reading plumes under contrasting conditions and using the procedures set forth in this method. The results of these studies (field trials) which involve a total of 769 sets of 25 readings each are as follows:

(1) For black plumes (133 sets at a smoke generator), 100 percent of the sets were read with a positive error of less than 7.5 percent opacity; 99 percent were read with a positive error of less than 5 percent opacity. (Note: For a set, positive error = average opacity determined by observers' 25 observations - average opacity determined from transmissometer's 25 recordings.)
(2) For white plumes (170 sets at a smoke generator, 168 sets at a coal-fired power plant, 298 sets at a sulfuric acid plant), 99 percent of the sets were read with a positive error of less than 7.5 percent opacity; 95 percent were read with a positive error of less than 5 percent opacity.

The positive observational error associated with an average of twenty-five readings is therefore established. The accuracy of the method must be taken into account when determining possible violations of applicable opacity standards.

1. Principle and Applicability

1.1 Principle. The opacity of emissions from stationary sources is determined visually by a qualified observer.

1.2 Applicability. This method is applicable for the determination of the opacity of emissions from stationary sources pursuant to §60.11(b) and for qualifying observers for visually determining opacity of emissions.

2. Procedures

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

2.1 Position. The qualified observer shall stand at a distance sufficient to provide a clear view of the emissions with the sun oriented in the 140° sector to his back. Consistent with maintaining the above requirement, the observer shall, as much as possible, make his observations from a position such that his 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. The observer's line of sight should not include more than one plume at a time when multiple stacks are involved, and in any case the observer should make his observations with his line of sight perpendicular to the longer axis of such a set of multiple stacks (e.g., stub stacks on baghouses).

2.2 Field Records. The observer shall record the name of the plant, emission location, type 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 (Figure 9–1). 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 are recorded on a field data sheet at the time opacity readings are initiated and completed.

2.3 Observations. Opacity observations shall be made at the point of greatest opacity in that portion of the plume where condensed water vapor is not present. The observer shall not look continuously at the plume, but instead shall observe the plume momentarily at 15-second intervals.

2.3.1 Attached Steam Plumes. When condensed water vapor is present within the plume as it emerges from the emission outlet, opacity observations shall be made beyond the point in the plume at which condensed water vapor is no longer visible. The observer shall record the approximate distance from the emission outlet to the point in the plume at which the observations are made.

2.3.2 Detached Steam Plume. When water vapor in the plume condenses and becomes visible at a distinct distance from the emission outlet, the opacity of emissions should be evaluated at the emission outlet prior to the condensation of water vapor and the formation of the steam plume.

2.4 Recording Observations. Opacity observations shall be recorded to the nearest 5 percent at 15-second intervals on an observational record sheet. (See Figure 9–2 for an example.) A minimum of 24 observations shall be recorded. Each momentary observation recorded shall be deemed to represent the average opacity of emissions for a 15-second period.

2.5 Data Reduction. Opacity shall be determined as an average of 24 consecutive observations recorded at 15-second intervals. Divide the observations recorded on the record sheet into sets of 24 consecutive observations. A set is composed of any 24 consecutive observations. Sets need not be consecutive in time and in no case shall two sets overlap. For each set of 24 observations, calculate the average by summing the opacity of the 24 observations and dividing this sum by 24. If an applicable standard specifies an averaging time requiring more than 24 observations, calculate the average for all observations made during the specified time period. Record the average opacity on a record sheet. (See Figure 9–1 for an example.)

3. Qualifications 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 section 3.2. Smoke generators used pursuant to section 3.2 shall be equipped with a smoke meter which meets the requirements of section 3.3. The certification shall be valid for a period of 6 months, at which time the qualification procedure must be repeated by any 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 within each set of 25 black and 25 white runs shall be presented in random order. The candidate assigns an opacity value to each plume and records his 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 purposes of section 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 pathlength 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 9–1. The smoke meter shall be calibrated as prescribed in section 3.3.1 prior to the conduct of each smoke reading test. At the completion of each test, the zero and span drift shall be checked and if the drift exceeds ±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 9–1. 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 warmup 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 ±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 9–1.

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°. The total angle of view may be calculated from: $\Theta = 2 \tan{-1}\ d/2L$, where Θ = total angle of view; d = the sum of the photocell diameter + the diameter of the limiting aperture; and L = the 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°. The total angle of projection may be calculated from: $\Theta = 2 \tan{-1}\ d/2L$, where Θ = 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 pathlength. Filters calibrated within ±2 percent shall be used. 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 error on any one reading shall be 3 percent opacity.

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. Bibliography

1. Air Pollution Control District Rules and Regulations, Los Angeles County Air Pollution Control District, Regulation IV, Prohibitions, Rule 50.
2. Weisburd, Melvin I., Field Operations and Enforcement Manual for Air, U.S. Environmental Protection Agency, Research Triangle Park, NC. APTD–1100, August 1972, pp. 4.1–4.36.
3. Condon, E.U., and Odishaw, H., Handbook of Physics, McGraw-Hill Co., New York, NY, 1958, Table 3.1, p. 6–52.

Table 9-1 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 - Citation 3)
c. Angle of view	15° maximum total angle
d. Angle of projection	15° maximum total angle
e. Calibration error	±3% opacity, maximum
f. Zero and span drift	±1% opacity, 30 minutes
g. Response time	5 seconds

Figure 9-1. Record of visual determination of opacity.

Company_____				
Location_____				
Test No._____				
Date_____				
Type Facility_____				
Control Device_____				
Hours of Observation_____				
Observer_____				
Observer Certification Date_____		Observer Affiliation_____		
Point of Emissions_____		Height of Discharge Point_____		
CLOCK TIME	Initial			Final
OBSERVER LOCATION				
Distance to discharge				
Direction from discharge				
Height of observation point				
BACKGROUND DESCRIPTION				
WEATHER CONDITIONS				
Wind Direction				
Wind Speed				
Ambient Temperature				
SKY CONDITIONS (clear, overcast, %clouds, etc.)				
PLUME DESCRIPTION				
Color				
Distance Visible				
OTHER INFORMATION				

SUMMARY OF AVERAGE OPACITY			
Set Number	Time	Opacity	
	Start - End	Sum	Average

Readings ranged from _____ to _____ % opacity.

The source was/was not in compliance with _____ at the time evaluation was made.

Figure 9–2—Observation Record

Company	Observer	
Location	Type facility	
Test Number	Point of emissions	
Date		

Hr.	Min.	Seconds				Steam plume (check if applicable)		Comments
		0	15	30	45	Attached	Detached	
	0							
	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							
	21							
	22							
	23							
	24							
	25							
	26							
	27							
	28							

Company		Observer	
Location		Type facility	
Test Number		Point of emissions	
Date			

Hr.	Min.	Seconds				Steam plume (check if applicable)		Comments
		0	15	30	45	Attached	Detached	
	29							
	30							
	31							
	32							
	33							
	34							
	35							
	36							
	37							
	38							
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	58							
	59							

EPA METHODS 203A, 203B, and 203C

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

[https://www.epa.gov/emc/method-203a-opacity-determination-time-averaged-regulations]

1.0 Scope and Application

What is Method 203A? Method 203A is an example test method suitable for State Implementation Plans (SIP) and is applicable to 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. Method 203A is virtually identical to EPA's Method 9 of 40 CFR Part 60, Appendix A, except for the data-reduction procedures, which provide for averaging times other than 6 minutes. Therefore, using Method 203A with a 6-minute averaging time would be the same as following EPA Method 9. The certification procedures for this method are identical to those provided in Method 9 and are provided here, in full, for clarity and convenience. An example visible emission observation form and instructions for its use can be found in reference 7 of Section 17 of Method 9.

2.0 Summary of Method

The opacity of emissions from sources of visible emissions is determined visually by an observer certified according to the procedures in Section 10 of this method. Readings taken every 15 seconds are averaged over a time period specified in the applicable regulation ranging from 2 minutes to 6 minutes.

3.0 Definitions [Reserved]
4.0 Interferences [Reserved]
5.0 Safety [Reserved]

6.0 Equipment and Supplies

What equipment and supplies are needed?

6.1 Stop Watch. Two watches are required that provide a continuous display of time to the nearest second.

6.2 Compass (optional). A compass is useful for determining the direction of the emission point from the spot where the visible emissions (VE) observer stands and for determining the wind direction at the source. For accurate readings, the compass should be magnetic with resolution better than 10 degrees. It is suggested that the compass be jewel-mounted and liquid-filled to dampen the needle swing; map reading compasses are excellent.

6.3 Range Finder (optional). Range finders determine distances from the observer to the emission point. The instrument should measure a distance of 1000 meters with a minimum accuracy of ±10 percent.

6.4 Abney Level (optional). This device for determining the vertical viewing angle should measure within 5 degrees.

6.5 Sling Psychrometer (optional). In case of the formation of a steam plume, a wet- and drybulb thermometer, accurate to 0.5°C, are mounted on a sturdy assembly and swung rapidly in the air in order to determine the relative humidity.

6.6 Binoculars (optional). Binoculars are recommended to help identify stacks and to characterize the plume. An 8 x 50 or 10 x 50 magnification, color-corrected coated lenses and rectilinear field of view is recommended.

6.7 Camera (optional). A camera is often used to document the emissions before and after the actual opacity determination.

6.8 Safety Equipment. The following safety equipment, which should be approved by the Occupational Safety and Health Association (OSHA), is recommended: orange or yellow hard hat, eye and ear protection, and steel-toed safety boots.

6.9 Clipboard and Accessories (optional). A clipboard, several ball-point pens (black ink recommended), a rubber band, and several visible emission observation forms facilitate documentation.

7.0 Reagents and Standards (Reserved]

8.0 Sample Collection, Preservation, Storage, and Transport

What is the Test Procedure? An observer qualified in accordance with Section 10 of this method must use the following procedures to visually determine the opacity of emissions from stationary sources.

8.1 Procedure for Emissions from Stacks. These procedures are applicable for visually determining the opacity of stack emissions by a qualified observer.

8.1.1 Position. You must stand at a distance sufficient to provide a clear view of the emissions with the sun oriented in the 140-degree sector to your back. Consistent with maintaining the above requirement as much as possible, you must 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, non-circular stacks), approximately perpendicular to the longer axis of the outlet. You should 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).

8.1.2 Field Records. You must 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. An example visible emission observation form can be found in reference 7 of Section 17 of this method. You must 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.

8.1.3 Observations. You must 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.

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

8.1.3.2 Detached Steam Plumes. When water vapor in the plume condenses and becomes visible at a distinct distance from the emission outlet, you must make the opacity observation at the emission outlet prior to the condensation of water vapor and the formation of the steam plume.

8.2 Recording Observations. You must record the opacity observations to the nearest 5 percent every 15 seconds on an observational record sheet such as the example visible emission observation form in reference 7 of Section 17 of this method. Each observation recorded represents the average opacity of emissions for a 15-second period. The overall length of time for which observations are recorded must be appropriate to the averaging time specified in the applicable regulation.

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization

10.1 What are the Certification Requirements? To receive certification as a qualified observer, you must be trained and knowledgeable on the procedures in Section 8.0 of this method, 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. You must be tested according to the procedures described in Section 10.2 of this method. Any smoke generator used pursuant to Section 10.2 of this method must be equipped with a smoke meter which meets the requirements of Section 10.3 of this method. Certification tests that do not meet the requirements of Sections 10.2 and 10.3 of this method are not valid. The certification must 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.

10.2 What is the 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 must be presented in random order within each set of 25 black and 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.

10.3 Smoke Generator.

10.3.1 What are the Smoke Generator Specifications? Any smoke generator used for the purpose of Section 10.2 of this method must be equipped with a smoke meter installed to measure opacity across the diameter of the smoke generator stack. The smoke meter output must 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 must meet the specifications shown in Table 203A–1 of this method. The smoke meter must be calibrated as prescribed in Section 10.3.2 of this method prior to conducting each smoke reading test. At the completion of each test, the zero and span drift must be checked and, if the drift exceeds ±1 percent opacity, the condition must be corrected prior to conducting any subsequent test runs. The smoke meter must be demonstrated at the time of installation to meet the specifications listed in Table 203A–1 of this method. This demonstration must 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.

10.3.2 How is the Smoke Meter Calibrated? 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 a 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 must 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.

10.3.3 How is the Smoke Meter Evaluated? The smoke meter design and performance are to be evaluated as follows: Method 203A 8/4/2017 5

10.3.3.1 Light Source. You must verify from manufacturer's data and from voltage measurements made at the lamp, as installed, that the lamp is operated within 5 percent of the nominal rated voltage.

10.3.3.2 Spectral Response of the Photocell. You must verify from manufacturer's data that the photocell has a photopic response; i.e. the spectral sensitivity of the cell must closely approximate the standard spectral-luminosity curve for photopic vision which is referenced in (b) of Table 203A–1 of this method.

10.3.3.3 Angle of View. You must 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:

$\Phi v = 2 \tan{-1} (d/2L)$

Where:

Φv = Total angle of view
d = The photocell diameter + the diameter of the limiting aperture
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.
10.3.3.4 Angle of Projection. You must 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:

$\Phi p = 2 \tan{-1} (d/2L)$

Where:
Φp = Total angle of projection
d = The sum of the length of the lamp filament + the diameter of the limiting aperture
L = The distance from the lamp to the limiting aperture.

10.3.3.5 Calibration Error. Using neutral-density filters of known opacity, you must 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 Section 10.3.2 of this method 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 2 percent. Care Method 203A 8/4/2017 6 should be taken when inserting the filters to prevent stray light from affecting the meter. Make a total of five non-consecutive readings for each filter. The maximum opacity error on any one reading shall be ±3 percent.
10.3.3.6 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.
10.3.3.7 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.

11.0 Analytical Procedures [Reserved]

12.0 Data Analysis and Calculations
12.1 Time-Averaged Regulations. A set of observations is composed of an appropriate number of consecutive observations determined by the averaging time specified (i.e., 8 observations for a two minute average). 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. For each set of observations, calculate the average opacity by summing the opacity readings taken over the appropriate time period and dividing by the number of readings. For example, for a 2-minute average, eight consecutive readings would be averaged by adding the eight readings and dividing by eight.

13.0 Method Performance
13.1 Time-averaging Performances. The accuracy of test procedures for time-averaged regulations was evaluated through field studies that compare the opacity readings to a transmissometer. Analysis of these data shows that, as the time interval for averaging increases, the positive error decreases. For example, over a 2-minute time period, 90 percent of the results underestimated opacity or overestimated opacity by less than 9.5 percent opacity, while over a 6-minute time period, 90 percent of the data have less than a 7.5 percent positive error. Overall, the field studies demonstrated a negative bias. Over a 2-minute time period, 57 percent of the data have zero or negative error, and over a 6-minute time period, 58 percent of the data have zero or negative error. This means that observers are more likely to assign opacity values that are below, rather than above, the actual opacity value. Consequently, a larger percentage of noncompliance periods will be reported as compliant periods rather than compliant periods reported as violations. Table 203A-2 highlights the precision data results from the June 1985 report: "Opacity Errors for Averaging and Non Averaging Data Reduction and Reporting Techniques."

14.0 Pollution Prevention [Reserved]
15.0 Waste Management [Reserved]
16.0 Alternative Procedures [Reserved]

17.0 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, NC. May 1982.

3. Office of Research and Development. "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 Non-averaging Data Reduction and Reporting Techniques." Final Report–SR–1–6–85. Emission Measurement Branch, Research Triangle Park, NC. June 1985.

5. 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. Volume 55, No. 74. Pages 14246–14279. April 17, 1990.

6. Office of Air Quality Planning and Standards. "Collaborative Study of Opacity Observations of Fugitive Emissions from Unpaved Roads by Certified Observers." Emission Measurement Branch, Research Triangle Park, NC. October 1986.

7. Office of Air Quality Planning and Standards. "Field Data Forms and Instructions for EPA Methods 203A, 203B, and 203C." EPA 455/R–93–005. Stationary Source Compliance Division, Washington, DC, June 1993.

18.0 Tables, Diagrams, Flowcharts, and Validation Data

Table 203A–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—Citation 3).
c. Angle of view	15° maximum total angle.
d. Angle of projection	15° maximum total angle.
e. Calibration error	±3% opacity, maximum.
f. Zero and span drift	±1% opacity, 30 minutes
g. Response time	5 seconds.

Table 203A–2—Precision Between Observers: Opacity Averaging

Averaging period	Number of observations	Standard deviation (% opacity)	Amount with <7.5% opacity difference
15-second	140,250	3.4	87
2 minutes	17,694	2.6	92
3 minutes	11,836	2.4	92
6 minutes	5,954	2.1	93

Method 203B--Visual Determination of Opacity of Emissions from Stationary Sources for Time-Exception Regulations.

[https://www.epa.gov/emc/method-203b-opacity-determination-time-exception-regulations]

1.0 Scope and Application

What is Method 203B? Method 203B is an example test method suitable for State Implementation Plans (SIPs) and is applicable to the determination of the opacity of emissions from sources of visible emissions for time-exception regulations. A time-exception regulation means any regulation that allows predefined periods of opacity above the otherwise applicable opacity limit (e.g., allowing exceedances of 20 percent opacity for 3 minutes in 1 hour.) Method 203B is virtually identical to EPA's Method 9 of 40 CFR Part 60, Appendix A, except for the data-reduction procedures, which have been modified to apply to time-exception regulations. The certification procedures for this method are identical to those provided in Method 9. An example visible emission observation form and instructions for its use can be found in reference 7 of Section 17 of Method 203A.

2.0 Summary of Method

The opacity of emissions from sources of visible emissions is determined visually by a qualified observer.

3.0 Definitions [Reserved]
4.0 Interferences [Reserved]
5.0 Safety [Reserved]

6.0 Equipment and Supplies

What equipment and supplies are needed? The same as specified in Section 6.0 of Method 203A.

7.0 Reagents and Standards [Reserved]

8.0 Sample Collection, Preservation, Storage, and Transport

What is the Test Procedure? The observer qualified in accordance with Section 10 of Method 203A must use the following procedures for visually determining the opacity of emissions.

8.1 Procedures for Emissions From Stationary Sources. The procedures for emissions from stationary sources are the same as specified in 8.1 of Method 203A.

8.2 Recording Observations. You must record opacity observations to the nearest 5 percent at 15-second intervals on an observational record sheet. Each observation recorded represents the average opacity of emissions for a 15-second period. The overall length of time for which observations are recorded must be appropriate to the applicable regulation.

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization

The Calibration and Standardization requirements are the same as specified in Section 10 of Method 203A.

11.0 Analytical Procedures [Reserved]

12.0 Data Analysis and Calculations

Data Reduction for Time-Exception Regulations. For a time-exception regulation, reduce opacity observations as follows: count the number of observations above the applicable standard and multiply that number by 0.25 to determine the minutes of emissions above the target opacity.

13.0 Method Performance

13.1 Time-Exception Regulations. "Opacity Errors for Averaging and Non-Averaging Data Reduction and Reporting Techniques" analyzed the time errors associated with false compliance or false non-compliance determinations resulting from a sample of 1110 opacity readings with 6-minute observation periods. The study applied a 20 percent opacity standard. Fifty one percent of the data showed zero error in time determinations. The standard deviation was 97.5 seconds for the 6-minute time period.

13.1.1 Overall, the study showed a negative bias. Each reading is associated with a 15 second block of time. The readings were multiplied by 15 seconds and the resulting time spent above the standard was compared to the transmissometer results. The average amount of time that observations deviated from the transmissometer's determinations was -8.3 seconds. Seventy percent of the time determinations were either correct or underestimated the time of excess emissions. Consequently, a larger percentage of noncompliance periods would be reported as compliant periods rather than compliant periods reported as violations.

13.1.2 Some time-exception regulations reduce the data by averaging over 1-minute periods and then counting those minutes above the standard. This data reduction procedure results in a less stringent standard than determinations resulting from data reduction procedures of Method 203B.

14.0 Pollution Prevention [Reserved]
15.0 Waste Management [Reserved]

16.0 Alternative Procedures [Reserved]

17.0 References
The references are the same as specified in Section 17 of Method 203A.

18.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

Method 203C--Visual Determination of Opacity of Emissions from Stationary Sources for Instantaneous Limitation Regulations.

[https://www.epa.gov/emc/method-203c-opacity-determination-instantaneous-regulations]

1.0 Scope and Application
What is Method 203C? Method 203C is an example test method suitable for State Implementation Plans (SIPs) and is applicable to the determination of the opacity of emissions from sources of visible emissions for regulations with an instantaneous opacity limitation. An instantaneous opacity limitation is an opacity limit which is never to be exceeded. Method 203C is virtually identical to EPA's Method 9 of 40 CFR Part 60, Appendix A, except for 5-second reading intervals and the data-reduction procedures, which have been modified for instantaneous limitation regulations. The certification procedures for this method are virtually identical to Method 9. An example visible emission observation form and instructions for its use can be found in reference 7 of Section 17 of Method 203A.

2.0 Summary of Method
The opacity of emissions from sources of visible emissions is determined visually by an observer certified according to the procedures in Section 10 of Method 203A.

3.0 Definitions [Reserved]
4.0 Interferences [Reserved]
5.0 Safety [Reserved]

6.0 Equipment and Supplies
The equipment and supplies used are the same as Section 6.0 of Method 203A.

7.0 Reagents and Standards [Reserved]

8.0 Sample Collection, Preservation, Storage, and Transport
What is the Test Procedure? The qualified observer must use the following procedures for visually determining the opacity of emissions.
8.1 Procedures for Emissions From Stationary Sources. These are the same as Section 8.1 of Method 203A.
8.1.1 Position. Same as Section 8.1.1 of Method 203A.
8.1.2 Field Records. Same as Section 8.1.2 of Method 203A.
8.1.3 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, instead, observe the plume momentarily at 5-second intervals.
8.1.3.1 Attached Steam Plumes. Same as Section 8.1.3.1 of Method 203A.
8.1.3.2 Detached Steam Plumes. Same as Section 8.1.3.2 of Method 203A.
8.2 Recording Observations. You must record opacity observations to the nearest 5 percent at 5-second intervals on an observational record sheet. Each observation recorded represents the average of emissions for the 5-second period.
The overall time for which recordings are made must be of a length appropriate to the applicable regulation for which opacity is being measured.

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization
The calibration and standardization procedures are the same as Section 10 of Method 203A.

11.0 Analytical Procedures [Reserved]

12.0 Data Analysis and Calculations
12.1 Data Reduction for Instantaneous Limitation Regulations. For an instantaneous limitation regulation, a 1-minute averaging time will be used. You must divide the observations recorded on the record sheet into sets of consecutive observations. A set is composed of the consecutive observations made in 1 minute. Sets need not be consecutive in time, and in no case must two sets overlap. You must reduce opacity observations by dividing the sum of all observations recorded in a set by the number of observations recorded in each set.

12.2 Reduce opacity observations by averaging 12 consecutive observations recorded at 5-second intervals.
Divide the observations recorded on the record sheet into sets of 12 consecutive observations. For each set of 12 observations, calculate the average by summing the opacity of the 12 observations and dividing this sum by 12.

13.0 Method Performance
The results of the "Collaborative Study of Opacity Observations at Five-second Intervals by Certified Observers" are almost identical to those of previous studies of Method 9 observations taken at 15-second intervals and indicate that observers can make valid observations at 5-second intervals. The average difference of all observations from the transmissometer values was 8.8 percent opacity, which shows a fairly high negative bias. Underestimating the opacity of the visible emissions is more likely than overestimating the opacity of the emissions.

14.0 Pollution Prevention [Reserved]
15.0 Waste Management [Reserved]
16.0 Alternative Procedures [Reserved]

17.0 References
The references are the same as references 1–7 in Method 203A in addition to the following:

1. Office of Air Quality Planning and Standards. "Collaborative Study of Opacity Observations at Five-second Intervals by Certified Observers." Docket A–84–22, IV–A–2. Emission Measurement Branch, Research Triangle Park, N.C. September 1990.

18.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

EPA Reference Method 22

Method 22 - Visual Determination of the Fugitive Emissions from Material Sources and Smoke Emissions from Flares

Source: 2004 CFR [Code of Federal Regulations] Title 40, Volume 7, Chapter 1, Part 60, Appendix A-7, Pages 476-480 [https://www.epa.gov/emc/method-22-visual-determination-fugitive-emissions]

NOTE: This method is not inclusive with respect to observer certification. Some material is incorporated by reference from Method 9.

1.0 Scope and Application.
This method is applicable for the determination of the frequency of fugitive emissions from stationary sources, only as specified in an applicable subpart of the regulations. This method also is applicable for the determination of the frequency of visible smoke emissions from flares.

2.0 Summary of Method.
2.1 Fugitive emissions produced during material processing, handling, and transfer operations or smoke emissions from flares are visually determined by an observer without the aid of instruments.
2.2 This method is used also to determine visible smoke emissions from flares used for combustion of waste process materials.
2.3 This method determines the amount of time that visible emissions occur during the observation period (*i.e.*, the accumulated emission time.) This method does not require that the opacity of emissions be determined. Since this procedure requires only the determination of whether visible emissions occur and does not require the determination of opacity levels, observer certification according to the procedures of Method 9 is not required. However, it is necessary that the observer is knowledgeable with respect to the general procedures for determining the presence of visible emissions. At a minimum, the observer must be trained and knowledgeable regarding the effects of background contrast, ambient lighting, observer position relative to lighting, wind, and the presence of uncombined water (condensing water vapor) on the visibility of emissions. This training is to be obtained from written materials found in References 1 and 2 or from the lecture portion of the Method 9 certification course.

3.0 Definitions.
3.1 Emission frequency means the percentage of time that emissions are visible during the observation period.
3.2 Emission time means the accumulated amount of time that emissions are visible during the observation period.
3.3 Fugitive emissions means emissions generated by an affected facility which is not collected by a capture system and is released to the atmosphere. This includes emissions that (1) escape capture by process equipment exhaust hoods; (2) are emitted during material transfer; (3) are emitted from buildings housing material processing or handling equipment; or (4) are emitted directly from process equipment.
3.4 Observation period means the accumulated time period during which observations are conducted, not to be less than the period specified in the applicable regulation.

3.5 Smoke emissions means a pollutant generated by combustion in a flare and occurring immediately downstream of the flame. Smoke occurring within the flame, but not downstream of the flame, is not considered a smoke emission.

4.0 Interferences.
4.1 Occasionally, fugitive emissions from sources other than the affected facility (*e.g.*, road dust) may prevent a clear view of the affected facility. This may particularly be a problem during periods of high wind. If the view of the potential emission points is obscured to such a degree that the observer questions the validity of continuing observations, then the observations shall be terminated, and the observer shall clearly note this fact on the data form.

5.0 Safety.
5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment.
6.1 Stopwatches (two). Accumulative type with unit divisions of at least 0.5 seconds.
6.2 Light Meter. Light meter capable of measuring illuminance in the 50 to 200 lux range, required for indoor observations only.

7.0 Reagents and Supplies. [Reserved]
8.0 Sample Collection, Preservation, Storage, and Transfer. [Reserved]
9.0 Quality Control. [Reserved]
10.0 Calibration and Standardization. [Reserved]

11.0 Analytical Procedure.
11.1 Selection of Observation Location. Survey the affected facility, or the building or structure housing the process to be observed, and determine the locations of potential emissions. If the affected facility is located inside a building, determine an observation location that is consistent with the requirements of the applicable regulation (*i.e.*, outside observation of emissions escaping the building/structure or inside observation of emissions directly emitted from the affected facility process unit). Then select a position that enables a clear view of the potential emission point(s) of the affected facility or of the building or structure housing the affected facility, as appropriate for the applicable subpart. A position at least 4.6 m (15 feet), but not more than 400 m (0.25 miles), from the emission source is recommended. For outdoor locations, select a position where the sunlight is not shining directly in the observer's eyes.
11.2 Field Records.
11.2.1 Outdoor Location. Record the following information on the field data sheet (Figure 22-1): Company name, industry, process unit, observer's name, observer's affiliation, and date. Record also the estimated wind speed, wind direction, and sky condition. Sketch the process unit being observed, and note the observer location relative to the source and the sun. Indicate the potential and actual emission points on the sketch.
11.2.2 Indoor Location. Record the following information on the field data sheet (Figure 22-2): Company name, industry, process unit, observer's name, observer's affiliation, and date. Record as appropriate the type, location, and intensity of lighting on the data sheet. Sketch the process unit being observed, and note the observer location relative to the source. Indicate the potential and actual fugitive emission points on the sketch.

[Note available modification to EPA Reference Method 22 designated Method ALT-109 (see Barrett H. Parker letter below): *The EPA Acting Administrator, Andrew R. Wheeler, signed the following notice on 11/5/2018, and EPA is submitting it for publication in the Federal Register (FR): [https://www.federalregister.gov/documents/2018/11/14/2018-24747/testing-regulations-for-air-emission-sources] [Federal Register Volume 83, Number 220 (Wednesday, November 14, 2018)][Rules and Regulations][Pages 56713-56734] In Method 22, sections 11.2.1 and 11.2.2 are revised as proposed to allow digital photography to be used for a subset of the recordkeeping requirements. As proposed, section 11.2.3 is added to specify the requirements for digital photographic records. In response to comments on the proposal, the next to the last sentence in section 11.2.3 regarding photographs that must be taken within 15 minutes of the observation period is revised from the proposal, and another sentence is added to provide clarity. The revised and new sentences read: "The photograph(s) representing the environmental conditions including the sky conditions and the position of the sun relative to the observer and the emission point must be taken within a reasonable time of the observation (i.e., 15 minutes). When observations are taken from exactly the same observation point on a routine basis (e.g., daily) and as long as there are no modifications to the units depicted, only a single photograph each day is necessary to document the observer's location relative to the emissions source, the process unit being observed, and the location of potential and actual emission points." The agency notes that ALT-109 (see https://www.epa.gov/emc) is the associated broadly applicable alternative that allows the use of digital photographs for specific recordkeeping requirements.**]**

11.3 Indoor Lighting Requirements. For indoor locations, use a light meter to measure the level of illumination at a location as close to the emission source(s) as is feasible. An illumination of greater than 100 lux (10 foot candles) is considered necessary for proper application of this method.

11.4 Observations.

11.4.1 Procedure. Record the clock time when observations begin. Use one stopwatch to monitor the duration of the observation period. Start this stopwatch when the observation period begins. If the observation period is divided into two or more segments by process shutdowns or observer rest breaks (see Section 11.4.3), stop the stopwatch when a break begins and restart the stopwatch without resetting it when the break ends. Stop the stopwatch at the end of the observation period. The accumulated time indicated by this stopwatch is the duration of observation period. When the observation period is completed, record the clock time. During the observation period, continuously watch the emission source. Upon observing an emission (condensed water vapor is not considered an emission), start the second accumulative stopwatch; stop the watch when the emission stops. Continue this procedure for the entire observation period. The accumulated elapsed time on this stopwatch is the total time emissions were visible during the observation period (*i.e.*, the emission time.)

11.4.2 Observation Period. Choose an observation period of sufficient length to meet the requirements for determining compliance with the emission standard in the applicable subpart of the regulations. When the length of the observation period is specifically stated in the applicable subpart, it may not be necessary to observe the source for this entire period if the emission time required to indicate noncompliance (based on the specified observation period) is observed in a shorter time period. In other words, if the regulation prohibits emissions for more than 6 minutes in any hour, then observations may (optional) be stopped after an emission time of 6 minutes is exceeded. Similarly, when the regulation is expressed as an emission frequency and the regulation prohibits emissions for greater than 10 percent of the time in any hour, then observations may (optional) be terminated after 6 minutes of emission are observed since 6 minutes is 10 percent of an hour. In any case, the observation period shall not be less than 6 minutes in duration. In some cases, the process operation may be intermittent or cyclic. In such cases, it may be convenient for the observation period to coincide with the length of the process cycle.

11.4.3 Observer Rest Breaks. Do not observe emissions continuously for a period of more than 15 to 20 minutes without taking a rest break. For sources requiring observation periods of greater than 20 minutes, the observer shall take a break of not less than 5 minutes and not more than 10 minutes after every 15 to 20 minutes of observation. If continuous observations are desired for extended time periods, two observers can alternate between making observations and taking breaks.

11.5 Recording Observations. Record the accumulated time of the observation period on the data sheet as the observation period duration. Record the accumulated time emissions were observed on the data sheet as the emission time. Record the clock time the observation period began and ended, as well as the clock time any observer breaks began and ended.

12.0 Data Analysis and Calculations.

If the applicable subpart requires that the emission rate be expressed as an emission frequency (in percent), determine this value as follows: Divide the accumulated emission time (in seconds) by the duration of the observation period (in seconds) or by any minimum observation period required in the applicable subpart, if the actual observation period is less than the required period, and multiply this quotient by 100.

13.0 Method Performance. [Reserved]

14.0 Pollution Prevention. [Reserved]

15.0 Waste Management. [Reserved]

16.0 References.

1. Missan, R., and A. Stein. Guidelines for Evaluation of Visible Emissions Certification, Field Procedures, Legal Aspects, and Background Material. EPA Publication No. EPA-340/1-75-007. April 1975.

2. Wohlschlegel, P., and D.E. Wagoner. Guideline for Development of a Quality Assurance Program: Volume IX--Visual Determination of Opacity Emissions from Stationary Sources. EPA Publication No. EPA-650/4-74-005i. November 1975.

FUGITIVE OR SMOKE EMISSION INSPECTION
OUTDOOR LOCATION

Company Location Company Rep.	Observer Affiliation Date
Sky Conditions Precipitation	Wind Direction Wind Speed
Industry	Process Unit

Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin Observation	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____		
End Observation		_____	_____
	_____		

Figure 22-1

FUGITIVE OR SMOKE EMISSION INSPECTION
INDOOR LOCATION

Company Location Company Rep.	Observer Affiliation Date
Industry	Process Unit

Light type (fluorescent, incandescent, natural)
Light location (overhead, behind observer, etc.)
Illuminance (lux or footcandles)
Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin Observation	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
End Observation	_____		

Figure 22-2

VISIBLE EMISSIONS REGULATIONS AND GUIDANCE FOR COMPLIANCE WITH THE EPA AND STATE ENVIRONMENTAL CONSERVATION AGENCES IN PENNSYLVANIA AND THE SURROUNDING STATES

What is Particulate Matter? [http://www.epa.gov/region5/air/naaqs/pm.html]

Thick, black smoke belching out of the exhaust pipes of trucks. White smoke that comes from burning leaves or burning wood in the fireplace. A hazy brown layer in the morning sky. Visible material (other than steam) puffing out of smoke stacks. Swirls of dust stirred up by a car on a dirt road. These are all examples of particulate matter.

Particulate matter arises both from direct emissions from many types of sources and from atmospheric reactions of gaseous pollutants. The examples above are direct emission sources. Particles originating from atmospheric reactions arise from the same process as acid rain. As the most important examples, sulfur dioxide and nitrogen oxides are emitted into the atmosphere, where they undergo chemical reactions that result in formation of sulfate and nitrate particles.

Particles generated by stirring up dust or by crushing or grinding operations tend to consist of more large particles than small particles. Particles generated by combustion and high temperature metallurgy are predominantly small particles. Particles that originate from atmospheric reactions are generally very small. Consequently, particles from combustion, from metallurgy, and from atmospheric reactions generally have greater health impacts than particles from stirred up dust.

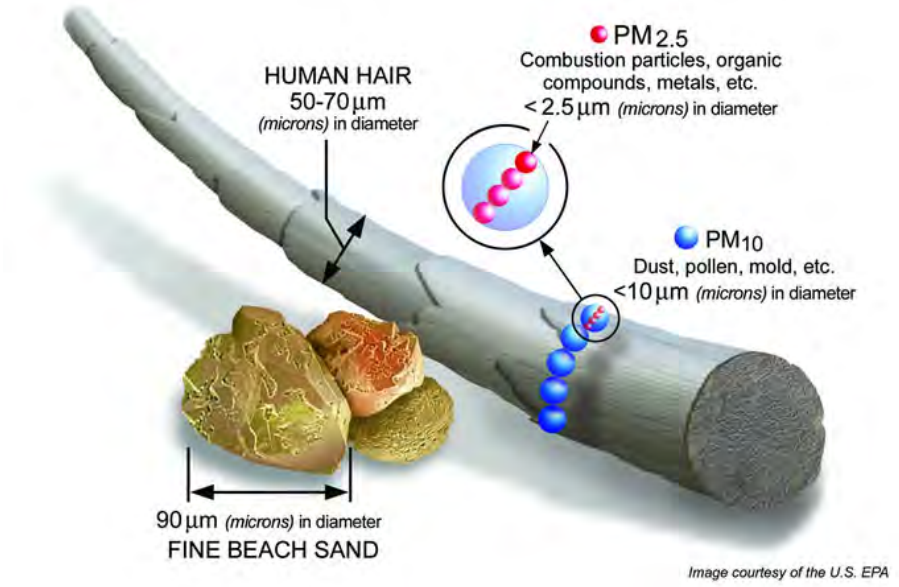
Health and Environmental Effects [http://www.epa.gov/region5/air/naaqs/pm.html]

Numerous recent studies have shown that airborne particles (either solid or liquid) cause serious health problems. EPA has estimated that airborne particles cause over 15,000 premature deaths in the United States per year. Scientists have correlated exposure to airborne particles with increased hospitalizations for asthma attacks, worsening of lung disease, chronic bronchitis, and heart damage. A March 2002 study suggests furthermore that airborne particles can cause lung cancer. In addition to these human health effects, particulate matter is the main cause of haze which decreases visibility. Particulates eventually settle on land or water which can acidify lakes, deplete the nutrients in soil, and damage sensitive forests and crops. Particulate matter is present in many different sizes. The smaller the particle, the more dangerous, because it can travel deeper into the lungs.

How Big Are These Particles? [http://www.epa.gov/region5/air/naaqs/pm.html]

Particulate matter comes in a range of sizes. Some particles are as small as large molecules, below 0.1 µm. Particles that remain airborne are generally below a nominal aerodynamic diameter of about 75 micrometers (µm). However, particles in the upper end of this size range are mostly trapped in the nose or upper respiratory system. More serious health effects result from breathing particles below 10 µm, especially from particulate matter below 2.5 µm in size. Particulate matter of 10 µm and smaller is called PM10 and particulate matter of 2.5 µm and under is known as PM2.5, also called fine particles.

[Figure from https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#PM]



How long is a micrometer? A micrometer is one millionth of a meter. A micrometer is also called a micron. This small distance translates to about 1/25000 of an inch. Common comparisons are to an average human hair, which is about 70 µm. So, a 10 µm particle would thus be about 1/7 the diameter of an average human hair, and a 2.5 µm particle would be about 1/30 the diameter of an average human hair.

"Nominal aerodynamic diameter" refers to a favored choice of various ways of defining size for real world particles with irregular shapes and various densities. A particle with a nominal aerodynamic diameter of 2.5 µm is a particle that has the same aerodynamic characteristics as a spherical particle with a 2.5 µm diameter with a density equal to that of water. Thus it would similarly penetrate deep into a lung. EPA is interested in how deeply a particle penetrates into the lung, using the nominal aerodynamic diameter is the method of assessing size of non-spherical particles. A particle's nominal aerodynamic diameter is generally similar to its conventional, nominal physical diameter.

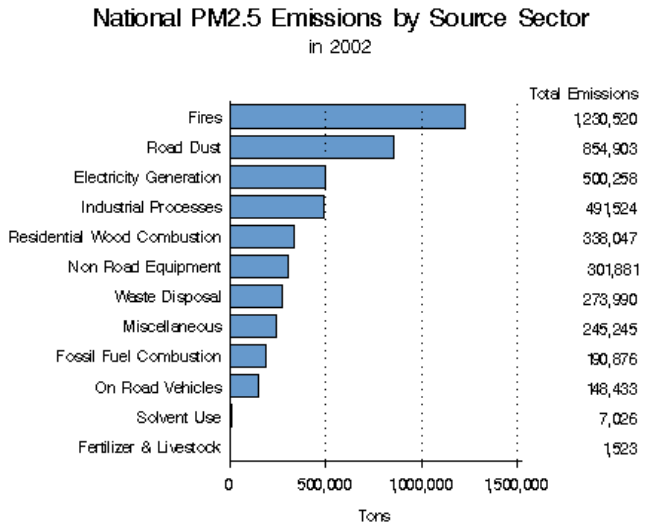
Types of Air Emission Sources: [http://www.epa.gov/region7/programs/artd/air/emissions/emission.htm]

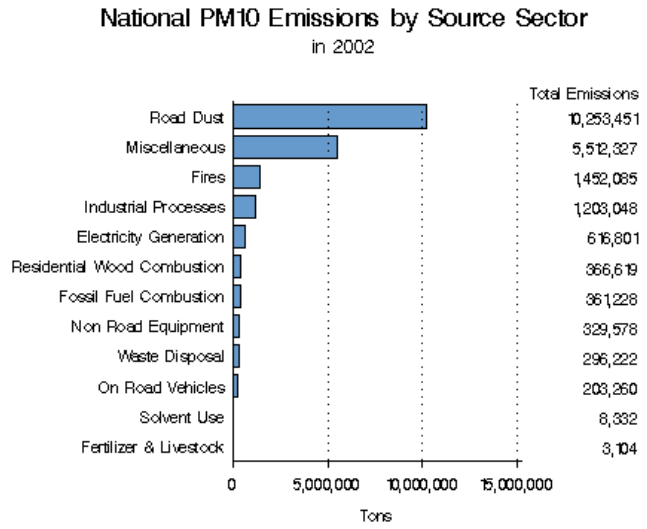
Point Sources: The major point source emissions categories are power plants, industrial boilers, petroleum refineries, industrial surface coatings and chemical manufacturing industries. Point sources' emissions are generated from stack emissions. Since most of the records are kept in AIRS/AFS (**A**erometric **I**nformation **R**etrieval **S**ystem / **A**irs **F**acility **S**ubsystem), the point sources information is readily available for developing control strategies, tracking and implementation of the State Implementation Plans (SIP). For SIP inventory purposes, the point source emission cutoff is 10 tons per year for volatile organic compounds (VOC) and 100 tons per year for nitric oxide (NOx) and carbon monoxide (CO) sources. For VOC sources emitting 10 tons per year or more, base year inventory emissions must be determined from each facility. Emissions information for individual point sources can be obtain using Envirofacts' Air Release Query Form.

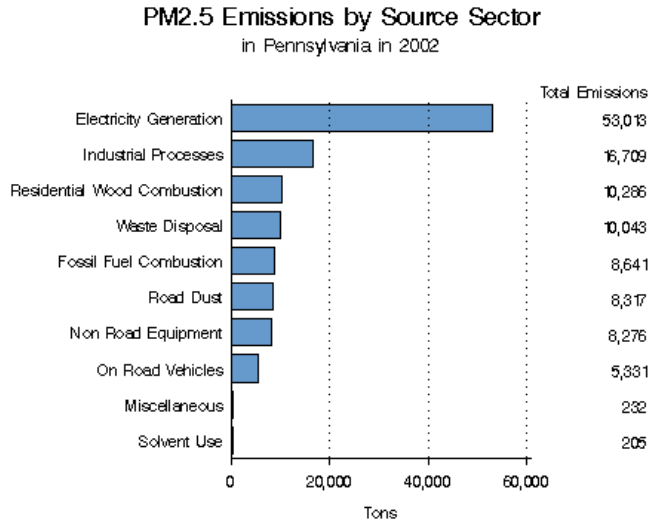
Area sources: Area sources are those emissions that are too small to be treated as point sources. Area sources' emissions can be generated from solvents used for surface coating operation, degreasing, graphic arts, dry cleaning and gasoline station (tank truck unloading and refueling). Area sources are the activities where aggregated source emissions information is maintained for the entire source categories instead of each point source, and are reported at the county level.

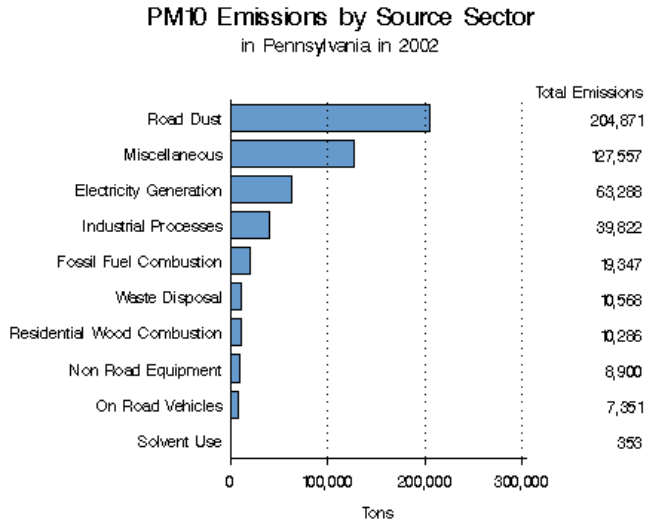
Mobile Sources: Mobile sources are categorized for highway and off-highway sources. The highway sources include automobiles, buses, trucks, and other vehicles traveling on local and highway roads. The emission from highway vehicles represents one third of the overall national VOC and 40 percent of the overall NOx emissions. Highway emissions are calculated using MOBILE models. States must present highway mobile source emissions by pollutant (VOC, NOx and CO) and by individual nonattainment county. Off-highway sources are any mobile combustion sources such as railroads, marine vessel, off-road motorcycle, snowmobiles, farm, construction, industrial and lawn/garden equipment. Emissions are determined based on a source activity variable. Activity levels for each off-highway category must be developed using EPA guidance documents.

National Summary of Particulate Matter Emissions [http://www.epa.gov/air/emissions/pm.htm]









The Clean Air Act in a Nutshell: How It Works [https://www.epa.gov/clean-air-act-overview/clean-air-act-nutshell-how-it-works]

The Act contains key provisions to control common pollutants which, at the time of the 1970 amendments, formed dense, visible smog in many of the nation's cities and industrial centers. To protect public health and welfare nationwide, the law requires EPA to establish national ambient air quality standards based on the latest science, and requires states to adopt enforceable plans to achieve the standards. State plans also must control emissions that drift across state lines and harm air quality in downwind states. Congress designed the law to minimize pollution increases from growing numbers of motor vehicles, and from new or expanded stationary sources (i.e., power plants, industrial plants, and other facilities that are not mobile). The law calls for new stationary sources to be built with best technology, and allows less stringent standards for existing stationary sources.

What are the Air Quality Standards for PM? [https://www3.epa.gov/region1/airquality/pm-aq-standards.html]

National air-quality standards for PM were first established in 1971 and were not significantly revised until 1987 when EPA changed the indicator to focus on "inhalable particles", which are particles equal to or smaller than 10 microns (PM_{10}).

In July 1997, after evaluating hundreds of health studies and conducting an extensive peer-review process, EPA established PM standards that specifically addressed particles smaller than 2.5 microns ($PM_{2.5}$). The annual standard was set at 15 micrograms per cubic meter ($\mu g/m^3$), based on the 3-year average of annual mean $PM_{2.5}$ concentrations. The 24-hour standard was set at 65 $\mu g/m^3$based on the 3-year average of the annual 98th percentile concentrations. The 1997 standards retained, but slightly revised, standards for PM_{10}, which limited PM_{10} concentrations to 50 $\mu g/m^3$based on an annual average, and 150 $\mu g/m^3$ based on a 24-hour average.

Since 1997, EPA has evaluated thousands of new studies on PM and, in September, 2006, EPA revised the PM standards by lowering the level of the 24-hour $PM_{2.5}$ standard to 35 $\mu g/m^3$ and retaining the level of the annual $PM_{2.5}$ standard at 15 $\mu g/m^3$. The Agency retained the 24-hour PM_{10} standard of 150 $\mu g/m^3$. However, the annual PM_{10} standard was revoked because of a lack of evidence establishing a link between long-term exposure to coarse particles and health problems. The secondary standards continue to be identical to the primary standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings. The 2006 revised PM standards became effective in December 2006.

In February 2009, the US Court of Appeals for the DC Circuit remanded the 2006 $PM_{2.5}$ standards after a challenge to the standards by several environmental groups and states. By remanding, rather that vacating, the standards, the Court left the standard intact while EPA reconsiders the standard. Under the Clean Air Act, EPA is required to review and, if necessary, revise air-quality standards for criteria pollutants, including PM, every five years. Therefore, reconsideration of the 2006 $PM_{2.5}$ standard was done at the same time as this five-year review.

On December 14, 2012, EPA finalized an update to the National Ambient Air Quality Standard for $PM_{2.5}$. The annual standard was reduced from 15 $\mu g/m^3$ to 12 $\mu g/m^3$. The daily $PM_{2.5}$ standard and standards for PM_{10} were retained. The revised 2012 PM standard became effective on March 18, 2013.

What Is EPA Doing about Particulate Matter? [http://www.epa.gov/region5/air/naaqs/pm.html]

EPA is also taking action itself to reduce emissions. EPA is administering the acid rain program that Congress enacted as part of the Clean Air Act Amendments of 1990. Despite the significant reductions in emissions that have occurred over the last 30 years, we now know that more needs to be done to protect the public health from the effects of particulate matter. EPA has issued the Clean Air Interstate Rule which will cut sulfur dioxide and nitrogen oxide emissions from power plants. New clean diesel rules will dramatically reduce fine particulate emissions from heavy trucks and other diesel powered equipment. The Clean Air Visibility Rule will reduce haze in National Parks and other pristine areas by limiting PM2.5 emissions along with PM2.5 precursors such as sulfur dioxide and nitrogen oxides.

Brief History of the Clean Air Act [https://www.epa.gov/sites/production/files/2015-08/documents/peg.pdf]

In October 1948, a thick cloud of air pollution formed above the industrial town of Donora, Pennsylvania. The cloud which lingered for five days, killed 20 people and caused sickness in 6,000 of the town's 14,000 people. In 1952, over 3,000 people died in what became known as London's "Killer Fog." The smog was so thick that buses could not run without guides walking ahead of them carrying lanterns.

Events like these alerted us to the dangers that air pollution poses to public health. Several federal and state laws were passed, including the original Clean Air Act of 1963, which established funding for the study and the cleanup of air pollution. But there was no comprehensive federal response to address air pollution until Congress passed a much stronger Clean Air Act in 1970. That same year Congress created the EPA and gave it the primary role in carrying out the law. Since 1970, EPA has been responsible for a variety of Clean Air Act programs to reduce air pollution nationwide.

In 1990, Congress dramatically revised and expanded the Clean Air Act, providing EPA even broader authority to implement and enforce regulations reducing air pollutant emissions. The 1990 Amendments also placed an increased emphasis on more cost-effective approaches to reduce air pollution.

Clean Air Act Roles and Responsibilities [https://www.epa.gov/sites/production/files/2015-08/documents/peg.pdf]

The Clean Air Act is a federal law covering the entire country. However, states, tribes and local governments do a lot of the work to meet the Act's requirements. For example, representatives from these agencies work with companies to reduce air pollution. They also review and approve permit applications for industries or chemical processes.

EPA's Role [https://www.epa.gov/sites/production/files/2015-08/documents/peg.pdf]

Under the Clean Air Act, EPA sets limits on certain air pollutants, including setting limits on how much can be in the air anywhere in the United States. This helps to ensure basic health and environmental protection from air pollution for all Americans. The Clean Air Act also gives EPA the authority to limit emissions of air pollutants coming from sources like chemical plants, utilities, and steel mills. Individual states or tribes may have stronger air pollution laws, but they may not have weaker pollution limits than those set by EPA.

EPA must approve state, tribal, and local agency plans for reducing air pollution. If a plan does not meet the necessary requirements, EPA can issue sanctions against the state and, if necessary, take over enforcing the Clean Air Act in that area.

EPA assists state, tribal, and local agencies by providing research, expert studies, engineering designs, and funding to support clean air progress. Since 1970, Congress and the EPA have provided several billion dollars to the states, local agencies, and tribal nations to accomplish this.

State and Local Governments' Role [https://www.epa.gov/sites/production/files/2015-08/documents/peg.pdf]

It makes sense for state and local air pollution agencies to take the lead in carrying out the Clean Air Act. They are able to develop solutions for pollution problems that require special understanding of local industries, geography, housing, and travel patterns, as well as other factors.

State, local, and tribal governments also monitor air quality, inspect facilities under their jurisdictions and enforce Clean Air Act regulations.

States have to develop State Implementation Plans (SIPs) that outline how each state will control air pollution under the Clean Air Act. A SIP is a collection of the regulations, programs and policies that a state uses to clean up polluted areas. The states must involve the public and industries through hearings and opportunities to comment on the development of each state plan.

Tribal Nations' Role [https://www.epa.gov/sites/production/files/2015-08/documents/peg.pdf]

In its 1990 revision of the Clean Air Act, Congress recognized that Indian Tribes have the authority to implement air pollution control programs.

EPA's Tribal Authority Rule gives Tribes the ability to develop air quality management programs, write rules to reduce air pollution, and implement and enforce their rules in Indian Country. While state and local agencies are responsible for all Clean Air Act requirements, Tribes may develop and implement only those parts of the Clean Air Act that are appropriate for their lands.

How Does the Program Work? [http://www.epa.gov/air/oaqps/permits/permitupdate/brochure.html#what]

The Clean Air Act requires all states to develop and implement an operating permit program that meets minimum federal requirements. Most of the significant air pollution sources throughout the country must obtain a permit from their respective state, tribal, or local permitting authority.

> **Each state and local government can tailor its permit program to its individual needs, while meeting minimum federal requirements.**

All "major" stationary sources (primarily industrial facilities and large commercial operations) emitting certain air pollutants are required to obtain operating permits. Whether a source meets the definition of "major" depends on the type and amount of air pollutants it emits and, to some degree, on the overall air quality in its vicinity. Generally, major sources include those stationary facilities that emit 100 tons or more per year of a regulated air pollutant. Regulated pollutants include compounds such as carbon monoxide, particulates, volatile organics, sulfur dioxide, and nitrogen oxides. Smaller sources are considered "major" in areas that are not meeting the national air quality standards for a particular pollutant. For example, certain sources releasing 25 or even 10 tons of pollutant emissions per year are considered "major" in areas with extreme ozone (urban smog) problems. The operating permit program also covers a variety of other significant operations, including:

- Large coal-burning utility boilers and industrial boilers subject to control requirements under the acid rain provisions of the Clean Air Act.
- Sources that are subject to requirements under New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants.

- Sources of toxic air pollutants (i.e., any source that emits more than 10 tons per year of an individual toxic air pollutant or more than 25 tons per year of any combination of toxic air pollutants).
- Sources required to have pre-construction or new source permits (under New Source Review or Prevention of Significant Deterioration requirements).

Often these facilities can be very large with a wide variety of process operations and hundreds of emission sources. Examples include chemical plants, petroleum refineries, and large manufacturing facilities.

How Are Visible Emissions Measured? [http://www.state.me.us/dep////air/compliance/visibleemissions.htm]

The Ringelmann Chart was developed in the late 1800s and became one of the first tools used to measure visible emissions. Introduced into the United States in 1897, it was soon accepted as the standard measure of black smoke density and later adapted for gray, white, and other colors of smoke plumes. This then became the basis for many city, state, and federal regulations on smoke density limitations. The Ringelmann Chart is based on the premise that the darker the plume, the more particles are present to block the light and reduce visibility.

In the 1950's and 60's, Los Angeles added two major refinements to the visible emissions observation method. One was training and certifying inspectors using a smoke generator equipped with an opacity meter. Certified inspectors no longer needed to carry and use Ringelmann cards. Also, the Ringelmann method was expanded to white and other colors of smoke by the introduction of the idea of "equivalent opacity". Equivalent opacity meant that white smoke was equivalent to a Ringelmann number in its ability to obscure the view of a background. In some states, equivalent opacity was still measured in Ringelmann numbers while in others the 0 to 100% scale was used. In the 1960's, the Federal Government published AP-30 describing accuracy of smoke reader's observations when compared to a transmissometer. It also addressed the problem of viewing a plume with the sun in the wrong place relative to the source.

EPA stopped using Ringelmann numbers when EPA Method 9 procedures for New Source Performance Standards (NSPS) were published in 1974, unless required by a State Implementation Plan. Current NSPS procedures are based solely on opacity. Plume opacity is measured in percent: the greater the opacity, the more the background behind the plume is obscured and the less light can come through the plume. If none of the background is obscured, then the opacity is 0%. If the entire background is obscured, then the opacity is 100%.

What is Opacity? [http://www.epa.gov/region5/air/naaqs/opacity.html]

Opacity is the amount of light that is blocked by a medium, like smoke or a tinted window. Opacity is a measurement and is usually stated as a percentage. An opacity of 0% means that all light passes through, and an opacity of 100% means that no light can pass through. Opacity is important because it gives an indication of the concentration of pollutants leaving a smokestack. The more particles that pass through a stack, the more light that is blocked, and, as a result, a higher opacity percentage is achieved.

How Is Opacity Determined? [http://www.epa.gov/region5/air/naaqs/opacity.html]

There are many ways to measure opacity: 1) by instruments, and 2) by human observers.

EPA requires many companies to install instruments in their smokestacks to measure opacity continuously. These monitors can be certified according to standardized specifications and procedures in the Code of Federal Regulations (CFR): 40 CFR Chapter I, Part 60, Appendix B.

Also, commonly, opacity is determined through visual observation by people who have been trained and certified as Visible Emission Observers. These people have attended "smoke school", where they are trained on reading opacity and tested for their ability to judge the opacity of plumes with known opacity. Federal, state, and local inspectors as well as industry staff have been trained to conduct opacity readings to determine if a source is meeting their federal and/or state opacity requirements. Essentially, these people have been trained to estimate the percentage of opacity for black or white smoke coming from smokestacks.

EPA has adopted standardized training and certification procedures in 40 CFR Chapter I, Part 60, Appendix A, Method 9. Smoke school involves basic education and certification using these procedures. For certification, black and white smoke is generated at different opacities for a total of 50 separate visible emission readings. Opacities must be within a certain percentage of accuracy, for both types of smoke, for certification to be obtained. Certification expires after six months.

How Does EPA Use Opacity Information? [http://www.epa.gov/region5/air/naaqs/opacity.html]

EPA and the states use opacity as a convenient surrogate for assessing mass emissions, as a means to assure effective particulate emissions control. Typically, a stack has two applicable limits, one that specifies a maximum allowable mass of emissions that exit the stack (e.g., 25 pounds of particulate matter per hour or 0.2 pounds of particulate matter per ton of widgets produced), and one that specifies a maximum acceptable opacity (e.g., 30% opacity). Stack tests for measuring the mass of emissions take extensive planning and cannot affordably be done very often. In contrast, opacity measurements can reasonably occur much more frequently, either continuously by instrumentation or on a regular basis by a human observer.

Consequently, opacity measurements provide a cheaper means of getting much more frequent information on the effectiveness of a source's emission control. In fact, EPA insists on being able to take enforcement action against any source that exceeds applicable opacity limits irrespective of the source's mass emissions. The goal is low mass emissions. But high opacity

is easier to detect than high mass emissions. Therefore, EPA insists on being able to take a case to court against a company with excessive opacity without having to prove that the mass emissions are too high.

With some sources, the emissions do not come out of a stack, and there is no reliable and suitable way of measuring mass emissions. In these cases, opacity limits may be the only limit that can be established, tested, and enforced. For example, where emissions are generated in an open process and the emissions control device is unable to capture all the emissions, the uncaptured emissions may escape through vents in the building (typically, a "roof monitor") that cannot be reliably sampled and measured. In these cases, the only means of assuring good emissions control (e.g., effective emissions capture to route the emissions through an emission control device) is by setting and enforcing a suitable opacity limit.

Region 5 states have also pioneered the use of opacity limits for regulating emissions from vehicles traveling on dusty plant roadways, a significant source of PM10 in many of the industrial areas that have violated the PM10 standards. The approach has uncertainties in the level of emissions associated with various opacity limits. Nevertheless, opacity limits give more of a performance basis and thus give companies more flexibility in control techniques than the traditional work practice approach, which requires the company to implement a fixed set of control measures.

Visible Emissions Field Manual EPA Methods 9 and 22 – Introduction

[https://www3.epa.gov/ttn/emc/methods/VEFieldManual.pdf]

The Federal opacity standards for various industries are found in 40CFR Part 60 (Standards of Performance for New and Modified Stationary Sources) and 40 CFR Part 61 and 62 (Emission Standards for Hazardous Air Pollutants). These standards require the use of Reference Method 9 or Reference Method 22, contained in Appendix A of Part 60, for the determination of the level or frequency of visible emissions by trained observers.

In addition to the plume observation procedures, Method 9 also contains data reduction and reporting procedures as well as procedures and specifications for training and certifying qualified visible emission (VE) observers.

State Implementation Plans (SIPS) also typically include several types of opacity regulations, which in some cases may differ from the federal opacity standards in terms of the opacity limits, the measurement method or test procedure, or the data evaluation technique. For example, some SIP opacity rules limit visible emissions to a specified number of minutes per hour or other time period (time exemption); some limit opacity to a certain level averaged over a specified number of minutes (time averaged); some set opacity limits where no single reading can exceed the standard (instantaneous or "'cap"). Regardless of the exact format of the SIP opacity regulations, nearly all use the procedures in Method 9 for conducting VE field observations and for training and certifying VE observers. The observation procedures contain instructions on how to read the plume and record the values, including where to stand to observe the plume and what information must be gathered to support the visible emission determinations. The validity of the VE determinations used for compliance or noncompliance demonstration purposes depends to a great extent on how well the field observations are documented on the VE Observation Form. This field manual will stress the type and extent of documentation needed to satisfy Method 9 requirements.

Federal opacity standards and most SIP opacity regulations are independently enforceable, i.e., a source may be cited for an opacity violation even when it is in compliance with the particulate mass standard. Thus, visible emission observations by qualified agency observers serve as a primary compliance surveillance tool for enforcement of emission control standards. In addition, many federal and SIP regulations and construction and operating permits also require owners/operators of affected facilities to assess and report opacity data during the initial compliance tests and at specified intervals over the long term.

Regulated sources may be subject to stiff penalties for failure to comply with federal and state emission standards, including opacity standards. Civil and administrative penalties of up to $25,000 per day per violation can be assessed under the Clean Air Act (CAA). States and local agencies are encouraged under Title V of the CAA to have program authority to levy fines up to $10,000 per day per violation. Therefore, visible emission determinations for compliance demonstration or enforcement purposes must be made accurately and must be sufficiently well documented to withstand rigorous examination in potential enforcement proceedings, administrative or legal hearings, or eventual court litigation.

Procedural errors or omissions on the visible emission evaluation forms or data sheets can invalidate the data or otherwise provide a basis for questioning the evaluation. Only by carefully following the procedures set forth in Method 9 (or any other reference method) and by paying close attention to proper completion of the VE Observation Form can you be assured of acceptance of the evaluation data.

What Constitutes a Visible Emissions Violation using EPA Method 9?

According to Method 9, a violation of a six minute opacity standard has occurred if the ***average*** of any group of 24 ***consecutive*** readings (six minutes) in a one-hour period exceeds the standard. Sources subject to federal New Source Performance Standards must calculate opacity as specified in Method 9, unless stricter standards are in effect. The standards in the States' Visible Emission Regulation or a facility's air emission license will often take precedence.

Pennsylvania's Use of EPA Reference Method 9

EPA Reference Method 9 is found in 40 CFR Part 60, Appendix A. It was adopted as a visible emissions inspection method in an effort to standardize the training and certification of observers and to ensure that reliable and repeatable opacity observations could be conducted anywhere in the United States.

Pennsylvania uses a method based upon EPA Reference Method 9. Method 9 describes the requirements for training and testing of opacity observers, steps to follow in determining opacity, and the data to record while documenting an observation. Pennsylvania's State Implementation Plan (SIP) for the determination of the opacity of emissions from sources of visible emissions is a time-exception regulation. A time-exception regulation means any regulation that allows predefined periods of opacity above the otherwise applicable opacity limit (e.g., allowing exceedances of 20 percent opacity for 3 minutes in 1 hour.) Pennsylvania's procedure follows EPA Method 203B which is virtually identical to EPA's Method 9 of 40 CFR Part 60, Appendix A, except for the data-reduction procedures, which have been modified to apply to time-exception regulations. The certification procedures for this method are identical to those provided in Method 9. In Pennsylvania, visible emissions from any point of emission cannot be equal to or greater than 20% opacity for more than three minutes in any 60-minute period. Opacity is NEVER allowed to be equal to or greater than 60%.

What Constitutes a Visible Emissions Violation in Pennsylvania?

If opacity EVER equals or exceeds 60% then a violation has occurred.

Further, to determine compliance with the Pennsylvania visible emissions standard, opacity is calculated as follows:

- Step 1: Count the number of observations in one hour that are equal to or greater than the percent opacity limitation (in most cases, 20%). Each observation represents 15 seconds.
- Step 2: Divide this number by four to find the number of minutes in excess of the opacity limitation.
- Step 3: **If the opacity does not equal or exceed the limit for more than three minutes during an hour, no violation has occurred.**

Suggested use of Method 9 data sets in Pennsylvania:

Method 9 calls for the averaging of 24 observations over six minutes (each observation representing 15 seconds) to determine opacity. Method 9 does not address the criteria for when a violation has occurred. These criteria are set by each state. Pennsylvania does not use the average of 24 observations to determine if a violation occurs because such averaging might allow for more than 3 minutes of exceedances in an hour. In Pennsylvania the Method 9 reading of 24 observations can be useful in deciding whether the source requires a full hour of data to determine compliance. If the source is a steady-state process and none of the twenty-four observations exceed the opacity limitation and the average is not close to the cut-off, then a full hour of data is usually not needed. If there is any doubt about whether the source exceeds the opacity limit then it is necessary to use a full hour of data to make a determination.

PENNSYLVANIA VISIBLE EMISSIONS STATUTES (25 Pa. Code)

§ 123.41. Limitations. [http://www.pacode.com/secure/data/025/chapter123/s123.41.html]

A person may not permit the emission into the outdoor atmosphere of visible air contaminants in such a manner that the opacity of the emission is either of the following:

(1) Equal to or greater than 20% for a period or periods aggregating more than 3 minutes in any 1 hour.
(2) Equal to or greater than 60% at any time.

Source: The provisions of this § 123.41 adopted September 10, 1971, effective September 11, 1971, 1 Pa.B. 1804; amended March 3, 1972, effective March 20, 1972, 2 Pa.B. 383.

Cross References: This section cited in 25 Pa. Code § 121.8 (relating to compliance responsibilities); 25 Pa. Code § 123.42 (relating to exceptions); 25 Pa. Code § 123.45 (relating to alternative opacity limitations); and 25 Pa. Code § 264.345 (relating to operating requirements).

§ 123.42. Exceptions. [http://www.pacode.com/secure/data/025/chapter123/s123.42.html]

The limitations of § 123.41 (relating to limitations) shall not apply to a visible emission in any of the following instances:

(1) When the presence of uncombined water is the only reason for failure of the emission to meet the limitations.
(2) When the emission results from the operation of equipment used solely to train and test persons in observing the opacity of visible emissions.
(3) When the emission results from sources specified in § 123.1 (a) (1)-(9) (relating to prohibition of certain fugitive emissions).
(4) When arising from the production of agricultural commodities in their unmanufactured state on the premises of the farm operation.

Source: The provisions of this § 123.42 adopted September 10, 1971, effective September 11, 1971, 1 Pa.B. 1804; amended March 3, 1972, effective March 20, 1972, 2 Pa.B. 383; amended August 12, 1977, effective August 29, 1977, 7 Pa.B. 2251.

§ 123.43. Measuring techniques. [http://www.pacode.com/secure/data/025/chapter123/s123.43.html]

Visible emissions may be measured using either of the following:

(1) A device approved by the Department and maintained to provide accurate opacity measurements.
(2) Observers, trained and qualified to measure plume opacity with the naked eye or with the aid of devices approved by the Department.

Cross References: This section cited in 25 Pa. Code § 264.345 (relating to operating requirements).

Source: The provisions of this § 123.2 adopted September 10, 1971, effective September 11, 1971, 1 Pa.B. 1804; amended March 3, 1972, effective March 20, 1972, 2 Pa.B. 383; amended August 12, 1983, effective August 13, 1983, 13 Pa.B. 2478.

Fugitive Emissions

§ 123.1. Prohibition of certain fugitive emissions. [http://www.pacode.com/secure/data/025/chapter123/s123.1.html]

(a) No person may permit the emission into the outdoor atmosphere of a fugitive air contaminant from a source other than the following:

(1) Construction or demolition of buildings or structures.
(2) Grading, paving and maintenance of roads and streets.
(3) Use of roads and streets. Emissions from material in or on trucks, railroad cars and other vehicular equipment are not considered as emissions from use of roads and streets.
(4) Clearing of land.
(5) Stockpiling of materials.
(6) Open burning operations.
(7) Blasting in open pit mines. Emissions from drilling are not considered as emissions from blasting.
(8) Coke oven batteries, provided the fugitive air contaminants emitted from any coke oven battery comply with the standards for visible fugitive emissions in § § 123.44 and 129.15 (relating to limitations of visible fugitive air contaminants from operation of any coke oven battery; and coke pushing operations).
(9) Sources and classes of sources other than those identified in paragraphs (1)—(8), for which the operator has obtained a determination from the Department that fugitive emissions from the source, after appropriate control, meet the following requirements:
   (i) The emissions are of minor significance with respect to causing air pollution.
   (ii) The emissions are not preventing or interfering with the attainment or maintenance of an ambient air quality standard.

(b) An application form for requesting a determination under either subsection (a)(9) or § 129.15(c) is available from the Department. In reviewing these applications, the Department may require the applicant to supply information including, but not limited to, a description of proposed control measures, characteristics of emissions, quantity of emissions and ambient air quality data, and analysis showing the impact of the source on ambient air quality. The applicant is required to demonstrate that the requirements of subsections (a)(9) and (c) and § 123.2 (relating to fugitive particulate matter) or of the requirements of § 129.15(c) have been satisfied. Upon such demonstration, the Department will issue a determination, in writing, either as an operating permit condition, for those sources subject to permit requirements under the act, or as an order containing appropriate conditions and limitations.

(c) A person responsible for any source specified in subsections (a)(1)-(7) or (9) shall take all reasonable actions to prevent particulate matter from becoming airborne. These actions include, but not be limited to, the following:

(1) Use, where possible, of water or chemicals for control of dust in the demolition of buildings or structures, construction operations, the grading of roads, or the clearing of land.
(2) Application of asphalt, oil, water or suitable chemicals on dirt roads, material stockpiles, and other surfaces which may give rise to airborne dusts.
(3) Paving and maintenance of roadways.
(4) Prompt removal of earth or other material from paved streets onto which earth or other material has been transported by trucking or earth moving equipment, erosion by water, or other means.

(d) The requirements contained in subsection (a) and § 123.2 do not apply to fugitive emissions arising from the production of agricultural commodities in their unmanufactured state on the premises of the farm operation.

Source: The provisions of this § 123.1 adopted September 10, 1971, effective September 11, 1971, 1 Pa.B. 1804; amended March 3, 1972, effective March 20, 1972, 2 Pa.B. 383; amended August 12, 1977, effective August 29, 1977, 7 Pa.B. 2251.

§ 123.2. Fugitive particulate matter. [http://www.pacode.com/secure/data/025/chapter123/s123.2.html]

A person may not permit fugitive particulate matter to be emitted into the outdoor atmosphere from a source specified in § 123.1(a)(1)-(9) (relating to prohibition of certain fugitive emissions) if the emissions are visible at the point the emissions pass outside the person's property.

Source: The provisions of this § 123.2 adopted September 10, 1971, effective September 11, 1971, 1 Pa.B. 1804; amended March 3, 1972, effective March 20, 1972, 2 Pa.B. 383; amended August 12, 1983, effective August 13, 1983, 13 Pa.B. 2478.

Alternate Opacity Limitations

§ 123.45. Alternative opacity limitations. [http://www.pacode.com/secure/data/025/chapter123/s123.45.html]

(a) ***Coverage.*** Coverage shall comply with the following:

(1) This section applies to a source:

(i) That is covered under § 123.41 (relating to limitations) and is also covered by an emission limitation in the form of a mass rate or a stack gas concentration or a fuel requirement.

(ii) That is not a fugitive air contaminant.

(iii) For which the mass rate or concentration can be determined:

(A) Using techniques specified in § § 139.11—139.16.

(B) By any other method approved by the Department that is consistent with accepted air pollution testing practices and with obtaining accurate results that are representative of the conditions evaluated.

(2) Appendix D presents the applicability of this section for various emission limitation formats.

(b) ***Procedure for application.*** The procedure for application shall comply with the following:

(1) The owner or operator of a source may request the Department to determine the opacity of emissions from the source during a demonstration of compliance with the applicable mass rate standard or stack gas concentration standard or fuel requirement. The request must be made in the form of a plan approval application under Chapter 127 Subchapter A (relating to general).

(2) The owner or operator shall provide for any test the Department deems necessary for determining compliance with the applicable emission limitation.

(3) The owner or operator shall provide sufficient notification to the Department so that the proposed test methods may be reviewed and approved by the Department. No test will be considered by the Department for the purpose of establishing an alternative opacity limitation unless the test methods have been first approved by the Department and a trained and qualified observer is present during the test.

(c) ***Eligibility.*** A source shall be eligible for an alternative opacity limitation (AOL) if the following conditions are met:

(1) The Department finds that the source is in compliance with this article except § 123.41. The Department will specify the method of demonstrating compliance.

(2) During the time the determination of compliance and AOL is conducted, the source fails to meet any applicable opacity limitation.

(3) The Department finds:

(i) That the source has not discontinued measures to minimize opacity of emissions, within the bounds of good engineering and good economic practice.

(ii) That the source and associated air pollution control equipment are operated and maintained in a manner to minimize the opacity of emissions, within the bounds of good engineering and good economic practice.

(4) The demonstration of compliance and the alternative opacity tests are performed under the conditions established by the Department.

(5) The Department determines that the AOL would not create or contribute to a public nuisance nor cause air pollution as defined under the act.

(d) ***Level of the alternative standard.*** The Department will set the AOL at the opacity levels measured during the performance test, even if the emissions were substantially less than those allowed under the regulations or permit conditions of the Department. The Department will enter the AOL as a condition of the operating permit of the source.

(e) ***Operating conditions.*** The Department will specify the operating conditions under which the determination of compliance and AOL will be made. The conditions must be based on technical knowledge of the process concerning normal operation and the effects of deviations from normal operations.

(f) ***Timing of test.*** The Department will specify the day, time of day and time of year for conducting the determination of compliance and AOL where these factors may substantially affect the determination of source opacity. Where the source exhibits high opacity only under certain specified conditions or during certain times, the Department may limit the applicability of the AOL to operation during those conditions or times. These conditions or times must be specified in the permit.

(g) ***Continuous monitoring.*** Continuous monitoring shall consist of the following:

(1) A source that requests an AOL must install, operate and maintain a continuous opacity monitor before the determination of compliance and AOL is made.

(2) The Department will use the data from the monitor during the determination of compliance and AOL to set the AOL. After the AOL is entered on the operating permit of the source, the Department will use the data from the monitor to enforce the AOL.

(3) The Department may exempt a source from the requirement of paragraph (1) if the Department determines that the monitor would not give representative opacity readings for that source. The Department may require an exempted source to:
(i) Use trained and qualified observers to measure the opacity.
(ii) Monitor and report operating parameters of the process and of air pollution control equipment.
(iii) Perform such activities on a specified schedule maintaining relevant records for inspection by the Department.

(h) ***Granting and quantifying the AOL.*** Granting and quantifying the AOL include the following:
(1) The Department will issue a permit establishing the AOL for the source or will deny the application for plan approval if the Department determines that the source is not eligible for, or entitled to, an AOL.
(2) The Department will use the procedure of § § 139.17 and 139.18 (relating to general requirements; and calculation of alternative opacity limitations) to quantify the AOL.
(i) *Special situations.* Special situations include the following:
(1) For sources that make several products of varying opacity-producing capabilities, the Department may establish an overall AOL independent of the product. The Department may, however, establish a separate AOL for each product where the Department determines that the opacities from the products differ to such an extent that enforcement of the mass rate standard or stack gas concentration standard or fuel requirement may be hampered with only one AOL.
(2) For cases in which several processes vent to a single stack, the Department will set an AOL at the opacity level produced after each process is determined to be in compliance with the appropriate mass rate standard or stack gas concentration standard or fuel requirement.

Authority: The provisions of this § 123.46 issued under the Air Pollution Control Act (35 P. S. § § 4001—4015).

Source: The provisions of this § 123.46 adopted June 19, 1981, effective June 20, 1981, 11 Pa.B. 2132; corrected June 26, 1981, effective June 20, 1981, 11 Pa.B. 2225

Continuous Opacity Monitoring Systems (COMS)

§ 123.46. Monitoring Requirements. [https://www.pacode.com/secure/data/025/chapter123/s123.46.html]

(a) The following sources are subject to this section:

(1) Fossil fuel-fired steam generators with an annual average capacity factor of greater than 30%, as demonstrated to the Department by the owner or operator, and of greater than 250 million Btu per hour heat input except where:

(i) Natural gas is the only fuel burned.

(ii) Oil or a mixture of gas and oil are the fuels burned and the source is able to comply with the applicable particulate matter and opacity regulations without utilization of particulate matter collection equipment and the source has not been found, within the 5 years previous to the applicability of this section, through any administrative or judicial proceedings to be in violation of any visible emissions standard.

(2) Catalyst regenerators for fluid bed catalytic cracking units at petroleum refineries, if the unit is of greater than 20,000 barrels per day fresh feed capacity.

(b) All sources subject to the provisions of this section shall install, operate and maintain continuous opacity monitoring devices in compliance with Chapter 139, Subchapter C (relating to requirements for continuous in-stack monitoring for stationary sources). Results of opacity monitoring shall be submitted to the Department on a regular basis in compliance with the requirements of Chapter 139, Subchapter C.

(c) The Department may exempt a source from the requirements of subsection (b) if the Department determines that the installation of a continuous emission monitoring system would not provide accurate determination of emissions or that installation of a continuous emission monitoring system may not be implemented by a source due to physical plant limitations or to extreme economic reasons. The Department will require such an exempted source to fulfill alternative emission monitoring and reporting requirements.

(d) The Department may use the data from the monitoring devices or from the alternative monitoring systems required by this section to enforce the visible emission limitations defined in this article.

(e) Compliance with this section shall be obtained no later than 18 months after the effective date of the listing of any source identified in subsection (a). The Department may grant orders providing reasonable extension of time for sources that have made

good faith efforts to install, operate and maintain continuous monitoring devices but have been unable to complete such operations within the time period provided.

Authority: The provisions of this § 123.46 issued under the Air Pollution Control Act (35 P. S. § § 4001—4015).
Source: The provisions of this § 123.46 adopted June 19, 1981, effective June 20, 1981, 11 Pa.B. 2132; corrected June 26, 1981, effective June 20, 1981, 11 Pa.B. 2225.

Subchapter A. SAMPLING AND TESTING METHODS AND PROCEDURES

§ 139.17. General requirements.

The following are applicable to source tests for determining alternative opacity limitations under § 123.45 (relating to alternative opacity limitations).

(1) A series of three consecutive performance tests shall be conducted in accordance with the requirements of § § 139.1—139.4, 139.11 and 139.12. The time period from the beginning of the first test to the end of the third test may not exceed 8 hours.

(2) The opacity of emissions, as determined in accordance with the measurement technique specified in § 123.45 (relating to alternative opacity limitations), shall be recorded for the entire time period from the beginning of the first performance test to the end of the third performance test.

(3) If continuous opacity monitoring equipment is required, it shall be installed, operated and maintained in accordance with Subchapter C (relating to requirements for source monitoring for stationary sources).

(4) If continuous opacity monitoring equipment is not required, visual observation of opacity shall be conducted by the source owner or operator in accordance with the procedures in Appendix A, Method 9 of § 139.102(1) (relating to references).

(5) Prior to the first performance test, the results of opacity measurements obtained in accordance with the technique specified in § 123.45 will be compared to the results of visual observations conducted by the Department in accordance with Appendix A, Method 9 of § 139.102(1).

(i) A series of 60 consecutive observations will be conducted by the Department observer at intervals of 15 seconds. The results will be reduced to fifteen 1-minute averages.

(ii) The opacity measurements obtained by the techniques specified in § 123.45 for the same time period will be reduced to fifteen 1-minute averages corresponding to those calculated in subparagraph (i).

(iii) If any of the 1-minute averages as calculated in subparagraph (ii) differ by more than 15% opacity from the corresponding 1-minute average as calculated in subparagraph (i), the cause shall be determined and the comparison repeated after appropriate adjustments have been made but before commencement of the first performance test.

(iv) If the average of the absolute values of the differences between the 1-minute averages as calculated in subparagraph (ii) and the corresponding 1-minute averages as calculated in subparagraph (i) is greater than 7.5% opacity, the cause shall be determined and the comparison repeated after appropriate adjustments have been made but before commencement of the first performance test.

Source

The provisions of this § 139.17 adopted June 19, 1981, effective June 20, 1981, 11 Pa.B. 2132.

Cross References

This section cited in 25 Pa. Code § 123.45 (relating to alternative opacity limitations); and 25 Pa. Code § 139.12 (relating to emissions of particulate matter).

Subchapter B. MONITORING DUTIES OF CERTAIN SOURCES

§ 139.52. Monitoring methods and techniques.

Persons responsible for the operation of sources subject to monitoring requirements established by order, by condition of plan approval or permit, or under this subchapter, shall:

(1) Conduct source testing or air sampling and perform analyses in accordance with the requirements of Subchapter A (relating to sampling and testing methods and procedures), or shall install, operate and maintain a device approved by the Department for installation in a flue for the purpose of continuous measurement of specific air contaminants.

(2) Perform visible emission observations in accordance with the methods for observing and recording visible emissions established pursuant to Chapter 123 (relating to standards for contaminants); provided, however, visible emissions discharged through a flue may also be monitored by use of a device approved by the Department for installation in a stack for the purpose of measuring opacity.

Source

The provisions of this § 139.52 adopted August 12, 1977, effective August 29, 1977, 7 Pa.B. 2251.

Cross References

This section cited in 25 Pa. Code § 139.53 (relating to filing monitoring reports).

Subchapter C. REQUIREMENTS FOR SOURCE MONITORING FOR STATIONARY SOURCES

§ 139.102. References.

The following are references of this subchapter:

(1) ''Standards of Performance for New Stationary Sources,'' 40 CFR Chapter I, Subchapter C, Part 60, Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402-9328.

(2) ''Minimum Emission Monitoring Requirements,'' 40 CFR Subchapter C, Part 51, Appendix P, Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402-9328.

(3) ''Continuous Source Monitoring Manual,'' Commonwealth of Pennsylvania, Department of Environmental Resources, Bureau of Air Quality Control, Post Office Box 8468, Harrisburg, Pennsylvania 17105-8468.

Source

The provisions of this § 139.102 adopted April 27, 1979, effective August 1, 1979, 9 Pa.B. 1447; corrected May 11, 1979, effective August 1, 1979, 9 Pa.B. 1534; amended August 12, 1983, effective August 13, 1983, 13 Pa.B. 2478; amended October 26, 1990, effective October 27, 1990, 20 Pa.B. 5416; amended November 25, 1994, effective November 26, 1994, 24 Pa.B. 5899. Immediately preceding text appears at serial page (188275).

Cross References

This section cited in 25 Pa. Code § 123.108 (relating to source emissions monitoring requirements); 25 Pa. Code § 139.5 (relating to revisions to the source testing manual and continuous source monitoring manual); 25 Pa. Code § 139.17 (relating to general requirements); 25 Pa. Code § 139.101 (relating to general requirements); 25 Pa. Code § 139.103 (relating to opacity monitoring requirements); 25 Pa. Code § 139.108 (relating to TRS compound monitoring requirements); and 25 Pa. Code

§ 139.103. Opacity monitoring requirements.

This section applies to sources monitoring opacity.

(1) Opacity measurements shall be converted to represent plume opacity as described in the manual referenced in § 139.102(3) (relating to references). The conversion method shall be approved by the Department.

(2) Opacity monitoring systems shall meet at least one of the following minimum data availability requirements unless other data availability requirements are stipulated elsewhere in this title for a particular process:

(i) At least 90% of the hours in each calendar month shall be valid hours as set forth in the quality assurance section of the manual referenced in § 139.102(3).

(ii) At least 95% of the hours in each calendar quarter shall be valid hours as set forth in the quality assurance section of the manual referenced in § 139.102(3).

Source

The provisions of this § 139.103 adopted April 27, 1979, effective August 1, 1979, 9 Pa.B. 1447; corrected May 11, 1979, effective August 1, 1979, 9 Pa.B. 1534; amended June 19, 1981, effective June 20, 1981, 11 Pa.B. 2132; amended October 26, 1990, effective October 27, 1990, 20 Pa.B. 5416; amended November 25, 1994, effective November 26, 1994, 24 Pa.B. 5899. Immediately preceding text appears at serial pages (188275) to (188276).

CITY OF PHILADELPHIA DEPARTMENT OF PUBLIC HEALTH AIR POLLUTION CONTROL BOARD
AIR MANAGEMENT REGULATIONS I, II, III OF THE AIR POLLUTION CONTROL BOARD

[Selected Excerpts – Complete Document: https://www.phila.gov/media/20190205124637/AMS-Regulation-I-II-III-Combined-__-2_5_19.pdf]

Adopted: Air Pollution Control Board... April 10, 1970 (AMENDMENTS AND REVISIONS THROUGH AUGUST 29, 2018)

These Regulations have been developed to provide guidance for compliance with the Air Management Code. They specify limits and delineate procedures to be followed in improving the quality of the air for both the City of Philadelphia and the Delaware Valley Region. In recognition of the concept that the atmosphere is a resource to be used by all, but which should not be abused by any, these Regulations are based on the principle that the use of the atmosphere for disposal of waste materials or for other purposes which tend to degrade the quality of the air for other users implies a responsibility to use every means available to limit bad effects resulting from such use.

To this end, the numbers set forth herein indicate levels which have been selected to represent limits possible under available technology and beyond which point justification for additional degradation can be properly required.

To enable public and technical examination of those instances for which technology might not yet be available to meet these desirable limits, a review mechanism has been provided with appropriate procedures set forth to make possible adjustments to specific needs. This relief is to be applied in cases where it is impossible to meet, by any known equipment, procedures, or changes in process, the proposed levels of control.

At such time as the maintenance and protection of the air resource has been established at the level representing the limits of today's technology, aerometric measurements and evaluation of air quality may properly be made. Then decisions can be planned to determine if unacceptable insults to the air resource still exist and what action is needed to get and maintain acceptable air quality for the Region.

* This Preface is a brief explanatory statement describing the principle upon which the levels set by the Regulations are based. It is not to be construed as part of the Regulations; the provisions of the Regulations and the levels set therein are definite and should be consulted for any question of requirement.

REGULATIONS OF THE AIR POLLUTION CONTROL BOARD CITY OF PHILADELPHIA, PENNSYLVANIA

REGULATION II -- AIR CONTAMINANT AND PARTICULATE MATTER EMISSIONS

SECTION IV. VISIBLE EMISSIONS

1. No person shall discharge into the atmosphere from any single source of emission whatsoever any air contaminant, except uncombined water,
   a. for a period or periods aggregating more than three minutes in any one hour which
      (1) is equal to or darker in shade than that designated as No. 1 on the Ringelmann Chart, as published by the U. S. Bureau of Mines, or
      (2) is equal to or darker than a comparable standard using such other charts or devices as the Department determines to be equivalent thereto; or
   b. for any period, which is equal to or darker than No. 3 on the Ringelmann Chart, or its equivalent; or
   c. of such opacity as to obscure an observer's view to an equal or greater degree than either (a) or (b) above;
   d. The provisions of (a) above, do not apply to incinerators. Incinerators are regulated under the provisions of Air Management Regulation XI, Control of Emissions from Incinerators.
2. The provisions of (1) above shall apply to visible emissions of air contaminants that are white, black, shades of grey or colored.
3. Trained employees certified by the Department may make observations to determine compliance with the provisions of (1) and (2) above without direct reference to standards.

SECTION VIII. FUGITIVE DUST

No person shall cause or permit the handling, transporting, storing or disposing of any substance or material which is likely to be scattered by the wind, or is susceptible to being wind-borne, without taking effective precautions or measures to prevent air contamination. No person shall operate or maintain, or allow or cause to be operated or maintained, any premises, open area, right of way, storage piles, or vehicle, or any construction, alterations, demolition, or wrecking operation, or any other enterprises, which involves any material or substance likely to be scattered by the wind, or susceptible to being wind-borne, without effective precautions or measures to prevent air contamination. No person shall maintain, conduct, or use, or cause to be maintained, conducted, or used, any parking lot, or similar areas, unless the lot, area, or roadway is maintained in such manner as to prevent air contamination.

COUNTY OF ALLEGHENY, PENNSYLVANIA, CHAPTER 505 - AIR POLUTION CONTROL

[Selected Excerpts – Complete Document: https://ecode360.com/8481388]

[HISTORY: Adopted by the Board of County Commissioners (now County Council) of Allegheny County effective 2-1-1994; amended in its entirety effective 10-20-1995. Subsequent amendments noted where applicable.]

Article IV. Pollution Emissions Standards

§ 505-30 Visible emissions.

A. General. No person shall operate, or allow to be operated, any source except those specifically excluded by Subsection **B** below in such manner that the opacity of visible emissions from a flue or process fugitive emissions from such source, excluding uncombined water:

(1) Equal or exceed an opacity of 20% for a period or periods aggregating more than three minutes in any sixty-minute period; or

(2) Equal or exceed an opacity of 60% at any time.

B. Exclusions. Subsection **A** above shall not apply to:

(1) Coke ovens or a battery of coke ovens;

(2) Incinerators; or

(3) Visible emissions resulting solely from the cold start of fuel-burning or combustion equipment, if such a cold start has been reported as required by § **505-74D** of this chapter.

C. Alternative standards for fugitive emissions.

(1) With respect to fugitive emissions only, the Department may establish an alternative standard(s) to those standards set forth in Subsection **A** above for a particular source if:

(a) Fugitive emission control equipment has been installed and placed into operation on such source and/or other enforceable fugitive emission control techniques have been implemented on such source;

(b) The Department determines that the control equipment and/or other techniques installed or implemented on such source represent RACT as applied to the particular source involved; and,

(c) The person responsible for such source demonstrates that the fugitive emissions remaining after the application of such control equipment or other techniques are of only minor significance with respect to causing air pollution and do not prevent or interfere with the attainment or maintenance of any ambient air quality standard.

(2) The person responsible for such source shall make written application to the Department and shall, at its own expense, provide all data and other information which is needed by the Department to make the determinations set forth above and to establish an alternative opacity standard(s).

(3) Any alternative standard(s) established pursuant to this subsection shall require the continued operation and/or implementation of that control equipment or other techniques on which the above determinations are based and shall require compliance with an opacity standard which represents the optimum performance of such control equipment and/or other techniques. Any such alternative standard(s) shall apply only to the particular source for which the above determinations were made.

(4) Any alternative standard(s) established pursuant to this subsection shall be proposed as an amendment to this chapter. Upon the adoption of any such amendment, the affected source shall thereafter comply with the alternative standard(s) so established and shall be relieved of the duty to comply with the provisions of Subsection **A** above with respect to fugitive emissions. The Department shall submit any such amendment as a proposed revision to Allegheny County's portion of the SIP.

(5) The failure to comply with any provision of an amendment adopted pursuant to this subsection shall be a violation of this chapter giving rise to the remedies set forth in § **505-79** of this chapter.

D. Measurements. Measurements of visible emissions shall be performed according to the procedures established by § **505-68** of this chapter.

E. Enforcement. Notwithstanding any other provision of this chapter the prohibitions of Subsection **A** of this section may be enforced against the owner or operator of any source at a single-family residence or multiple-dwelling unit of no more than two dwelling units by any municipal or local government unit having jurisdiction over the place where the visible emissions occur. Such enforcement shall be in accordance with the laws governing such municipal or local government unit. In addition, the Department may pursue the remedies provided by § **505-79** of this chapter for any violation of this section.

Article V. Source Emissions and Operating Standards

§ 505-47 Miscellaneous fugitive sources.

A. Permit source premises (see Subsection **I** regarding applicability).

(1) General. No person shall operate, or allow to be operated, any source for which a permit is required by Article **III** of this chapter in such manner that emissions from any open land, roadway, haul road, yard, or other premises located upon the source or from any material being transported within such source or from any source-owned access road, haul road, or parking lot over five parking spaces:

(a) Are visible at or beyond the property line of such source;

(b) Have an opacity of 20% or more for a period or periods aggregating more than three minutes in any sixty-minute period; or

(c) Have an opacity of 60% or more at any time.

(2) Deposition on other premises. Visible emissions from any solid or liquid material which has been deposited by any means

from a source onto any other premises shall be considered emissions from such source within the meaning of Subsection **A(1)** above.

Article VII. Methods

§ 505-68 Visible emissions.

[Amended 2-6-2007 by Ord. No. 4-07[1]]

Measurements of visible emissions shall be performed in either of the following two ways:

A. As specified in Chapter 9 of the Allegheny County Source Testing Manual, entitled "Visible Determination of the Opacity of Emissions from Stationary Sources"; or

B. Using any continuous opacity monitoring system (COMS) required by regulation, permit, consent agreement, consent decree, or enforcement order.

[1]*Editor's Note: This amendment was initially adopted by the County Health Department 11-1-2006.*

Article VIII. Reporting, Testing and Monitoring

§ 505-76 Continuous emissions monitoring.

A. Fossil fuel-fired steam generators. The owner or operator of each fossil fuel-fired steam generator which has a rated capacity greater than 250 million BTU's per hour heat input and which has an annual average capacity factor of greater than 30% shall operate such continuous monitoring instruments as are required by 40 CFR Part 51, Appendix P, and shall comply with such maintenance, calibration, quality assurance and reporting requirements as are specified therein.

D. Reports. Unless otherwise provided under this section or § **505-75** above, the owner or operator of any source which is required to install and operate a continuous emission monitoring system by this section, or by an order or permit condition, shall retain the data collected by such system for a period of two years and shall, upon request, make such data available to the Department for inspection and copying. In addition, such person shall submit to the Department a written report of such data at three month intervals, or such other intervals as is specified by the Department in the applicable order or permit condition. Unless otherwise specified by the Department, such report shall include at a minimum:

(1) An identification of each instance during the reporting period during which emissions exceeded the applicable emission limitations established by this chapter and an identification of the reasons, if known, for such exceedance. The averaging period, if any, used for making such identification shall correspond to the averaging period, if any, specified in the applicable emission limitation established by this chapter.

(2) For opacity measurements, the report shall list the magnitude in actual percent opacity as measured at fifteen-second intervals of all one-minute periods during which opacity equaled or exceeded 20% at any such fifteen-second interval. The report need not include information for periods during which opacity equals or exceeds 20% solely because of a cold start of fuel-burning or combustion equipment, if such cold start has been reported as required by § **505-74** of this chapter. In addition, the report shall list the magnitude in actual percent opacity of any measurement that equals or exceeds sixty-percent opacity.

(3) An identification of each period during which the continuous emission monitoring system was inoperative, except for zero and span drift checks, the reasons therefor, and the nature of repairs or adjustments performed or to be performed.

(4) An identification of calibrations, zero and span drift checks, and other quality assurance procedures.

Allegheny County Health Department, Air Quality Program, Source Testing Manual Monitoring Section (May 5, 2010)

[https://www.alleghenycounty.us/uploadedFiles/Allegheny_Home/Health_Department/Programs/Air_Quality/SourceTestingManual_revMay2010.pdf]

INTRODUCTION

This manual is provided by the Air Quality Program of the Allegheny County Health Department to assist the owners, managers, and operators of regulated sources, consultants, and members of this agency, to understand and comply with the procedures of source sampling.

Specific detail is included to guide source sampling through the required functions of the Air Quality Program. Organizational structures are presented with functional duties outlined to permit all concerned the necessary information as to all sampling responsibilities.

Sampling and analytical procedures likewise cannot always be exactly defined because they will vary with the purposes intended and the circumstances. There are specific procedures included, however, which are adaptable to most sampling requirements.

CHAPTER 9

"VISUAL DETERMINATION OF THE OPACITY OF EMISSIONS FROM STATIONARY SOURCES", United States Environmental Protection Agency, 40 CFR 60 Appendix A (Method 9), as modified by the Allegheny County Air Quality Program (Method 9A)

ALLEGHENY COUNTY METHOD OF DETERMINING VISIBLE EMISSIONS

In determining compliance with the visible emission standards of the Rules and Regulations of the Allegheny County Health

Department, the Following EPA Method 9 shall be used, except that the "averaging" provisions of paragraph 2.5 of Method 9 shall not apply.

Rather than applying the "averaging" provisions of Method 9, each momentary observation that is recorded shall be deemed to represent the opacity of emissions for a 15- second period. Each observation that is recorded to be equal to or greater than 20% opacity shall be counted in determining the hourly aggregated period.

DELAWARE VISIBLE EMISSIONS STATUTES (7 DE Admin. Code)
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF AIR AND WASTE MANAGEMENT
Statutory Authority: 7 Delaware Code, Chapter 60, (7 **Del.C.** Ch. 60)

Air Quality Management Section

1114 Visible Emissions (05/01/2018) [http://regulations.delaware.gov/AdminCode/title7/1000/1100/1114.shtml]

1.0 General Provisions

1.1 The purpose of this regulation is to control the emissions of visible air contaminants from all stationary sources.

1.2 Measurements of air contaminant visibility shall be in accordance with accepted practices of Ringelmann values or opacity percentages.

1.3 The provisions of this regulation shall not apply to the start-up and shutdown of equipment which operates continuously or in an extended steady state when emissions from such equipment during start-up and shutdown are governed by an operation permit issued pursuant to the provisions of 2.0 of 7 **DE Admin. Code** 1102.

2.0 Requirements

No person shall cause or allow the emission of visible air contaminants or smoke from a stationary or mobile source, the shade or appearance of which is greater than 20% opacity for an aggregate of more than three minutes in any one hour or more than 15 minutes in any 24 hour period. For guideline purposes only, Shade Number 1 of the Ringlemann Smoke Chart coincides with the regulatory limit of 20% opacity, when observing black smoke.

3.0 Alternate Opacity Requirements

3.1 Whenever the Secretary determines that a source complies with an applicable mass emission standard and demonstrates that the opacity of the complying emissions is more restrictive than the requirements of 2.0 of this regulation, the Secretary will make an appropriate adjustment to the opacity standard for the affected source.

3.2 Whenever an owner or operator can establish compliance with an applicable mass emission standard and fails to comply with 2.0 of this regulation, the owner or operator may petition the Secretary setting forth the results of the emission testing or evaluation and request the Secretary to make an appropriate adjustment to the opacity standard for the affected source.

3.3 The Secretary may grant such a petition as outlined in 3.2 of this regulation upon a demonstration by the owner or operator that the affected source and associated air pollution control equipment was operated and maintained during the mass emission test in a manner to minimize the opacity of emissions during emission testing or evaluation that the mass emissions testing was performed in accordance with procedures approved by the Department; and that the affected source and associated air pollution control equipment is incapable of continuously meeting applicable opacity standards as set forth in 2.0 of this regulation.

3.4 The Secretary may establish an opacity standard for the affected source at a level at which the source will be able to meet the adjusted opacity standard at all times during which the source is meeting the applicable mass emission rate standard. The Secretary will make the adjusted opacity standard a part of the operating permit in the form of an operating condition.

3.5 Any action by the Secretary pursuant to the provisions of 3.0 of this regulation shall be incorporated in the State Implementation Plan.

4.0 Compliance with Opacity Standards

For purposes of this regulation, compliance with opacity standards shall be in accordance with 1.5.3 of 7 **DE Admin. Code** 1120.

1120 New Source Performance Standards (12/7/1988)
[http://regulations.delaware.gov/AdminCode/title7/1000/1100/1120.shtml]

1.0 General Provisions

1.5 Compliance with Standard and Maintenance Requirements

1.5.1 Compliance with standards in the regulation, other than opacity standards, shall be determined only by performance test established by 1.4 of this regulation.

1.5.2 Compliance with standards in this regulation shall be determined by Reference Methods 1 through 12 and 15 through 25 set forth in Appendix A, 40 CFR Part 60, revised July 1, 1982, which are hereby adopted by reference. Where the person responsible for the applicable source can provide evidence acceptable to the Secretary that the presence of uncombined water is the only reason for failure to meet the opacity standard such failure shall not be a violation of the standard.

1.5.3 Compliance with opacity standards in this regulation shall be determined by conducting observations at consecutive 15-second intervals for a period of not less than one hour except that the observations may be discontinued whenever a violation of the applicable standard is recorded. The results of continuous monitoring by transmissometer which indicate that the opacity at the time visual observations were made was not in excess of the standard are probative but not conclusive evidence of the actual opacity of an emission, provided that the source shall meet the burden of proving that the instrument used meets, at the time of the alleged violation, Performance Specification 1, has been properly maintained and calibrated and that the resulting data have not been tampered with in any way.

The additional procedures, qualifications and testing to be used for visually determining the opacity of emissions shall be those specified in Section 2 and 3 (except for Section 2.5 and the second sentence of Section 2.4) of Reference Method 9 set forth in Appendix A, 40 CFR Part 60, revised July 1, 1982, which are hereby adopted by reference.

1.5.4 The opacity standards set forth in this regulation shall apply at all times including periods of startup and shutdown unless the emissions during startup and shutdown are governed by an operation permit.

1.5.5 At all times, including periods of startup, shutdown, and malfunction, owners and operators shall, to the extent practicable, maintain and operate any applicable source including associated air pollution control equipment in a manner consistent with good air pollution control practice for minimizing emissions. Determination of whether acceptable operating and maintenance procedures are being used will be based on information available to the Secretary which may include, but is not limited to, monitoring results, opacity observations, review of operating and maintenance procedures, and inspection of the source.

1.6 Circumvention. No owner or operator subject to the provisions of 1.0 of this regulation shall build, erect, install, or use any article, machine, equipment or process, the use of which conceals an emission, which would otherwise constitute a violation of an applicable standard. Such concealment includes, but is not limited to, the use of gaseous dilutants to achieve compliance with an opacity standard or with a standard, which is based on the concentration of a pollutant in the gases discharged to the atmosphere.

2.0 Standards of Performance for Fuel Burning Equipment

2.1 Applicability. Except as provided in 9.0 and 11.0 of this regulation, the provisions of 2.0 of this regulation are applicable to any fuel burning equipment of more than 250 million BTU per hour heat input, which is the applicable source. Any change to existing fuel burning equipment to accommodate the use of combustible fuels other than fossil fuels as defined herein shall not bring that equipment under the applicability of 2.0 of this regulation.

2.2 Standard for Particulate Matter. On and after the date on which the initial performance test is completed no person subject to the provisions of 2.0 of this regulation shall discharge or cause the discharge into the atmosphere of particulate matter, which is:

2.2.1 In excess of 0.10 lb. per million BTU heat input (0.18 grams per million calories heat input).

2.2.2 Greater than 20% opacity, except that a maximum of 40% opacity shall be permissible for not more than two minutes in any hour.

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
NEW JERSEY ADMINISTRATIVE CODE TITLE 7, CHAPTER 27B, SUBCHAPTER 2
[Complete Document: http://www.nj.gov/dep/aqm/NJAC%207_27B.doc]

AIR TEST METHOD 2

PROCEDURES FOR VISUAL DETERMINATION OF THE OPACITY (PERCENT) AND SHADE OR APPEARANCE (RINGELMANN NUMBER) OF EMISSIONS FROM SOURCES

New Rule Effective: March 20, 1975. See: 7 N.J.R. 144(a)
Promulgated: April 21, 1976. To be effective: 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 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 (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.

REFERENCE: 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.

Air Quality Permitting Program [New Jersey] Bureau of Technical Services Technical Manual 1005
Guidelines for Continuous Emissions Monitoring Systems (CEMS) and Continuous Opacity Monitoring Systems (COMS)
[Selected Excerpts: -- Complete Document: http://*www.state.nj.us/dep/aqpp/downloads/techman/1005.pdf]*

III. DEFINITIONS

- CEMS (Continuous Emission Monitoring System) - The total equipment required for the determination of a gas concentration or emission rate. The system consists of the following major subsystem sample interface, pollutant analyzer, diluent analyzer (if applicable) and data recorder/acquisitions system.
- COMS (Continuous Opacity Monitoring System) - The total equipment required for the determination of the opacity of emissions which must meet the minimum requirements of Performance Specification One of 40 CFR - Part 60 and 40 CFR Part 51 - Reference Method 203.
- EXCESS EMISSIONS - A period of time during which emissions of a regulated pollutant at a given source exceed the limit in units of the standard as specified in the conditions associated with the applicable permit and/or regulation.
- DOWNTIME - The period of time when the source is producing emissions which are monitored by the CEMS/COMS but the monitors and/or recorders are not providing valid compliance emission data. This includes periods of Quality Assurance (QA) and Preventative Maintenance (PM) procedures, CEMS Calibration (Cal) that exceed 15 minutes in any one hour. (See definitions of Rolling and Block Averaging on Page 2 of the Instructions for Completing the EEMPR).
- SOURCE - The production equipment and/or control equipment attached to and serving the production equipment for which the CEMS/COMS are monitoring emissions data.

IV. MINIMUM SPECIFICATIONS FOR CEMS/COMS

A. Minimum Requirements
The following list of performance requirements may be applicable to any CEMS or COMS required to be installed by one or more regulations identified in Section II.

1. Opacity , 40 CFR - Part 51, Reference Method 203 and; 40 CFR - Part 60 - Appendix B
Performance Specification Test No. 1

APPENDIX B -- Excess Emissions and Monitoring Performance Report (EEMPR) for Continuous Monitoring Systems
REPORTING OPACITY EXCEEDANCES

Reporting Opacity Exceedances for Sources NOT regulated by NJAC 7:27-3 [NOT a marine or mobile source] Provisions in this Technical Manual 1005, concerning "No Visible Emissions (NVE)", supersede any DEP Technical Manual, including Manual #1410, page 9, which may have established NVE to mean anything other than: opacity not greater than 5 percent.

Opacity is required to be measured by a six minute averaging method; an emission exceedance is said to have occurred after the six minute average value exceeds the permit allowable. A continuous opacity exceedance is an incident in which consecutive six minute average readings are greater than the permit allowable. Such an incident should be reported in the form of six minute block averages (i.e., separate line item entries for each six minute average).

Example: A cogeneration plant subject to the opacity provisions in its permit cannot exceed 10% opacity in any 6 minute block period. From 15:03 to 15:33, the six minute average opacity readings from this source were 12%, 20%, 35%, etc.

MARYLAND VISIBLE EMISSIONS STATUTES (COMAR 26.11.10)
.02 Visible Emissions. [http://www.dsd.state.md.us/comar/comarhtml/26/26.11.06.02.htm]

A. General Exceptions.

(1) The visible emission standards set forth in §C of this regulation, do not apply to emissions from the installations or sources listed below:
  (a) The burning of wood in fireplaces;
  (b) Open fires (except salamanders) permitted under provisions of COMAR 26.11.07.03, .04, and .05;
  (c) Fugitive emissions from iron and steel production installations in compliance with COMAR 26.11.10.03B;
  (d) Fugitive emissions from metallurgical, slot-type, byproduct coke ovens in compliance with COMAR 26.11.10.03C;
  (e) Emissions from grain drying and grain-handling installations in compliance with COMAR 26.11.18.03;
  (f) Fugitive emissions from skull cracker oxygen lancing in compliance with COMAR 26.11.10.04C;
  (g) Fugitive emissions from batch-type hot-dip galvanizing installations in compliance with COMAR 26.11.12.04;
  (h) Confined emissions from glass melting furnaces and fugitive emissions from forming and post-forming equipment in compliance with COMAR 26.11.25.03;
  (i) Emissions from food preparation installations subject to COMAR 26.11.18.06;
  (j) Emissions at a federal facility or other facility under contract with a federal facility that result from testing, training, or demonstrations of explosives, obscurant materials, propellants, or other incendiary devices; or

(k) Sources in compliance with Regulation .03C and D of this chapter.

(2) The visible emissions standards in §C of this regulation do not apply to emissions during start-up and process modifications or adjustments, or occasional cleaning of control equipment, if:
(a) The visible emissions are not greater than 40 percent opacity; and
(b) The visible emissions do not occur for more than 6 consecutive minutes in any 60 minute period.

B. Case-by-Case Exception to Visible Emissions Standards.

(1) Except as provided in §B(5) of this regulation, a person who owns or operates an existing installation subject to a visible emissions standard in §C of this regulation may request an exception. The request shall be submitted to the Department in writing and shall include the following:
(a) A description of the installation and all associated air pollution control devices;
(b) Process information, including operating parameters and the substances that cause or the substances that are suspected of causing the visible emissions;
(c) A demonstration, based on stack tests, a material balance, or other method of equivalent certainty that all other applicable regulations are met when the visible emissions occur;
(d) An analysis of any methods that may be available to reduce the visible emissions, the cost effectiveness of the methods, and the economic burden that would result from the use of these methods; and
(e) Any other information requested by the Department and relating to its determination to grant or deny an exception.

(2) The application for an exception to a visible emissions standard will be processed as follows:
(a) Within 10 working days, the Department will acknowledge receipt of an application for an exception to a visible emissions standard.
(b) Within 60 days after receipt of a completed application, the Department shall notify the applicant of its intent to proceed with the application or deny the request. The Department will make a determination to proceed if the conditions in §B(2)(c)(i)—(iii) and (d) of this regulation are met.
(c) Conditions.
(i) The applicant has provided an adequate demonstration that the installation for which a visible emissions exception is requested meets all other applicable air pollution control requirements within this subtitle when the visible emissions occur.
(ii) The applicant has demonstrated to the satisfaction of the Department that complying with the applicable visible Emission standard would cause an unreasonable economic burden.
(iii) The applicant has demonstrated to the satisfaction of the Department that the applicant has sufficient control of the installation to be capable of meeting an alternative visible emission limit established by the Department.
(d) Test Methods. A person shall demonstrate compliance with all other applicable regulations, as required by §B(1)(c) of this regulation, through the use of:
(i) Applicable federally approved test methods in the Department's TM 91-01 "Test Methods and Equipment Specifications for Stationary Sources", which is incorporated by reference in COMAR 26.11.01.04C; or
(ii) Other compliance methods required under this subtitle that are federally enforceable.
(e) Test Methods for Visible Emissions. Compliance with any visible emissions or opacity standard in this subtitle, including any alternative opacity standard established pursuant to this section, shall be determined using applicable federally approved test methods in the Department's TM 91-01 "Test Methods and Equipment Specification for Stationary Sources", which is incorporated by reference in COMAR 26.11.01.04C, or any other applicable federally approved test method.

(3) Opportunity for Public Comment.
(a) Within 10 days after notification by the Department of a determination to proceed, the applicant shall notify the public, by local notice and by prominent advertisement in at least one newspaper of general circulation in the region where the applicant's source is located, of the opportunity to comment on the application.
(b) The advertisement shall be made at the applicant's expense and in a format approved by the Department, and shall include a summary of all the information in the application that was considered by the Department.

(4) Final Action on a Request for an Application.
(a) The Department will make a final determination on the application after considering any public comments.
(b) If an exception is granted, the Department will issue an order which establishes an alternative opacity standard applicable to the installation receiving the exception. The order may also include any conditions or requirements determined by the Department to be necessary to insure continuous compliance with the alternative standard.
(c) Exceptions may not be granted for a period of more than 5 years and may be renewed. In requesting a renewal of a visible emissions exception, the applicant shall submit an application and satisfy all the requirements in this regulation that relate to an initial exception request, including the opportunity for public comment required in §B(3) of this regulation.

(5) The Department or control officer may bypass the procedure above and may grant exceptions to visible emission requirements if the:

(a) Application of a visible emission requirement to a residential building housing two or fewer families creates undue economic hardship on individuals residing in it; or
(b) Equipment's primary way of transferring heat is by the radiant method rather than a piped fluid system such as forced hot air, hot water, or steam. Equipment in this category would include stoves, room heaters, floor or wall-mounted circulating heaters, or similar devices.

C. Visible Emission Standards.

(1) In Areas I, II, V, and VI a person may not cause or permit the discharge of emissions from any installation or building, other than water in an uncombined form, which is greater than 20 percent opacity.
(2) In Areas III and IV a person may not cause or permit the discharge of emissions from any installation or building, other than water in an uncombined form, which is visible to human observers.

.03 Delineation of Areas. [http://www.dsd.state.md.us/comar/comarhtml/26/26.11.01.03.htm]

A. Area I means the western area of the State comprising the counties of Allegany, Garrett, and Washington.
B. Area II means the central area of the State composed of Frederick County.
C. Area III means the Baltimore metropolitan area of the State comprising Baltimore City and the counties of Anne Arundel, Baltimore, Carroll, Harford, and Howard.
D. Area IV means the Washington metropolitan area of the State comprising the counties of Montgomery and Prince George's.
E. Area V means the southern area of the State comprising the counties of Calvert, Charles, and St. Mary's.
F. Area VI means the eastern shore area of the State comprising the counties of Caroline, Cecil, Dorchester, Kent, Queen Anne's, Somerset, Talbot, Wicomico, and Worcester.

NEW YORK VISIBLE EMISSIONS STATUTES (6 NYCRR)
Department of Environmental Conservation – Division of Air Resources -- The Bureau of Stationary Sources

Subpart 227-1 Stationary Combustion Installations
[Selected Excerpts – Complete Document: https://www.dec.ny.gov/regs/2492.html]

§227-1.3 Opacity

(a) No person shall operate a stationary combustion installation which exhibits greater than 20 percent opacity (six minute average), except for one six-minute period per hour of not more than 27 percent opacity.
(b) Compliance with the opacity standard may be determined by:
  (1) conducting observations in accordance with Reference Method 9;
  (2) evaluating Continuous Opacity Monitoring System (COMS) records and reports; and/or
  (3) considering any other credible evidence.
(c) Upon written application by a source owner, the commissioner may accept an equivalent opacity standard less stringent than the opacity standard of subdivision (a) of this section for a stationary combustion installation with a maximum operating heat input greater than 50 million Btu per hour, if such source owner can demonstrate through acceptable emission tests for such stationary combustion installation that it is in compliance with all applicable emission standards other than the opacity standard and that the source and any associated emission control equipment is operated and maintained in a manner acceptable to the commissioner. Any stationary combustion installation to be eligible for an equivalent opacity standard must have applied Best Available Control Technology (BACT) as determined by the commissioner. Any equivalent opacity standard granted by the commissioner shall be submitted to the USEPA for approval as a SIP revision. The owner or operator of a source for which an equivalent opacity standard has been accepted shall not cause or allow emissions to exceed the equivalent opacity.

§227-1.4 Stack monitoring

(a) Any person who owns a stationary combustion installation (excluding gas turbines), with a total maximum heat input capacity exceeding 250 million Btu per hour shall install, operate in accordance with manufacturer's instructions, and properly maintain, accurate instruments satisfying the criteria in appendix B of title 40, part 60 of the *Code of Federal Regulations*, or approved by the commissioner on an individual case basis, for continuously monitoring and recording opacity, and when sulfur dioxide continuous monitoring is required by Part 225 of this Title for continuously monitoring and recording either the percent oxygen or carbon dioxide in the flue gases from such installations at all times that the combustion installation is in service. Where gas is the only fuel burned, monitoring and recording of opacity is not required.
(b) Each owner or operator required to operate a Continuous Opacity Monitoring System (COMS) in accordance with subdivision (a) of this section shall submit an accurate excess emissions and monitoring system performance report to the department for each calendar year quarter. All reports shall be certified by a responsible corporate official as true, accurate and complete and postmarked by the 60th day following the end of each calendar quarter. The quarterly excess emissions report shall be submitted in a form acceptable to the department and shall include the following minimum information:
  (1) the magnitude, date and time of each six minute block average during which the average opacity of emissions exceeds 20 percent, except for one six minute block average per hour not to exceed 27 percent;

(2) for each period of excess emission, specific identification of the cause and corrective action taken;
(3) identification of all periods of COMS downtime, including the date, time and duration of each inoperable period, and the cause and corrective action for each COMS downtime period;
(4) the total time in which the COMS are required to record data during the reporting period;
(5) the total number of exceedences and the duration of exceedences expressed as a percentage of the total time in which the COMS are required to record data; and
(6) such other things as the department may deem necessary, proper or desirable in order to enforce article 19 of the Environmental Conservation Law or the rules promulgated thereunder.

(c) If the sum of the maximum heat input capacity of all furnaces, which are operated simultaneously and are connected to a common air cleaning device and/or a common stack exceeds 250 million Btu per hour maximum heat input capacity, stack monitoring shall be required for such combustion installation in accordance with this section. The continuous stack monitoring and reporting requirements of this section as they may pertain to existing stationary combustion installations shall apply within one year after the effective date of this section, or by such later date as determined by an order of the commissioner.

(d) Upon written application by a source owner, the commissioner may except a source owner or operator from the provisions of this section and set forth alternative stack monitoring and reporting requirements if the source owner can demonstrate that:
(1) commercially available continuous stack monitoring systems would not provide accurate determinations of readings;
(2) the installation of a continuous stack monitoring system would impose an extreme economic burden on the source owner;
(3) existing stack monitoring equipment which does not conform to the criteria in appendix B of title 40, part 60 of the *Code of Federal Regulations* provides accurate and reliable data; or
(4) a continuous stack monitoring system cannot be installed due to physical limitations.

OHIO VISIBLE EMISSIONS STATUTES – OHIO ENVIRONMENTAL PROTECTION AGENCY
Ohio Administrative Code (OAC)

3745-17-07 Control of visible particulate emissions from stationary sources.
[Selected Excerpts – Entire Document: http://codes.ohio.gov/oac/3745-17-07]

(A) Visible particulate emission limitations for stack emissions:
(1) General limitations:
(a) Except as otherwise specified in paragraphs (A)(1)(b), (A)(2) and (A)(3) of this rule, visible particulate emissions from any stack shall not exceed twenty per cent opacity, as a six-minute average.
(b) Except as otherwise specified in paragraphs (A)(2) and (A)(3) of this rule, visible particulate emissions from any stack may exceed twenty per cent opacity, as a six-minute average, for not more than six consecutive minutes in any sixty minutes, but shall not exceed sixty per cent opacity, as a six-minute average, at any time.
(2) It shall be deemed not to be a violation of this rule where the presence of uncombined water is the only reason for failure of a stack emission to meet the requirements of this rule.
(3) The visible particulate emission limitations established in paragraph (A)(1) of this rule shall not apply to the following:
(a) The start-up of the following fuel burning equipment:
(b) The shutdown of the following fuel burning equipment:
(c) The malfunction of any air contaminant source or the malfunction/shutdown of air pollution control equipment associated with any air contaminant source, if the owner or operator of said air contaminant source or air pollution control equipment complies with the requirements of rule 3745-15-06 of the Administrative Code and none of the conditions listed in paragraph (C) of rule 3745-15-06 of the Administrative Code exists.
(d) Intermittent soot-blowing operations (the cleaning of heat transfer surfaces with pressurized air or steam) for fuel burning equipment which are uncontrolled or which are equipped solely with mechanical collectors (including mechanical collectors which are equipped with sidestream separators or similar devices) for the control of particulate emissions, provided that the owner or operator of such fuel burning equipment maintains a daily record which clearly documents the date, beginning time and ending time for all intermittent soot-blowing operations.
(f) Intermittent ash removal operations (the dumping or pulling of ash) for fuel burning equipment which are uncontrolled or which are equipped solely with mechanical collectors (including mechanical collectors which are equipped with sidestream separators or similar devices) for the control of particulate emissions, provided that the owner or operator of such fuel burning equipment maintains a daily record which clearly documents the date, beginning time and ending time for all intermittent ash removal operations.

(B) Visible particulate emission limitations for fugitive dust:
(1) Except as provided in paragraphs (B)(2) to (B)(11) of this rule, visible particulate emissions from any fugitive dust source shall not exceed twenty per cent opacity as a three-minute average.
(3) Except as provided in paragraph (B)(11) of this rule, visible particulate emissions of fugitive dust from electric arc furnace shop roof monitors, argon-oxygen decarburization shop roof monitors, blast furnace casthouses and sintering

operations shall not exceed twenty per cent opacity as a six-minute average.

(4) Except as provided in paragraphs (B)(7), (B)(8), and (B)(11) of this rule, there shall be no visible particulate emissions from any paved roadway or parking area except for a period of time not to exceed six minutes during any sixty-minute observation period, as determined in accordance with paragraph (B)(4) of rule 3745-17-03 of the Administrative Code.

(5) Except as provided in paragraphs (B)(7), (B)(8), and (B)(11) of this rule, there shall be no visible particulate emissions from any unpaved roadway or parking area except for a period of time not to exceed thirteen minutes during any sixty-minute observation period, as determined in accordance with paragraph (B)(4) of rule 3745-17-03 of the Administrative Code.

(6) Except as provided in paragraphs (B)(7) to (B)(11) of this rule, there shall be no visible particulate emissions from any material storage pile except for a period of time not to exceed thirteen minutes during any sixty-minute observation period, as determined in accordance with paragraph (B)(4) of rule 3745-17-03 of the Administrative Code.

Ohio EPA Division of Air Pollution Control. Engineering Guide #73

[http://www.epa.state.oh.us/portals/27/engineer/eguides/guide73.pdf]

Questions and Answers:

When should the field office inspectors take visible emission observations? How frequently should these readings be taken?

In general, during compliance monitoring inspections, field office inspectors should conduct visible emissions observations in accordance with Methods 9 or 22 of 40 CFR, Part 60, Appendix A for all non-insignificant and non-registration status emissions units subject to visible emission or opacity limitations. Therefore, the frequency of visible emissions observations coincides with the frequency of facility inspections. This is a minimum frequency. Additional visible emission observations may be taken as a result of a complaint response or surveillance project.

How long must the inspector take the visible emission observations?

In general, Method 9 readings should be taken for *at least* twice as long as the averaging period. For a six-minute average this is 12 minutes. For a three-minute average this is 6 minutes. This generality is meant for determinations of ongoing compliance only. Initial, one-time compliance demonstrations may be required by rule or regulation with specific, required observation periods (e.g., Subpart OOO requires 1 to 3 hours of readings for initial compliance). Initial compliance demonstrations are the responsibility of the facility to perform or have performed.

Method 22 requires that observations occur for one hour plus two mandatory breaks. This can be quite time consuming. Therefore, if after one half hour of readings it doesn't appear that a violation will occur, the field office inspector may consider the half hour of readings sufficient for purposes of compliance monitoring.

What information should be included in the form to ensure that the observations will hold up in an enforcement situation?

Method 9 contains a form for recording observations. All the information on the form should be completed. Instead of leaving a section blank, explain why the information is not present (i.e., unavailable, unknown, etc.). Particular care should be taken to make sure that the observer's position with respect to the sun and compass orientation are clearly documented. It is also important to make sure that the observation conditions do not adversely affect the efficacy of the visible emissions observations. Do not attempt to make observations through glass or any other transparent medium (with the exception of tinted personal glasses used during certification) and do not make observations when the atmospheric visibility is significantly reduced (e.g., 1/4 mile in haze).

When is it acceptable to forgo visible emissions observations for an emissions unit during an inspection?

A field inspector may forgo visual emissions observations under any of the following circumstances:

- The emissions unit is an insignificant or registration status emissions unit. (Each field office may use its discretion in deciding whether to perform readings. Possible reasons for performing readings include (a) an expectation of the presence of visible emissions and (b) visible emission requirements in a PTI or applicable rule.)
- An existing emissions unit is located in an area of the facility where buildings or other obstructions do not allow for proper positioning to take Method 9 readings. It is assumed that new installations will not be constructed with obstructions that will prohibit the proper positioning to take Method 9 readings.
- The emissions unit is "inherently clean" (assumes no complaints or other credible evidence such as videos or photographs that show problems); or the emissions unit is well-controlled, has a very low mass emission rate, and no visible emissions have been observed during past inspections. In these cases, the inspector should simply check for the presence or absence of visible emissions during the inspection. However, if visible emissions are present, visible emissions observations should be performed.
- Facility personnel certified in Method 9 have already conducted observations and the forms have been reviewed.
- The facility has hired outside consultants certified in Method 9 to perform the observations and the forms have been reviewed.
- The emissions unit is equipped with a certified, continuous opacity monitoring system.

- For units venting inside of a building, the inspector should observe the unit operating inside the building and if no visible emissions are noted, the inspector can forgo Method 9 readings. However, if visible emissions are noted inside of the building, the inspector should perform Method 9 or Method 22 readings, whichever is applicable, at the nearest building egress point.

A field inspector may forgo visual emissions observations under any of the following circumstances during an inspection; however, **follow-up readings are necessary**:

- Weather conditions or sun position prohibit readings at the time of the inspection.
- The inspection occurred at night.
- The emissions unit is not operating at the time of the inspection.
- The inspector is not certified to perform Method 9 readings.
- Safety issues prohibit Method 9 observations at the time of inspection.

When is it appropriate to use Method 9 and Method 22?

Method 9 is used to determine compliance for any limit involving opacity. This method is used for stack or fugitive emissions depending on the applicable emission limit.

Method 22 is used to determine compliance for any limit of "no visible emissions" or any limit allowing a maximum length of time of visible particulate emissions during a specified observation period, usually 1 hour. This method is used predominantly for roadways and storage piles due to the respective limits within OAC [Ohio Administrative Code] rule 3745-17-07(B)(4) through (B)(6). It is also used for other fugitive or stack sources, if required, to determine compliance with a BAT [Best Available Technology] limit or a federal regulation.

Roadways and storage piles are the only fugitive dust sources regulated under OAC Chapter 3745-1 that are subject to a Method 22-based limit from this Chapter. No other fugitive dust source is subject to a limit based upon Method 22 from Chapter 3745-17 [with the exception of facilities with site-specific emission limits such as in OAC rule 3745-17-07(B)(7) for some power plant facilities, OAC rule 3745-17-12 for facilities in Cuyahoga County, or OAC rule 3745-17-13 for facilities in Jefferson County]. However, opacity limits for roadways and storage piles have been established as part of BAT and for specific facilities listed by name in OAC Chapter 3745-17; and Method 9 is the method for determining compliance in such cases.

"No visible emissions" is a limit where compliance must be determined using Method 22. Compliance for a 0% opacity limit must be determined using Method 9. A 0% opacity limit is actually less stringent than a "no visible emissions" limit. When determining compliance with 0% opacity, a couple of readings higher than zero may occur, but as a six-minute average the result may be less than 0.5% (i.e., two readings of 5% would result in 0.4% opacity, as a six-minute average). This would round down to 0% and no violation would have occurred.

When is data reduction other than six-minute averaging used?

The limits must be treated as six-minute averages unless otherwise stated. Method 9 is written to include data reductions using a six-minute averaging procedure. OAC rule 3745-17-07(B)(1) specifies a 20% opacity limit, as a three-minute average, for fugitive emissions. A provision in OAC rule 3745-17-03(B)(3) allows for this by providing the alternative method of data reduction using 12 consecutive 15-second readings, as a three-minute average, for fugitive emissions rather than 24 consecutive 15-second readings, as a six-minute average, for stack emissions.

How is a Method 22 observation properly performed using the modifications to the Method in OAC Chapter 3745-17?

OAC rule 3745-17-03(B)(4) provides for modifications to Method 22 when determining compliance with 3745-17-07(B)(4) through (6). When performing a Method 22 observation, care must be taken to do the following or the readings are not satisfactory to determine compliance:

- Take 5 to 10-minute breaks every 15 to 20 minutes of readings as outlined in the method. The time taken for breaks does not count toward the total observation period (usually 1 hour).
- Observe roadway dust at one single point, which cannot be changed during the observation. This point must be at a height of approximately 4 feet above the ground as specified in OAC rule 3745-17-03(B)(4).
- Do not observe more than one emissions source or egress at a time using Method 22.
- It may not be necessary to take a full hour of readings if the limit is exceeded before you reach a full hour. In other words, if the facility is allowed 13 minutes of visible particulate emissions in any 60-minute observation period, when you get to 14 minutes of recorded visible emissions readings during an observation period of less than one hour, you can stop. However, it would be advisable to continue for the hour in case a math error has occurred or to demonstrate by how much the source has exceeded the standard.

TF/ April 27, 2005

WEST VIRGINIA – DEPARTMENT OF ENVIRONMENTAL PROTECTION – DIVISION OF AIR QUALITY

TITLE 45 LEGISLATIVE RULE DIVISION OF ENVIRONMENTAL PROTECTION OFFICE OF AIR QUALITY

SERIES 2 TO PREVENT AND CONTROL PARTICULATE AIR POLLUTION FROM COMBUSTION OF FUEL IN INDIRECT HEAT EXCHANGERS [https://dep.wv.gov/daq/planning/Documents/45-02.pdf]

§45-2-1. General.

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

§45-2-3. Visible Emissions of Smoke And/Or Particulate Matter Prohibited And Standards of Measurement.

3.1. No person shall cause, suffer, allow or permit emission of smoke and/or particulate matter into the open air from any fuel burning unit which is greater than ten (10) percent opacity based on a six minute block average.

3.2. Compliance with the visible emission requirements of subsection 3.1 shall be determined in accordance with 40 CFR Part 60, Appendix A, Method 9 or by using measurements from continuous opacity monitoring systems approved by the Director. The Director may require the installation, calibration, maintenance and operation of continuous opacity monitoring systems and may establish policies for the evaluation of continuous opacity monitoring results and the determination of compliance with the visible emission requirements of subsection 3.1. Continuous opacity monitors shall not be required on fuel burning units which employ wet scrubbing systems for emission control.

3.3. If the owner or operator of a fuel burning unit can demonstrate to the satisfaction of the Director that compliance with subsection 3.1 cannot practically be achieved with respect to soot blowing operations or during the cleaning of a fire box, the Director may formally approve an alternative visible emission standard applicable to the fuel burning unit for soot blowing periods; provided that the exception period shall not exceed a total of six (6) six minute time periods in a calendar day with visible emissions limited to thirty percent (30%) opacity, as determined in accordance with 40 CFR Part 60, Appendix A, Method 9, or by using measurements from a certified continuous opacity monitoring system.

3.4. The Director may approve an alternative visible emission standard to that required under subsection 3.1, not to exceed twenty (20) percent opacity, upon the filing of a written petition by the owner or operator, which petition shall include a demonstration satisfactory to the Director:

3.4.a. That it is technologically or economically infeasible to comply with subsection 3.1;

3.4.b. That emissions from the fuel burning unit for which an alternative visible emission standard is proposed impact no area in which the National Ambient Air Quality Standards for particulate matter are being exceeded nor will any such emissions cause or contribute to a violation of the National Ambient Air Quality Standards for particulate matter in an area which currently meets such standards;

3.4.c. That the particulate weight emission standards under section 4 of this rule are being met, as determined in accordance with the Appendix to this rule -- "Compliance Test Procedures for 45CSR2";

3.4.d. That the fuel burning unit for which an alternative visible emission standard is proposed is at all times operated and maintained in accordance with the provisions of subsection 9.2;

3.4.e. That the fuel burning unit for which an alternative visible emission standard is proposed and its associated air pollution control equipment are incapable of being adjusted or operated at normal operating loads to meet the applicable visible emission standard;

3.4.f. That the owner or operator will install, calibrate, maintain and operate a continuous opacity monitoring system approved by the Director, for the fuel burning unit for which an alternative visible emission standard is proposed, and will submit the results of such monitoring system to the Director on a calendar monthly basis in a format approved by the Director, provided that this provision shall not apply to fuel burning units which employ wet scrubbing systems for emission control; and

3.4.g. That all other requirements of law and rules enforced by the Director will be met.

§45-2-8. Testing, Monitoring, Recordkeeping and Reporting.

8.1. Testing.

8.1.a. The owner or operator of a fuel burning unit(s) shall demonstrate compliance with section 3 by periodic testing in accordance with 40 CFR Part 60, Appendix A, Method 9, or a certified continuous opacity monitoring system, as approved by the Director, and section 4 by periodic particulate matter stack testing, conducted in accordance with the appropriate test method set forth in the Appendix to this rule or other equivalent EPA approved method approved by the Director. The owner or operator shall conduct such testing at a frequency to be established by the Director.

8.2. Monitoring.

8.2.a. The owner or operator of a fuel burning unit(s) shall monitor compliance with section 3 as set forth in an approved monitoring plan for each emission unit. Such monitoring plan(s) shall include, but not be limited to, one or more of the following: continuous measurement of emissions, monitoring of emission control equipment, periodic parametric monitoring, or such other monitoring as approved by the Director. 8.2.a.1. Direct measurement with a certified continuous opacity monitoring system (COMS) shall be deemed to satisfy the requirements for a monitoring plan. Such COMS shall be installed, calibrated, operated

and maintained as specified in 40 CFR Part 60, Appendix B, Performance Specification 1 (PS1). COMS meeting the requirements of 40 CFR Part 75 (Acid Rain) will be deemed to have satisfied the requirements of PS1.
8.4. Exceptions.
8.4.a. The owner or operator of a fuel burning unit(s) may petition for alternatives to testing, monitoring and reporting requirements prescribed pursuant to this rule for conditions, including, but not limited to, the following:
8.4.a.1. Infrequent use of a fuel burning unit(s).
8.4.a.2. Continuous emission measurement equipment that does not meet the design requirements of 40 CFR Part 60, Appendix B, Performance Specification 1 (PS1) or 40 CFR 75 (Acid Rain), where it can be adequately demonstrated that there is a definite and consistent relationship between its measurement and the measurements of opacity by a system complying with PS1. The Director may require that such demonstration be performed for each fuel burning unit.

§45-2-9. Start-ups, Shutdowns and Malfunctions.

9.1. The visible emission standards set forth in section 3 shall apply at all times except in periods of start-ups, shutdowns and malfunctions. Where the Director believes that start-ups and shutdowns are excessive in duration and/or frequency, the Director may require an owner or operator to provide a written report demonstrating that such frequent start-ups and shutdowns are necessary.
9.2. At all times, including periods of start-ups, shutdowns and malfunctions, owners and operators shall, to the extent practicable, maintain and operate any fuel burning unit(s) including associated air pollution control equipment in a manner consistent with good air pollution control practice for minimizing emissions. Determination of whether acceptable operating and maintenance procedures are being used will be based on information available to the Director which may include, but is not limited to, monitoring results, visible emission observations, review of operating and maintenance procedures and inspection of the source.
9.3. The owner or operator of a fuel burning unit(s) subject to this rule shall report to the Director any malfunction of such unit or its air pollution control equipment which results in any excess particulate matter emission rate or excess opacity (i.e., emissions exceeding the standards in section 3 and 4) as provided in one of the following subdivisions: 9.3.a. Excess opacity periods meeting the following conditions may be reported on a quarterly basis unless otherwise required by the Director:
9.3.a.1. The excess opacity period does not exceed thirty (30) minutes within any 24- hour period; and
9.3.a.2. Excess opacity does not exceed 40%.
9.3.b. The owner or operator shall report to the Director any malfunction resulting in excess particulate matter or excess opacity, not meeting the criteria set forth in subdivision 9.3.a, by telephone, telefax, or e-mail by the end of the next business day after becoming aware of such condition. The owner or operator shall file a certified written report concerning the malfunction with the Director within thirty (30) days providing the following information:
9.3.b.1. A detailed explanation of the factors involved or causes of the malfunction;
9.3.b.2. The date and time of duration (with starting and ending times) of the period of excess emissions;
9.3.b.3. An estimate of the mass of excess emissions discharged during the malfunction period;
9.3.b.4. The maximum opacity measured or observed during the malfunction;
9.3.b.5. Immediate remedial actions taken at the time of the malfunction to correct or mitigate the effects of the malfunction; and
9.3.b.6. A detailed explanation of the corrective measures or program that will be implemented to prevent a recurrence of the malfunction and a schedule for such implementation.
9.4. A malfunction, as defined under this rule, constitutes an affirmative defense to an action brought for noncompliance with the weight emission standards under section 4 if the owner or operator demonstrates to the satisfaction of the Director that the requirements of subsections 9.2 and 9.3 have been met.
9.5. In any enforcement proceeding, the owner or operator seeking to establish the occurrence of a malfunction has the burden of proof.

§45-2-10. Variances.

10.1. In the event of an unavoidable shortage of fuel having characteristics or specifications necessary for a fuel burning unit to comply with the visible emission standards set forth in section 3 or any emergency situation or condition creating a threat to public safety or welfare, the Director may grant an exception to the otherwise applicable visible emission standards for a period not to exceed fifteen (15) days, provided that visible emissions during the exception period do not exceed a maximum six (6) minute average of thirty (30) percent and that a reasonable demonstration is made by the owner or operator that the emission standards under section 4 will not be exceeded during the exemption period.
10.2. In the event a fuel burning unit employing a flue gas desulphurization system must by-pass such system because of necessary planned or unplanned maintenance, visible emissions may not exceed twenty percent (20%) opacity during such period of maintenance. The Director may require advance notice of necessary planned maintenance, including a description of the necessity of the maintenance activity and its expected duration and may limit the duration of the variance or the amount of the excess opacity exception herein allowed. The Director shall be notified of unplanned maintenance and may limit the duration of the variance or the amount of excess opacity exception allowed during unplanned maintenance.

§45-2-11. Exemptions.

11.1. Any fuel burning unit(s) having a heat input under ten (10) million B.T.U.'s per hour will be exempt from sections 4, 5, 6, 8 and 9. However, failure to attain acceptable air quality in parts of some urban areas may require the mandatory control of these sources at a later date.

EXAMPLE OF VISIBLE EMISSIONS LIMITATIONS IN A WEST VIRGINIA PERMIT: Permit to Construct an Electrical Power Generation Facility

[Complete File: https://epa.ohio.gov/portals/27/transfer/ptiApplication/amp/mact/5%20-%202004%20March-Longview.pdf*]*

Name of Facility: Longview Power Effective Date of Permit: March 2, 2004
Type of Facility or Modification: Construction of 6,114 MMBtu/hr pulverized coal fired boiler, which is capable of generating 600 MW of electricity.

A. SPECIFIC REQUIREMENTS

29. Visible emissions from the PC Boiler shall not exceed 10% opacity on a 6-minute averaging period.
34. The following conditions and requirements are specific to the coal handling operations:
    c. Visible emissions from the coal crushers, conveying equipment and coal storage silos shall not exceed 20% opacity on a 6-minute averaging period.
        i. The permittee shall conduct periodic compliance testing on a monthly basis in accordance with U.S. EPA Method 22 for the purpose of determining visible emissions from the coal crushers, conveying equipment and coal storage silos. Should the results of a periodic compliance test reveal that visible emissions are being emitted; the permittee has 24-hours from conducting Method 22 to conduct a Method 9 test to determine compliance with the emission limit in A.34.c of this permit.
35. The following conditions and requirements are specific to the limestone handling operations:
    e. The limestone day silo (SL-11) shall be enclosed and vent to a dust collector (EL-11).
        iii. Visible emissions from emission point EL-11 shall not exceed 7% opacity on a six-minute averaging period.
        v. The permittee shall conduct periodic compliance testing on a monthly basis in accordance with U.S. EPA Method 22 for the purpose of determining visible emissions from emission point EL-11. Should the results of a periodic compliance test reveal that visible emissions are being emitted; the permittee has 24-hours from conducting Method 22 to conduct a Method 9 test to determine compliance with the emission limit in A.35.e.iii of this permit.
37. Fugitive dust control measures as proposed in Permit Applications R14-0024 shall be installed, maintained, and operated in such a manner as to minimize dust generation and atmospheric entrainment pursuant to Section 5 of 45 CSR 2. Such measures shall include, but not be limited to, the following:
    a. Water spray systems for the purpose of fugitive particulate dust control shall be designed, installed, operated, and maintained so as to minimize the generation of fugitive particulate emissions from the wind erosion of stockpiles. A properly designed, installed, and maintained winterization system on each of the water spray systems shall be in place so to functionally maintain all fugitive particulate dust control during periods when ambient temperature falls to or below 32 degrees Fahrenheit.
    b. The permittee shall maintain a fixed water spray system and/or a water truck on site at the facility and in good operating condition, and shall utilize same to apply water, or a mixture of water and an environmentally acceptable dust control additive, hereinafter referred to as solution, as often as is necessary in order to minimize the atmospheric entrainment of fugitive particulate emissions that may be generated from haul roads and other work areas where mobile equipment is used. The spray bar shall be equipped with commercially available spray nozzles, of sufficient size and number, so as to provide adequate coverage to the surface being treated. The pump delivering the water, or solution shall be of sufficient size and capacity so as to be capable of delivering to the spray nozzle(s) an adequate quantity of water, or solution, and at a sufficient pressure.
    c. The permittee shall maintain and operated as need to minimize fugitive particulate matter from haul roads a street sweeper or other mobile equipment designed to remove debris (road dust) from paved plant roads. This activity shall be conducted daily to minimize fugitive particulate matter from paved plant roadways.
    d. All belt conveyors shall be at a minimum partially enclosed.

West Virginia's Use of EPA Guidance on Periodic Monitoring for Opacity

As illustrated by the example above**, West Virginia** has applied a tiered system of determining visible emissions compliance that allows for initial screening with a less rigorous technique followed by additional measurement using a more rigorous technique when warranted. The tiered techniques are described by EPA REGION 7 POLICY ON PERIODIC MONITORING FOR OPACITY (see below) and are referenced by West Virginia through incorporation of the EPA document in the West Virginia compliance guidance: TITLE 45 INTERPRETIVE RULE DIVISION OF ENVIRONMENTAL PROTECTION OFFICE OF AIR QUALITY SERIES 2A TESTING, MONITORING, RECORDKEEPING AND REPORTING REQUIREMENTS UNDER 45CSR2 [http://www.dep.wv.gov/daq/planning/Documents/45-02a.pdf]

EPA REGION 7 POLICY ON PERIODIC MONITORING FOR OPACITY – April 18, 1997

[https://www.epa.gov/sites/production/files/2015-08/documents/opacity.pdf]

Purpose and Scope

The purpose of this document is to provide guidance to permitting agencies and sources in EPA Region 7 on selecting appropriate periodic opacity monitoring for Title V sources which are subject to an opacity requirement. This policy is intended to encourage consistent application of the periodic monitoring requirements of 40 CFR §70.6(a)(3) and corresponding requirements of permitting agencies. Failure by a permitting agency to consider the policy and to document periodic monitoring in the permits' public record may result in an EPA objection to the permit.

Initial Compliance Certification for Opacity

Part 70 requires that the Title V permit application include an initial compliance certification. It is anticipated that any Title V application not yet submitted as of the date of this guidance will include whatever information is available to document the source's compliance with any generic opacity standard at the time of submission, including the results of any annual state or local agency inspection.

Ongoing Compliance Certification for Opacity

General Principles

- Opacity limitations apply during all periods of source operation, except for certain time periods due to startup, shutdown, or malfunction as specified by rule.
- Once-a-year or other infrequent inspections by a state or local agency do not satisfy the requirements for ongoing periodic monitoring of opacity. Periodic monitoring is a source responsibility.
- A source has an obligation to certify, at least once per year or more often as required by the permit authority, whether compliance with the applicable opacity standard was continuous or intermittent. Implicit in this obligation is that the source has collected data throughout the compliance period for which they can then rely on when making the certification.
- To the extent possible, a source should use the appropriate reference method to verify compliance with opacity limits. However, Reference Method 9 and continuous opacity monitors (COMS) are not a practical solution for all situations.
- Routine source surveillance, along with record keeping and reporting of the results of the surveillance should provide some assurance that sources are meeting their visible emissions requirements. This daily, routine operation and maintenance practice results in more environmental benefit than less frequent, "official" compliance determinations.
- It is not practical for a state or local agency to inspect every facility on a frequency that provides meaningful assurance that they are meeting their visible emission requirements on a continuous basis. To minimize any doubts, the permit authority should require the source to certify at least annually -- or more frequently -- that they conducted a visible emissions survey each day the plant operated and that they were in compliance with, or in violation of, with the applicable opacity requirements. Public complaints and department inspections should also help to verify the validity of source observations.

General Strategy

Even though preferred, COMS or Method 9 readings may not be appropriate for every situation. For example, COMS or Method 9 readings on clean gas-fired boilers or internal combustion engines, or other infrequently operated equipment may not provide fruitful results. The following approach outlines a hierarchy that can be used to select the appropriate "monitoring" technique for each piece of air pollution equipment at a plant. Where appropriate, the permit authority may elect to mix the "tiers" to match the appropriate situation.

Tier 1

COMS are the preferred visible emissions measurement technique. COMS create an unbiased, continuous, and permanent record of opacity. In conjunction with a periodic quality assurance program and the regulatory authority's ability to use "any credible evidence" to establish a violation, COMS may be used to assess whether a source is in compliance. Where the source already has a COMS, the instrument would be used as the periodic monitoring device.

COMS are appropriate for vents or stacks which carry a major portion of the plant's particulate or other condensible emission streams. For example, coal-fired boilers are good candidates for COMS. In addition, any other equipment for which an NSPS establishes a COMS requirement -- whether NSPS affected or not -- should be considered strong candidates for COMS. EPA has already verified that COMS are both technically and economically feasible for a large number of emission units, including industrial, institutional, commercial, and utility steam boilers firing other than natural gas or "clean" fuel oil, fluidized catalytic cracking units, Portland cement kilns and clinker coolers, primary metal smelters, ferroalloy and steel arc furnaces, pulp mill recovery furnaces, glass melting furnaces, rotary lime kilns, and phosphate rock and other mineral dryers, calciners, and grinders. The above list is not meant to limit the source types for which COMS may be appropriate, but instead provides examples of the sources types for which COMS already work.

When evaluating Title V permit applications that involve emissions units at the source types described above, the presumption is that COMS will be specified by the permit authority as the opacity measurement method. The responsibility to show that COMS are not technically or economically feasible for a particular installation, and that lesser monitoring under Tiers 2 or 3 is more appropriate, rests with the permit applicant.

Tier 2

Alternatives to COMS may be acceptable if such devices are not technically or economically practical. For example, wet, condensible plumes or roof vents that exceed the practical path length of an opacity monitor present technical challenges for which COMS may not be appropriate. In addition, the economics of installing COMS on multiple opacity emission points or low capacity factor units may not be justifiable. In these cases, lesser monitoring under Tiers 2 and 3 may be appropriate. Reasons for selecting lesser monitoring requirements under Tiers 2 and 3 should be fully explained in the permit statement of basis or other documents contained in the permit administrative record.

"Lesser monitoring" may include visual observations by Reference Method 9, a plant- wide visible emissions survey, measurement of other surrogate parameters, or a combination of one or more of these measures to evaluate whether opacity is likely being met or not.

Visual Observations

Method 9 is the preferred visual observation method. To the extent practicable, a source should attempt to record daily opacity measurements on each emission point subject to an opacity standard. Of course, readings would only be required when the emission unit is operating and when the weather conditions allow. Method 9 data may be used by EPA, the state or local agency, and the public as direct evidence of an opacity violation.

In those cases where Method 9 readings are impractical because of a large number of emission points or because a certified Method 9 observer is not available, the source representative would note the visible emissions performance of the plant each operating day. Specifically, the source would first conduct a quick survey of the entire plant. In most cases, this "qualitative" assessment shouldn't take more than 10-15 minutes, even for complex sources. The source representative would maintain a daily log noting 1) whether any air emissions (except for water vapor) were visible from the plant, 2) all emission points from which visible emissions occurred, and 3) whether the visible emissions were normal for the process. If no visible or other significant emissions are observed then no further observations would be required.

For those emission points with visible emissions perceived or believed to exceed the applicable opacity standard, the source representative would attempt to record formal Method 9 readings for the emission points of concern. If Method 9 readings can not be obtained, the source would also indicate 1) the color of the emissions, 2) whether the emissions were light or heavy, 3) the cause of the abnormal emissions, and 4) any corrective action taken. For a source with many emission points, such as a quarry operation, the representative could make a statement or use a check sheet that, for example, would indicate that "all 57 emission points had normal visible emissions today, except for emission points 1, 3, and 5", and further describe any corrective action taken. Whether recording "qualitative" visible emission characteristics or taking Method 9 readings, the source operator should also document the total duration of any visible emission incident as part of the log described above.

Where a source opts to record "qualitative" visible emissions data, rather than record official Method 9 readings on a daily basis, it may be prudent for the source to bring in a certified Method 9 observer to periodically "quantify" visible emissions. For example, if the permit authority requires the source to make an annual compliance certification, these periodic Method 9 readings along with the daily survey results would give the responsible official some reasonable assurance that the source is meeting its opacity obligations.

In all cases, we recommend that all persons responsible for making visible emission observations acquire basic training in the general principles and practices of "reading" opacity. At a minimum, the observer should be trained and knowledgeable about the effects on visibility of emissions caused by background contrast, ambient lighting, observer position relative to lighting, wind, and the presence of uncombined water. EPA's Reference Method 22, found at 40 CFR Part 60, Appendix A, suggests two references in Section 7 that may be helpful.

Other Surrogate Means

A source may also propose alternative methods that relate other process measurements to the level of opacity. For example, a source may be able to show that a properly functioning baghouse should result in no excess visible emissions as long as it operates within an established pressure drop range. As another example, a source of particulate emissions controlled by a fabric filter may choose to perform periodic monitoring of opacity with a triboflow monitor reading as a surrogate indicator. Any increase in the triboflow reading would be assumed to result in an increase in opacity. Like COMS, these methods likely produce a continuous and unbiased record of emission unit performance.

The responsibility for establishing the relationship between the process parameter and opacity rests solely with the source operator. As described above, the source would make measurements, at least daily, to establish a reasonable assurance that they are in compliance with the opacity standards on a continuous basis.

These "qualitative" data, collected via the source site survey or by surrogate means, would only be indicators of a problem, prompting the state to step up its surveillance if opacity problems persist. In addition, quality-improvement- principles could be used to select the appropriate visible emissions measurement method to require the source to step up to the next "higher" monitoring system Tier if opacity problems are repeated. In other words, if a source continually has problems with opacity, it may be appropriate for the permit authority to revise the monitoring method to Method 9, or to go straight to an opacity monitor.

Tier 3

Certain sources may not benefit from evaluating and recording opacity on a daily basis, where little or no opacity problems are expected. For example, a boiler firing natural gas may only experience opacity problems during startup, shutdown, or malfunction, or during use of an emergency fuel like oil. In these cases, the source could easily observe the appropriate emission

points during these special periods of time. Other sources for which opacity problems would be expected to be minimal include natural gas fired IC engines, natural gas fired turbines, and other gaseous streams where particulate matter or other condensible are not expected to present problems. In these cases, the source may submit a justification in its application to the permit authority to approve less frequent opacity monitoring.

Effect of the Policy

This policy may not be used to relax any compliance methodology required by the SIP, NSPS, NESHAP, MACT, federally enforceable preconstuction or operating permit, or other federally imposed standard without first completing the proper rulemaking procedures.

Nothing in this policy precludes the permit authority from establishing more rigorous opacity monitoring requirements.

Nothing in this strategy precludes the permit authority, EPA, or the public-at-large from pursuing enforcement where opacity excursions are deemed excessive.

This policy does not preclude EPA from objecting to a permit as authorized under Part 70.

This policy is not intended as rulemaking or other action described in Section 307(b) of the Clean Air Act nor does it create new requirements not already required by the periodic monitoring provisions under Title V. As permit authorities gain more experience in working with periodic monitoring this policy may be revised to better reflect that experience.

Public Availability

The Region will place this policy on our web site [www.epa.gov/region07/] under "Air Program, Policies and Guidance". Title V permit authorities are also free to distribute to sources potentially affected by the policy.

Guide to 40 CFR Part 60, Subpart OOO -- Standards of Performance for Nonmetallic Mineral Processing Plants

(Air Pollution Control Program fact sheet, Division of Environmental Quality Director: Ed Galbraith, PUB02387, 09/2014) [Selected Excerpts – Complete Document: https://dnr.mo.gov/pubs/pub2387.htm]

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The statements in this document are intended solely as guidance. This document is not intended, nor can it be relied on, to create any rights enforceable by any party in litigation. This guidance may be revised without public notice to reflect changes in law, regulation or policy.

Introduction

This fact sheet will clarify portions of 40 CFR 60, Subpart OOO – Standards of Performance for Nonmetallic Mineral Processing Plants. This subpart typically applies to rock crushing plants in Missouri. This rule is often referred to as New Source Performance Standard, or NSPS-OOO.

Use of the term, affected facility, does not mean a complete rock crushing plant or installation. It refers to specific equipment including, but not limited to, a screen, conveyor, bucket elevator or a crusher.

Definitions

Affected Facility - any crusher, grinding mill, screening operation, bucket elevator, belt conveyor, bagging operation, storage bin and enclosed truck or railcar loading station used at the installation. Static (non-moving) grizzly screens are not considered a screening operation, and are therefore not considered an affected facility.

Capacity - the cumulative capacity rate of all initial crushers that are part of the plant.

Crush or Crushing - to reduce the size of nonmetallic mineral material by means of physical impaction of the crusher or grinding mill upon the material.

Fugitive emission - particulate matter not collected by a capture system and released to the atmosphere at the point of generation.

Initial Crusher – this is the point of initial crushing for any nonmetallic minerals at the plant.

Nonmetallic Mineral Processing Plant - any combination of equipment used to crush or grind any nonmetallic mineral wherever located, including lime plants, power plants, steel mills, asphalt concrete plants, portland cement plants, or any other facility processing nonmetallic minerals.

Stack Emission - the particulate matter released into the atmosphere from a capture system.

Transfer Point - a point in a conveying operation where the nonmetallic mineral is transferred to or from a belt conveyor, except where the nonmetallic mineral is being transferred to a stockpile.

For a more complete list of definitions please see the rule text.

Nonmetallic Minerals

Following is a list of nonmetallic minerals as defined in the rule. A crushing plant that processes any of these nonmetallic minerals, or a mixture of which any of these are the majority, is considered a nonmetallic mineral processing plant.

Crushed and broken stone	Boron
Sand and gravel	Barite
Clay	Fluorospar
Rock salt	Feldspar
Gypsum (natural or synthetic)	Diatomite
Sodium compounds	Perlite
Pumice	Vermiculite
Gilsonite	Mica
Talc and pyrophyllite	Kyanite

Applicability and Affected Facilities

If you own or operate an affected facility (or facilities) with a manufacture date on or after Aug. 31, 1983, this rule applies to you. However, your affected facilities with a manufacture date on or after April 22, 2008, will usually have different emission limits, and different monitoring and performance testing requirements.

The rule does not apply to the following operations:

- Facilities located in underground mines.
- Plants with no crusher or grinding mill above ground.
- Wet material processing operations. Please see the rule text for the definition of a wet material processing operation.
- Fixed crushing or sand and gravel plants with an initial crushing capacity of 25 tons per hour or less.
- Portable crushing or sand and gravel plants with an initial crushing capacity of 150 tons per hour or less.
- Common clay plants and pumice plants with an initial crushing capacity of 10 tons per hour or less.
- An installation that is subject to 40 CFR Part 60, Subpart F or I.

Emission Limits

The emission limits for affected facilities manufactured before April 22, 2008, remain unchanged. This means a particulate matter emission limit of 0.022 grains per dry standard cubic foot or gr/dscf, a visible emission limit of 7 percent opacity for stack emissions, and a visible emission limit of 10 percent opacity (15 percent for crushers) for fugitive emissions.

Emission limits for affected facilities manufactured on or after April 22, 2008, have changed. The emission limits for affected facilities that fall into this category are as follows:

- For stack emissions the particulate matter emission limit is 0.014 gr/dscf. There is no visible emission limit, it has been replaced with ongoing baghouse monitoring requirements.
- For fugitive visible emissions the opacity limit is 7 percent (12 percent for crushers).

If you have a baghouse controlling emissions from a single storage bin, the visible emissions from the baghouse exhaust are limited to 7 percent opacity. There is no particulate matter emission limit for this exhaust. This does not apply to baghouses controlling multiple storage bins, only a baghouse controlling a single storage bin.

There is no emission limit specified in this rule for truck dumping of nonmetallic minerals into any screening operation, feed hopper, or crusher. State fugitive emission limits, generally 20 percent opacity, and rules apply where appropriate.

Compliance Requirements

Initial Performance Testing

Initial performance testing is required for your affected facilities whether the manufacture date is prior to, or on or after April 22, 2008. This testing must be conducted within 180 days of initial start up of the affected facility.

If you control emissions from your affected facilities with a baghouse or any other type of capture and control system, initial performance testing for particulate matter emissions may be conducted using either EPA Method 5 or 17. If required (see emission limits above) opacity of visible emissions from a stack must be determined using EPA Method 9.

If you have fugitive emissions from your affected facilities, initial performance testing must be conducted using EPA Method 9. The duration of the performance test has been reduced from 60 minutes to 30 minutes in the revised rule, and there is no requirement to test for three hours in the revised rule. Compliance with the opacity limit is based on the average of the five consecutive six minute averages. This applies to facilities manufactured prior to, or on or after April 22, 2008.

If fugitive emissions are escaping a capture system you have installed, those fugitive emissions points are also subject to the initial performance testing requirements mentioned in the previous paragraph. An example of this situation is a capture system not capable of capturing all the emissions from an emission point. Sources should ensure all capture systems, ducting and control devices are working properly prior to any testing.

If you have a baghouse controlling emissions from a single storage bin you do not need to test for particulate matter emissions, only the opacity of visible emissions. You must use EPA Method 9 to conduct the initial performance test. The duration of the test must be 60 minutes.

For performance tests involving only Method 9 testing, you are no longer required to notify the Department of Natural Resources, or your local agency, 30 days prior to testing. The revised rule requires only a seven day notification prior to testing. Also, if a performance test date falls during a seasonal shutdown, you may postpone the test date to no later than 60 days after resuming operation. However, you must obtain prior approval from the department, or your local agency.

Ongoing Compliance

Except for the ongoing monitoring requirements for wet scrubbers, most of the monitoring requirements in the revised rule are new, and they generally affect facilities with a manufacture date on or after April 22, 2008. Following is a summary of monitoring requirements that may affect you.

If you use a baghouse to control emissions from your affected facilities manufactured on or after April 22, 2008, you must conduct ongoing monitoring of the baghouse. This includes, but is not limited to, conducting quarterly 30 minute visible emissions inspections using EPA Method 22. Please see Sections 60.674 – Monitoring of Operations and 60.676 – Reporting and Recordkeeping, of the rule for specific requirements.

If you use a wet suppression system, or "carryover" from a wet suppression system, to control fugitive emissions from your affected facilities manufactured on or after April 22, 2008, you must conduct ongoing monitoring of the wet suppression system. This includes, but is not limited to, monthly inspections and corrective actions when needed. Again, please see Sections 60.674 – Monitoring of Operations and 60.676 – Reporting and Recordkeeping, of the rule for specific requirements.

If you do not use a wet suppression system, or "carryover" from a wet suppression system, to control fugitive emissions from an affected facility manufactured on or after April 22, 2008, you must conduct a repeat EPA Method 9 performance test for that affected facility within five years of the previous performance test. However, if the affected facility is enclosed in a building, a repeat performance test is not required.

If you use a wet scrubber to control emissions from your affected facilities, whether they were manufacture before, or on or after, April 22, 2008, you must conduct ongoing monitoring of the wet scrubber parameters in accordance with Sections 60.674 – Monitoring of Operations and 60.676 – Reporting and Recordkeeping, of the rule.

Buildings that Enclose Affected Facilities

The rule contains an optional compliance method that allows emission measurement from any building(s) that enclose any affected facilities, instead of each affected facility within the building. The revised rule limits visible emissions from any building opening, except vents, to 7 percent opacity. To demonstrate initial compliance using this option, you must use EPA Method 9 for the initial performance test, the same way you would for a fugitive emission point. Vents must meet the stack emission limits and initial performance test requirements mentioned above. Please see the rule text for the definition of a vent.

Notifications and Reports

The revised rule requires that notifications and reports required under the rule need only be sent to the Department of Natural Resources' Air Pollution Control Program, or your local agency. There is no longer a requirement to send these to the EPA.

Complete Reference: **Title 40: Protection of Environment**
PART 60—STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES
Subpart OOO—Standards of Performance for Nonmetallic Mineral Processing Plants
Source: 74 FR 19309, Apr. 28, 2009, unless otherwise noted.
[https://www.govinfo.gov/content/pkg/CFR-2015-title40-vol7/pdf/CFR-2015-title40-vol7-part60-subpartOOO.pdf]

EPA METHOD ALT – 082, DIGITAL CAMERA OPERATING TECHNIQUE (DCOT)
[https://www3.epa.gov/ttn/emc/approalt/ALT082.pdf]

(Method ALT – 082, Digital Camera Operating Technique (DCOT), is a modified EPA Method 9 technique which uses digital photography and image analysis to determining the opacity of a plume, employing standard test method ASTM D7520-09.)

ALT-082 Approval of Method 9 Alternative Revised (see Conniesue Oldham, Ph.D. letter below):

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

MAY 15 2012

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

Colonel Patrick C. Higby, Commander
7285 4th St., Bldg. 180, Suite 115
Hill Air Force Base, UT 84056-5206

Dear Colonel Higby:

In your July 22, 2010, letter and through follow-up clarification with Steve Rasmussen of Hill Air Force Base, you requested approval to use the Standard Test Method for Determining the Opacity of a Plume in the Outdoor Ambient Atmosphere, ASTM D7520-09, in lieu of EPA Method 9 to meet opacity measurement requirements for Federal New Source Performance Standards (40 CFR Part 60) and National Emission Standards for Hazardous Air Pollutants (40 CFR Part 63) regulations at your facility.

We approve your request for the use of ASTM D7520-09 in lieu of EPA Method 9 for demonstrating compliance with Federal opacity regulations under any subpart to 40 CFR Part 60, 61, and 63 regulating ducted emission sources that fall within the ASTM D7520-09 method's scope as set out in Section 1 at Hill Air Force Base with the following limitations:

1. During the digital camera opacity technique (DCOT) certification procedure outlined in Section 9.2 of ASTM D7520-09, you or the DCOT vendor must present the plumes in front of various backgrounds of color and contrast representing conditions anticipated during field use such as blue sky, trees, and mixed backgrounds (clouds and/or a sparse tree stand).

2. You must also have standard operating procedures in place including daily or other frequency quality checks to ensure the equipment is within manufacturing specifications as outlined in Section 8.1 of ASTM D7520-09.

3. You must follow the record keeping procedures outlined in section 63.10(b)(1) for the DCOT certification, compliance report, data sheets, and all raw unaltered JPEGs used for opacity and certification determination.

4. You or the DCOT vendor must have a minimum of four (4) independent technology users apply the software to determine the visible opacity of the 300 certification plumes. For each set of 25 plumes, the user may not exceed 15% opacity of any one reading and the average error must not exceed 7.5% opacity.

5. This approval does not provide or imply a certification or validation of any vendor's hardware or software. The onus to maintain and verify the certification and/or training of the DCOT camera, software and operator in accordance with ASTM D7520-09 and this letter is on the facility, DCOT operator, and DCOT vendor.

6. This approval does not alter any duration or averaging requirements of any specific regulation.

Since this alternative method is applicable to other facilities, we will be posting this letter on our website at http://www.epa.gov/ttn/emc/approalt/ for use by other interested parties.

If you have questions or would like to further discuss the matter, please call Jason DeWees at (919) 541-9724, or you may email him at dewees.jason@epa.gov.

Sincerely,

Robin R. Segall for

Conniesue Oldham, Ph.D, Group Leader
Measurement Technology Group

cc: James B. Martin, Region 8
Utah, UDAQ
Steve Rasmussen, Hill AFB
EPA Regional Air Division Directors

Note about Broadly Applicable Approved Alternative Test Methods:

These methods are approved alternatives to the methods required by 40 CFR Parts 60, 61 and 63 as described by the General Provisions of the corresponding Parts and as further explained in a Federal Register notice dated January 30, 2007. As such, the methods may be used by sources for determining compliance with the requirements of these Parts per their specified applicability provisions without further EPA approval. The Administrator, or designee (currently Steffan Johnson, Group Leader of the Measurement Technology Group in the Air Quality Assessment Division of the Office of Air Quality Planning and Standards), has approved these methods for the specified applications; this approval has been documented through an official EPA letter. These methods include quality control and quality assurance procedures that must be met. The EPA staff may not necessarily be the technical experts on these methods.

Standard Test Method for Determining the Opacity of a Plume in the Outdoor Ambient Atmosphere (ASTM D7520-09)

(ASTM D7520-09 is available from **www.ASTM.org**. A summary version follows. The purpose of this summary is to familiarize those certified in EPA Method 9 with this alternate technique and should not be used as an operating manual.)

Scope of ASTM D7520-09

1. This test method describes the procedures for determining the opacity of a plume caused by particulate matter emitted from a stationary point source into the outdoor ambient environment, using digital imagery and associated software and hardware.
2. The opacity of emissions is determined by the application of a Digital Camera Opacity Technique (DCOT) that consists of a Digital Still Camera, Analysis Software, and the Output Function's content, to obtain and interpret digital images and to determine and report plume opacity.
3. This method is suitable for determining the opacity of plumes from zero (0) percent to one hundred (100) percent.
4. This test method is not applicable to stacks with internal diameters greater than 7.0 ft.
5. Conditions that shall be considered when using this method to obtain the digital image of the plume include the plume's background, the existence of condensed water in the plume, orientation of the Digital Still Camera to the plume and the sun.
6. This standard describes the procedures to certify the DCOT, hardware, software, and method to determine the opacity of the plumes.
7. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.

Referenced Documents

ASTM Standards:

D1356 Terminology Relating to Sampling and Analysis of Atmospheres

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

U.S. Environmental Protection Agency (USEPA) Document:

USEPA Method 9 Visual Determination of the Opacity of Emissions from Stationary Sources, 40 CFR, Part 60, Appendix A-4

Institute of Electrical and Electronics Engineers (IEEE) Document:

IEEE 12207-2008. Systems and Software Engineering—Software Life Cycle Processes (ISO/IEC 12207:2008(E)), Edition: 2nd, Institute of Electrical and Electronics Engineers, 01-Feb-2008, 138 pages, ISBN: 9780738156637

Japanese Electronic and Information Technology Industries Association (JEITA) Document:

Exchangeable Image File Format (EXIF) for Digital Still Cameras: Joint Photographic Experts Group: JPEG file format version 2.21, JEITA CP-3451-1 (English version) dated 2003-09; http://www.jeita.or.jp/english/standard/list/list.asp?cateid=1&subcateid=4

International Organization for Standardization (ISO) Standard:

ISO 9001:2000(s)

Terminology

For definitions of terms used in this test method, refer to Terminology D1356 (Relating to Sampling and Analysis of Atmospheres).

Definitions of Terms Specific to This Standard:

analysis software—software that when combined with a defined operating environment: *a*) inputs images captured by the Digital Still Camera image capture devices; *b*) produces opacity measurements from the combination of human interaction, open or proprietary calculations and algorithms, and image content viewing; *c*) and then output said opacity measurement along with Analysis Software's configuration, image source documentation and other environmental parameters.

certified—for the purpose of this standard, certified refers to achieving or excelling the requirements described in this method.

DCOT operator—refers to the human operating the DCOT system who records the digital still images with the Digital Still Camera and then determines plume opacity with the Analysis Software.

Digital Still Camera—an image capture device used to collect store and forward digital still images to the Analysis Software for analysis as defined by the DCOT vendor's certification documentation.

image transfer file—an electronic file that contains the image captured by the Digital Still Camera and its associated environment documentation that is consistent with EXIF 2.1 JPG (or higher) format and is input to the Analysis Software. All of the digital images obtained by a DCOT system shall be reviewed by a qualified human DCOT operator to assess if the digital images are acceptable (for example, no obvious errors in the digital images).

opacity—measurement of the degree to which particulate emissions reduce the intensity of transmitted photopic light and obscure the view of an object through an effluent gas stream of a given path length in ambient air.

opacity source—any source that produces emissions that are visible to the human eye.

output function—human readable information documenting the image being analyzed and configuration of the Analysis Software used, the opacity measurement and the other required environment variables defined (for example, view angle, wind direction).

Summary of Test Method

A Digital Camera is used to capture a set of digital images of a plume against a contrasting background. Each image is analyzed with software that determines plume opacity by comparing a user defined portion of the plume image where opacity is being measured in comparison to the background providing the contrasting values. The Analysis Software is used to average the opacities from the series of digital images taken of the plume over a fixed period of time. The software is also used to archive the image set utilized for each opacity determination including the portion of each image selected by the operator. The following conditions must be followed to make a valid opacity determination:

1. The image must be captured in a JPEG format that adheres to the EXIF 2.1 (or higher) standard.
2. The image must be captured with the sun within a 140° sector directly behind the Image capture device.
3. The image must be captured perpendicular to the direction of plume travel.
4. Digital enhancement capabilities of the Image Capture Device (that is, flash, optical filters, digital zoom, and image stabilization) shall not be used. However, the optical zoom may be used when capturing the JPG image.
5. The ambient light must be sufficient to show a clear contrast between the plume and its background.
6. The portion of the plume selected for opacity determination shall not contain condensed water vapor.
7. The selected portions of each image representing the visible plume and the uniform background must contrast sufficiently for the software to differentiate between the plume and its background.
8. The portion of the plume selected for opacity determination shall represent the part of the plume with the highest apparent opacity, excluding water vapor, as determined by the DCOT operator.
9. The area of the digital image to be analyzed for opacity shall be centered in the digital image when taking the photograph.
10. Each DCOT vendor shall provide training for operators of their DCOT system. The training shall include the content of the "Principles of Visual Emissions Measurements and Procedures to Evaluate those Emissions Using the Digital Camera Optical Technique (DCOT)" (Annex A1 of D7520-09 also known as EPA Reference Method 9) and a description of how to operate that specific DCOT system that passed smoke school (certified to the D7520-09).

Significance and Use

Air permits from regulatory agencies often require measurements of opacity from stationary air pollution point sources in the outdoor ambient environment. Opacity has been visually measured by certified smoke readers in accordance with USEPA (USEPA Method 9). DCOT is also a method to determine plume opacity in the outdoor ambient environment. This standard sets a minimum level of performance for products that use DCOT to determine plume opacity in outdoor ambient environments.

Interferences

Contrast—As the contrast between the color of the plume and the background decreases, the observed opacity decreases. To achieve maximum opacity, the opacity shall be measured at a point where the maximum contrast exists between the plume and the background.

Luminescence—Low light levels adversely impact the determination of plume opacity. Adequate natural light must be available to illuminate the plume and background during the period the images are captured. This method shall only be used during daytime conditions.

Steam Plumes—Steam plumes (or condensed water vapor) cause significant errors in measuring opacity, and occur in two distinct modes as either attached plumes or detached plumes. Water droplets in steam plumes will scatter light resulting in increased plume opacity until the water evaporates, and shall not be included in the determination of opacity. When either condition is noted to exist, the camera operator must record sufficient images to document the type of plume observed and the relative position of the exhaust stack with relationship to the point the opacity measurement is made.

Attached Steam Plumes—When condensed water vapor is present within the plume as it emerges from the emission outlet, opacity images shall be made beyond the point in the plume at which condensed water vapor is no longer visible. The operator shall record the approximate distance from the emission outlet to the point in the plume at which the images are made.

Detached Steam Plume—When water vapor in the plume condenses and becomes visible at a distinct distance from the emission outlet, the opacity of emissions shall be evaluated at the emission outlet prior to the condensation of water vapor and the formation of the steam plume.

Angle of View—The position of the camera operator with respect to the smoke plume and sun will impact the perceived contrast between the smoke plume and the background. Changes in apparent contrast will impact the measurement of opacity using this technique and must be minimized by following the procedures specified in EPA Method 9.

Slant-Angle—The path length of the plume is lengthened when a Digital Still Camera is too close to a stack. The plume shall be observed at least three stack heights away, where the slant-angle is 18° or less to reduce the effect of slant angle on the perceived opacity of the plume.

System Description

The DCOT system is formulated into three distinct and severable components: (1) Digital Still Camera, (2) Analysis Software and its associated computing platform, and (3) the Output Function. This section describes each of the components and the dependency each component has to the others.

1. ***The first component of the system is the Digital Still Camera.*** The Digital Still Camera's sole purpose with respect to the DCOT system is the acquisition of images and documentation of the pictorially represented emission source. All manufacturers of a Digital Still Camera used with the DCOT system shall meet ISO 9001 Quality Standards. The DCOT operator shall use the Digital Still Camera's default auto-focus settings, default auto-exposure settings and may use optical zoom when recording the digital images of the plumes. The DCOT operator shall not use digital image control such as the flash, optical filters, digital zoom, and image stabilization of the Digital Still Camera when recording the digital images of the plume. The Analysis Software shall verify that such conditions were used when obtaining the digital images. The Analysis Software shall define the areas to determine plume opacity and the acceptable size of areas used to determine plume opacity. The entire digital image shall remain in its native state. The Digital Still Camera must be capable of generating EXIF 2.1 JPG (or higher) formatted output files (JEMA EXIF 2.1 JPG, 1995) and the Analysis Software shall stipulate the required values of the EXIF 2.1 JPG (or higher) file as defined in its certification documentation. The Digital Still Camera performs the image acquisition function and thus images must be captured in accordance with the procedures described in the ***Procedures*** section below to ensure that ***Interferences*** discussed above are reduced. Once the images have been captured and stored into the resulting EXIF 2.1 JPG (or higher) file per the minimum EXIF 2.1 JPG (or higher) data requirements of this standard the image capture component is complete and the Analysis Software takes over. EXIF 2.1 JPG (or higher) data shall be available for each digital image from the Digital Still Camera and shall be provided by the Output Function of the Analysis Software. EXIF data may also include other camera specific information that is important to document but is not part of the EXIF 2.1 JPG (or higher) standard (for example, use of image stabilization). This information is required to describe the: *(1)* manufacturer, model name or model number of the Digital Still Camera used to obtain the digital images, *(2)* operating conditions of the Digital Still Camera, *(3)* when the digital images were created or changed, *(4)* properties of the digital images, and *(5)* name and version of the software or firmware of the Digital Still Camera used to generate the digital images. Such documentation will inhibit the opportunity to modify the digital images and the resulting analysis of the plumes' opacity values. The Digital Still Camera is dependent on the minimum image requirements of the associated Analysis Software and thus must conform to the requirements for image capture as dictated by the Analysis Software component.
2. ***The second component of the DCOT is the Analysis Software***, which reads the images captured by the Digital Still Camera, performs analysis of the image, and calculates the opacity level of the pictorially represented emission from the Digital Still Camera. The Analysis Software portion of the DCOT enforces the specific requirements of the Digital Still Camera (that is, JPEG 2.1 output, or higher) and the minimum requirements of the system to support required output capabilities (that is, compliant with Method 9 and certification documentation (IEEE 12207- 2008)). The configuration documentation describing the Analysis Software must include a listing of all non-proprietary components of the software, such as: *(1)* the required hardware platform (that is, processors supported), *(2)* basic input output system (BIOS) supported, *(3)* storage media required and supported, *(4)* video drivers and Dynamic Link Libraries (DLLs) required and supported, *(5)* visual display requirements, (for example, VGA, SVGA), and *(6)* image viewers required and supported (for example, Internet Explorer 6.1, Microsoft Picture Manager 2.1). The configuration of the Analysis Software must also include the source version numbering definition, and the version control plan for the proprietary components of the Analysis Software, such as required by IEEE 12207. The Analysis Software shall be locally hosted on personal computing platforms, mobile devices and/or network hosted. The certification documentation defines the Analysis Software and its host platform environment under which certification of this standard was achieved.
3. ***The third and final component of the DCOT is the Output Function.*** The Output Function serves as the audit capability for the DCOT as well as the formal reporting of the output of the DCOT. Each DCOT shall establish its own representation of output as long as the minimum set of information that is described in the Procedures section below and the image requirements specified above is included in the Output Function file. The minimum required content from the header of the EXIF 2.1 JPG (or higher) file is described above. Further the output must contain the version of the Analysis Software and the configuration of prerequisite components used in the determination of the opacity of the image and/or image set being analyzed.
4. ***Each combination of the Digital Still Camera make and model number, Analysis Software, and Output Function shall determine a specified DCOT configuration for testing and possible certification by this ASTM method.*** The DCOT is certified to this standard as a single entity with requisite definitions of the components embedded in the certification documentation. For instance a single configuration of the Analysis Software and Output Function meets this requirement with multiple Digital Still Cameras with the same make and model number and a single Digital Still Camera make and model number is certifiable to this standard to operate with multiple specified Analysis Software and Output components.

Procedures

1. The DCOT operator must be knowledgeable about observing plumes to determine their opacity in accordance with "Principles of Visual Emissions Measurements and Procedures to Evaluate those Emissions Using Digital Camera Optical Technique (DCOT)" (Annex A1 of D7520-09 also known as EPA Reference Method 9). The DCOT operator shall use the following procedures for determining the opacity of emissions in the ambient environment. All equipment shall be maintained in accordance with the manufacturer's specifications.
2. The Digital Still Camera of the certified DCOT shall be held as steady as possible or be tripod mounted at a distance sufficient to provide a clear view of the plume with the sun oriented in the 140° sector behind the Digital Still Camera's line of sight and toward the plume. Consistent with maintaining the above requirement, the Digital Still Camera shall, as much as possible, capture digital images from a position such that the Digital Still Camera's line of sight is perpendicular to the plume's direction and, when photographing opacity of emissions from rectangular outlets (for example, roof monitors, open bag houses, noncircular stacks), approximately perpendicular to the longer axis of the outlet. The Digital Still Camera's line of sight must be such that any plume shall be isolated from its background and analyzed independent of other sources, and in any case the Digital Still Camera's line of sight shall be perpendicular to the longer axis of such a set of multiple stacks (for example, stub stacks on bag houses). The relative areas of the plume and its background in the digital image are dependent on the software used and will be described with training associated with the software that is used to analyze the digital images. The observation shall be restarted at a time when the conditions are appropriate to restart the observation if ambient conditions change to inappropriate conditions during the observation (for example, change in wind direction causing the plume's path to change direction). Quality assurance of the camera shall occur by the human operator viewing the camera to visually assess the operating conditions of the camera.
3. The DCOT operator shall record at a minimum the name of the facility, emission location, facility type, operator's name and affiliation, the date of the field data record, and the Digital Still Camera's make, model and serial numbers. The time, estimated distance to the emission location, location of the Digital Still Camera with respect to the emission source and sun, approximate wind direction, estimated wind speed, description of the sky condition (presence and color of clouds), and plume background are recorded on a field data record at the time the Digital Still Camera captures the images to be used by the Analysis Software to determine opacity.
4. A minimum of 24 consecutive opacity images shall be taken at 15-second intervals. These 24 images constitute a record set. Each image taken shall be deemed to represent the average opacity of emissions for a 15-second period.
5. Opacity shall be determined as an average of 24 consecutive images recorded at 15-second intervals. Divide the recorded images into sets of 24 consecutive images. A set is composed of any 24 consecutive images with the opacity values from each digital image rounded to the closest 5 %. Sets need not be consecutive in time and in no case shall two sets overlap. For each set of 24 images, calculate the average by summing the opacity of the 24 observations and dividing this sum by 24. If an applicable standard specifies an averaging time requiring other than 24 images, calculate the average for all images made during the specified time period.

Certification of DCOT and DCOT Operator

Certification Requirements of DCOT—To be certified to this standard as a qualified DCOT, the specified DCOT must be tested and demonstrate the ability to assign opacity readings in 5 % increments to 25 different black plumes and 25 different white plumes, with an error not to exceed 15 % opacity on any one reading and average error not to exceed 7.5 % opacity in each category. Specified DCOT configurations shall be tested in accordance with the ***DCOT Certification Procedure*** described below. Smoke generators used shall be equipped with a smoke meter which meets the requirements specified in ***Smoke Generator Specifications*** below. Valid certification for that DCOT will last for 3.5 years for the documented DCOT configuration as described by the manufacturer, model name, and model number of the Digital Still Camera, the version of the Analysis Software, and the Output Function. Re-certification to this standard is required if the documented configuration of the original DCOT is revised. Each DCOT shall provide a self-test facility upon startup. The Self test shall utilize existing certification data to ensure that no impacts to the configured DCOT have occurred due to operating system updates. The procedure shall utilize the same comparison methodology as the certification. For instance, if the DCOT identifies an area in the plume as compared to an area outside the plume (background) to derive opacity, the exact same areas/dimensions must be used for the self-test. If a different result on any reading is returned, a re-certification is required, or the OS update must be rolled back, restoring the DCOT configuration to a version consistent with what was certified.

DCOT Certification Procedure—The specific DCOT shall be certified to determine the opacity of plumes once it passes six individual complete runs of 50 plumes within a six month period as described in ***Certification Requirements of DCOT*** above. The DCOT operator must include in the certification documentation the results of all smoke school tests. Those results shall include whether the DCOT passed or failed the tests and for the time periods between and during the six successful smoke school tests. Each individual run consists of collecting images of a complete run of 50 plumes: 25 black plumes and 25 white plumes-generated by a calibrated smoke generator. Plumes within each set of 25 black and 25 white runs shall be presented in random order and distributed over the entire range of opacities (that is, 0 to 100 % opacity values for black and white plumes). The DCOT operator shall use the Digital Still Camera's default auto-focus settings, default auto-exposure settings and may use optical zoom when recording the digital images of the plumes. The DCOT operator shall not use digital image control such as

the flash, optical filters, digital zoom, and image stabilization of the Digital Still Camera when recording the digital images of the plumes. The Analysis Software shall verify that such conditions were used when obtaining the digital images. The Analysis Software shall define the areas to determine plume opacity and the acceptable size of areas used to determine plume opacity. The entire digital image shall remain in its native state. The DCOT must capture the image of the measured plume and assign an opacity value to each along with the required environment information listed in the ***Procedures*** section of this standard outlined above. At the completion of each run of 50 readings, the score of the DCOT is determined. If a DCOT fails to qualify, the complete run of 50 readings must be repeated in any retest. The smoke test shall be administered as part of a smoke school or training program and shall be preceded by training or familiarization runs of the smoke generator during which candidates are shown black and white plumes of known opacity.

Smoke Generator Specifications—Any smoke generator used for the ***DCOT Certification Procedure*** 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 % chart recorder scale. The smoke meter shall be calibrated prior to the conduct of each smoke reading test. At the completion of each test, the zero and span drift shall be checked and if the drift exceeds +/- l % opacity, the condition shall be corrected prior to conducting any subsequent test runs. 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.

Calibration—The smoke meter is calibrated after allowing a minimum of 30 minutes warm-up by alternately producing simulated opacity of 0 % and 100 %. When stable response at 0 % or 100 % is noted, the smoke meter is adjusted to produce an output of 0 % or 100 %, as appropriate. This calibration shall be repeated until stable 0 % and 100 % opacity values are produced by alternately switching the power to the light source on and off while the smoke generator is not producing smoke.

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

Light Source—Verify from manufacturer's data and from voltage measurements made at the lamp, as installed, that the lamp is operated within +/- 5 % of the nominal rated voltage.

Spectral Response of Photocell—Verify from manufacturer's data that the photocell has a photopic response (daylight spectral response of the human eye).

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°. The total angle of view shall be calculated from: u = 2tan-1 (d/2L), where u = total angle of view; d = the sum of the photocell diameter plus the diameter of the limiting aperture; and L = the 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.

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°. The total angle of projection shall be calculated from: u = 2tan-1 (d/2L), where u = total angle of projection; d = the sum of the length of the lamp filament plus the diameter of the limiting aperture; and L = the distance from the lamp to the limiting aperture.

Calibration Error—Using National Institute of Standards and Technology (NIST) traceable 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 as described in ***Calibration*** above. The operator will then insert a series of three neutral-density filters of nominal opacity of 20, 50, and 75 % in the smoke meter path length. Filters calibrated within 2 % shall be used. Care shall 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 error on any one reading shall be 3 % opacity.

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

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

Certification of DCOT Operator—The DCOT operator shall be certified to acquire digital images from the Digital Still Camera to determine plume opacity by meeting the requirements specified by the training course for the specified DCOT system. The operator will use and shall be knowledgeable of the content described in "Principles of Visual Emissions Measurements and Procedures to Evaluate those Emissions Using Digital Camera Optical Technique (DCOT)")" (Annex A1 of D7520-09 also known as EPA Reference Method 9).

Precision and Bias

General Considerations:

1. The precision and bias of this test method has been evaluated by using the statistical procedures described in Practice E691 cases where the number of samples were not the same in each opacity level, the maximum number at any level were used in the calculation to be conservative. The database included 11 to 24 tests at each opacity level from three smoke school

experiments, therefore the precision results should be considered "interim." This precision statement shall be updated with additional data prior to reauthorization of the method. It shall be the responsibility of the Subcommittee chairman to ensure that such data are gathered, appropriate precision calculations made and such calculations incorporated into this method prior to reauthorization. The repeatability and reproducibility values are in percent opacity absolute. For example, if 20 % opacity is presented by the smoke generator, then there is a 95 % probability that the DCOT will read between 36.63 and 3.37 % opacity (20 +/- 16.63 %). As a point of clarification, the percent opacity absolute is the absolute opacity value. For example, the absolute opacity difference between 20 % opacity and 10 % opacity is 10 % opacity.

Bias: Bias is a systematic error that contributes to the difference between the mean of a large number of test results and an accepted reference value. Variables such as the angle at which images of the plume are captured, portion of the plume analyzed, direction of plume travel versus angle of image captured, luminescence and color contrast between the plume and the background against which the plume is viewed exert an influence upon the appearance of the plume and affect the ability of the technology to assign accurate opacity values. Studies of the theory of plume opacity have demonstrated that a plume is most visible and presents the greatest apparent opacity when viewed against a contrasting background (USEPA Method 9). Accordingly, the opacity of a plume viewed under conditions where a contrasting background is present is assigned with the greatest degree of accuracy. DCOT's opacity results must document the bias variables in order to minimize their effects on the resulting opacity determination. Captured images must document the environment under which the image was captured to determine the applicability of the opacity measurement. Mandatory environment variables are described above in the ***Procedures*** section of this standard. DCOTs certified to this standard are instructed to round to the nearest 5 % increment. DCOTs report opacity in increments of 5 %. As expected, the bias varied from opacity level to opacity level. Bias was determined by comparing the mean difference between the readings and the smoke generator reference value. If the absolute value of the mean difference was greater than the 95 % confidence coefficient, then a bias was calculated by dividing the mean difference by the mean DCOT value. The database included 11 to 24 tests at each opacity level from three smoke school experiments, therefore these bias results should be considered "interim." This bias statement shall be updated with additional data prior to reauthorization of the method. It shall be the responsibility of the Subcommittee chairman to ensure that such data are gathered, appropriate bias calculations made and such calculations incorporated into this method prior to reauthorization.

Keywords
digital camera; digital image; digital still camera; opacity

CONTINUOUS OPACITY MONITORING SYSTEMS (COMS) AT STATIONARY SOURCES – EPA PROCEDURE 3

New and Revised 40 CFR Part 60, Appendix F, Quality Assurance Procedures (for Continuous Monitoring Systems)
[https://www3.epa.gov/ttn/emc/news/highlights-2005-final.pdf]

Procedure 3 - Quality Assurance Requirements for Continuous Opacity Monitoring Systems at Stationary Sources - As a result of the comments received after re-opening the comment period for the rulemaking formerly known as "Method 203," which includes requirements for ongoing quality assurance and quality control evaluations of COMS used as continuous compliance monitoring systems, we decided to form a stakeholders' group to undertake the task of rewriting this rule package. The stakeholders' group was comprised of opacity monitor manufacturers, State/local agencies, EPA region personnel, as well as representatives from owners/operators. Method 203 has been rewritten as Procedure 3, and was re-proposed as an addition to 40 CFR part 60, appendix F in the Federal Register on May 8, 2003 (68 FR 24692); we expect to promulgate it by the end of 2005. **(Solomon Ricks 919/541-5242)**

FACT SHEET (Rev. 10/14/14) Quality Assurance Requirements for Continuous Opacity Monitoring Systems at Stationary Sources [https://www3.epa.gov/ttn/emc/perfspec/comspro3faq.pdf]

ACTION

- On May 16, 2014, the U.S. Environmental Protection Agency (EPA) issued a final rule which establishes quality assurance and quality control (QA/QC) procedures for continuous opacity monitoring systems (COMS) installed for compliance purposes.
- The rule requires daily instrument and status indicator checks, quarterly performance audits, annual zero alignment audits and corrective action for malfunctioning COMS.
- These procedures (referred to as Procedure 3) will apply to COMS used to demonstrate continuous compliance with opacity standards in EPA issued or approved regulations.
- The deadline for complying with Procedure 3 is no later than November 12, 2014.
- The first calibration error test and other quarterly auditing requirements must be conducted no later than March 31, 2015 (i.e., within the first calendar quarter of the compliance deadline for Procedure 3).
- The first annual zero alignment must be performed no later than December 31, 2015 (i.e., within the calendar year of the compliance deadline for Procedure 3).

• The deadline to perform the first zero alignment audits with the COMS off the stack (for sources that use an external zero device) is no later than December 31, 2017 (i.e., within three years of the compliance deadline for Procedure 3).
• Although daily system checks must be performed, only the periods in which the COMS was out-of-control based on the daily checks and the corrective actions taken to bring the COMS back in control must be included in the Data Assessment Report (DAR); individual results of all daily system checks are not required to be provided in the DAR. BACKGROUND
• On February 14, 2012, the EPA published both a direct final and parallel proposed Procedure 3 rule. EPA received comments on the proposed rule and after considering them, incorporated changes as appropriate in this final rule.
• Procedure 3 will enhance monitoring performance and improve a facility's ability to take immediate action to correct opacity issues.

FOR MORE INFORMATON
• Interested parties can download the rule from EPA's web site on the Internet under Recent Actions at the following address: http://www. epa.gov/ttn/oarpg.
• For further information about the rulemaking, contact Lula Melton at EPA's Office of Air Quality Planning and Standards at (919) 541-2910.

PROCEDURE 3—QUALITY ASSURANCE REQUIREMENTS FOR CONTINUOUS OPACITY MONITORING SYSTEMS AT STATIONARY SOURCES

[https://www.epa.gov/emc/procedure-3-quality-assurance-requirements-continuous-opacity-monitoring-systems-stationary]

1.0 What are the purpose and applicability of Procedure 3?
The purpose of Procedure 3 is to establish quality assurance and quality control (QA/QC) procedures for continuous opacity monitoring systems (COMS). Procedure 3 applies to COMS used to demonstrate continuous compliance with opacity standards specified in new source performance standards (NSPS) promulgated by EPA pursuant to section 111(b) of the Clean Air Act, 42 U.S.C. 7411(b)—Standards of Performance for New Stationary Sources.
1.1 What are the data quality objectives of Procedure 3? The overall data quality objective (DQO) of Procedure 3 is the generation of valid and representative opacity data. Procedure 3 specifies the minimum requirements for controlling and assessing the quality of COMS data submitted to us or the delegated regulatory agency. Procedure 3 requires you to perform periodic evaluations of a COMS performance and to develop and implement QA/QC programs to ensure that COMS data quality is maintained.
1.2 What is the intent of the QA/QC procedures specified in Procedure 3? Procedure 3 is intended to establish the minimum QA/QC requirements to verify and maintain an acceptable level of quality of the data produced by COMS. It is presented in general terms to allow you to develop a program that is most effective for your circumstances.
1.3 When must I comply with Procedure 3? You must comply with Procedure 3 no later than November 12, 2014.
2.0 What are the basic functions of Procedure 3?
The basic functions of Procedure 3 are assessment of the quality of your COMS data and control and improvement of the quality of the data by implementing QC requirements and corrective actions. Procedure 3 provides requirements for:
(1) Daily instrument zero and upscale drift checks and status indicators checks;
(2) Quarterly performance audits which include the following assessments:
(i) Optical alignment,
(ii) Calibration error, and
(iii) Zero compensation.
Sources that achieve quality assured data for four consecutive quarters may reduce their auditing frequency to semi-annual. If a performance audit is failed, the source must resume quarterly testing for that audit requirement until it again demonstrates successful performance over four consecutive quarters.
(3) Annual zero alignment.
3.0 What special definitions apply to Procedure 3?
The definitions in Procedure 3 include those provided in Performance Specification 1 (PS-1) of Appendix B of this part and ASTM D6216-12 and the following additional definitions.
3.1 Out-of-control periods. Out-of-control periods mean that one or more COMS parameters falls outside of the acceptable limits established by this rule.
(1) Daily Assessments. Whenever the calibration drift (CD) exceeds twice the specification of PS-1, the COMS is out-of-control. The beginning of the out-of-control period is the time corresponding to the completion of the daily calibration drift check. The end of the out-of-control period is the time corresponding to the completion of appropriate adjustment and subsequent successful CD assessment.
(2) Quarterly and Annual Assessments. Whenever an annual zero alignment or quarterly performance audit fails to meet the criteria established in paragraphs (2) and (3) of section 10.4, the COMS is out-of-control. The beginning of the out-of-control period is the time corresponding to the completion of the performance audit indicating the failure to meet these established criteria. The end of the out-of-control period is the time corresponding to the completion of appropriate corrective actions and the subsequent successful audit (or, if applicable, partial audit).

4.0 What interferences must I avoid?
Opacity cannot be measured accurately in the presence of condensed water vapor. Thus, COMS opacity compliance determinations cannot be made when condensed water vapor is present, such as downstream of a wet scrubber without a reheater or at other saturated flue gas locations. Therefore, COMS must be located where condensed water vapor is not present.
5.0 What do I need to know to ensure the safety of persons using Procedure 3?
Those implementing Procedure 3 may be exposed to hazardous materials, operations and equipment. Procedure 3 does not purport to address all of the safety issues associated with its use. It is your responsibility to establish appropriate health and safety practices and determine the applicable regulatory limitations before performing this procedure. You should consult the COMS user's manual for specific precautions to take.
6.0 What equipment and supplies do I need?
The equipment and supplies that you need are specified in PS-1. You are not required to purchase a new COMS if your existing COMS meets the requirements specified in Procedure 3.
7.0 What reagents and standards do I need?
The reagents and standards that you need are specified in PS-1. You are not required to purchase a new COMS if your existing COMS meets the requirements specified in Procedure 3.
8.0 What sample collection, preservation, storage, and transport are relevant to this procedure? [Reserved]
9.0 What quality control measures are required by this procedure for my COMS?
You must develop and implement a QC program for your COMS. Your QC program must, at a minimum, include written procedures which describe in detail complete step-by-step procedures and operations for the activities in paragraphs (1) through (4):
(1) Procedures for performing drift checks, including both zero and upscale drift and the status indicators check,
(2) Procedures for performing quarterly performance audits,
(3) A means of checking the zero alignment of the COMS, and
(4) A program of corrective action for a malfunctioning COMS. The corrective action must include, at a minimum, the requirements specified in section 10.5.
9.1 What QA/QC documentation must I have? You are required to keep the QA/QC written procedures required in section 9.0 on site and available for inspection by us, the state, and/or local enforcement agencies.
9.2 What actions must I take if I fail QC audits? If you fail two consecutive annual audits, two consecutive quarterly audits, or five consecutive daily checks, you must either revise your QC procedures or determine if your COMS is malfunctioning. If you determine that your COMS is malfunctioning, you must take the necessary corrective action as specified in section 10.5. If you determine that your COMS requires extensive repairs, you may use a substitute COMS provided the substitute meets the requirements in section 10.6.
10.0 What calibration and standardization procedures must I perform for my COMS?
(1) You must perform daily system checks to ensure proper operation of system electronics and optics, light and radiation sources and detectors, electric or electro-mechanical systems, and general stability of the system calibration. Daily is defined as any portion of a calendar day in which a unit operates.
(2) You must subject your COMS to a performance audit to include checks of the individual COMS components and factors affecting the accuracy of the monitoring data at least once per QA operating quarter. A QA operating quarter is a calendar quarter in which a unit operates at least 168 hours.
(3) At least annually, you must perform a zero alignment by comparing the COMS simulated zero to the actual clear path zero. Annually is defined as a period wherein the unit is operating at least 28 days in a calendar year. The simulated zero device produces a simulated clear path condition or low-level opacity condition, where the energy reaching the detector is between 90 and 110 percent of the energy reaching the detector under actual clear path conditions.
10.1 What daily system checks must I perform on my COMS? The specific components required to undergo daily system checks will depend on the design details of your COMS. At a minimum, you must verify the system operating parameters listed in paragraphs (1) through (3) of this section. Some COMS may perform one or more of these functions automatically or as an integral portion of unit operations; other COMS may perform one or more of these functions manually.
(1) You must check the zero drift to ensure stability of your COMS response to the simulated zero device. The simulated zero device, an automated mechanism within the transmissometer that produces a simulated clear path condition or low-level opacity condition, is used to check the zero drift. You must, at a minimum, take corrective action on your COMS whenever the daily zero drift exceeds twice the applicable drift specification in section 13.3(6) of PS-1.
(2) You must check the upscale drift to ensure stability of your COMS response to the upscale drift value. The upscale calibration device, an automated mechanism (employing an attenuator or reduced reflectance device) within the transmissometer that produces an upscale opacity value is used to check the upscale drift. You must, at a minimum, take corrective action on your COMS whenever the daily upscale drift check exceeds twice the applicable drift specification in section 13.3(6) of PS-1.
(3) You must, at a minimum, check the status indicators, data acquisition system error messages, and other system self-diagnostic indicators. You must take appropriate corrective action based on the manufacturer's recommendations when the COMS is operating outside preset limits.

10.2 What are the quarterly auditing requirements for my COMS? At a minimum, the parameters listed in paragraphs (1) through (3) of this section must be included in the performance audit conducted on a quarterly basis as defined in section 10.0(2).
(1) For units with automatic zero compensation, you must determine the zero compensation for the COMS. The value of the zero compensation applied at the time of the audit must be calculated as equivalent opacity and corrected to stack exit conditions according to the procedures specified by the manufacturer. The compensation applied to the effluent by the monitor system must be recorded.
(2) You must conduct a three-point calibration error test of the COMS. Three calibration attenuators, either primary or secondary must meet the requirements of PS-1, with one exception. Instead of recalibrating the attenuators semi-annually, they must be recalibrated annually. If two annual calibrations agree within 0.5 percent opacity, the attenuators may then be calibrated once every five years. The three attenuators must be placed in the COMS light beam path for at least three nonconsecutive readings. All monitor responses must then be independently recorded from the COMS permanent data recorder. Additional guidance for conducting this test is included in section 8.1(3)(ii) of PS-1. The low-, mid-, and high-range calibration error results must be computed as the mean difference and 95 percent confidence interval for the difference between the expected and actual responses of the monitor as corrected to stack exit conditions. The equations necessary to perform the calculations are found in section 12.0 of PS-1. For the calibration error test method, you must use the external audit device. When the external audit device is installed, with no calibration attenuator inserted, the COMS measurement reading must be less than or equal to one percent opacity. You must also document procedures for properly handling and storing the external audit device and calibration attenuators within your written QC program.
(3) You must check the optical alignment of the COMS in accordance with the instrument manufacturer's recommendations. If the optical alignment varies with stack temperature, perform the optical alignment test when the unit is operating.
10.3 What are the annual auditing requirements for my COMS?
(1) You must perform the primary zero alignment method under clear path conditions. The COMS must be removed from its installation and set up under clear path conditions. There must be no adjustments to the monitor other than the establishment of the proper monitor path length and correct optical alignment of the COMS components. You must record the COMS response to a clear condition and to the COMS's simulated zero condition as percent opacity corrected to stack exit conditions. For a COMS with automatic zero compensation, you must disconnect or disable the zero compensation mechanism or record the amount of correction applied to the COMS's simulated zero condition. The response difference in percent opacity to the clear path and simulated zero conditions must be recorded as the zero alignment error. You must adjust the COMS's simulated zero device to provide the same response as the clear path condition as specified in paragraph (3) of section 10.0.
(2) As an alternative, monitors capable of allowing the installation of an external zero device may use the device for the zero alignment provided that: (1) The external zero device setting has been established for the monitor path length and recorded for the specific COMS by comparison of the COMS responses to the installed external zero device and to the clear path condition, and (2) the external zero device is demonstrated to be capable of producing a consistent zero response when it is repeatedly (i.e., three consecutive installations and removals prior to conducting the final zero alignment check) installed on the COMS. This can be demonstrated by either the manufacturer's certificate of conformance (MCOC) or actual on-site performance. The external zero device setting must be permanently set at the time of initial zeroing to the clear path zero value and protected when not in use to ensure that the setting equivalent to zero opacity does not change. The external zero device response must be checked and recorded prior to initiating the zero alignment. If the external zero device setting has changed, you must remove the COMS from the stack in order to reset the external zero device. If you employ an external zero device, you must perform the zero alignment audits with the COMS off the stack at least every three years. If the external zero device is adjusted within the three-year period, you must perform the zero alignment with the COMS off the stack no later than three years from the date of adjustment.
(3) The procedure in section 6.8 of ASTM D6216-12 is allowed.
10.4 What are my limits for excessive audit inaccuracy? Unless specified otherwise in the applicable subpart, the criteria for excessive inaccuracy are listed in paragraphs (1) through (4).
(1) What is the criterion for excessive zero or upscale drift? Your COMS is out-of-control if either the zero drift check or upscale drift check exceeds twice the applicable drift specification in PS-1 for any one day.
(2) What is the criterion for excessive zero alignment? Your COMS is out-of-control if the zero alignment error exceeds 2 percent opacity.
(3) What is the criterion to pass the quarterly performance audit? Your COMS is out-of-control if the results of a quarterly performance audit indicate noncompliance with the following criteria:
(i) The optical alignment indicator does not show proper alignment (i.e., does not fall within a specific reference mark or condition).
(ii) The zero compensation exceeds 4 percent opacity, or
(iii) The calibration error exceeds 3 percent opacity.
(4) What is the criterion for data capture? You must adhere to the data capture criterion specified in the applicable subpart.
10.5 What corrective action must I take if my COMS is malfunctioning? You must have a corrective action program in place to address the repair and/or maintenance of your COMS. The corrective action program must address routine/preventative maintenance and various types of analyzer repairs. The corrective action program must establish what diagnostic testing must be performed after each type of activity to ensure that the COMS is collecting valid, quality-assured data. Recommended maintenance and repair procedures and diagnostic testing after repairs may be found in an associated guidance document.

10.6 What requirements must I meet if I use a temporary opacity monitor?
(1) In the event that your certified opacity monitor has to be removed for extended service, you may install a temporary replacement monitor to obtain required opacity emissions data provided that:
(i) The temporary monitor has been certified according to ASTM D6216-12 for which a MCOC has been provided;
(ii) The use of the temporary monitor does not exceed 1080 hours (45 days) of operation per year as a replacement for a fully certified opacity monitor. After that time, the analyzer must complete a full certification according to PS-1 prior to further use as a temporary replacement monitor. Once a temporary replacement monitor has been installed and required testing and adjustments have been successfully completed, it cannot be replaced by another temporary replacement monitor to avoid the full PS-1 certification testing required after 1080 hours (45 days) of use;
(iii) The temporary monitor has been installed and successfully completed an optical alignment assessment and status indicator assessment;
(iv) The temporary monitor has successfully completed an off-stack clear path zero assessment and zero calibration value adjustment procedure;
(v) The temporary monitor has successfully completed an abbreviated zero and upscale drift check consisting of seven zero and upscale calibration value drift checks which may be conducted within a 24-hour period with not more than one calibration drift check every three hours and not less than one calibration drift check every 25 hours. Calculated zero and upscale drift requirements are the same as specified for the normal PS-1 certification;
(vi) The temporary monitor has successfully completed a three-point calibration error test;
(vii) The upscale reference calibration check value of the new monitor has been updated in the associated data recording equipment;
(viii) The overall calibration of the monitor and data recording equipment has been verified; and
(ix) The user has documented all of the above in the maintenance log.
(2) Data generated by the temporary monitor is considered valid when paragraphs (i) through (ix) in this section have been met.
10.7 When do out-of-control periods begin and end? The out-of-control periods are as specified in section 3.1.
10.8 What are the limitations on the use of my COMS data collected during out-of-control periods? During the period your COMS is out-of-control, you may not use your COMS data to calculate emission compliance or to meet minimum data capture requirements in this procedure or the applicable regulation.
10.9 What are the QA/QC reporting requirements for my COMS? You must report in a Data Assessment Report (DAR) the information required by sections 10.0, 10.1, 10.2, and 10.3 for your COMS at the interval specified in the applicable regulation.
10.10 What minimum information must I include in my DAR? At a minimum, you must include the information listed in paragraphs (1) through (5) of this section in the DAR.
(1) Name of person completing the report and facility address,
(2) Identification and location of your COMS(s),
(3) Manufacturer, model, and serial number of your COMS(s),
(4) Assessment of COMS data accuracy/acceptability and date of assessment as determined by a performance audit described in section 10.0. If the accuracy audit results show your COMS to be out-of-control, you must report both the audit results showing your COMS to be out-of-control and the results of the audit following corrective action showing your COMS to be operating within specifications, and
(5) Summary of all corrective actions you took when you determined your COMS was out-of-control.
10.11 Where and how long must I retain the QA data that this procedure requires me to record for my COMS? You must keep the records required by this procedure for your COMS on site and available for inspection by us, the state, and/or the local enforcement agency for the period specified in the regulations requiring the use of COMS.
11.0 What analytical procedures apply to this procedure? [Reserved]
12.0 What calculations and data analysis must I perform for my COMS?
The calculations required for the quarterly performance audit are in section 12.0 of PS-1.
13.0 Method Performance [Reserved]
14.0 Pollution Prevention [Reserved]
15.0 Waste Management [Reserved]
16.0 References
16.1 Performance Specification 1-Specifications and Test Procedures for Continuous Opacity Monitoring Systems in Stationary Sources, 40 CFR part 60, Appendix B.
16.2 ASTM D6216-12-Standard Practice for Opacity Monitor Manufacturers to Certify Conformance with Design and Performance Specifications, American Society for Testing and Materials (ASTM).
17.0 What tables, diagrams, flowcharts, and validation data are relevant to this procedure? [Reserved]

Method ALT-109 Approval of Alternative Approach for Method 22 Outdoor Location Field Record

[https://www3.epa.gov/ttn/emc/approalt/alt109.pdf]

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

April 29, 2015

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

Jason Rauen
Senior Specialist
EOG Resources, Inc.
600 Seventeenth Street
Suite 1000N
Denver, CO 80202

Dear Mr. Rauen:

I write in response to your letter of February 13, 2015, requesting the use of an alternative approach to the field record requirements of Section 11.2.1 of EPA Method 22, 40 CFR part 60 Appendix A-7, in application of Method 22 as visible emissions inspections in accordance with regulations given in 40 CFR part 60 Subpart OOOO "Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution," 40 CFR 63.11(b), and 40 CFR part 63, Subpart HH "National Emission Standards for Hazardous Air Pollutants From Oil and Natural Gas Production Facilities."

Section 11.2.1 of Method 22 requires the recording of company name, industry, process unit, observer's name, observer's affiliation, date, estimated wind speed, wind direction, sky condition, and a sketch of the process unit being observed showing the observer location relative to the source and the sun and an indication of the potential and actual emission points. You request to use digital photographic documentation in lieu of sketch or recorded information for relative position of the observer to the source and sun, potential and actual emissions points, and sky conditions during the measurement. Your request seeks to improve efficiencies and allow for new technology in the recordkeeping process of Method 22, especially with respect to the transition to electronic systems.

We approve this alternative for the use of digital photographic documentation for the following parts of Section 11.2.1 of Method 22:

1. Sky condition,
2. Observer's location relative to the source,
3. Observer's location relative to the sun,
4. Sketch of process unit being observed,
5. Potential emission points, and
6. Actual emission points.

In order to use the digital photographic documentation, the following criteria must be met:

- The image must have the proper field of view and depth of field to properly distinguish the sky condition, process unit, potential emission point and actual emission point.

- The image must be taken from the point of view of the observer.
- The image must be taken within a reasonable time of the observation to show sky conditions and sun location (i.e., within 15 minutes of the start or end time of the Method 22 observation).
- If the image is annotated or altered (e.g., to highlight the potential emission points), the original unaltered digital image must be retained per the appropriate recordkeeping provisions (e.g., those contained in 40 CFR 63.10).

This approval is applicable only to the outside location field record (Section 11.2.1 of Method 22).

We believe your alternative method would be applicable to source categories other than the ones you mention, therefore, we approve the use of this alternative whenever Method 22 is required by any federal regulation within 40 CFR parts 60, 61, or 63. Since this alternative method will be available for use by other facilities, we will post this broadly applicable alternative test method on our website at *http://www.epa.gov/ttnemc01/approalt.html* for use by other interested parties.

If you have any questions or would like to discuss this matter further, please call Jason M. DeWees of my staff at (919)-541-9724, or you may email him at dewees.jason@epa.gov.

Sincerely,

Barrett H. Parker, Acting Leader
Measurement Technology Group

Cc: Jason DeWees, EPA/OAQPS/AQAD

Robin Segall, EPA/OAQPS/AQAD

Alexis North, EPA Region 8

Fred DiLella, Wyoming Department of Environmental Quality

Mark McMillan, Colorado Department of Public Health and Environment

Jennifer Mattox, Colorado Department of Public Health and Environment

Note about Broadly Applicable Approved Alternative Test Methods:

These methods are approved alternatives to the methods required by 40 CFR Parts 60, 61 and 63 as described by the General Provisions of the corresponding Parts and as further explained in a Federal Register notice dated January 30, 2007. As such, the methods may be used by sources for determining compliance with the requirements of these Parts per their specified applicability provisions without further EPA approval. The Administrator, or designee (currently Steffan Johnson, Group Leader of the Measurement Technology Group in the Air Quality Assessment Division of the Office of Air Quality Planning and Standards), has approved these methods for the specified applications; this approval has been documented through an official EPA letter. These methods include quality control and quality assurance procedures that must be met. The EPA staff may not necessarily be the technical experts on these methods.

REFERENCES

These documents contain technical information and guidance for visible emission determinations by trained observers.

Field Observation Procedures

- Guidelines for Evaluation of Visible Emissions: Certification, Field Procedures, Legal Aspects, and Background Material, EPA 340/l-75-007, 4/75.
- EPA Visible Emission Inspection Procedures, S. 24, 8/75.
- Quality Assurance Handbook for Air Pollution Measurements Systems: Vol. III Stationary Source-Specific Methods, Section 3.12 - Method 9 Visible Determination of Opacity of Emissions from Stationary Sources, EPA 600/4-77-027b, 2/84.
- Guide to Effective Inspection Reports for Air Pollution Violations, EPA 340/1-85-019, 9/85.
- Instructions for the Use of the VE Observation Form, EPA 340/1-86-017, 1/86.
- EPA Visible Emission Field Manual, EPA 340/1-92-004.
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- Evaluation and Collaborative Study of Method for Visual Determination of Opacity of Emissions from Stationary Sources, EPA 650/4-75-009, 1/75.
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- Evaluation of Visible Fugitive Emission Data, (Final Draft) SSCD/SR 1-11-83, 11/83.
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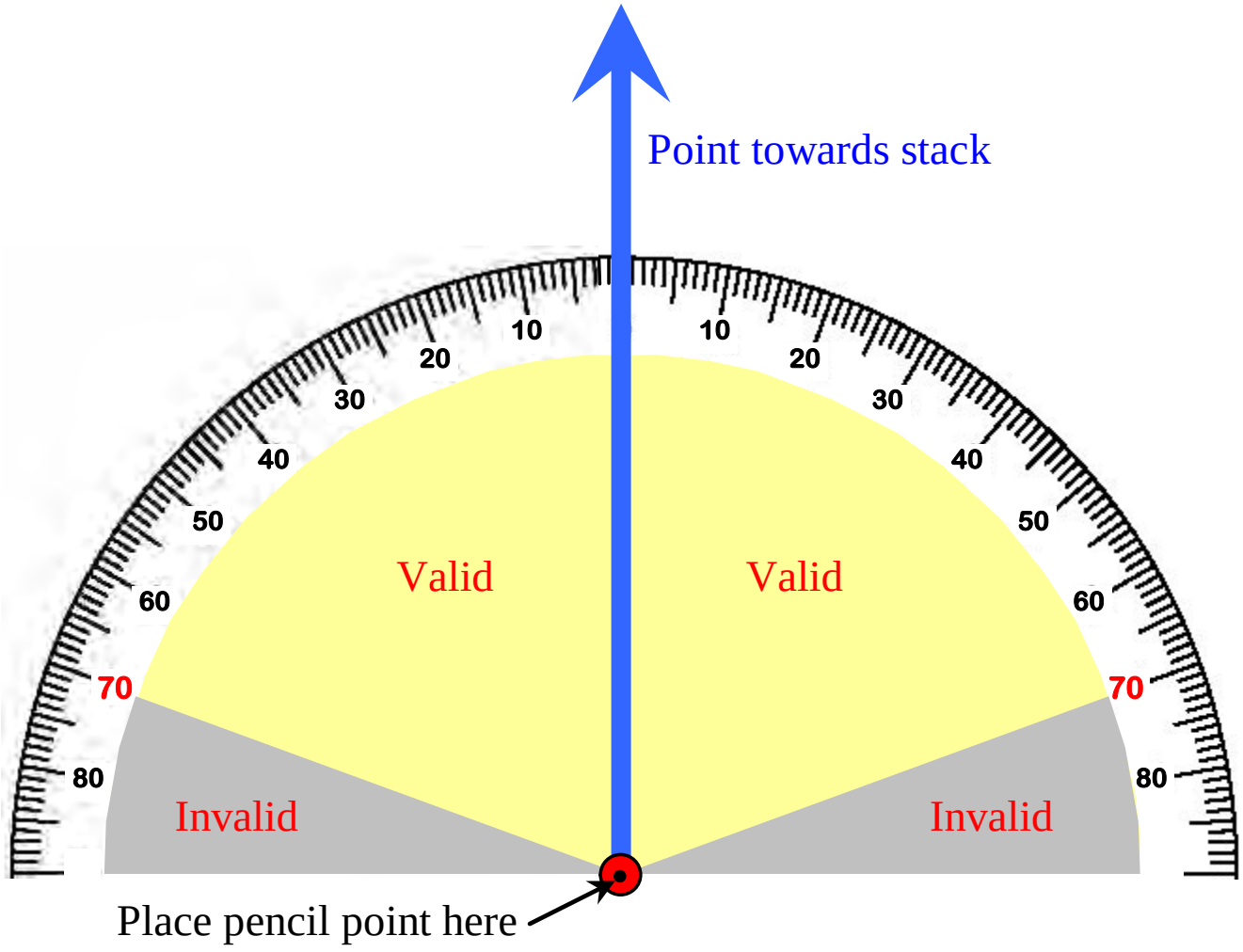
- Visible Emission Enforcement Workshop - Smoke Generator Troubleshooting Guide.
- Confidence Interval Calculations for Smoke School Operation.
- Control Techniques for Fugitive VOC Emissions from Chemical Process Facilities, EPA/625/R-93/005, 3/94.

FORMS

Sun Shadow Line

(Use this diagram to determine if the sun is oriented in the 140º sector to your back)

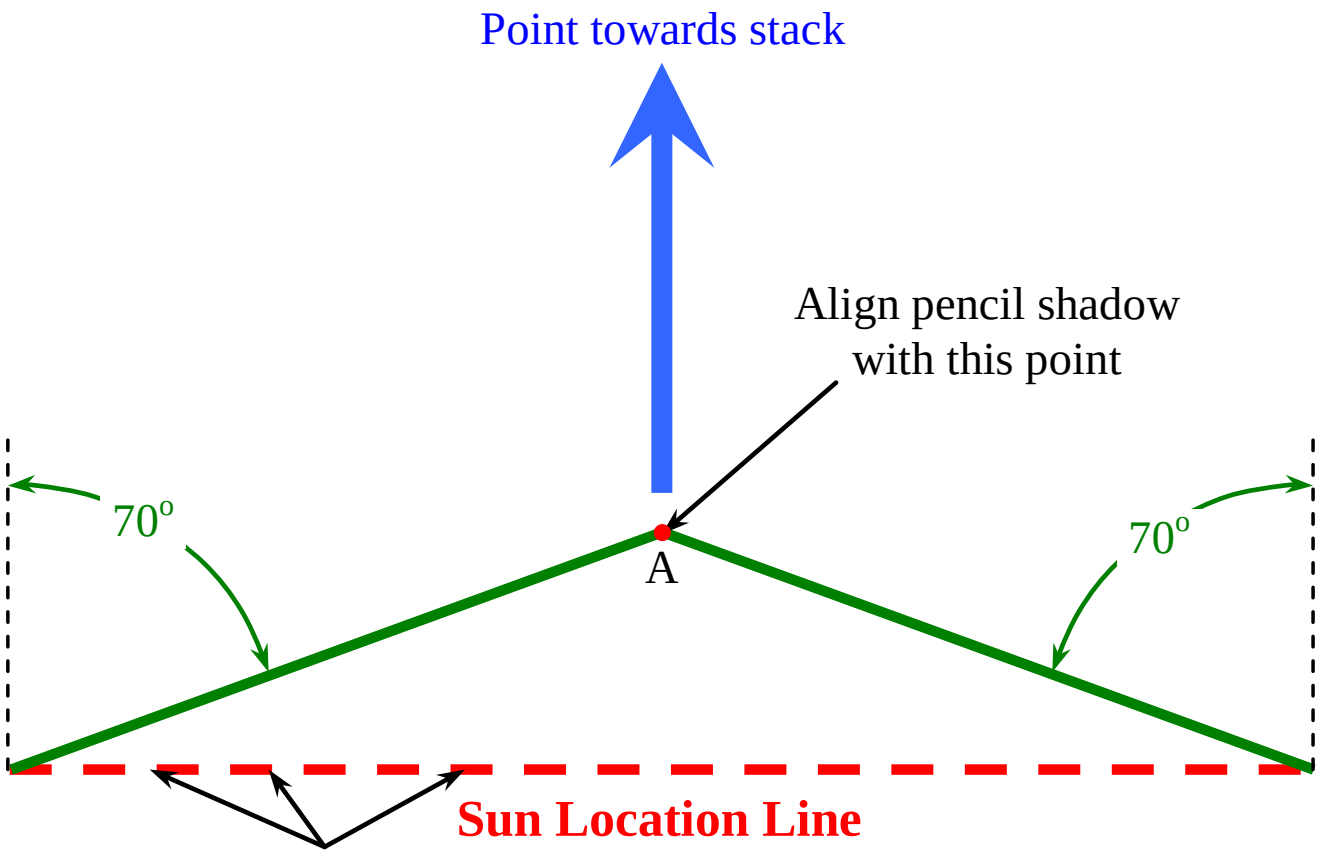


Instructions:

1. Hold paper horizontally and point arrow towards the stack
2. Hold a pencil vertically and place the point of the pencil at the indicated location
3. Sketch the position of the pencil's shadow on the protractor region
4. The shadow must lie in the valid range

Sun Location Line

(Use this diagram to determine if the sun is oriented in the 140º sector to your back)



Instructions:

1. Hold paper horizontally and point arrow towards the stack
2. Hold a pencil vertically and place the point of the pencil along the sun location line
3. Move the pencil tip along the sun location line until its shadow intersects the top of the triangle
4. Mark the location of the pencil tip
5. The reading is valid if the mark lies *along* the sun location line

Description of Source

General information:	
Test or observation number	
Observation date	
Hours of observation	
Observer information:	
Observer name	
Observer affiliation	
Observer Method 9 certification date	
Name of Method 9 certifying agency	
Company, facility, and source information:	
Company name	
Company location or address	
Type of facility	
Specific information about source	
Source ID number	
Control device(s) (In use? – Y or N)	
Point of emission	
Height of discharge point (ft)	
Stack diameter (ft)	
Observer location and plume direction:	
Distance from observer to emission point (ft)	
Height of observer location (ft)	
Description of observer location	
Prominent direction of plume (e.g., NE to SW)	

Sketch (source, observer, direction of plume – indicate North, wind direction, buildings, roads, etc.):

Summary of Data

	Beginning		End
Time:			
Description of plume:			
describe emission (continuous, fugitive, intermittent, etc.)			
color			
type			
water drops present? (Y or N)			
attached steam plume? (Y or N)			
detached steam plume? (Y or N)			
secondary plume? (Y or N)			
point in plume where opacity read			
target used behind plume? (Y or N)			
describe background behind plume			
Weather conditions:			
wind direction (indicate both to and from)			
approximate wind speed (mph)			
air temperature (degrees F)			
approximate percentage of cloud cover			
relative humidity (%)			
presence of rain, fog, snow, haze, etc.? (if so, describe)			
approximate visibility (miles; write “clear” if clear conditions)			
Glasses and/or sunglasses:			
corrective lenses worn? (Y or N)			
contact lenses worn? (Y or N)			
sunglasses worn? (Y or N; if so, describe type)			

Describe any unique features of the plume or any unusual events during observation:

Name, visual emissions observer	Title	Signature	Date

Name, company representative	Title	Signature	Date

Six-Minute Opacity Data Sheet

Page ____ of ____

Opacity observations (%), every 15 seconds for 6 minutes. Average = (sum of 24 observations)/24:

Record number				
Start (hour, min)				
End (hour, min)				
min.	0 s	15 s	30 s	45 s
0				
1				
2				
3				
4				
5				
Average opacity				%

Record number				
Start (hour, min)				
End (hour, min)				
min.	0 s	15 s	30 s	45 s
0				
1				
2				
3				
4				
5				
Average opacity				%

Record number				
Start (hour, min)				
End (hour, min)				
min.	0 s	15 s	30 s	45 s
0				
1				
2				
3				
4				
5				
Average opacity				%

Record number				
Start (hour, min)				
End (hour, min)				
min.	0 s	15 s	30 s	45 s
0				
1				
2				
3				
4				
5				
Average opacity				%

Record number				
Start (hour, min)				
End (hour, min)				
min.	0 s	15 s	30 s	45 s
0				
1				
2				
3				
4				
5				
Average opacity				%

Record number				
Start (hour, min)				
End (hour, min)				
min.	0 s	15 s	30 s	45 s
0				
1				
2				
3				
4				
5				
Average opacity				%

Record number				
Start (hour, min)				
End (hour, min)				
min.	0 s	15 s	30 s	45 s
0				
1				
2				
3				
4				
5				
Average opacity				%

Record number				
Start (hour, min)				
End (hour, min)				
min.	0 s	15 s	30 s	45 s
0				
1				
2				
3				
4				
5				
Average opacity				%

Record number				
Start (hour, min)				
End (hour, min)				
min.	0 s	15 s	30 s	45 s
0				
1				
2				
3				
4				
5				
Average opacity				%

One-Hour Opacity Data Sheet

Opacity observations (%), every 15 seconds for one full hour (240 observations):

Record number				
min.	0 s	15 s	30 s	45 s
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				

Start (hour, min)				
min.	0 s	15 s	30 s	45 s
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				

End (hour, min)				
min.	0 s	15 s	30 s	45 s
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				
52				
53				
54				
55				
56				
57				
58				
59				

Summary:

Opacity	Number of observations	Time in minutes (divide number of observations by 4)	PA Title 25 Regulation
< 20%			-
≥ 20%			Out of compliance if more than 3 minutes (more than 12 readings)
≥ 60%			Out of compliance if any single observation ≥ 60%

This source was (circle one) in compliance out of compliance at the time of this evaluation.

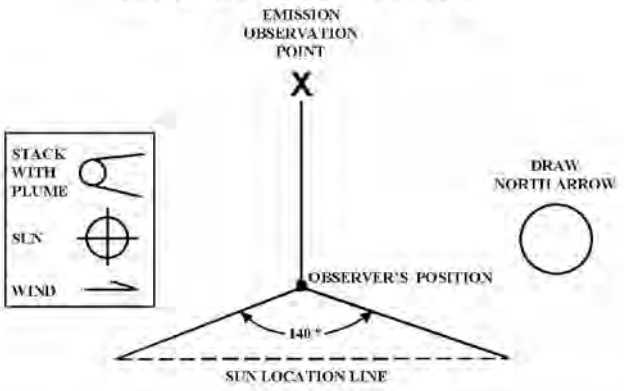
Name, visual emissions observer	Title	Signature	Date

Name, company representative	Title	Signature	Date

VISIBLE EMISSION OBSERVATION FORM

Company Name		
Location		
City	**State**	**Zip**
Process Equipment		**Operating Mode**
Control Equipment		**Operating Mode**
Describe Emission Point		
Height of Emission Point	**Height Relative to Observer** Start End	
Distance to Emission Point Start End	**Direction to Emission Point** Start End	
Vertical Angle to Observation Pt. Start End	**Direction to Observation Point** Start End	
Describe Emissions Start End		
Emission Color Start End	**If Water Droplet Plume (Circle)** Attached Detached N/A	
Point In The Plume At Which Opacity Was Determined Start End		
Describe Plume Background Start End		
Background Color Start End	**Sky Condition** Start End	
Wind Speed Start End	**Wind Direction** Start End	
Ambient Temp Start End	**Wet Bulb Temp**	**RH Percent**

SOURCE LAYOUT SKETCH



Additional Information

Observation Date	**Start Time**	**End Time**

Sec / Min	0	15	30	45	Comments
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Observer's Name (Print)	
Observer's Signature	**Date**
Organization	
Certified by	**Date**

Continue on reverse side

Sec / Min	0	15	30	45	Comments
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					
52					
53					
54					
55					
56					
57					
58					
59					
60					

Additional Information

Source: Arizona Department of Environmental Quality, www.azdeq.gov/environ/air/compliance/download/veo.pdf

The Beaufort Scale: A simple way to estimate wind speed

Wind force number (Beaufort number)	Description	Approximate speed at 20 ft (6.1 m) above the ground				Observation/Specification
		mph	km/h	knots	m/s	
0	Calm	< 1	< 1	< 1	< 0.5	Smoke rises vertically
1	Light Air	1-3	1-5	1-3	0.5-1.7	Smoke drifts slowly; wind vanes and flags stay still
2	Slight Breeze	4-7	6-11	4-6	1.8-3.5	Wind felt on face; leaves rustle; flags stir; wind vanes move
3	Gentle Breeze	8-12	12-19	7-10	3.6-5.7	Leaves and small twigs in constant motion; flags are unfurled and flap
4	Moderate Breeze	13-18	20-29	11-16	5.8-8.4	Dust and loose paper blow around; small branches move; flags flap
5	Fresh Breeze	19-24	30-39	17-21	8.5-11.1	Small trees with leaves begin to sway; flags ripple
6	Strong Breeze	25-31	40-50	22-27	11.2-14.2	Large branches sway; flags beat; air whistles around telephone and power wires
7	Moderate Gale	32-38	51-61	28-33	14.3-17.3	Whole trees sway; flags extended; it can be hard to walk into the wind
8	Fresh Gale	39-46	62-74	34-40	17.4-20.9	Twigs break off trees; walking is hindered
9	Strong Gale	47-54	75-85	41-47	21.0-24.5	Branches break off trees; slight damage to buildings (shingles blow off roofs)
10	Whole Gale	55-63	89-101	48-55	24.6-28.5	Trees broken or uprooted; buildings definitely damaged
11	Storm	64-73	102-118	56-63	28.6-33.0	Widespread damage to buildings; trees blow across the ground
12	Hurricane	74+	119+	64+	33.1+	Extreme destruction; trees and power lines knocked down

Adapted from Meteorology Education and Training website, http://www.meted.ucar.edu/