ENVIRONMENTAL HEALTH AND SAFETY
University of Nebraska-Lincoln

Safe Operating Procedure

(REVISED 5/21)

OPACITY OF EMISSIONS FROM COMBUSTION SOURCES AND OPERATING LOG RECORDS

The University of Nebraska-Lincoln (UNL) Air Quality Operating Permits require monitoring of visible stack emissions (opacity) from stationary combustion sources and written operating logs. This Safe Operating Procedure (SOP) provides a summary of opacity monitoring and operating log requirements associated with the following combustion sources:

- UNL East Campus NVDC Pathological Waste Incinerators
- UNL City and East Campus Physical Utility Plants

Definition and Visual Determination of Opacity

Method 9

With regards to stack emissions, opacity is the degree to which visibility of a background (i.e., blue sky) is reduced by particulates (smoke). The ***EPA Method 9 Opacity Observation Form***, provided in Appendix A, is the enforceable monitoring record which evaluates the quantitative 20% opacity limit. Only persons with current credentials as an EPA Method 9 Certified Observer are authorized to evaluate stack emissions using EPA Method 9. Measurements are made as a percentage in increments of 5. At an opacity reading of 5%, for example, smoke blocks enough of the background to be just visible. At 20%, the legal limit, smoke blocks enough of the background that the smoke is very visible with distinct edges. See the Washington State Department of Ecology pictures at the end of this SOP for an example of 20%, 40% and 80% opacities.

In cold weather, steam is often a part of the emission. In order to make an accurate reading, opacity must be read after the steam has dissipated. This change is readily visible as the apparent opacity will drop significantly but stay constant after that.

Method 22

Method 22 is a Visible Emissions (VE) survey, described in Appendix B, which can be used to assess whether a formal Method 9 Opacity Observation needs to be conducted. Method 22 indicates only the presence or absence of VE rather than an actual opacity value (%) as determined by Method 9. Since Method 22 does not require opacity levels of emissions be determined, observer certification is not required. However, the observer must be educated on the general procedures for determining the presence of VE. At a minimum, the observer must be trained and knowledgeable regarding the effects caused by background contrast, sunlight, wind direction, observation point, etc., before conducting the VE survey. This training can be obtained from the lecture portion of the Method 9 certification course.

Method 22 surveys determine the accumulated amount of time that VE occur during the observation period. The required observation period is 6 minutes. If VE are detected for less than 5% of the observation time (less than 18 total seconds), record your observation on Method 22 VE survey form and *no further action is required*.

If VE are detected for 5% or more of the 6-minute observation time (18 seconds or more), then one of two following actions must be taken:

1. Take necessary corrective action to eliminate VE within one hour, then conduct a follow-up Method 22 VE survey to ensure corrective action addressed the VE. If VE are detected for less than 5% of the observation time (less than 18 total seconds), record the follow-up observation on Method 22 VE form and *no further action is required*. Corrective action(s) and follow-up survey(s) may be repeated (within one hour) until elimination of VE is achieved; or
2. An EPA Certified Observer may conduct a formal EPA Method 9 opacity reading no later than one hour after the initial Method 22 VE survey to verify compliance with 20% six minute average opacity limit. If the result of a single 6-minute Method 9 opacity reading exceeds 20% during normal operation, the condition must be reported to Environmental Health and Safety (EHS) immediately. If the result is less than 20%, *no further action is required.*

Note: A formal EPA Method 9 Observation can be performed by an EPA Certified Observer in lieu of initial or follow-up Method 22 VE surveys at any time.

UNL's Air Permit Opacity Monitoring Requirements

- **Pathological Waste Incinerator**
  Visible emissions from the Incinerator must be monitored at least once during each month the unit operates. In addition, Method 22 VE form must be filled out *every month* regardless of whether the unit operates (see Instructions in Appendix B)

  When the unit is in operation during any given month, compliance with the 20% six-minute average opacity limit must be verified, maintained, and documented either by Method 9 or Method 22 (which verifies Method 9 not required). If the result of a single 6-minute Method 9 opacity reading exceeds 20% during normal operation, the condition must be reported to Environmental Health and Safety (EHS) immediately. *Opacity monitoring is not required during startups, shutdowns, malfunctions, or after sunset and during inclement weather.*

- **City and East Campus Utility Plant**
  Visible emissions from the Utility Plant boilers must be monitored at least once each month when fuel oil is combusted at "service load" operations for greater than 24 hrs. In addition, Method 22 VE form must be filled out *every month* regardless of whether a boiler is operated on fuel oil (see Instructions in Appendix B)

  When the boilers are operating on fuel oil, compliance with the 20% six-minute average opacity limit must be verified, maintained, and documented either by Method 9 or Method 22 (which verifies Method 9 not required). If the result of a single 6-minute Method 9 opacity reading exceeds 20% during normal operation, the condition must be reported to Environmental Health and Safety (EHS) immediately and corrective action taken to eliminate the excess emissions. *Opacity monitoring is not required during startups, shutdowns, malfunctions, after sunset and during inclement weather, during load testing, or when boilers are operated on natural gas.*

Training Requirements

- For EPA Method 9 Certification (a.k.a 'Smoke School') there are two components to the certification process; lecture and field testing. The lecture portion reviews proper observation and documentation procedures and is recommended every 3 years. The field testing portion trains, tests, and certifies operators on their ability to read (observe) the percent opacity of visible

emissions. If operators conduct a formal EPA Method 9 Observation, they must be an EPA Method 9 Certified Observer. Method 9 observation date must be within six (6) months of certification date and operators must re-test and pass field test qualification procedures every 6 months to retain valid EPA Method 9 Certification.

- For Method 22, operators must be familiar with the qualitative technique that checks only the presence or absence of VE. Operators simply record the amount of time (how many seconds) VE are observed. No certification is required. However, since knowledge of observation procedures is essential, operators must have training. This can be obtained from the lecture portion of the Method 9 certification course. Observers must maintain competency to perform accurate Method 22 VE readings.

Recordkeeping and Reporting

EPA Method 9 Opacity Observation Forms & Method 22 VE monthly surveys must be maintained for a minimum of 5 years. Method 9 Certified Observers are required to use the ***EPA Method 9 Opacity Observation Form***, provided in Appendix A. Specific instructions on how to measure and record Method 9 opacity readings and Method 22 VE surveys are included in the instructional pages following the forms.

- Incinerators – Opacity monitoring and survey records must be maintained on-site. These records are subject to review by regulatory authorities. The record must include every month when VE monitoring/surveying was not performed because the unit was not operated. Therefore, the VE log must be completed for every month of the year. The Method 22 form at the end of this SOP can be used for this purpose.
- East Campus Utility Plant boilers – Opacity monitoring and survey records must be maintained on-site. These records are subject to review by regulatory authorities. The record must include every month when VE monitoring/surveying was not performed because the unit was not operated. Therefore, the VE log must be completed for every month of the year. The Method 22 form at the end of this SOP can be used for this purpose.
- City Campus Utility Plant boilers – Opacity monitoring and survey records must be maintained on-site. These records are subject to review by regulatory authorities. In addition, copies of ***EPA Method 9 Opacity Observation Forms*** must be submitted to EHS on a monthly basis (no later than the 15th for the preceding month; and typically submitted with the fuel burn/emissions records). EHS is required to submit all ***EPA Method 9 Opacity Observation Forms*** to regulatory authorities on a regular reporting basis.

References

[1]EPA Method 9-*Visual Determination of the Opacity of Emissions from Stationary Sources* can be found at *40 Code of Federal Regulations, Chapter I, Part 60, Appendix A, Method 9*.

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Appendix A

EPA Method 9 Opacity Observation Form

EPA Method 9 Opacity Observation Form
University of Nebraska – Lincoln

Process Equipment (Check appropriate box) Lincoln, NE 68583

☐ **NVDC** Consumat C-75P Incinerator (4040 EC Loop)
☐ **NVDC** Consumat C-225P Incinerator (4040 EC Loop)
☐ **CC Utility Plant** (14th & Avery St) Boiler # _____
☐ **EC Utility Plant** (37th & EC Loop) Boiler # _____

1. Operating Mode *(i.e., Full Capacity or 80% capacity etc.)* ____________

2. Describe Emission Point *Stack location, color, shape etc., for ID purposes (i.e., tallest, easternmost, red brick, circular stack etc.)*

3. Height of Emission Point: *What is height of stack from ground level?*

4. Height of Emission Point Relative to Observer: *What is stack height relative to your position? Above your position (+)? Below your position (-)?*
start: **end:**

5. Distance to Emission Point: *The distance from you to stack exit. You should be at least 3 stack heights away from stack exit.*
start: **end:**

6. Direction Emission Point: *Use compass (0-360) in degrees (Reference to 'North on sketch)*
start: ° **end:** °

7. Vertical Angle to Observation Point *Angle from you to observation point.*
start: ° **end:** °

8. Direction to Observation Point: *Use compass (0-360) in degrees (Reference to 'North' on sketch)*

9. Distance & Direction to Observation Point from Emission Point: *(100 ft west)*

10. Describe Emissions: *Plume behavior/ physical characteristics. Coning? Looping? Secondary particle formation? etc.*
start:
end:

11. Emission Color: *(Gray, white, clear)*
start: **end:**

12. Water Droplet Plume: ☐None
☐Attached *(forms prior to exiting stack)*
☐Detached *(forms after exiting stack)*

12. Describe Plume Background & Color: *What is plume read against? Blue sky? White clouds? Green trees? etc.*
start: **end:**

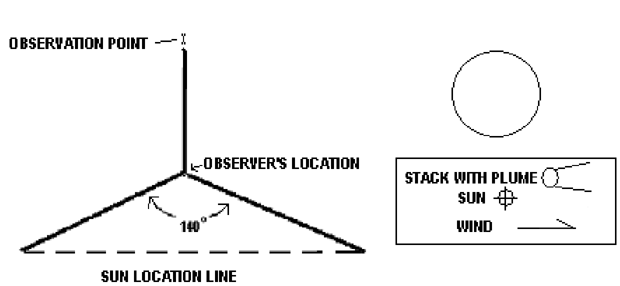
13. Sky Conditions: *Indicate cloud cover by description (i.e., clear, scattered, overcast)*
start: **end:**

14. Wind Speed: *Obtain from internet (i.e., Nat'l Weather Service)*
start: **end:**

15. Wind Direction: *from* _______ *(Direction must be perpendicular to your position – indicate on sketch)*
start: **end:**

17. Source Layout Sketch

DRAW NORTH ARROW



Observation Point: Area of plume that you are reading opacity
Observer's Location: You
Sun Location Line: The sun has to be at your back within 140°

Date	Start Time	Stop Time	Outside Temp		
Sec / Min	0	15	30	45	Comments
1					
2					
3					
4					
5					
6					

Date	Start Time	Stop Time	Outside Temp		
Sec / Min	0	15	30	45	Comments
1					
2					
3					
4					
5					
6					

Date	Start Time	Stop Time	Outside Temp		
Sec / Min	0	15	30	45	Comments
1					
2					
3					
4					
5					
6					

Observer's Name (Print)	
Observer's Signature	Date

Additional Information:

Instructions for EPA Method 9 Opacity Observation Form

All entries must be legible. Use a separate form for each source and each reading. Complete every field on the left side of the form. Write N/A if not applicable. Maintain the completed form for 5 years and make it readily available for state and/or federal environmental inspectors.

Specific instructions for completing each field:

1. **OPERATING MODE:** Manner at which the process equipment is operating
   a. (i.e., 85% maximum capacity)
2. **DESCRIBE EMISSION POINT:** Stack or emission point location, color, shape etc., for identification purposes (i.e., tallest, easternmost, red brick, circular stack).
3. **HEIGHT OF EMISSION POINT:** Stack or emission point height, from engineering drawings. The height may also be estimated by observer.
4. **HEIGHT OF EMISSION POINT RELATIVE TO OBSERVER:** Stack or emission point height relative to your position (above your position +, below your position -).
5. **DISTANCE TO EMISSION POINT:** The distance from your eyes to the above emissions point, or stack exit. Your position should be at least 3 times farther away from the emission point as the height of the emissions point relative to your position. You can make an educated guess.
6. **DIRECTION TO EMISSION POINT (Degrees):** Use a compass or make an educated guess of the angle. (Reference to 'North' on sketch)
7. **VERTICAL ANGLE TO OBSERVATION POINT:** Vertical angle from you to observation point (i.e., point in plume at which opacity was determined)
8. **DIRECTION TO OBSERVATION POINT (Degrees):** Use a compass to identify the direction to observation point from the observer position.
9. **DISTANCE & DIRECTION TO OBSERVATION POINT FROM EMISSION POINT:** (i.e., 100 ft west)
10. **DESCRIBE EMISSIONS:** Plume behavior and/or physical characteristics (i.e., coning, looping, secondary particle formation, etc.)
11. **EMISSION COLOR:** Gray, brown, white, etc.
12. **DESCRIBE PLUME BACKGROUND & COLOR:** Object(s) plume is read against (i.e., blue sky, white clouds, green tree, building etc).
13. **WATER DROPLET PLUME:** Indicate 'None' if no steam is present. If steam is present, specify 'Attached' (forms prior to exiting stack) or 'Detached' (forms after exiting stack).
14. **SKY CONDITIONS:** Indicate cloud cover by description (i.e., clear, scattered, overcast).

15. **WIND SPEED:** Miles per hour wind speed can be obtained from local weather news reports or from National Weather Service Internet sites. Be accurate to + or – 5 MPH.

16. **WIND DIRECTION:** Direction wind is from. (Direction must be perpendicular to your position).

17. **COMPLETE SOURCE SKETCH LAYOUT:** The sun has to be at your back within a 140-degree angle and the wind must be perpendicular to your position. Draw an arrow pointing North in the circle. Draw a circle or rectangle that represents the stack or emissions point and lines representing the flow of the plume. The small 'x' represents the observation point. Draw an arrow indicating the wind direction. Draw a circle with a '+' indicating the sun's location.

OPACITY READINGS: Record the date, start and stop time of your observations. Indicate the outside air temperature in degrees Fahrenheit. Take one, 2-second opacity reading every 15 seconds after the reading begins. Do not stare at the plume. Do not look at the plume between readings. The first opacity reading is recorded in the box for 'Minute 1' and 'Second 0.' The second opacity reading is recorded in the box for 'Minute 1' and 'Second 15,' and so on until four readings are taken per minute. Record your readings from left to right and top to bottom.

a. A six-minute average is required. To achieve this, 15-second opacity readings must be taken for a minimum of six consecutive minutes.

b. To calculate a six-minute average, select any set of 24 sequential readings. The set does not have to start at the beginning of a minute; it can start at any point in the observation data. For each set of 24 observations, calculate the average by summing the opacity of the 24 observations and dividing this sum by 24. Record the average opacity reading as a percentage in the Comments Section.

EPA CERTIFIED OBSERVER'S NAME: Print your name in full. Sign and date when you have completed all entries you intend to complete. Any additional entries made after you sign the form must be dated and initialed.

Appendix B

UNL Method 22 Visible Emission (VE) Survey Form

Calendar Year _____ UNL Method 22 Visible Emission (VE) Survey Form Emission Unit #

Month	Incin: Operating & temp is minimum 1200°F? / UP Boiler operation No. 2 fuel oil >24 hrs?	Date & Time	Weather Conditions	Method 22 Result[1] (6 min period)	*Corrective Action(s) & Follow Up Observation(s)	Name
Jan.	❑ Yes ❑ No					
Feb.	❑ Yes ❑ No					
March	❑ Yes ❑ No					
April	❑ Yes ❑ No					
May	❑ Yes ❑ No					
June	❑ Yes ❑ No					
July	❑ Yes ❑ No					
Aug.	❑ Yes ❑ No					
Sept.	❑ Yes ❑ No					
Oct.	❑ Yes ❑ No					
Nov.	❑ Yes ❑ No					
Dec.	❑ Yes ❑ No					

Calendar Year _____ UNL Method 22 Visible Emission (VE) Survey Form Emission Unit #

Month	*Corrective Actions & Follow Up Observation(s) *(cont'd from front page if necessary)*	Name
Jan.		
Feb.		
March		
April		
May		
June		
July		
Aug.		
Sept.		
Oct.		
Nov.		
Dec.		

Instructions for UNL Method 22 VE Survey Form

All entries must be legible. Use a separate form for each source & complete every field on each row of the form. Write N/A if not applicable. Maintain the completed form for 5 years and make it readily available for state and/or federal environmental inspectors.

Fill out a separate form for each boiler or incinerator on a monthly basis, regardless of operation. Be sure to record the boiler number on the form so the record can be linked to the specific emission unit.

Specific instructions for completing each field:

1. **OPERATING:** Manner at which the emission unit is operating.
    a. **Utility Plant Boilers**: verify boiler(s) is/are operating on fuel oil for a period of greater than 24 hrs. **If fuel oil has NOT been combusted for more than 24 hours during the current month, then mark 'NO' and sign last column.** *No further action is required.*
        - If boiler is operating on fuel oil for a period of greater than 24 hours, mark 'YES' and move to next column.
    b. **Incinerator: If incinerator has not operated for the current month, mark 'NO' and sign last column.** *No further action is required.*
        - If incinerator is operating and has reached the required 1200°F temperature, then mark 'YES' and move to next column.
2. **DATE & TIME:** Enter the date and time of observation.
3. **WEATHER CONDITIONS:** At the time of observation, record estimated wind speed, wind direction, and sky condition (e.g., cloudy, sunny, partly cloudy, etc.)
4. **METHOD 22 RESULT:** Stack must be observed for six (6) minutes. Observer will need two timepieces. Use one timepiece (i.e. wristwatch/stopwatch) to time the entire six minute observation period. Stop timing if you take a break or the process stops operating. Restart it without resetting time when you begin your observations again. When this timepiece indicates you have finished the six minute observation period, conclude observation. *During* the six minute observation period, continuously watch the source, and if you see any visible emissions, start a second timepiece and stop it when the emissions stop. Restart it without resetting it if emissions occur again, and stop it if the emissions stop. Continue doing this throughout the six minute observation period.
    a. Record time (in seconds) that emissions were observed. Emissions must not be visible for more than an accumulative 18 seconds during six minute observation time. *If 18 seconds or less, then no further action required.*
5. **CORRECTIVE ACTION(S) & FOLLOW UP OBSERVATION(S):** If VE are observed for greater than 18 seconds, perform & document corrective action(s). Conduct follow up six minute observation & verify 18 seconds or less VE, *no further action required.*
    a. If after one hour, corrective actions are exhausted and VE are still detected for greater than 18 seconds, then conduct follow-up formal Method 9 to verify less than 20% opacity, *no further action required.*
    b. If Method 9 verified greater than 20% opacity, *contact EHS immediately.*
6. **NAME:** Print observer's full name (or legible signature).

20% - Legal *40% - Illegal* *80% - Outrageous!*

How much smoke is legal?

State law prohibits the generation of excessive chimney smoke. Except for brief periods during start-up and refueling, smoke is in violation when it obscures objects viewed through it by more than 20%. Pictured above is what smoke looks like at densities of 20%, 40% & 80%. Generation of smoke densities greater than 20% could result in fines from air pollution control officials. Stoves operated with dry wood and a generous air supply produce less smoke and more heat.

WASHINGTON STATE DEPARTMENT OF ECOLOGY