

OPACITY OF EMISSIONS FROM COMBUSTION SOURCES

(For assistance, please contact EHS at (402) 472-4925, or visit our web site at <http://ehs.unl.edu/>)

The University of Nebraska-Lincoln (UNL) Air Quality Operating Permits require monitoring of visible emissions (opacity) from combustion sources. Opacity monitoring & measurements are taken in accordance with Environmental Protection Agency's (EPA) Reference Test Method 9. This Safe Operating Procedure (SOP) provides a summary of opacity monitoring requirements associated with the following combustion sources:

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

Definition and Visual Determination of Opacity

With regards to stack emissions, opacity is the degree to which visibility of a background (i.e., blue sky) is reduced by particulates (smoke). Measurements are made as a percent in increments of 5. At an opacity of 5%, 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.

UNL's Air Permit Opacity Monitoring Requirements

- Visible emissions from the Pathological Waste Incinerators must be monitored during each burn cycle. Compliance with the 20% six-minute average opacity limit must be verified, maintained, and documented. Operators are required to take two additional six-minute average opacity readings if the first six-minute average opacity reading exceeds 15%. If the opacity 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.*
- Visible emissions from the City and East Campus Utility Plant boilers must be monitored on a weekly basis when fuel oils are being combusted, the equipment is being operated at "service load" conditions, and after startup is complete. If no visible emissions are detected during the first 18 seconds of observation, the observation can be recorded and opacity monitoring ended. If visible emissions are detected, a complete 6-minute observation per EPA's method 9 must be conducted and recorded. If a single 6-minute opacity reading exceeds 15% during normal operation, two additional 6-minute readings must be conducted. If the opacity 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. If readings cannot be taken due to extreme weather conditions (i.e., high wind, heavy fog, rain, or snow which impairs visibility) or operations that occur after dark, it must be noted on the data observation sheet. *Opacity monitoring is not required during startups, shutdowns, malfunctions, during load or performance testing, or when boilers are operated on natural gas.*

- Visible emissions from Emergency Generators must not exceed 20% for a six-minute average (EPA Method 9) during normal operation. Operators must notify EHS immediately if it appears that emissions from any generator are approaching or exceeding the opacity limit. It is not necessary to maintain opacity records.

Training

- Operators of boilers, incinerators and generators must be familiar with EPA Method 9 procedures and maintain competency to take accurate opacity readings.

Recordkeeping and Reporting

When records of opacity monitoring must be maintained, operators are required to use the ***UNL Opacity Observation Form***, provided at the end of this SOP. Specific instructions on how to measure and record opacity readings are included in the instructional pages following the form.

- Incinerators – Opacity monitoring records must be maintained on-site. These records are subject to review by regulatory authorities.
- East Campus Utility Plant boilers – Opacity monitoring records must be maintained on-site. These records are subject to review by regulatory authorities
- City Campus Utility Plant boilers – Copies of opacity monitoring records 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 opacity monitoring records to regulatory authorities on a regular reporting basis. Copies should also be maintained on-site.
- Generators – Written records of opacity monitoring are not required.

References

¹EPA 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.*

This Page Intentionally Blank

EPA Method 9 Visible Emission Observation Form

University of Nebraska – Lincoln

Process Equipment (Check appropriate box) Lincoln, NE 68583

LsCA (formerly ARF) Consumat C-120P Incinerator (Fair St. & EC Loop)

VDC Consumat C-225P Incinerator (Fair St. & 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
 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, brown, white)
 start: _____ end: _____

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

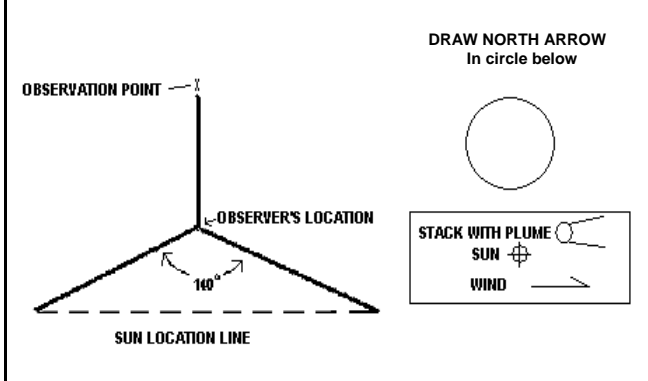
12. Describe Plume Background & Color: *What is plume read against? Blue sky? White clouds? Green trees? etc*
 start: _____ end: _____

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



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 UNL Visible Emission 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.

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.



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.

