MISSOURI DEPARTMENT OF NATURAL RESOURCES

July 28, 2015

Clean Air Act 110(l) Demonstration to Support Amendment to 10 CSR 10-6.220, Restriction of Emission of Visible Air Contaminants

Opacity is the original and most easily detected form of air pollution. It is a measure of the degree to which stack emissions reduce the transmission of light or obscure the view of an object in the background, and is used as an indicator of the effectiveness of controls for particulate matter (PM) emissions. In general, the higher the concentration of particulate passing through an emissions point, the more light will be blocked, thus increasing the opacity percentage. Over the course of a century, monitoring opacity has evolved from comparing effluent smoke to cards with black lines of different thicknesses drawn on them (Ringelmann scale) to utilizing state-of-the-art lasers and light-sensing technology. Advancements in monitoring technology and our understanding of chemistry have allowed us to break down atmospheric emissions to the molecular level, differentiate those molecules by species, and determine emission rates and concentrations.

The technological advancements are not only evident in our monitoring capabilities, but in our emission units themselves. Much of the fuel burning equipment in use today is highly efficient. In addition, we have air pollution control equipment with collection efficiencies as high as 99%. Lastly, we have access to cleaner burning fuels such as natural gas. All of these factors combined have resulted in a dramatic decrease in air pollution since the industrial revolution when you could not see more than half a city block on some days due to poor combustion efficiency.

Over time, some of Missouri's regulations become obsolete in certain applications. Missouri's opacity rules originated in 1967, and since their consolidation in 1999 into 10 CSR 10-6.220 *Restriction of Emission of Visible Air Contaminants,* continue to maintain the same standards and requirements. Whether it is due to a limit superseded by newer federal standards, more advanced equipment with greater efficiency, or the use of cleaner burning fuels, the monitoring and recordkeeping requirements in outdated rules can be an unnecessary burden on Missouri companies. This rulemaking will update the opacity rule in order to reduce the regulatory burden on these sources while still being protective of air quality. Because 10 CSR 10-6.220 is included in Missouri's State Implementation Plan (SIP), Clean Air Act Section 110(l) is applicable when making changes to this rule even though there are no National Ambient Air Quality Standards (NAAQS) for opacity. This demonstration presents the amendments being made to 10 CSR 10-6.220 *Restriction of Emission of Visible Air Contaminants* and supporting information affirming that these amendments satisfy the state of Missouri's obligation under the Clean Air Act section 110(l) to ensure these changes do not "interfere with any applicable requirement concerning attainment and reasonable further progress, or any other applicable requirement of [the] Act."

Issue: Under the federal regulation 40 CFR 60 subpart UUUUU, known as Mercury and Air Toxics Standards or MATS, power plants are no longer required to measure opacity using Continuous Opacity Monitoring Systems (COMS) when they have installed Particulate Matter Continuous Emissions Monitoring Systems (PM CEMS). However, 10 CSR 10-6.220 *Restriction of Emission of Visible Air Contaminants* does require them to have COMS installed, and power plants have made a request to remove this requirement as it has been removed from federal regulations.

Other regulations including 40 CFR 63 subparts DDDDD and JJJJJJ, commonly known as the boiler MACT (Maximum Achievable Control Technology) have particulate matter limits similar to those in the MATS rule that result in minimal opacity emissions. In 40 CFR 63 subparts DDDDD and JJJJJJ, for certain emission units, there are also opacity limits (10%) that are stricter than those of 10 CSR 10-6.220 (20%). Exemptions for certain emission units subject to these regulations will be established to eliminate these overlaps.

Industry also suggested that natural gas, propane, liquefied petroleum, landfill gas, digester gas and refinery gas fired units should be exempt from opacity monitoring requirements since these units have minimal opacity emissions and never exceed the opacity limit.

Finally, to clarify and more accurately portray the manner in which 10 CSR 10-6.220 is enforced, the internal combustion (IC) engine exemption is being revised to include all IC engines.

This demonstration provides supporting information to show that these amendments would not have a negative impact on air quality.

Background and Supporting Information-40 CFR 63 subpart UUUUU Exemption: MATS requirements call for quarterly stack tests or the installation of PM CEMS for compliance demonstration. Many power plants are electing to install PM CEMS. There are five different types of PM CEMS; each measures a different parameter that correlates with particulate concentration or measures particulate mass directly.

- Light Extinction: measures opacity and gives particulate concentration based on a site specific correlation.
- Light Scatter: found in-stack or in extractive PM monitoring devices, works by measuring the amount of light that is scattered in a certain direction by the flue gas which is correlated with particulate concentration.
- Probe Electrification: measures the mass of particulate traveling through a duct or stack based on the amount of static electricity transferred from each particle that bumps into the probe. When flow rate is also measured, dividing mass by flow rate gives particulate concentration.
- Optical Scintillation: measures the change in amplitude of a light wave as it crosses a stack. This can be correlated with particulate concentration.
- Beta Ray Attenuation: is an always extractive method that collects samples in batches. This method measures the amount of beta rays absorbed by a sample extracted from the stack and collected on filter tape. The more beta rays absorbed by the sample the higher the PM mass concentration.

When deciding which of these PM CEMS models to install, stack conditions are the major factor. Plants with dry stacks can use any version of PM CEMS. Those with wet stacks, on the other hand, are limited to models that extract samples from the stack before measuring PM concentration. PM CEMS utilizing beta attenuation are a common form, but there are some extractive models that use vaporizing

chambers and light scatter to measure particulate matter. This prevents water droplets from being measured as particulate matter.

The issue that power plants in Missouri are facing is the requirement to have both PM CEMS and COMS installed. For plants that have dry stacks, it would be possible for them to monitor opacity and PM concentration simultaneously using a light extinction PM CEMS, because opacity is the parameter that this type of PM CEMS measures to give a particulate concentration. For facilities with wet stacks, a correlation between PM emission rates and opacity in the stack cannot be measured due to moisture. Facilities with wet scrubbers have been able to demonstrate compliance with the opacity limit by monitoring opacity up stream of the scrubbers. Actual emissions would be measured after the wet scrubber and would be even lower after this additional particulate matter control device.

MATS limits on particulate matter emissions are so strict, any power plant in compliance with MATS will also meet the opacity limits in 10 CSR 10-6.220. This conclusion is drawn by extrapolating from correlation data gathered from power plant Compliance Assurance Monitoring (CAM) plans. The least restrictive PM emission limit in the MATS regulation is 0.04 pounds of filterable PM (PM-FIL) per mmBtu, and the most restrictive opacity limit in 6.220 is 20%. Figures (1) through (4) show the correlation of PM-FIL emission rates and opacity measurements collected during the calibration of COMS used in the CAM plans of typical Missouri power plants. According to a linear regression, there is a strong correlation, greater than 94%, between opacity and particulate concentration for individual emission units. Using the equations of each trendline, opacity, when in compliance with MATS, can be predicted by solving each function when x=0.04 (least stringent MATS lb PM-FIL/mmBtu limit). In all cases, predicted opacity, when in compliance with MATS, is below the 10 CSR 10-6.220 opacity limit of 20%.

There is a difference in reporting requirements between MATS and 10 CSR 10-6.220. MATS emissions are recorded as an hourly average over a 30-day period and allows for averaging across multiple units within a facility. 10 CSR 10-6.220 calls for emissions to be recorded in 6-minute averages and allows for one 6-minute exceedance every 60-minutes during which the limit is increased to 40% opacity in the St. Louis metropolitan area and 60% opacity for the rest of the state. Regardless of the difference in averaging, the MATS requirement would still keep opacity below the 20% threshold. These facilities typically operate around 10% opacity. Furthermore, according to Figure (2), the unit closest to 20% opacity when in compliance with MATS would have to exceed the MATS limit by over 6% (0.0025 lb PM-FIL/mmBtu) to reach 20% opacity. If this did occur, the facility would require an offset from another unit to average within the limit, and would still result in an overall reduction in emissions and opacity percentages within the 20% limit from the offsetting unit (18.72% if an identical unit to that in Figure (2) were used to offset).

The correlations used to justify these exemptions were collected from the data provided in the CAM plans of 10 emission units located at 4 different power plants. The Department of Natural Resources' Air Pollution Control Program is confident that these units can be used to represent all Missouri power plants due to the variation in boiler design rating, firing method, and fuel. These characteristics, along with the number of data points and high goodness of fit (r^2) illustrated in each Figure, offer strong evidence to support the exemptions described in this demonstration.

The emission units represented in Figures (1)-(4) range in design rating from 220 mmBtu/hr to 6,183 mmBtu/hr. The six boilers represented by the data in Figures (1) and (2) are tangentially-fired, the boiler represented by the data in Figure (3) is wall-fired, and the two boilers represented by the data in Figure (4) are cyclone-fired. The fuel burned in these boilers include: pulverized coal, western subbituminous coal, low-sulfur subbituminous coal, Illinois basin bituminous coal, petroleum coke, and fuel oil number 2.

Based on this evidence the Department of Natural Resources' Air Pollution Control Program is amending 10 CSR 10-6.220 to exempt any facility regulated by MATS and monitoring with a PM CEMS. This exemption will be listed in subsection (1)(N) of 10 CSR 10-6.220.

Background and Supporting Information-40 CFR 63 subpart DDDDD Exemption:

Industry suggested adding an exemption for emission units regulated by 40 CFR 63 subpart DDDDD, *National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters*. After reviewing the various requirements of this regulation, the Department of Natural Resources' Air Pollution Control Program found that it would be appropriate to exempt emission units that meet one of the following criteria:

1. Constructed or reconstructed after June 4, 2010;
2. The unit is subject to a 10 percent opacity limit as described in Table 4 of 40 CFR 63 subpart DDDDD; or
3. The unit is in Table 2 of 40 CFR 63 subpart DDDDD and has a filterable particulate matter limitation of less than or equal to 4E-02 pounds per million British thermal units (lbs/MMBtu).

This determination is based on PM limits that would keep emissions below the 20% opacity and stricter opacity requirements. For new or reconstructed emission units (emission units constructed or reconstructed after June 4, 2010), the least restrictive PM emission limit is 0.03 lb PM-FIL/mmBtu. Some existing emission units (emission units constructed or reconstructed on or before June 4, 2010) have PM-FIL emission limits that are too high to allow them to be exempt from 10 CSR 10-6.220. Therefore, only those existing emission units that are subject to at least a 0.04 lb PM-FIL/mmBtu emission limit will be exempt on the basis of PM limitations. However, any emission unit regulated under 40 CFR 63 subpart DDDDD that is subject to a 10% opacity limit will be exempt, because this is a stricter opacity requirement than any specified in 10 CSR 10-6.220.

As described above, Figures (1) through (4) show the correlation of PM-FIL concentration and opacity measurements for various boilers, and can be used to estimate opacity at certain PM emission rates. For the emission units meeting the criteria for this exemption on the basis of PM limitations, the least restrictive PM emission limit is 0.04 lb PM-FIL/mmBtu. Using the equations of each trendline in Figures (1) through (4), the predicted opacity at that PM-FIL emission rate is below the 10 CSR 10-6.220 opacity limit of 20%.

This exemption will be listed in subsection (1)(J) of 10 CSR 10-6.220.

Background and Supporting Information-40 CFR 63 subpart JJJJJJ Exemption:

Industry suggested adding an exemption for new emission units regulated by 40 CFR 63 subpart JJJJJJ, *National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers Area Sources*. After reviewing the various requirements of this regulation, the Department of Natural Resources' Air Pollution Control Program found that it would be appropriate to exempt emission units that meet all of the following criteria:

1. The emission unit was constructed or reconstructed after June 4, 2010;
2. The emission unit is in compliance with the 0.03 pounds per million British thermal units filterable particulate matter emission limit described in Table 1 of 40 CFR 63 Subpart JJJJJJ or maintaining opacity to less than or equal to 10 percent as described in Table 3 of 40 CFR 63 Subpart JJJJJJ; and
3. Demonstrating compliance with a continuous monitoring system (CMS), including a continuous emission monitoring system (CEMS), a continuous opacity monitoring system (COMS), or a continuous parameter monitoring system (CPMS).

As described above, Figures (1) through (4) show the correlation of PM-FIL concentration and opacity measurements for various boilers, and can be used to estimate opacity at certain PM-FIL emission rates. For the emission units meeting the criteria for this exemption on the basis of PM limitations, the least restrictive PM emission limit is 0.03 lb PM-FIL/mmBtu. Using the equations of each trendline in Figures (1) through (4), the predicted opacity at that PM-FIL emission rate is below the 10 CSR 10-6.220 opacity limit of 20%. This exemption will be listed in subsection (1)(M) of 10 CSR 10-6.220.

Background and Supporting Information-Natural Gas, Liquefied Petroleum Gas, Landfill Gas, Digester Gas and Refinery Gas Fired Unit Exemption: Although most combustion sources are well known sources of particulate matter and visible emissions, the combustion of gaseous organic compounds is notoriously low in this air pollutant category. The Department of Natural Resources' Air Pollution Control Program is confident that emission units burning gaseous fuels can be exempted from 10 CSR 10-6.220 based on the following information:

A. Natural Gas-

By using AP-42 emission factors for PM-FIL emissions from natural gas units (Tables 3.1-2a, 1.4-2) and the heat content of the natural gas burned in two different natural gas fired units (reported on MoEIS) a theoretical emission rate can be calculated (Table (1)). When these rates are compared to the PM-FIL emissions of coal fired units (Table (2)), it is clear that natural gas is a much cleaner burning fuel.

By using the calculated PM emission rate of natural gas and the opacity correlation of the coal fired boilers in Figures (1)–(4), an estimated opacity reading can be gathered (Table (3)). Coal has a much higher ash content (thus a higher emission rate of PM-FIL per mmBtu) so it can be assumed that the actual correlation for a natural gas fired unit would have an even lower opacity reading at the PM emission rate being used to compare. Nonetheless, with a calculated average uncontrolled opacity of 4.3% it is unnecessary to monitor the opacity of natural gas fired units when the limit is 20% as in 10 CSR 10-6.220.

B. Liquefied Petroleum Gas (LPG)-

LPG is primarily composed of either propane or butane. These gaseous fuels have very low PM emissions, and thus low opacity emissions. The emission factors for total PM emissions can be found in AP-42 section 1.5 Table 1.5-1. By using the heat content of each of these fuels to convert their respective emission factors into lb/mmBtu, we can estimate the opacity emissions from combusting each species by referring to the PM /opacity correlations from Figures (1)-(4) below. The correlation that violates the 20% opacity limit at the lowest PM emission rate is found in Figure (2), and will be used to estimate opacity based on the theoretical PM emission rates of propane and butane.

1. Butane- Butane has a PM-FIL emission factor of 0.2 lb/10^3gal. Using the recommended heat content, listed in the same AP-42 document, of 102 X 10^6 Btu/10^3 gallon, we can determine that butane combustion results in a PM-FIL emission rate of 0.00196 lb/mmBtu. According to the correlation in Figure(2), this PM emission rate would have an opacity of 9.71%; well within the 20% limit. Based on this information, it is unnecessary to subject butane fired emission units to 10 CSR 10-6.220.
2. Propane- Propane has a PM-FIL emission factor of 0.2 lb/10^3gal. Using the recommended heat content, listed in the same AP-42 document, of 91.5 X 10^6 Btu/10^3 gallon, we can determine that propane combustion results in a PM-FIL emission rate of 0.00219 lb/mmBtu. According to the correlation in Figure(2), this PM emission rate would have an opacity of 9.77%; well within the 20% limit. Based on this information, it is also unnecessary to subject propane fired emission units to 10 CSR 10-6.220.

C. Landfill Gas-

Emission units combusting landfill gas includes boilers, turbines, internal combustion engines (ICEs), and flares. Of these types of units, the combustion of landfill gas in gas turbines has the highest emission rate of particulate matter. According to *Background Information Document for Updating AP42 Section 2.4 for Estimating Emissions from Municipal Solid Waste Landfills* (2008), the PM-FIL emission factors for landfill gas combustion in flares, ICEs, and boilers have been updated to 238 kg/10^6 dscm CH_4, 232 kg/10^6 dscm CH_4, and 41 kg/10^6 dscm CH_4 respectively. The PM-FIL emission factor for landfill gas combustion in gas turbines remains unchanged at 350 kg/10^6 dscm CH_4 in table 2.4-4 of AP-42. By converting kilograms to pounds, cubic meters to cubic feet, and dividing by the heat content of CH_4 (1,012 Btu/dscf CH_4), an emission rate of 0.02159 lb PM-FIL/mmBtu is derived. This emission rate can be compared to the PM-FIL/opacity correlations in Figures (1)-(4) below. Again, since the correlation in Figure (2) violates the opacity limit of 20% at the lowest PM emission rate, it will be used for comparison. This correlation gives an opacity value of 14.69%; well within the 20% limit. Based on this information it is unnecessary to subject landfill gas fired units to 10 CSR 10-6.220.

D. Refinery Gas-

Refinery gas is a byproduct of the refining process of crude oil. It is a gaseous mixture of various alkanes and alkenes, and is commonly compared to natural gas in regard to the products of its combustion. EPA's response to comments made on the boiler MACT describes the PM emissions from units burning natural gas and refinery gas as near the detection limit and very close to zero.[1] With PM emissions near zero, opacity emissions form these units would be negligible. For this reason, it is also appropriate to exempt any unit burning only refinery gas from 10 CSR 10-6.220.

E. Digester Gas-

Digester gas is another type of biogas that is comparable to landfill gas, but with higher methane content. The uncontrolled PM-10 emission factor for digester gas burned in stationary gas turbines found in Chapter 3 (Table 3.1-2b.) of AP-42 is 1.2 E-02 lb PM-10/mmBtu. Using this emission factor, we can estimate opacity emissions from emission units burning digester gas. By comparing the emission rate of 1.2 E-02 lb/mmBtu to the opacity and particulate matter correlations found in the demonstration for the proposed amendments, we get an estimated opacity of 3.866%. Although the digester gas emission factor for particulate matter is for PM-10 and not PM-FIL, particulate matter emissions from the combustion of gaseous fuels are generally considered to be composed of compounds less than 10 micrometers in aerodynamic diameter. This evidence suggests that it is not possible for emission units burning digester gas to exceed the opacity limits in 10 CSR 10-6.220; therefore it is appropriate to exempt them from the rule.

The exemption for emission units burning gaseous fuels will be listed in subsection (1)(L) of 10 CSR 10-6.220.

Background for complete IC engine exemption: Currently, the exemption for internal combustion engines in 10 CSR 10-6.220 includes all stationary IC engines in the state and mobile IC engines outside of the Kansas City and St. Louis Metropolitan Areas. However, in practice, the Department of Natural Resources' Air Pollution Control Program does not require a permit to operate mobile IC engines in the St. Louis or Kansas City Metropolitan areas nor does the department enforce the limits of 10 CSR 10-6.220 on IC engines in these areas. The original regulations for opacity limits on mobile sources in these areas date back to 1967 and 1968 when control technology for automobiles and regulations on fuel were first being developed and installed on new automobiles.

Today there are many federal fuel and mobile IC engine emission standards that have resulted in significant reductions in particulate matter and other air pollutants(e.g., federal Tier 2 rule for light-duty vehicles and trucks, heavy-duty highway engine standards, and a variety of rules addressing offroad vehicles including exhaust emission standards for locomotives). The EPA has established progressively more stringent emission standards for carbon monoxide, hydrocarbons, nitrogen oxides, and particulate

matter, starting in the mid-1970s for on-road vehicles and in the early 1990s for nonroad engines and equipment. Emissions standards set limits on the amount of pollution a vehicle or engine can emit.

Emission reductions have occurred as mobile source fleets, across the state of Missouri (including the Kansas City and St. Louis Metropolitan areas), have turned over to newer, cleaner engines.

At the state level we have vehicle emissions inspections in the St. Louis Metropolitan Area to ensure light-duty vehicle emissions control equipment is functioning properly (10 CSR 10-5.381 On-Board Diagnostics Motor Vehicle Emission Inspection), and regulations limiting heavy duty diesel vehicle idling in both Kansas City and St. Louis Metropolitan Areas (10 CSR 10-2.385 and 5.385 Control of Heavy Duty Diesel Vehicle Idling Emissions). There have not been any opacity complaints or issues regarding mobile IC engines raised in the St. Louis or Kansas City Metropolitan Areas in recent history. In order to more accurately portray the applicability of this regulation, the IC engine exemption will include all IC engines.

The modified exemption for internal combustion engines will be listed in subsection (1)(L) of 10 CSR 10-6.220.

Conclusion: This demonstration satisfies Clean Air Act section 110(l) by providing supporting information to show that these amendments to 10 CSR 10-6.220, *Restriction of Emission of Visible Air Contaminants* will not have a negative impact on air quality. Rule 10 CSR 10-6.220 is not directly relied upon in any Missouri plans demonstrating attainment or maintenance of any National Ambient Air Quality Standard. Exempting power plants regulated by 40 CFR 60 subpart UUUUU that install PM CEMS, certain emission units regulated by 40 CFR 63 subpart DDDDD and 40 CFR 63 subpart JJJJJJ, and gaseous fuel fired units, including those that combust only natural gas, LPG, landfill gas, and refinery gas, will not harm air quality. In addition, amending the exemption for internal combustion engines to include mobile IC engines in the St. Louis and Kansas City Metropolitan Areas will simply clarify the manner in which this rule is being enforced.

[1]"National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters (Final Rule)." Federal Register 76:54 (March 21, 2011) p. 15637. Available from: www.gpo.gov; Accessed: 2/7/2014

Visuals:

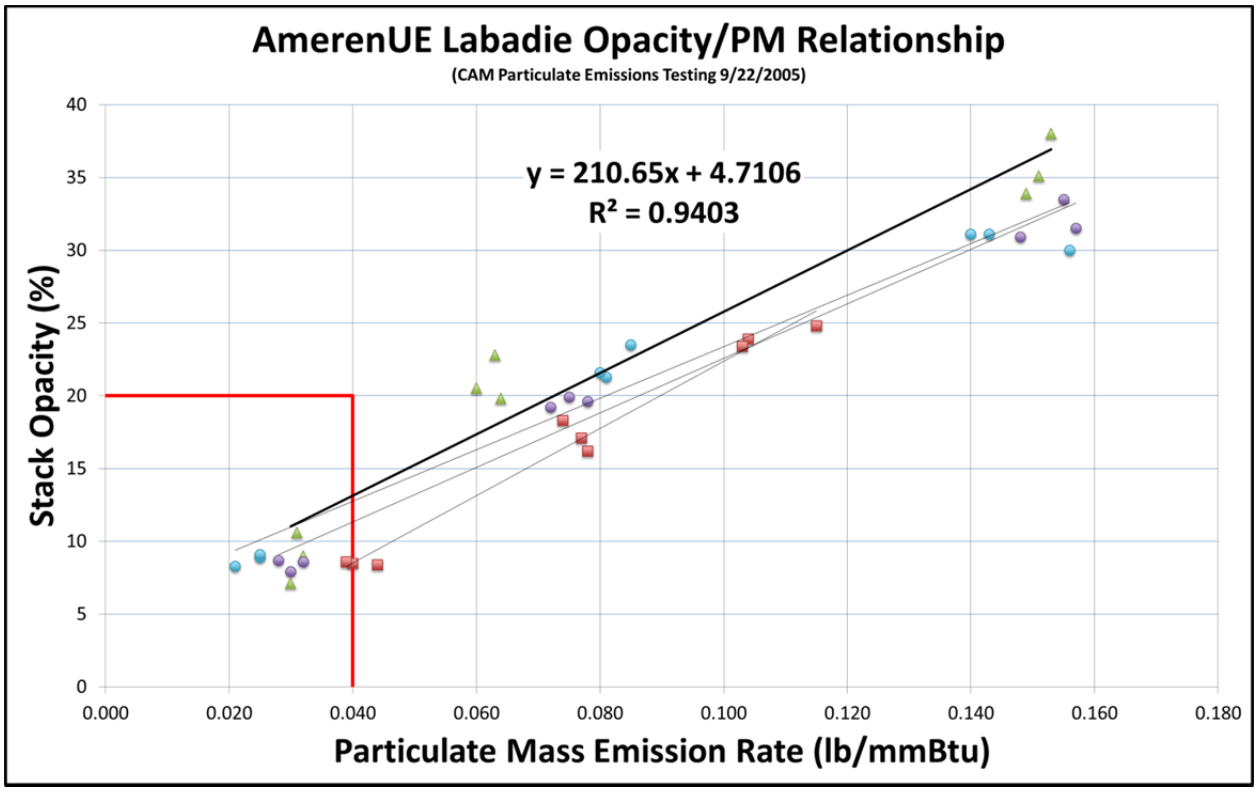
Figure (1)

UNIT 1 ALL TESTS	
[PM-FIL] (lb/mmBtu)	Opacity (%)
0.040	8.5
0.039	8.6
0.044	8.4
0.074	18.3
0.077	17.1
0.078	16.2
0.104	23.9
0.115	24.8
0.103	23.4

UNIT 2 ALL TESTS	
[PM-FIL] (lb/mmBtu)	Opacity (%)
0.031	10.6
0.032	9.0
0.030	7.1
0.063	22.8
0.060	20.5
0.064	19.8
0.149	33.9
0.151	35.1
0.153	38.0

UNIT 3 ALL TESTS	
[PM-FIL] (lb/mmBtu)	Opacity (%)
0.030	7.9
0.032	8.6
0.028	8.7
0.072	19.2
0.078	19.6
0.075	19.9
0.157	31.5
0.155	33.5
0.148	30.9

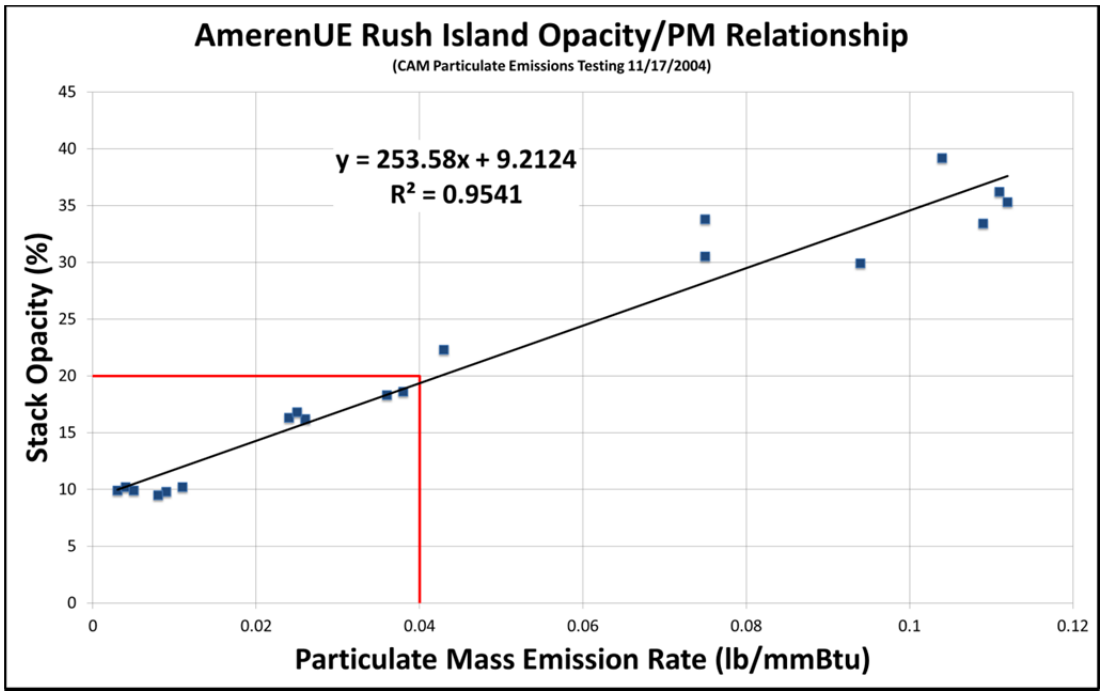
UNIT 4 ALL TESTS	
[PM-FIL] (lb/mmBtu)	Opacity (%)
0.021	8.3
0.025	8.9
0.025	9.1
0.081	21.3
0.080	21.6
0.085	23.5
0.156	30.0
0.143	31.1
0.140	31.1



Max opacity for Unit 2 when in compliance with MATS: 13.14%

Figure (2)

ALL RUSH ISLAND TESTS	
[PM-FIL] (lb/mmBtu)	Opacity (%)
0.011	10.2
0.009	9.8
0.008	9.5
0.026	16.2
0.038	18.6
0.036	18.3
0.111	36.2
0.109	33.4
0.112	35.3
0.003	9.9
0.004	10.2
0.005	9.9
0.024	16.3
0.043	22.3
0.025	16.8
0.075	33.8
0.075	30.5
0.104	39.2
0.094	29.9

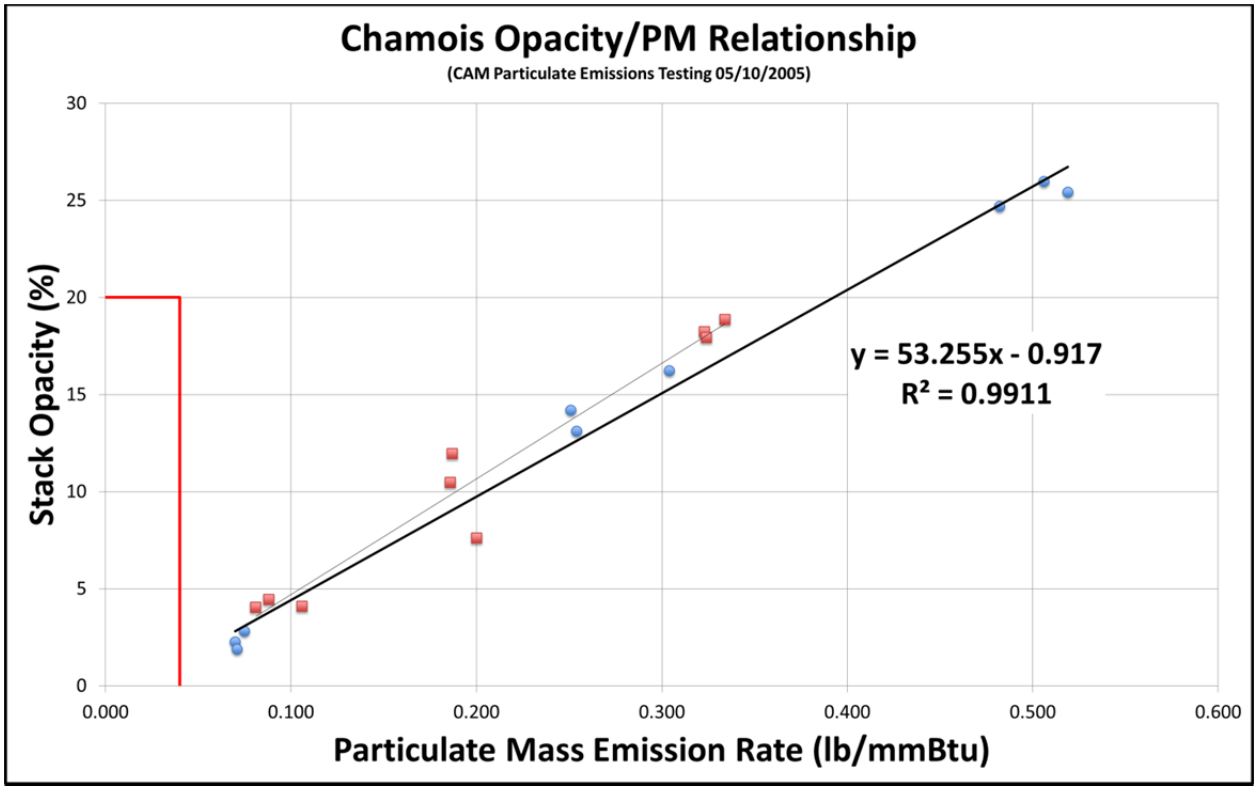


Max opacity when in compliance with MATS: 19.36%

Figure (3)

UNIT 1 ALL TESTS	
[PM-FIL] (lb/mmBtu)	Opacity (%)
0.075	2.81
0.070	2.26
0.071	1.89
0.482	24.70
0.519	25.43
0.506	25.97
0.304	16.22
0.251	14.19
0.254	13.12

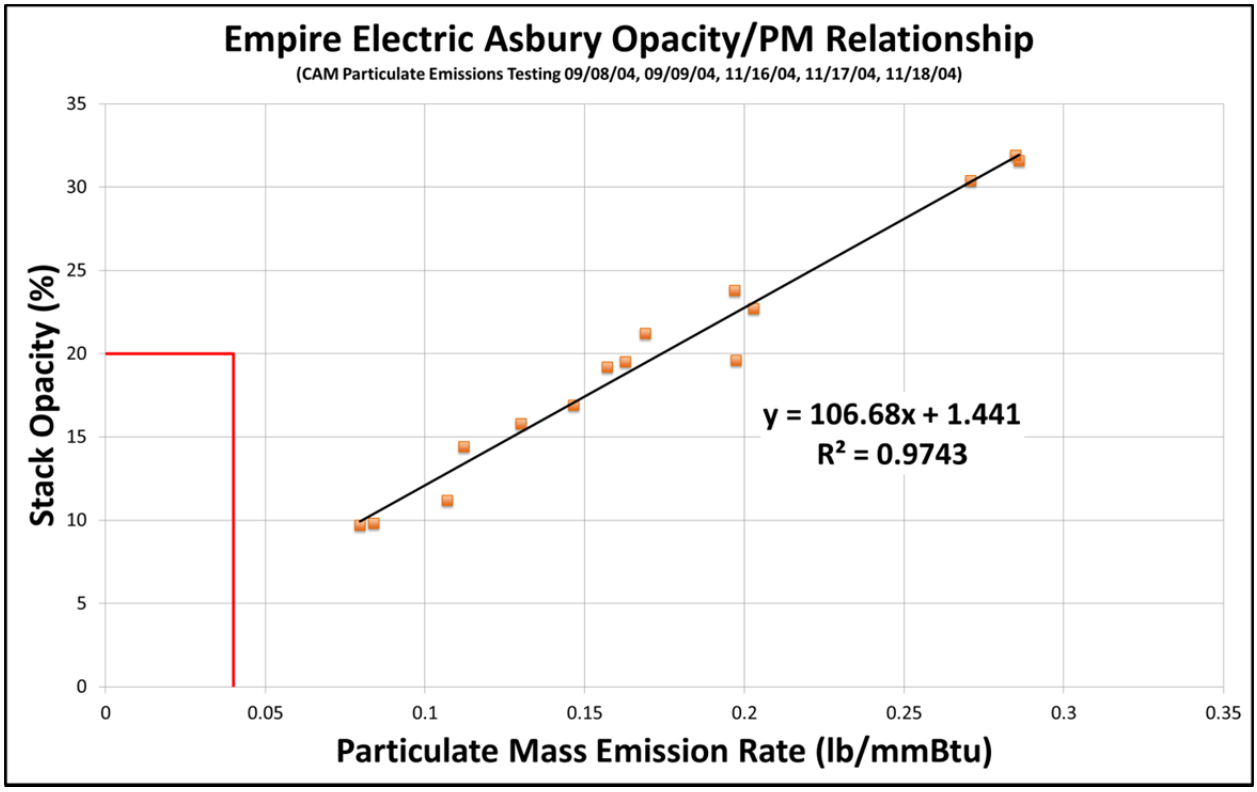
UNIT 2 ALL TESTS	
[PM-FIL] (lb/mmBtu)	Opacity (%)
0.106	4.09
0.081	4.03
0.088	4.45
0.334	18.87
0.323	18.24
0.324	17.92
0.200	7.61
0.186	10.46
0.187	11.96



Max opacity for Unit 1 when in compliance with MATS: 1.21%

Figure (4)

UNIT 1 ALL TESTS	
[PM-FIL] (lb/mmBtu)	Opacity (%)
0.1690	21.2
0.1970	23.8
0.2030	22.7
0.2860	31.6
0.2710	30.4
0.2850	31.9
0.1071	11.2
0.0797	9.7
0.0839	9.8
0.1628	19.5
0.1974	19.6
0.1571	19.2
0.1122	14.4
0.1301	15.8
0.1466	16.9



Max opacity for Unit 1 when in compliance with MATS: 5.71%

Table (1)

	Boeing Emissions Unit: GT-102-01 (Narutal Gas Turbine)	Boeing Emission Unit: CS-STL-04 (Natural Gas Boiler)
SCC	20200201	10200603
AP-42 PM-FIL Emission Factor	1.9E-3 lb/mmBtu	1.9 lb/MMcf
PM Emissions (lb/MMcf)	1.94	1.9
Heat Capacity (Btus/MMcf)	1,020,521,946	1,022,099,407
Emission Rate (lb/mmBtu)	0.0019	0.0019

Table (2)

	Ameren-Labadie (Coal Boiler)	Ameren-Rush Island (Coal Boiler)	Central Electric (Chamois Boiler 1)	Central Electric (Chamois Boiler 2)	Empire Electric (Coal Boiler)
SCC	10100226	10100226	10100202	10100223	10100223
AP-42 PM-FIL Emission Factor (A = % Ash)	10*A	10*A	10*A	2*A	2*A
% Ash	5.04	4.86	9.36	4.81	5.66
PM Emissions (lb/TON)	50.4	48.6	93.6	9.62	11.32
Heat Capacity (Btu/TON)	17,654,920	17,302,420	21,839,167	16,898,700	17,526,000
Emission Rate (lb/mmBtu)	2.855	2.809	4.286	0.569	0.646

Table (3)

	NG Turbine (% Opacity)	NG Boiler (% Opacity)
Compared to Ameren-Labadie Correlation	5.11	5.11
Compared to Ameren-Rush Island Correlation	9.69	9.69
Compared to Chamois Boiler 1 Correlation	-0.82 (0)	-0.82 (0)
Compared to Empire Electric Correlation	2.40	2.40
Average	4.3	4.3