MISSOURI DEPARTMENT OF NATURAL RESOURCES

February 20, 2014

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 and 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 more opaque the particles that pass through an emissions point, the more light that 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 efficiency 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 couldn't see more than half a city block on some days.

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 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 Whether it is due to a limit superseded by newer federal standards, more advanced equipment with greater efficiency, or the use of cleaner burning fuels, the monitoring and recordkeeping requirements in outdated rules can be an unnecessary burden on Missouri companies.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 opacity National Ambient Air Quality Standards (NAAQS). This demonstration presents the amendments being made to 10 CSR 10-6.220, Restriction 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. Since 40 CFR 63 subpart DDDDD (commonly known as the boiler MACT (maximum available control technology)) has opacity limits that are stricter than those of 10 CSR 10-6.220 an exemption for sources falling under this regulation will be established as well.

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

Furthermore, in order to reduce the regulatory burden of establishing a standard monitoring schedule, units with potential uncontrolled PM10 emissions below the limit that would require a construction permit (one (1) lb/hour) will be exempt from the monitoring and recordkeeping requirements of 10 CSR 10-6.220.

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-Power Plant Exemption: MATS requirements now 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 concentration 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 (0.03 lb/mmBtu) will also meet the opacity limit in 10 CSR 10-6.220 (20%). This conclusion is drawn by extrapolating from correlation data gathered from power plant Compliance Assurance Monitoring (CAM) plans. Figures (1) through (5) show the correlation of PM concentration 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 trend line, opacity, when in compliance with MATS, can be predicted by solving each function when x=0.03 (MATS lb/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 30% (0.0429 lb/mmBtu) to reach 20% opacity. If this did occur, the facility would require a substantial offset from another unit to average within the limit, and would still result in an overall reduction in emissions and opacity percentages well within the 20% limit from the offsetting unit (13% if an identical unit to that in Figure (2) were used to offset).

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.

Background and Supporting Information-Natural, Liquefied Petroleum, Landfill, 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.

A. Natural Gas-

By using AP-42 emission factors for total filterable PM (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)–(5), an estimated opacity reading can be gathered (Table (3)). Coal has a much higher ash content (thus a higher emission rate of PM 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 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)-(5) 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 total PM emission factor of 0.8 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 emission rate of 0.00784 lb/mmBtu. According to the correlation in Figure(2), this PM emission rate would have an opacity of 11.24%; 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 total PM emission factor of 0.7 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 emission rate of 0.00765 lb/mmBtu. According to the correlation in Figure(2), this PM emission rate would have an opacity of 11.196%; 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 include boilers, turbines, internal combustion engines, and flares. Of these types of units, landfill gas flare combustion has the highest emission rate of particulate matter according to the revised AP-42 emission factor for landfill gas flares found in *Background Information Document for Updating AP42 Section 2.4 for Estimating Emissions from Municipal Solid Waste Landfills* subsection 3.1.3.The emission factor is 238 kg/10^6 dscm CH_4 and has an A quality rating. By converting kilograms to pounds, cubic meters to cubic feet, and dividing by the heating value of landfill gas of 400 Btu/scf found in the footnotes of table 3.1-2b of AP-42, an emission rate of 0.0372 lb PM-10/mmBtu is derived. This emission rate can be compared to the PM/opacity correlations in Figures (1)-(5) 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 18.56%. Although this opacity level is close to the limit, we have calculated the PM emission rate used for comparison from a factor that includes condensable particulate matter, which was not included in the PM values used to establish the correlations in Figures (1)-(5) and can expect that actual opacity readings would be even lower, especially if the landfill gas being combusted had a higher heating value which is not uncommon. 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 when describing the emissions 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.

Monitoring and Recordkeeping exemption for units below insignificant emission levels for PM10: Units with potential uncontrolled PM10 emissions below the insignificant level of one (1) lb/hour are not expected to have an issue with meeting the opacity standard established by this regulation. Although these units will remain subject to the 20% opacity limit, they will not be required to monitor or maintain records of opacity emissions in order to reduce unnecessary regulatory burden.

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 as onroad and offroad fleets have turned over to newer, cleaner engines (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). 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.

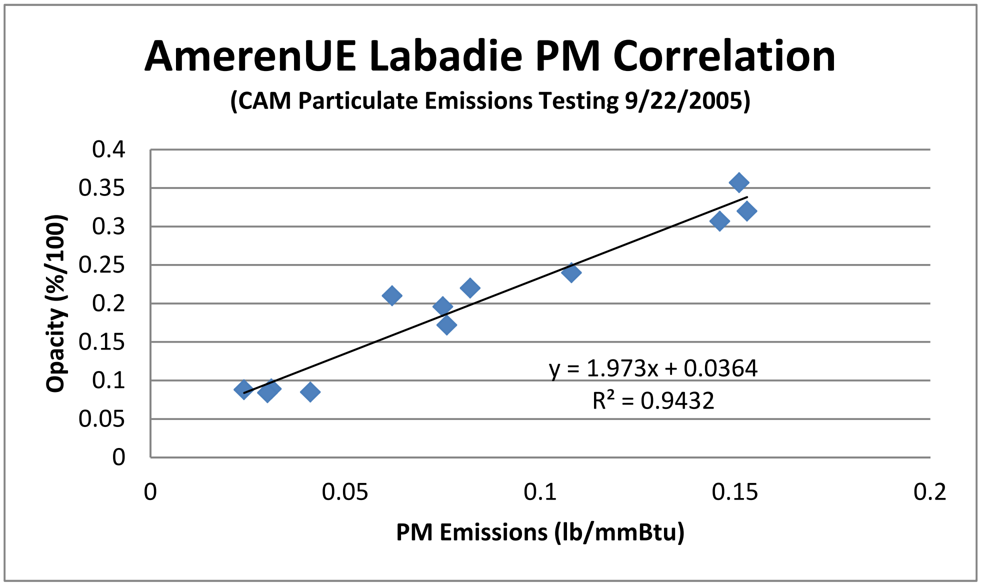
Conclusion: This demonstration satisfies Clean Air Act section 110(l) by providing supporting information to show that these amendments to 10 CSR 10-6.220, Restriction of Visible Air Contaminants will not have a negative impact on air quality. Rule 10 CSR 10-6.220 is not directly relied upon in any Missouri 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, emission units regulated by 40 CFR 63 subpart DDDDD, 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. Finally, relieving sources from the monitoring and recordkeeping requirements of 10 CSR 10-6.220 for units with potential uncontrolled PM10 emissions below the insignificant levels established in Table 1. of 10 CSR 10-6.061 Construction Permit Exemptions under subparagraph (3)(A)3.A. will not have a detrimental effect on air quality, and will eliminate unnecessary regulatory burden.

[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)

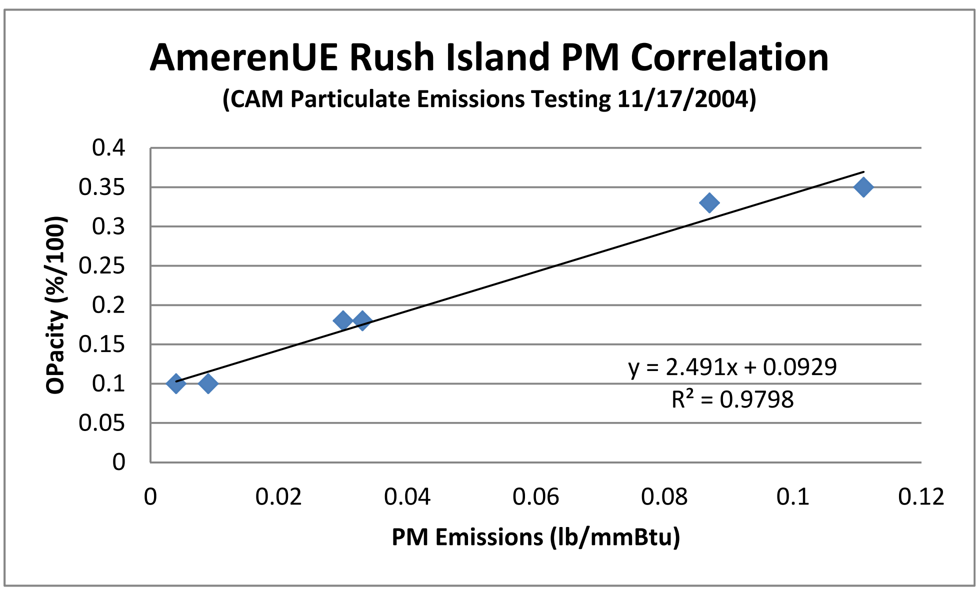
[PM] (lb/mmBtu)	Opacity (%/100)
0.041	0.085
0.076	0.172
0.108	0.24
0.031	0.089
0.062	0.21
0.151	0.357
0.03	0.084
0.075	0.196
0.153	0.32
0.024	0.088
0.082	0.221
0.146	0.307



Max opacity when in compliance with MATS: 9.56%

Figure (2)

[PM] (lb/mmBtu)	Opacity (%/100)
0.009	0.1
0.033	0.18
0.111	0.35
0.004	0.1
0.03	0.18
0.087	0.33



Max opacity when in compliance with MATS: 16.76%

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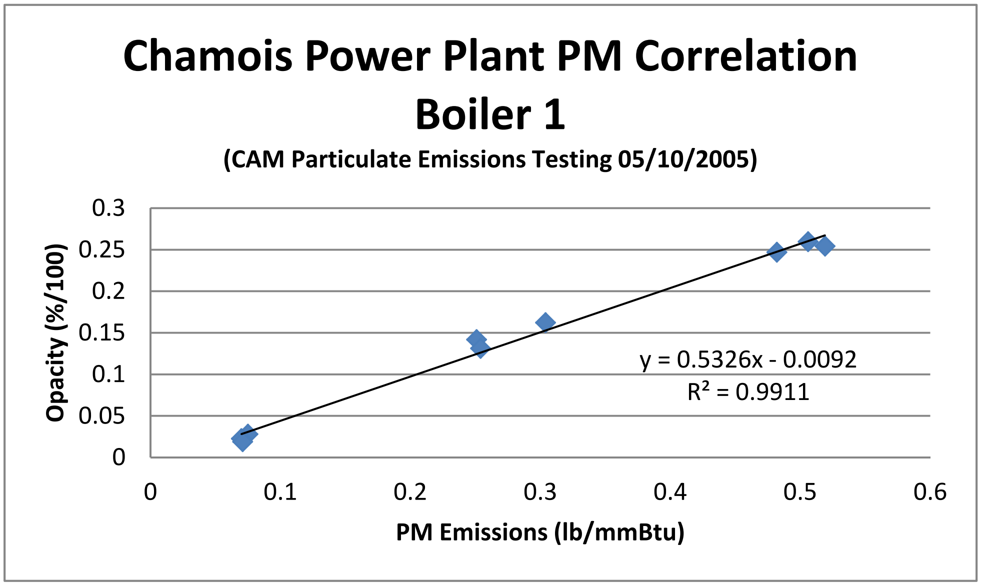
Figure (3)

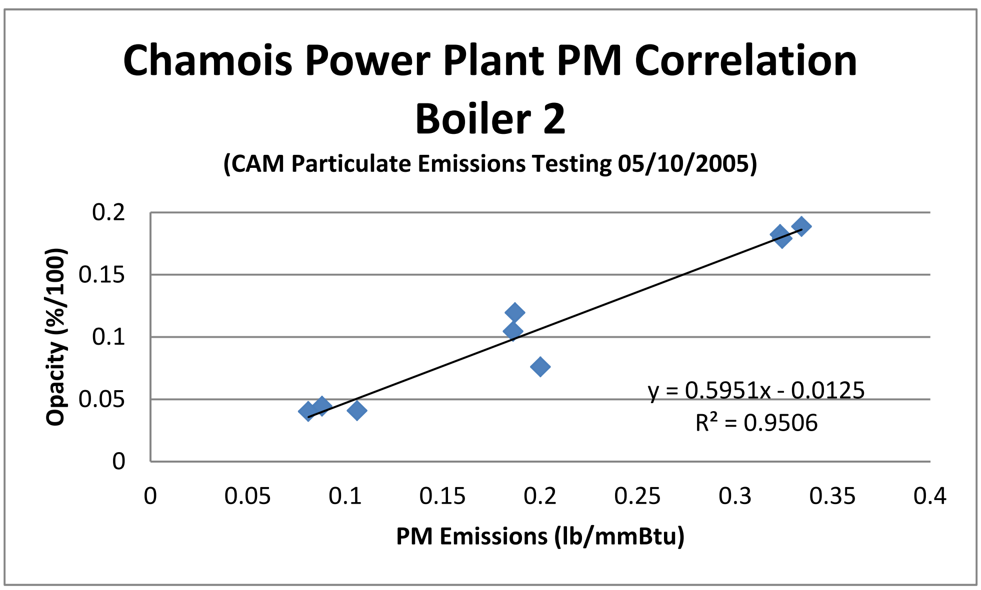
[PM] (lb/mmBtu)	Opacity (%/100)
0.075	0.0281
0.07	0.0226
0.071	0.0189
0.482	0.247
0.519	0.2543
0.506	0.2597
0.304	0.1622
0.251	0.1419
0.254	0.1312



Max opacity when in compliance with MATS: 0.68%

Figure (4)

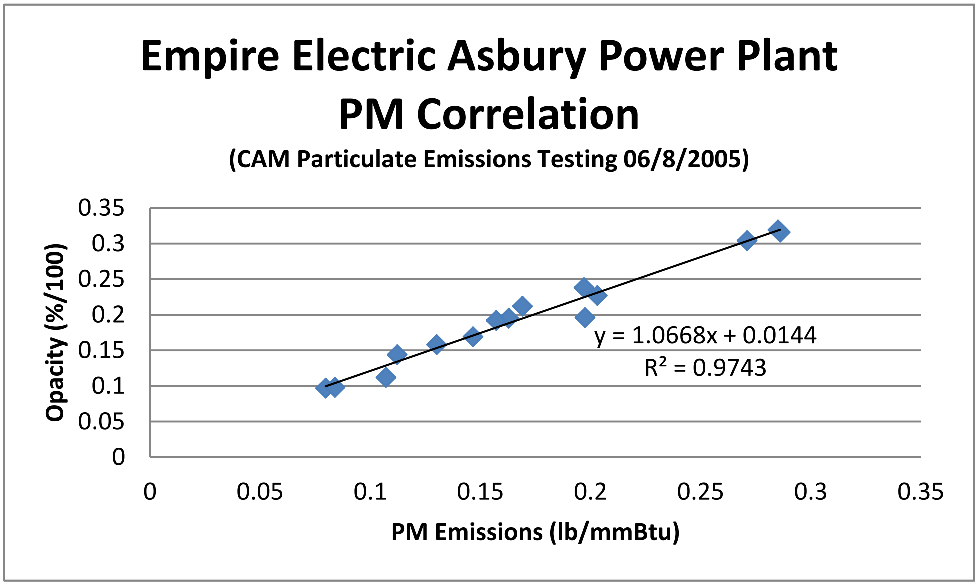
[PM] (lb/mmBtu)	Opacity (%/100)
0.106	0.0409
0.081	0.0403
0.088	0.0445
0.334	0.1887
0.323	0.1824
0.324	0.1792
0.2	0.0761
0.186	0.1046
0.187	0.1196



Max opacity when in compliance with MATS: 0.0053%

Figure (5)

[PM] (lb/mmBtu)	Opacity (%/100)
0.1071	0.112
0.0797	0.097
0.0839	0.098
0.169	0.212
0.197	0.238
0.203	0.227
0.286	0.316
0.271	0.304
0.285	0.319
0.1628	0.195
0.1974	0.196
0.1571	0.192
0.1122	0.144
0.1301	0.158
0.1466	0.169



Max opacity when in compliance with MATS: 4.64%

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	4.01	4.01
Compared to Ameren-Rush Island Correlation	9.80	9.80
Compared to Chamois Boiler 1 Correlation	-0.80 (0)	-0.80 (0)
Compared to Chamois Boiler 2 Correlation	-1.10 (0)	-1.10 (0)
Compared to Empire Electric Correlation	1.60	1.60
Average	3.082	3.082