Electric Utility Steam Generating Units
Potential Utility MACT Requirements

Presented by:

Kenneth J. Snell, J.D., P.E.

Paul S. Farber, P.E., DEE

September 9, 2010

Sargent & Lundy LLC

Potential Utility MACT Requirements
September 2010

Summary of the Potential Utility MACT Requirements based on:

- **Proposed Utility MACT Rule (January 2004, 69 FR 4652)**
- **U.S. Court of Appeals MACT Decisions:**
  - ***Nat'l Lime Ass'n v. EPA*, 233 F.3d 625 (D.C. Cir. 2000)**
  - ***Cement Kiln Recycling Coalition v. EPA*, 255 F.3d 855 (D.C. Cir. 2001)**
  - ***Mossville Envt'l Action Now v. EPA*, 370 F.3d 1232 (D.C. Cir. 2004)**
  - ***Sierra Club v. EPA*, 479 F.3d 875 (D.C. Cir. 2007)**
- **Proposed Industrial Boiler MACT (June 2010, 75 FR 32006)**

Potential Utility MACT Requirements
September 2010

Documents were reviewed to identify:

- **Potential Categories and Subcategories;**
- **Potential List of Hazardous Air Pollutants (HAP) that may be regulated;**
- **Potential Use of Surrogates;**
- **The Methodology EPA may use to determine the applicable MACT floors, including:**
  - ***Identifying the top performing existing sources;***
  - ***Assessing variability; and***
  - ***Beyond-the-floor assessment.***

Sargent & Lundy LLC

Potential Utility MACT Requirements
Subcategories

Categories and Subcategories:

- **The CAA allows EPA to divide source categories into subcategories.**
- **Subcategories can be based on differences in class, type, or size, if the differences can lead to corresponding differences in the nature of emissions and the technical feasibility of applying emission control techniques (75 FR 32016 col. 3).**

Potential Utility MACT Requirements
Subcategories

2004 Proposed Utility MACT:

Subcategories:

Coal-fired boiler subcategories:

- (1) Bituminous (including anthracite);
- (2) Subbituminous;
- (3) Lignite;
- (4) Coal Refuse; and
- (5) IGCC (coal syngas).

2004 Findings:

1. Coal rank "has an enormous impact on overall plant design."

2. Coal rank "has a significant impact on the design and operation of the emission control equipment."

3. Hg emission characteristics from all boiler designs are similar (when common ranks of coal are fired).

Industrial Boiler Proposed MACT:

Subcategories:

5 subcategories for fuel-dependent HAP (metals, mercury, acid gases):

- (1) coal;
- (2) biomass;
- (3) liquid fuel;
- (4) natural gas/refinery gas; and
- (5) other process gases.

For organic HAP emissions, units were further subcategorized based on unit design. Coal-fired boilers were further subcategorized as:

- (1) pulverized coal;
- (2) fluidized bed combustion; and
- (3) stoker

Note: EPA did not subcategorize the coal-fired units by type of coal burned.

Potential Utility MACT Requirements
Subcategories

Potential Utility MACT Subcategories:

1. **Subcategorize coal-fired units based on fuel for the fuel-related HAPs (e.g., mercury, metals, acid gases);**
2. **Further subcategorize coal-fired units by combustion system (if EPA decides to regulate organic HAP emissions):**
   - **Pulverized Coal**
   - **Fluidized Bed Combustion**
   - **Stoker**
   - **IGCC**

Potential Utility MACT Requirements
Regulated HAP

2004 Proposed Utility MACT:

Regulated HAP:

- **Coal Fired Boilers: Hg**

2004 Findings:

1. …section 112 (n)(1)(A) should be interpreted such that the standard for electric utility steam generating units may address only those pollutants for which EPA has made a finding that regulation is appropriate…
2. …our [December 20, 2000] regulatory finding was expressly based solely on concerns about Hg emissions from the source category…
3. … we found that dioxins, hydrogen chloride, and hydrogen fluoride are three additional HAP of potential concern that might be evaluated further…
4. …we concluded that other HAP studied in the risk assessment do not appear to be a concern for public health…

Industrial Boiler Proposed MACT:

Regulated HAP:

- **Mercury**
- **PM (as surrogate for non-mercury metals)**
- **HCl (as surrogate for acid gases)**
- **CO (as surrogate for non-dioxin organics)**
- **Dioxin/Furan**

Potential Utility MACT Requirements
Regulated HAP

Potential Utility MACT Regulated HAP:

1. Expand to include:

- **Mercury**
- **Acid Gases (HCl and HF)**
- **Dioxins/Furans**
- **Non-Mercury Trace Metals**
- **Non-Dioxin Organic HAPs**

Potential Utility MACT Requirements
Surrogates

Use of Surrogates:

- **EPA may use a surrogate to regulate hazardous pollutants if it is reasonable to do so.” *Nat’l Lime*, 233 F.3d at 637.**
- **EPA may attribute characteristics of a subclass of substances to an entire class of substances if doing so is scientifically reasonable.**
- **EPA may regulate a pollutant indirectly when its emissions are controllable by regulation of other pollutants.**
- **For example, because there are always HAP metals in particulate matter, and the removal of the particulate matter removes the HAP metals, PM is a reasonable surrogate for trace metal HAP. *Id.* at 639.**

Potential Utility MACT Requirements
Surrogates

2004 Proposed Utility MACT:

Surrogates:

- **None**
- **Regulated Hg only**

Industrial Boiler Proposed MACT:

Surrogates:

- **PM (as surrogate for non-mercury metals);**
- **HCl (as surrogate for acid gases);**
- **CO (as surrogate for non-dioxin organics)**

Potential Utility MACT Requirements
Surrogates

Potential Utility MACT Surrogates:

1. **Likely surrogates:**

   - PM (as surrogate for non-mercury metals)

   - CO (as surrogate for non-dioxin organic HAP)

2. **SO_2 or HCl may be used as surrogate for acid gases, or EPA could regulate HCl and HF separately.**

Potential Utility MACT Requirements
MACT Floors

- **Existing Sources: …cannot be less stringent than the average emission limitation achieved by the best performing 12% of existing sources for subcategories with 30 or more sources, or the best-performing 5 sources for subcategories with fewer than 30 sources.**

- **The DC Circuit Court of Appeals has recognized that EPA may consider variability in estimating the degree of emission reduction achieved by best-performing sources and in setting MACT floors. *Mossville Envt'l Action Now v. EPA*, 370 F.3d 1232, 1241-42 (DC Cir 2004).**

Potential Utility MACT Requirements
MACT Floors

2010 Boiler MACT Approach:

For each pollutant…

1. **EPA ranked all the available emissions data for a subcategory from lowest to highest;**
2. **EPA calculated the numerical average of the test results from the best performing (lowest emitting) 12% of sources (75 FR 32019 col. 1);**
3. **EPA assessed variability of the best performers using statistical analysis designed to estimate a MACT floor that is achievable by the average of the best performing sources (75 FR 32019, col. 3).**

Potential Utility MACT Requirements
MACT Floors

2010 Boiler MACT Approach:

- **Evaluated the distribution of the emissions data for the best performing 12% by computing the skewness and kurtosis statistics.**
- **MACT Floor calculated as an Upper Prediction Limit (UPL) using Student's t-test, the average (or sample mean), and sample standard deviation , for example:**

UPL = X + [SD x TINV x SQRT((1/n) + (1/3))] **(Normal Distribution)**

Where:

X = average of test runs in top 12%
SD = standard deviation of test runs in top 12%
TINV = inverse of the Student's t distribution
n = sample size

Potential Utility MACT Requirements
MACT Floor - Example

Unit	lb Hg/TBtu out control
A	0.4452
B	0.6863
C	0.6897
D	1.0763
E	1.3834
F	1.8593
G	1.9267
H	2.1357
I	2.6154
J	2.6611
K	2.6906
L	3.0504
M	3.1025
N	4.0847
O	4.4806
P	4.755
Q	4.8364
R	4.9038
S	5.0527
T	5.147
U	5.1853
V	5.7757
W	6.1366
X	7.1935
Y	7.6658
Z	8.0526
AA	8.3071
BB	8.3264
CC	10.2732
DD	11.4905

Test	Value	Formula
n	5	top 12% of test results
Skewness Statistic (S)	0.636	=SKEW(A:DD)
Std. Error of the Skewness Statistic (SES)	1.10	=SQRT(6/n)
S/SES	0.58	If >2 the data distribution can be considered non-normal
Kurtosis Statistic (K)	0.794	=KURT(A:DD)
Std. Error of the Kurtosis Statistic (SEK)	2.19	=SQRT(24/n)
K/SEK	0.36	If >2 the data distribution can be considered non-normal
Student's t (TINV)	3.75	=TINV(2 x (1 - 0.99), n-1)
Average (X)	0.86	=AVERAGE(A:DD)
Standard Deviation (SD)	0.37	=STDEV(A:DD)
UPL	1.87	=X + [SD x TINV x SQRT((1/n)+(1/3))]

Potential Utility MACT Requirements
Beyond-the-Floor Analysis

- **Beyond-the-floor options for existing units… "require the maximum degree of reduction in emissions of the hazardous air pollutants… taking into consideration the cost of achieving such emission reduction, and any non-air quality health and environmental impacts and energy requirements…" CAA 7412(d)(2).**

Boiler MACT Approach:

- **"We could not identify better HAP emissions reduction approaches that could achieve greater emissions reductions of HAP than the control technology combination (fabric filter, carbon injection, scrubber, and GCP) that we expect will be used to meet the MACT floor level of control." (75 FR 32026, col. 1)**

- **EPA proposed an energy assessment as a beyond-the-floor control technology for all existing sources. (75 FR 32026, col. 3)**

Potential Utility MACT Requirements
MACT Floors and Beyond the Floor Analysis

Potential Utility MACT Floors:

1. **Similar approach used for the Boiler MACT:**
   - **Establish Subcategories;**
   - **Rank Emission Data (ICR Emissions Data);**
   - **Average of top 12%;**
   - **Variability Analysis**
2. **Potential Beyond-the-Floor Requirements:**
   - ***FGD for Acid Gas control on all subcategories;***
   - ***ACI for Hg and D/F control;***
   - ***Dry Sorbent Injection (DSI) for acid gas control;***
   - ***Energy Assessment***

Potential Utility MACT Requirements
Subcategory and HAP Matrix

Subcategory	PM (lb/mmBtu)	HCl (lb/mmBtu)	Hg (lb/mmBtu)	CO (ppm @ 3% O2)	D/F (TEQ) (ng/dscm)
	Fuel-Related	Fuel-Related	Fuel-Related	Combustion-Related	Combustion-Related
Pulverized Coal–Bituminous	X_{PM}	X_{HCl}	X_{Hg}	X_{CO}	$X_{D/F}$
Fluidized Bed-Bituminous	X_{PM}	X_{HCl}	X_{Hg}	Y_{CO} $Y_{CO} < X_{CO}$	$Y_{D/F}$ $Y_{D/F} < X_{D/F}$
Stoker-Bituminous	X_{PM}	X_{HCl}	X_{Hg}	Z_{CO} $Z_{CO} < X_{CO}$	$Z_{D/F}$ $Z_{D/F} < X_{D/F}$
Pulverized Coal-Subbituminous	Y_{PM} $Y_{PM} \approx X_{PM}$	Y_{HCl} $Y_{HCl} < X_{HCl}$	Y_{Hg} $Y_{Hg} > X_{Hg}$	X_{CO}	$X_{D/F}$
Fluidized Bed-Subbituminous	Y_{PM} $Y_{PM} \approx X_{PM}$	Y_{HCl} $Y_{HCl} < X_{HCl}$	Y_{Hg} $Y_{Hg} > X_{Hg}$	Y_{CO} $Y_{CO} < X_{CO}$	$Y_{D/F}$ $Y_{D/F} < X_{D/F}$
Stoker-Subbituminous	Y_{PM} $Y_{PM} \approx X_{PM}$	Y_{HCl} $Y_{HCl} < X_{HCl}$	Y_{Hg} $Y_{Hg} > X_{Hg}$	Z_{CO} $Z_{CO} < X_{CO}$	$Z_{D/F}$ $Z_{D/F} < X_{D/F}$
Pulverized Coal-Lignite	Z_{PM} $Z_{PM} \approx X_{PM}$	Z_{HCl} $Z_{HCl} < X_{HCl}$	Z_{Hg} $Z_{Hg} > X_{Hg}$	X_{CO}	$X_{D/F}$
Fluidized Bed-Lignite	Z_{PM} $Z_{PM} \approx X_{PM}$	Z_{HCl} $Z_{HCl} < X_{HCl}$	Z_{Hg} $Z_{Hg} > X_{Hg}$	Y_{CO} $Y_{CO} < X_{CO}$	$Y_{D/F}$ $Y_{D/F} < X_{D/F}$
Stoker-Lignite	Z_{PM} $Z_{PM} \approx X_{PM}$	Z_{HCl} $Z_{HCl} < X_{HCl}$	Z_{Hg} $Z_{Hg} > X_{Hg}$	Z_{CO} $Z_{CO} < X_{CO}$	$Z_{D/F}$ $Z_{D/F} < X_{D/F}$

Potential Utility MACT Requirements
Subcategory and Control Technology Matrix

Subcategory	PM	HCl	Hg	CO	D/F
Pulverized Coal–Bituminous	FF or ESP	Scrubber DSI (B-T-F)	Fuel Cl^- and Scrubber	GCP	GCP ACI (B-T-F)
Fluidized Bed-Bituminous	FF or ESP	Limestone / FF DSI (B-T-F)	Fuel Cl^- and Limestone / FF	GCP	Limestone / FF ACI (B-T-F)
Stoker-Bituminous	FF or ESP	Scrubber DSI (B-T-F)	Fuel Cl^- and Scrubber	GCP	GCP ACI (B-T-F)
Pulverized Coal-Subbituminous	FF or ESP	FF DSI (B-T-F)	ACI / FF	GCP	GCP ACI (B-T-F)
Fluidized Bed-Subbituminous	FF or ESP	Limestone / FF DSI (B-T-F)	ACI / FF	GCP	Limestone / FF ACI (B-T-F)
Stoker-Subbituminous	FF or ESP	FF DSI (B-T-F)	ACI / FF	GCP	GCP ACI (B-T-F)
Pulverized Coal-Lignite	FF or ESP	Scrubber DSI (B-T-F)	ACI / FF	GCP	GCP ACI (B-T-F)
Fluidized Bed-Lignite	FF or ESP	Limestone / FF DSI (B-T-F)	ACI / FF	GCP	Limestone / FF ACI (B-T-F)
Stoker-Lignite	FF or ESP	FF DSI (B-T-F)	ACI / FF	GCP	GCP ACI (B-T-F)

FF = Fabric Filter; DSI = Dry Sorbent Injection; ACI = Activated Carbon Injection; GCP = Good Combustion Practices; B-T-F = Beyond-the-Floor Technology

Sargent & Lundy LLC

Note – ACI has been demonstrated as a D/F control technology for Wastes-to-Energy and Hazardous Wastes Incineration