Workshop J
New MACT Standard for Boilers: Road Map for Timely Compliance

Presenters

- Ted Fares
  Engineering Director
  Ohio University, Athens, Ohio
- Dan Brewer
  Plant Environmental Manager
  The Procter & Gamble Paper Products Company, Albany, Georgia
- Jessie J. Edgar
  Environmental Technician
  The Procter & Gamble Paper Products Company, Albany, Georgia
- Robert J. Miller
  Principal
  Fosdick & Hilmer, Inc., Cincinnati, Ohio
- Yatendra M. Shah
  President
  Optim Environmental Resources, Inc., Cincinnati, Ohio

Topics

- Applicability
- Emission Limitations
- Compliance provisions
- Compliance Assessment and Planning
- Recordkeeping and Reporting
- Key Milestones
- Case Histories

Applicability

- Applies to industrial boilers, institutional and commercial boilers, and process heaters located at a major source of Hazardous Air Pollutants (HAP)
- If a facility is not major HAP source (10/25 TPY), Boiler MACT Rule does not apply

Process Heater

- An enclosed device using controlled flame, that is not a boiler, and the unit's primary purpose is to transfer heat indirectly to a process material (liquid, gas, or solid) or to heat a transfer material for use in a process unit, instead of generating steam.

Boilers and Process Heater Subcategories

- Solid fuel units
  - Large (Greater than 10 MM Btu/hr heat input)
  - Small (all firetubes and others less than 10 MM Btu/hr)
  - Limited-use (less than 10% capacity factor)
- Liquid fuel units
  - Large (Greater than 10 MM Btu/hr heat input)
  - Small (all firetubes and others less than 10 MM Btu/hr)
  - Limited-use (less than 10% capacity factor)
- Gaseous fuel units
  - Large (Greater than 10 MM Btu/hr heat input)
  - Small (all firetubes and others less than 10 MM Btu/hr)
  - Limited-use (less than 10% capacity factor)
- **Total of 9 subcategories**

Pollutants Regulated

- Mercury
- Non-Mercury Metallic HAP
  - Total Selected Metals (TSM)
- Inorganic HAP
  - Hydrogen chloride (HCl)
- Organic HAP
  - Carbon monoxide

Total Selected Metals (TSM)

- Arsenic
- Beryllium
- Cadmium
- Chromium
- Lead
- Manganese
- Nickel
- Selenium

Emissions Limits – Existing Units

- **Existing large solid fuel units**

  PM -- 0.07 lb/million Btu, OR TSM – 0.001 lb/million Btu

  HCl -- 0.09 lb/million Btu (~ 90 ppm)

  Mercury (Hg) – 9 lb/trillion Btu

- **Existing limited use solid fuel units**

  PM -- 0.21 lb/million Btu, OR TSM – 0.004 lb/million Btu

- **No emissions standards for existing small solid fuel units or any existing liquid and gaseous fuel subcategories**

Emission Limits – New Units

- **New/Modified solid fuel units**

  PM -- 0.025 lb/million Btu, OR TSM 0.0003 lb/million Btu
  HCl -- 0.02 lb/million Btu (20 ppm)
  Hg – 3 lb/trillion Btu
  CO – 400 ppm @ 7% oxygen (not for small units)

- **New/Modified liquid fuel units**

  PM -- 0.03 lb/million Btu

  HCl -- 0.0005 lb/million Btu (large units)

  0.0009 lb/million Btu (small and limited use units)

  CO – 400 ppm @ 3% oxygen (not for small units)

- **New/Modified gaseous fuel-fired units**

  CO – 400 ppm @ 3% oxygen (not for small units)

Testing and Monitoring Requirements

- Testing:
  - Initial compliance tests (PM or TSM, HCl, mercury)
    - Performance tests (stacks tests) OR fuel analyses
  - Annual performance tests
  - Fuel analysis every 5 years or each new fuel type
- Monitoring
  - Process parameters (opacity, pressure drop, CO, sorbent injection rate, fuel, etc.)
    - CO CEM only for large units greater than 100 million Btu/hr
    - Annual CO tests for others
- Continuous Compliance
  - Demonstrated by maintaining operating limits

Additional Provisions

- Health-based HCl compliance alternative
- Health-based TSM compliance alternative
- Emissions averaging

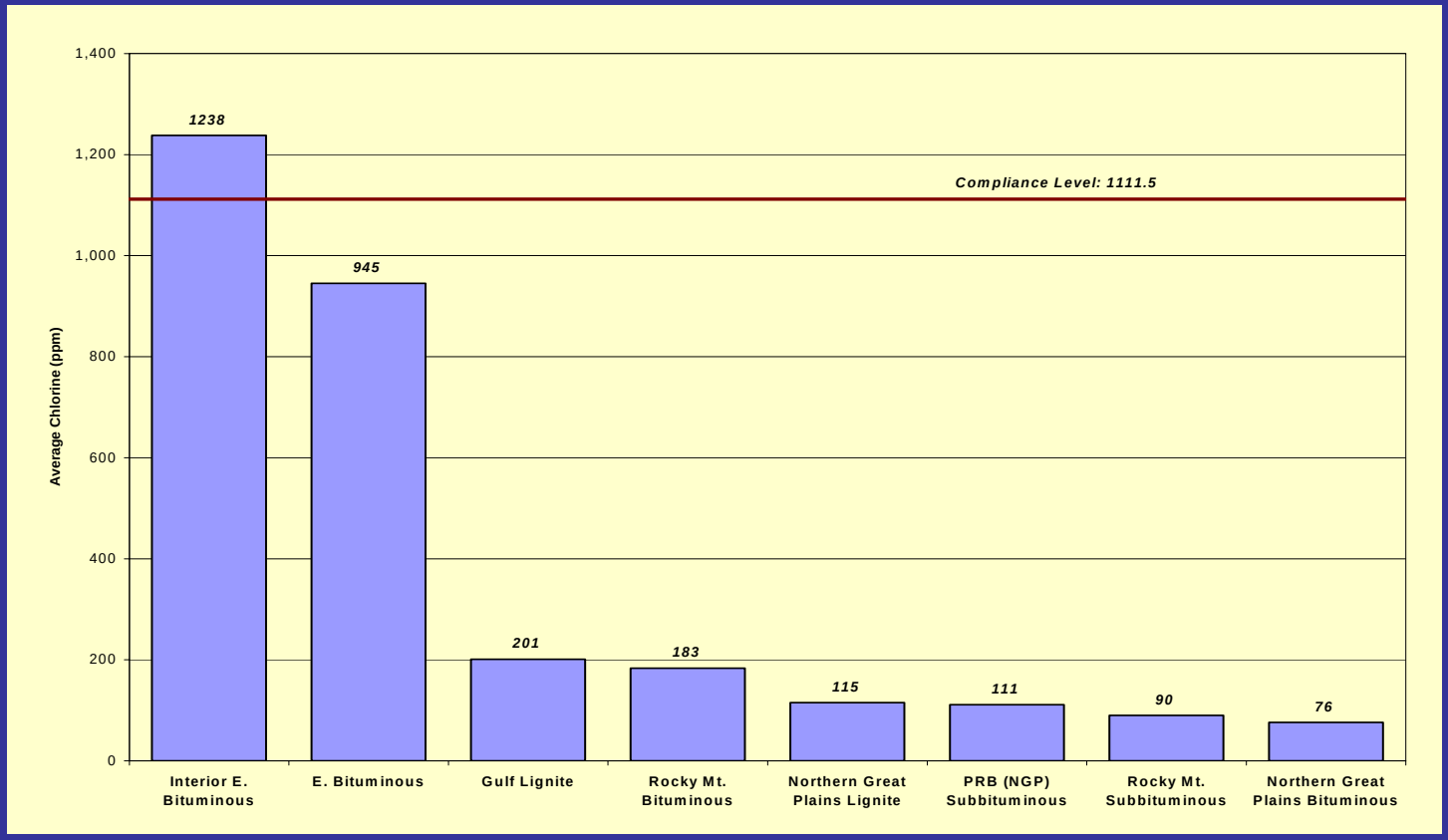
Key Dates

- March 12, 2005—Initial notification
- September 13, 2006—If using health-based approach, submit demonstration
- February 13, 2007—Submit emissions averaging plan
- July 13, 2007—Submit fuel analysis plan
- ***September 13, 2007***—In compliance (all controls, monitors in place and operational)
- February 11, 2008—Notification of initial performance test
- March 11, 2008—Conduct initial performance test
- May 11, 2008—Notification of compliance status
- July 31, 2008—First semiannual report
- March 11, 2009—Conduct subsequent performance test

Initial Assessment

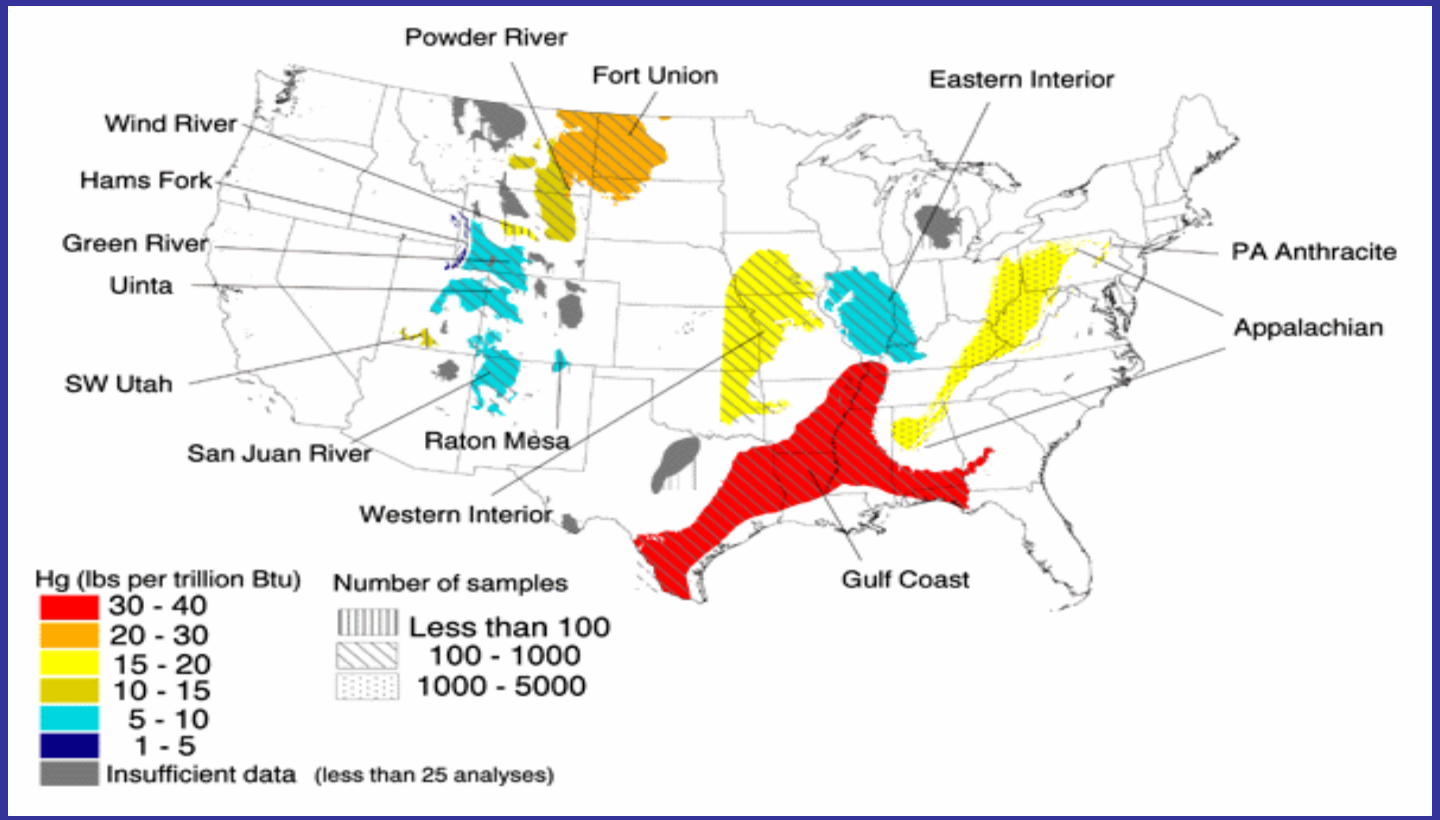
- Review MACT requirements specific to each boiler and identify pollutant-specific limits
- Review in-house stack test data and fuel analysis data
- Conduct fuel analyses to gauge feasibility of fuel analysis approach for complying with the rule
- Conduct limited initial emission testing to determine actual emission levels for MACT pollutants
- Quantify additional control requirements
- Review applicability of health-based compliance provisions

Chlorine Content of U.S. Coals (ppm)



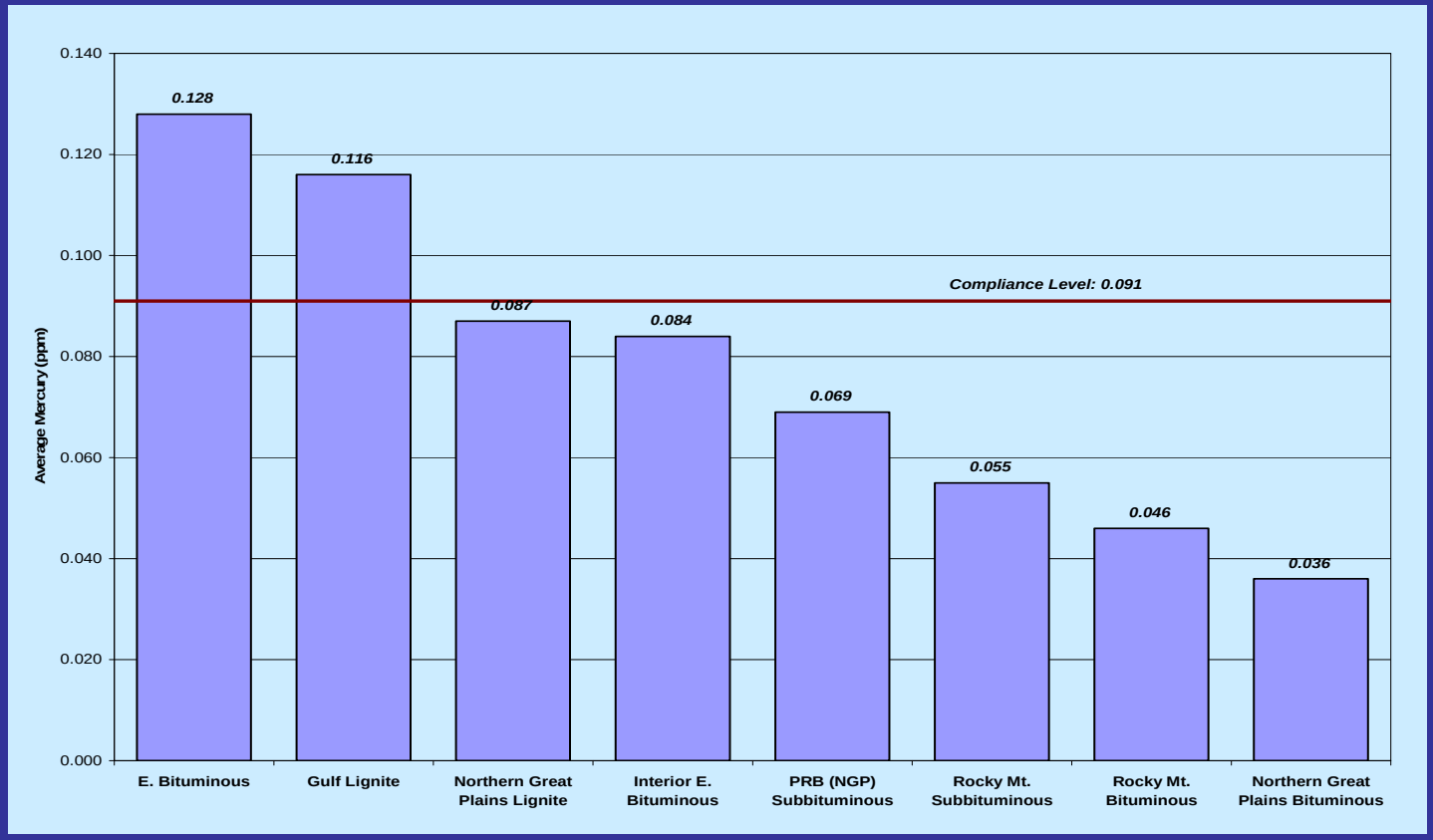
Source: EPRI

Mercury Content of U.S. Coals
(pounds per trillion Btu)



Source: USGS

Mercury Content of U.S. Coals (ppm)



Source: EPRI

MACT Compliance Approach

- Review of long-term energy management plan and their impact on the MACT selection decision making process
- Review of design parameters, current operating status, and control equipment performance data for the candidate boilers
- Review fuel analysis and stack test data
- Compilation of site-specific database of control measures for controlling emissions of pollutants regulated by Boiler MACT
- Literature search of control equipment performance
- Vendor contacts for performance and cost elements

MACT Compliance Approach (contd.)

- Identification of retrofit factors and plant adaptability factors
- Technical evaluation of individual and multi-pollutant control strategies and identification of technical feasible MACT compliance measures
- Formulation of alternative MACT compliance strategies taking to account retrofit factors and characteristics of individual boilers and existing emission controls
- Perform cost-effectiveness analysis of applicable options

MACT Compliance Approach (concluded)

- Identification of potential issues impacting the success of individual control measures
- Life-cycle cost analysis of technically feasible control measures
- Documentation and reports

Boiler MACT Compliance Approach - Example

- Review in-house stack test data for PM
  The data shows emission rate consistently below 0.07 lb/MMBtu heat input
  Limit for PM/TSM can be met
- Analyze fuel for mercury and chlorine
  The concentrations are in compliance
  Fuel analysis can be used to demonstrate compliance
- If the mercury and/or chlorine concentrations are not in compliance, then conduct emission tests
  If emission test results show compliance, use performance test approach for demonstrating compliance on annual basis
- If HCl stack test results above compliance level, conduct health-based analysis
  If results show compliance, use health-based approach for HCl
- *If above measures fail, install additional controls*

Compliance Analysis - HCl

- Fuel Analysis Option
  -- Fuel analysis requirements
  -- Site-specific fuel analysis plan
  -- Collecting samples and conducting analysis
  -- HCl emission rate calculation
- Health-Based Equivalent Emission Limit
- In-Place Controls
- New Add-On Controls

Compliance Analysis - Mercury

- Fuel Analysis Requirements
- Site Specific Fuel Analysis Plan
- Collecting Samples and Conducting Fuel Analysis
- Emission Rate Calculation

Compliance Analysis PM/TSM

- Fuel Analysis Option
  -- Site Specific Fuel Analysis Plan
  -- Collecting Samples and Conducting Fuel Analysis
  -- TSM Emission Rate Calculation
- Health-Based Emission Limit
- Performance Testing
  Site Specific Test Plan
  Performance Test Requirements
  Establishing Operating Limits
  Site Specific Monitoring Plan

Emissions Averaging

- Can be used for existing large solid fuel units
- Applicable to PM/TSM, HCl, and mercury
- Develop and submit an implementation plan no later than 6 months prior to the date of compliance demonstration

Fuel Analysis Requirements - Chlorine

Procedure	Method
Collect fuel samples	Procedure in Section 63.7521(c) or ASTM D22324M-03 or equivalent
Composite fuel samples	Procedures in Section 63.7521(d) or equivalent
Prepare composite fuel samples	SW-846-3050B (for solid samples) or ASTM D2013-01 or equivalent
Determine heat content of fuel	ASTM D5865-03a or equivalent
Determine moisture content of fuel	ASTM D3173-02 or equivalent
Measure chlorine concentration in fuel sample	SW-846-9250 or equivalent

Fuel Analysis Requirements - Chlorine

Procedure	Method
Collect fuel samples	Procedure in Section 63.7521(c) or ASTM D22324M-03 or equivalent
Composite fuel samples	Procedures in Section 63.7521(d) or equivalent
Prepare composite fuel samples	SW-846-3050B (for solid samples) or ASTM D2013-01 or equivalent
Determine heat content of fuel	ASTM D5865-03a or equivalent
Determine moisture content of fuel	ASTM D3173-02 or equivalent
Measure chlorine concentration in fuel sample	SW-846-9250 or equivalent

HCl Emission Rate Calculation

$$C_{90} = \text{mean} + (\text{SD} \times \text{t})$$

Where:

C90 = 90th percentile confidence level chlorine concentration, lb/MMBtu

Mean = Arithmetic average of fuel chlorine concentration in the fuel samples, lb/MMBtu

SD = Standard deviation of the chlorine concentration in the fuel samples, lb/MMBtu

t = t distribution critical value for the 90th percentile (0.1) probability for the appropriate degrees of freedom (number of samples minus one) as obtained from a Distribution Critical Value Table.

Fuel Analysis Requirements - Mercury

Procedure	Method
Collect fuel samples	Procedure in Section 63.7521(c) or ASTM D2234M-03 or equivalent
Composite fuel samples	Procedures in Section 63.7521(d) or equivalent
Prepare composite fuel samples	ASTM D2013-01 or equivalent
Determine heat content of fuel	ASTM D5865-03a or equivalent
Determine moisture content of fuel	ASTM D3173-02 or equivalent
Measure mercury concentration in fuel sample	ASTM D3684-01

Emission Rate Calculation - Mercury

$$M_{90} = \text{mean} + (\text{SD} \times \text{t})$$

Where:

M90 = 90th percentile confidence level mercury concentration, lb/MMBtu

Mean = Arithmetic average of fuel mercury concentration in the fuel samples, lb/MMBtu

SD = Standard deviation of the mercury concentration in the fuel samples, lb/MMBtu

t = t distribution critical value for the 90th percentile (0.1) probability for the appropriate degrees of freedom (number of samples minus one) as obtained from a Distribution Critical Value Table.

Fuel Analysis Requirements - TSM

Procedure	Method
Collect fuel samples	Procedure in Section 63.7521(c) or ASTM D2234M-03 or equivalent
Composite fuel samples	Procedures in Section 63.7521(d) or equivalent
Prepare composite fuel samples	ASTM D2013-01 or equivalent
Determine heat content of fuel	ASTM D5865-03a or equivalent
Determine moisture content of fuel	ASTM D3173-02 or equivalent
Measure total selected metals concentration in fuel sample	SW-846-6010B or ASTM D3683-94(2000)

Emission Rate Calculation - TSM

$$TSM_{90} = \text{mean} + (\text{SD} \times \text{t})$$

Where:

TSM90 = 90th percentile confidence level TSM concentration, lb/MMBtu

Mean = Arithmetic average of fuel TSM concentration in the fuel samples, lb/MMBtu

SD = Standard deviation of the TSM concentration in the fuel samples, lb/MMBtu

t = t distribution critical value for the 90th percentile (0.1) probability for the appropriate degrees of freedom (number of samples minus one) as obtained from a Distribution Critical Value Table.

Health-Based HCl Compliance Alternative

- **As alternative to complying with HCl MACT limit, may demonstrate compliance with a health-based HCl equivalent allowable limit**
  - Must include all affected units covered by subpart DDDDD
  - Must conduct HCl and chlorine emission tests
  - Must calculate the total maximum hourly mass HCl-equivalent emission rate
- **Compliance determine by using:**
  - Lookup table
    - Average stack height
    - Minimum distance to property boundary
  - Site-specific compliance demonstration
    - Hazard Index (HI) can not exceed 1.0

Health-Based Compliance Analysis - HCl

(1) Conduct emission tests for HCl and chlorine using specified reference methods

(2) Calculate the total maximum hourly mass HCl-equivalent emission rate

(3) Use Look-Up Table 2 in Appendix A of the Boiler MACT rule to determine if the facility is in compliance with the health-based HCl-equivalent emission limit

(4) Select the maximum allowable HCl-equivalent emission rate from the look-up table using the stack height and the minimum distance between the stack and the boundary of the Heating Plant

(5) The facility is in compliance if the maximum HCl-equivalent emission rate does not exceed the value obtained from the Appendix A look-up table.

(6) As an alternative to using the look-up table, a facility may conduct a site-specific compliance demonstration which shows that the candidate boilers are not expected to cause individual chronic inhalation exposure from HCl and chlorine which can exceed a Hazard Index (HI) value of 1.0.

Health-Based Compliance Analysis - HCl

- Based on the recommended RfC values of 0.2 µg/m^3 and 20 µg/m^3 for chlorine gas and HCl, respectively, the simplified HCl-equivalent emission rate equation is:

  HCl-Equivalent Emission Rate, lbs/hr =
  (HCl Emission Rate, lbs/hr) +(100 x Chlorine Emission Rate, lbs/hr)

Health-Based Compliance Analysis - HCl

$$ER_{tw} = \sum(ER_i \times (RfC_{HCl} / RfC_i))$$

Where:

ER_{tw} = HCl-equivalent emission rate, lbs/hr

ER_i = Emission rate for HAP i in lbs/hr

RfC_i = Reference concentration of HAP i

RfC_{HCl} = Reference concentration of HCl

Health-Based TSM Compliance Alternative

- **Health-based TSM compliance alternative**
  - **As alternative to complying with TSM limit based on 8 metals, may demonstrate compliance with TSM limit based on 7 metals by excluding manganese**
    - Must include all affected units covered by subpart DDDDD
    - Must conduct manganese emission tests
    - Must calculate the total maximum hourly mass manganese emission rate
  - **Eligible for demonstrating compliance based on 7 metals excluding manganese by using:**
    - Lookup table
      - Average stack height
      - Minimum distance to property boundary
    - Site-specific compliance demonstration
      - Hazard Quotient (HQ) can not exceed 1.0

Performance Test Requirements - PM

Test Requirement	Method
Select sampling ports locations and the number of traverse points	Method 1 of 40 CFR Part 60, Appendix A
Determine velocity and volumetric flow rate of the stack gas	Method 2, Method 2F, or Method 2G of Appendix A to 40 CFR part 60
Determine oxygen and carbon dioxide concentrations	Method 3A or 3B in Appendix A to 40 CFR part
Measure moisture content of the stack gas	Method 4 in Appendix A to 40 CFR part 60
Measure the particulate matter emission concentrations	Method 5 or Method 17 in Appendix A to 40 CFR 60
Convert emissions concentrations to lb/MMBtu emission rates	F-Factor methodology in Method 19 in Appendix A to 40 CFR part 60

Boiler 2 – P&G, Albany, Georgia

- Installed in 1981
- Rated at 216 MMBtu/hr heat input
- Fires wood waste, peanut hulls, and pecan hulls
- Also permitted to fire limited quantify of plastic waste
- Equipped with a wet electrostatic precipitator for controlling emissions of particulate matter
- Emission test data show PM consistently below the Boiler MACT limit of 0.07 lb/MMBtu

P&G Albany – Boiler 2

	Bark		50/50	
	Mercury	Chlorine	Mercury	Chlorine
Sample 1	0.0046	1.1000	0.0035	1.4000
Sample 2	0.0043	1.3000	0.0049	1.5000
Sample 3	0.0040	1.0000	0.0034	3.7000
Mean	0.0043	1.1333	0.0039	2.2000
Standard Deviation	0.0003	0.1528	0.0008	1.3000
t-value For Sample Set Of 3	1.8860	1.8860	1.8860	1.8860
90^{th} Percentile Concentration (mg/Kg)	0.0049	1.4214	0.0055	4.6518
Quantity of fuel, lb/MMBtu	232.56	232.56	232.56	232.56
Emission Rate, lb/MMBtu	**0.0000011**	**0.00034**	**0.0000013**	**0.00111**
MACT Emission Limit, lb/MMBtu	**0.0000090**	**0.09000**	**0.0000090**	**0.09000**

Coal Boilers, Ohio University, Athens, Ohio

- Boilers 1, 2, and 3, each rated at 96.25 MMBtu/hr heat input
- PM controlled by a common baghouse
- Also equipped with a multi-pollutant control system (Fluesorbent)
- Fire eastern bituminous coal

Ohio University Fuel Analysis

	Mercury, mg/Kg	Chlorine, %
Sample 1	0.1500	0.1900
Sample 2	0.1170	0.1800
Sample 3	0.1170	0.1700
Mean	0.1280	0.1800
Standard Deviation	0.0191	0.0100
t-value For Sample Set Of 3	1.8860	1.8860
90^{th} Percentile Concentration	0.1639	0.1989
Quantity of fuel, lb/MMBtu	83.33	83.33
Emission Rate, lb/MMBtu	**0.0000137**	**0.17036**
MACT Emission Limit, lb/MMBtu	**0.0000090**	**0.09000**

Notification Requirements

- Initial Notification
- Performance Test Notification
- Compliance Status Notification

Ongoing Compliance Requirements

- Hydrogen Chloride (HCl) and Mercury Fuel Analyses
- Particulate Matter Performance Testing
- Continuous Compliance with Operating Limits
- Demonstrating continuous compliance
- Reporting requirements
- Recordkeeping requirements

Ongoing Compliance Requirements
Alternative Options

- HCl Health Based Compliance Demonstration
- HCl and Mercury Performance Tests