How to Comply With The EPA’s New Boiler MACT Rules

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How to Use Your Console

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Agenda

Regulations
- Timeline/schedule for compliance
- Exit strategies (e.g., natural gas boilers are not subject to control devices in this regulation)
- The fine print and definitions that affect limits
- Numerical emission limits

Compliance process and hardware upgrades
- Changing fuel mix to achieve limits (e.g., Hg)
- Upgrading air pollution control for multi-pollutant removal
What Important Rules Are We Going to Discuss Today?

- **NESHAPs Subpart 63 Subpart DDDDD (5D) – MACT Rule**
  - Industrial, Commercial, Institutional (ICI) boilers and process heaters – Final air toxics standards for major sources
  - Applies to coal, oil, biomass (i.e., wood products), natural gas, refinery gas boilers and process heaters
  - Code of Federal Regulations (CFR) 63.7480 through 63.7575

- **NESHAPs Subpart 63 Subpart JJJJJJJ (6J) – GACT Rule**
  - ICI Boilers — Final air toxics standards for area sources (i.e., minor sources)
  - Coal, oil, biomass boilers (and not natural gas)
  - Code of Federal Regulations (CFR) 63.11193 through 63.11237
What Types of Fired Equipment are Subject to the 5D & 6J Rules?

- The final major source **5D Rule** affects ICI boilers and process heaters; the final area source **6J Rule** affects only ICI boilers.
  - **Process heater definition**: Combustion gases do not come directly into contact with process material or gases in the combustion chamber (e.g., indirect fired).
  - **Boiler definition**: Enclosed device using controlled flame combustion and having the primary purpose of recovering thermal energy in the form of steam or hot water.

- **Area vs. Major source**
  - **5D MACT – Major Source**: >10 tpy any single hazardous air pollutant (HAP) or >25 tpy all HAPs
  - **6J GACT – Area Source**: <10 tpy/<25 tpy HAP thresholds

- What equipment types are *not* subject to this rule?
  - Boilers and process heaters that combust solid waste
  - Temporary (moveable, <12 months-single location, for major sources)
Long & Sordid History of 5D & 6J Rules
## 5D MACT vs. 6J GACT

### MACT – 5D
- **Maximum Achievable Control Technology**
- Applies to **major HAP sources**
- The **MACT Floor** for **existing facilities**: HAP control performance of top 12% of existing sources
- **New facilities**: Best available HAP control for the type of facility
- **15 Subcategories** in final 5D rule

### GACT – 6J
- **Generally Available Control Technology**
- Applies to **area HAP sources**
- **GACT**: Based on appropriate practices/techniques commercially available and **taking into account economic and technical considerations**
- Fewer subcategories than the 5D MACT standard
HAPs Regulated by the Final Rules

• Emission limits apply to **new** and **existing** units for each of the **subcategories**, which are based on design and fuel.

• Fuel-based pollutants (direct result of the contaminants in fuels combusted):
  - **PM** (as a surrogate for non-Hg HAP metals)
  - **HCl** (as a surrogate for acid gas HAP)
  - **Hg**

• Combustion-based pollutants:
  - **CO** (as a surrogate for non-dioxin organic HAP)
  - **Dioxins & furans**
Relationship Between Final MACT/GACT & Other Combustion Rules

• If units combust fuels that are defined as “solid waste,” those units are not subject to Boiler MACT.
• Units currently subject to another MACT standard are not subject to 5D or 6J. Such as:
  – Ethylene cracking furnace covered by Part 63 Subpart YY
  – Recovery furnace covered by Part 63 Subpart MM
• For 5D: Boiler/Heater used as a control device to comply with another subpart (if 50% of heat input is regulated by another MACT)
• Sources subject to NSPS rules also will be subject to the 5D/6J standards:
  – MACT/GACT requirements regulate HAPs; NSPS does not.
  – Per EPA: NSPS requirements were considered to avoid duplicating requirements.
• Applicable Rule?
  – 5D Major Source Rule
  – 6J Area Source Rule

• Size of Heater/Boiler?
  – Large > 10 MMBtu/hr
  – Small < 10 MMBtu/hr

• Limited Use (for 5D rule)?
  – ✓ if < 876 hours/yr
  – ✗ if > 876 hours/yr

• Fuel Type?
  – Coal
    – Area source: <15% biomass,
    – Major: <10% biomass
  – Biomass
    – Area source: >15% biomass
    – Major: >10% biomass
  – Liquid
  – Gaseous

• Construction Status?
  – Existing (before June 4, 2010)
  – New (after June 4, 2010)
  – Reconstructed (after June 4, 2010)
# Major Source MACT – 5D Rule

<table>
<thead>
<tr>
<th>Boiler/Heater Subcategories</th>
<th>Applicable Emission Limits</th>
<th>Work Practice Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>New/ existing &lt;10MMBtu/hr or limited use (that are subject to rule)</td>
<td>NA</td>
<td>Biennial tune-ups</td>
</tr>
<tr>
<td>New/existing natural gas (i.e. clean)</td>
<td>NA</td>
<td>Annual tune-ups</td>
</tr>
<tr>
<td>&gt;10MMBtu/hr new and existing units: solid fuel, coal, biomass, liquid, Gas 2 (not clean gas)</td>
<td>CO, PM, HCl, Hg, dioxan/furan (dependant on subcategory)</td>
<td></td>
</tr>
<tr>
<td>Existing boiler or heater</td>
<td>As above</td>
<td>One-time energy assessment</td>
</tr>
</tbody>
</table>

Initial and annual stack tests if subject to emission limits. However, in lieu of test, a performance evaluation of continuous PM monitor is required if PM monitor installed. Dioxan/furan: Initial performance tests only

**KEY POINT:** For the many facilities that burn only natural gas or a clean gaseous fuel: Per the 5D rule, for all new and existing natural gas and refinery gas-fired units, the operator must perform an annual tune-up (instead of emission limit). Other gases can qualify for tune-ups by demonstrating that they burn “clean fuel,” with contaminant levels similar to natural gas.
## 5D Rule Operating & Monitoring Parameters

<table>
<thead>
<tr>
<th>Control</th>
<th>Monitoring and Operating Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet PM scrubber</td>
<td>Pressure drop and liquid flow rate</td>
</tr>
<tr>
<td>Wet acid gas scrubber</td>
<td>pH and liquid flow rate</td>
</tr>
<tr>
<td>CO</td>
<td>O₂ monitor</td>
</tr>
<tr>
<td>ESP</td>
<td>Minimum voltage and total power input (if no PM monitor)</td>
</tr>
<tr>
<td>Activated carbon injection</td>
<td>Activated carbon injection rate.</td>
</tr>
<tr>
<td>Fabric filters</td>
<td>Bag leak detection alarm</td>
</tr>
<tr>
<td>Coal, biomass, or residual fuel oil &gt;250 MMBtu/hr</td>
<td>Continuous PM monitor (and exempt from PM performance tests)</td>
</tr>
<tr>
<td>Demonstrate compliance using performance test</td>
<td>Maintain an operating load no greater than 110% of the operating load</td>
</tr>
<tr>
<td>Fuel analysis in lieu of stack test (for Hg and HCl)</td>
<td>Monthly fuel records</td>
</tr>
<tr>
<td>Operating parameters are established during performance tests.</td>
<td></td>
</tr>
</tbody>
</table>
5D Rule Major Source Compliance Dates
### Area Source GACT – 6J Rule

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Applicable Limits</th>
<th>Work Practice Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>New coal w/&gt;10 MMBtu/hr</td>
<td>PM, Hg, CO</td>
<td>N/A</td>
</tr>
<tr>
<td>Existing coal w/&gt;10 MMBtu/hr</td>
<td>Hg, CO</td>
<td>N/A</td>
</tr>
<tr>
<td>New and existing coal w/&lt;10 MMBtu/hr</td>
<td>None</td>
<td>Biennial tune-up program</td>
</tr>
<tr>
<td>New biomass and new oil-boiler &gt;10 MMBtu/hr</td>
<td>PM</td>
<td>Biennial tune-up program</td>
</tr>
<tr>
<td>New biomass and new oil-boiler &lt;10 MMBtu/hr</td>
<td>None</td>
<td>Biennial tune-up program</td>
</tr>
<tr>
<td>Existing biomass and oil boilers</td>
<td>None</td>
<td>Biennial tune-up program</td>
</tr>
<tr>
<td>Existing coal, biomass, oil boilers &gt;10 MMBtu/hr</td>
<td>As above</td>
<td>One-time energy assessment</td>
</tr>
</tbody>
</table>

As applicable, conduct initial and triennial performance tests to verify emissions and establish operating limits. Hg can be stack-tested w/fuel or fuel analysis or fuel analysis only.
# 6J Rule Continuous Compliance

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Compliance Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM or mercury emission limits (if initial performance test was used to demonstrate compliance)</td>
<td>Maintain fuel records to demonstrate that no new fuel type or new mixture (monthly average) was burned.</td>
</tr>
<tr>
<td>Hg (if compliance demonstrated by fuel analysis)</td>
<td>Perform monthly fuel analysis.</td>
</tr>
<tr>
<td>CO emission limits</td>
<td>Continually monitor oxygen and maintain an acceptable oxygen concentration level based on performance test results.</td>
</tr>
<tr>
<td>PM, CO, and Hg</td>
<td>Comply with site-specific operating limits defined in performance test.</td>
</tr>
</tbody>
</table>

If initial performance test required, then stack-test every 3 years (refer to rules for any exceptions and qualifications).
6J Rule Compliance Options
(Based on Add-On Control Device)
6J Rule Area Source Compliance Dates

Existing Boiler and Heater:
- Subject to emission limits: Comply by March 21, 2014
- Subject to tune-ups: Comply by March 21, 2012

New or Reconstructed:
- Comply by May 20, 2011 or upon startup

Existing Unit Switching from Solid Waste to Fuel:
- Comply by effective date of fuel switch
Tune-Ups

• Units subject to tune-up work practices are **not** subject to emission limit requirements.

• What units are subject to tune-ups?
  - **6J Rule** – *Area* sources: All biomass and oil-fired units
  - **5D Rule** – *Major* sources:
    • New and existing natural gas and refinery gas-fired units: **Every year**
    • Other gases can qualify for **annual tune-ups** by demonstrating that they burn “clean fuel,” with contaminant levels similar to natural gas.
    • New and existing units <10 MMBtu/hr: **Every 2 years**
    • Limited use boilers: **Every 2 years**
Tune-Ups (cont.)

- **Tune-Up Procedures**
  - Inspect the flame pattern and burner. Adjust, clean, and replace as necessary.
  - Inspect the system controlling the air-to-fuel ratio.
  - Optimize CO emissions.
  - Measure CO concentrations in the flue gas stream, both before and after the adjustments are made.
What Is an Energy Assessment?

• Applicability
  – **6J Rule** for *area* sources: Existing boilers >10 MMBtu/hr coal, oil, or biomass boiler
  – **5D Rule** for *major* sources: Existing boilers and heaters

• Performed by a **qualified energy assessor** who has demonstrated capabilities to evaluate a set of the typical energy savings opportunities

• Assessment completed **one time**
• Energy assessment must include:
  – Visual inspection
  – Inventory of major energy-consuming systems
  – A review of available architectural and engineering plans
  – A review of the facility’s energy management practices
  – A list of major energy conservation measures
  – A list of energy savings
  – A comprehensive report detailing the ways to improve efficiency
Energy Assessment Requirements
5D and 6J Rules

Facility-wide energy use <0.3 Tbtu/yr
- Corresponds to <34 MMBtu/hr at 8760 hrs/yr.
- One-day maximum.
- At least 50% of the energy output must be evaluated to identify energy savings opportunities.

Facility-wide energy use >0.3 and < 1.0 Tbtu/yr
- Corresponds to >34 and <114 MMBtu/hr at 8760 hrs/yr.
- Three-day maximum.
- At least 33% of the energy output must be evaluated to identify energy savings opportunities.

Facility-wide energy use > 1.0 Tbtu/yr
- Corresponds to >114 MMBtu/hr at 8760 hrs/yr.
- At least 20% of the energy output must be evaluated to identify energy savings opportunities.
Key Startup, Shutdown, & Malfunction (SSM) Requirements

• Similar requirements for both 5D major sources and 6J area sources
• For startup/shutdown (S/S):
  – Meet a work practice standard:
    • Follow manufacturer’s recommended procedures for minimizing S/S periods in lieu of numeric emission limits.
  – Not technically feasible to complete stack testing during S/S:
    • Due to physical limitations and the short duration of SS periods.
• For malfunctions:
  – EPA added affirmative defense language
    • Helpful for enforcement proceedings for exceedances of the numerical emission limits that are caused by malfunctions.
  – Maintain records of malfunctions and corrective actions
Elect to demonstrate compliance with HCl or Hg emission limit through fuel analysis in lieu of performance testing.

Follow these procedures:

- Maintain monthly fuel records to document that no new fuels or new suppliers were used.
- If either the fuel or supplier is changed, then recalculate maximum Hg or HCl inputs using new data.
- If you burn more than one fuel type, you must determine the fuel mixture that would result in the maximum emission rates of the pollutants.
Fuel Specification for Boilers/Heaters at *Major Sources*

- Elect to demonstrate that a gaseous fuel meets the specifications of Gas 1 fuel (i.e., natural gas).
- Benefit: Subject to Gas 1 requirements (i.e., comply w/tune-ups instead of numerical limits).
  - Must conduct an initial fuel specification analysis to determine H$_2$S and Hg content.
  - If the H$_2$S and Hg levels in fuel qualify as Gas 1, include a signed certification with the Notification of Compliance Status.
  - If gas constituents could potentially exceed the specification, conduct monthly testing.
Key 5D and 6J Recordkeeping Requirements

• Limited use: Monitor and record the operating hours per year *(for major sources only)*.

• Tune-ups: Include dates, results, procedures, and manufacturer’s specifications.

• Any deviations?

• If elected to comply w/emission limit based on fuel analysis, then for each 30-day period, record:
  – Fuel usage, description, and information on the fuel supplier.

• A site-specific monitoring plan
  – Required for any continuous operating or emissions monitoring systems
  – Plan includes the following:
    • Ongoing operation and maintenance procedures
    • Data quality assurance
    • Reporting and recordkeeping procedures
### General Provision NESHAPs Reports

<table>
<thead>
<tr>
<th>aspect</th>
<th>Deadlines</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial notification (existing source)</td>
<td>No later than 120 days after May 20, 2011</td>
<td>Must submit even if initial notification was submitted for vacated 2004 rule.</td>
</tr>
<tr>
<td>Initial notification (new source)</td>
<td>15 days after startup</td>
<td>—</td>
</tr>
<tr>
<td>Notification of intent to conduct performance tests</td>
<td>60 days prior to performance test</td>
<td>—</td>
</tr>
<tr>
<td>Notification of compliance status</td>
<td>60 days after performance test (or if no stack test required, 120 days after compliance date)</td>
<td>—</td>
</tr>
<tr>
<td>Semi-annual compliance reports</td>
<td>Standard semi-annual calendar periods</td>
<td>Required ONLY when any deviations or any process changes</td>
</tr>
<tr>
<td>Annual or biennial report (as appropriate for major sources)</td>
<td>First date (June 30 or Dec. 31) after Year 1 or 2 (as appropriate)</td>
<td>For units subject only to tune-ups. And can be in lieu of semiannual report.</td>
</tr>
</tbody>
</table>
Miscellaneous Reports

- **Area and major sources:** Submit to EPA an electronic copy of reports of required performance tests using the Electronic Reporting Tool (ERT) via EPA’s Central Data Exchange (CDX).

- **Area and major sources:** Via notification of compliance status, submit statement of completed energy assessment.

- **Area sources:**
  - Maintain on-site and submit, if requested, a biennial tune-up report.
  - If subject to an emission or operating limit: prepare by March 1st of each year (and submit upon Agency request) certification and monthly fuel usage report
    - Report certifies if source has complied with all the relevant standards for the previous calendar year.
    - Submit by March 15th if any deviations occurred.
Proposed to Final Rule – Key Changes

• **5D Rule** for *Major Sources*:
  – Existing sources can demonstrate compliance on an output basis instead of on a heat input basis.
  – Use of ENERGY STAR Facility Energy Assessment Matrix is recommended, but removed as a requirement.
  – >100 MMBtu/hr units: CO CEMS is no longer applicable.
    – Instead, stack test and continuous oxygen monitor are applicable.
  – Clarified that <10 MMBtu/hr units are not subject to CO performance test since not subject to CO emission limit.

• **6J Rule** for *Area Sources*:
  – New small units are now subject to tune-ups instead of emission limits.
Your Path Forward

• First step: EHS Department to develop a **compliance strategy** and plan.
• **Determine applicable** subcategories and requirements.
• Review emissions data and **identify if any controls are required**. If so, schedule meetings w/appropriate equipment vendors.
• Submit **initial reports** and develop a systematic recordkeeping and reporting system.
Your Path Forward (cont.)

• Install any applicable **monitoring systems** (emissions or operating).
• Schedule **energy assessments** and **performance tests**. Are units configured with ports, etc.?
• Train Maintenance Department to perform any required **tune-ups** (annual or biennial, as applicable).
• Inform Operations of **SSM procedures**.
New Boiler & Process Heater MACT
>10 and <30 MM Btu/hr
NSPS 40CFR63 Subpart JJJJJJJ Final 2/21/11

EMISSION LIMITS FOR AREA SOURCE BOILERS (PTE < 10/25 tpy for HAPs)
[lb/MM Btu heat input except CO]

<table>
<thead>
<tr>
<th>Source</th>
<th>Category</th>
<th>PM</th>
<th>Hg</th>
<th>CO ppmvd Daily Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>New</td>
<td>Coal</td>
<td>0.42</td>
<td>4.8E-06</td>
<td>400 (@ 3% oxygen)</td>
</tr>
<tr>
<td></td>
<td>Biomass</td>
<td>0.07</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Oil</td>
<td>0.03</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Existing</td>
<td>Coal</td>
<td>NA</td>
<td>4.8E-06</td>
<td>400 (@ 3% oxygen)</td>
</tr>
</tbody>
</table>

Dropping below 15% biomass allows higher PM, CO
## New Boiler & Process Heater MACT (cont.)

>30 MM Btu/hr
NSPS 40CFR63 Subpart JJJJ
Final 2/21/11

### EMISSION LIMITS FOR AREA SOURCE BOILERS (PTE < 10/25 tpy for HAPs)
[lb/MM Btu heat input except CO]

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<td>New</td>
<td>Coal</td>
<td>0.03</td>
<td>4.8E−06</td>
<td>400 (@ 3% oxygen)</td>
</tr>
<tr>
<td></td>
<td>Biomass</td>
<td>0.03</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Oil</td>
<td>0.03</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Existing</td>
<td>Coal</td>
<td>NA</td>
<td>4.8E−06</td>
<td>400 (@ 3% oxygen)</td>
</tr>
</tbody>
</table>

Assuming 10,000 dscf/MM Btu, equals ~ 0.02 gr/dscf or ~50 mg/m³
### Boiler and Process Heater MACT Major Sources

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Particulate Matter (PM) lb/MM Btu</th>
<th>Hydrogen Chloride (HCl) lb/MM Btu</th>
<th>Mercury (Hg) lb/MM Btu</th>
<th>Carbon Monoxide (CO) (ppmvd @3% oxygen)</th>
<th>Dioxin/Furan (TEQ) (ng/dscm @ 7% oxygen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing – Coal Stoker</td>
<td>0.039</td>
<td>0.035</td>
<td>4.6E-06</td>
<td>270</td>
<td>0.003</td>
</tr>
<tr>
<td>Existing - Coal Fluidized Bed</td>
<td>0.039</td>
<td>0.035</td>
<td>4.6E-06</td>
<td>82</td>
<td>0.002</td>
</tr>
<tr>
<td>Existing – Pulverized Coal</td>
<td>0.039</td>
<td>0.035</td>
<td>4.6E-06</td>
<td>160</td>
<td>0.004</td>
</tr>
<tr>
<td>Existing – Biomass Stoker/other</td>
<td>0.039</td>
<td>0.035</td>
<td>4.6E-06</td>
<td>490</td>
<td>0.005</td>
</tr>
<tr>
<td>Existing - Biomass Fluidized Bed</td>
<td>0.039</td>
<td>0.035</td>
<td>4.6E-06</td>
<td>430</td>
<td>0.02</td>
</tr>
</tbody>
</table>

For 13000 Btu/lb coal, 100% Hg emitted, limit = 0.000006% Hg in coal

### Boiler and Process Heater MACT Major Sources (cont.)

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Particulate Matter (PM) lb/MM Btu</th>
<th>Hydrogen Chloride (HCl) lb/MM Btu</th>
<th>Mercury (Hg) lb/MM Btu</th>
<th>Carbon Monoxide (CO) (ppmvd @3% oxygen)</th>
<th>Dioxin/Furan (TEQ) (ng/dscm @ 7% oxygen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing – Biomass Dutch Oven/Suspension Burner</td>
<td>0.039</td>
<td>0.035</td>
<td>4.6E-06</td>
<td>470</td>
<td>0.2</td>
</tr>
<tr>
<td>Existing – Biomass Fuel Cells</td>
<td>0.039</td>
<td>0.035</td>
<td>4.6E-06</td>
<td>690</td>
<td>4</td>
</tr>
<tr>
<td>Existing – Biomass Suspension/Grate</td>
<td>0.039</td>
<td>0.035</td>
<td>4.6E-06</td>
<td>3,500</td>
<td>0.2</td>
</tr>
<tr>
<td>Existing – Liquid</td>
<td>0.0075</td>
<td>0.00033</td>
<td>3.5E-06</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Existing – Gas 2 (Other Process Gases)</td>
<td>0.043</td>
<td>0.0017</td>
<td>.13E-06</td>
<td>9.0</td>
<td>0.08</td>
</tr>
<tr>
<td>Existing – non-continental liquid</td>
<td>0.0075</td>
<td>0.00033</td>
<td>0.78E-06</td>
<td>160</td>
<td>4</td>
</tr>
</tbody>
</table>

*Depends on chlorine in feed, temp at boiler outlet/APC*
### Boiler and Process Heater MACT Major Sources (cont.)

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Particulate Matter (PM) lb/MM MM Btu</th>
<th>Hydrogen Chloride (HCl) lb/MM MM Btu</th>
<th>Mercury (Hg) lb/MM MM Btu</th>
<th>Carbon Monoxide (CO) (ppmvd @3% oxygen)</th>
<th>Dioxin/Furan (TEQ) (ng/dscm @ 7% oxygen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New – Coal Stoker(a), FB(b), Pulverized(c)</td>
<td>0.0011</td>
<td>0.0022</td>
<td>3.5E-06</td>
<td>6(a) 18(b) 12(c)</td>
<td>0.003(a), 0.002(b), 0.003(c)</td>
</tr>
<tr>
<td>New – Biomass Stoker(a), FB(b), Dutch Oven/Suspension.(c), Fuel Cells (d), Suspension/grate(e)</td>
<td>0.0011</td>
<td>0.0022</td>
<td>3.5E-06</td>
<td>160(a), 260(b), 470(c), 470(d), 1500(e)</td>
<td>0.005(a), 0.02(b), 0.2(c), 0.003(d), 0.2(e)</td>
</tr>
<tr>
<td>New – Liquid</td>
<td>0.0013</td>
<td>0.00033</td>
<td>0.21E-06</td>
<td>3</td>
<td>0.002</td>
</tr>
<tr>
<td>New – Gas 2 (Other Process Gases)</td>
<td>0.0067</td>
<td>0.0017</td>
<td>7.9E-06</td>
<td>3</td>
<td>0.08</td>
</tr>
<tr>
<td>New – non-continental liquid</td>
<td>0.0013</td>
<td>0.00033</td>
<td>0.78E-06</td>
<td>51</td>
<td>0.002</td>
</tr>
</tbody>
</table>

~ 0.007 gr/dscf or ~20 mg/m³
Boiler MACT Emissions and Controls

Hardware APC Solutions:

- HCl (SO2): Wet or dry scrubbing
- CO: Better combustion, or end of pipe catalyst
- PM: Baghouse (FF), wet or dry ESP
- Mercury: Activated carbon, higher LOI/carbon on flyash plus $\leq 350^\circ F$ ESP/FF temp, or condensing scrubber
- Dioxins/Fs: Activated carbon

Process Solutions

- Hg: Co-fire biomass with coal
- Dioxins/Fs: Catalytic bagfilter material, limit baghouse or dry ESP temperature to 450F
5D Rule – Examples of MACT Controls

- Scrubbers
- Baghouses – Fabric Filters
- Carbon Injection
  - Storage silo plus 3 distributors
  - PAC

Courtesy Norit Americas
Particulate Matter Controls
Wet vs. Dry

• Some applications are a natural for dry systems:
  – Cement kilns use ESP or FF to get dry byproduct

• Wet systems frequently used where:
  – Sparklers would burn holes in FF bags
  – Acid gas recovery is worthwhile
  – There is a high and variable acid gas level
Venturi Scrubber

- Very high-pressure drop required to achieve MACT, **not** a good solution for PM

- Usually have venturi, cyclonic slinger, packaged bed absorber, and demister all in line for PM/acid gas removal
Countercurrent Packed Bed Column for HCl

![Diagram of a countercurrent packed bed column](Image)


TMTS Assoc., Inc & Sage Environmental Consulting © 2011
Cross-Flow Scrubber for HCl
Wet Electrostatic Precipitators (WESP)

- Precondition gas to cool, removal some PM, and acid gas
- Charges particles to impart electrostatic charge
- Wetted collection surface with continuous flush
- No dust re-entrainment
- Has low energy consumption, no PM resistivity problems
- Low power use/efficient removal of submicron particles
SonicKleen™ WESP:
Integrated System with gas quenching, sub-cooling, absorption
Ionizing Wet Scrubbers (IWS)

- Cross-flow layout
- Precondition gas, remove high concentration of acid gases
- Charge particles
- Collect on wetted packing
- Normally used in 2 or 3 stages; require cyclic power off/flush cycles
- About 84% PM removal per stage
- Pressure drop about 5" w.c. per stage
Absorber/IWES System

Flue Gas → Ionizing Wet Scrubbing 
Stack

Packed Bed Absorber
Ionizing Elements

Packing

Fan

Two-stage Industrial IWES
Scaling of Nozzle

- Lime fouls packing and nozzles
- Caustic-derived salt more soluble, but caustic costs more
- Design lances and manifolds so they can be pulled and changed without need to enter vessels!
Mist Coalescers and Demisters

Standard Demister

- Gases leaving wet scrubbers carry mist containing acids and PM.
- Pad or chevron baffles
- Coolers & condensers remove water vapor effectively—increase PM size; require demister on outlet
Dry PM Removal

- FF, ESPs, and cyclones
- Generally lower cost than wet systems
- Dry product simplifies handling
Pulse Jet Baghouse
Pulse Jet Baghouse, Bag, Cage, and Blowpipes
Wet/Dry Scrubbing System with Fabric Filter
Spray Dryer Absorber and Baghouses
Dry/Dry Scrubbing System

- Na2CO3 or lime
- Inject activated carbon for Hg control also
Plate-Type Electrostatic Precipitator
High-Temp Ceramic Filters for Multipollutant Removal

- Tri-Mer represents Madison in U.S.
- High temp for PM
- Catalyst for SCR NOx (1” thick bags), with temps as low as 350F, with 400F preferred
- Dry reagent injection for HCl (&SO2)
- Carbon injection for Hg
- In use in Europe, plus 3 older U.S. installations, and current units going in now in U.S.
Ceramic Filters for Multipollutant Removal

High temp for PM removal

PM and NOx with reagent

Ceramic filter tubes in the UltraTemp Filtration system for hot gas filtration.

Small UltraTemp module incorporating new ceramic filter tubes.

Control of PM, SO₂, NOₓ in One System

Particulate captured on filter surface

PM does not penetrate walls of the filter

NOₓ and ammonia react with catalyst to destroy NOₓ

Sorbent Injection for SO₂ / HCl Control

Urea/Ammonia Injection for NOₓ Control

Ceramic Filters with Embedded Catalyst for NOₓ and Dioxin Control, PM Capture

Courtesy of Tri-Mer
PAC for Mercury Removal

• Typical Hg level = 0.1 ppm in coal; approx. 60% emitted

Hg removal:
  – PAC before baghouse or precipitator (~40-60% removal at 0.08 g/m³ loading
  – Use increased levels of unburned carbon to act as adsorbent (this carbon loss reduces fuel efficiency)
  – Typical carbon injection rates coal boilers: 7-10 lb/MM acf for ESPs, and 2-5 lb/MM acf for FF
  – Depends on type of coal, <350F temp required!
  – Some use high ratio baghouse downstream of other APC just for carbon injection

• Or — removal with wet scrubbers (e.g., B&W additive reagent to SO₂ scrubber liquid)

AWMA Journal, 11/03, pgs 1318-1325; AWMA Journal, 8/02, pgs 902-911; Power Engineering, 10/04, page 41
Mercury Removal With PAC

Used with permission, Calgon Carbons, from FLUEPAC®-MC PLUS Powdered Activated Carbon
Mercury Removal Catalyst/Wet Scrubbers

- Cormetech NOx catalyst also oxidizes Hg.
- Oxidation puts elemental Hg into soluble form: One test 64% $\rightarrow$ 98% as oxide.
- Oxide is then removed by wet scrubber.
- Application is for coal-fired boilers.

Ref: Power Engineering, 1/09, Scott Pritchard
Questions?

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QUESTIONS?

Please Submit your questions by:

Typing your question in the box and hitting submit.

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