North Carolina Division of Air Quality - 2012 Report on Control of Mercury Emissions from Coal-Fired Electric Generating Units

In response to 15 NCAC 02D .2509(b)
Presented to
Environmental Management Commission
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Topics Covered

15 NCAC 02D .2509(b) subjects:
- Mercury emissions, including projections
- Principal mercury emission sources
- Mercury emission control technologies
- Mercury deposition modeling results
- Mercury levels in fish and related health issues
- Rulemaking recommendations
ACRONYMS

EGU = Electrical generating unit
MATS = Mercury and Air Toxics Standards
PM = Particulate matter
ESP = Electrostatic precipitator, PM control
SO\(_2\) = Sulfur dioxide
FGD = Flue gas desulfurization, SO\(_2\) control
NO\(_x\) = Nitrogen oxides
SCR = Selective catalytic reduction, NO\(_x\) control
SNCR = Selective non-catalytic reduction, NO\(_x\) control
Why Interest for Mercury in North Carolina back in 2002?

- Mercury in fish tissue prompted NC fish advisories
- Coal-fired power plants released 3,200 pounds of mercury representing 2/3 of NC emissions
- Limited data available on speciated mercury emissions
- Mercury emission control varied from 0-90+% for U.S. power plants, prompting questions as to why
- Little known about relationship among emissions, deposition, and fish tissue level for mercury.
2010 Mercury Emission Inventory

- **1,850 lb/yr** from largely same top 22 facilities
- **52%** from 14 Electric Generating Units (EGUs)
  - Mercury emissions 3,350 lb in 2002, 960 lb in 2010
  - > 70% reduction over 8 years
- **33%** from 8 industrial facilities firing coal, waste, or iron
  - Most with effective mercury controls
  - Mercury emissions 1,950 lb in 2002, 890 lb in 2010
  - > 50% reduction over 8 years
  - Remaining industrial boilers subject to pending Boiler MACT
  - Few industrial boilers switched from coal to gas, others expected
- **15%** from 600 other low emitting facilities
Top 60 NC Mercury Emission Sources 2007-2010

Legend:
Mercury emissions, lb/yr
- 1 - 10
- 10 - 50
- 50 - 100
- 100 - 150
- >150
Electric Utilities Response to Clean Smokestack Act

- From 2003-2010 NC utilities spent $2.9 billion:
  - Selective catalytic reduction (SCR), or Selective non-catalytic reduction (SNCR) on NOx control
  - Flue gas desulfurization (FGD) on SO2 control
- SCR/SNCRs reduce NOx by 80+\% and condition mercury to be more collectable
- FGDs collect 99\% SO2 emissions, 70-85\% mercury
- SCR- or SNCR-ESP-FGD combo removes 90+\% mercury
North Carolina Mercury Emissions from 2002-2025

- EGU
- Non-EGU
- Total

2005-2010 EGU emission decline
2011-2025 EGU emission decline from retiring smaller
EPA Electrical Generating Units (EGU) Mercury and Air Toxics Standards Rule

- **Maximum Achievable Control Technology Rule**
  aka EGU MATS (Mercury and Air Toxics Standards)
- Compliance April 2015 with 1 or 2-yr extension option
- Numerical emission limits and Continuous monitors
  - Mercury
  - Particulate matter (surrogate for 10 toxic metals)
  - Acid gases (SO₂ or Hydrogen chloride)
NC Coal-Fired Utility Boilers
EGU Pre-MATS 2010 Status

13 gigawatts of NC EGU coal-fired electrical capacity:

- 7 facilities with ¾ state capacity and 19 largest boilers
  - Most well-positioned to meet EGU MATS soon
  - All will continue to operate

- 7 facilities with ¼ state capacity and 26 smallest boilers
  - 10% - 30% mercury emission reduction
  - None can meet any EGU MATS standards
  - All 26 coal-fired units retire by 2015
  - Facilities also operate natural gas boilers
NC EGU Mercury Emission Performance
Reported under 15 NCAC 02D .2511(d)

Mercury level, lb/TBtu

ESP out/FGD in  FGD out/Stack

Allen 5 SNCR/ESP-CS/FGD
Belews Creek 2 SCR/ESP-CS/FGD
Cliffside 5 SCR/ESP-CS/FGD
Marshall 3 SNCR/ESP-CS/FGD
Asheville 2 SCR/ESP-CS/FGD
Roxboro 2 SCR/ESP-CS/FGD
Roxboro 4 SCR/ESP-HS/FGD
EPA MATS Emission Limit
### Three Airborne Mercury Species

<table>
<thead>
<tr>
<th>Mercury Species</th>
<th>Physical/Chemical Properties</th>
<th>Atmospheric Transport</th>
<th>Emission controllability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elemental</td>
<td>Gaseous, volatile, non-reactive, water insoluble</td>
<td>Long time and distance (weeks or months)</td>
<td>0% by ESP or FGD, 50-90% by activated carbon, small portion converted to oxidized mercury by SCR</td>
</tr>
<tr>
<td>Oxidized</td>
<td>Gaseous, reactive, water soluble</td>
<td>Short time and distance (hours or days)</td>
<td>20-30% by cold-side ESP, 0-10% by hot-side ESP, 50-90% by FGD scrubber, 50-90% by activated carbon</td>
</tr>
<tr>
<td>Particle-bound</td>
<td>Attached to particles</td>
<td>Short time and distance (hours or days)</td>
<td>99% by ESP and FGD scrubber</td>
</tr>
</tbody>
</table>
Mercury Speciation Profile for NC Coal-Fired EGUs with SCR/ESP/FGD Emission Controls
EPA performed deposition modeling for EGU MATS Community Multi-scale Air Quality (CMAQ) Model Modeled with 3 scenarios:
1. Base year with 2005 emissions (Pre-rule)
2. Projected 2016 emission data (Post-rule)
3. Projected 2016 emissions without U.S. EGU emissions
Patterns of total and U.S. EGU-related mercury deposition differ considerably: Elevated deposition areas distributed, several in eastern U.S. close to EGUs.

U.S. deposition dominated by sources other than EGUs.
- EGUs contribute 5% deposition for 2005, 2% for 2016.

In 2005, U.S. EGUs contributed 5% deposition in U.S., but up to 30% for certain watersheds.

NC DAQ conducted deposition modeling similar to EPA.
EPA modeling suggests deposition in NC should decrease by 10% between 2005 and 2016.

DAQ modeling indicates 16% of NC deposition from NC sources in 2005, down to 3% by 2016.

70% of mercury deposition in NC originates from outside the central and eastern U.S. in 2005, up to 90% by 2016.
DAQ Deposition Modeling 
Results for NC Scenarios 

Mercury Deposited in NC 
Mercury Emitted from NC sources

Mercury, lb/yr

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000

2005 with EGUs 2016 with EGUs 2016 without EGUs
Mercury Levels in Fish

- Statewide analysis of mercury in fish tissue since 1990
  - At 330 sites on rivers and lakes
  - Including 13 sites near EGUs since 2008
  - Results on largemouth bass show no significant change:
    - In fish tissue levels statewide,
    - Nor at sites near EGUs
  - Some studies indicate selenium released from EGUs may mitigate mercury in fish tissue levels
Annual Fish-Mercury Monitoring Sites near Coal-fired EGU Facilities

Fish Sites:
1. Lake Lure
2. Lake James
3. Lake Norman
4. Belews Lake
5. Hyco Lake
6. Jordan Lake
7. Lumber River
8. Mayo Lake
9. Lake Waccamaw
10. Kerr Lake
11. Neuse River
12. Tor River
13. Phelps Lake

Ecoregions:
- Mountains
- Piedmont
- Sandhills
- Inner Coastal Plain
- Outer Coastal Plain
Mercury in Fish Related Health Issues

- U.S. Center for Disease Control / N.C. Health and Human Services study with locally-caught fish diet
- SE NC area with elevated mercury levels for
  - Fish tissue
  - Atmospheric deposition
  - Methylation conditions
- Blood analysis of 100 participants showed
  - No childbearing age women with unsafe blood
  - No correlation found between blood levels and fish eaten
DAQ Rulemaking Recommendations

- No new mercury control rules for existing facilities
- Additional controls beyond those required by CSA and EPA offer limited opportunities and benefits to further reduce mercury emissions from coal-fired EGUs
- Future reports required under 15 NCAC 02D .2509(e):
  - 2018 and 2023
  - State of mercury control technology
  - Cost of installation and operation
  - Changes in fish tissue data
Questions?

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DAQ Clean Smokestack Act website:
http://daq.state.nc.us/news/leg/

EPA EGU MATS website:
http://www.epa.gov/airquality/powerplanttoxics/index.html