United States
Environmental Protection
Agency

# Supplement to the Non-Hg Case Study Chronic Inhalation Risk Assessment In Support of the Appropriate and Necessary Finding for Coal- and Oil-Fired Electric Generating Units

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# Supplement to the Non-Hg Case Study Chronic Inhalation Risk Assessment In Support of the Appropriate and Necessary Finding for Coal- and Oil-Fired Electric Generating Units

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Research Triangle Park, NC

## Introduction

A previous document[1] discussed the methods and results of the chronic inhalation risk assessment of hazardous air pollutants (HAPs) other than mercury from coal- and oil-fired electric utility steam generating units (EGUs) at sixteen case study facilities, which was performed in support of the "appropriate and necessary" finding for coal- and oil-fired EGUs. Several changes were made to the emissions estimates, dispersion modeling, and risk characterization of these facilities in response to public comments on the proposed rule, and this report documents those changes and their impact on the estimated risks from the case study facilities.

## 1. Emissions

In response to comments on the proposed rule, the emissions data used in the case studies were updated for several facilities in two ways. First, in response to comments that EPA's methodology was not sufficiently refined, EPA used year-specific heat input for the modeled years 2005 through 2009, rather than the average 2007-2009 heat input for all years. Second, in response to comments that EPA's approach to emission factor development should use outlier tests, EPA revised its calculations for emission factors to apply to those units that had not been tested in the ICR. Only the arsenic, chromium, and nickel emissions were recomputed for use in modeling because these pollutants were the key risk drivers for the case studies. Both of these updates were made only to the case study facilities that had estimated cancer risks near 1 in a million at proposal. The subsections below provide more information on these updates. In addition, the detailed calculations for the case study emissions at the unit level are provided in the spreadsheet "Case_Study_Emis_MATS_Final.xlsx," which is included in the docket (EPA-HQ-OAR-2009-0234-2939).

### 1.1 Unit-Level Annual Heat Input

The preferred source of unit-level annual heat input data was EPA's Clean Air Markets continuous emission monitoring (CEM) program. Unit-level annual heat input data for calendar years 2002-2010 were obtained for all units that report these data to EPA. Heat input data are important because emissions are proportional to heat input. The only facility without CEM data was the HECO Waiau facility (ORIS 766). This facility was contacted directly to obtain actual unit-specific annual heat input data. The year-specific heat input data used for the final rule are an improvement over the approach used at proposal, which used a multi-year average heat input for each modeled year.

Table 1 provides the total facility-level heat input for each year, as well as the average value. While the average value was not used for any calculations, it is provided for comparison to the value used at proposal. For three of the case study facilities remodeled for the final rule, the revised heat input is higher (Amerenue-Labadie, 0.3%; James River, 2.5%; and Conesville, 24%). For the rest of the facilities, the heat input is lower (Dominion – Yorktown, 12%; Chesapeake Energy Center, 8.8%, Heco Waiau, 2.5%; OG &E – Muskogee, 8.6%; PSHNH –

[1] Non-Hg Case Study Chronic Inhalation Risk Assessment for the Utility MACT "Appropriate and Necessary" Analysis, March 16, 2011. Docket ID No. EPA-HQ-OAR-2009-0234-2939. Available at www.regulations.gov.

Merrimack, 16%; and TVA Gallatin, 3.2%). While these facility-level changes give some indication of the impact on risk, because each unit at a facility can contribute differently to the risk, the unit-level heat input changes can give a somewhat different view of the changes. These unit-level changes are available in the case study emissions spreadsheet discussed above.

**Table 1: Final case study heat input (MMBtu) compared to heat input used at proposal.**

| Facility | 2005 | 2006 | 2007 | 2008 | 2009 | Average | Proposed Rule |
|---|---|---|---|---|---|---|---|
| Amerenue-Labadie | 168,514,660 | 170,157,435 | 182,401,603 | 165,591,139 | 166,226,274 | 170,578,222 | 171,126,775 |
| City Utilities of Springfield - James River | 16,452,496 | 15,943,500 | 13,610,535 | 15,181,310 | 11,968,020 | 14,631,172 | 14,997,208 |
| Conesville | 96,719,546 | 92,193,174 | 108,230,769 | 100,770,581 | 66,087,859 | 92,800,386 | 115,092,253 |
| Dominion - Yorktown | 40,366,974 | 21,700,400 | 29,638,959 | 22,409,846 | 19,286,905 | 26,680,617 | 23,447,200 |
| Dominion Chesapeake Energy Center | 41,070,023 | 37,711,371 | 40,777,823 | 36,222,677 | 35,255,050 | 38,207,389 | 34,853,246 |
| Heco Waiau | 14,673,660 | 14,397,785 | 14,935,405 | 13,320,107 | 14,884,983 | 14,442,388 | 14,080,684 |
| OG&E - Muskogee | 106,454,236 | 104,916,428 | 87,737,665 | 104,566,459 | 92,434,936 | 99,221,945 | 90,739,465 |
| PSHNH - Merrimack | 34,045,565 | 34,410,607 | 36,317,955 | 30,332,534 | 25,319,652 | 32,085,263 | 26,821,184 |
| TVA Gallatin | 73,113,053 | 74,908,225 | 77,474,644 | 79,699,781 | 64,123,359 | 73,863,812 | 71,515,151 |

## 1.2 Development of Emission Factors

For several of the case study facilities, emission factors were used as the best available alternative source of emissions information because appropriate facility-specific stack test data were not available to compute emissions. The case study facilities using emission factors that were not based on site-specific stack test data are Conesville (3% of the risk driver emissions), PSHNH – Merrimack (35%), and all risk driver emissions at Chesapeake Bay Energy Center, Dominion – Yorktown, OG&E – Muskogee, and Amerenue-Labadie. The risk driver emissions are those emissions that contributed the most to the total facility risk. The emission factors used in these cases were recalculated based on revised methods that had not been used at the time of proposal, including the use of well-established, robust outlier checks (Dixon or Rosner tests), depending on the number of values and when more than three values were evaluated.
The complete documentation for the arsenic, chromium, and nickel emission factors is available in the docket in separate documents: Coal_Fired_Utility_Boiler_Arsenic.pdf, Coal_Fired_Utility_Boiler_Chromium.pdf, and Coal_Fired_Utility_Boiler_Nickel.pdf. The same hexavalent chromium percentages of total chromium used at proposal were used for the final rule analysis (12% for coal units and 18% for oil units).

1.3 Emissions Estimates

Tables 2 through 4 give the estimated emissions for the facilities remodeled. These emissions estimates reflect the changes in heat inputs and emission factors described above. While the average values shown were not used in the modeling (the year-specific values were used), they are provided for comparison to the emissions values used at proposal. The detailed calculations and unit-level emissions are available in the case study emissions spreadsheet.

**Table 2: Final case study arsenic emissions (tons/year) compared to emissions used at proposal.**

| Facility | 2005 | 2006 | 2007 | 2008 | 2009 | Average | Proposed Rule |
|---|---|---|---|---|---|---|---|
| Amerenue-Labadie | 1.05E+00 | 1.06E+00 | 1.14E+00 | 1.03E+00 | 1.04E+00 | 1.07E+00 | 1.72E+00 |
| City Utilities of Springfield -James River | 1.96E-02 | 1.90E-02 | 1.63E-02 | 1.82E-02 | 1.43E-02 | 1.75E-02 | 1.78E-02 |
| Conesville | 1.65E-01 | 1.46E-01 | 1.76E-01 | 1.76E-01 | 1.13E-01 | 1.55E-01 | 3.26E-01 |
| Dominion - Yorktown | 2.29E-01 | 1.32E-01 | 1.73E-01 | 1.35E-01 | 1.17E-01 | 1.57E-01 | 2.09E-01 |
| Dominion Chesapeake Energy Center | 2.57E-01 | 2.36E-01 | 2.55E-01 | 2.26E-01 | 2.20E-01 | 2.39E-01 | 3.46E-01 |
| Heco Waiau | 2.53E-02 | 2.50E-02 | 2.56E-02 | 2.30E-02 | 2.57E-02 | 2.49E-02 | 2.46E-02 |
| OG&E -Muskogee | 6.65E-01 | 6.56E-01 | 5.48E-01 | 6.54E-01 | 5.78E-01 | 6.20E-01 | 9.11E-01 |
| PSHNH -Merrimack | 2.76E-01 | 2.79E-01 | 2.94E-01 | 2.46E-01 | 2.05E-01 | 2.60E-01 | 2.33E-01 |
| TVA Gallatin | 1.45E-02 | 1.49E-02 | 1.54E-02 | 1.58E-02 | 1.27E-02 | 1.47E-02 | 1.42E-02 |

**Table 3: Final case study hexavalent chromium emissions (tons/year) compared to emissions used at proposal.**

| Facility | 2005 | 2006 | 2007 | 2008 | 2009 | Average | Proposed Rule |
|---|---|---|---|---|---|---|---|
| Amerenue-Labadie | 4.94E-01 | 4.99E-01 | 5.35E-01 | 4.86E-01 | 4.88E-01 | 5.00E-01 | 5.77E-01 |
| City Utilities of Springfield -James River | 5.55E-01 | 5.42E-01 | 4.66E-01 | 5.24E-01 | 4.13E-01 | 5.00E-01 | 4.99E-01 |
| Conesville | 4.06E-01 | 2.85E-01 | 3.77E-01 | 4.53E-01 | 2.74E-01 | 3.59E-01 | 6.74E-01 |
| Dominion - Yorktown | 1.51E+00 | 2.84E-01 | 7.78E-01 | 3.67E-01 | 2.51E-01 | 6.37E-01 | 4.25E-01 |
| Dominion Chesapeake Energy Center | 1.20E-01 | 1.11E-01 | 1.20E-01 | 1.06E-01 | 1.03E-01 | 1.12E-01 | 1.27E-01 |
| Heco Waiau | 2.86E-03 | 2.89E-03 | 2.86E-03 | 2.60E-03 | 2.91E-03 | 2.82E-03 | 2.87E-03 |
| OG&E -Muskogee | 3.12E-01 | 3.08E-01 | 2.57E-01 | 3.07E-01 | 2.71E-01 | 2.91E-01 | 3.06E-01 |
| PSHNH -Merrimack | 3.69E-02 | 3.73E-02 | 3.94E-02 | 3.29E-02 | 2.75E-02 | 3.48E-02 | 4.77E-02 |
| TVA Gallatin | 1.16E+00 | 1.19E+00 | 1.23E+00 | 1.27E+00 | 1.02E+00 | 1.17E+00 | 1.14E+00 |

**Table 4: Final case study nickel emissions (tons/year) compared to emissions used at proposal.**

| Facility | 2005 | 2006 | 2007 | 2008 | 2009 | Average | Proposed Rule |
|---|---|---|---|---|---|---|---|
| Amerenue-Labadie | 2.31E+00 | 2.33E+00 | 2.50E+00 | 2.27E+00 | 2.28E+00 | 2.34E+00 | 4.21E+00 |
| City Utilities of Springfield -James River | 3.36E+00 | 3.27E+00 | 2.80E+00 | 3.15E+00 | 2.48E+00 | 3.01E+00 | 3.03E+00 |
| Conesville | 3.26E+00 | 2.59E+00 | 3.25E+00 | 3.55E+00 | 2.21E+00 | 2.97E+00 | 3.95E+00 |
| Dominion - Yorktown | 7.26E+01 | 1.18E+01 | 3.63E+01 | 1.59E+01 | 1.04E+01 | 2.94E+01 | 1.84E+01 |
| Dominion Chesapeake Energy Center | 5.63E-01 | 5.17E-01 | 5.59E-01 | 4.96E-01 | 4.83E-01 | 5.23E-01 | 8.89E-01 |
| Heco Waiau | 3.96E+00 | 3.93E+00 | 4.01E+00 | 3.60E+00 | 4.02E+00 | 3.90E+00 | 3.87E+00 |
| OG&E -Muskogee | 1.46E+00 | 1.44E+00 | 1.20E+00 | 1.43E+00 | 1.27E+00 | 1.36E+00 | 2.23E+00 |
| PSHNH -Merrimack | 1.55E-01 | 1.56E-01 | 1.65E-01 | 1.38E-01 | 1.15E-01 | 1.46E-01 | 2.85E-01 |
| TVA Gallatin | 5.48E+00 | 5.61E+00 | 5.80E+00 | 5.97E+00 | 4.80E+00 | 5.53E+00 | 5.35E+00 |

Annual emissions estimates for all case study facilities are given in Table 5, including estimates for facilities that have been revised as discussed above, and the same estimates used at the time of proposal for facilities without revised emissions estimates.

**Table 5. Case study average annual emissions (2005-2009).**

| Facility | Location | Unit Type | Unit ID | As (TPY) | $Cr^{+6}$ (TPY) | Ni (TPY) |
|---|---|---|---|---|---|---|
| Xcel Bayfront | Ashland, WI | 1 coal | 5 | | | |
| Cambria Cogen | Ebensburg, PA | 2 coal | B1 | 1.00E-03 | 3.60E-02 | 2.20E-01 |
| | | | B2 | 1.10E-03 | 7.80E-03 | 7.20E-02 |
| SC&E Canadys | Canadys, SC | 3 coal | CAN001 | 5.10E-02 | 1.90E-02 | 1.30E-01 |
| | | | CAN002 | 4.90E-02 | 1.80E-02 | 1.30E-01 |
| | | | CAN003 | 2.20E-02 | 2.40E-03 | 9.60E-02 |
| Dominion Chesapeake Energy Center* | Chesapeake, VA | 4 coal | Unit 1 | 4.1E-02 | 1.9E-02 | 8.9E-02 |
| | | | Unit 2 | 4.4E-02 | 2.1E-02 | 9.6E-02 |
| | | | Unit 3 | 6.5E-02 | 3.0E-02 | 1.4E-01 |
| | | | Unit 4 | 9.0E-02 | 4.2E-02 | 2.0E-01 |
| Conesville* | Conesville, OH | 4 coal | 3 | 4.6E-02 | 3.3E-01 | 1.8E+00 |
| | | | 4 | 4.7E-02 | 1.1E-02 | 5.1E-01 |
| | | | 5 | 3.2E-02 | 7.2E-03 | 3.5E-01 |
| | | | 6 | 3.0E-02 | 6.9E-03 | 3.3E-01 |
| Exelon Cromby Generating Station | Phoenixville, PA | 1 coal | Unit 1 | 6.60E-02 | 3.00E-03 | 1.80E-02 |
| | | 1 oil | Unit 2 | 2.40E-03 | 6.00E-04 | 3.40E-01 |
| TVA Gallatin* | Gallatin, TN | 4 coal | 1 | 3.5E-03 | 2.8E-01 | 1.3E+00 |
| | | | 2 | 3.4E-03 | 2.8E-01 | 1.3E+00 |
| | | | 3 | 3.9E-03 | 3.2E-01 | 1.5E+00 |
| | | | 4 | 3.8E-03 | 3.1E-01 | 1.4E+00 |
| City Utilities of Springfield -James River* | Springfield, MO | 3 coal | 3 | 3.9E-03 | 1.0E-01 | 6.3E-01 |
| | | | 4 | 4.2E-03 | 3.8E-02 | 4.1E-01 |
| | | | 5 | 9.4E-03 | 3.6E-01 | 2.0E+00 |
| Amerenue-Labadie* | Labadie, MO | 4 coal | 1 | 2.4E-01 | 1.1E-01 | 5.4E-01 |
| | | | 2 | 2.7E-01 | 1.3E-01 | 5.9E-01 |
| | | | 3 | 2.7E-01 | 1.3E-01 | 6.0E-01 |
| | | | 4 | 2.8E-01 | 1.3E-01 | 6.1E-01 |
| PSHNH –Merrimack* | Bow, NH | 2 coal | 1 | 7.8E-02 | 1.0E-02 | 4.4E-02 |
| | | | 2 | 1.8E-01 | 2.4E-02 | 1.0E-01 |
| Monticello Steam Electric Plant | Mount Pleasant, TX | 3 coal | 1 | 6.10E-02 | 1.16E-01 | 4.10E-01 |
| | | | 2 | 6.20E-02 | 1.17E-01 | 4.10E-01 |

| Facility | Location | Unit Type | Unit ID | As (TPY) | $Cr^{+6}$ (TPY) | Ni (TPY) |
|---|---|---|---|---|---|---|
| | | | 3 | 1.10E-01 | 1.98E-02 | 1.70E-01 |
| OG&E –Muskogee* | Fort Gibson, OK | 3 coal | 4 | 2.0E-01 | 9.5E-02 | 4.4E-01 |
| | | | 5 | 2.0E-01 | 9.3E-02 | 4.4E-01 |
| | | | 6 | 2.2E-01 | 1.0E-01 | 4.8E-01 |
| Spruance Genco | Richmond, VA | 8 coal | GEN1 | 8.40E-04 | 3.10E-04 | 2.40E-03 |
| | | | GEN2 | 9.00E-04 | 3.20E-04 | 8.30E-03 |
| | | | GEN3 | 3.50E-03 | 5.60E-04 | 6.20E-03 |
| | | | GEN4 | 2.40E-03 | 3.60E-04 | 4.10E-03 |
| PSI Energy – Wabash River | West Terre Haute, IN | 1 coal-gas | PG7221FA | 1.30E-03 | 7.50E-04 | 5.00E-03 |
| | | 2 coal | 4 | 1.10E-01 | 4.50E-03 | 4.10E-02 |
| | | | 6 | 3.30E-01 | 1.40E-02 | 1.20E-01 |
| Heco Waiau* | Waiau, HI | 6 oil | W3 | 2.0E-03 | 2.1E-04 | 3.2E-01 |
| | | | W4 | 2.0E-03 | 2.1E-04 | 3.0E-01 |
| | | | W5 | 2.8E-03 | 2.9E-04 | 4.3E-01 |
| | | | W6 | 2.1E-03 | 1.2E-04 | 3.2E-01 |
| | | | W7 | 8.5E-03 | 1.2E-03 | 1.4E+00 |
| | | | W8 | 7.5E-03 | 7.9E-04 | 1.2E+00 |
| Dominion – Yorktown* | Yorktown, VA | 2 coal | Units 1&2 | 1.2E-01 | 5.6E-02 | 2.6E-01 |
| | | 1 oil | Unit 3 | 3.9E-02 | 5.8E-01 | 2.9E+01 |

* Facility was remodeled for the final rule. Facilities not remodeled for the final rule have the same annual emissions estimate for each year.

## 2. Dispersion Modeling

The methodology used for dispersion modeling of the case study facilities was discussed in more detail in the previous document.[2] The modeling was done using AERMOD, EPA's preferred model for near-field dispersion. Table 6 provides the model scenario information used for the case study facilities. This information is unchanged from the proposed rule. Table 7 provides the stack parameters used for the final rule modeling.

**Table 6. Model scenario information.**

| Facility | Downwash | Urban/rural (population) | Surface station | Upper air station |
|---|---|---|---|---|
| Xcel Bayfront | No | Rural | Ashland Kennedy Memorial Airport, WI | Minneapolis, MN |
| Cambria Cogen | Yes | Rural | Johnstown Cambria County Airport, PA | Pittsburgh, PA |
| SC&E Canadys | No | Rural | Charleston Intl. Airport, SC | Charleston Intl. Airport, SC |
| Dominion Chesapeake Energy Center* | No | Urban (200,000) | Norfolk Intl. Airport, VA | Washington Dulles, VA |
| Conesville* | No | Rural | Zanesville Municipal Airport, OH | Wilmington, OH |
| Exelon Cromby Generating Station | No | Rural | Philadelphia Intl. Airport, PA | Washington Dulles, VA |
| TVA Gallatin* | No | Rural | Nashville Intl. Airport, TN | Nashville Intl. Airport, TN |
| City Utilities of Springfield -James River* | No | Rural | Springfield Regional Airport, MO | Springfield Regional Airport, MO |
| Amerenue-Labadie* | No | Rural | St. Louis Lambert Intl. Airport, MO | Lincoln, IL |
| PSHNH –Merrimack* | No | Rural | Concord Municipal Airport, NH | Albany, NY |
| Monticello Steam Electric Plant | No | Rural | Tyler Pounds Field, TX | Shreveport, LA |
| OG&E –Muskogee* | No | Rural | Muskogee Davis Field, OK | Norman, OK |
| Spruance Genco | No | Urban (200,000) | Richmond Intl. Airport, VA | Washington Dulles, VA |
| PSI Energy – Wabash River | No | Rural | Terre Haute Hulman Regional Airport ,IN | Wilmington, OH |
| Heco Waiau* | Yes | Urban (300,000) | Honolulu Intl Airport, HI | Lihue, HI |
| Dominion – Yorktown* | Yes | Rural | Newport News Intl. Airport, VA | Washington Dulles, VA |

* Facility was remodeled for the final rule.

[2] Non-Hg Case Study Chronic Inhalation Risk Assessment for the Utility MACT "Appropriate and Necessary" Analysis, March 16, 2011. Docket ID No. EPA-HQ-OAR-2009-0234-2939. Available at www.regulations.gov.

**Table 7. Stack parameter data.**

| Facility | Location | Unit Type | Unit ID | Lat | Long | Stack Height (m) | Stack Temperature (K) | Stack Velocity (m/s) | Stack Diameter (m) |
|---|---|---|---|---|---|---|---|---|---|
| Xcel Bayfront | Ashland, WI | 1 coal | 5 | 46.5872 | -90.9018 | 59.44 | 371.48 | 13.05 | 1.86 |
| Cambria Cogen | Ebensburg, PA | 2 coal | B1 | 40.4748 | -78.703 | 70.10 | 466.48 | 27.83 | 2.29 |
| | | | B2 | 40.4748 | -78.703 | 70.10 | 466.48 | 27.83 | 2.29 |
| SC&E Canadys | Canadys, SC | 3 coal | CAN001 | 33.0646 | -80.6235 | 60.96 | 415.37 | 11.00 | 4.88 |
| | | | CAN002 | 33.0653 | -80.6232 | 60.96 | 412.04 | 12.62 | 4.88 |
| | | | CAN003 | 33.065 | -80.6218 | 60.96 | 413.71 | 19.93 | 4.88 |
| Dominion Chesapeake Energy Center* | Chesapeake, VA | 4 coal | Unit 1 | 36.7705 | -76.3012 | 53.34 | 430.35 | 17.37 | 3.97 |
| | | | Unit 2 | 36.7706 | -76.3011 | 53.34 | 429.25 | 17.37 | 3.97 |
| | | | Unit 3 | 36.7709 | -76.3009 | 60.96 | 407.05 | 17.98 | 3.97 |
| | | | Unit 4 | 36.7712 | -76.3008 | 60.96 | 427.05 | 21.34 | 4.27 |
| Conesville* | Conesville, OH | 4 coal | 3 | 40.1648 | -81.9044 | 137.16 | 416.48 | 10.31 | 5.33 |
| | | | 4 | 40.1862 | -81.8787 | 243.84 | 416.48 | 25.30 | 7.93 |
| | | | 5 | 40.1856 | -81.8798 | 243.84 | 324.82 | 23.90 | 7.93 |
| | | | 6 | 40.1856 | -81.8798 | 243.84 | 324.82 | 23.90 | 7.93 |
| Exelon Cromby Generating Station | Phoenixville, PA | 1 coal | Unit 1 | 40.1524 | -75.5303 | 91.44 | 388.71 | 17.92 | 4.27 |
| | | 1 oil | Unit 2 | 40.152 | -75.5304 | 91.44 | 388.71 | 17.11 | 4.27 |
| TVA Gallatin* | Gallatin, TN | 4 coal | 1 | 36.3156 | -86.4005 | 152.70 | 406.48 | 17.07 | 7.62 |
| | | | 2 | 36.3156 | -86.4005 | 152.70 | 406.48 | 17.07 | 7.62 |
| | | | 3 | 36.3151 | -86.4009 | 153.01 | 395.37 | 18.90 | 7.62 |
| | | | 4 | 36.3151 | -86.4009 | 153.01 | 395.37 | 18.90 | 7.62 |
| City Utilities of Springfield - James River* | Springfield, MO | 3 coal | 3 | 37.1084 | -93.2602 | 60.96 | 427.59 | 9.45 | 3.65 |
| | | | 4 | 37.1084 | -93.2598 | 60.96 | 427.59 | 10.06 | 3.65 |
| | | | 5 | 37.1084 | -93.2605 | 106.68 | 433.15 | 27.70 | 3.12 |
| Amerenue-Labadie* | Labadie, MO | 4 coal | 1 | 38.5626 | -90.8381 | 213.36 | 436.21 | 32.66 | 6.25 |
| | | | 2 | 38.5621 | -90.8377 | 213.36 | 424.21 | 30.32 | 6.25 |
| | | | 3 | 38.5614 | -90.8371 | 213.36 | 413.54 | 31.96 | 6.25 |
| | | | 4 | 38.5614 | -90.8371 | 213.40 | 446.93 | 34.83 | 6.25 |
| PSHNH – Merrimack* | Bow, NH | 2 coal | 1 | 43.142 | -71.4685 | 68.58 | 391.48 | 41.98 | 2.62 |
| | | | 2 | 43.1418 | -71.4682 | 96.62 | 422.04 | 36.92 | 4.42 |

| Facility | Location | Unit Type | Unit ID | Lat | Long | Stack Height (m) | Stack Temperature (K) | Stack Velocity (m/s) | Stack Diameter (m) |
|---|---|---|---|---|---|---|---|---|---|
| Monticello Steam Electric Plant | Mount Pleasant, TX | 3 coal | 1 | 33.0907 | -95.0375 | 121.92 | 453.15 | 24.69 | 6.55 |
| | | | 2 | 33.0914 | -95.038 | 121.92 | 453.15 | 24.69 | 6.55 |
| | | | 3 | 33.0923 | -95.0378 | 140.21 | 354.26 | 26.52 | 2.44 |
| OG&E – Muskogee* | Fort Gibson, OK | 3 coal | 4 | 35.7618 | -95.2886 | 106.68 | 402.04 | 14.02 | 7.31 |
| | | | 5 | 35.7619 | -95.288 | 106.68 | 402.04 | 14.02 | 7.31 |
| | | | 6 | 35.7621 | -95.2872 | 152.40 | 402.04 | 25.13 | 6.55 |
| Spruance Genco | Richmond, VA | 8 coal | GEN1 | 37.4552 | -77.4312 | 76.20 | 355.37 | 17.03 | 2.62 |
| | | | GEN2 | 37.4555 | -77.4309 | 76.20 | 355.37 | 17.03 | 2.62 |
| | | | GEN3 | 37.4557 | -77.4307 | 76.20 | 355.37 | 17.03 | 2.62 |
| | | | GEN4 | 37.4559 | -77.4304 | 76.20 | 355.37 | 17.03 | 2.62 |
| PSI Energy – Wabash River | West Terre Haute, IN | 1 coal-gas | PG7221FA | 39.5303 | -87.4256 | 68.58 | 452.59 | 19.17 | 5.49 |
| | | 2 coal | 4 | 39.5274 | -87.4232 | 137.16 | 410.93 | 34.26 | 7.62 |
| | | | 6 | 39.5274 | -87.4232 | 137.16 | 410.93 | 34.26 | 7.62 |
| Heco Waiau* | Waiau, HI | 6 oil | W3 | 21.3891 | -157.9615 | 42.09 | 469.26 | 12.25 | 3.05 |
| | | | W4 | 21.389 | -157.9613 | 42.09 | 469.26 | 12.25 | 3.05 |
| | | | W5 | 21.3888 | -157.9612 | 41.91 | 414.26 | 12.25 | 2.74 |
| | | | W6 | 21.3887 | -157.961 | 41.91 | 414.26 | 12.25 | 2.74 |
| | | | W7 | 21.3885 | -157.9606 | 41.91 | 392.04 | 16.12 | 3.20 |
| | | | W8 | 21.3884 | -157.9603 | 41.91 | 392.04 | 16.12 | 3.20 |
| Dominion – Yorktown* | Yorktown, VA | 2 coal | Units 1&2 | 37.2154 | -76.4622 | 98.80 | 417.35 | 22.60 | 4.90 |
| | | 1 oil | Unit 3 | 37.2152 | -76.4612 | 149.05 | 415.93 | 33.52 | 6.86 |

* Facility was remodeled for the final rule.

The list below discusses the inputs used in the modeling of the case study facilities for the final rule, and notes where there were differences compared to the proposed rule.

1. Each boiler or combination of boilers was modeled as an individual emission point in AERMOD, unchanged from the proposed rule analysis.
2. Hourly emissions for 2005-2009 were modeled explicitly for each emission point for arsenic, chromium (VI), and nickel. Five-year average concentrations were calculated within AERMOD. For the proposed rule analysis, a unit emission rate (1 gram per second ) was used, and the resulting hourly concentrations were scaled using hourly heat input values to derive pollutant-specific 5-year average concentrations calculated outside of AERMOD. This methodology difference does not change the concentration estimates.
3. Building parameterization and surface characteristics were unchanged from the proposed rule analysis.
4. Some stack parameters changed because of new data received during the public comment period.
5. Current versions of AERMINUTE (11059) and AERMET (11059) were used, and the meteorological data used for the proposed rule analysis were reprocessed using these versions. Beta versions of AERMINUTE and AERMET were used for the proposed rule analysis.
6. Receptor locations (Census blocks within 20 km of the source) were unchanged from the proposed rule analysis. The current version of AERMAP (11103) was used to calculate source and receptor elevations, whereas version 09040 was used for the proposed rule analysis.
7. The current version of AERMOD (11103) was used. A beta version of AERMOD was used for the proposed rule analysis.

As noted above, updated versions of AERMAP, AERMINUTE, AERMET, and AERMOD were used in the modeling of the case study facilities for the final rule. The changes between versions 09040 and 11103 of AERMAP resulted in no differences in elevations of sources and receptors. The meteorological data used for the proposed rule were reprocessed using versions 11059 of AERMINUTE and AERMET, and processed along with the proposal emission inputs in version 11103 of AERMOD to compare differences due to AERMET and AERMOD changes. The differences in the modeled concentrations were insignificant between the beta and current versions of AERMET and AERMOD.

### 3. Chronic Inhalation Risk Assessment

For chronic inhalation exposures, we used the 5-year average ambient concentrations of HAP estimated from the refined dispersion modeling. The estimated ambient concentration at each nearby census block centroid was used as a surrogate for the chronic inhalation exposure concentration for all the people who reside in that census block. We assessed non-cancer health effects from chronic exposures by comparing the chronic inhalation exposure concentration to the Reference Concentration values. We calculated the maximum individual risk, or MIR, for each facility as the cancer risk associated with a continuous lifetime (24 hours per day, 7 days per week, and 52 weeks per year for a 70-year period) exposure to the maximum concentration at the centroid of an inhabited census block. Individual cancer risks were calculated by multiplying the estimated lifetime exposure to the ambient concentration of each HAP (in micrograms per cubic meter) by its cancer unit risk estimate (URE), which is an upper bound estimate of an individual's probability of contracting cancer over a lifetime of exposure to a concentration of 1 microgram of the pollutant per cubic meter of air. We used URE values for arsenic and hexavalent chromium from EPA's Integrated Risk Information System (IRIS), which is a human health assessment program that evaluates quantitative and qualitative risk information on effects that may result from exposure to environmental contaminants. Unit risk estimates in IRIS have undergone both internal and external peer review.

In the preamble to the proposed rule, we discussed the reasons for using 65% of the IRIS URE for nickel subsulfide for all nickel compounds. In July 2011, we completed an external peer review (using three independent expert reviewers) of the methods used to evaluate the risks from nickel compounds emitted by EGUs in a report titled, "Methods to Develop Inhalation Cancer Risk Estimates for Chromium and Nickel Compounds."[3] Based on the views of major scientific bodies such as the International Agency for Research on Cancer (IARC), the World Health Organization (WHO), and the European Union's Scientific Committee on Health and Environmental Risks (SCHER), and those of the expert peer reviewers who commented on our approaches to risk characterization of nickel compounds, we consider all nickel compounds to be carcinogenic as a group and do not consider nickel speciation or nickel solubility to be strong determinants of nickel carcinogenicity.

Based on this review, we decided to use 100 percent of the current IRIS URE for nickel subsulfide, rather than assuming that 65 percent of the total mass of emitted nickel might be nickel subsulfide, as used in previous analyses. We used the IRIS URE value because IRIS values are typically preferred for use in HAP risk assessments performed in support of air toxics regulations under the Clean Air Act.[4] The IRIS values are preferred because they are developed in accordance with EPA risk assessment guidelines and because of the level of peer review IRIS values receive. We used 100 percent of the IRIS value because of the concerns about the potential carcinogenicity of all forms of nickel raised by the major national and international scientific bodies. Nevertheless, taking into account that there are potential differences in toxicity and/or carcinogenic potential across the different nickel compounds, and given that there have been two URE values derived for exposure to mixtures of nickel compounds that are 2-3 fold lower than the IRIS URE for nickel subsulfide [5], the EPA also considers it reasonable to use a value that is 50 percent of the IRIS URE for nickel subsulfide for providing an estimate of the lower end of a plausible range of cancer potency values for different mixtures of nickel compounds.

The health reference values used in the assessment are given in Table 8.

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[3] Mercury and Air Toxics Standards Rule Docket, ID No. EPA-HQ-OAR-2009-0234. Available at www.regulations.gov.
[4] http://www.epa.gov/ttn/atw/toxsource/chronicpriority.html
[5] Two UREs (other than the current IRIS values) have been derived for nickel compounds: one developed by the California Department of Health Services (http://www.arb.ca.gov/toxics/id/summary/nickel_tech_b.pdf) and the other by the Texas Commission on Environmental Quality (http://www.epa.gov/ttn/atw/nata1999/99pdfs/healtheffectsinfo.pdf).

**Table 8. Health reference values used in the assessment.**

| Pollutant | CAS Number | URE (1/µg/m3) | Source | RfC ($mg/m^3$) | Source |
|---|---|---|---|---|---|
| Arsenic | 7440382 | 4.3E-03 | IRIS | 0.000015 | CalEPA |
| Chromium (VI) | 18540299 | 0.012 | IRIS | 0.0001 | IRIS |
| Nickel | 7440020 | 0.00048 | IRIS | 0.00009 | CalEPA |
| HCl | 7647010 | | | 0.02 | IRIS |

3. Results.

The results of the assessment are given in Table 9. Based on estimated actual emissions, the highest estimated lifetime cancer risk from any of the sixteen case study facilities was 20 in a million, driven by nickel emissions from the one case study facility with only oil-fired EGUs. For the facilities with coal-fired EGUs, there were five with maximum cancer risks greater than 1 in a million (the highest was five in a million), four driven by hexavalent chromium, and one driven by nickel from an oil-fired EGU. There were also two facilities with coal-fired EGUs with cancer risks at 1 in a million. All of the facilities had non-cancer target-organ-specific hazard index (HI) values less than one, with a maximum HI value of 0.4 (also driven by nickel emissions from the one case study facility with only oil-fired EGUs).

The cancer risk estimates from this assessment indicate that the EGU source category would not be eligible for delisting under section 112(c)(9)(B)(i) of the CAA, which specifies that a category may be delisted only when the Administrator determines "… that no source in the category (or group of sources in the case of area sources) emits such hazardous air pollutants in quantities which may cause a lifetime risk of cancer greater than one in one million to the individual in the population who is most exposed to emissions of such pollutants from the source…." We note that, since these case studies do not cover all facilities in the category, and since our assessment does not include the potential for impacts from different EGU facilities to overlap one another (i.e., these case studies only look at facilities in isolation), the maximum risk estimates from the case studies may underestimate true maximum risks.

**Table 9. Chronic inhalation risk assessment results.**

| Facility | Proposed Rule Assessment | | | | Final Rule Assessment | | | |
|---|---|---|---|---|---|---|---|---|
| | Max Risk | Risk Driver | Max HI | HI Driver | Max risk | Risk Driver | Max HI | HI Driver |
| Xcel Bayfront | $4.0 \times 10^{-9}$ | Formaldehyde | 0.005 | HCl | Not Remodeled | | | |
| Cambria Cogen | $5.0 \times 10^{-7}$ | Chromium VI | 0.003 | Nickel | Not Remodeled | | | |
| SC&E Canadys | $6.0 \times 10^{-7}$ | Arsenic | 0.009 | HCl | Not Remodeled | | | |
| Dominion Chesapeake Energy Center | $3.0 \times 10^{-6}$ | Chromium VI | 0.05 | HCl | 2x10-6 | Chromium VI | 0.05 [a] | HCl [a] |
| Conesville | $3.0 \times 10^{-6}$ | Chromium VI | 0.01 | Nickel | 2x10-6 | Chromium VI | 0.008 | Nickel |
| Exelon Cromby Generating Station | $3.0 \times 10^{-7}$ | Arsenic | 0.008 | Nickel | Not Remodeled | | | |
| TVA Gallatin | $1.0 \times 10^{-6}$ | Chromium VI | 0.006 | Nickel | 2x10-6 | Chromium VI | 0.007 | Nickel |
| City Utilities of Springfield - James River | $8.0 \times 10^{-6}$ | Chromium VI | 0.04 | Nickel | 5x10-6 | Chromium VI | 0.03 | Nickel |
| Amerenue-Labadie | $8.0 \times 10^{-7}$ | Arsenic | 0.006 | Arsenic | 7x10-7 | Chromium VI | 0.004 | Arsenic |
| PSHNH - Merrimack | $1.0 \times 10^{-6}$ | Arsenic | 0.01 | Arsenic | 1x10-6 | Arsenic | 0.01 | Arsenic |
| Monticello Steam Electric Plant | $6.0 \times 10^{-7}$ | Chromium VI | 0.003 | Arsenic | Not Remodeled | | | |
| OG&E - Muskogee | $1.0 \times 10^{-6}$ | Arsenic | 0.01 | Arsenic | 1x10-6 | Chromium VI | 0.008 | Arsenic |
| Spruance Genco | $8.0 \times 10^{-8}$ | Arsenic | 0.007 | HCl | Not Remodeled | | | |
| PSI Energy – Wabash River | $1.0 \times 10^{-7}$ | Arsenic | 0.001 | Arsenic | Not Remodeled | | | |
| Heco Waiau | $1.0 \times 10^{-5}$ | Nickel | 0.4 | Nickel | 2x10-5 [b] | Nickel | 0.4 | Nickel |
| Dominion - Yorktown | $1.0 \times 10^{-6}$ | Chromium VI | 0.02 | Nickel | 2x10-6 [b] | Nickel | 0.03 | Nickel |

[a] Although HCl was not included in the remodeling of this facility, HCl was the HI driver pollutant at proposal, and this is carried through for the final rule assessment.

[b] Based on considering the emitted nickel to be 100% as potent a carcinogen as pure nickel subsulfide; if we consider the emitted nickel to be 50% as potent a carcinogen as nickel subsulfide (see text), estimated risks would be $1 \times 10^{-5}$ for Heco Waiau and $1 \times 10^{-6}$ for Dominion - Yorktown.

| | | |
|---|---|---|
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