UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Memorandum: Emissions Overview: Hazardous Air Pollutants in Support of the Final Mercury and Air Toxics Standard

EPA-454/R-11-014
November 2011

Memorandum: Emissions Overview: Hazardous Air Pollutants in Support of the Final Mercury and Air Toxics Standard

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MEMORANDUM

To: Toxics Rule docket, number EPA-HQ-OAR-2009-0234
From: Marc Houyoux, group leader Emission Inventory and Analysis Group
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Subject: Emissions Overview: Hazardous Air Pollutants in Support of the Final Mercury and Air Toxics Standard
Date: December 1, 2011

1 Introduction

The purpose of this document is to summarize the mercury (Hg) and non-Hg Hazardous Air Pollutants (HAP) emissions from U.S. electric generating utilities (EGUs) associated with the final Mercury and Air Toxics Standard (MATS). This information includes both background information about these pollutants as well as emissions totals from several emissions cases developed for the final MATS. In this memo, we summarize current HAP emissions estimates from U.S. EGUs, the estimates used in the national-scale Hg risk assessment (Hg Risk TSD) for years 2005 and 2016, and the estimates for the future impact of the rule when fully implemented (in 2016).

2 Hg Emissions

2.1 Hg Emissions Overview

Mercury is an element. There is a fixed amount of it in the world. As long as it is bound up, for example in coal, it cannot affect people or the environment. Once it is released, for example via the combustion process, it enters the environment and becomes available for chemical conversion. Once emitted, Hg remains in the environment and can bioaccumulate in organisms or be remitted through natural processes. Mercury is emitted through natural and anthropogenic processes, and previously deposited Hg from either process may be re-emitted. The majority of natural Hg emissions arise from volcanoes, geothermal activity, Hg-enriched topsoil, oceans/lakes, and vegetation. The category of natural Hg emissions may or may not include biomass burning, due to the difficulty in determining whether biomass burning events are started by anthropogenic or natural causes. Generally, natural Hg emissions are dominated by the elemental form of mercury, and as a result have more impact on the global pool of Hg than on deposition in the region of the emissions.

Mercury is known to exist in the atmosphere in three forms: (1) elemental mercury, Hg^0, (2) gaseous oxidized mercury, Hg^{+2}, and (3) particulate bound mercury, Hg_p. Hg^0 dominates total mercury composition in the atmosphere (greater than 95%) and has a much greater residence time than Hg^{+2} or Hg_p[1]. Hg^0 ambient concentrations are spatially uniform due to the long atmospheric residence time and a more uniform distribution of sources due to re-emission of previously deposited mercury. Hg^{+2} and Hg_P concentrations are locally elevated near sources due to their shorter atmospheric lifetime. Total mercury deposition is likely to be dominated by all sources of Hg^0 including global sources, while deposition of Hg^{+2} and Hg_p is primarily from local and regional sources.[2]

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[1] Schroeder, W. H. and J. Munthe (1998). "Atmospheric mercury - An overview." Atmospheric Environment **32**(5): 809-822.

[2] Marsik, F. J., G. J. Keeler, et al. (2007). "The dry-deposition of speciated mercury to the Florida Everglades: Measurements and modeling." Atmospheric Environment **41**(1): 136-149.

The categories for anthropogenic Hg emissions include the combustion of fossil-fuels, cement production, waste incineration, metals production, and other industrial processes. Anthropogenic Hg emissions consist of all three forms of Hg.

Mercury re-emissions include previously deposited Hg originating from both natural and anthropogenic sources. At this time, it is not possible to determine the original source of previously deposited Hg, i.e., whether its source is natural emissions or re-emissions from previously deposited anthropogenic Hg.[3,4,5] Current publications on this topic estimate that half of re-emitted Hg originates from anthropogenic sources.[6,7]

Current estimates of total global Hg emissions based on a 2005 inventory range from 6,600 to 7,500 metric tons per year (mt/yr). The United Nations Environment Programme (UNEP) estimates of global Hg emissions for 2005 are somewhat lower, at 5,600 mt/yr[8,9]. Global anthropogenic Hg emissions, excluding biomass burning, have been estimated by many researchers. UNEP's 2005 estimate is approximately 1,900 mt/yr (with a range of 1,200 to 3,000 mt/yr)[10] and the 2005 estimate by Pirrone, et al. is approximately 2,400 mt/yr. [11] Global fossil-fuel fired power plants total approximately 500 to 800 mt/yr, a large fraction (25 to 35 percent) of the total global anthropogenic emissions.[12]

There are large uncertainties regarding projected mercury global inventories. To model Hg deposition for the national-scale Hg risk assessment, initial and boundary conditions were based on a GEOS-CHEM simulation using a 2000-based global inventory that includes approximately 7,000 mt/yr of mercury emissions[13]. Recent research shows that Hg emissions from China were consistent between 2000 and 2006 (approximately 1,300 mt/yr)[14], so no adjustments were made to the 2000-based global Hg emissions for the 2005 simulation. Recent research has shown that ambient mercury concentrations have been decreasing in

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[3] Lindberg, S., Bullock, R., Ebinghaus, R., Engstrom, D., Feng, X., Fitzgerald, W., et al. (2007). A Synthesis of Progress and Uncertainties in Attributing the Sources of Mercury in Deposition. *Ambio, 36*(1), 19-33.

[4] Lohman, K., Seigneur, C., Gustin, M., & Lindberg, S. (2008). Sensitivity of the global atmospheric cycle of mercury to emissions. *Applied Geochemistry, 23*(3), 454-466.

[5] Seigneur, C., Vijayaraghavan, K., Lohman, K., Karamchandani, P., & Scott, C. (2004). Global Source Attribution for Mercury Speciation in the United States. *Environmental Science and Technology*(38), 555-569.

[6] Mason, R., Pirrone, N., & Mason, R. P. (2009). Mercury emissions from natural processes and their importance in the global mercury cycle. In *Mercury Fate and Transport in the Global Atmosphere* (pp. 173-191): Springer U.S.

[7] Selin, N. E., Jacob, D. J., Park, R. J., Yantosca, R. M., Strode, S., Jaeglé, L., et al. (2007). Chemical cycling and deposition of atmospheric mercury: Global constraints from observations. *J. Geophys. Res, 112*, 1071-1077.

[8] UNEP (United Nations Environment Programme), Chemicals Branch, 2008. The Global Atmospheric Mercury Assessment:Sources, Emissions and Transport, UNEP Chemicals, Geneva.

[9] The 5,600 metric ton estimate is from the Figure on page 37 of the report. The report also provides ranges in the executive summary.

[10] Study on Mercury Sources and Emissions and Analysis of the Cost and Effectiveness of Control Measures "UNEP Paragraph 29 study", UNEP (DTIE)/Hg/INC.2/4. November, 2010.

[11] Pirrone, N., Cinnirella, S., Feng, X., Finkelman, R. B., Friedli, H. R., Leaner, J., et al. (2010). Global mercury emissions to the atmosphere from anthropogenic and natural sources. *Atmospheric Chemistry and Physics Discussions, 10*(2), 4719-4752.

[12] Study on Mercury Sources and Emissions and Analysis of the Cost and Effectiveness of Control Measures "UNEP Paragraph 29 study", UNEP (DTIE)/Hg/INC.2/4. November, 2010.

[13] Selin, N.E., Jacob, D.J., Park, R.J., Yantosca, R.M., Strode, S., Jaegle, L., Jaffe, D., 2007. Chemical cycling and deposition of atmospheric mercury: Global constraints from observations. Journal of Geophysical Research-Atmospheres 112.

[14] Streets, D.G., Zhang, Q., Wu, Y., 2009. Projections of Global Mercury Emissions in 2050. Environmental Science & Technology 43, 2983-2988.

the northern hemisphere since 2000[15], so no adjustments were made to the boundary condition inflow for the 2016 simulations.

2.2 Estimating Current Hg Emissions

In 1990, Hg emissions for coal and oil EGUs in the U.S. were 59 tons[16] out of a total of 246 tons[17], and by 1999 Hg emissions for U.S. EGUs were 49[18] out of 115 tons. In 2005, they were 53[19] tons out of a total of 105 tons. As part of the development of the MATS, EPA completed in 2010 an Information Collection Request (ICR) that gathered the latest available emissions data from coal- and oil-fueled EGUs. The ICR data have been used in several ways, including to calculate EPA's best estimate of current emissions, called the "current base" from U.S. EGUs. At proposal, the current base Hg emissions estimate (labeled "2010" at proposal) was 29 tons, and after the revisions made and described here for the final MATS, the current base estimate remains 29 tons of Hg from U.S. EGUs.

While the current base Hg emissions estimate is not a basis for the MATS rule, the risk assessment, or the Regulatory Impact Analysis (RIA), EPA received numerous comments on its value as part of the proposed rule. These comments compared the current base estimate to EPA's future year Hg emissions estimate from U.S. EGUs and called into question the future-year estimate since it was the same as the current base estimate. Since the current base estimates use a 2007-2009 average heat input, it did not seem likely that the current base estimate would be the same as future years that include additional controls from other rules. As a result, EPA has reviewed and updated its methods for the current base emissions, and these updates are described in this section. These changes resulted in a decrease of 0.3 tons/year, which rounds to the same 29 ton/yr value included with the proposed MATS.

The calculations underlying the current base inventories are available in the MATS docket in an Excel® workbook entitled "MATS_Final_Current_Base_HAP_inven.xlsx".

EPA updated the current base national inventories for the final rule in the following three ways:

- Updated list of units assumed to be subject to the rule for the purposes of calculating the national inventory values. Within a given facility, some units are subject to the rule and some are not depending on each unit's capacity and fuels.
- Revised EFs for untested units. These revisions included outlier statistical tests of the underlying stack test data for each pollutant to improve the quality of the estimates. This approach was also consistent with the EF method used to estimate emissions for untested units in the non-Hg risk case studies.
- Revised the heat input to use the 2007-2009 average CEM-based heat input for units reporting to the CEM program, rather than ICR-based heat input. For other units, EPA used the same approach as at proposal, which was based on the ICR data and also represents a 2007-2009 average.

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[15] Slemr, F., Brunke, E.G., Ebinghaus, R., Kuss, J., 2011. Worldwide trend of atmospheric mercury since 1995. Atmospheric Chemistry and Physics 11, 4779-4787.

[16] 2008 EPA Report on the Environment available at http://www.epa.gov/ncea/roe/index.htm

[17] This value was transposed as 264 tons in the version of this memorandum included with the MATS proposal.

[18] ftp://ftp.epa.gov/pub/EmisInventory/finalnei99ver3/haps/summaries

[19] Emission Inventory Technical Support Document (TSD) for the proposed MATS rule

To update the list of assumed affected units in the current base inventory, EPA compared the primary fuels listed for each unit in the NEEDS v4.0 and NEEDS v4.10[20] databases as well as 2005 data available from the Energy Information Administration. The updated list of affected units is provided in the current base workbook, including the reason a unit was added to, or excluded from, the original list of units developed for the MATS ICR.

Mercury EFs were developed based on reported data from 323 units (boilers), with data from 6 of these units excluded as outliers. Using these data, EPA computed unit-specific EFs and industry-wide average EFs associated with boiler configuration, which considers combinations of fuel type, boiler type, and control devices. The average EFs were assigned to untested boilers based on their configuration. The boiler-specific EFs from the test data and the average EFs were applied to the units reporting data. The EFs were combined with average heat input for 2007-2009 for all units subject to the rule. The approaches and data are available in "Emission Factors Supporting Documentation for the Final Mercury and Air Toxics Standards," which is available in the MATS docket.

For the final rule, EPA revised the approach for the operating data (heat input). For proposal, the operating data gathered as part of the ICR was used, which included calculating an average throughput using the 3-year average capacity factor for 2007 to 2009 and the boiler maximum heat input. For the final rule, heat input data were compiled from the CEM program for 2007, 2008, and 2009 when available for units included in that program. For units not reporting to the CEM program, the same approach as at proposal was used: the operating data collected as part of the rule were used by calculating the 3-year average capacity factor for 2007 to 2009 and applying to the boiler maximum heat input.

One goal of using the average 2007-2009 approach to estimate the current base emissions was to limit the impact of the economic downturn on Hg emissions estimates, since lower throughput of EGUs caused by decreased electricity demand is not a long-term or enforceable decrease in emissions. To evaluate this impact, EPA computed demand-adjusted U.S. EGU emissions for 2002 through 2010 based on the *current*, ICR-based boiler configurations (fuels, technologies, controls). The heat input data were based on the year-specific CEM data where available. For units that did not report to EPA using CEMs for a given year, the heat input was held constant at the 2007-2009 average. Table 1 shows the resulting demand-adjusted emissions. The emissions estimate for 2009 represents a low point in Hg demand-adjusted emissions assuming current boiler configurations for all years, whereas 2007 and 2008 are relatively consistent with historical values. Demand-adjusted increases start to occur in 2010, which is about 1 ton/year higher than 2009 based on demand impacts alone. Thus, a 2007-2009 average will include some impact of temporary decreased demand since it includes 2009. Since CEM data were used only where available and a 2007-2009 average heat input is used for other units, this approach will tend to somewhat dampen the resulting trend; however, this is a reasonable guide to help understand the impact of demand decreases on emissions levels.

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[20] http://www.epa.gov/airmarkets/progsregs/epa-ipm/BaseCasev410.html#needs

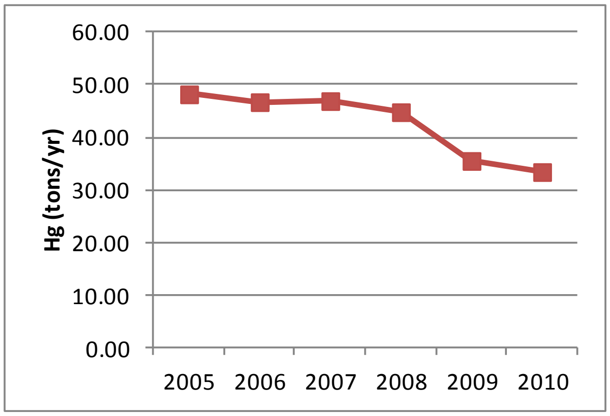
Table 1: Demand-adjusted ICR-based U.S. EGU Hg emissions

Year	Total Mercury using ICR-based boiler configurations (tons/year)
2002	29.5
2003	30.1
2004	29.8
2005	30.3
2006	29.9
2007	30.5
2008	29.6
2009	25.5
2010	26.8

To further evaluate EPA's current base Hg emissions estimate for MATS, EPA reviewed the data available from industry as reported into the Toxics Release Inventory (TRI). Table 2 provides the TRI-based emissions and illustrates that while industry-reported emissions in TRI were lower than EPA estimates in 2005, the 2010 TRI compilation of 33.5 tons/year is higher than the EPA current base estimate for MATS of 29 tons/year. Since facilities estimate and report their emissions to the TRI Program, facilities are responsible for estimating emissions using a variety of method reporting codes[21]. These methods include continuous monitoring data, periodic or random monitoring data or measurements, mass balance calculations, using published general emission factors or site-specific emission factors, and other approaches. Since the methods used by industry will be a complex composite of these different methods, and EPA's approach for MATS uses a single method based on site-specific and general emission factors using the latest source test data, it is not surprising that the estimates are different.

Table 2: Industry-reported emissions from the Toxics Release Inventory

Year	Total mercury (tpy)
2005	48.2
2006	46.7
2007	46.5
2008	44.8
2009	35.6
2010	33.5



2.3 Hg Emissions Trend and Projections

Table 3 shows past U.S. emissions of Hg, the revised current emissions estimates, and future emission projections for the year 2016. In 2005, 53 out of 105 tons of Hg came from combustion of coal and oil at U.S. EGUs, or approximately 50%. The current estimate shows a decrease in these emissions to 29 tons, which includes reductions resulting from the installation of Hg controls to comply with state Hg-

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[21] See TRI 2010 reporting instructions for form R, http://www.epa.gov/tri/report/rfi/ry2010rfi_061511.pdf, pg 46-47.

specific rules, voluntary reductions, as well as from the co-benefits of Hg reductions from control devices installed for the reduction of SO_2 and PM as a result of state and federal actions, such as New Source Review (NSR) enforcement actions. The 2016 Hg estimate of 27 tons for U.S. EGUs was projected using the Integrated Planning Model (IPM), which uses a different methodology to project emissions.[22] The 2016 base-case scenario has been updated since the proposal to reflect known federal measures for all sectors, including the recently finalized Cross-State Air Pollution Rule (CSAPR), but without state Hg rules.[23]. It also reflects projected economic changes and fuel usage for the EGU and mobile sectors. Based on this modeling, the estimated U.S. EGU proportion of Hg emissions in 2016 is 42%. More information on IPM is available in the "Documentation Supplement for EPA Base Case v.4.10_MATS – Updates for Final Mercury and Air Toxics Standards (MATS) Rule," which is available in the MATS docket.

Table 3: U.S. anthropogenic Hg emissions trends for U.S. EGUs.

	1990[1] (tons)	**1999[2] (tons)**	**2005[3] (tons)**	**Current Base[4] (tons)**	**Final 2016 Base Case[5] (tons)**
U.S. EGUs	59	49	53	29	27
Non-EGU Anthropogenic U.S. Hg	205	66	52	Not Available[6]	35
Total U.S. Anthropogenic Hg	264	115	105	Not Available[6]	64
Percent of U.S. Anthropogenic Hg Emissions from U.S. EGUs					
	1990	1999	2005	Current Base	2016
	22%	43%	50%	Not Available[6]	42%

1. 2008 EPA Report on the Environment available at http://www.epa.gov/ncea/roe/index.htm, which also has 2002 emissions that used a consistent approach as 1990.
2. ftp://ftp.epa.gov/pub/EmisInventory/finalnei99ver3/haps/summaries/. The 1999 estimates used different methods than the 1990 and 2005 methods, and so trends shown here also reflect changes in methods.
3. Emission Inventory Technical Support Document (TSD) for the proposed MATS rule
4. The estimate of the current base emissions of Hg may underestimate Hg emissions from U.S. EGUs due to targeting of the 2010 ICR on the best performing EGUs.
5. The 2016 base case scenario represents predicted emissions including known federal measures for all sectors, and excludes state Hg rules for EGUs. It reflects projected economic changes and fuel usage for the EGU and mobile sectors. The term "Final" is used to indicate that the EGUs were projected utilizing the final version of the IPM version 4.10_MATS developed for the final MATS rule as opposed to the Interim version. "Base" indicates that these are the projected emissions in absence of the Final MATS policy.
6. Information on recent U.S. EGU emissions was obtained using an ICR for EGUs only. This same information is not available for other sources, which were not covered by the ICR.

Table 4 below provides the projections for non-EGU emission sources that include expected future reductions from existing and proposed regulations for HAPs that are expected to be implemented prior to

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[22] IPM is a multi-regional, dynamic, deterministic linear program model of the U.S. power sector that determines the least cost solution to meeting a set of environmental constraints while still meeting specified electric demand. For more detail on IPM see: http://www.epa.gov/airmarkets/progsregs/epa-ipm/index.html

[23] 2016 base Hg emissions from U.S. EGUs were estimated to be 29 tons/year at proposal. The future-year emissions are described further in Section 4.

2016. These regulations include the NESHAPs that affect the following industries: Portland Cement; Industrial, Commercial and Institutional Boilers and Process Heaters; Gold Ore Mining and Production, Electric Arc Furnaces, Hazardous Waste Incineration, and Mercury Cell Chlor-alkali facilities. The projections also include the replacement of a smelter and a pulp and paper plant, which will result in the elimination of Hg emissions from those sources, along with other known plant closures. This projection shows that U.S. EGU emissions will continue to comprise a significant, dominant portion of the total U.S. anthropogenic inventory in 2016. In 2016, Hg emissions from U.S. EGUs are projected to comprise 27 tons out of a total of 62 tons. More information on the non-EGU projections of Hg is available in the Emission Inventory Technical Support Document (TSD) for the proposed MATS rule. This document has not been updated for the final rule.

Table 4: Anthropogenic Hg emissions and projections in the Continental U.S.

Category	**2005 Mercury (tons)**	**2016 Base Mercury (tons)**
Electric Generating Units	53	27
Portland Cement Manufacturing	7.5	1.1
Stainless and Non-stainless Steel Manufacturing: Electric Arc Furnaces	7.0	4.6
Industrial, Commercial, Institutional Boilers & Process Heaters	6.4	4.6
Chemical Manufacturing	3.3	3.3
Hazardous Waste Incineration	3.2	2.1
Mercury Cell Chlor-Alkali Plants	3.1	0.3
Gold Mining	2.5	0.7
Municipal Waste Combustors	2.3	2.3
Sum of other source categories (each of which emits less than 2 tons)	17	16
Total	**105**	**62**

3 Non-Hg HAP Emissions

Fossil-fuel fired boilers emit a variety of metal HAP, organic HAP and HAP that are acid gases. Acid gas and metal HAP emissions are discussed below.

The same three updates made for the Hg national inventory were made for the acid gases and non-Hg metal emissions: a slightly updated list of units are assumed to be subject to the rule, improved heat input data based on the CEM program is used where available, and improved EF estimation methods are used to exclude statistical outliers. The emissions factors (EFs) used to estimate current non-Hg HAP emissions are consistent with the EFs used to calculate chromium, nickel, and arsenic emissions for EGUs without available facility-specific stack test data in the revised Non-Hg Case Study Chronic Inhalation Risk Assessment.

3.1 Acid Gases

Acid gas emissions from U.S. EGUs include hydrogen chloride (HCl), hydrogen fluoride (HF), chlorine (Cl_2) and hydrogen cyanide (HCN). Table 5 shows emissions of certain acid gases from EGUs, based on the 2010 ICR data by fuel type. Although Cl_2 was not included in the data collected from the 2010 ICR, Cl_2 gas is expected to be emitted at significantly lower amounts than HCl (ratios of HCl-to- Cl_2 can be as high as 200:1[24]).

Similar to the Hg estimates, the current base emissions estimates for the acid gases are based on emission factors generated from boiler-specific emission tests. These emission factors are based on test data from 330 boilers for hydrogen chloride, 324 boilers for hydrogen fluoride, and 314 boilers for hydrogen cyanide. Unit-specific emission factors were developed and applied from unit test averages where available; otherwise, average emission factors were applied. Current-year estimates are not available for other U.S. anthropogenic emission sources, so the latest available complete set of data, 2005, were used to approximate the percentage contribution of U.S. EGUs to total U.S. anthropogenic emissions. As illustrated by Table 5, U.S. EGUs are estimated to emit the majority of HCl and HF nationally. Additional documentation on the inventory calculations and emission factors used for each unit is available in the inventory workbook identified in Section 2.2. Additional information on the approach to calculate binned emission factors is available in “Emission Factors Supporting Documentation for the Final Mercury and Air Toxics Standards”, available in the docket.

Table 5: Summary of acid gas emissions from U.S. EGU sources

	Selected Nationwide Acid HAP current base emissions (tons/yr) from U.S. EGUs					2005 Acid HAP Emissions (tons/yr) from the inventory used for the National Air Toxics Assessment (NATA)[1]		Percent of U.S. Anthropogenic Emissions from EGUs, based on the inventory used for the 2005 NATA
	Coal	**IGCC[2]**	**PC[3]**	**Oil**	**Total Current Base EGU[4]**	Total 2005 EGU	2005 Non-EGU	
Hydrogen Cyanide[5]	5,459	0	84	83	**5,626**	1,200	14,000	**8%**
Hydrogen Chloride	99,565	1	81	329	**99,976**	350,000	78,000	**82%**
Hydrogen Fluoride	25,657	1	7	67	**25,732**	47,000	28,000	**62%**
Total	**130,680**	**3**	**172**	**480**	**131,334**	398,200	120,000	**77%**

[1] 2005 NATA: http://www.epa.gov/ttn/atw/nata2005/ EGU emissions were extracted from the total using the MACT code field (1808)
[2] IGCC = integrated gasification combined cycle
[3] PC = petroleum coke
[4] The estimate of the current base emissions for acid gases may underestimate total EGU emissions due to targeting of the 2010 ICR on the best performing EGUs.
[5] Used cyanide emissions for hydrogen cyanide

For the final rule, average emission factors for the untested units were recomputed using improved

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[24] 200:1 is based on testing done at the EPA’s pilot facility in Research Triangle Park, NC. Personal communication, Nick Hudson.

methods. The approaches and underlying data are available in "Emission Factors Supporting Documentation for the Final Mercury and Air Toxics Standards," which is available in the docket. For acid gases, the data and calculations used for the average emission factors are available in the spreadsheet "MATS_Final_Utility_Boiler_Mercury_and_Acid_Gases.xlsx".

3.2 Metal HAP

Metals are emitted primarily because they are present in fuels. Table 6 shows selected metals emitted by EGUs and emission estimates based on data from the 2010 ICR. Similar to the Hg and acid gas estimates, the current base emissions for the metal HAPs are based on emission factors generated from boiler-specific emission tests. The number of tests used for each metal was different depending on the available data and the impact of outlier tests applied to the analysis. Unit-specific emission factors were developed and applied from unit test averages where available; otherwise, average emission factors were applied. Current-year estimates are not available for other U.S. anthropogenic emission sources, so the latest available complete set of data, 2005, was used to approximate the percentage contribution of U.S. EGUs to total U.S. anthropogenic emissions.

Table 6: Summary of metal emissions from U.S. EGU sources.

	Selected Nationwide Metal HAP current-base emissions(tons/yr) from EGUs					2005 Metal HAP Emissions from the inventory used for the National Air Toxics Assessment (NATA)[1]		Percent of U.S. Anthropogenic Emissions from EGUs, based on the inventory used for the 2005 NATA
	Coal	**IGCC**[2]	**PC**[3]	**Oil**	**Total Current Base EGU**[4]	Total 2005 EGU	2005 Non-EGU	
Antimony	8	0	0	15	**23**	19	83	19%
Arsenic	55	0	1	1	**57**	200	120	62%
Beryllium	2	0	0	0	**2**	10	13	44%
Cadmium	3	0	0	0	**3**	25	38	39%
Chromium	236	0	0	4	**240**	120	430	22%
Cobalt	10	0	0	7	**18**	54	60	47%
Lead	43	0	2	3	**48**	21	1,194	2%
Manganese	137	0	0	12	**149**	270	1800	13%
Nickel	238	0	1	161	**399**	320	840	28%
Selenium	230	0	0	1	**231**	580	120	83%
Total	**962**	**0**	**4**	**204**	**1170**	1619	4698	**26%**

[1] 2005 NATA: http://www.epa.gov/ttn/atw/nata2005/ EGU emissions were extracted from the total using the MACT code field (1808)

[2] IGCC = integrated gasification combined cycle

[3] PC=petroleum coke

[4] The estimate of the current base emissions for metals may underestimate EGU metal emissions due to targeting of the 2010 ICR on the best performing EGUs.

As shown by the table, U.S. EGUs are estimated to be a significant source of emissions nationally for these metals.

For the final rule, average emission factors for the untested units were recomputed using improved methods as compared to the proposed rule. The approaches and underlying data are available in "Emission Factors Supporting Documentation for the Final Mercury and Air Toxics Standards," which is available in the docket. For Chromium, Nickel, and Arsenic, the data and calculations used for the average emission factors are available in the spreadsheet "EPA_Ar_Cr_Ni_Bin_EFs.xlsx".

3.3 Expected Impact on Non-Hg HAP Emissions from Existing Clean Air Act (CAA) and Other Regulations and Programs

It is expected that acid gas and metal emissions will be reduced in the future due to existing CAA and other regulations and programs. Acid gases and metals are emitted by a number of other industries already regulated or scheduled for regulation under the National Emissions Standards for Hazardous Air Pollutants (NESHAP) or the Risk and Technology Review (RTR) program. In addition, because acid gases respond somewhat to the same types of controls used for SO_2, it is expected that acid gas emissions will be reduced at both EGU and non-EGU sources as a result of national, state, and local control programs to control SO_2. Likewise, metals respond to the same types of controls used for PM, and as a result it is expected that metal emissions will be reduced at both EGU and non-EGU sources due to national, state, and local control programs to control direct PM.

4. Hg and non-Hg HAP Emissions Projections

This section summarizes the base and future-year emissions for Hg and HCl used as part of the public record for this rule. Future projections of other HAPs were not developed; therefore, they are not included in this section. The current base emissions estimate has been described in Section 2.2. This section includes further information about the emissions created for (a) the Hg Risk TSD conducted to inform the appropriate and necessary finding, and (b) the base and final policy cases using the final version of IPM for the final co-benefit estimates in the final RIA[25].

For the 2016 emissions estimates, different phases of analysis resulted in slightly different emissions estimates for the appropriate and necessary finding and the final base and policy cases. The purpose of this section is to explain the source of these differences and document the different Hg and HCl emissions values. The subsections below provide additional information on emissions for the Hg Risk TSD and the final RIA. Table 7 summarizes the origin information about all of the emissions cases, and Table 8 summarizes the emissions estimates of Hg and HCl for each, including speciated Hg.

4.1 Emissions for the Hg Risk TSD

The Hg Risk TSD is based on modeling Hg deposition associated with total 2005 Hg emissions and total 2016 projected Hg emissions, as well as modeling Hg deposition resulting from scenarios that zeroed out Hg emissions from U.S. EGUs. While the Hg Risk TSD was revised in response to comments received during the peer review, EPA did not remodel Hg deposition since the MATS proposal.

The "2005 base year" emissions case in Table 7 uses emissions of criteria pollutants, Hg, HCl, and Cl_2 from all source categories. All emissions except Hg come from the 2005 version 4.1 modeling platform,

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[25] While the final MATS included an updated RIA to capture the final co-benefits of SO2 and PM2.5 changes, the Hg emissions and benefits for that analysis were kept identical to those used for the MATS proposal.

which is derived from the 2005 National Emissions Inventory (NEI). The HCl and Cl_2 emissions have a slight impact on the modeled ozone and are therefore included in the standard modeling configuration used for this effort. 2005 Hg emissions for all sources (EGU and non-EGU) come from the 2005 National Air Toxics Assessment (NATA) inventory, a revised version[26] of the 2005 NEI. EPA further revised the 2005 NATA inventory for non-EGU point and nonpoint sources based on data collected from the NESHAP for industrial, commercial and institutional boilers. The current base case contains emissions only for U.S. EGUs, and the Hg, HCl, and metal emissions in this inventory are based on the 2010 ICR data. As previously described, initial and boundary conditions for the photochemical and deposition modeling were based on a GEOS-CHEM simulation using a 2000 based global inventory that includes approximately 7,000 mt/yr of mercury emissions[27].

Also summarized in Table 7, the "Proposal interim 2016 base case" emissions projections were developed for use in modeling based on the latest available (at the time of the proposed rule) projection techniques and they account for emissions reductions of all modeled pollutants from federal measures. In addition, the "Proposal interim 2016 policy case" emissions projections are an interim version of the expected emissions from U.S. EGUs after reductions associated with the proposed CSAPR and interim proposed MATS. The interim 2016 EGU emissions for both the base and MATS policy cases were created using an interim version of the IPM because the modeling needed to be completed in advance of the IPM revisions associated with the proposed MATS. EPA concluded that the deposition modeling for the Hg Risk TSD was sufficient; therefore, all of the emissions reflected below for the proposal interim 2016 base case are unchanged from proposal. The change in the 2016 base Hg emissions estimate for U.S. EGUs of two tons of Hg between proposal and final would not have a significant impact on risk results. The non-EGU source emissions were created for the interim 2016 base projected emissions, and these are described in the Emission Inventory TSD for the proposed MATS. These emissions in Table 8 were used for all other 2016 emission cases.

The emissions used for the Hg Risk TSD are described in more detail in the three TSDs associated with this rule: (1) the 2005 version 4.1 Platform TSD, (2) the Emission Inventory TSD for the *proposed* MATS, and (3) the Air Quality Modeling TSD: EGU Mercury Analysis. These documents and the IPM results are available in the MATS docket.

4.2 Emissions for the Regulatory Impact Analysis (RIA) for the final rule

EPA updated the emissions estimates of the 2016 base and policy case emissions for the final rule. In Tables 7 and 8, the resulting emissions are labeled as the "Final 2016 base" and "Final 2016 policy" cases. The final IPM emissions are cited in the preamble for the MATS and in any summaries stating the final 2016 emissions associated with the rule generally. The final base and policy case emissions were not used in the modeling. Instead, the PM-related health co-benefits estimated for the final interim scenario were scaled using benefit-per-ton estimates, which is fully described in the RIA for the final rule.

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[26] Mercury revisions for NATA primarily affected non-EGU sources such as cement kilns and hazardous waste combustors.

[27] Selin, N.E., Jacob, D.J., Park, R.J., Yantosca, R.M., Strode, S., Jaegle, L., Jaffe, D., 2007. Chemical cycling and deposition of atmospheric mercury: Global constraints from observations. Journal of Geophysical Research-Atmospheres 112.

Table 7: Emission sources and basis for current and future-year emissions HAP inventories.

Purpose	Emissions Case	Pollutants	Sector	Emissions source
Hg Deposition modeling for the Appropriate and Necessary Finding and Hg benefits analysis	2005 base year	Hydrogen chloride, and chlorine	EGU Non-EGU point Non-point Mobile	2005 emissions from the version 4.1 modeling platform, derived from the 2005 National Emission Inventory (NEI) data
		Mercury	EGU Mobile	2005 National Air Toxics Assessment (NATA) data
			Non-EGU point Non-point	2005 NATA data, adjusted to account for Boiler MACT ICR data
	Proposal Interim 2016 Base Case projections	mercury and hydrogen chloride	EGU	Emissions from IPM v.4.10, including the Transport Rule Proposal
			Non-EGU point Nonpoint Mobile	Emissions from the version 4.1 modeling platform: projected 2005 emissions to account for all known national rules, consent decrees, and plant closures
	Proposal Interim 2016 Policy Case projections	Criteria pollutants, mercury and hydrogen chloride	EGU	Emissions from IPM v.4.10, including the Transport Rule Proposal and interim MATS Proposal
			Non-EGU point Nonpoint	Same as interim 2016 base projections
Current significance of EGUs	Current base Emissions	Mercury, acid gases, and metals	EGU	EGU emissions inventory based on unit-specific emission factors for tested units and average emission factors for untested units. 2007-2009 average CEM heat input data used to represent current conditions where available, and ICR-based 2007-2009 heat input estimates otherwise.
Final impact of the rule (no modeling done with these data)	Final 2016 Base Case	Criteria pollutants, mercury and hydrogen chloride	EGU	IPM 4.10_MATS, including the final Cross-State Air Pollution Rule
			Non-EGU point Nonpoint Mobile	Interim 2016 Base Case projections
	Final 2016 Policy Case	Criteria pollutants, mercury and hydrogen chloride	EGU	IPM 4.10_MATS, including the final Cross-State Air Pollution Rule
			Non-EGU point Nonpoint Mobile	Interim 2016 Base Case projections

Table 8 summarizes the Hg and HCl emissions for the anthropogenic sources of these emissions across the various cases. All EGU emissions presented in Table 8 represent units greater than 25 MW. The 2005 base case includes 105 tons of Hg and 430,000 tons of HCl from all sources, of which 53 tons of Hg and 350,000 tons of HCl are from EGUs. The current base emissions include the Hg and HCl emission estimates from U.S. EGUs are lower than in 2005, at 29 tons and 100,000 tons respectively. Speciated Hg emissions were not computed for the current base case. The interim 2016 base total Hg emissions from all sources are 64 tons and HCl emissions are 140,000 tons, with 29 tons of Hg and 74,000 tons of HCl from EGUs. For the interim 2016 policy case, total Hg was estimated to be 42 tons, with 6.8 tons from EGUs. For HCl, the interim 2016 policy case shows a total of 75,000 tons from all sources with EGU emissions emitting 8,800 tons.

The final 2016 base case EGU emissions were 27 tons of Hg out of a total of 62 tons, and 45,000 tons of HCl out of a total of 115,000 tons. In the final 2016 MATS policy case, EGU emissions of Hg are estimated to be reduced to 6.6 tons and emissions of HCl reduced to 5,500 tons.

Table 8. Summary of Hg and HCl emissions for emissions cases.

	Hg^0 (tons)	**Hg^{2+} (tons)**	**Hg_p (tons)**	**Total Hg (tons)**	**Hydrogen chloride (tons)**
2005 Base Case Emissions (tons)					
EGU [*]	30	21	1.6	53	350,000
NonEGU Point	30	11	6.2	46	49,000
Nonpoint	3.1	1.06	0.65	4.8	29,000
Mobile	0.79	0.29	0.13	1.2	
All sources	64	33	8.5	105	430,000
Current Base Emissions (tons)					
EGU	n/a	n/a	n/a	29	100,000
Proposal interim 2016 base case projections (tons)					
EGU[**]	21.1	6.9	0.67	28.7	74,000
NonEGU Point	16.9	7.9	4.4	29.2	38,000
Nonpoint	3.1	1.06	0.65	4.8	29,000
Mobile	0.79	0.29	0.13	1.2	
All sources	42	16	5.9	64	140,000
Proposal interim 2016 policy case projections (tons)					
EGU[**]	4.8	1.6	0.36	6.8	8,800
NonEGU Point	16.9	7.9	4.4	29.2	38,000
Nonpoint	3.1	1.06	0.65	4.8	29,000
Mobile	0.79	0.29	0.13	1.2	
All sources	26	11	5.6	42	75,000
Final 2016 base case projections (tons)					
EGU	20.6	5.5	0.37	26.5	45,300
NonEGU Point	16.9	7.9	4.4	29.2	41,000[**]
Nonpoint	3.1	1.06	0.65	4.8	29,000
Mobile	0.79	0.29	0.13	1.2	
All sources	41	15	5.5	62	115,300
Final 2016 policy projections (tons)					
EGU	5.2	1.2	0.15	6.6	5,500
NonEGU Point	16.9	7.9	4.4	29.2	41,000[**]
Nonpoint	3.1	1.06	0.65	4.8	29,000
Mobile	0.79	0.29	0.13	1.2	
All sources	26	10	5.3	42	75,500

* For this table, the EGU Sector is defined as follows: (1) For all pollutants other than mercury (Hg): 2005 NEI v2 point source EGUs mapped to the Integrated Planning Model (IPM) model using the National Electric Energy Database System (NEEDS) 2006 version 4.10 database. A few revisions were made to the 2005 NEI v2 annual emission estimates as discussed in the 2005-based, Version 4.1 platform document. (2) For Hg: 6/18/2010 version of the inventory used for the 2005 National Air Toxics Assessment (NATA) mapped to IPM using NEEDS version 4.10. The NATA inventory is an update to the 2005 NEI v2 and was divided into EGU and non-EGU sectors consistent with the other pollutants. We additionally removed Hg from sources from the NESHAP for Industrial, Commercial, and Institutional Boilers and Process Heaters (aka "Boiler MACT") Information Collection Request (ICR) database because we included these emissions in the non-EGU sector. For more information, see the 2005-based Platform Documentation, version 4.1.

** EGU Sector for 2016 is consistent with the 2005 base case discussed above. The future year emissions were generated by the Interim version of IPM4.10 and adjustments were made to remove Hg associated with the Boiler MACT ICR (which is accounted for in the Non-EGU sector), and to apply the impact of the final Boiler MACT for the other pollutants.

Since proposal, EPA has compiled additional documentation on the speciation approach applied to U.S. EGUs. The speciation approach applied for the final MATS was developed as part of the Clean Air Mercury Rule (CAMR) based on a 1999 ICR. Eighty mercury emissions tests were collected from 69 facilities. These data include inlet and outlet speciated mercury concentration measurements (µg/dscm) for Hg_p, Hg^{2+}, and Hg^0 mercury. Only the outlet data (measurements after the last control device) were used to develop the mercury speciation profiles. Forty-three mercury speciation profiles were developed from these data based on the same bins developed for the Emission Reduction Factors used in IPM. Additional information on these profiles is available in the "Electric Generating Utility Mercury Speciation Profiles for the Clean Air Mercury Rule" and the workbook "Hg_speciation_data_CAMR.xlsx", which are available in the docket.

Table 9 highlights the U.S. EGU emissions for the various cases shown in Table 8. It also includes the average percent of divalent gaseous and particulate Hg. The divalent gaseous Hg ranges from 20% to 40% of the total Hg emissions, and the particulate Hg ranges from 1% to 5% of total Hg emissions.

Table 9: EGU emissions of Hg and HCl for emissions cases in support of the final MATS.

	Hg^0 (tons)	**Hg^{2+} (tons)**	**Hg_p (tons)**	**Total Hg (tons)**	**Hydrogen chloride (tons)**	**Hg^{2+} Percent of total Hg**	**Hg_p Percent of total Hg**
2005 Base Case Emissions	30	21	1.6	53	350,000	40%	3%
Current base Emissions	N/A*	N/A*	N/A*	29	100,000		
Proposal interim 2016 base case projections	21.1	6.9	0.67	28.7	74,000	24%	2%
Proposal interim 2016 policy case projections	4.8	1.6	0.36	6.8	8,800	24%	5%
Final 2016 base case projections	20.6	5.5	0.37	26.5	45,300	21%	1%
Final 2016 policy case projections	5.2	1.2	0.15	6.6	5,500	18%	2%

* Speciation data were not collected for Hg in the 2010 ICR and CAMR-based speciation profiles were not applied to the current base emissions estimate.

United States
Environmental Protection
Agency

Office of Air Quality Planning and Standards
Air Quality Assessment Division
Research Triangle Park, NC

Publication No. EPA-454/R-11-014
November, 2011