VII. EPA Must Finalize HAP-Specific MACT Floors Except Where Surrogacy-Based Standards Meet the Legal Requirements for Surrogacy-Based MACT, and are Otherwise Justified by the Technical and Emissions Data Available to the Agency

A. Introduction

Rather than proposing HAP-specific emissions limits for this industry for all HAPs and all subcategories, EPA proposes surrogate-pollutant based floors, with pollutant-specific emissions limits only for mercury, and for some toxic metals and some acid gases from some industry subcategories. Specifically for all coal-fired EGUs including IGCCs and what it calls "solid oil-fired EGUs" (together, the "solid fuel subcategories"), EPA proposes mercury standards, and also proposes for the other toxic metals *either* that owners and operators of existing and new units can meet a total particulate matter standard (filterable plus condensable) *or* a total non-Hg HAP metals standard, *or* specific metals-based floors for ten metals.[1] For oil-fired units, mercury is regulated under an alternative total HAP metals standard.[2] Acid gas emissions from the solid fuel subcategories are regulated using HCl as a surrogate for all the acid gas emissions (HCl, HF, HCN), *or* SO2 as a surrogate only where some form of flue gas desulfurization controls are installed. EPA proposes separate HCl and HF standards for liquid oil-fired units. EPA asserts such surrogacy-based limits are justified because: "the

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[1] Alternative pollutant-specific emissions limits are proposed for antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, nickel and selenium. We support these HAP-specific limits.

[2] EPA properly observes that mercury and certain other metals, for example arsenic and selenium, do not behave like particulates, but instead have the potential to exist in both particulate and vapor phases. These pollutants will not be well correlated with particulate matter – that is, the metals are not invariably present in PM, and controlling particulates does not indiscriminately control emissions of these metals. 76 Fed. Reg. 25,024. While noting this EPA at the same time proposes to use an emissions limit based on total PM as an alternative surrogate standard for selenium and arsenic from solid-fuel fired EGUs.

acid gas HAP, HCl and HF, are water-soluble compounds," such that "the technologies for removal of the acid gases are primarily those that are also used for [flue gas desulfurization]," 76 Fed. Reg. at 25,023; and "[e]missions of certain non-Hg metallic HAP … have been assumed to be well controlled by PM control devices," *id.* at 25,024. EPA requests comments on the surrogate-based emissions limits, the theories under which they were derived and established, and the alternative emissions standards proposed.

B. Legal Standard for the Use of Surrogates In Setting MACT Emissions Limits

EPA's authority to issue surrogacy-based standards is not unlimited. Clean Air Act section 112(d)(1) requires EPA to set emission standards for every [listed] HAP emitted from each [listed] category or subcategory of major sources." *Mossville Envt'l Action Now v. EPA,* 370 F.3d 1232, 1236 (D.C. Cir. 2004). EPA may set MACT emissions standards for "surrogate" pollutants in lieu of emissions limits addressing each HAP only under limited circumstances. *Nat'l Lime Ass'n v. EPA,* 233 F.3d 625, 637-39(D.C. Cir. 2000)(*Nat'l Lime II*); *Sierra Club v. EPA,* 353 F.3d 976, 982-985 (D.C. Cir. 2004) (*Sierra Club I).* While the D.C. Circuit Court has held that it is within EPA's authority to regulate a surrogate air pollutant that effectively minimizes emissions of the target HAP, *Nat'l Lime II,* EPA must identify each of the HAPs it regulates by surrogates, specifically link the surrogate and the HAP it is intended to represent, *Mossville Envtl. Action Now,* 370 F.3d at 1243, and further show that three well-established conditions are satisfied:

1) the identified listed HAP is "invariably" present in the surrogate pollutant;
2) methods to control or capture the surrogate pollutant "indiscriminately" control or capture the listed HAP as well; and
3) surrogate controls are the "only means" by which facilities "achieve" reductions of the listed HAP.

Sierra Club I, 353 F.3d at 984 (quoting *National Lime*, 233 F.3d at 639). EPA has relied on this test for the validity of surrogates in previous air toxics rules, as it does here, 76 Fed. Reg. at 25,021.

EPA has not adequately demonstrated that the three pre-conditions supporting the reasonableness of surrogacy-based limits are met for all of the HAPs that the Agency proposes to regulate through surrogate limits, as discussed below. Where the use of surrogates is not supported by the record, pollutant specific emissions limits are required.

C. EPA Has Not Justified Use of a Total PM Limit as a Surrogate for all Non-Mercury Metal HAPs

EPA has proposed MACT limits on individual metal HAPs for all subcategories of the industry, and an alternative total non-Hg metal HAPs limt, The Agency also proposes as an alternative to allow existing and new units to comply with an emission limit for total PM (condensable plus filterable) as a surrogate for non-mercury metal HAPs. *See*, e.g., Tables 1 and 2 to Subpart UUUUU of Part 63 (76 Fed. Reg. 25,124-25,128 (May 3, 2011) (setting out the alternative compliance options for non-mercury metals, including the surrogacy-based approach)). The particulate matter surrogacy-based emissions limits do not meet the legal requirements for surrogacy, and (as a result) do not ensure the maximum achievable reductions in all non-mercury metal HAPs.

1. Non-Mercury HAP Metals Are Not All Invariably Present in Particulate Matter.

The first precondition for the use of a surrogate pollutant in MACT standard setting is that the HAP in question is "invariably present" in the surrogate pollutant. *Sierra Club I,* 353 F.3d at 984. This precondition is not met by EPA's proposed total PM surrogate for the non-mercury metal HAPs. As EPA has acknowledged, "[i]t has become widely recognized that some trace metals concentrate in certain waste particle streams from a combustor (bottom ash,

collector ash, flue gas particulate), while others do not…."[3] These elements are not all consistently present in particulate matter (that is, the particulates that arrive at the inlet to the particulate control device). Ex. 7-1[4] at 223-224; Ex. 7-2.[5] Some are present as gases and as such are not removed by pollution-control devices that limit particulate matter. Metal HAPs can be divided into the following groups: "Class 1: Elements which are approximately equally distributed between fly ash and bottom ash, or show little or no small particle enrichment; Class 2: Elements which are enriched in fly ash relative to bottom ash, or show increasing enrichment with decreasing particle size; Class 3: Elements which are intermediate between Class 1 and 2; Class 4: Volatile elements which are emitted in the gas phase."[6] These substances are not all consistently present in particulate matter (that is, the particulates that arrive at the inlet to the particulate control device). Ex. 7-1[7] and Ex. 7-2.[8]

Class I elements, which include beryllium and manganese, do not volatilize during combustion and distribute more or less equally between bottom ash and flyash. Class II elements, including lead, cadmium, antimony, and nickel, are vaporized in the boiler but are found mainly in the fly ashes after condensation on particles and nucleation mechanisms from decreasing temperature through the

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[3] *See* Emission Factor Documentation for AP-42, Section 1.1, Bituminous and Subbituminous Coal Combustion, EPA OAQPS, April 1993, at 2-14 (Available at http://www.epa.gov/ttn/chief/ap42/ch01/index.html).

[4] Minghou Xu, Rong Yan, Chunguang Zheng, Yu Qiao, Jun Han, and Changdong Sheng, *Status of Trace Element Emission in a Coal Combustion Process: A Review*, Fuel Processing Technology, v. 85, 2003, at 215-237.

[5] William P. Linak and Jost O.L. Wendt, *Trace Metal Transformation Mechanisms During Coal Combustion*, Fuel Processing Technology, v. 39, 1994, at 173-198.
[6] *Id.* at 2-13.

[7] Minghou Xu, Rong Yan, Chunguang Zheng, Yu Qiao, Jun Han, and Changdong Sheng, *Status of Trace Element Emission in a Coal Combustion Process: A Review*, Fuel Processing Technology, v. 85, 2003, at 215-237 at 223-244.

[8] William P. Linak and Jost O.L. Wendt, *Trace Metal Transformation Mechanisms During Coal Combustion*, Fuel Processing Technology, v. 39, 1994, at 173-198.

control train. A limit on total particulate matter, if appropriately designed, may effectively serve a surrogate for these pollutants.

However, Class III elements, which include arsenic, selenium, as well as mercury, are vaporized and condense only partially within the control train. *See* reviews in Exs. 7-1 and 7-3. EPA has recognized these issues with mercury and has not proposed any surrogate for mercury. *See* 76 Fed. Reg. 25,038 (May 3, 2011).

EPA has acknowledged that selenium is not always invariably present in particulate matter. EPA found that 55-90% of selenium tended to be in the gas phase upstream of the particulate control device when bituminous coal was fired in its pilot-scale boiler. *See* 76 Fed. Reg at 25,038. When the unit was fired with subbituminous coal, EPA found that 95% of the selenium was in the particulate form. *Id.* And EPA found that 80% of the selenium was in the particulate form when firing Gulf Coast lignite. *Id.*

It does not appear that EPA analyzed all of the metal HAPs to determine if the HAPs were in the gas phase upstream of the particulate control device. If EPA had done so, it would have likely found arsenic, chromium, and cadmium exists in the gaseous form upstream of the PM controls.[9] Up to 52% of the arsenic also may be present as a gas. Ex. 7-4.[10] Depending upon the fuel and control train, some of the otherwise nonvolatile trace metals, including cadmium, chromium and nickel, may be present in the vapor phase. Exs. 7-3,[11] 5,[12] 6,[13] 7.[14]

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[9] Mercury controls such as powdered activated carbon have been demonstrated to increase the amount of chromium and nickel in stack gases, compared to no mercury control. McIlvaine Hot Topic Hour, Hazardous Air Pollutants, May 15, 2008, Presentation of John Pavlish, EERC. Voice recording also available online to subscribers of McIlvaine Power Plant Knowledge System and available for purchase EPA has not adequately addressed this cross-controls related issue.

[10] Honghong Yi and others, *Fine Particle and Trace Element Emissions from an Anthracite Coal-Fired Power Plant Equipped with a Baghouse in China*, Fuel, v. 87, 2008, pp. 2050-2057.

[11] Zevenhoven and Kilpinen, *Trace Elements*, Alkali Metals, http://web.abo.fi/~rzevenho/tracalk.PDF.

2. Particulate Matter Control Technologies Do Not Indiscriminately Capture All HAP Metal Emissions

The second precondition for the use of a surrogate pollutant is that control of the surrogate must "indiscriminately capture" the air toxic along with the surrogate. *Sierra Club I,* 353 F.3d at 984. The capture efficiency of particulate control devices – whether a fabric filter baghouse, an electrostatic precipitator (ESP) or a particle scrubber – varies for particles of different sizes. Because, as discussed above, metallic HAP are not uniformly present in PM of all sizes, different devices achieve different rates of capture of non-mercury metal HAP emissions.[15] For those metal HAPs in the gaseous form upstream of the particulate control device, only a baghouse might remove some HAPs. Other control devices are unlikely to remove any of them.

Many of the metal HAPs that do exist in the particulate form are concentrated in the smallest particles or are condensable particulates, which are not always efficiently collected by the particulate collection device (and are usually collected with less efficiency than larger particles). Metallic HAPs that are enriched in particulate matter are, as a general matter, volatilized in the boiler and condense as very fine particulate matter or nanoparticles (typically smaller than 1 micron) in

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[12] McIlvaine Hot Topic Hour, Hazardous Air Pollutants, May 15, 2008, Presentation of John Pavlish, EERC, Trace Metals in Combustion Systems. Voice recording also available online to subscribers of McIlvaine Power Plant Knowledge System and available for purchase.

[13] Frank B. Meserole and Winston Chow, *Controlling Trace Species in the Utility Industry, In: Winston Chow and Katherine K. Connor* (Ed.), Managing Hazardous Air Pollutants, 1993.

[14] Frank Meserole, Greg Behrens, and Winston Chow, *Fate of Trace Elements in Coal-Fired Power Plants*, 84th Annual Meeting, Air & Waste Management Association, June 1991.

[15] EPA's proposal for solid fuel-fired EGUs includes a total PM based alternative limit only for non-Hg metals.

the pollution control train. Exs. 7-8,[16] 9[17], 10[18]*; see also* Exs. 7-2 and 7-5. The highest concentrations of most metallic HAPs are consistently found in the smallest particles. Exs. 7-1, 7-11,[19] 7-12,[20] 7-13,[21] and 7-14.[22] And the metallic HAPs of greatest environmental concern are enriched in these tiny submicron particles. Ex. 7-1, at 222-223. These smaller particles also cause proportionately more of the adverse health impacts because they can penetrate deep into the lung. Ex. 7-15.

In order to satisfy the second element of the surrogacy test, for particulate matter as a surrogate for non-mercury metallic HAP, the surrogacy-based standard must be based on sources using controls that efficiently capture the smaller fraction of particulates, where such HAP reside.[23]

But particulate-matter control devices in use at the best performing sources do not capture these smaller particles as efficiently as they capture larger particles.

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[16] R.C. Flagan and S.K. Friedlander, Particle Formation in Pulverized Coal Combustion – A Review, In: *Recent Developments in Aerosol Science*, D.T. Shaw (Ed.), 1978, Chapter 2..

[17] A.S. Damale, D.S. Ensor, and M.B. Ranade, *Coal Combustion Aerosol Formation Mechanisms: A Review*, Aerosol Science & Technology, v. 1, no. 1, 1982, pp. 119-133.

[18] S.K. Friedlander, *Smoke, Dust, and Haze: Fundamentals of Aerosol Dynamics*, 2nd Ed., Oxford University Press, 2000.

[19] Richard L. Davidson and others, *Trace Elements in Fly Ash,* Environmental Science & Technology, v. 8, no. 13, December 1974, pp. 1107-1113.

[20] E.S. Gladney and others, *Composition and Size Distribution of In-State Particulate Material at a Coal-Fired Power Plant*, Atmospheric Environment, v. 10, 1976, pp. 1071-1077.

[21] John M. Ondov, Richard C. Ragaini, and Arthur H. Biermann, *Emissions and Particle-size Distributions of Minor and Trace Elements at Two Western Coal-fired Power Plants Equipped with Cold-side Electrostatic Precipitators,* Environmental Science & Technology, v. 13, 1979, pp. 946-953.

[22] W.P. Linak and others, *Comparison of Particle Size Distributions and Elemental Partitioning from Combustion of Pulverized Coal and Residual Fuel Oil*, J. Air & Waste Manage. Assoc., v. 50, 2000, pp. 1532-1544.

[23] It should be noted that methods for measuring particulate matter smaller than 2.5 microns or PM2.5, have been developed.

Exs. 7-16 (Table 1.1-6)[24], 7-17 (Fig. 8)[25], 7-6[26], 7-7.[27] For example, the record shows that the universe of best performing sources contains sources with a variety of electrostatic precipitators, baghouses, as well as some with a variety of different scrubber designs. The capture efficiency of fine particles is a function of the design and operating parameters of such devices, for which EPA did not collect adequate data. It cannot be assumed that all of these devices are capturing the smaller particles that contain the metallic HAPs in question. As a result, particulate matter controls – at least the ones on which the proposed total PM floors are based -- do not "indiscriminately" capture HAP metals at the same rate as other particulates; they favor the larger, non-HAP-bearing particles. For example, one study found that particles smaller than 1 micron made up 5% of the total particle mass before the particulate control device while after the device, they made up 50% of the mass. Ex. 7-5.

EPA's analysis of its experience with its pilot plant demonstrates the problem with total PM as a surrogate for non-Hg metal HAPs. The particulate matter control device in use at the pilot plant (either a fabric filter or an ESP) does not indiscriminately remove metal HAPs with particulate matter. Specifically, EPA found that the average PM control during the tests was 99.5%, but the average metal HAP control varied from 95.3% for antimony to 97.6% for nickel to 98% for arsenic and chromium. *See* 76 Fed. Reg. at 25,038. While these control efficiencies may look similar or reasonably close, they are not. Nearly ten times more HAP is emitted at a control efficiency of 95.3 % than at 99.5%. Only a few metal HAPs had

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[24] U.S. EPA, Compilation of Air Pollutant Emission Factors, September 1998, Section 1.1, Coal Combustion.

[25] M.W. McElroy and others, *Size Distribution of Fine Particles from Coal Combustion*, Science, v. 215, no. 4528, January 1, 1982.

[26] Frank B. Meserole and Winston Chow, *Controlling Trace Species in the Utility Industry, In: Managing Hazardous Air Pollutants, State of the Art, Winston Chow and Katherine K. Conner*, 1993.

[27] Frank Meserole, Greg Behrens, and Winston Chow, *Fate of Trace Elements in Coal-Fired Power Plants, Presentation*, 84th Annual Meeting, Air & Waste Management Association, 1991.

similar control efficiencies as the 99.5% PM control efficiency (manganese, lead and cobalt). *Id.* That the efficiencies were "greater than 95%," 76 Fed. Reg. at 25,038, does not indicate a lack of wide variations in actual emissions of non-mercury metals (or even particulate matter).

Most significant for the Agency's attempt to include selenium (a metal that is often volatized in stack emissions) under the total particulate matter surrogate emissions limit, EPA found in its pilot plant studies that selenium was *not* consistently well controlled among coal types or control types, except for subbituminous coal.[28] Selenium control with an ESP and eastern bituminous coal ranged from 0 to 73%, and with lignite was 80%. *Id.*

Based on the above data and information, it cannot be said that the particulate control devices on which the total PM surrogacy-based floors are set indiscriminately remove all metal HAPs. This is especially true for selenium.

3. Facilities Achieve Reductions in HAP Metal Emissions By Means Other Than Particulate Matter Control.

The third precondition for the use of a surrogate pollutant is that control of the surrogate must be the "only means by which facilities achieve reductions" in the air toxic in question. *Sierra Club I,* 353 F.3d at 984. Particulate matter control is not the only means by which facilities achieve reductions in metallic HAP. As the D.C. Circuit Court of Appeals has observed, in order for particulate matter to serve as an adequate surrogate for metal HAP:

> other inputs [such as fuel type] must "affect HAP metal emissions in the same fashion than they affect the other components of [particulate matter.]" Put another way, "[particulate matter] might not be an appropriate surrogate for HAP metals if switching fuels would decrease HAP metal emissions without causing a corresponding reduction in total [particulate matter] emissions. The reason is clear: if EPA looks only to [particulate matter], but HAPs are reduced by altering inputs in a way that does not reduce [particulate matter], the best achieving

[28] When subbituminous coal was the fuel, similar control efficiencies averaging 98.9% were achieved irrespective of the particulate control device. *Id.*

> sources, and what they can achieve with respect to HAPs, might not be properly identified.

Sierra Club I, 353 F.3d at 985 (quoting *National Lime,* 233 F.3d at 639).

Several "other inputs" affect HAP metal emissions in a different fashion than they affect particulate matter emissions. *Id.* First, "switching fuels would decrease HAP metal emissions without causing a corresponding reduction" in total particulate matter. *Id.* Burning coals that contain lower amounts of metallic HAP can yield reductions in the HAPs contained on and in the particulate matter residue. In such cases, a standard based on burning those coals in combination with particulate controls will result in even lower non-mercury metal HAP emissions. Conversely, setting a PM-based surrogate standard and applying it to units burning coals with high metal content will result in higher HAP emissions than would result from a metals-specific limit were in place.

The effect of fuel-related inputs on metallic HAP emissions differs from such inputs' effect on particulate matter for three reasons. The ash[29] content of the coal used as a fuel determines the particulate matter concentration in a plant's flue gases. Ex. 7-19.[30] The summary of Powder River coal quality attached as Ex. 7-20A shows that the ash content remains stable across many coals, while the trace elements can vary significantly. For example, coal from the Jacobs Ranch mine contains about 5.5% ash and lower concentrations of antimony, arsenic, cadmium, chromium, lead and selenium than coal from the

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[29] Ash is a measure of the inorganic material present in coal. This inorganic material is not burned, but becomes bottom ash, removed in the boiler, and fly ash, which becomes airborne and is particulate matter. About 80% of the ash becomes fly ash. *See, e.g.*, Gary L. Borman and Kenneth W. Ragland, Combustion Engineering, WCB McGraw-Hill, 1998, pp. 522-523 and Exhibit 9, Table 1.1-4 (filterable PM emission factors expressed as a constant times the ash content).

[30] J-I. Yoo and others, *Particle-Size Distributions and Heavy Metal Partitioning in Emission Gas from Different Coal-Fired Power Plants*, Environmental Engineering Science, v. 22, No. 2, 2005.

Cordero mine. Lower stack emissions of these elements could be obtained by burning Jacobs Ranch coal instead of Cordero coal. Such alterations in fuel supply thus "affect HAP metal emissions" in a far different fashion than they affect particulate matter. *Sierra Club I,* 353 F.3d at 985.

In addition, the relationship between individual HAPs and particulate matter is different for the individual HAPs that are included in the collection of elements represented by the particulate matter surrogate. Exs. 7-21A, 7-21B, and 7-21C show the relationship between ash content and selenium, lead, manganese, chromium, cadmium, beryllium, and arsenic for Kentucky bituminous coals. These charts show that there is a direct positive relationship between ash and the amount of selenium, manganese, and chromium in this coal, but no relationship between ash and the amount of lead, cadmium, beryllium and arsenic.

The relationship between ash and metallic HAPs varies for different coals in unpredictable ways. Ex. 7-20B[31] reports an analysis of the relationship between ash and metallic HAPs for Pittsburg 8 coals. This analysis found not only different relationships between HAPs and ash for each HAP (*see* equations for each HAP at bottom of page 8), but also different relationships for Kentucky coal in Exs. 7-6 and 7-7 and Pittsburg 8 coal in Ex. 7-20B. As a result of this variation in HAP-content of coals (and thus coal ash, and then particulate matter derived from such coals), particulate matter cannot be reliably used as an indicator of HAP emissions.

EPA has exacerbated these problems by proposing to allow a limit on total particulate matter as its surrogate (meaning all sizes of particles from the largest to the smallest). As discussed above, HAP metals are present primarily in fine particulates, less than 1 micron in size. As a result, particulate controls

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[31] P.R. Tumati and R.A. Bilonick, *Estimating Trace Element Emissions Using USGS Coal Data*, Journal of the Air & Waste Management Association, v. 46, no. 1, 1996, pp. 58-65.

focusing on total particulates may not significantly reduce metallic HAP emissions.

Finally, most of the particulate matter mass (98%,) is bigger than 1 micron. Ex. 7-16, Table 1.1-6 of AP-42. Indeed, the sum of the non-mercury metallic HAPs in stack gases reported in lb/MMBtu is less than 1% of the filterable PM reported in the same units. The other 99% of the particulate mass is mostly oxides of silica, iron, sodium, calcium, and potassium. These substances are affected by different chemical and physical mechanisms than the metallic HAPs, which are controlled by volatilization and condensation reactions that concentrate them in the very smallest particles with the largest surface area. Thus, particulate matter per se is too diverse and the target HAP fraction too small to serve as a surrogate for less than 1% of the whole.

As explained above, the EPA's proposed surrogate particulate matter limit could be met by removing the larger particles, without removing (or less efficiently removing) the smaller particles where the metallic HAPs are found. The removal efficiencies of the two most common particulate matter control devices within EPA's universe of best-performers – fabric filter baghouses and electrostatic precipitators – are much higher for big particles than small particles. The most commonly used particulate control devices, including the device proposed here to comply with MACT (a conventional baghouse designed to remove total filterable particulate matter), capture a large fraction of coarse particulates, but are far less effective in capturing finer particulates where the non-mercury metallic HAPs are found, thus providing low total particulate emissions but high metallic HAP emissions. An ESP and a baghouse designed to capture fine particulates might produce similar emissions of total particulates, but very different metallic HAP emissions.

4. There is No Correlation Between Total Particulate Emissions and Emissions of Non-Mercury Metallic HAP.

Using EPA's data in the record, we have attempted to verify the degree to which emissions of non-metal HAPs correlate with particulate matter. Focusing

on the best controlled (using PM as the surrogate) universe. The table below shows the correlation of each of the non-mercury metal HAPs with EPA's proposed surrogate, total particulate matter, and with each other. We only used data for units that had all metal HAPs reported (around 109 of the best controlled units).

Correlation of Emissions of Total Particulate Matter and non-Mercury Metal HAPs for Best Controlled Units

	Total_Particulate	*Antimony*	*Arsenic*	*Beryllium*	*Cadmium*	*Chromium*	*Cobalt*	*Lead*	*Manganese*	*Nickel*	*Selenium*
Total_Particulate	1.000										
Antimony	0.224	1.000									
Arsenic	0.177	0.924	1.000								
Beryllium	0.185	0.307	0.094	1.000							
Cadmium	0.226	0.220	0.057	0.759	1.000						
Chromium	0.124	0.015	-0.028	0.110	0.094	1.000					
Cobalt	0.136	0.110	-0.031	0.552	0.402	0.596	1.000				
Lead	0.199	0.900	0.959	0.145	0.089	-0.023	0.019	1.000			
Manganese	-0.001	0.172	-0.004	0.827	0.693	0.101	0.576	0.015	1.000		
Nickel	0.132	0.003	-0.035	0.093	0.093	0.917	0.560	-0.020	0.078	1.000	
Selenium	0.329	0.683	0.690	0.305	0.091	-0.048	0.018	0.686	-0.022	-0.039	1.000

As can be seen from the second column, none of the metals strongly correlates with total PM. Total PM cannot, therefore, be a surrogate for any of the non-mercury metal HAPs.

This is further demonstrated in tests of two separate filtration media used in the baghouse at Hawthorne Unit 5.[32] Membrane filtration bags resulted in

[32] R.E. Snyder, et al., Impact of Fabric Filter Media and SDA Operations on Multi-Pollutant Emissions, Presented at EPRI-DOE-AWMA-Mega Symposium, August 2006.

much lower filterable PM but allowed a substantial increase in condensable PM (the fraction where most of the metallic HAPs reside) compared to OEM needle felt bags. Such bag selection, to take one example, can allow the total PM standard to be met while allowing substantial increases in the target HAP emissions.

5. The Total PM Surrogate does not Permit or Support Future Residual Risk Standard Setting as Required by the Statute.

Residual risk standards, moreover, will require direct monitoring of each non-mercury metallic HAP, which a total PM standard does not support. The Clean Air Act requires EPA to develop and implement a program for future assessment of risks remaining ('residual risk') after facilities in a listed industry have implemented MACT standards. 42 U.S.C. § 7412(f). If necessary, EPA is required to issue regulations to reduce any residual risks in order to protect the public health with an "ample margin of safety, and if needed to prevent "an adverse environmental effect, taking into consideration costs, energy, safety and other relevant factors. " *Id.* §7412(f)(2)(A). EPA must issue risk-based regulations within eight (or nine) years after the promulgation of the MACT standard.

Cancer, chronic and acute health risks are estimated using emission rates of individual HAPs to calculate ambient concentrations, which are then used with cancer potency factor and reference exposure levels to calculate cancer risk and chronic and acute hazard indices. This requires direct measurement of emissions from MACT sources. Residual risk cannot be estimated from surrogates. While emission data can be obtained from a Section 114 request, this provides no information on actual emissions from the MACT-controlled sources.

6. Conclusion

For all of these reasons, EPA's proposal to allow compliance with a total PM limit as a surrogate for a MACT limit on all non-mercury metal HAPs has not been legally or technically justified either based on EPA's own testing, or on numerous studies published in refereed journals. Any use of particulate matter as a surrogate

for non-Hg HAP metals would, first, need to be limited to only those HAP that are consistently present in particulate matter. Second, it would need to be based on the fine fraction of PM (PM less than 2.5 microns in diameter), where the non-mercury HAPs reside.[33] As set forth above, including larger particulates disrupts the necessary relationship between the surrogate (particulate matter) and the regulated HAP (trace metals) and allows compliance with the standard while allowing elevated metal emissions.

At the very least, a lawful particulate matter standard as a surrogate for non-mercury metal HAPs must be set based on PM2.5 rather than total particulate matter without regard to particle size. EPA considered this issue, but decided to propose a limit on total PM because the test method for measuring PM2.5 (Method 201A) is only applicable for stack emissions without entrained water droplets, and thus PM2.5 can't be measured at a unit with a wet scrubber. 76 Fed.Reg. 25,039 (May 3, 2011). Measurement difficulties cannot, in any event, justify the use of a surrogate that does not properly represent the target HAP. EPA has enough information to propose (and indeed has proposed for 10 non-mercury metal HAPs) specific HAP-based emissions limits. Moreover, such difficulties may be overcome, by requiring any particulate matter surrogate to be based on PM2.5 for those units without wet scrubbers and PM10 for those units with wet scrubbers. EPA's Emission Measurement Center website states that when water droplets are present, Method 5 should be used instead of Method 201A, and consider the particulate matter catch as PM10 emissions.[34] Another alternative is to use Method 5 to measure filterable PM2.5 and to use Method 202 to measure condensables (and assume that all condensables are in the 2.5 micron size or smaller, which is typically the case). Given that EPA itself has acknowledged that the non-mercury metal HAPs are typically in the PM2.5 size range, any surrogate limit on particulate matter must limit PM2.5 emissions in order to properly act as a

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[33] Kilgroe, J.D. et al. *Control of Mercury Emissions from Coal-Fired Electric Utility Boilers: Interim Report*, EPA-. 600/R-01-109, December 2001. Ex. 7-22.

[34] *See* http://www.epa.gov/ttn/emc/methods/method201a.html#thrun.

surrogate for the maximum achievable control technology of non-mercury metal HAPs. Any difficulties in measuring various size fractions of particulate matter in situations involving presence of water droplets provides yet another reason for avoiding particulate matter (of any type) as a surrogate for metal HAPs, rather than embracing an admittedly insufficient surrogate.

D. EPA Has Not Justified Use of an HCl Limit or an SO2 Limit as a Surrogate for All Non-Metal Inorganic Acid Gas HAP

EPA has proposed to use a limit on HCl as a surrogate for all non-metal inorganic acid gas HAPs, which would presumably include HF, Cl_2, and hydrogen cyanide (HCN). 76 Fed.Reg. 25,039 (May 3, 2011). It appears that EPA is also assuming a limit on HCl would suffice as a surrogate for selenium when in the gaseous form of SeO_2. *Id.* EPA has also proposed to use a limit on SO2 as a surrogate for all of these acid gas HAPs – but only for EGUs with some sort of flue gas desulfurization unit in operation. *Id.* at 25,040. EPA has not provided sufficient justification to reasonably or lawfully use HCl or SO2 as a surrogate for all of these acid gas HAPs as discussed below.

1. The Non-Metal Inorganic HAPs Are Not All Invariably Present in Hydrogen Chloride Nor Are these HAPs Present in Sulfur Dioxide.

As noted above, in order to use a surrogate pollutant in MACT standard setting, the Agency must show that the HAP in question is "invariably present" in the surrogate pollutant. *Sierra Club I,* 353 F.3d at 984. This precondition is not met by EPA's proposed use of HCl and SO2 as surrogates for the acid gases emitted by coal and oil-fired EGUs. EPA did not provide any analysis of or discussion as to whether HF, Cl_2, HCN, or SeO_2 are invariably present in HCl or whether these HAPs and HCl are invariably present in SO2. They are not.

First, there is no reason to expect that these different pollutants will be "invariably present" since they are not formed (nor destroyed) by the same mechanisms. While HCl, HF, SO2, and to a certain extent, SeO2 all arise from precursors present in the fuel (i.e., coal, pet coke, etc.), they are not present in equal

proportions even for the same fuel. For example, even though HCl is formed from chlorine in the coal, HF from fluorine in the coal, and SO2 from sulfur in the coal, these precursors are all present in different chemical forms and proportions. Once in the boiler, some of the sulfur (depending on chemical form) ends up in the bottom ash but this is generally not expected for chlorine or fluorine. The remaining sulfur, chlorine, and fluorine then undergo reactions to convert to SO2, HCl, and HF in the firebox. HCN, on the other hand, is simply not formed via the same type of reactions as SO2, HCl, or HF. HCN is formed in the rich regions of the flame from fuel nitrogen but its formation mechanism is complex and there is no general relationship between coal nitrogen content and HCN formation. Thus, all of these acid gases cannot be lumped into the same category from a formation standpoint.

The rate at which these gases, once formed, can be destroyed or then emitted is also not correlated. Removal or destruction depends on the form of the compounds and their properties. For example, while all of these may be gaseous compounds, their solubility in various reagents (for example, water, lime-slurry, limestone-slurry, etc.) is not the same, even keeping process conditions constant (for example, pH and temperature). In an actual exhaust gas, there are usually competing reactions that make the removal picture even more complex. Thus, there is no reason to expect removal to be the same – and therefore, they cannot be expected to be "*invariably* present" in the emissions.

The table below shows, using EPA's data collected for this rulemaking, the correlation of emissions of SO2, HCl, HF, and HCN (no data were available for SeO2) from the various units in the floor analysis.

Correlations of Emissions of SO2, HCl, HF, and HCN

	SO2	*HCl*	*HF*	*HCN*
SO2	1.000			
HCl	0.510	1.000		
HF	0.116	0.284	1.000	
HCN	0.005	-0.020	-0.030	1.000

There is no correlation between these emissions. Even the 0.51 correlation coefficient between SO2 and HCl is not a very strong one. There is no correlation between SO2 and HF (0.116) or SO2 and HCN (0.005). And there is poor or no correlation between HCl and HF (0.284) and HCl and HCN (-0.02). EPA's proposed HCl or SO2 surrogates for the non-metal inorganic HAPs is not reasonable or lawful. EPA asserts it "has gathered sufficient data on HCl, HF, and HCN to establish individual emission limitations if warranted," 76 Fed. Reg. at 25,023, the Agency unreasonably and unlawfully instead relies on the HCl surrogate in most instances. EPA must finalize acid-gas specific floors.

2. The HCl or SO2 Control Technologies Do Not Indiscriminately Capture All Target HAP Emissions.

The second precondition for the use of a surrogate pollutant in MACT standard setting is that control of the surrogate must "indiscriminately capture" the air toxic along with the surrogate. *See Sierra Club I,* 353 F.3d at 984 (holding same for particulates and metal HAPs).

a. EPA's Pilot Scale Testing Does Not Demonstrate that High Levels of SO2 Removal or HCl Removal Indiscriminately Capture the Target HAPs.

EPA asserts that two tests it conducted at its Multi-Pollutant Control Research Facility (MPCRF) support the surrogacy relationships it proposes for acid gas HAPs. Those tests were run with eastern bituminous coal and a limestone-based wet FGD scrubber. 76 Fed.Reg. 25,039. EPA found consistently high levels of HCl and SO2 removal for both of the runs. For Cl_2, EPA observed 76% control in the first test run and 92% control in the second test run, whereas for HF EPA observed 92% control in the first run and 76% control in the second run. *Id.* Clearly there is a great deal of variability even in these test runs. . Clearly these two test runs fail to provide sufficient basis for EPA's broad claim that the HCl and SO2 control technologies *indiscriminately* capture all the acid gas HAPs emitted by solid fuel-fired EGUs. EPA would need to collect more data

from full-scale units showing more consistent correlations to support such conclusions.

b. The Available Data Presented by EPA Does Not Support the Concept that SO2 Controls Indiscriminately Capture All Non-Metal Inorganic HAPs Simultaneously.

EPA's testing and other test data indicate that SO2 controls do not achieve high levels of removal of these acid gas HAPs concurrently (even for HF and HCl, let alone HCN). For example, as discussed above, EPA's testing at its MPCRF showed that removal of Cl_2 was higher when removal of HF was lower, and vice versa. *See* 76 Fed.Reg. 25,039. A review of the ICR data shows similar results. For example, Springerville Unit 3 achieved 96% HF removal but only 70% HCl removal.[35] Wygen I achieved 80% HCl removal and 95% HF removal, and Wygen II achieved 47% HCl removal and 76% HF removal.

Lowering HCl emissions is not indiscriminately linked to lowered chlorine (Cl2) emissions. For chlorine, EPA only collected a limited amount of data. Of the 131 lowest HCl emitting units, there is only chlorine test data provided for 16 units. We analyzed the average chlorine emission rate for the 131 lowest HCl-emitting sources and compared it to the average chlorine emission rate for the subset of the lowest 65 HCl-emitting units, and when we did so, we found that chlorine emissions increased with decreasing HCl (from 2.58×10^{-4} lb/MMBtu to 3.20×10^{-4} lb/MMBtu).

c. EPA's Pilot Scale Testing Did Not Collect Any Data on Control of HCN Across SO2 Controls.

Far from showing that controlling SO2 always indiscriminately also controls the acid gas HCN, EPA did not provide *any* data on control of HCN across a wet scrubber. EPA collected sufficient data on HCN emissions in its ICR, to set an HCN-specific MACT standard, and should do so, as it does not

[35] *See* EPA's Spreadsheet entitled "Floor analysis coal HCl 31611" at "AcidGas_Coal." The uncontrolled HCl and HF emission rates were calculated for these units based on the chlorine and fluorine content of the coal provided in the spreadsheet and, with that data and the HCl and HF emission rates, the HCl and HF removal efficiencies could be calculated.

appear that EPA has evaluated whether HCN is controlled across SO2 control equipment at all, much less justified an SO2-HCN surrogacy relationship (especially in light of the non-correlation of acid gas emissions discussed above)

d. EPA's Pilot Scale Testing Did Not Evaluate SO2 Controls Other than a Wet Scrubber.

EPA did not do any evaluation of the relationship between acid gas removal and the use of a dry scrubber or any other other SO2 control technologies. Those alternative SO_2 control mechanisms may have poor, or no significant, effect on acid gas emissions.

3. SO2 Control Is Not the Only Factor that Accounts for Low Emissions of HCl, or of the other Acid Gases for Which EPA Proposes to Use SO2 as a Surrogate.

The third precondition for the use of a surrogate pollutant is that control of the surrogate must be the "only means by which facilities achieve reductions" in the air toxic in question. *Sierra Club I,* 353 F.3d at 984. The data collected by EPA, and the manner in which acid gases are formed, suggest that SO2 controls alone are not the only reason for low acid gas emissions.For example, chlorine levels in coal are a factor that can account for lower HCl emissions, independent of the SO2 removal efficiency of any SO2 controls. While SO2 controls can affect HCl emissions, a review of the ICR data collected by EPA shows that SO2 controls are not the "only means" by which lower acid gas emissions are achieved – those units burning the lowest chlorine coal (typically subbituminous, western bituminous, and lignite) can have lower HCl emissions than units burning higher chlorine coal without SO2 controls, Our review of available HCl test results shows that EGUs burning lower chlorine coals result in lower HCl emissions rates. For example, Clay Boswell Unit 2 achieved an HCl emission factor of rate of 0.0000011 lb/MMBtu and this EGU had a coal chlorine content by weight of 0.000028%.[36]

[36] See Energy and Environmental Research Center, University of North Dakota, "A Comprehensive Assessment of Toxic Emissions from Coal-Fired Power Plants: Phase I Results from the U.S. Department of Energy Study," September 1996, HCl

We also observed lower chlorine coals, as expected, were an important factor in obtaining lower HCl levels – regardless of other factors (such as the presence of SO2 controls). For example, by separating the lowest 131 HCl-emitting units' emissions data for those units that burn low chlorine coal (i.e. subbituminous, lignite and western bituminous) from the data for units that burn higher chlorine coal (i.e., bituminous coals), we found that the low chlorine coal units averaged lower HCl emissions than the units burning higher chlorine coal (1.94×10^{-4} lb/MMBtu compared to 2.35×10^{-4} lb/MMBtu),

In addition, there are other options for removing HCl that may not remove all acid gases (especially HCN). For example, chloride prescrubbers can remove HCl and likely also HF, but weaker acids like HCN would not likely be removed by such a prescrubber. Where HCN has been removed in other instances, reagents that are used include sodium hydroxide, which are general not used to control other pollutants from coal-fired units.

A scrubber is operated to primarily remove SO2 emissions, with the amount of reagent needed to meet SO2 emission limits dependent on the uncontrolled SO2 emissions coming into the scrubber. Hydrogen chloride removal is similarly based on the stoichiometric ratio of reagent to chlorine.[37] However, there is no correlation between sulfur content of the coal and chlorine levels in the coal. This is made clear by Exs. 7-23 and 7-24 which include raw data from the USGS COALQUAL database for subbituminous Powder River Basin coal (Ex. 7-23) and for bituminous Central Appalachian coal (Ex. 7-24).[38] Because there is no correlation between sulfur content and chlorine content of coal, a scrubber operated to achieve certain levels of

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emissions determined in lb/MMBtu from Table A-7 (at p A-7) and chlorine in coal from Table 4-7. Ex. 7-29.

[37] *See* Maezawa, Akinori et al., *Simulation of Removal of HCl Gas in a Spray Dry Tower*, Chem. Eng. Technol. *19* (1996), 550-552, Figure 2 at 552. Ex. 7-25.

[38] The data for these spreadsheets was downloaded from http://energy.er.usgs.gov/products/databases/CoalQual/. For the charts in Exs. 7-23 and 7-24 which plot chlorine versus sulfur content, only samples with chlorine and sulfur concentrations greater than zero were plotted, as it was assumed that zero concentration values meant that element was not tested for that coal sample.

SO2 may not be optimized for HCl removal. If the scrubber is operated to achieve of SO2 removal and the sulfur content of the coal stays the same but the chlorine content increases, then HCl emissions could increase in proportion to the increase in chlorine emissions could increase in proportion to the increase in chlorine The SO2 control is accordingly not the only factor affecting HCl emissions.

Options for removing individual acid gases vary, and they do not remove the other acid gases. Even in instances where gases might appear to be similar (such as HCl and HF, for example), actual removal is a complex function of operating conditions including reagent used, pH, temperature, ratio of reagent to gas flows, concentrations of these gases in the exhaust, manner in which the reagent is mixed, and the presence of other competing gases. Correlated removal is not the norm and this is clearly shown in the poor correlations of emissions of these gases described earlier using EPA's own data.

4. Conclusion

EPA has not legally or technically justified the use of either HCl or SO2 as surrogates for all of the non-metals inorganic acid gas HAP. Moreover, it appears that EPA is improperly conflating the establishment of a MACT emission limitation for acid gases with consideration of control methods. While it EPA may find those EGUs with the best SO_2 controls also are the lowest acid gas emitters, the proper approach as a matter of science and law is to establish separate MACT limits for each acid gas – and as noted above, EPA asserts it believes it has collected sufficient data to do so. The experience with case-by-case MACT for this industrial category since the 2008 vacatur of EPA's Clean Air Mercury Rule demonstrates that individual acid gas floors are eminently reasonable. There are examples of case-by-case MACT permits with separate emission limits for each acid gas (particularly separate limits for HCl and HF). Measurement methodologies for these HAPs are readily available. Thus, there are no experiential or technological limitations to the imposition of emission limitations for each acid gas HAP.

E. Summary: Use of Surrogate Pollutant Emission Limits Must Be Limited to Meet MACT.

EPA has not legally or technically justified the use of a limit on total PM for all of the non-mercury metal HAPs or limits on HCl or SO2 for all of the non-metal inorganic HAPs. While we realize EPA is attempting to minimize the testing, recordkeeping and reporting requirements by proposing surrogate emission limits, EPA also has to comply with the law on allowable surrogate emission limits to meet MACT.

EPA has not justified the use of a limit on total PM as a surrogate for metal HAPs. Similarly, EPA has not legally or technically justified the use of either a limit on HCl or SO2 as surrogates for the non-metal inorganic HAPs. At the minimum, EPA must adopt separate MACT standards for HCl, HF, HCN, and SeO_2.