



Consumers Energy Company
Case-by-Case MACT Determination

Case-by-Case MACT Determination
in
Support of the Permit to Install Application
No. 341-07
Installation of a New Advanced Supercritical Pulverized Coal Boiler
Consumers Energy Company
Karn/Weadock Generating Station
Hampton Township, Michigan

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1.0 INTRODUCTION

Consumers Energy Company (Consumers) is submitting this updated case-by-case Maximum Achievable Control Technology (MACT) determination to clarify and supplement the previously submitted (August 26, 2008) 112(g) MACT Analysis for the Advanced Supercritical Pulverized Coal (ASCPC) boiler, and in response to recently available technical data and discussions with the Michigan Department of Environmental Quality (MDEQ). Specifically, the acid gas, organic and metal HAP sections are being revised. This document demonstrates that the emission limitations and air pollution control technology proposed in the permit to install (PTI) application and previous MACT submittal meets the requirements of a case-by-case 112(g) MACT determination.

Consumers has applied to the MDEQ for a PTI for the installation and operation of a new ASCPC boiler at the existing Karn/Weadock Generating Station, located in Bay County, Hampton Township, Michigan. The new boiler will be nominally rated at 8,190 MMBtu/hr with a gross output of approximately 930 megawatts (MW). Western sub-bituminous coal from the Powder River Basin (PRB) is currently the primary fuel for the existing solid fuel boilers at both the Karn and Weadock Generating Plants with additional heat input supplied by bituminous coals. The ASCPC boiler is being designed to burn 100 percent PRB coal as the primary fuel, but will also have the ability to blend up to 50 percent Eastern bituminous coal, as limited by heat input, with the sub-bituminous coal.

Construction on this unit is expected to start in May 2011. Major construction is expected to be complete in June 2015, and initial startup will begin then. Commercial operation is expected to commence in December 2015.

The Air Quality Control System (AQCS) for the ASCPC boiler will consist of combustion controls and post combustion controls. Combustion controls include low NO_x burners (LNBs) and over-fire air (OFA) to minimize nitrogen oxide (NO_x) formation within the boiler. Post-combustion controls include a selective catalytic reduction (SCR) system to further control NO_x emissions, a hydrated lime injection system to control sulfur trioxide (SO₃) and other acid gases (hydrogen chloride, hydrogen fluoride), an activated carbon injection (ACI) system to control



mercury emissions, a fabric filter to remove particulate and solid hazardous air pollutants (HAPs), primarily metals and metal compounds from the flue gases, and a wet flue gas desulfurization (FGD) system using a limestone slurry to remove sulfur dioxide (SO₂) and acid gases.



2.0 REGULATORY BACKGROUND

On February 8, 2008, the United States Circuit Court of Appeals for the District of Columbia (Court) issued an opinion evidencing its intent to vacate the Clean Air Mercury Rule (CAMR) and to overturn the United States Environmental Protection Agency's (USEPA) decision to delist electric generating units as a source category regulated under section 112 of the Clean Air Act (CAA). The court issued its mandate vacating the rule on March 14, 2008. At this time, the exact implications of this decision on electric generating units (EGUs) in the permitting process are not known. One interpretation is that the vacatur results in a requirement for major new sources of HAPs to conduct case-by-case preconstruction reviews under section 112(g)(2) of the CAA and 40 CFR §63.40 et seq. until such time as a MACT standard can be promulgated for EGUs. Regardless of the uncertainty surrounding the issue, Consumers has elected to proactively apply for a case-by-case MACT preconstruction review consistent with section 112(g) of the CAA. In the event that a successful appeal of the vacatur, or other action results in re-instatement of CAMR and the delisting of EGUs from MACT review, Consumers requests that the permit contain language rendering all permit conditions associated with the MACT requirements as not applicable.

Michigan has developed regulations to both implement and supplement the federal requirements. Specifically, MDEQ has promulgated rules and regulations under the Natural Resources and Environmental Protection Act (Act 451 of 1994, As Amended) and section 336 of the Michigan Compiled Law (MCL) for the control of air pollution. Per Rule 299(e), Michigan has adopted, by reference, the regulations implementing section 112(g), codified as 40 CFR §63.40 through §63.44. Michigan has also published Operational Memorandum No. 15, which defines the "procedure for processing permit applications subject to Federal Clean Air Act Section 112(g)."

This case-by-case determination has been prepared in accordance with Michigan Rule 299(e) and Operational Memorandum No. 15. Section 112(g) MACT requirements apply to the proposed ASCPC boiler because the boiler itself is a major source of HAPs.



3.0 APPLICATION REQUIREMENTS

The application requirements for a case-by-case MACT determination under CAA Section 112(g) are provided at 40 CFR 63.43(e). It states: “(1) An application for a MACT determination ... shall specify a control technology selected by the owner or operator that, if properly operated and maintained, will meet the MACT emission limitation or standard as determined according to the principles set forth in paragraph (d) of this section.” In each instance where a constructed or reconstructed major source would require additional control technology or a change in control technology, the application for a MACT determination must contain the following information in Table 3-1. Much of this required information has already been provided with PTI Application No. 341-07 and the remaining is included with this updated application for a MACT determination.



Table 3-1. Application Information

Required Information	Where Found
(i) The name and address (physical location) of the major source to be constructed or reconstructed;	Application
(ii) A brief description of the major source to be constructed or reconstructed and identification of any listed source category or categories in which it is included;	Application
(iii) The expected commencement date for the construction or reconstruction of the major source;	MACT Analysis
(iv) The expected completion date for construction or reconstruction of the major source;	MACT Analysis
(v) the anticipated date of start-up for the constructed or reconstructed major source;	MACT Analysis
(vi) The HAP emitted by the constructed or reconstructed major source, and the estimated emission rate for each such HAP, to the extent this information is needed by the permitting authority to determine MACT;	Application
(vii) Any federally enforceable emission limitations applicable to the constructed or reconstructed major source;	Application
(viii) The maximum and expected utilization of capacity of the constructed or reconstructed major source, and the associated uncontrolled emission rates for that source, to the extent this information is needed by the permitting authority to determine MACT;	Application
(ix) The controlled emissions for the constructed or reconstructed major source in tons/yr at expected and maximum utilization of capacity, to the extent this information is needed by the permitting authority to determine MACT;	Application and MACT Analysis
(x) A recommended emission limitation for the constructed or reconstructed major source consistent with the principles set forth in paragraph (d) of this section;	MACT Analysis
(xi) The selected control technology to meet the recommended MACT emission limitation, including technical information on the design, operation, size, estimated control efficiency of the control technology (and the manufacturer's name, address, telephone number, and relevant specifications and drawings, if requested by the permitting authority);	MACT Analysis
(xii) Supporting documentation including identification of alternative control technologies considered by the applicant to meet the emission limitation, and analysis of cost and non-air quality health environmental impacts or energy requirements for the selected control technology; and	MACT Analysis
(xiii) Any other relevant information required pursuant to subpart A.	MACT Analysis



4.0 HAP EMISSIONS

The proposed ASCPC boiler will be nominally rated at 8,190 MMBtu/hr heat input with a gross output of approximately 930 MW. The emission rates are reflective of maximum operation with coal as the fuel source and consistent with the maximum pollutant emissions across the range of coal fuels proposed for this project. The detailed fuel specifications have been presented in Section 2.2 of PTI application 341-07.

As identified in the permit to install support materials, the proposed ASCPC boiler will emit HAPs listed in section 112(b)(1) of the CAA. In its proposed 2004 National Emission Standard for Hazardous Air Pollutants (NESHAP), the USEPA only established a MACT limit for mercury from coal-fired EGUs. Nevertheless, this MACT analysis will evaluate groupings of non-mercury HAPs in addition to mercury. Pursuant to Michigan Rule 299(e) and Operational Memorandum No. 15, the analysis does not require that each HAP be considered independently but different forms of HAPs (e.g., particulate HAPs, organic HAPs, etc.) are expected to be evaluated separately. EPA has allowed the grouping of HAPs based on how they are characterized and controlled together, along with using surrogates for measuring compliance. As such, the HAPs have been broken down into the following categories: acid gases, mercury compounds, metal compounds, and organic HAPs.

Radionuclide emissions, a listed HAP in section 112(b) of the CAA, have not been included in this analysis because the emissions are considered *de minimus* and an analysis is not required pursuant to section 112(q) of the CAA. Section 112(q) of the Clean Air Act provides:

[T]his section [CAA 112], as in effect prior to the date of enactment of the Clean Air Act Amendments of 1990, shall remain in effect for radionuclide emissions from . . . coal-fired utility and industrial boilers . . . unless the Administrator, in the Administrator's discretion, applies the requirements of this section as modified by the Clean Air Act Amendments of 1990 to such sources of radionuclides.



A MACT analysis was not required until the 1990 amendments to the CAA. Since the CAA 112(q) savings provision states that pre-1990 CAA 112 requirements remain in effect for radionuclide emissions from coal-fired utilities, no MACT analysis is required for radionuclide emissions from Consumers' proposed ASCPC boiler.

Additionally, recent EPA studies have found that the health risks due to exposure to radionuclide emissions from coal fired boilers are minimal when compared to the natural background radiation. Specifically, USEPA's report, *Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units - Final Report to Congress*, Volume 1, Executive Summary at ES-22 to ES-23 (February 24, 1998), states that the average exposure to natural background radiation (excluding radon) for the U.S. population has been estimated to be about 67 times higher than the highest exposure due to radionuclide emissions from utilities. Radionuclides are emitted primarily as particulate; therefore control measures for particulate and metal compounds can also be used to reduce radionuclide emissions.

The potential HAP emission factors for coal (Western sub-bituminous and Eastern bituminous coals) are based on Consumers coal data, United States Geological Survey COALQUAL database, and the Compilation of Air Pollutant Emissions Factors, USEPA Document No. AP-42, Fifth Edition, September 1998 in the absence of vendor information. The emissions represent normal operating conditions and do not include startups or shutdowns. All annual calculations are based on continuous operation for 8,760 hours per year at base load (100 percent load) conditions. The potential emissions of HAPs from the ASCPC are summarized in Table 4-1 below.



Table 4-1. Potential HAP emissions from the ASCPC Boiler

Compound	Western Sub-Bituminous Coal		50/50 Blend ²		Maximum Emission Rates	
	Emission Rates		Emission Rates		Emission Rates	
	(lb/hr)	(tpy)	(lb/hr)	(tpy)	(lb/hr)	(tpy)
Acid Gases ¹						
HCl	7.1	7.6	18.8	25.7	18.8	25.7
HF	1.3	4.8	1.2	4.2	1.3	4.8
Mercury Compounds						
Mercury	5.7E-03	2.5E-02	7.3E-03	3.22E-02	7.3E-03	3.22E-02
Metal Compounds						
Antimony	8.88E-03	3.89E-02	7.44E-03	3.26E-02	8.88E-03	3.89E-02
Arsenic	2.02E-01	8.86E-01	1.69E-01	7.42E-01	2.02E-01	8.86E-01
Beryllium	1.04E-02	4.54E-02	8.68E-03	3.80E-02	1.04E-02	4.54E-02
Cadmium	2.52E-02	1.10E-01	2.11E-02	9.23E-02	2.52E-02	1.10E-01
Chromium, total	1.28E-01	5.62E-01	1.07E-01	4.70E-01	1.28E-01	5.62E-01
Chromium, hexavalent	3.90E-02	1.71E-01	3.26E-02	1.43E-01	3.90E-02	1.71E-01
Cobalt	4.93E-02	2.16E-01	4.13E-02	1.81E-01	4.93E-02	2.16E-01
Lead	3.50E-02	0.15	6.54E-02	0.29	6.54E-02	0.29
Manganese	2.42E-01	1.06	2.02E-01	8.87E-01	2.42E-01	1.06
Nickel	1.38E-01	6.05E-01	1.16E-01	5.07E-01	1.38E-01	6.05E-01
Selenium	6.41E-01	2.81	5.37E-01	2.35	6.41E-01	2.81
Organic HAP Compounds						
Organic HAPs	4.4	19.2	3.7	16.0	4.4	19.2
Total HAP Emission Rates	14.3	38.3	25.0	51.7	26.1	56.5

¹ This table has been updated with revised HCl emission estimates based on USGS COALQUAL fuel analysis, rather than the AP-42 emission factor used in the original application. HF and HCl lb/hr values based on 99th percentile values while tpy values based on 95 percent upper confidence level on the mean (UCL). Assumed control efficiency of 98.37%

² The coal blend is based on 50 percent Western sub-bituminous and 50 percent Eastern bituminous coals, based on heat input, as described in the permit application support document.



5.0 CASE-BY-CASE MACT ANALYSIS METHODOLOGY

MACT is a case-by-case analysis for categories of major sources of HAP emissions where EPA has not promulgated emission standards. It is meant as a means to predict what EPA would determine is MACT in rulemaking for each source category.

Maximum Achievable Control Technology is defined in §63.41 as:

the emission limitation which is not less stringent than the emission limitation achieved in practice by the best controlled similar source, and which reflects the maximum degree of reduction in emissions that the permitting authority, taking into consideration the cost of achieving such emission reduction, and any non-air quality health and environmental impacts and energy requirements, determines is achievable by the constructed or reconstructed major source. (emphasis added)

The principles of case-by case MACT determinations have been codified in 40 CFR 63.43(d):

(d) Principles of MACT determinations.

The following general principles shall govern preparation by the owner or operator of each permit application or other application requiring a case-by-case MACT determination concerning construction or reconstruction of a major source, and all subsequent review of and actions taken concerning such an application by the permitting authority:

(1) The MACT emission limitation or MACT requirements recommended by the applicant and approved by the permitting authority shall not be less stringent than the emission control which is achieved in practice by the best controlled similar source, as determined by the permitting authority.

(2) Based upon available information, as defined in this subpart, the MACT emission limitation and control technology (including any requirements under paragraph (d)(3) of this section) recommended by the applicant and approved by the permitting authority shall achieve the maximum degree of reduction in emissions of HAP which can be achieved by utilizing those control technologies that can be identified from the available information, taking into consideration the costs of achieving such emission reduction and any non-air quality health and environmental impacts and energy requirements associated with the emission reduction.

(3) The applicant may recommend a specific design, equipment, work practice, or operational standard, or a combination thereof, and the permitting authority may approve such a standard if the permitting authority specifically determines that it is not feasible to



prescribe or enforce an emission limitation under the criteria set forth in section 112(h)(2) of the Act.

(4) If the Administrator has either proposed a relevant emission standard pursuant to section 112(d) or section 112(h) of the Act or adopted a presumptive MACT determination for the source category which includes the constructed or reconstructed major source, then the MACT requirements applied to the constructed or reconstructed major source shall have considered those MACT emission limitations and requirements of the proposed standard or presumptive MACT determination.

The methodology requested by MDEQ, and described in Op. Memo No. 15, establishes a three-step analysis in determining MACT. Step 1 of the MACT analysis is to describe the proposed control technology and air quality control system, and the emission reductions that can be achieved by each. Step 2 of the MACT analysis is to identify the emission limit achieved in practice by the best controlled similar source. This is often referred to as the “MACT floor”. While the term “MACT floor” is specifically defined in §63.51 for sources subject to 112(j) of the CAA, it is used here to describe the compilation of the best controlled similar sources. Step 3 of the MACT analysis requires the applicant to look at the maximum reduction in HAPs using any technology, not just that representing the MACT floor. This entails determining the maximum reduction in HAP emissions that the specific source, on a case-by-case basis, can achieve taking into consideration cost, and non-air quality health and environmental impacts and energy requirements. Step 3 is referred to as “beyond-the-floor” MACT analysis.

5.1 DESCRIPTION OF THE AIR QUALITY CONTROL SYSTEM

As requested by MDEQ, the assessment provides for each pollutant considered in the MACT analysis, a description of the air emission control system equipment, how the equipment reduces air emissions (i.e., the physics and/or chemistry of emission reductions) and the expected level of performance for the equipment or system.

5.2 IDENTIFYING THE MACT FLOOR

Pursuant to 40 CFR 63.43(d), an applicant is required to review all “available information” in determining the emission limit achieved in practice by the best controlled similar source.



Available information is defined in §63.41 as:

for purposes of identifying control technology options for the affected source, information contained in the following information sources as of the date of approval of the MACT determination by the permitting authority:

- (1) A relevant proposed regulation, including all supporting information;*
- (2) Background information documents for a draft or proposed regulation;*
- (3) Data and information available for the Control Technology Center developed pursuant to section 113 of the Act;*
- (4) Data and information contained in the Aerometric Informational Retrieval System including information in the MACT data base;*
- (5) Any additional information that can be expeditiously provided by the Administrator; and*
- (6) For the purpose of determinations by the permitting authority, any additional information provided by the applicant or others, and any additional information considered available by the permitting authority.*

40 CFR 63.43(d) (4), as well as the definition of “available information” described above, require that the emission limitations and requirements of a proposed standard or presumptive MACT determination for a source category be considered in a MACT determination. Therefore, it is appropriate to consider background and supporting information for the proposed and vacated regulations regarding coal-fired EGUs when establishing the MACT floor (e.g., CAMR, 40 CFR Part 63, Subpart UUUUU).

5.2.1 Determination of Similar Source

For a coal-fired EGU similar to the proposed ASCPC boiler, it is important to recognize that not all EGUs will qualify as a similar source. EPA defined “similar source” at 40 CFR 63.41as:

*“a stationary source or process that has **comparable emissions** and is **structurally similar in design and capacity** to a constructed or reconstructed major source such that the source could be **controlled using the same control technology**.” (emphasis added)*



Based on this definition, when proposing the mercury NESHAP for EGUs, USEPA proposed subcategories based on the fuel used, as well as distinct combustion technologies. Specifically, EPA subcategorized coal-fired EGUs based on the rank of coal fired (e.g., bituminous, sub-bituminous, etc.) and identified IGCC units separately (69 FR 4652, 4662-63, Jan. 30, 2004). For units that fire multiple fuels (e.g., bituminous coal and sub-bituminous coal), EPA proposed a blended standard based on a weighted average of the amount of each fuel fired (69 FR 4674-75, Jan. 30, 2004). For example, an EGU burning 80 percent bituminous coal and 20 percent sub-bituminous coal would be subject to a different standard than a unit burning 50 percent bituminous coal and 50 percent sub-bituminous coal even though both units may be using the same control technologies. Thus, in determining what a best controlled similar source is for a proposed coal-fired EGU for which a case-by-case MACT is being performed, the most important parameter is the fuel that will be fired.

Regarding the proper role of sub-categorization in determining what is a similar source, the Clean Air Act also provides, and legislative history makes clear, that a MACT determination should be closely tailored to the particular type of source. *See* CAA § 112(d)(1); S. Rep. No. 228, 101st Cong., 1st Sess. 166. Thus, the state is authorized by the Act to develop **appropriate categories and subcategories** for sources and to distinguish among types and sizes of sources within a category or subcategory when these differences affect the feasibility of air pollution control technology, the effectiveness of the technology and the cost of control. *Id.*; *see also, NRDC v. EPA*, 489 F.3d 1364, 1372 (D.C. Cir. 2007); H.R. Rep. 101-490 at 328.

In its proposed MACT rule for EGUs, EPA sub-categorized standards according to coal rank and unit design type. Since that time, court decisions reviewing EPA's promulgation of MACT standards for other industries have made it clear that subcategories need finer division if they are to account for differences among unit design and raw material quality. Without sufficient subcategorization, the MACT definition might be internally inconsistent because it might require a limit that is "achieved in practice by the best controlled source" but, due to site specific factors, that limit might not be achievable (taking into account cost, energy requirements or environmental impacts as required by statute) for a source.



This issue of appropriate subcategorization has been addressed in a case involving the MACT standard for the brick and structural ceramic manufacturing industry in which one of the issues was whether or not EPA could distinguish performance levels based on raw material quality; i.e. use of “clean clay.” *Sierra Club v. EPA*, 479 F3d 875, 881 (D.C. Cir. 2007). EPA found that such manufacturing plants were located near suitable local clay deposits, transportation of clean clays was prohibitively expensive and a given process could not use different raw materials without altering product characteristics. *Id* at 883. Although it acknowledged that clay quality affected emissions, EPA contended it did not have sufficient data to quantify those effects and floors based on clean clay would be unachievable because of the inability of kilns to switch clays. *Id*. The court held that it was impermissible for EPA to consider only control technology and ignore such non-control technology factors as clay quality. In addressing this potential internal conflict between limits “demonstrated in practice” and limits that are “achievable” and the possibility that it might require “judicial surgery” a D.C. Circuit Court judge provided helpful guidance by recognizing EPA’s broad authority to make reasonable subcategorizations in setting MACT limits:

Happily § 112 is not such a statute. Section 112(d) authorizes the Administrator to “distinguish among classes, types and sizes of sources within a category or subcategory,” and the language of subsections 112(d) (2) and (3) persuasively refers to standards for sources in each “*category or subcategory*.” The authority to generate subcategories is obviously not unqualified: at least it must be limited by the usual ideas of reasonableness. And there is not necessarily any guarantee that, even with suitable subcategorization, every source will be able to achieve standards that meet a lawful application of § 112(d)(3) to reasonably defined subcategories. Nonetheless, one legitimate basis for creating new subcategories must be the interest in keeping the relation between “achieved” and “achievable” in accord with common sense and the reasonable meaning of the statute.

Id. at 885 (Williams, Senior Judge, concurring)



In addition to CAA § 112(d)(2) and (3) authority to subcategorize sources in setting MACT standards, CAA § 112(g) expressly requires a **case-by-case** MACT determination; therefore, the MACT-like analysis for the ASCPC boiler should draw further distinctions in making comparisons to other units to account for site-specific factors without setting precedent for further MACT-related deliberations. Thus, MDEQ has latitude to set a reasonable MACT-like standard for the ASCPC boiler that takes into account the coal quality and operational variability expected at the unit.

The design and size of the unit can also be a factor in determining whether the source is similar (*Sierra Club v. EPA*, 479 F3d. 885). For example, a small CFB unit (less than 100 MW) using bituminous coal may be able to comply with stringent mercury emission limits, such as the AES Thames units in Connecticut, without the use of activated carbon injection. This means that small CFB units are not similar to large PC units like the ASCPC unit proposed by Consumers.

The ASCPC boiler is a 930 MW (gross) fossil fuel-fired boiler that will burn sub-bituminous coal from the Powder River Basin and will have the capability to blend up to 50 percent low-sulfur Eastern bituminous coal. The boiler technology is advanced supercritical. According to the mercury NESHAP, EPA subcategorized coal-fired EGUs based on the rank of coal fired (e.g., bituminous, sub-bituminous, etc.) and identified IGCC units separately. Therefore, similar sources for this MACT analysis are defined as large supercritical boilers that burn primarily sub-bituminous coal and have the capability to blend up to 50 percent low-sulfur Eastern bituminous coal. While circulating fluid bed (CFB) boilers might be similar to the ASCPC for some pollutants when burning bituminous coal, there is little experience or data for CFB's operating on sub-bituminous coal. In some cases (e.g., acid gases), the inherent design and operation of a CFB would make it a dissimilar source.

5.2.2 Achieved In Practice

The determination of best controlled similar source is limited to emission limits that have been achieved in practice, which of necessity means existing and operating units, and not units that may operate in the future. As proposed, the ASCPC will fire 100 percent PRB coal, or a blend of low sulfur bituminous coal, and PRB (sub-bituminous) coals. Therefore, similar sources to be



considered and compared to the proposed ASCPC are multi-fuel pulverized coal (PC) boilers. However, just because an EGU is a PC unit burning bituminous coal and sub-bituminous coal that does not automatically mean that it is a similar source to the ASCPC. As discussed above, the blend of fuels is critically important in determining what is similar. Emissions of HAPs (such as metals and acid gases) are directly related to the amount of the pollutant (or precursor) in the fuel, which varies even within the same fuel type. Coal properties affecting emissions (mercury, fluoride and chlorine contents) vary from each mine and even from each seam. Short-term stack test results do not adequately account for that variability in fuel type, much less with different blends.

Achieved in practice means a limit that is able to be met continuously under reasonably foreseeable worst-case conditions (*Sierra Club v. EPA*, 167 F.3d 658, 665, D.C. Cir. 1999). It does not mean the lowest HAP emission rate ever measured from a similar source, which primarily, if not exclusively, are determined by short-term stack tests conducted under normal operations. To establish a limit based on the lowest emission rate ever measured would guarantee that limit would be violated, even by the source upon which it is based. *See id.* (“It is reasonable to suppose that if an emissions standard is as stringent as ‘the emissions control that is achieved in practice’ by a particular unit, then that particular unit will not violate the standard. This only results if ‘achieved in practice’ is interpreted to mean ‘achieved under the worst foreseeable circumstances.’”) Thus, to ensure the MACT limits are continuously achievable, it is appropriate to include a margin of safety in the limit to ensure that reasonably foreseeable worst-case circumstances are covered, particularly when based on limited data. *See id.*; *see also* 69 Fed. Reg. at 4678 (describing approach EPA used in developing proposed MACT limits for new EGUs to address uncertainty and variability in emission test results).

The method of measurement of the emissions is also an important factor when it comes to the determination of variability and achievability. This is especially important when evaluating mercury emissions. In evaluating the emission rates that have been achieved by similar sources, it is important to compare units with similar methods of measurement.



5.3 BEYOND THE MACT FLOOR

Having identified the MACT floor, the next step is referred to as “beyond the floor” (BTF) analysis. The BTF analysis involves a review of whether or not it is appropriate to set an emission limit at a level more stringent than the MACT floor. BTF determines the maximum reduction that can be achieved using available technology and taking into consideration economic cost, non air quality related health and environmental impacts and energy requirements (40 CFR 63.43(d)(2)).

The permit application for the ASCPC boiler contains limits consistent with the state and federal Prevention of Significant Deterioration (PSD) Best Available Control Technology (BACT), New Source Performance Standards (NSPS), and Michigan’s BACT for toxic air contaminants (T-BACT). However, a case-by-case MACT review requires that the proposed control technology be re-evaluated to determine whether the proposed PSD BACT limits also satisfy the MACT standard. In some cases, the limits on criteria emissions such as PM or CO, will serve as the surrogate limit for HAPs. For example, a stringent limit on CO emissions requires good combustion practices, which is also needed to minimize emissions of individual organic HAPs. It is also noted that some control technologies are effective in removing multiple pollutants; for example, hydrated lime injection, as a co-benefit to controlling SO₃, controls acid gases such as hydrogen chloride and hydrogen fluoride.

A review of the USEPA’s RACT/BACT/LAER Clearinghouse (RBLC) for existing pulverized coal (PC) units using a similar fuel blend to the ASCPC boiler shows that the best controlled operating PC units use low NO_x burners and good combustion practices with post-combustion control consisting of SCR, hydrated lime injection, fabric filters and wet FGD, to control emissions. It is important to note that the list of PC units from the RBLC contains only supercritical and subcritical units as compared to the advanced supercritical design of the proposed Consumers boiler. While an emission rate or reduction may not be directly transferable to the ASCPC unit because such units may not be a similar source, the control technology used by those best controlled PCs is transferable. Consumers has proposed the same control technologies, as well as additional technology (activated carbon injection) to control both HAPs and regulated New Source Review (NSR) pollutants (e.g., PM, SO₂ and NO_x).



6.0 CASE-BY-CASE MACT ANALYSIS

The ASCPC air quality control system includes SCR, hydrated lime, PAC injection, fabric filter, and wet flue gas desulfurization (FGD) system. Selective catalytic reduction is specifically designed to reduce emissions of NO_x from the flue gas by reacting it with ammonia in the presence of a catalyst to produce nitrogen and water. Typical control efficiencies for a SCR are typically near 90 percent. Hydrated lime injection is being installed as a trimming technique to reduce SO_3 in the flue gas stream. This system will only be used when the concentration of SO_3 exceeds certain levels to help minimize the formation of acid gases, especially H_2SO_4 . The wet FGD system, specifically limestone forced oxidation (LSFO), is designed to control emissions SO_2 by reacting it with calcium carbonate to produce either calcium sulfate or calcium sulfite. Reductions of SO_2 in the flue gas of 95 percent to 98 percent can be expected from this type of system. A fabric filter is specifically designed to capture solid particles (ash, metals and carbonaceous materials) on specially designed bags. As the flue gas passes through these bags, solid particulate matter is captured from the gas stream. Such capture devices are designed to achieve very high removal efficiencies and are on the order of 99.9 percent. The only system specifically designed to control Hg emissions is the PAC system. In these systems, powdered activated carbon is injected into the flue gas upstream of the fabric filter baghouse. Since activated carbon is very porous, the pores allow vapor-phase mercury to adsorb to the carbon, which is then collected by the fabric filters.

The case-by-case MACT analysis for the ASCPC unit for each HAP category is described below.

6.1 MERCURY COMPOUNDS

Mercury is a naturally occurring constituent of coal. Thus, emissions of mercury leaving the boiler are primarily dependent upon the mercury content of the fuel. Factors that affect the potential emissions of mercury as measured in the flue stack include the chlorine content of the coal, unburned carbon, or loss on ignition (LOI) within the boiler, type of boiler/burner design, boiler operating conditions and the removal efficiency of the add-on control technology.



6.1.1 ASCPC Mercury Emission Control System

As indicated above, the ASCPC air quality control system includes an SCR, hydrated lime, PAC injection, fabric filter, and wet FGD system. It is acknowledged that, even without the PAC, the system would be effective at removing mercury resulting from the combustion of bituminous coal. The SCR system will be effective at converting some of the elemental mercury to the divalent or oxidized form, which is more easily captured in the fabric filter and the wet FGD. The fabric filter is highly effective at removing particle-bound mercury, and some of the elemental mercury will be removed by the passage of the exhaust gas through the filter cake that lines the fabric filter. Although oxidized mercury is water soluble, and wet FGD systems can also be highly effective at removing it from the exhaust gas stream, the ASCPC wet FGD is downstream of the fabric filter. By adding PAC to the control train, the mercury control will essentially take place upstream of the wet FGD. The mercury that makes it to the inlet of the wet FGD is likely to be primarily elemental, and wet FGD systems are not effective at removing gaseous phase mercury. The current vendor guarantees for this type of system (SCR, hydrated lime, PAC, FF, WFGD) are limited to 90 percent removal or a Hg emission floor of 0.9 lb/TBtu.

6.1.2 Mercury MACT Floor Analysis

According to §63.43(d) this MACT determination must consider any proposed §112(d) MACT standard. In proposing MACT standards (69 Federal Register 4652, January 30, 2004), USEPA made several determinations relevant to this MACT analysis. They include:

- The performance of the best performing units was dependent on mercury and chlorine content of the coal, which vary considerably with coal rank. Specifically, bituminous coals have higher chlorine content than sub-bituminous coals. The higher chlorine content results in more conversion of the elemental mercury that exists in the high temperature boiler region to oxidized mercury, which is more amenable to collection. This resulted in the sub-categorization of coal into bituminous, sub-bituminous and lignite fuels.
- To encourage fuel efficiency, the limits were proposed on a mass per energy output basis. (69 Federal register 4652, page 4667, January 30, 2004).



- The type of firing equipment (pulverized, stoker, cyclone or fluidized bed) for bituminous coal did not greatly affect the mass rate of emissions or the emission characteristics. The same claim was not made for sub-bituminous coals.
- The proposed MACT standard for new bituminous coal-fired units was 6.0 pounds of mercury per trillion watt hours (terawatt-hour). The proposed standard for new sub-bituminous coal-fired units was 20.0 pounds of mercury per terawatt-hour. This was based on best performing units, taking into account fuel and performance variability.
- The final CAMR standards (40 CFR 60.45Da(a)(1)) for new bituminous coal-fired units was 20 pounds of mercury per terawatt-hour; and for new sub-bituminous coal-fired units in areas receiving more than 25 inches rain per year was 66 pounds of mercury per terawatt-hour. Units burning a blend of bituminous and sub-bituminous coal would have an emission limit that was based on a weighted average of these two limits.

In addition to the information sources listed in Section 5.2, there are three additional sources of information for this analysis. The first is from the National Association of Clean Air Agencies (NAACA), which published a summary in December 2007 of actions taken by the states to control mercury emission from coal-fired electric generating units (EGUs).¹ The second is from the USEPA, which published an update to the list of the national coal projects on April 29, 2008.² The third source is the May 31, 2006 Memorandum from William H. Maxwell, Energy Strategies Group, Office of Air Quality Planning and Standards, U.S. EPA concerning the “Revised new source performance standard (NSPS) statistical analysis for mercury emissions.”³

The NAACA list shows that, currently, there are effective emission limitations in three states, which provide the opportunity to have units that have demonstrated compliance, and thus be considered for the MACT floor. These three state requirements are shown below in Table 6-1.



Table 6-1. State Mercury Emission Limitations for Coal-fired EGUs

State	Requirement	Limit Lb/GWh ¹	Reduction Required
Connecticut	State statute requires 90 percent reduction or to comply with mercury emissions limit of 0.6 lb/TBtu by 7/1/2008, with provision for alternative if controls fail to achieve limitation. More stringent limits possible after 7/1/2012. Alternate limit allowed for units unable to meet standard	0.006	90 percent
Massachusetts	Adopted rule requires 85 percent capture or 0.0075 lb/GWh by 1/1/2008 and 95 percent capture or 0.0025 lb/GWh by 10/1/2012. Averaging between units at the same facility is allowed.	0.0075	85 percent
New Jersey	Adopted rule requires control efficiency of 90 percent or 3 mg/MW-hr by 12/15/2007, for coal-fired boilers of any size. A multi-pollutant approach can reduce the initial reduction required and extend compliance to 12/15/2012.	0.0066	90 percent

¹ Assumes 10MMBtu/MW-hr conversion factor

6.1.2.1 Bituminous Coal-fired Facilities

The operating facilities that have emission limits from state permits, state rules or state law that are considered for setting the MACT floor for bituminous coals are listed in Table 6-2.

Table 6-2. Operating Units Considered for MACT Floor Analysis for Mercury - Bituminous Coal

State	Unit	Largest Unit Size (MW)	Equivalent Mercury Limit (lb/GWh)
New Jersey	B.L. England	176	0.0066
Massachusetts	Brayton Point	630	0.0075
South Carolina	Santee Cooper Cross 3	640	0.036

The lowest limit listed in the table is the B.L. England Generating Station in New Jersey, which has 2 coal-fired boilers with a wet FGD to remove SO₂ from the West Virginia coal and tire fuel



that is used. New Jersey Department of Environmental Protection stated in a conversation with NTH on July 14, 2008 that "... these units have achieved compliance on its initial test, but that 4 quarters of documented compliance is required." Other Plants, including the PSEG Mercer and Hudson Stations have not yet tested, and have extended compliance dates. For the purpose of this MACT demonstration, while Consumers accepts that the emission limit of **0.0066 lb/GWh** for the B.L. England Generating Station may set the MACT floor for bituminous fired facilities, Consumers has reservations regarding the size of this unit with respect to the ASCPC. The B.L. England Generating Station is only 176MW in size compared to 930MW for the proposed ASCPC and even EPA has acknowledged (and the court has concurred) that the size of the unit does have an effect on the performance of mercury removal systems.

Not included in the MACT floor analysis for bituminous coal is the AES Thames plant in Connecticut, which is subject to a limit of 0.6 pounds per trillion Btu (lb/TBtu), or 90 percent reduction, which became effective on July 1, 2008. According to the Connecticut Clean Air Mercury Rule State Plan dated October 29, 2007, the AES Thames Units 1 & 2 complies with this emission limit, as verified by stack testing. According to that plan, "AES Thames, LLC operates a cogeneration facility located in the Uncasville, Connecticut. The facility produces electricity, which it sells to the grid, and steam, which it sells to a neighboring paper plant. The two units are identical Combustion Engineering circulating fluidized bed boilers, each with maximum heat input of 923 MMBtu/hr. Together the two units can generate 181 MW of electricity. Dry limestone injection followed by fabric filtration controls sulfur emissions. The boilers are primarily fired with bituminous coal. Distillate oil is used during startup, shutdown and operational stabilization. The boilers are designed to operate continuously." These units do not use activated carbon for additional control. These 90 MW CFB boilers using bituminous coal are not "similar" to the proposed 930 MW gross ASCPC unit due to size, steam cycle parameters, fuel and firing configuration , and therefore are not considered for determining the MACT floor.

6.1.2.2 Sub-bituminous Coal-fired Facilities

There are no sub-bituminous coal-fired EGUs that have been demonstrated to be in compliance with the requirements of Connecticut, Massachusetts or New Jersey mercury rules. Therefore all of the units to be considered for setting the MACT floor are operating units with state permit



mercury limits. The units with lowest emission limits that have demonstrated compliance are shown in Table 6-3.

Table 6-3. Operating Units Considered for MACT Floor Analysis for Mercury – Sub-bituminous Coal

State	Unit	Size (MW)	Equivalent Mercury Limit (lb/GWh)
Connecticut	Bridgeport Harbor ¹	410	0.0060
Iowa	MidAmerican Energy Walter Scott Jr. 4 ²	870	None
Arizona	Springerville 3	400	0.068

¹ Operating, but not yet tested for compliance

² Operating, but §112(g) emission limit of 0.015 lb/GWh was removed from permit in May 2007

The PSEG Power plant at Bridgeport Harbor has 3 coal-fired boilers, permitted under Title V Permit No. 015-0217-TV. Unit 3 is a 410 MW coal-fired boiler that has installed a fabric filter control system and activated carbon injection for mercury control for compliance with the state imposed limit. This plant uses Adaro sub-bituminous coal from Indonesia. This coal typically has very low mercury content (3-4 lb/TBtu) compared to the PRB coal specified for the ASCPC unit (maximum of 13.2 lb/TBtu; average 7 lb/TBtu) and a relatively high heating value (9,600 Btu/lb) compared to the ASCPC design coal of 8,300 Btu/lb. Therefore this fuel would constitute another sub-category of fuels for the purpose of this MACT analysis. Additionally, according to the Connecticut Department of Environmental Protection, as of July 11, 2009, the facility had completed installation but had not yet submitted the protocol for the compliance test. Thus it is several months before the data will be available that would allow this unit to be considered for the MACT floor. While NTH has been informed that preliminary vendor test data from the plant indicates that compliance has been achieved, this does not represent compliance data and hence is not available to the public for use in evaluating the MACT floor, including the variability analysis because of the difference in critical fuel parameters.

The next most stringent mercury emission limit for an operating EGU using sub-bituminous coal was the Walter Scott Jr. Energy Center Unit 4, operated by Mid American Energy Company and



located in Council Bluffs, Iowa. An emission limit of 1.7×10^{-6} lb/MMBtu was set by a §112(g) determination in 2003 in Permit No. 03-A-425P. The emission limit was based on a design capacity of 7,675 MMBtu/hr, 870 megawatts (gross) and a gross heat rate of approximately 8,820 MMBtu/KWh and is equivalent to 0.015 pounds per GWh (lb/GWh), when expressed on a gross output basis. While data from emission tests conducted in May and August 2007 confirm compliance with this limit, the limit was rescinded in May 2005 under Permit No. 03-A-425P2. Since construction of this unit commenced prior to January 30, 2004 it is not subject to the mercury (Hg) standards of Subpart Da, therefore no Hg limit currently applies. This was confirmed by the Iowa Department of Natural Resources on July 11, 2008. Therefore this unit cannot be considered for establishing the MACT Floor for sub-bituminous coal.

Springerville Unit 3 in Arizona is the only unit listed in Table 6-3 that can be considered in the MACT floor analysis because it is contained in a permit, and since the unit started operation in 2006, it is assumed to have demonstrated compliance. The permit limit is 6.9 lb/TBtu, equivalent to 0.068 lb/ GWh.

Since the Springerville 3 mercury emission limit exceeds the limit of 20 pounds per terawatt for new sub-bituminous coal fired units proposed by USEPA on January 30, 2004 at 40 CFR §63 Subpart UUUUU, and USEPA had determined that this was an achievable level for new facilities it is appropriate to set the MACT floor for sub-bituminous coals at **0.020 lb/GWh**.

6.1.2.3 Burning of Blended Bituminous and Sub-bituminous Coals

Some research has shown that chlorine concentrations in the fuel in the 300-500 ppmw range, depending on calcium and other coal constituents, are sufficient to promote oxidation of the mercury. The PRB sub-bituminous coal considered for the ASCPC unit is expected to have a chlorine concentration of between approximately 10 ppm and 200 ppm (0.001 lb/MMBtu to 0.025 lb/MMBtu). The Eastern bituminous coal is expected to have a mean concentration of approximately 1,100 ppmw (95 percent of the time at or above 800 ppmw). There are substantial variations in each type of coal. This means that the chlorine content of the sub-bituminous coal will not be high enough to promote as much oxidation of the mercury as would bituminous coal, or even a coal blend that is primarily bituminous.



Duke Energy has taken the position in their recent §112(g) analysis for the Cliffside Station that the blending up to 50 percent sub-bituminous coal into their principal bituminous coal will not affect the mercury oxidation from that which would be achieved by burning only bituminous coal. The ASCPC unit is fundamentally different than the proposed Cliffside unit in that the ASCPC unit will be principally a PRB fired unit with the ability to fire up to a 50 percent blend of bituminous coal. Determining the level of chlorine in the coal being burned needed to achieve compliance with the proposed mercury emission limit can only be determined by an optimization study.

It is also noted that the only Department of Energy/National Energy Technology Laboratory (DOE/NETL) study on a facility that was using a highly blended fuel was the DTE St. Clair Unit 4, which was burning a 60/40 blend of sub-bituminous/bituminous blend. The native control for the SCR/ESP system was a reported 25 percent, and control with injection of DARCO® Hg (an untreated, powdered activated carbon (PAC) developed by NORIT Americas, Inc.), increased the overall control to 78 percent. There are no reported studies found for blended fuel facilities using halogenated PAC.

6.1.2.4 Summary of the Mercury MACT Floor Analysis

The MACT floors for bituminous and sub-bituminous coals have been identified above as 0.0066 pound per GWh for bituminous coal and 0.020 pound per GWh for sub-bituminous coal. Since the ASCPC unit is being designed to burn a blend of these fuels, the MACT floor would be a weighted ratio of these floors based on the amount of each fuel used. In other words, the lowest MACT floor would be for the 50/50 blend of bituminous and sub-bituminous coals proposed by Consumers, which would be $(0.0066 + 0.020)/2 = \mathbf{0.0133 \text{ lb/GWh}}$.

6.1.3 *Mercury MACT Beyond the Floor Analysis*

The final step in the MACT setting process is to perform a BTF analysis for the ASCPC unit. The purpose of this portion of the analysis is to determine whether Consumers can reduce the mercury emissions from the proposed ASCPC unit to levels that are more stringent than the MACT Floor levels, taking into consideration the cost of achieving such emission reductions, and any non-air quality health and environmental impacts and energy requirements.



In the permit application submitted on October 15, 2007 Consumers determined its estimated emissions of mercury based on the “worst-case” of blended fuel, i.e., the highest Hg input which would result from a 50/50 blend of bituminous and sub-bituminous coals. As presented in Section 3.1.10, USEPA’s ProUCL software was employed to perform a statistical analysis on the analytical data from the years 2001-2005 with the 95 percent UCL values from the worst-case year chosen for calculating the annual emissions (tpy). Mercury data were available on a part per million by weight basis along with the Btu value of each shipment of coal to existing Consumers plants. Therefore, the mercury concentrations were converted to a lb/MMBtu value for each shipment of coal before performing the statistical analysis. The results of the statistical analysis are presented in Table 3-9 of the application and are also presented in Table 6-4 below, but expressed in pounds per trillion Btu (lb/TBtu) with the bolded values representing the maximum values for each coal type.

Table 6-4. ProUCL Results for Mercury

Year	Western sub-bituminous (lb/TBtu)	Eastern bituminous (lb/TBtu)
	95% UCL	95% UCL
2005	6.96	4.93
2004	5.32	8.73
2003	5.36	11.0
2002	5.52	10.2
2001	5.86	8.75



The uncontrolled emission rate was conservatively estimated assuming the facility operated the boiler at maximum rated capacity and at a 50/50 Western sub-bituminous /Eastern bituminous coal blend (based on heat input) on a continuous basis (i.e., 8,760 hr/yr).

$$\text{Uncontrolled Hg Emissions} = \frac{6.96 \text{ lb}}{\text{TBtu}} \times 50\% + \frac{11 \text{ lb}}{\text{TBtu}} \times 50\% = \frac{8.98 \text{ lb}}{\text{TBtu}}$$

$$\begin{aligned} \text{Uncontrolled Hg Emissions} &= \frac{8.98 \text{ lb}}{\text{TBtu}} \times \frac{1 \text{ TBtu}}{1,000,000 \text{ MMBtu}} \times \frac{8190 \text{ MMBtu} / \text{hr}}{930 \text{ MW}_{\text{gross}}} \times \frac{1000 \text{ MW}}{\text{GW}} \\ &= \frac{0.079 \text{ lb}}{\text{GWh}_{\text{gross}}} \end{aligned}$$

While the above analysis reflects the “worst-case” from actual shipments of coal to Consumers during the time period 2001-2005, it does not reflect “worse case” for the type of fuel to be burned. Rather, the design coal for the ASCPC is a subset of the bituminous and sub-bituminous coals available in the United States. For example, coal quality could have alternatively been ascertained from the United States Geological Survey (USGS) COALQUAL data base. A review of that database indicates that the 95 percent UCL for mercury in all reported PRB coal is approximately 15 lb/TBtu as shown in Table 6-5. This is more than twice what Consumers used for their PRB coal.

Table 6-5. ProUCL Results of COALQUAL Data for PRB Coal

Parameter	Sub-bituminous BTU/ lb	Sub-bituminous Hg (Lb/ T Btu)	Sub-bituminous Cl (Lb/ MM Btu)
Number of Samples	489	489	237
Minimum	4454	0.299	0.00642
Maximum	10898	127.8	0.146
Mean	8088	12.67	0.0118
Median	8052	10.17	0.00897
Standard Deviation	1006	11.72	0.0105
95% UCL	8164	14.98	0.013



Table 6-6. ProUCL Results of COALQUAL Data for Eastern Bituminous Coal

Parameter	Bituminous BTU/ lb	Bituminous Hg (Lb/ T Btu)	Bituminous Cl (Lb/ MM Btu)
Number of Samples	3582	3579	2433
Minimum	6390	0.201	0.00242
Maximum	15247	221.2	0.644
Mean	12576	14.62	0.0684
Median	12715	10.6	0.0601
Standard Deviation	1281	15	0.0522
95% UCL	12611	15.72	0.073

In considering what can be achieved beyond the MACT floor, permitted but not yet demonstrated units are considered, as well as relevant Hg emission test results.

6.1.3.1 Permit Limits

The most stringent limits for permitted units are listed in Table 6-7. None of the state permitted units using bituminous coal are as low as the MACT floor for bituminous coal as established in this analysis.

Table 6-7. Permitted Units Considered for BTF Analysis for Mercury

State	Unit	Size (MW)	Mercury Limit (lb/GWh)
Bituminous			
Wisconsin	Elm Road ¹	727	0.012
Kentucky	Thoroughbred Generating	750	0.021
West Virginia	Longview Maidsville	600	0.024
Texas	Sandy Creek	860	1.09
Sub-bituminous			
Georgia	Longleaf	600	0.015

¹ The Elm Road permit limit is based on use of bituminous coal, although it will have ability to blend PRB coal.



The most stringent permit limit for sub-bituminous coal in any permit is the 15 lb/TBtu (0.015 lb/GWh) in the LS Energy, Longleaf Energy Station Permit.⁴ The most stringent limit contained in law or rule is the Connecticut Law (CGS Section 22a-199), which according to the Connecticut CAMR Plan⁵ “requires the owners and operators of the three CAMR units to meet an emissions rate of equal to or less than 0.6 pounds of mercury per TBtu, or meet a mercury emissions rate equal to a 90 percent reduction of mercury from the measured inlet conditions for the unit.” Connecticut also has an opportunity for facilities to establish an alternate limit if this limit, or control efficiency cannot be met. In Massachusetts, the regulation allows compliance with a mercury emission limit of 0.0075 lb/GWh or 85 percent removal efficiency.

The proposed control technology for the ASCPC unit (SCR, hydrated lime injection and ACI, fabric filter and wet FGD) include all of the known control equipment that has been shown to be effective in reducing mercury emissions. For pulverized coal-fired boilers, there are no other control technologies that are as effective as this combination of controls for either bituminous or sub-bituminous coal. The issue therefore becomes not whether additional control equipment needs to be installed, but how can this equipment be optimized to control emissions. Because of the variables that will affect the performance of this control system, optimization cannot be established until the facility is operating and has the opportunity to perform a mercury emission optimization study. Two important variables are:

1. The chlorine content of the coal. There is a range of chlorine contents for both bituminous and sub-bituminous coal. The low chlorine content typical of PRB coal makes mercury removal more difficult. When exclusively firing PRB coal, halide addition to the process will likely be necessary. This can be done by using halogenated PAC, commonly, brominated PAC (B-PAC), or adding chloride to the boiler, perhaps as a dust suppressant for the coal. However, the addition of halides for mercury control must be carefully weighed against balance of plant impacts. For example, chlorine addition to the coal will cause increased corrosion in the boiler, and it is difficult to control the chlorine addition to ensure that consistent concentrations are maintained throughout operation.



2. The rate of PAC injection. Optimization studies are important to determine what this rate should be. For example, an optimization study at the Walter Scott Jr. Energy Center Unit 4 on December 20, 2007 concluded that “further increases in PAC feed rate beyond approximately 1.5 lbs/MSCF will not produce significant additional reduction in stack emissions of mercury.”

6.1.3.2 Emission Test Data and Possible Co-Benefits

With respect to specific stack emission test data, there are DOE/NETL sponsored field studies on mercury removal from coal-fired power plants, studies by the Electric Power Research Institute (EPRI) and independent tests of individual power plants. The DOE/NETL sponsored field studies are now in their third phase. The most relevant results from the DOE/NETL Phase II sponsored field studies are summarized in Table 6-8. This data is taken from “Updated Economic Analysis of Mercury Control via Activated Carbon Injection” by Andrew P. Jones of Science Applications International Corporation (SAIC) dated December 12, 2007. ⁶



**Table 6-8. Mercury Removal Test Results Summary
DOE/NETL Phase II Data**

Unit (MW)	AQCS	Coal Type	Technology being tested ¹	Average Co-Benefit Hg Capture (%)	Approx. ACI Injection Rate (lb/MMacf)	Average Hg Removal (Native and new Technology) (%)
Holcomb 1 (360)	SDA/FF	PRB	DARCO® Hg-LH	37	1.5	93
Meramec 2 (140)	CS-ESP	PRB	DARCO® Hg-LH	32	3.5	93
Dave Johnston 3 (240)	CS-ESP	PRB	Mer-Clean™ 8	12	0.63	92
St. Clair 1 (145)	CS-ESP	85:15 PRB/Bituminous Blend	B-PAC	25	3	94
Monroe 4 (785)	SCR & CS-ESP	60:40 PRB/Bituminous Blend	DARCO® Hg	25	6	78
Yates 1 (100)	CS-ESP & Wet FGD	Bituminous	Super HOK	40	9.5	76
Portland Station I (170)	CS_ESP	Bituminous	Mer-Clean™ 8-21	29	9	95
Lee 1 (79)	CS-ESP	Bituminous	B-PAC	21	8	82

¹ DARCO® Hg and Super HOK are untreated activated carbons. All other sorbent materials are brominated or otherwise chemically treated sorbents.

As described in “[An Update on DOE/NETL’s Mercury Control Technology Field Testing Program](#)” by Thomas J. Feeley, III of DOE/NETL and Andrew P. Jones of SAIC dated July 2008, “The intent of NETL's Phase I and II Hg control technology field testing programs was to work with industry to evaluate the most promising Hg control technologies at full-scale in a variety of configurations. **Although 30-day long-term tests were conducted in Phase II, the test period was not sufficient to answer many fundamental questions about longterm consistency of Hg removal and reliability of the system when integrated with plant processes.** As the technologies move towards commercial implementation, it is critical to accurately define the Hg removal performance and costs so that power companies and policy makers can make informed decisions. DOE/NETL awarded nine new projects in 2006 to conduct Hg control tests at full-scale coal-fired units and in the laboratory, under a Phase III



Hg control solicitation.” (emphasis added) The paper goes on to describe the Phase III studies that are underway. The Phase III studies that are most relevant to the future performance of the ASCPC unit are the We Energies Presque Isle study and the Rocky Mountain Power Hardin Station Study.

Additional comments on the most relevant Phase II and Phase III studies are warranted.

1. DTE St. Clair Power Plant Unit 1 Demonstration Project⁸

This 30-day demonstration project completed in 2004 that showed “... the average total gas-phase mercury removal was 94 percent. Discounting the native mercury removal of about 25 percent, the B-PAC removed about 91.5 percent of the plant’s mercury that it saw.” Most of the trial was conducted when the plant was burning its normal blend of 85 percent sub-bituminous coal and 15 percent bituminous coal. A short trial with 100 percent PRB coal showed a slightly higher removal rate. In 2004 when this study was conducted, the results were encouraging. They showed that high removal efficiencies are possible when using B-PAC with coals that produce higher elemental Hg concentrations when combusted, such as sub-bituminous coals. These are similar to the results that We Energies experienced over specific 30-day periods during their long-term demonstration project. See subparagraph 4 for details. However, the DTE St. Clair results require further qualification.

As noted in greater detail below, accurate measurement of Hg continues to be a concern in the industry. The DTE St. Clair study’s quoted removal efficiencies are based on semi-continuous monitoring (SCEM) method using wet conversion. Since the test was conducted, there have been continued improvements in Hg CEMS performance. It is noted that during one of the September 9, 2004, St. Clair comparative tests, the two measurement techniques (i.e., SCEMS and Ontario-Hydro Method) showed different removal efficiencies. The Ontario-Hydro Method (OHM) showed 88.4 percent removal and the SCEMS showed 92.1 percent removal. (See page 40 of the report) We are also aware that DTE maintains reservations about the reliability of these results to predict greater than 90 percent removal over a long period of time. For these reasons, we believe



the data from the Presque Isle Demonstration Program (conducted more recently) to be more reliable.

2. Sunflower Electric's 360-MW Holcomb Station, Unit 1

Holcomb Unit 1 is a PC boiler fueled entirely with sub-bituminous (PRB) coals. Sunflower Electric conducted a full-scale field test of mercury control using sorbent injection. The Holcomb Topical Report⁹ dated June 28, 2005 presents results from testing including the effect on mercury emissions of: 1.) blending PRB coal with western bituminous coal, 2.) spraying chemical additives onto the coal, and 3.) injecting alternative sorbents specifically designed to operate in a halogen-deficient flue gas (see Attachment 2). This study showed Hg emission reductions of 93 percent using halogenated PAC, resulting in an emission of 0.83 lb/TBtu, based on a 30-day test. These results were based on SCEM and some OHM testing.

3. Mid-American Walter Scott Jr. Unit 4

Mid-American conducted stack testing in May and August 2007, and performed an Optimization Study for PAC in December 2007.¹⁰ These tests were not part of a DOE/NETL study. These reports were provided to the MDEQ, in Consumers submittal on July 31, 2008. Walter Scott Jr. Unit 4 is a supercritical pulverized coal fired boiler with a dry scrubber, fabric filter and PAC injection. The May 2007 report showed Hg emissions of 0.72 lb/TBtu and the August 2007 test showed Hg emissions of 1.2 lb/TBtu. Inlet data and fuel analysis was not presented in either report, so an estimate of removal efficiency has not been made. The outlet data showed some important variability between the two tests. Their optimization study concluded that a PAC feed rate greater than 1.5 pounds per million standard cubic feet of gas “will not produce significant additional reduction in stack emissions of mercury.” The optimization study also showed a disparity between the Hg CEMS and EPA Method 30B, and concluded the Method 30B results were considered more reliable.



4. We Energies Presque Isle Power Plant (PIPP) (Phase III)

We Energies conducted a comprehensive Demonstration Project during 2007 using EPRI's TOXECON™ system for Hg removal.¹¹ The complete 2007 data is summarized in Figure 6-1, which shows that the average removal efficiency for all of 2007 was 90 percent. Consumers' Engineer, HDR|CB, and NTH believe this is the best long-term performance information available for control of mercury emissions from a utility boiler firing only PRB coals. The information supports the position that 90 percent removal is the demonstrated, long-term removal achieved in practice for control of mercury from PRB coals. The PIPP data shows that the unit was able to maintain an average reduction of 90 percent when using PAC or B-PAC for relatively long test intervals over a 12-month test period. There were periods of time where the removal was greater than 90 percent; however, there were also operational variations in the process, sorbent, and unit that resulted in periods of lower removal.

5. Rocky Mountain Power Hardin Station (Phase III)

According to the July 2008 report An Update on DOE/NETL's Mercury Control Technology Field Testing Program¹² from the DOE/NETL has a Phase III study ongoing for "*Long-Term ACI Field Test for >90% Mercury Removal*" at the Rocky Mountain Power Hardin Station, which uses PRB coal. This study has been underway for only a few months and the final results are not yet available. The preliminary results presented in this July 2008 update show that they are achieving 90 percent control. See Figure 6-2.

Both the We Energies Presque Isle Plant and the Rocky Mountain Power are the only year long performance studies on PRB coal with PAC injection and both are showing 90 percent control on a long term basis. Consumers, HDR|CB and NTH are not aware of any other long-term demonstration projects having greater than 90 percent removal efficiency. Further HDR|CB reports that in bidding control equipment for other proposed plants, no vendors have guaranteed greater than 90 percent performance, and even when they guarantee 90 percent, the vendor also places a floor of on the emission level. As of August 2008, this floor is, at the lowest, 0.9 lb/Tbtu.



Figure 6-1. 2007 Mercury Removal Data from We Energies Presque Isle Power Plant Study

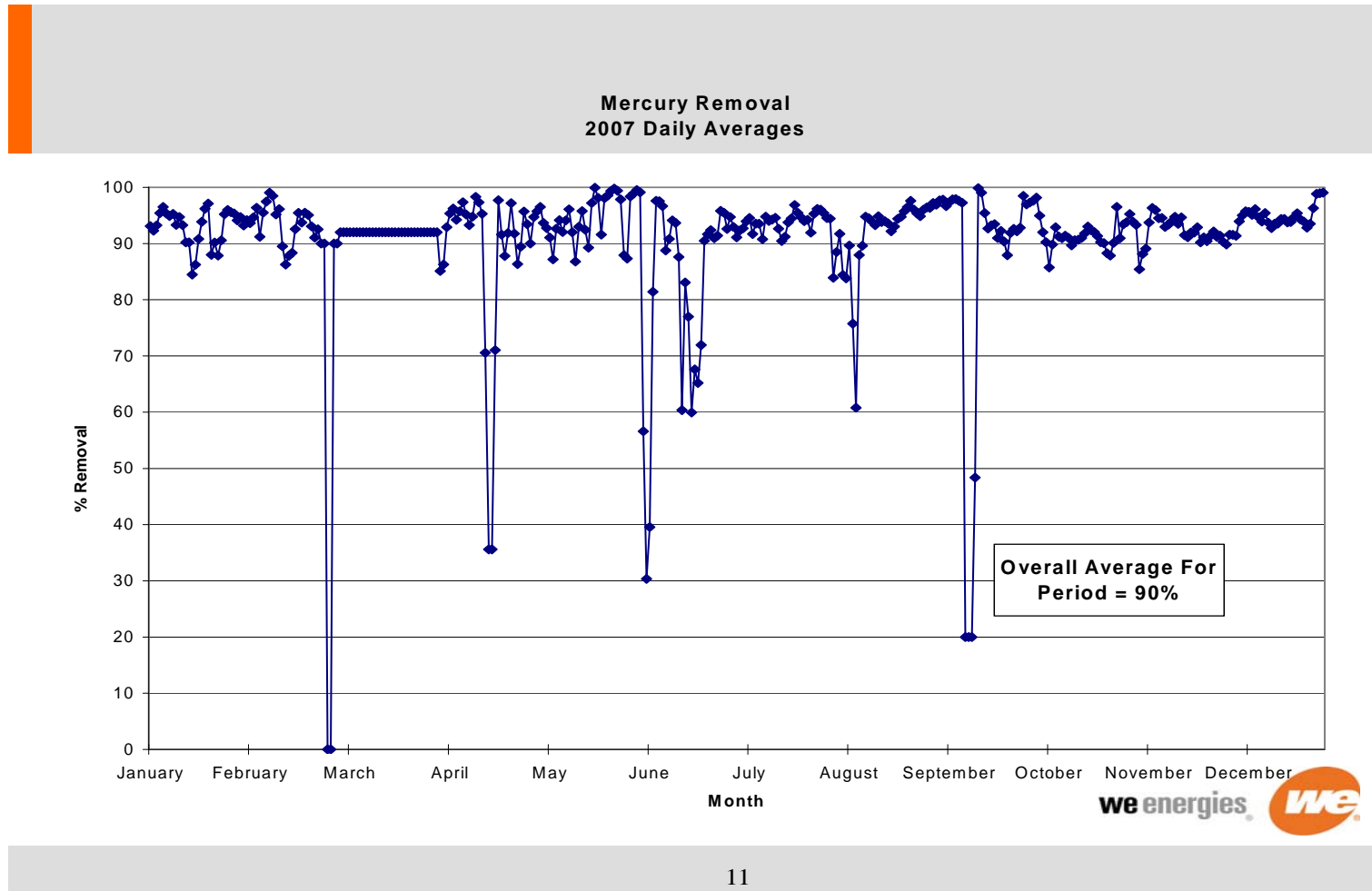
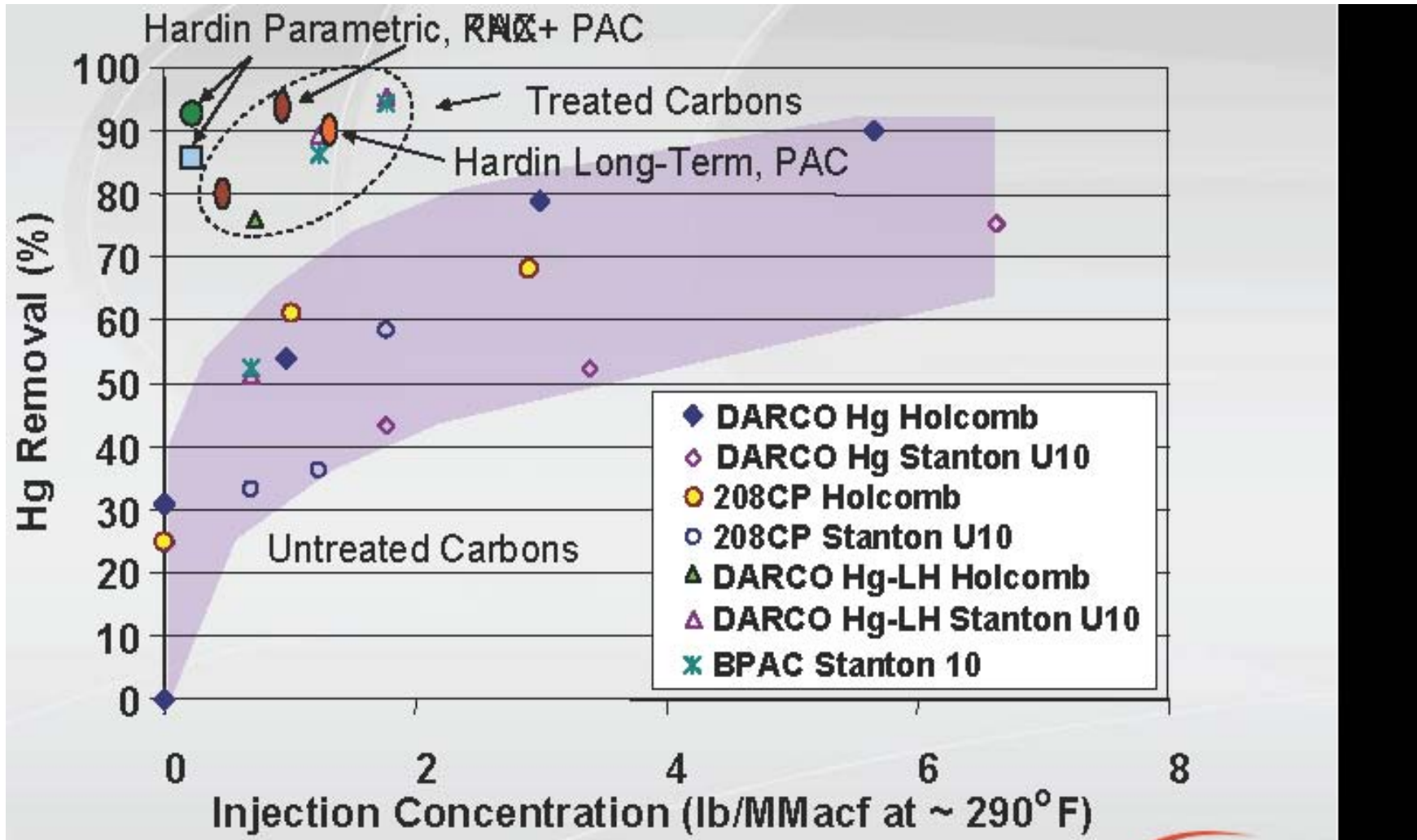




Figure 6-2. PAC Injection Results SDA+ FF, PRB and ND Lignite Fuels





6.1.3.3 ASCPC System Capabilities

So what is the ASCPC proposed air quality control system which includes an SCR, hydrated lime, PAC injection, a fabric filter, a wet FGD system capable of with respect to mercury removal? As stated previously, the current vendor guarantee for this type of system is 90 percent removal or an emission floor of 0.9 lb/TBtu. It is worth restating that that even without the PAC, the system would be effective at removing mercury resulting from the combustion of bituminous coal. The SCR system will be effective at converting some of the elemental mercury to the divalent or oxidized form, which is more easily captured in the fabric filter and the wet FGD. The fabric filter is highly effective at removing particle bound mercury, and some of the elemental mercury will be removed by the passage of the exhaust gas through the filter cake that lines the fabric filter. Since oxidized mercury is water soluble the wet FGD can also be highly effective at removing it from the exhaust gas stream. It must be noted that DOE/NETL has reported studies showing some re-emission of elemental mercury because some oxidized mercury can be reduced within the system. See An Update on DOE/NETL's Mercury Control Technology Field Testing Program by Thomas J. Feeley, III of DOE/NETL and Andrew P. Jones of SAIC dated July 2008 at page 10.¹³ In the case of the ASCPC system, however, the wet FGD is downstream of the SCR which helps convert the elemental mercury to oxidized mercury, which will be removed with the PAC injection and the fabric filter, and the remaining mercury that gets to the inlet of the wet FGD is likely to be primarily elemental. Therefore, the added removal of mercury by the wet FGD and the possibility of re-entrainment within the FGD should both be minimal.

EPA used their power plant ICR database to develop a predictive algorithm for native mercury removal based on chlorine content. This was presented in EPA-600/R-03-110, Performance and Cost of Mercury and Multipollutant Emission Control Technology Applications on Electric Utility Boilers, October 2003.¹⁴ Given the uncertainties with the ICR database, which is now 10 years old, and the uncertainty of using limited best fit data from a few tests to predict future performance, a review of more recent data was undertaken. DOE has estimated in a 2006 report (Evaluation of Mercury Emissions from Coal Fired /Facilities with SCR and FGD Systems, Project Final Report, Consol Energy, for USDOE, NETL, April 2006)¹⁵ that units burning bituminous coal using a suite of controls similar to the proposed ASCPC achieved a range of



reduction in mercury emissions from 67 to 96 percent and an average reduction in mercury emissions of 85 percent. These test results are all short term, as measured by the OHM.

In regards to previous studies on co-benefit mercury removal levels, the tests have generally been conducted in the absence of any mercury specific controls such as sorbent injection. Indeed, the very concept of “co-benefit” entails mercury reductions via existing control systems that are not specifically designed for mercury removal. Significant mercury reduction co-benefits have generally been observed in those boilers firing fuels with an appreciable chlorine content (> 300 to 500 ppmw) and equipped with the following types of control systems: 1) an SCR followed by a dry FGD/fabric filter combination or 2) an SCR, followed by an ESP (or fabric filter) and then a wet FGD.

When mercury specific control such as sorbent injection are installed, the technology is typically installed upstream of the particulate matter control device (in order to collect the sorbent material). The likely result is that the level of co-benefits is decreased, even though the overall mercury reduction may stay the same or increase slightly. This is due to the fact that when sorbent injection is installed between an SCR and the particulate matter control device, with a downstream wet FGD, the sorbent and particulate control device would be expected to remove nearly all of the oxidized mercury and any native particle bound mercury that is present. The mercury which is not captured is likely to exist in an elemental form, and therefore would be expected to pass through the downstream wet FGD, as elemental mercury is not particularly soluble in scrubber solutions. With adequate chlorine levels in the fuel, an ideal co-benefits control configuration may be able to achieve approximately 70 percent to greater than 90 percent reduction in Hg, but adding sorbent injection to such a system may not appreciably increase the overall mercury reduction. Rather, the addition of mercury specific controls will simply shift where the majority of the mercury removal occurs; e.g., the particulate matter control device (via the removal of the mercury laden sorbent material) versus at the wet FGD (via the collection of oxidized mercury).



Some studies, such as the one at the DTE St. Clair Plant in 2004, have shown that with very low chlorine content coal, native removal can be very low. However, with the use of B-PAC the ACI system can still achieve 90 percent overall removal, with short term removal efficiencies that are even higher. The NETL studies have clearly shown that adding PAC will improve removal above that which would be achieved with native (non-PAC) control. That does not mean that the integration of the PAC injection into the ASCPC AQCS will provide proportionately additive benefit. PAC injection performance is typically not independent of the rest of the system, and is certainly not expected to be for the proposed AQCS. That is because the PAC will be injected prior to the fabric filter, which is also upstream of the wet FGD. The PAC will not be a separate control system downstream of the rest of the control system and as such will not provide additive removal efficiency but more likely competitive removal efficiency.

There are two study reports that support this independent relationship. First is the DTE St. Clair Power Plant study. On page 39 of the Technical Progress report included as Attachment 1, it was stated, "During the parametric testing program there was a week during which the native mercury removal across ESP 1A was as high as 67 percent. Attempts were made to discover the cause of this event, without result. The high native removal appeared to have the effect of reducing the performance of the B-PAC sorbents, although the total mercury removal was nearly as it was under normal operating conditions." Thus, higher native removal did not increase overall removal, because B-PAC removal was reduced when higher native removal existed.

In the Holcomb Topical Report, it is stated on page 51 that "The comparison of the baseline and long-term samples suggests that mercury is bound to these samples in different forms because the desorption peaks occurred at different temperatures for the two samples. Connie Senior, Reaction Engineering International, suggests that when activated carbon is injected into the duct, *there is no "native" mercury capture by the fly ash*; instead, the more reactive activated carbon reacts with gaseous mercury before reacting with fly ash. This is an important result when assessing the effectiveness of activated carbon. The effectiveness of activated carbon is often described as the ability of the material to remove mercury above that achieved during baseline conditions. The thermal desorption results for Holcomb suggest that the activated carbon preferentially removes



mercury that would be otherwise collected by the native fly ash in addition to any incremental increase in the mercury removal.”

To further examine what the proposed ASCPC AQCS can achieve with respect to mercury control, we consider what it can do for of the principle fuel (PRB coal) and the fuel blend.

PRB Sub-Bituminous Coal

If the facility is burning all sub-bituminous coal, and the average inlet mercury loading from the coal is 6.96 lb/TBtu as shown in Table 6-4, then 90 percent control would result in an emission of approximately 0.70 lb/TBtu, which can then be converted to 0.0062 lb/GWh. Note that the emission rate of 0.70 lb/TBtu is well below the emission level floor AQCS equipment vendors are currently guaranteeing for Hg emissions.

$$Hg \text{ Emissions} = \frac{6.96 \text{ lb}}{TBtu} \times (1 - 0.90) = \frac{0.70 \text{ lb}}{TBtu}$$

$$Hg \text{ Emissions} = \frac{0.70 \text{ lb}}{TBtu} \times \frac{1 TBtu}{1,000,000 MMBtu} \times \frac{8190 MMBtu / hr}{930 MW_{gross}} \times \frac{1000 MW}{GW} = \frac{0.0062 \text{ lb}}{GWh_{gross}}$$

50/50 Blend of Sub-Bituminous and Bituminous Coal

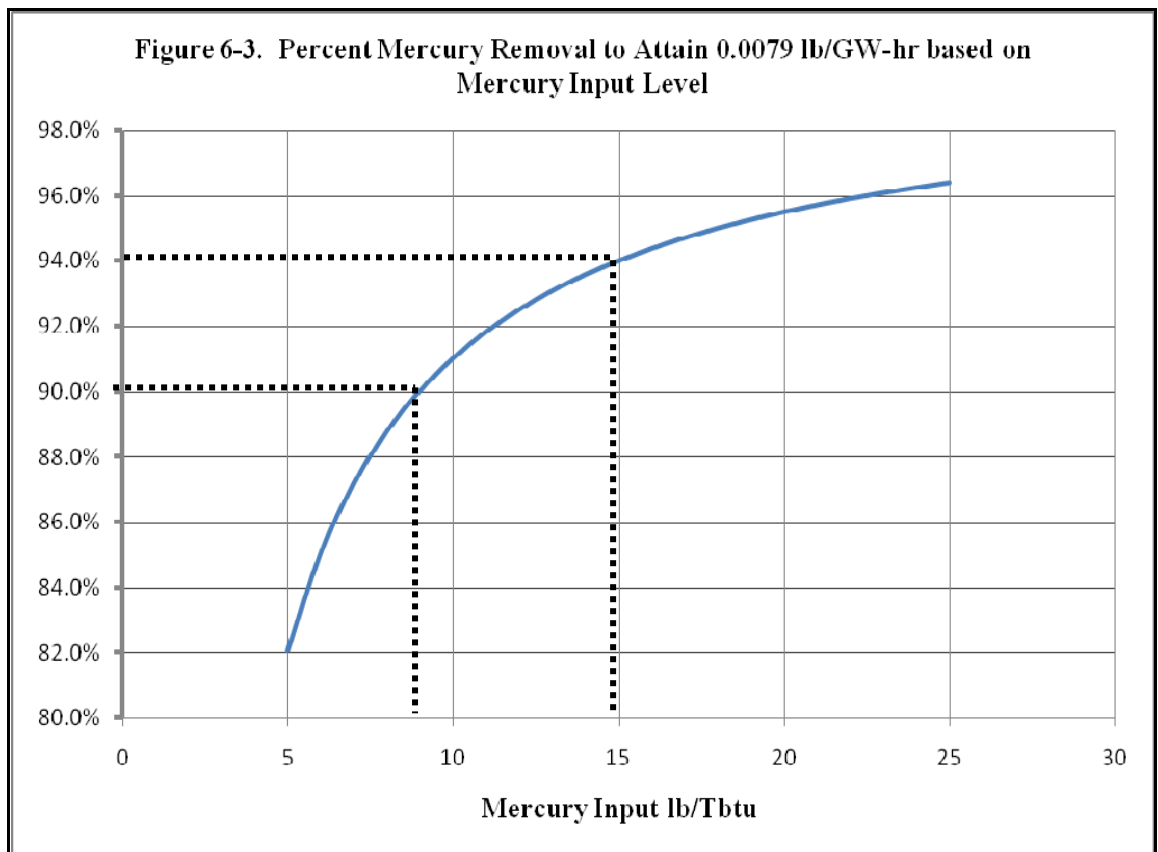
A 90 percent removal on the blend of coal specified in this application would yield an emission of 0.90 lb/TBtu or 0.0079 lb/GWh.

$$Hg \text{ Emissions} = \frac{8.98 \text{ lb}}{TBtu} \times (1 - 0.90) = \frac{0.90 \text{ lb}}{TBtu}$$

$$Hg \text{ Emissions} = \frac{0.90 \text{ lb}}{TBtu} \times \frac{1 TBtu}{1,000,000 MMBtu} \times \frac{8190 MMBtu / hr}{930 MW_{gross}} \times \frac{1000 MW}{GW} = \frac{0.0079 \text{ lb}}{GWh_{gross}}$$



While vendors have guaranteed a 90 percent removal efficiency for similar proposed AQCS as that proposed for the ASCPC, the 90 percent removal applied to Consumers mercury in coal data also demonstrates that the proposed limit will be approaching the vendor floor for emissions of 0.9 lb/TBtu. If we use that floor with higher mercury in coal content such as that from USGS COALQUAL data, Figure 6-3 shows that much higher removal efficiency would be required.



These can be calculated for the 95 percent UCL values from the USGS COALQUAL data as shown in Table 6-5 and Table 6-6 as follows:

Sub-bituminous Coal

$$\text{Percent Control Efficiency} = \left(\frac{14.98 \text{ lb}}{\text{TBtu}} - \frac{0.9 \text{ lb}}{\text{TBtu}} \right) \div \frac{14.98 \text{ lb}}{\text{TBtu}} \times 100 = 94.0\%$$



Bituminous Coal

$$\text{Percent Control Efficiency} = \left(\frac{15.72\text{lb}}{\text{TBtu}} - \frac{0.9\text{lb}}{\text{TBtu}} \right) \div \frac{15.72\text{lb}}{\text{TBtu}} \times 100 = 94.3\%$$

This analysis shows that the ASCPC AQCS will allow the achievement of an emission limit (0.0079 lb Hg/GWh) that goes beyond the floor for the blended fuel, which is the worst case condition for which the MACT should be set. Based upon the design coals and the blending of up to 50 percent bituminous coal with sub-bituminous coal, this beyond the floor emission rate is achievable with a 90 percent long term emission reduction. If the mercury contents of the actual coals fired in the ASCPC are greater than the design values, maintaining compliance with the proposed emission limit will require that greater than 90 percent control be achieved on a long term basis. While the ASCPC AQCS may have the potential to provide greater than 90 percent control for mercury, there has been no demonstration of that level of performance for a year or more of operation for a unit using sub-bituminous coal, especially at the lower than typical coal mercury concentrations associated with the design coals for the ASCPC unit, and no assurance that it can be achieved.

6.1.4 MACT for Mercury

This review demonstrates that the case-by-case MACT for mercury for the ASCPC unit with SCR, hydrated lime injection, ACI, fabric filter and wet FGD, under all fuels blends is an emission limit of **0.0079 lb/GWh**. Based on the select fuels that Consumers has chosen, this MACT limit also represents the maximum control efficiency and the minimum emission level a vendor will currently guarantee. This MACT limit is also substantially lower than the MACT floor of 0.013 lb/GWh. Consumers is not raising any additional considerations for the cost or energy requirements of achieving this proposed MACT limit. It is noted that the human health risk assessment was conducted on the basis of this level of mercury emission and demonstrated that the additional impact from the ASCPC unit will not result in adverse health effects.

While Consumers believes this limit is achievable, this case-by-case MACT analysis found a great deal of uncertainty with respect to the measurement and control of mercury emissions from



electric generating units. Even the NAACA list of state mercury rules reflect that almost every state allows the option for an alternate emission limit or additional time if the state limit is not met.

The MACT limits must be met during all operating conditions. The uncertainties in measurement and the lack of long term monitoring data to show compliance with these stringent emission limits lead Consumers to propose that an optimization study be included in the mercury MACT decision. This optimization study would consider PAC injection rates, effects of fuel blending, the need for halide addition or the use of B-PAC when low chlorine content fuels are being used, boiler operating conditions, and other factors that appear relevant during the first few months of startup. If the optimization study indicates that the ASCPC unit cannot achieve the 0.0079 lb/GWh, the limits established as MACT may need to be revised to reflect the levels that can be achieved with the highly sophisticated air pollution control system that will be utilized.

Finally, the ability to demonstrate compliance with the proposed emission limit will depend on the measurement method used and the expected outlet mercury concentrations. Mercury CEMS have been proposed for compliance determination rather than discrete stack testing. The Hg concentrations in the outlet of a well controlled system will likely be in the range of 1-2 $\mu\text{g}/\text{m}^3$ (0.0079 lb/GWh is approximately equivalent to 1.1 $\mu\text{g}/\text{m}^3$). The required relative accuracy of Hg CEMS in the now vacated Hg monitoring provisions of 40 CFR Parts 60 and 75¹ was 20 percent, or less than or equal to an absolute difference of 1.0 $\mu\text{g}/\text{m}^3$ in cases where the 20 percent relative accuracy requirement was not met and the average reference method value was less 5.0 $\mu\text{g}/\text{m}^3$. Therefore, it is likely that average mercury concentrations out the stack could be approximately the same as the true quantification level of the Hg CEMS. While there continues to be improvements in Hg CEMS technology (the effective minimum detection limit of the mercury analyzer is claimed to be quite low, i.e., less than 0.01 $\mu\text{g}/\text{m}^3$), the long term accuracy of the Hg CEMS at low Hg concentrations still needs to be demonstrated. Thus, the performance of Hg CEMS makes the results subject to significant uncertainty at low concentrations. This was seen in

¹ Refer to section 13.4 of Performance Specification 12A of 40CFR60, Appendix B or section 3.3.8 of 40CFR75, Appendix A.



the Walter Scott Jr. Energy Center Unit 4 optimization study conducted in December 2007, where the CEMS were determined to be unreliable for the purpose of the study.

6.2 ACID GASES

The primary acid gases (HAPs) emitted from the ASCPC boiler will be hydrogen fluorides (HF) and hydrogen chlorides (HCl). HF and HCl are generated in the boiler from the fluoride and chlorine present in the fuel. Control systems have not been designed to primarily control emissions of HF and HCl. Instead, acid gas reduction is achieved in conjunction with the sulfur dioxide (SO₂) and sulfur trioxide (SO₃) controls (SO₃ formation contributes to emissions of sulfuric acid mist). Since SO₂ and sulfuric acid (H₂SO₄) are typically PSD pollutants for large coal-fired boilers, there is available data on control technology and emission limits. Based upon the five-step, top-down PSD BACT procedure, Consumers has selected a wet FGD system to control emissions of SO₂. The two primary technologies to control H₂SO₄ from utility boilers are a wet ESP on the back end of the air quality control system or a hydrated lime injection system upstream of the particulate control device. In general, a wet ESP is used on utility boilers firing higher sulfur bituminous coals where the SO₃ inlet loading to the wet ESP is relatively high. For utility boilers primarily designed to burn lower sulfur coals, such as that proposed for this project, the hydrated lime injection system is the preferred alternative as this technology provides good control of H₂SO₄ emissions and is used to maintain mercury sorbent performance. Therefore, in addition to the wet FGD, Consumers has proposed to utilize hydrated lime injection upstream of the particulate control device (fabric filter) to control SO₃ formation.

6.2.1 ASCPC Acid Gas Emission Control System

As mentioned previously, the ASCPC air quality control system includes an SCR, hydrated lime, PAC injection, fabric filter, and wet FGD system. Many of the same systems used to control emissions of SO₂ are also effective at removing acid gases.

6.2.2 Acid Gas MACT Floor Analysis

As stated in the PSD BACT analysis for SO₂, PC boilers that are required to control SO₂ emissions will do so using dry, semi-dry or wet flue gas desulfurization (FGD). In wet FGD



systems, an alkaline slurry of limestone is sprayed into the flue gas as it passes through an absorber tower. All wet FGD systems are considered post-combustion FGD systems. In dry or semi-dry FGD systems, an alkaline sorbent (usually hydrated lime) is sprayed into the flue gas as it passes through a spray dryer vessel or limestone can be added directly into the boiler in the case CFB technology.

For HF and HCl, the achievable limit is highly dependent on fluoride and chlorine content of the coal, and the type of control system that can be utilized. Facilities that are committed to burning 100 percent sub-bituminous coal typically control sulfur dioxide and other acid gases with a dry FGD system. Consumers has selected wet FGD to control SO₂ and acid gases because of the potential to blend bituminous and sub-bituminous coals. The MACT floor analysis needs to consider similar sources for HF and HCl as using a similar blend of fuels.

At the time the application was submitted, USEPA had promulgated emission limits for utility boilers under the New Source Performance Standards (NSPS) in lieu of emission standards under the originally proposed National Emission Standard for Hazardous Air Pollutants (NESHAP). Further, USEPA had determined that it was neither necessary nor appropriate to regulate emissions from utility boilers under section 112 of the CAA. Consequently, the control system selected for emissions of acid gases (primarily sulfur-based compounds) was selected based upon employment of best available control technology (BACT) for criteria pollutants. In the case of the proposed ASCPC boiler and selected fuel blend, wet flue gas desulfurization (FGD) was determined to provide the greatest control of emissions of SO₂ and H₂SO₄.

While it is likely that a dry FGD system could provide greater control of HF and HCl emissions, this type of technology would not represent BACT for SO₂ for the proposed boiler and blend of coals and would yield less control of H₂SO₄. Therefore, a trade-off is realized in selecting a wet system over a dry system. Table 6-9 lists the operating units with a HF or HCl emission limit.



Table 6-9. Operating Units Considered for MACT Floor Analysis for Acid Gases

State	Unit	Fuel	HF Limit (lb/MMBtu)	HCl Limit (lb/MMBtu)
South Carolina	Cross 3	Bituminous/petcoke	0.0003	0.0024
Wisconsin	Weston 4	PRB	0.000217	0.0021 ¹
Arizona	Springerville 3	PRB	0.00044	NA ²
Iowa	Council Bluffs	PRB	0.0009	0.0029

¹This was calculated based on a permit limit of 10.94 lb/hr and a heat input rate of 5,173 MMBtu/hr.

²The Permit did not contain HCl limits.

None of the sources listed above use the blend of coals and wet FGD control technology that Consumers is proposing for the ASCPC boiler. Since Consumers is permitting up to a 50/50 blend of PRB and bituminous coals, the floor for HF is set at 0.00026 lb/MMBtu which is a weighted average between the Cross 3 (bituminous) and Weston 4 (sub-bituminous) limits. For HCl, the Cross 3 and Weston 4 Units would also set the MACT floor at a weighted average of 0.0023 lb/MMBtu. Although Cross 3 is also allowed to burn up to 30 percent petcoke, recent stack test data at 100 percent bituminous coal demonstrated compliance with the permitted HCl emission limit.

6.2.3 Acid Gas Beyond the Floor Analysis

Whether or not a facility utilizes wet or dry FGD is dependant on the rank or blend of coal used. As previously stated, this is an important point when defining a similar source for acid gas control. Removal of acid gases takes place for both wet and dry FGD processes through reaction with the reagent slurry in the scrubber system and through reaction with the alkaline constituents in the fly ash. Due to the configuration of a dry FGD system with the particulate collection system located downstream of the dry scrubber, removal of acid gases is expected to be slightly better in a dry scrubber than a wet scrubber. This is because there is longer residence time for reaction of acid gases with the alkaline particulate and the intimate contact between the alkaline particulate cake and acid constituents as the flue gas is drawn through the filter bags of a fabric filter.



A wet FGD system and hydrated lime injection upstream of the fabric filter is the most optimum control for the fuel blend being proposed. Table 6-10 below lists the permitted HF and HCl limits for sources which are similar to the ASCPC unit proposed by Consumers. These sources are not yet operating and therefore have not been demonstrated.

Table 6-10. Permitted Units Considered for BTF Analysis for Acid Gases

State	Unit	Fuel	HF Limit (lb/MMBtu)	HCl Limit (lb/MMBtu)
West Virginia	Longview Power	Bituminous	0.00001	0.00001
Arizona	Desert Rock	PRB	0.00024	NA ²
Missouri	Iatan 2	PRB	0.004 ¹	NA ²
Utah	Intermountain Unit 3	Bituminous/PRB	0.0005	0.004 ³
Nevada	Ely Generating	PRB	0.0004	0.011 ⁴

¹ This was calculated based on a permit limit of 33.15 lb/hr and a heat input rate of 8,100 MMBtu/hr.

² The Permit did not contain HCl limits.

³ This was calculated based on a permit limit of 38.13 lb/hr and a heat input rate of 9,050MMBtu/hr.

⁴ This was calculated based on a permit limit of 96.78 lb/hr and a heat input rate of 8,710 MMBtu/hr.

The Longview Power Plant contains the lowest permitted limits for acid gas emissions. As this source is not yet operating, these limits have not been demonstrated and therefore do not represent the MACT floor. Nevertheless, the MACT analysis requires that the applicant evaluate whether a similar beyond the floor reduction is achievable.

The final emission level achievable is dependent on the level of the contaminants in the fuel. The emission factors for HF are shown in Section 3.1.8 and Table 3-9 of the permit application support document and are repeated below as Table 6-11. USEPA's ProUCL software was employed to perform a statistical analysis on the Consumers coal analytical data from the years 2001-2005. The 99th percentile values from the worst-case year were chosen for the maximum short-term emissions (lb/hr) and the 95 percent UCL values were chosen for calculating the annual emissions (tpy).



Table 6-11. Summary of Short- and Long-term Emission Factors as Hydrogen Fluoride

Coal Type	Hydrogen Fluoride (lb/MMBtu)	
	Hourly Emission Rate (99 th Percentile)	Annual Emission Rate (95% UCL)
Western sub-bituminous coal	9.99E-03	8.14E-03
Eastern bituminous coal	7.81E-03	6.09E-03

$$\text{Short-term Uncontrolled HF Emissions} = \frac{0.00999 \text{ lb}}{\text{MMBtu}} \times 50\% + \frac{0.00781 \text{ lb}}{\text{MMBtu}} \times 50\% = \frac{0.0089 \text{ lb}}{\text{MMBtu}}$$

$$\text{Long-term Uncontrolled HF Emissions} = \frac{0.00814 \text{ lb}}{\text{MMBtu}} \times 50\% + \frac{0.00609 \text{ lb}}{\text{MMBtu}} \times 50\% = \frac{0.0071 \text{ lb}}{\text{MMBtu}}$$

The chlorine data from the Consumers dataset referenced in the July 31, 2008 addition information letter has recently been determined to be invalid. Therefore, USEPA's ProUCL software was employed to perform a statistical analysis on the PRB and the eastern bituminous coal data in the COALQUAL database. The 99th percentile values from the worst-case year were chosen for the maximum short-term emissions (lb/hr) and the 95 percent UCL values were chosen for calculating the annual emissions (tpy). These data are presented in Table 6-12. The resultant HCl emission factors are shown in table 6-13.

Table 6-12. Summary of Short-term and Long-Term Emission Factors for Chlorine

Coal Type	Chlorine (lb/MMBtu)	
	Hourly Emission Rate (99 th Percentile)	Annual Emission Rate (95% UCL)
PRB sub-bituminous Coal	0.052	0.013
Eastern bituminous Coal	0.223	0.073



Table 6-13. Summary of Short-term and Long-Term Emission Factors as HCl

Coal Type	HCl (lb/MMBtu)	
	Hourly Emission Rate (99 th Percentile)	Annual Emission Rate (95% UCL)
Western sub-bituminous Coal	0.053	0.013
Eastern bituminous Coal	0.229	0.075

$$\text{Short-term Uncontrolled HCl Emissions} = \frac{0.053 \text{ lb}}{\text{MMBtu}} \times 50\% + \frac{0.229 \text{ lb}}{\text{MMBtu}} \times 50\% = \frac{0.141 \text{ lb}}{\text{MMBtu}}$$

$$\text{Long-term Uncontrolled HCl Emissions} = \frac{0.013 \text{ lb}}{\text{MMBtu}} \times 50\% + \frac{0.075 \text{ lb}}{\text{MMBtu}} \times 50\% = \frac{0.044 \text{ lb}}{\text{MMBtu}}$$

The worst case (99th percentile) HF and HCl inputs were used to calculate the maximum emission limits to be achieved on a short-term basis. It is recognized that there will be an additional reduction in acid gas emissions as a result of the hydrated lime injection system in conjunction with the fabric filter. As discussed in the permit application support document, a control efficiency of 43 percent for the hydrated lime injection system and fabric filter was assumed along with 97 percent from the wet FGD system. This represents a combined 98.3 percent control efficiency. The proposed emissions limits are calculated as follows:

$$\text{HF Emissions} = \frac{0.0089 \text{ lb}}{\text{MMBtu}} \times (1 - 0.43) \times (1 - 0.97) = \frac{0.00015 \text{ lb}}{\text{MMBtu}}$$

$$\text{HCl Emissions} = \frac{0.141 \text{ lb}}{\text{MMBtu}} \times (1 - 0.43) \times (1 - 0.97) = \frac{0.0024 \text{ lb}}{\text{MMBtu}}$$

The proposed HF emission limit of 0.00015 lb/MMBtu is beyond the MACT floor of 0.00025 lb/MMBtu. Although the calculated HCl emission limit based on the estimated system removal efficiency is slightly higher than the MACT floor, Consumers is proposing to meet the MACT floor of 0.0023 lb/MMBtu.



The Longview Power project represents the lowest HF and HCl permitted limits with a fabric filter, wet FGD and dry sorbent injection. This unit is not operational and therefore these limits have not been achieved in practice. Nevertheless, Consumers evaluated the feasibility of achieving a greater reduction down to the Longview Power levels (0.00001 lb/MMBtu for both HF and HCl). This would equate to over 99.89 percent reduction for HF and over 99.99 percent reduction for the system for HCl.

To evaluate the possibility of increased removal efficiency of HF and HCl from the current design, the use of additional control technology in the form of a dry FGD system (i.e., lime spray dryer) in conjunction with the already proposed wet FGD was investigated. While a control efficiency of 99.99 percent is not technically achievable due to the inability to measure accurately at such low levels, the cost to increase the control efficiency from an overall 98.37 percent efficiency to 99.99 percent with the addition of a dry FGD is significant. Specifically, the cost associated with adding a dry FGD to provide additional reductions in HF emissions is over \$6,000,000 per ton, and the cost for additional reductions in HCl is approximately \$900,000 per ton. A detailed cost spreadsheet is provided in Attachment A.

6.2.4 MACT for Acid Gases

The use of hydrated lime injection, fabric filter and wet FGD will control acid gas emissions to **0.00015 lb/MMBtu for HF** and **0.0023 lb/MMBtu for HCl**. The emission levels and combination of controls are currently used by the best controlled similar source and are therefore considered MACT for acid gas HAPs.

Consumers will meet the proposed limits identified above and conduct initial and periodic performance tests to demonstrate compliance with MACT. Consumers is not raising any additional considerations for the cost or energy requirements of achieving this proposed MACT limit. It is noted that the ambient air quality impact of these HAPs are well below the Screening Levels established for these compounds by the MDEQ as demonstrated in Section 6 of the Application.



6.3 METAL COMPOUNDS (OTHER THAN MERCURY)

Most of the non-mercury metallic HAPs from a PC boiler are present in the fly ash, which is emitted as particulate matter (PM). Therefore, the same control techniques that would be used to control the fly ash PM will control the non-mercury metallic HAP emissions.

6.3.1 ASCPC Metal Compounds Emission Control System

As discussed in the control technology section (Section 5.2) of the PTI application support document, the possible control technologies for particulate emissions (metal compounds) are fabric filters and electrostatic precipitators. The fabric filter and ESP technologies represent efficient and cost-effective methods for controlling PM emissions from utility boilers. While other control technologies exist, including mechanical collectors and wet scrubbers, neither has been proven to be an effective control technology due to efficiency and energy impacts and are used only as pre-cleaners to remove larger particles leaving the boiler. Since the metal compounds exist as particulates at the temperatures experienced at the fabric filter inlet, the focus is on filterable particulate emissions.

6.3.2 Metal Compounds MACT Floor Analysis

The best controlled similar PC units all use high efficiency fabric filters to achieve control efficiencies of 99 percent and above. As shown in Table 6-14 the PM emission limits for similar boilers shows that the lowest achieved PM filterable limit is 0.011 lb/MMBtu from the JEA Northside unit which sets the MACT floor.

Table 6-14. Operating Units Considered for MACT Floor Analysis for Metal HAPs

State	Unit	Size (MW)	PM Filterable Limit (lb/MMBtu)
Florida	JEA Northside	297.5	0.011
Connecticut	AES Thames	107	0.0144
Montana	Hardin	113	0.015
South Carolina	Santee Cooper Cross 3	610	0.018
Virginia	Clover	440	0.018
Missouri	Hawthorn 5	565	0.018



6.3.3 Metal Compounds Beyond the Floor MACT

The proposed ASCPC boiler is subject to BACT for PM emissions and a fabric filter will be utilized to control PM emissions from the boiler. Since the non-mercury metallic HAP emissions will be emitted as part of the PM emissions, the fabric filter will also control these emissions to the same level as for PM. The estimated control efficiency is expected to be approximately 99.9 percent. Therefore, the proposed fabric filter also represents MACT for this HAP category and further control beyond a fabric filter is not technically feasible.

A review of USEPA's RBLC database shows that there is no similar source with a lower permitted limit than the JEA Northside facility. The only other permitted limits that are lower than 0.011 lb/MMBtu are Dominion Hybrid at 0.010 lb/MMBtu and East Kentucky Spurlock 4 at 0.009 lb/MMBtu. Both are CFB's that are not operating. Dominion is permitted to burn bituminous, coal refuse and wood and Spurlock is permitted to burn run-of-the-mine Eastern bituminous and 10 percent tire derived fuel so are not similar sources to the ASCPC combustion technology or the ASCPC fuel blend.

In addition, the wet FGD on the back end of the control system will result in re-entrainment of some suspended particulate from scrubbing water. Therefore, achieving a level beyond the MACT floor of 0.011 lb/MMBtu is not feasible.

To comply with MACT, rather than establish emission limits for individual HAP metals, Consumers proposes that the particulate emission limits of **0.011 lb/MMBtu (filterable)** be used as a surrogate for other trace metal emissions. This limit represents the most stringent level of filterable particulates achieved in practice and is therefore MACT. As shown in Table 7-1, in Section 7 of this document, compliance with the particulate limits will be based on a continuous opacity monitoring system (COMS), a bag leak detector system or a particulate CEMS.

Consumers is not raising any additional considerations for the cost or energy requirements of achieving this proposed MACT limit. It is noted that the ambient air quality impact of all of the non-mercury metallic HAPs are well below the Screening Levels established for these materials



by the MDEQ as demonstrated in Section 6 of the Application. The proposed MACT limit for filterable particulate is more stringent than the proposed BACT limit listed in Section 5 of the PTI application. As such, a limit of 0.011 lb/MMBtu also represents BACT for filterable particulate emissions.

6.4 ORGANIC HAPS MACT

Similar to CO and VOCs, organic HAP compounds are emitted due to incomplete combustion of the organic matter in the coal. These emissions include alkanes, alkenes, aldehydes, alcohols and polycyclic organic matter (POM).

CO, VOCs and organic HAPs can be controlled using similar combustion methods (e.g., proper air-to-fuel ratios as well as temperature, residence time and mixing). Methods to measure CO/VOCs are much easier and cost effective than measuring each individual organic HAP. Therefore, using CO or VOCs as a surrogate for organic HAPs is a reasonable approach in determining MACT.

Consumers is proposing to use VOC emissions as a surrogate for organic HAPs. Since organic HAPs are a subset of VOCs, compliance with a VOC limit is a more direct surrogate measurement for the emissions of organic HAPs (as compared to the use of CO as an organic HAPs surrogate).

6.4.1 ASCPC Organic HAP Compounds Emission Control System

Organic HAP emissions include those compounds with a carbon chain. Most often, organic HAP emissions use CO or VOC as a surrogate for estimating control efficiencies as the controls for these pollutants will be equally effective at controlling other organic (HAP) compounds. While certain add-on control technologies are available for control of organic compounds, the only technically feasible option for the proposed ASCPC is efficient combustion. By operating the boiler in an efficient manner, most of the organic compounds will be destroyed during combustion.



6.4.2 *Organic HAP MACT Floor Analysis*

Since VOCs are typically PSD pollutants for coal-fired EGU's, emission limits and control technologies for these pollutants can be obtained through the RBLC or other sources. In determining what is a similar source for organic HAP emissions, the boiler technology (i.e., fluidized bed, supercritical, subcritical) and boiler size are more of a factor than the coal rank. Small gas or coal fired boilers that can inherently achieve significantly lower VOC emissions than large gas or coal fired boilers, under "good combustion conditions," are not similar units for consideration in the MACT floor. However, within a given boiler technology and size range, the coal rank (and the co-firing of other fuels) can impact the achievable VOC emission levels, as certain coals have an inherently higher level of volatile matter.

A review of recent BACT determinations for VOCs from similar-sized PC boilers indicates that utilizing good combustion practices is the only known control method to reduce these pollutants. As shown in Section 5.2 of the PTI application support document, add-on control such as catalytic or thermal oxidation are not considered technically feasible control options for coal-fired boilers.

A review of VOC emission levels that have been achieved in practice for similar sources shows that the lowest limit for a bituminous coal fired boiler is Santee Cooper Cross 3 at 0.0024 lb/MMBtu and the lowest PRB-fired boiler is Tucson Electric Springerville 3 at 0.0034 lb/MMBtu. Consumers is proposing to primarily burn PRB coal in the ASCPC but will have the ability to blend up to 50 percent bituminous coal. Due to the higher volatility matter content of PRB coals as compared to bituminous coals and petroleum coke, the worst-case VOC emissions will occur when the boiler operates using 100 percent PRB. As such, the floor is set at 0.0034 lb/MMBtu. Table 6-15 below shows VOC emission limits for units currently in operation.



Table 6-15. Operating Units Considered for MACT Floor Analysis for Organic HAPs

State	Unit	Size (MW)	Fuel	VOC Limit (lb/MMBtu)
South Carolina	Santee Cooper Cross 3	660	Bituminous/petcoke	0.0024
Arizona	Springerville 3	400	PRB	0.0034
Iowa	Council Bluffs	750	PRB	0.0036
Wisconsin	Weston 4	500	PRB	0.0036

6.4.3 Organic HAP Beyond the Floor MACT

The inherent design and operation of the boiler provides the factors facilitating complete combustion of most of the organic compounds. These design and operational features include: extended residence time; consistent temperature in the combustion chamber; and continuous mixture of air and fuel. The control method used to reduce organic HAP emissions from coal-fired boilers is good combustion practices. Consumers has concluded that good combustion practices also represent MACT for organic HAPs from this unit. These conclusions are consistent with the other MACT determinations for a number of recent coal-fired projects in the Midwest, including those made by the Wisconsin Department of Natural Resources. Table 6-16 presents a summary of all of the sub-bituminous coal-fired boiler facilities that have been issued PSD permits with VOC emission limitations.

Table 6-16. Permitted Units Considered for BTF Analysis for Organic HAPs

State	Unit	Size MW	Fuel	VOC Limit lb/MMbtu
Utah	Intermountain Power 3	900	Bituminous/PRB	0.0027 ¹
Arizona	Desert Rock Energy	1,500	PRB	0.003
Nebraska	Nebraska City 2	660	PRB	0.0034
Georgia	Longleaf Units 1 and 2	1,200	Bituminous/PRB	0.0036

¹ This project is listed as delayed or canceled by NextGen Energy Council.



Consumers is proposing a **VOC emission limit of 0.0034 lb/MMBtu**. This emission limit is consistent with the VOC emission limits for recently permitted similar sources, as shown in Table 6-16. Efficient combustion technologies will ensure that the ASCPC boiler is operating at optimum combustion conditions, which in turn will ensure that VOC emissions are minimized to the extent that is possible. Compliance with the proposed VOC emission limit will be based on stack testing.

Consumers is aware that there is a very limited set of VOC emissions test data for similar coal fired boilers, with some of the data associated with VOC emission rates of less than the proposed emission limit of 0.0034 lb/MMBtu. While we have considered this emissions testing data in the beyond the floor analysis, we do not believe that there is sufficient test data to indicate that a VOC emission rate of less than 0.0034 lb/MMBtu is consistently achievable for all similar coal fired boilers under normal operating conditions.

As discussed in Section 5.2.2, the concept of “achieved in practice” does not simply mean the selection of the lowest tested emission rate for a similar source. Rather, the available test data must be considered in its entirety (i.e. all results, not simply the lowest), and any resulting MACT emission limitation should include an appropriate margin of safety. This is especially important in the context of using discrete stack test data, as this type of emissions data does not readily capture the normal fuel and process variability that may occur over time. Thus, relative to the available stack test data, Consumers Energy believes that the proposed VOC emission limit is appropriate and has been selected such that compliance will be achieved regardless of variability in fuel quality or process fluctuations during normal operating conditions.

Consumers is not raising any additional considerations for the cost or energy requirements of achieving this proposed MACT limit. It is noted that the ambient air quality impact of all of the organic HAPs are well below the Screening Levels established for these materials by the MDEQ as demonstrated in Section 6 of the Application.



7.0 MONITORING, RECORDKEEPING, AND TESTING

To provide for monitoring of the proposed MACT standards, Consumers will install, calibrate, and maintain a CEMS for mercury while emissions of HF and HCl will be verified through periodic stack testing. The remaining pollutants will be tracked through the use of surrogate emissions with compliance demonstrations through stack testing and/or continuous monitoring systems. Table 7-1 describes the monitoring and testing requirements for each category of HAPs as well as the proposed control technologies. Final periodic monitoring, recordkeeping, and testing requirements will be determined upon issuance of the final PSD permit.

Table 7-1. MACT Compliance

Compound	Surrogate	Control Technology	Compliance Method
Acid Gases	HF, HCl	Fabric filter, wet FGD and hydrated lime injection	Stack testing
Mercury Compounds	Mercury	Fabric filter, SCR, Wet FGD and activated sorbent injection	Mercury CEMS
Metal Compounds	Particulate	Fabric filter (baghouse)	COMS and a bag leak detector system or a PM CEMS
Organic HAP Compounds	VOC	Good Combustion	Stack testing



8.0 SUMMARY

Consumers' combination of good combustion practices and back-end controls consisting of hydrated lime injection, activated sorbent injection, fabric filters and wet flue gas desulfurization represents control measures that are as stringent as the controls used by the best similar source and therefore will meet MACT under 112(g) for HAP emissions from the proposed ASCPC boiler.

Table 8-1 summarizes the MACT emission limits:

Table 8-1. MACT Summary

Compound	MACT Limit	Averaging Time Period
Acid Gases (HF and HCl)	HF: 0.00015 lb/MMBtu HCl: 0.0023 lb/MMBtu	2-hour
Mercury Compounds	0.0079 lb/GWh	12-month rolling
Metal Compounds (PM-Filterable)	0.011 lb/MMBtu	2-hour
Organic HAP Compounds (VOC)	0.0034 lb/MMBtu	2-hour



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ABBREVIATIONS AND ACRONYMS

ACI	Activated Carbon Injection
AQCS	Air Quality Control System
ASCPC	Advanced Supercritical Pulverized Coal (Proposed Unit)
BTF	Beyond the Floor
Btu	British Thermal Units
CAMR	Clean Air Mercury Rule
CEMS	Continuous Emission Monitoring System
CFB	Circulating Fluid Bed
CO	Carbon Monoxide
COMS	Continuous Opacity Monitoring System
CS-ESP	Cold Side Electrostatic Precipitator
DOE/NETL	Department of Energy/National Energy Technology Laboratory
EGU	Electric Generating Unit
ESP	Electrostatic Precipitator
FF	Fabric Filter
FGD	Flue Gas desulfurization
GWh	Gigawatt hour (1000 MWh)
H ₂ SO ₄	Sulfuric acid
HAPs	Hazardous Air Pollutants
HCl	Hydrogen chloride
HF	Hydrogen fluoride
Hg	Mercury
LAER	Lowest Achievable Emission Rate
lb	Pound
LNBs	Low NO _x Burners (LNBs)
MACT	Maximum Achievable Control Technology (MACT)
MCL	Michigan Compiled Law
MDEQ	Michigan Department of Environmental Quality (MDEQ)
MMBtu	Million British Thermal Units
MWh	Megawatt hour (1000 Kilowatt hours or one million watt hours)
NACAA	National Association of Clean Air Agencies
NESHAP	National Emission Standard for Hazardous Air Pollutants
NO _x	Oxides of Nitrogen
NSPS	New Source Performance Standards
NSR	New Source Review
OHM	Ontario-Hydro Method
PAC	Powdered Activated Carbon



PM ₁₀	Particulate Matter less than 10 microns in diameter
POM	Polycyclic organic matter
PRB	Powder River Basin
PSD	Prevention of Significant Deterioration
PTI	Permit to Install
RACT	Reasonably Available Control Technology
RBLC	RACT/BACT/LAER Clearinghouse
SAIC	Science Applications International Corporation
SCEM	Semi-continuous Emission Monitoring
SCR	Selective Catalytic Reduction
SDA	Spray Dryer Absorber
SO ₂	Sulfur dioxide
T-BACT	BACT for Toxic Air Contaminants
TBtu	Trillion British Thermal Units
UCL	Upper Confidence Level on the Mean
µg/m ³	micrograms per cubic meter
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile organic compound

Attachment A
Control Technology Cost Basis for Dry Flue Gas Desulfurization for Acid Gas Control
One (1) 930 MW Pulverized Coal Supercritical Boiler

Cost Item	Cost Description	Cost Factor	Cost 2007 \$
DIRECT CAPITAL INVESTMENTS (DCI)			
	Buildings		\$ 8,911,000.00
	Site Preparation		\$ 532,000.00
	Installation Cost		\$ 31,654,000.00
	Purchased Equipment		\$ 63,840,000.00
	Taxes	6% on 50% of buildings and foundations	\$ 267,330.00
	TOTAL DCI		\$ 105,204,330.00
INDIRECT CAPITAL INVESTMENT (ICI)			
	Engineering		\$ 5,261,812.50
	Construction & Field Expenses		\$ 21,047,250.00
	Contractor Fees		\$ 6,108,750.00
	Start-up	Included with Field Expense	\$ -
	Performance Test	Included with Field Expense	\$ -
	Contingencies		\$ 9,587,322.00
	TOTAL ICI		\$ 42,005,134.50
TOTAL CAPITAL INVESTMENT (TCI)	DCI + ICI		\$ 147,209,464.50
DIRECT OPERATING COSTS (DOC)			
	Labor		
	- Operator	2 operator @ \$115,000/year	\$ 230,000.00
	- Supervisory	20% of Operator Labor Cost	\$ 46,000.00
	- Maintenance	1 technicians @ \$115,000/year	\$ 115,000.00
	Materials		
	- Maintenance Materials		\$ -
	- Reagent (Lime)	\$70 per ton	\$ 1,370,502.00
	- Limestone		\$ -
	- Water	440 gpm	\$ 1,063,814.40
	Utilities		
	- Electricity	800 kW	\$ 419,541.43
	- Fuel		\$ -
	- Pressure Drop	5 " pressure drop	\$ 1,103,760.00
	- Waste Disposal	13.33 per ton	\$ 426,213.42
	TOTAL DOC		\$ 4,774,831.25
INDIRECT OPERATING COSTS (IOC)			
	Overhead	60% of Operator labor & Maintenance	\$ 234,600.00
	Property Taxes	1% of TCI	\$ 1,472,094.65
	Insurance	1% of TCI	\$ 1,472,094.65
	Administrative Charges	2% of TCI	\$ 2,944,189.29
	Capital Recovery	20 years; 7% interest = 0.0944 CRF	\$ 13,896,573.45
	TOTAL IOC		\$ 20,019,552.03
RECOVERY CREDITS (RC)			
	Materials		\$ -
	Energy		\$ -
	TOTAL RC		\$ -
TOTAL ANNUALIZED COSTS (TAC)	DOC + IOC - RC		\$ 24,794,383.28
HF EMISSIONS			
	98.37% Control (lb/MMBtu average)	0.00011573	4.15
	99.89% Control (lb/MMBtu average)	3.85E-06	0.14
	TOTAL REDUCTION		4.01
	Cost-Effectiveness	\$ per ton of HF removed	\$ 6,177,928
HCl EMISSIONS			
	98.37% Control (lb/MMBtu average)	0.0007172	25.73
	99.99% Control (lb/MMBtu average)	4.4E-06	0.16
	TOTAL REDUCTION		25.57
	Cost-Effectiveness	\$ per ton of HCl removed	\$ 969,678