Prepared for:
Wolverine Power Supply Cooperative
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Supplement to CAA Section 112(g) MACT Mercury - Amended

Application No. 317-07

Wolverine Clean Energy Venture

Rogers City, MI

ENSR
August 2008

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1.0 INTRODUCTION - MACT SUPPLEMENT

This supplement is being provided to the Michigan Department of Environmental Quality (MDEQ) in response to a June 24, 2008 letter from MDEQ concerning case-by-case maximum achievable control technology (MACT) analysis for the proposed Wolverine Clean Energy Venture (WCEV) Circulating Fluidized Bed (CFB) boilers. This supplement responds to the mercury (Hg) issues communicated in the June 24, 2008 letter, and provides additional background and analysis to provide the Department with a well documented 112(g) Maximum Available Control Technology (MACT) Demonstration for Hg for the proposed WCEV CFB boilers. The MDEQ request has been repeated below in ***bold italics*** followed by additional information intended to address the request.

> ***"The application proposes a MACT emission limit of 0.008 lb/GWhr for mercury and contends that this is as stringent as the controls on the best similar source. The details of how the proposed emission limit is calculated as the "best" controls which are a polishing scrubber, activated carbon injection, and fabric filtration for a CFB boiler is lacking. It is stated in the application that, "This emission limitation is based on the proposed Michigan Mercury Rule." Please submit the demonstration of how 0.008 lb/GWhr is based on the "best" controls for the MACT determination on the proposed CFB boilers."***

WCEV had proposed the MACT Limitation of 0.008 lb/GW-hr based on a combination of the independently derived case-by-case MACT limitation of 0.0077 lb/GW-hr rounded to three significant digits and consideration at that time of the proposed MI Mercury Rule Standard of 0.008 lb/GW-hr. Based on the Department's request for more complete analysis, the full derivation of the case-by-case MACT limitation for Hg of 0.0077 lb/GW-hr is provided in the following analysis.

Based on limited available data from which to establish the MACT Floor for the proposed WCEV CFB boilers, multiple factors were considered in proposing this level as MACT, including Michigan's proposed state regulations for control of mercury. This practice is consistent with, and goes beyond CAA 40 CFR 63.53(b)(2)(iii) which requires an applicant to incorporate "Any existing Federal, State, or local limitations or requirements governing emissions of hazardous air pollutants from those emission points…" Thus, part of the basis for initially proposing a mercury MACT limit of 0.008 lb/GW-hr included necessary compliance with the proposed Michigan Mercury Rule as stated in the Application. This is not, however, the only basis for the proposed MACT determination.

2.0 PROCEDURE FOR DEVELOPMENT OF CASE-BY-CASE HG MACT DETERMINATION

In its various MACT guidance documents, EPA frequently cross references procedures for determining case-by-case MACT for new units under Section 112(g) and for existing units under Section 112(j). The substantive difference in these two provisions is that case-by-case MACT for new units may not be less stringent than *the emission limitation achieved in practice by the best controlled similar source,* while case-by-case MACT determinations for existing units may not be less stringent than *"the average emission limitation achieved by the best performing 12 percent of the existing sources in the United States (for which the Administrator has emissions information).* This case-by-case MACT demonstration is based on the more stringent new source requirement, but follows the procedures of performing a case-by-case MACT analysis that are otherwise common to new and existing sources.

In "Guidelines for MACT Determinations under Section 112(j) Requirements" (EPA 453/R-02-001), EPA notes "case-by-case MACT determinations should be "equivalent" to the emission limitation that the source category would have been subject to if a relevant standard had been promulgated under Section 112(d) (or Section 112(h)).

EPA has divided the procedure for making a Determination of MACT into three "tiers", including several "steps" within each tier:

Tier I – Making a MACT Floor Finding

Step 1) – Identify the MACT Emission Unit

Step 2) – Make a MACT Floor Finding

According to EPA guidance, if a MACT Floor can be determined from available data, proceed directly to Tier 3. If a MACT Floor cannot be determined from available data, proceed to Tier 2.

Tier II – Considering All Control Technologies

Step 1) List all available /reasonable applicable control technologies

Step 2) Eliminate technically infeasible control technologies

Step 3) Determine efficiency of applicable control technologies

Tier III – Identifying MACT

Step 1) Identify maximum emission reduction technology

Step 2) Conduct an impacts analysis

Step 3) Establish the MACT emission limitation

These individual Tiers and steps for the case-by-case MACT analysis performed for the WCEV boilers are documented in the following Sections.

3.0 TIER I - MACT FLOOR FINDING

The first tier in performing the case-by-case MACT analysis is to identify the "MACT Floor", or in this case the best controlled similar source for Hg. This evaluation started with the available data from the universe of coal-fired boilers, including both pulverized coal (PC) and circulating fluidized bed (CFB) units, followed by identification of emission sources similar to the proposed WCEV units. EPA's Information Collection Request (ICR) database, available data for coal-fired PC and CFB units that have demonstrated compliance with MACT limits and PC and CFB units that have demonstrated compliance with various state Hg control regulations represent the identified available database for performing the MACT Floor analysis. Recently proposed MACT limits for units that have yet to be built or to have demonstrated continuous compliance, although not indicative of the best controlled similar source (since they have yet to operate) were also considered in Tier III for purposes of benchmarking and consideration as potential beyond the MACT Floor limitations.

3.1 Tier 1, Step 1 - Identify the MACT Emission Unit

In this case the MACT emission units being evaluated are the two proposed 300 MW multi fuel-fired CFB boilers to the extent that they fire coal as fuel. In the preamble to EPA's proposed National Emissions Standards for Hazardous Air Pollutants (NESHAPS) for New and Existing Electric Utility Steam Generating Units (F.R. Vol. 69 / Friday January 30, 2004), EPA states "…this Rule does not apply to the non-regulated supplementary fuels" [petroleum coke and tire derived fuel]. The proposed boilers are designed and intended to fire up to 100% sub-bituminous coal and/or bituminous coal in any combination, with or without the supplemental fuel petroleum coke and are subject to MACT requirements based on their use of coal.

3.2 Tier 1, Step 2 – Make a MACT Floor Finding

The MACT Floor should be based on *"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 executive director, 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."* WCEV's process of identifying the MACT Floor for the subject CFB boilers is documented in the following sections.

3.2.1 Identification of Best Controlled Similar Source

The definition of *Similar Source* for purposes of case-by-case MACT is provided at 40 CFR 60.41 – *Definitions,* as follows;

> *"Similar Source means a stationary source or process that has comparable emissions and is structurally similar in design and capacity to a constructed or re-constructed major source such that the source could be controlled using the same control technology."*

In an RTI Memorandum "MACT Floor Analysis for Coal- and Oil-fired Electric Utility Steam Generating Units National Emission Standards for Hazardous Air Pollutants", December 2003, and subsequently in EPA's proposed "National Emission Standards for Hazardous Air Pollutants" proposed rule (FR January 30, 2004), USEPA states;

"Based on their unique firing designs, FBC units employ a fundamentally different process for combusting coal from that employed by conventional-, stoker-, or cyclone-fired boilers. Fluidized-bed combustors are capable of combusting many coal ranks, including coal refuse. For these reasons, FBC can be considered a distinct type of boiler".

In its proposed Rulemaking, EPA elected not to establish CFBs burning various subcategorized coal ranks as a separate source subcategory for establishing Hg limits. Sub categorization of source categories is an important first step in identifying the best controlled similar source. In its proposed MACT Floor determination for new coal-fired utility steam electric generating units, EPA considered, but elected not to propose to subcategorize CFB boilers separately from pulverized coal (PC) units, noting that based on the limited 1999 ICR data set there was no discernable difference in emissions of Hg between the two given equivalent fuels fired. While EPA agreed that CFBs, PCs and Integrated Gasification Combined Cycle units (IGCCs) are fundamentally different process units, EPA proposed to combine CFBs and PCs under a single 112(d) MACT limitation based on their review of the limited mercury emission data available at the time. Much additional work has been done to better understand Hg control for coal-fired boilers since EPA's proposed National Emissions Standards for Hazardous Air Pollutants (NESHAPs) 112(d) Rule, and it is worthwhile to consider if differences in process and control technology influence case-by-case determination of the best controlled similar source.

CFB boilers are neither structurally similar in design and capacity nor able to be controlled using the same technology as PC boilers. For example, most PC boilers being permitted today are in the 600 MW size range, vs. the 330 MW maximum proven size of CFB boilers. No PC boiler burns coal in a medium temperature (~1,600 degrees F) fluidized bed of solids rich in alkali content, nor relies on this bed material plus optimized bed temperature control for multi-pollutant emissions control. PC boilers can not operate within the furnace temperature range of a CFB and vice versa. While all new PCs employ Selective Catalytic Reduction (SCR) for both NO_x control and pre-oxidation of mercury for easier collection, CFBs are not able to use SCR control technology to help pre-condition Hg for subsequent capture in downstream control devices. Finally, only CFB boilers are routinely capable of accommodating multiple fuels including sub bituminous coal, bituminous coal and petroleum coke, individually or in varying combinations- the fuel mix proposed for the WCEV Project. A CFB boiler that has been designed to utilize this range of fuels in ever varying proportions is engineered, designed and constructed specifically to accommodate that fuel flexibility.

In order to be considered a similar source for purposes of determining the case-by-case MACT Floor, another source would have to have *comparable emissions **and** be structurally similar in design and capacity… such that the source could be controlled using the same control technology."* Small CFB Boilers, that is industrial / small utility scale boilers less than 150 MW in capacity and any pulverized coal-fired boiler or stoker boiler should not be considered "similar" to a 300 MW multi fuel-fired CFB, since they are not similar in structural design or capacity, and could not be controlled using the same control technology. Thus, the determination of the best controlled similar source in this case-by-case 112(g) MACT analysis should be based upon the best controlled similar multi fuel fired CFB boiler in the 150-350 MW range.

As USEPA elected to subcategorize EGU's based on coal rank, it is also appropriate to review selection of fuel mix for the purpose of identifying similar sources. Case-by-case MACT must consider the use of lower emitting processes or pretreatment alternatives in addition to boiler control

technology in the evaluation of MACT alternatives. In establishing its proposed MACT Floor for EGU's, USEPA recognized "*Other types of fuel are blended with coal for a variety of unit specific needs. The two most common "supplementary fuels" in the coal industry are petroleum coke and tire-derived fuel (TDF). These supplementary fuels are generally blended with a much larger percentage of coal before combustion. If a unit were to burn one, or a combination of these supplementary fuels exclusively, it would not be subject to the coal and oil-fired electric utility NESHAP.*" Contrary to USEPA's premise, the proposed WCEV CFB's are designed to burn primarily petroleum coke supplemented with sub bituminous coal. The proposed units are also designed to burn up to 100 percent sub bituminous coal and as a secondary fuel, up to 100 percent bituminous coal. Only CFB boiler technology can accommodate this range of fuels on a day-to-day basis. As stated previously, case-by-case MACT is only applicable to the portion of the fuels that will be coal.

For purposes of MACT evaluation, and based on USEPA guidance, similar sources to the proposed WCEV CFBs, for purposes of identification of the best controlled similar source, should be limited to operating coke and coal-fired CFBs in the same capacity range of 150 -350 MW if proposed by the applicant and approved by the permitting Authority. In order to be entirely comparable, such similar units would have to have been tested under the full variation of potential fuels and fuel mixes as the range of coal sources and blends that the WCEV CFBs will process over their lifetime, and have demonstrated continuous compliance (based on Hg CEMs) with an enforceable MACT standard on an annual basis. We note that data from similar units that happened to be burning a blend of petroleum coke and coal can be misleading, in that that portion of their fuel that is coke is a relatively low Hg supplemental fuel compared with sub bituminous or bituminous coals.

3.2.2 Available Data from EPA ICE Database

A substantial amount of Hg stack test data was collected by USEPA during its Electric Utility /Information Collection Effort (EU/ICE) data collection process. We note that this data was originally collected during the 1999 timeframe, and represents individual stack tests from 79 operating boilers (EPA EU/ICE Part III Stack Emission Database). The units tested did not operate with any Hg limitation in their permits, and had no requirement to demonstrate continuous compliance with any particular limit. The data therefore reflects "snapshot" stack tests, and do not necessarily reflect worst case emissions, and in some cases might actually reflect best case conditions. As EPA stated in their MACT Floor development document ("MACT Floor Analysis for Coal- and Oil-Fired Electric Utility Steam Generating Units National Emission Standards for Hazardous Air Pollutants" December 2003), "testing for a short time may not reveal the range of emissions that would be found over extended time periods. Normal changes in operating conditions or in fuel characteristics may affect emission levels. For example, an increase in Hg content of the fuel being fired in a unit may tend to increase the Hg emission rate from the associated stack. Mercury emissions rates may also change with unit loads." EPA sought to account for variability in stack tested emissions vs. annual actual emissions by including these considerations in their MACT Floor development for new units. The ICE data indicated that mercury content in the coal fired varies from less than 2 pounds per trillion BTU (lb/TBtu) to over 14 lb/Tbtu, and that snapshot outlet emissions from the stack tested units ranged from 0.002 pounds per gigaWatt-hour (lb/GW-hr) to over 0.1 lb/GW-hr. Not surprisingly, the units tested with lowest coal Hg content tended to also yield the lowest Hg emission levels (however this was not universally true, as shown in the data for waste coals). USEPA relied upon this data set to develop a proposed MACT Floor for coal-fired electric utility

steam-generating units in 2003 as part of its 112(d) proposed rulemaking. Based on EPA's review and statistical analysis of the data, and based on EPA's proposed mechanism to convert snapshot stack test data to representative continuously monitored annual emission limitations, including reasonable allowance for variability, EPA determined the MACT Floor for new units to be 0.0196 lb/GW-hr for sub-bituminous coal-fired units, 0.006 lb/gW-hr for bituminous coal-fired units, and weighted average values in between for units firing sub-bituminous/bituminous coal blends. EPA's proposed MACT Floor for new units under Section 112(d) represented the starting point in establishing the MACT Floor for the WCEV 112(g) case-by-case MACT determination.

WCEV also considered data from specific units with low tested Hg emission rates. The Walter Scott (MidAmerican Council Bluffs) unit in Iowa burning PRB coal has been stack tested for demonstration of compliance with a 0.015 lb/GW-hr equivalent MACT limitation. Springerville Unit 3 (a PC boiler burning sub-bituminous coal) demonstrated 0.069 lb/GW-hr. The Intermountain Power Unit burning a blend of bituminous coal and delayed petroleum coke was tested at 0.0117 lb/GW-hr, presumably also attributed to the presence of low Hg delayed petroleum coke.

The lowest Hg MACT limit being achieved in practice identified from available data for any unit burning sub-bituminous coal and using powdered activated carbon is the Mid-American pulverized coal Unit 3 in Iowa, reported by Iowa DEP as having passed an initial Hg compliance test based on its case-by-case 112(g) MACT Floor limit of 0.015 lb/GW-hour equivalent. The lowest demonstrated MACT limit for a similar CFB boiler burning bituminous coal is Spurlock 3 at 0.0265 lb/GW-hr, although this value may be misleading as the unit is listed as also firing tire derived fuel (TDF) which has very little Hg.

3.2.3 Emission Limits in State Rules

WCEV also considered Hg emission limits contained in various state Hg rules, as summarized in the following Table;

Mercury Limits in State Statutes or Legislation

State	Statute or Legislation	Hg Limit (lb/GWh)	Hg Reduction (%)
Connecticut	State statute requires 90% reduction or compliance with emission limit of 0.6 lb/TBtu by 07/01/08, with provision to meet alternative limit if controls fail to achieve limit. More stringent limits possible after 07/01/12.	0.006	90
Massachusetts	State rule requires 85% capture or compliance with emission limit of 0.0075 lb/GWh by 01/01/08 and 95% capture or 0.0025 lb/GWh by 10/01/12. Averaging between units at same facility allowed.	0.0075	85
New Jersey	Adopted rule requires 90% control or compliance with emission limit of 3 mg/MWh by 12/15/07. A multi-pollutant approach can be used for initial reduction and extend compliance to 12/15/12.	0.0066	90
Delaware	State plan calls phased approach: Phase 1 requires 80% reduction of baseline emissions (emission limit of 1.0 lb/TBtu) by 2009; and Phase 2 requires 90% reduction of baseline emissions (emission limit of 0.6 lb/TBtu) by 2009	0.01	80
Montana	State adopted rule that establishes an emission limit of 0.9 lb/TBtu for facilities using sub-bituminous coal and 1.5 lb/TBtu for plants using lignite. If a facility uses appropriate controls but cannot meet the emission limit, it can apply for a temporary alternate emission limit.	0.009	None
Utah	State adopted rule that 90% control or compliance with emission limit of 0.65 lb/TBtu by 2013.	0.0065	90

We note that these limits range from 0.006 lb/GW-hr to 0.009 lb/GW-hr, however all except Montana (at 0.009 lb/gW-hr) allow for higher Hg emission levels so long as a minimum specified % removal (80-90%) is achieved. Thus, the MACT Floor established by units already complying with these standards reflects either a 90% control level or the limit specified, whichever is higher. Based on these state requirements and available data from operating sources, operation of Hg control

technology capable of removing at least 90% of mercury in the fuel(s) represents the best Hg control demonstrated by other units.

3.2.4 Selection of the MACT Floor for the WCEV CFBs

In proposing a MACT Floor for the proposed multi fuel-fired CFBs, all of the factors discussed above were considered. These are summarized in the following Table.

MACT Floor Basis Candidates for New Units

Source	Fuel	Boiler Type	Estimated % Reduction	Hg Emission Level (lb/GW-hr)
USEPA Proposed MACT Floor for New Units 112(d)	Sub-bituminous Only	Any	~ 90%	0.0196
USEPA Proposed MACT Floor for New Units 112(d)	Bituminous Only	Any	~90%	0.006
USEPA Proposed MACT Floor for New Units 112(d)	50/50 Bituminous/sub-bituminous blend	Any	~90%	0.013
Stockton CoGen	Bituminous and Delayed petroleum Coke Blend	CFB	~90%	0.0013
JEA Northside	50:50 Bituminous and Delayed petroleum Coke Blend	CFB	~90%	0.024 (USDOE)
JEA Northside	80:20 Pet Coke and Bituminous Coal Blend	CFB	~90%	0.00021 (USDOE)
Hugh Spurlock 3	Bituminous	CFB	90+%	
Mid-American 3	Sub-Bituminous	PC	90+%	0.015
MA Brayton Point 1-3	South American Bituminous	PC	0.0075 or 90%, whichever is	0.0075 or 90%, whichever is

			higher	higher
CT Bridgeport Harbor	Indonesian Bituminous	PC	0.006 or 90%, whichever is higher	0.006 or 90%, whichever is higher
MI Proposed Mercury Rule Standard	Not Specified	Any	Not specified – Based on 90%	0.008

Since no continuous or annual average Hg data could be located for a similar source to the proposed WCEV CFBs, EPA's proposed MACT Floor for the "worst case" fuel (sub-bituminous coal) was determined to reflect the MACT Floor for the proposed WCEV boilers. The "worst case" fuel was identified as sub bituminous coal because based on the ICE data available to EPA during its analysis to establish the MACT Floor, the available data showed that units burning sub-bituminous coal had higher Hg emissions (and hence a higher MACT Floor) than those burning bituminous coal. Since no available data was identified for another similar CFB boiler demonstrating continuous (12-month rolling average) compliance with a numerical limitation for Hg while firing any combination of bituminous or sub bituminous coals, EPA's proposed MACT Floor for new coal-fired steam electric generating units became the presumptive MACT Floor. However due to the data limitations noted, WCEV went on to consider Tier II of the case-by-case MACT determination process, consideration of Hg control technologies.

4.0 TIER II - CONSIDERATION OF HG CONTROL TECHNOLOGIES USED BY THE BEST CONTROLLED SIMILAR SOURCE

Case-by-case MACT is designed to *"reflect the maximum reduction in emissions which can be achieved by the Best Available Control Technology"* (CAA § 112(g)(2)(A)). Congress specified that new sources must adopt at minimum *"the emission control that is achieved in practice by the best controlled similar source, as determined by the Administrator."* (CAA § 112(d)(3)).

No complete information regarding the Hg control being achieved in practice by similar CFBs was available, because no similar multi fuel CFB could be identified of a similar capacity, that was also required to operate with 12-month rolling MACT limits for Hg, or had any regulatory requirement to demonstrate compliance continuously using Hg CEMs. In its document "Guidelines for MACT Determinations under Section 112(j) Requirements" (EPA 453 / R-02-001), USEPA states *" The methods used to establish an emission standard or case-by-case MACT emission limitation will be highly dependent upon the amount and type of information available, the complexity of the source, and the number of feasible control options. In some instances, a permitting authority's control technology determination procedures may yield the appropriate level of control without specifically following this guidance or making a MACT floor finding. The EPA is less concerned with the actual methodologies used, and more concerned that the outcome requires sources to comply with an emission limitation based on MACT."* Given that only very limited one time stack test data were available for any similar capacity multi fuel-fired CFB's, and since even those units for which data were available had no requirement to demonstrate continuous 12-month rolling average compliance

using continuous Hg emissions monitors, the case-by-case MACT determination for the WCEV CFB's next considered the emission control technology being used by the best controlled similar source. For Hg, this air pollution control train was determined to be a CFB boiler followed by high performance fabric filtration. Finally, the levels of mercury control being achieved by PC boilers burning the worst case fuel, sub bituminous coal, were also considered based on their potential mercury removal associated with add-on controls.

MACT limits also must be continuously achievable, that is, they must be able to be met continuously under reasonably foreseeable worst-case conditions (*Sierra Club v. EPA*, 167 F.3d 658, 665 (D.C. Cir. 1999)). Since fuel properties that affect Hg emissions vary widely from various types of bituminous coal to sub bituminous coals, and by definition vary widely even within an existing coal rank, in order to ensure that MACT limits are continuously achievable any enforceable MACT permit limit must account for reasonable variations in particular fuel properties. USEPA described the need to address uncertainty and variability from emission test results in developing proposed MACT limits for new EGUs in 69 Fed. Reg. 4678. Short-term stack test results do not adequately account for that variability for the purposes of establishing numerical MACT limits for new facilities. Thus, the MACT limit for mercury is proposed using a 12 month rolling averaging time. In its MACT Floor development document, USEPA notes that delayed petroleum coke is a petroleum refining byproduct and is not coal, and hence is not covered under this MACT category and is not a fuel that is subject to 112(g) MACT Floor limits for Hg. Petroleum coke has less Hg content than either bituminous coal or sub-bituminous coal, and hence even lower actual Hg emissions will result whenever it is blended with coal. This assumption is confirmed from testing of Stockton CoGen which demonstrated very low emissions (0.0013 lb/GW-hr) with a blend of bituminous coal and delayed petroleum coke.

4.1 Tier II, Step 1 – List Available / Reasonable Applicable Control Technologies

All known state-of-the-art large CFBs, regardless of fuel fired, utilize temperature controlled combustion in a bed of fluidized sorbent, selective non-catalytic reduction (SNCR) and a high performance fabric filter to control emissions including Hg. A few units (i.e. AES Puerto Rico) also utilize polishing SO_2 scrubbers. None of the CFB boilers for which data is available use any other Hg control technology, and are all believed capable of capturing about 90% of mercury contained in bituminous coal. This Hg reduction control, therefore, represents the control used by the best controlled CFB boilers and therefore is another useful component of establishing the MACT Floor for the proposed WCEV boilers.

Much work has been done to demonstrate the capability of activated carbon injection (ACI), halogenated activated carbon, trona, or other similar solid sorbents upstream of a fabric filter to achieve 90+ % mercury control when firing bituminous or sub-bituminous coal, apparently whether in a CFB or PC boiler. This is the basis for the Electric Power Research Institute (EPRI) TOXECON process, demonstrated at the WE Energies Presque Isle PC plant and others. This technology is considered a reasonable beyond the MACT Floor control technology for the proposed WCEV boilers.

WCEV also evaluated the potential of using "low Hg, high chlorine coals" as part of a total MACT strategy for the WCEV CFBs. This alternative was addressed by EPA in its MACT Floor development and rejected as a technically infeasible alternative.

4.2 Tier II, Step 2 – Eliminate Technically In-feasible Alternatives

In its MACT Floor development for coal-fired steam electric utility generating units, EPA considered pre-combustion measures such as use of lower HAP fuels, coal washing, or coal pretreatment and found these to be technically infeasible for practical application to coal-fired boilers due to geography, delivery infrastructure, and project design. The ICR data indicate that there are many variables that influence mercury emissions from coals, including not only the mercury content of the fuel but its rank, chlorine content, heating value, ash content, ash mineral content and other factors which may be as yet not well understood. However, it is clear from EPA's database that certain high mercury content coals (for example waste coal) exhibit low mercury emissions while certain low mercury content coals (such as certain Powder River basin seams) exhibit higher mercury emissions (as seen in EPA's proposed MACT limit for sub-bituminous ranked coal).

Coal washing is a means to reduce the sulfur content of high sulfur, bituminous coal. All of the high sulfur bituminous coals considered in this project are washed coals. Sub bituminous coals, which represent greatest mercury emissions, are not washed because of the low sulfur content to begin with and the relatively high moisture content.

Finally, several demonstration technologies have been proposed to pre-treat coal by heating it to remove some of the mercury. This technology is not, however, commercially available nor technically feasible to "pre-treat" the range of coals that may be utilized by the proposed WCEV boilers.

No known similar source is required to employ pre-combustion Hg reduction measures as part of a required MACT limitation. EPA's analysis of potential pre-combustion measures found them to be infeasible for purposes of setting MACT limitations for coal-fired utility steam-electric generating units.

4.3 Tier II, Step 3 – Determine Efficiency of Applicable Control Technologies

Despite the lack of available emission data from similar CFB boilers, all known CFBs tested for Hg utilize limestone injection followed by a fabric filter, the combination of technologies believed to result in the maximum level of mercury reduction from existing similar CFB boilers. The level of Hg control that can be achieved by large CFB boilers with this same control technology is in the range of 90% reduction from inlet Hg conditions. This value is generally consistent with EPA's proposed MACT Floor and the various state's alternative % reduction requirements.

Based on review of the available information, the MACT Floor technology, (a well designed CFB boiler followed by a high performance fabric filter and polishing SO_2 scrubber) represent the Hg control technology employed by the best controlled CFB boilers. When burning bituminous coal, this technology is believed capable of about 90% Hg reduction, and represents the control technology equivalent of the MACT Floor for this source subcategory. The proposed WCEV boilers will be required by permit limitation to utilize equivalent or better mercury control technology.

5.0 TIER III – IDENTIFYING MACT

Having identified the case-by-case MACT Floor for the proposed WCEV CFB boilers as a combination of the same Hg control technology employed by the best controlled operating CFB

boilers with a maximum Hg emission limitation equivalent to EPA's proposed MACT Floor for either new PC or CFB coal-fired utility steam electric generating units based on firing the worst case fuel (sub bituminous coal), the next step in a case-by-case MACT analysis is to evaluate potential levels of control that are more stringent than, or "beyond the MACT Floor". This analysis is provided in the following sections.

5.1 Tier III, Step 1 – Identify Maximum Emissions Reduction Technology

40 CFR 63.43(d) provides the general principals of case-by-case MACT determinations;

(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 on the available information, as defined in this subpart, the MACT emission limitation and control technology … 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 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 and 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 limitations and requirements of the proposed standard or presumptive MACT determination.

Case-by-case MACT is defined in 40 CFR 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 executive director, 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."*

As identified above, a case-by-case MACT Limitation may require a particular control technology capable of achieving the maximum degree of reduction [in Hg] or may be in the form of *a specific design, equipment, work practice, or operational standard, or a combination thereof* when it is not feasible to identify and enforce a numerical MACT emission limitation. Since no continuously monitored, 12-month rolling average MACT Floor limitation was identified for a similar source, a proposed MACT limitation based on CEMs can not be translated without proposing some assumed

variability factor. It is therefore appropriate, since a comparable numerical emission limitation can not be determined, to include a combination of both a numerical limitation *and* control technology limitation in the case-by-case MACT determination. WCEV proposes the primary case-by-case MACT limitation for mercury as the requirement to incorporate the best (maximum available) Hg control technology available – CFB boiler technology followed by sorbent injection upstream of a high performance fabric filter, a combination of control technology considered to be "beyond the MACT Floor". WCEV next considered proposing a numerical Hg limitation that would also be more stringent than, or "beyond the MACT Floor". While emission levels proposed or being permitted for other types of boilers that have yet to demonstrate compliance can not be considered representative of "the best controlled similar source", they may be considered as proposed limitations that are beyond the MACT Floor. Available data identified for both CFB and PC coal-fired boilers with mercury limitations are summarized in the following tables.

Name	State	Description	Date Issued	Generation per Unit (MW)	Heat Input per Unit (MMBtu/hr)	Fuel	Hg Permit Limit (lb/TBtu)	Hg Permit Limit (lb/GWh)	Controls	Operation
Bridgeport Harbor Station Unit 3	CT	PC Boiler	02/02/07	410	NA	Sub-bituminous	0.6	0.006	ESP, ACI, FF	Not yet tested
Prairie State	IL	2 PC Boilers	04/28/05	750	7,450	Bituminous Coal	2.1	0.021	SCR, ESP, WFGD, WESP	Began construction in Ocotber 2007
Longview Power	WV	PC Boiler	03/02/04	600	6,114	Bituminous Coal	2.4	0.024	SCR, FF, WFGD	Began construction in January 2007
Cross Generating Station Unit 3 & 4	SC	2 PC Boiler	02/05/04	660	5,700	Bituminous Coal	3.6	0.036	SCR, ESP, WFGD	Under construction subject to consent decree with EPA
Elm Road Generating Station	WI	2 PC Boilers	01/14/04	615	N.A.	Sub-bituminous	1.12	0.0112	SCR, FF, WFGD, WESP	Began construction in March 2007
Plum Point Energy Associates	AK	PC Boiler	08/20/03	800	8,400	Sub-bituminous	12.8	0.128	SCR, SI, FF	Began construction in March 2007
Trimble County	KY	SCPC Boiler	06/20/03; (2/29/08 Rev.)	750	6,942	Bituminous/ Sub Bituminous	N.A.	0.013	SCR, ESP, ACI, WFGD, WESP	Still in the environmental permitting process.
Council Bluffs Energy Center	IA	SCPC Boiler	6/17/2003	790	N.A.	Bituminous/ Sub Bituminous	1.7	0.017	SCR, FF, WFGD	Began operations in June 2007
Thoroughbred Generating Station	KY	2 PC Boilers	10/11/2002 (5/10/06 Rev.)	750	7,443	Bituminous	N.A.	0.021	SCR, ESP, WFGD, WESP	On hold pending litigation
Springerville Units 3 and 2	AZ	2 PC Units	2/14/2002	400	N.A.	Sub-bituminous	6.9	0.069	LNB, OFA, SDA, FF	Unit 3 in operation and Unit 4 under construction

These values are not directly comparable to those for CFB boilers, since all PCs listed utilize SCR oxidation of mercury to a more collectable form as part of their overall control strategy. Of more relevance are the Hg levels being proposed for other CFB boilers, even though these have yet to be demonstrated in practice.

Based on the MACT limits being proposed for other new CFB boilers, several facilities with the same or similar control technology being proposed for the WCEV CFBs (CFB technology with activated carbon injection and fabric filter, followed by a polishing scrubber), WCEV believes that mercury control levels beyond the MACT floor are achievable.

Mercury Limits in Recently Approved Permits for CFB Boilers

Name	State	Description	Date Issued	Generation per Boiler (MW)	Heat Input per Unit (MMBtu/hr)	Fuel	Hg Permit Limit (lb/TBtu)	Hg Permit Limit (lb/GWh)	Controls	Operation
Virginia City Hybrid Energy Center	VA	2 CFB Boilers	06/30/08	334	3,132	Waste Coal/ Bituminous	0.09	0.00088	LI, SNCR, DS, FF	Under Construction
Rodemacher Brownfield	LA	2 CFB Boilers	02/23/06	300	3,006	Petcoke/Lignite	13	0.013	LI, SNCR, DS, FF	Began construction in 2006
Hugh L. Spurlock 4	KY	CFB Boiler	06/31/06	278	2,800	Bituminous/TDF		0.021	LI, SNCR, DS, FF	Began construction in 2006
Highwood Generating Station	MT	CFB Boiler	05/25/06	270	2,771	PRB Coal	1.5	0.015	LI, DS, FF, SNCR	Began construction in 2008
Greene Energy	PA	2 CFB Boilers	07/05/05	290	2,532	Waste Coal/ Bituminous	16	0.016	LI, SNCR, DS, FF	Began constrcution in 2007
Beech Hollow Energy Project	PA	CFB Boiler	04/21/05	272	N.A.	Waste Coal	16	0.016	LI, SNCR, DS, FF	On hold
Sevier	UT	CFB Boiler	10/12/04	270	N.A.	Bituminous/ Sub Bituminous	0.4	0.004	LI, SNCR, DS FF	On hold
Hugh L. Spurlock 3	KY	CFB Boiler	08/04/02	268	2,500	Bituminous/TDF	2.65	0.0265	LI, SNCR, DS, FF	Began operations in April 2005

5.1.1 Identification of Worst Case Conditions

MACT limits must be able to be met continuously under reasonably foreseeable worst-case conditions (*Sierra Club v. EPA*, 167 F.3d 658, 665 (D.C. Cir. 1999)). Fuel mercury content therefore clearly affects outlet Hg emissions and whether the Hg control technology is capable of removing 90% or greater than 90% of inlet mercury

In its MACT Floor development document, USEPA notes that delayed petroleum coke is a petroleum refining byproduct and is not coal, and hence is not covered under this MACT category and is not a fuel that is subject to 112(g) MACT Floor limits for Hg. Delayed petroleum coke has less Hg content than either bituminous coal or sub-bituminous coal, and hence even lower Hg actual Hg emissions will result whenever it is blended with coal. For purposes of establishing the MACT Floor for the WCEV boilers, it must be assumed that they could operate on 100% sub-bituminous coal, 100% bituminous coal, or a blend of the two with or without delayed petroleum coke, and therefore Hg emission data for facilities tested while burning delayed petroleum coke is not considered for purposes of establishing the MACT Floor.

As EPA's proposed MACT Floor as well as the now vacated CAMR NSPS standards reflected, combustion of PRB coal presents the most challenging fuel for mercury control. This is primarily due to potentially high mercury levels in sub bituminous coal as well as the lack of chlorine in the PRB coal. The mercury in coal is vaporized to elemental mercury through the combustion process in a CFB boiler. As the gas cools, reactions occur and transform the mercury in the flue gas to three different forms: elemental, oxidized and particulate-bound. A fabric filter is effective in controlling oxidized and particulate-bound mercury. The amount of oxidized mercury and mercury adsorbed on the surface of particulate matter is influenced by four factors: 1) the mercury content and speciation of the coal, 2) the coal chlorine content and ash composition, 3) the combustion efficiency and resultant unburned carbon in the fly ash, and 4) the temperature and residence time in the particulate control device. The potentially higher Hg content combined with relatively low levels of chlorine in PRB coal is what makes controlling mercury more challenging for PRB than for other fuels. This trend can also be seen in the beyond the floor limits being proposed for facilities that will burn sub-bituminous coals in the above tables.

The Paper "Will the Hg Cycle be Unbroken? An Air and a Waste Management Issue! (Linero and Read, Florida Dept. of Environmental Protection) indicates that sub bituminous coals may have mercury levels **averaging** about 12.6 lb/TBtu. This inlet Hg concentration represents a reasonable expectation for the annual average Hg content of the worst case coal for the proposed WCEV

boilers. Comparison of the two potential coals for the proposed WCEV CFBs demonstrates that sub bituminous coals represent the worst (most difficult to control) case for the proposed project. The proposed MACT limit is therefore based on levels of control that are achievable burning the worst case fuel, sub bituminous coal.

5.2 Tier III, Step 2 – Conduct an Impacts Analysis

WCEV next considered what level of beyond the floor Hg emissions are actually achievable from a state-of-the-art multi fuel CFB boiler equipped with beyond-the-MACT Floor technology, specifically a CFB with activated carbon injection followed by a high performance fabric filter and a polishing scrubber, designed to burn up to 100% of the worst case fuel, sub bituminous coal. In addition to consideration of the limits being proposed in other permits, WCEV's Engineers, Burns and Roe Inc. solicited emission guarantee levels from qualified CFB manufacturers.

The two main CFB boiler vendors have indicated that they are ready to guarantee the following Hg reduction values:

- Foster Wheeler - 90% capture with floor 1 lb/TBtu (0.0086 lb/GWh)
- Alstom - 2 lb/TBtu outlet (0.017 lb/GWh)

Despite the differences in guarantees presented, WCEV believes that the state-of-the-art Hg control technology being proposed for WCEV can achieve greater than 90% reduction of mercury in the fuel, even for the most difficult to control fuel, sub bituminous coal.

The expected uncontrolled mercury emissions for sub bituminous, Powder River Basin (PRB) coal is shown in Table 5-3. The mercury contents shown for PRB coal are average values based on 489 samples from the USGS data base. There is a great variation in mercury content within a single mine and the difference from mine to mine can be substantial. The values in Table 5-3 reflect variability in PRB coals by assuming the average for this coal rank based on the 12.6 lb/TBtu presented in "Will the Hg Cycle be Unbroken? An Air and a Waste Management Issue!".

Table 5-3 Predicted Uncontrolled Mercury Emissions from PRB Coal and Design Capture Efficiency

Hg	Hg fuel	Low-Hg limestone	Hg total	Design Capture Efficiency	Annual Average Hg Outlet Emission
lb/TBtu	lb/GW-hr (gross)	lb/GW-hr (gross)	lb/GW-hr (gross)	Toxecon Equivalent with Sorbent Injection	
12.6	0.11	nil	0.11	93%	0.0077 lb/GW-hr

WCEV requested that the project be designed to achieve a beyond the MACT Floor emission removal capability equivalent to that demonstrated using sorbent injection and high performance fabric filter technology such as the demonstration trials reported by EPRI ("Development and Demonstration of Mercury Control by Dry Technologies, 2005 Update" R. Chang et al, EPRI # 1004263) for coal boilers burning sub bituminous coal including Holcomb 1, St Clair 1 and Meramec 2, demonstrated to have achieved continuous mercury reduction of 93% as listed in Table 5-4. The St. Clair testing reported slightly higher removal levels, presumably aided by using a blend of sub bituminous and bituminous coals. The equivalent of the technology demonstrated by EPRI, sorbent injection upstream of a high performance fabric filter, has been included in the design of the WCEV boilers and is expected to yield similar state-of-the-art beyond the MACT Floor Hg control.

Table 5- 4 EPRI Sub Bituminous Coal Boiler Hg Control Technology Demonstrations

Facility / Unit	Coal	Boiler Tested	Duration of Demonstration	Hg Control Technology	Average % Hg Reduction Demonstrated
Holcomb 1	Sub Bituminous	½ 360 MW PC	30 days	Sorbent Injection and Fabric Filter	93
St. Clair 1	85% Sub Bituminous / 15% Bituminous Coal Blend	80 MW PC	30 days	Sorbent Injection and ESP	94
Meramec 2	Sub Bituminous	½ 140 MW PC	34 days	Sorbent Injection and ESP	93

Source – "Development and Demonstration of Mercury Control by Dry Technologies, 2005 Update" R. Chang et al, February 2005, EPRI Document # 1004263, Table 2-5 – Full Scale Extended Field Test Sites.

The impact of employing a Beyond the MACT Floor control technology and numerical limitation for the proposed project would be that such a limit would be technology forcing, and since continuous, annual mercury monitoring data would be generated for this source sub category for the first time the availability of reference data for future MACT determinations would expand greatly. Additionally, less Hg would be allowed to enter the environment, and compliance with the proposed Hg Rule levels set by the MI DEQ would be supported and complied with. The risk for WCEV would be that these Hg levels have not been guaranteed by the CFB vendors, and if substantially higher mercury reduction levels than will be guaranteed can not be achieved in practice, that WCEV may have to restrict its use of PRB coal on an annual basis to ensure continuous compliance with the lower emission standard.

WCEV believes that EPA's ICR database indicate that 80-90% reduction can be achieved by the previous generation of CFBs, and that greater levels of control should be achievable with the introduction of activated carbon or halogenated activated carbons (on PRB). This belief is confirmed by results reported for Spurlock 3, as well as demonstration and pilot tests for technologies such as Toxecon at the St. Clair 7-9, Holcomb 1 and Meramec 2 units in trials of EPRI's Toxecon Hg control technology.

Based on the mercury content in PRB coal cited in the report "Will the Mercury Cycle be Unbroken" 12.6 lb/TBtu, and an assumed design capability of 93% control would result in annual Hg emissions of 0.0077 lb/GW-hr. WCEV is willing to accept the technical risk that the proposed boilers will be able to demonstrate 0.0077 lb Hg/GW-hr on a 12-month rolling basis, or if not will manage its fuel supply or other factors to ensure continuous compliance.

WCEV believes that the Beyond-the-MACT-Floor limitation to utilize mercury sorbent injection technology together with a maximum not-to-exceed limit of 0.0077 lb Hg/GW-hr for the proposed CFB boilers regardless of coal rank utilized represents state-of-the-art Hg control for the proposed CFB boilers. The use of continuous mercury emission monitors and data reporting on a 12-month rolling average, together with use of activated carbon or other Hg sorbent injection upstream of a high performance fabric filter will provide commercial demonstration of these technologies and will advance the available data to form the basis for future MACT determinations.

5.3 Tier III – Proposed MACT Limitation for the WCEV CFB Boilers

Since it was not possible to identify an enforceable Hg emission limit being continuously achieved by the best controlled similar source, various proposed regulatory standards were considered. USEPA's proposed MACT Floor for new coal-fired EGU's would have required the WCEV CFBs to limit emissions of Hg to 19.6 E-6 lb/MWhr (0.0196 lb/GWhr) based on the worst case fuel, sub bituminous coal.

No similar source to the proposed large, multi fuel-fired CFB boilers proposed could be identified which operates with a MACT limit for Hg, has been required to continuously monitor emissions of Hg, or has demonstrated compliance with such a limit on an annual average burning many combinations of fuels including delayed petroleum coke, bituminous coal and sub-bituminous coal in any combination on a potentially day to day basis. The best Hg control technology demonstrated by another large CFB is similar to that employed at Spurlock 3; CFB technology followed by a high performance fabric filter. The MACT Floor for the proposed WCEV CFBs was therefore concluded to be that technology, combined with EPA's proposed MACT Floor level for either CFB or PC units burning sub-bituminous coals, 0.0196 lb/gW-hr.

WCEV determined that the most difficult to control or worst case fuel to be fired is 100% sub bituminous coal, with an average potential annual mercury content of 12.6 lb/TBtu and very little chlorine content. While vendor guarantees are not available from CFB vendors at this level, WCEV specified Hg control technology for the project that would be equivalent to that demonstrated by EPRI using add-on control based on its "Toxecon" technology. Based on the 93% control demonstrated by EPRI for CFB or PC boilers burning sub bituminous coals, the combination of specifying CFB plus high performance fabric filter technology plus activated carbon injection plus a polishing scrubber technology in addition to an annual numerical MACT limitation of 0.0077 lb/GW-hr based on continuous Hg monitoring were determined to represent an achievable beyond the MACT Floor limitation for this particular project. WCEV and its engineers believe this to be maximum achievable level of control for this first of a kind combination of fuels, technology and continuous compliance monitoring. Numerical limitations lower than 0.0077 lb/GW-hr that have yet to be continuously achieved in practice by any similar source, and were determined to be speculative and not representative of case-by-case MACT for Hg from this particular project.