Prepared for:
Wolverine Power Supply Cooperative
Cadillac, Michigan

Supplement to BACT

Application No. 317-07

Wolverine Clean Energy Venture

Rogers City, MI

ENSR
August 2008

Supplement to BACT

Application No. 317-07

Wolverine Clean Energy Venture

Rogers City, MI

Prepared By: Michael Zebell, PE

Reviewed By: William Campbell

ENSR
August 2008

1.0 Introduction - BACT Supplement

Wolverine Power Cooperative submits this supplemental information to support and update the BACT conclusions reached in Chapter 5 of the air pollution control permit application for the proposed Wolverine Clean Energy Venture (WCEV) project (PTI No. 317-07). This supplement is being provided to the MDEQ in response to comments received from MDEQ. The specific request is in ***bold italics*** below followed by a response.

2.0 VOC for CFBs at Low Load (50% to less than 70% Boiler Load)

Provide an explanation of how WCEV arrived at the BACT emission value of 0.0066 lb/MMBtu for VOC from the CFB boilers at 50% to less than 70% load.

Similar to CO, volatile organic compounds (VOCs) are also emitted from solid fuel fired boilers as a result of incomplete combustion of the fuel. Control of incomplete combustion is accomplished in the same way CO emissions are controlled: by providing adequate fuel residence time and high temperature in the combustion zone to ensure complete combustion. WCEV proposes a tiered CO and VOC emission limit due to the physical constraints of a CFB boiler at loads below 70%. The CFB boiler bed temperature can not be maintained at optimal levels when the boiler is below 70% load, causing the combustion process to be less efficient. The boiler will not be operated below 50% load other than to complete startup or to shut the boiler down.

Step 1 – Identify All Control Technologies

VOC emissions from solid fuel fired boilers are a function of oxygen availability (excess air), flame temperature, residence time at flame temperature, combustion zone design, and turbulence. All coal-fired boilers identified utilize front-end methods such as combustion control wherein VOC formation is suppressed within the boiler. All listings in USEPA's RACT/BACT/LAER Clearinghouse for CFB boilers utilize combustion control techniques for VOC. While gas-fired combustion turbines have been equipped with oxidation catalyst control technology, this technology is not applicable to CFB boilers as determined in the original BACT evaluation.

Step 2 – Eliminate Technically Infeasible Options

The only remaining option for control of VOC emissions from a CFB boiler is good combustion control.

Step 3 – Rank Remaining Control Technologies

The only remaining option for control of VOC emissions from a CFB boiler is good combustion control.

Step 4 – Evaluate and Document Most Effective Controls

The only remaining option for control of VOC emissions from a CFB boiler is good combustion control.

Recent Permit Limits

All of the PSD permits for VOC emissions from CFB boilers listed in the EPA's RBLC since 1995 show good combustion control (practices) as BACT and the limits range from 0.0036 lb/MMBtu to 0.0130 lb/MMBtu. Emission levels have been summarized in Table 2-1 below.

Table 2-1 Recent CFB BACT VOC Limits

Facility	State	Fuel	Emission Limit
Hugh L. Spurlock Generating Station	KY	Coal	0.0036 lb/MMBtu
Seward Station	PA	Coal	0.005 lb/MMBtu
Knott County Generating Station	KY	Waste Coal	0.0072 lb/MMBtu
Energy Services of Manitowoc	WI	Pet Coke	0.0130 lb/MMBtu

The lowest VOC emission limit at full load for a CFB boiler is the Hugh L. Spurlock Generating Station at 0.0036 lb/MMBtu. No partial or low load emission limits are listed in the RBLC and no additional public information is available for this operating condition.

Step 5 – Select BACT

The BACT emission rate for VOC was established as 0.003 lb/MMBtu for the normal three hour testing at 100% to 70% load using combustion controls, which is better than any other CFB listed in the RBLC. Based on a manufacturer's guarantee and the absence of a BACT limit having been previously established for VOC emissions from a CFB boiler at loads from 50% to less than 70%, BACT for the WCEV project is good combustion control and 0.0066 lb/MMBtu.

3.0 BACT for PM10 Emissions from the Auxiliary Boiler

Provide justification for a PM_{10} emission rate of 0.03 lb/MMBtu from the Auxiliary boiler.

The composition and amount of particulate matter emitted from an oil fuel fired boiler is a function of firing configuration, boiler operation, oil properties and emission controls. Particulate matter will be emitted from the auxiliary boiler as a result of entrainment of incombustible inert matter (ash) in the oil to be burned and condensable substances such as acid gases. Both particulate matter (PM), and particulate matter smaller than 10 micrometer diameter (PM_{10}) are evaluated for control. Applicable rules of USEPA and the MDEQ authorize the use of USEPA's PM10 surrogate policy for PM 2.5.

Particulate matter (PM) is total filterable particulate matter as determined by USEPA Method 5 or 17. PM_{10} includes filterable particulate matter smaller than 10 micrometer diameter as determined by USEPA Method 201 or 201A as well as condensable particulate matter as determined by USEPA Method 202. No. 2 fuel oil contains trace amounts of inert matter, the primary constituent of filterable PM. The exact amount of condensable particulate matter is difficult to specify, but is related to the amount of SOx and NOx in the gas stream.

Step 1 – Identify All Control Technologies

Particulate control from a limited use, auxiliary oil fired boiler is accomplished with good combustion practices, but theoretically could be performed using either an electrostatic precipitator (ESP) or a fabric filter. Other less effective particulate control systems such as wet venture scrubbers or cyclones are also theoretically applicable but are not effectively employed to control particulate emissions from oil fired auxiliary boilers and are not considered in this BACT.

Step 2 – Eliminate Technically Infeasible Options

Wet ESP, Dry ESP or fabric filters all represent effective control devices for removing filterable particulate from exhaust gas. Although Dry ESPs and fabric filters can achieve comparable levels of control, fabric filters are considered to be more consistently able to achieve a high level of control and are considered the best level of control.

Wet ESPs are effective at controlling condensable particulate matter as well as filterable particulate. ENSR is not aware that that wet ESP technology has ever been demonstrated in practice on a limited use auxiliary boiler for any similar application.

Step 3 – Rank Remaining Control Technologies

Although ESPs and fabric filters can achieve high levels of PM control, fabric filters are considered to be the superior technology for fine particulate control, and are evaluated for cost effectiveness for the control of fine filterable particulate. There are currently no No. 2 distillate oil-fired boilers that have such add-on controls installed, operating, or permitted. The cost per ton of add-on emission control was calculated using various references such as the Coal Utility Environmental Cost (CUECost) model, or USEPA control technology factsheets (i.e., EPA-452/F-03-025 for pulse-jet baghouse cost estimating). The cost of installing a baghouse for particulate matter emission control was performed and these cost estimates are included in Attachment 1 to this report. The results of the cost estimates show that the cost per ton of particulate matter control is over $154,000 per ton. WCEV has concluded that the capital, and operation and maintenance costs of additional add-on control for particulate is too expensive and that the cost per ton of emission control is excessive.

Step 4 – Evaluate and Document Most Effective Controls

The only remaining option for control of particulate emissions from an auxiliary boiler is good combustion control.

Recent Permit Limits

PM_{10} emission limits at other sources and in other permits are difficult to assess as many listings in the BACT/LAER Clearinghouse and even in issued permits do not specify test methods. ENSR has determined that many emission limits only reflect filterable PM or PM_{10} and do not include condensable PM_{10}. Under USEPA's definition of PM_{10}, limits for total PM_{10} must account for additional emissions attributable to condensable PM_{10}.

The recently vacated Boiler MACT established emission limitations for selected metals, using PM as a surrogate at 0.03 lb/MMBtu. The auxiliary boiler proposed for WCEV will not exceed 73 MMBtu/hr and is planned to be operated less than 50% of the time. Accordingly, this unit would have been subject to emission limitations consistent within the former 40 CFR 63.7500 (a)(1) and Table 1 to 40 CFR 63 Subpart DDDDD if the regulation had not been vacated.

Listings in Appendix 11 of the WCEV Permit Application (September 2007) for PM emissions from auxiliary boilers indicate the lowest emission rate of 0.01 lb/MMBtu for 10 facilities. All of these facilities are using natural gas as the fuel for the auxiliary boiler and are not appropriate for this facility that does not have natural gas available at the site. The lowest emission for a fuel oil fired unit is the River Hill Power Company at 0.03 lb/MMBtu.

Step 5 – Select BACT

BACT for PM, PM_{10} and $PM_{2.5}$ from the WCEV project auxiliary boiler is determined to be the use of good combustion practices to limit total PM_{10} to 0.03 lb/MMBtu (including both the filterable and condensable portions of PM_{10}) based on stack testing using reference methods 5 and 202.

4.0 BACT for PM10 Emissions from the Black Start Generator

Provide justification for a PM_{10} emission rate of 0.03 lb/MMBtu from the combined cycle black start generator.

The Black Start Generator will be used to start the plant on the rare occasion when there is no power available from the electric grid and the plant must be brought back into service. The Black Start Generator is a fuel oil-fired combustion turbine arranged in simple cycle configuration. For the purposes of this BACT review it is assumed that the unit will fire low sulfur, distillate fuel oil (0.05% sulfur), based on availability to the site. The plant will have a single Black Start Generator and will limit the operation to no more than 500 hours per year as described in the original permit application in paragraph 5.2.6. This revised analysis will focus on PM emissions from this source.

Step 1 – Identify All Control Technologies

Particulate matter (PM) emissions from combustion sources consist of inert contaminants in the oil, sulfates from fuel sulfur, dust drawn in from the ambient air and particulate of carbon and hydrocarbons resulting from incomplete combustion. Therefore, units firing fuels with low ash content, low sulfur content, and which employ high combustion efficiency exhibit correspondingly low particulate emissions.

When the New Source Performance Standard for Stationary Gas Turbines (40 CFR 60 Subpart GG) was promulgated in 1979, the EPA recognized that "particulate emissions from stationary gas turbines are minimal," and noted that particulate control devices are not typically installed on gas turbines and that the cost of installing a particulate control device is prohibitive (EPA, September 1977). Performance standards for particulate control of stationary gas turbines were, therefore, not proposed or promulgated. This establishes good combustion controls with no add on controls as the NSPS limit.

The most stringent particulate control method demonstrated for gas turbines is the use of low ash and low sulfur fuel. Natural gas is not available at this site, so low sulfur, distillate fuel oil (0.05% sulfur) has been determined to be the cleanest fuel available. No add-on control technologies are listed in the RACT/BACT/LAER Clearinghouse listings for combustion turbines. Proper combustion control and the firing of fuels with negligible or zero ash content and a low sulfur content for the combustion turbines is the predominant control method listed.

Add-on controls, such as ESPs or baghouses, have never been applied to commercial distillate fuel oil fired turbines. The use of ESPs and baghouse filters is considered technically infeasible, and does not represent an available control technology.

Step 2 – Eliminate Technically Infeasible Options

The remaining option for control of PM emissions from a simple cycle turbine is good combustion control, firing low sulfur, distillate fuel oil (0.05% sulfur).

Step 3 – Rank Remaining Control Technologies

The remaining option for control of PM emissions from a simple cycle turbine is good combustion control, firing low sulfur, distillate fuel oil (0.05% sulfur).

Step 4 – Evaluate and Document Most Effective Controls

The remaining option for control of PM emissions from a simple cycle turbine is good combustion control, firing low sulfur, distillate fuel oil (0.05% sulfur).

Recent Permit Limits

A review of combustion turbines greater than 25 Mw in size, running on oil was conducted in the EPA's RBLC. All units show good combustion control (practices) as BACT for PM10 and the limits range from 0.03 lb/MMBtu to 0.037 lb/MMBtu. Emission levels have been summarized in Table 4-1 below.

Table 4-1 Recent SC Turbines BACT PM_{10} Limits

Facility and Permit ID Number	State	Fuel	Emission Limit
Fairbault Energy Park (MN-0053)	MN	NA	0.03 lb/MMBtu
Arvah B. Hopkins Station (FL-0261)	FL	0.05% S Oil	0.034 lb/MMBtu
Newmont Nevada Energy (NV-0053)	NV	0.05% S Oil	0.037 lb/MMBtu

Step 5 – Select BACT

The black start generator is a limited use source that is restricted to firing low sulfur, distillate fuel oil (0.05% sulfur). BACT for PM from the WCEV project black start generator is determined to be the use of good combustion practices to limit total PM_{10} to the vendor guarantee and proposed limit of 0.03 lb/MMBtu (including both the filterable and condensable portions of PM_{10}) based on stack testing using reference Methods 5 and 202.

5.0 BACT for PM10 Emissions from CFB Boilers

Additional Information received after the PSD Application was submitted on PM10 emission guarantees.

The PM10 analysis presented in paragraph 5.2.1.3 of the application established BACT for PM, PM10 and PM2.5 from the WCEV project CFBs to be the use of in bed acid gas control for the condensables SO3, HCL and HF, followed by a fabric filter to limit total PM10 0.03 lb/MMBtu (including both the filterable and condensable portions of PM10) based on periodic stack testing using reference Methods 5 and 202. Filterable PM10 will be limited to 0.01 lb/MMBtu based on reference Method 5.

MDEQ requested a justification of why the emission rates for the East Kentucky Power Cooperative (EKPC) Spurlock, Unit 4 were not applicable for the WCEV. A response was submitted on March 30, 2008 providing justification for the BACT emission limits proposed in the application.

WCEV has recently had further discussions with the equipment suppliers and has determined that additional data has been collected and the manufacturers can now guarantee a lower total PM10 number of 0.026 lb/MMBtu. Thus WCEV has now established that the BACT limit for total PM10 is 0.026 lb/MMBtu (including both the filterable and condensable portions of PM10) based on periodic stack testing using reference methods 5 and 202.

MDEQ requested a justification of why the emission rates for the East Kentucky Power Cooperative (EKPC) Spurlock, Unit 4 were not applicable for the WCEV. A response was submitted on March 30, 2008 providing justification for the BACT emission limits proposed in the application and is compatible with the reduced limit proposed by this supplement.

6.0 BACT for H2SO4 Emissions from CFB Boilers

Additional Information received after the PSD Application was submitted on H2SO4 emission guarantees.

The sulfuric acid mist (SAM) analysis presented in paragraph 5.2.1.6 of the application established BACT for H_2SO_4 for the WCEV is a circulating fluidized bed with state-of-the-art SO2 control including a fabric filter represents the BACT technology for sulfuric acid mist. The resulting sulfuric acid mist emission rate of 0.006 lb/MMBtu was established as BACT.

WCEV has recently had further discussions with the equipment suppliers and has determined that additional data has been collected and the manufacturers can now guarantee a lower H_2SO_4 number of 0.003 lb/MMBtu. Thus, WCEV has now established that the BACT limit for H_2SO_4 is 0.003 lb/MMBtu based on periodic stack testing. At this rate the maximum SAM emissions are 79.6 TPY.

Attachment 1

Auxiliary Boiler Fabric Filter
BACT Cost Estimate

Control Efficiency (%)	90

Facility Input Data

Item	Value
Operating Schedule	
Shifts per day	3
Hours per day	24
Days per week	7
Total Hours per year	4000
Economic Life, years	20
Interest Rate (%)	7
Source(s) Controlled	**Auxiliary Boiler**
Temperature (F)	400
Total Flowrate (acfm)	27,000
PM10 Emissions (tpy)	4.3
Site Specific Electricity Cost ($/kWh)	0.070
Site Specific Operating Labor Cost ($/hr)	$50.00
Site Specific Maint. Labor Cost ($/hr)	$50.00

Capital Costs

	Value	Basis
Direct Costs		
1.) Purchased Equipment Cost		
a.) Equipment cost + auxiliaries	$870,480	EPA-452/F-03-025
b.) Instrumentation	$87,000	0.10 x A
c.) Sales taxes	$43,500	0.05 x A
d.) Freight	$43,500	0.05 x A
Total Purchased equipment cost, (PEC)	$1,044,480	B = 1.22 x A
2.) Direct installation costs		
a.) Foundations and supports (w/ Piles)	$83,600	0.08 x B
b.) Handling and erection	$522,200	0.5 x B
c.) Electrical	$83,600	0.08 x B
d.) Piping	$10,400	0.01 x B
e.) Insulation for ductwork	$73,100	0.07 x B
f.) Painting	$41,800	0.04 x B
Total direct installation cost	$814,700	0..74 x B
3.) Site preparation	NA	As Required, SP
4.) Buildings	NA	As Required, Bldg.
Total Direct Cost, DC	$1,859,200	1.74B + SP + Bldg.
Indirect Costs (installation)		
5.) Engineering	$104,400	0.10 x B
6.) Construction and field expenses	$208,900	0.20 x B
7.) Contractor fees	$104,400	0.10 x B
8.) Start-up	$10,400	0.01 x B
9.) Performance test	$10,400	0.01 x B
10.) Contingencies	$261,100	0.25 x B
Total Indirect Cost, IC	$699,600	0.45B + Other
Total Capital Investment (TCI) = DC + IC	**$2,558,800**	**1.61B + SP + Bldg. + Other**

Annual Costs

Item	Value	Basis	Source
1) Electricity			
Fan Power Requirement (kW)	250		
Baghouse Power Requirement (kW)	100		
Electric Power Cost ($/kWh)	0.07		Utility
Cost ($/yr)	$98,000		
2) Operating Costs			
Operating Labor Requirement (hr/shift)	1.0	1/2 hour per shift	OAQPS
Unit Cost ($/hr)	$50.00	Facility Data	Estimate
Labor Cost ($/yr)	$54,600		
Disposal Costs ($/ton)	$25		
Tons Disposal required (tons/year)	4		
Disposal Costs ($/year)	$97		
Total Operating Costs	$152,697		Vendor
3) Supervisory Labor			
Cost ($/yr)	$8,190	15% Operating Labor	OAQPS
4) Maintenance			
Labor Cost ($/yr)	$18,590	1% of installed cost	Estimate
Material Cost ($/yr)	$18,590	100% of Maintenance Labor	OAQPS
Total Cost ($/yr)	$37,180		
5) Indirect Annual Costs			
Overhead	$59,980	60% of O&M Costs	OAQPS
Administration	$51,180	2% of Total Capital Investment	OAQPS
Property Tax	$25,590	1% of Total Capital Investment	OAQPS
Insurance	$25,590	1% of Total Capital Investment	OAQPS
Capital Recovery	$241,530	20 yr life; 7% interest	OAQPS
Total Indirect ($/yr)	$403,870		
Total Annualized Cost ($/yr)	**$601,900**		
Total Controlled (tpy)	**3.9**		
Cost Effectiveness ($/ton)	**$154,800**		