

July 27, 2009
Project No. G06783F

Ms. Melissa Byrnes
Air Quality Division
Michigan Department of Environmental Quality
Constitution Hall, 3rd Floor, North
525 West Allegan Street
Lansing, MI 48933

Re: Response to Comments on Wolverine Power Supply Cooperative, Inc. (Wolverine)
Draft Permit to Install No. 317-07

Dear Ms. Byrnes:

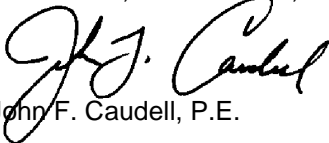
This letter is meant to assist the Michigan Department of Environmental Quality (MDEQ) in response to comments received during the public comment period for the Wolverine Clean Energy Venture Project related to perceived short-comings in our Best Available Control Technology (BACT) analysis

Enclosed with this letter is a document entitled *Wolverine Clean Energy Venture (PTI No. 317-07) PM_{2.5} BACT Review*. This enclosure is designed to address questions you have raised related to our supplemental BACT submittal dated June 19, 2009.

If you have any questions regarding any of these documents, please contact Mr. Brian Warner, of Wolverine, at (231) 775-5700 or me at (517) 887-4024.

Sincerely,

FISHBECK, THOMPSON, CARR & HUBER, INC.



John F. Caudell, P.E.

tc

Enclosures

By e-mail and U.S. Mail

cc/enc: Ms. Mary Ann Dolehanty – MDEQ (By e-mail)
Mr. Bill Presson – MDEQ (By e-mail)
Ms. Janis Denman – MDEQ (By e-mail)
Mr. Brian Warner, CHMM – Wolverine (By e-mail)
Mr. Eugene E. Smary – Warner Norcross & Judd, LLP (By e-mail)
Mr. Steven C. Kohl – Warner Norcross & Judd, LLP (By e-mail)
Mr. Michael L. Robinson – Warner Norcross & Judd, LLP (By e-mail)
Mr. William Campbell III – ENSR (By e-mail)
Mr. John Lagomarsino – Burns and Roe Enterprises, Inc. (By e-mail)
Mr. James A. Susan, P.E. – FTC&H (By e-mail)
Ms. Jacquelyn F. Linck, P.E. – FTC&H (By e-mail)
Mr. David M. Yanochko, P.E. – FTC&H (By e-mail)

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Enclosure 1

AECOM Environment

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Memorandum

Date: July 27, 2009
To: Wolverine Power Cooperative
From: Michael Zebell
Subject: **Subject: Wolverine Clean Energy Venture (PTI No. 317-07) PM_{2.5} BACT Review**

Distribution: B. Warner W. Campbell D. Yanachko J. Caudell

Wolverine Power Cooperative was asked by the Michigan Department of Environmental Quality (MDEQ) to clarify certain information concerning the Best Available Control Technology (BACT) for particulate matter less than 2.5 microns (PM_{2.5}) to augment the air pollution control permit application for the proposed Wolverine Clean Energy Venture (WCEV) project (PTI No. 317-07). A PM_{2.5} BACT review was submitted to MDEQ in September 2008¹ which followed the top down methodology. This letter supplements that BACT review for WCEV and provides a discussion of relevant industry developments since July 2008².

Overview of Identified Technologies

The air pollution control technologies which have been identified in the PM_{2.5} BACT review include base technologies that are demonstrated in practice, and emerging technologies with varying levels of demonstration in practice. The base technologies previously identified in Step 1 of the top down BACT analysis include both a dry electrostatic precipitator (ESP) and wet ESP (WESP), a fabric filter, alternative membrane filter bags for the fabric filter, and flue gas desulfurization (FGD) systems. Other, less effective particulate control systems such as wet venturi scrubbers or cyclones are not commonly employed to control particulate emissions from CFB boilers and, although identified and eliminated in earlier PM and PM₁₀ BACT submissions, were not reevaluated in detail in the PM_{2.5} BACT analysis. All of the emerging technologies are variants of the base technologies identified. Table 1 presents a summary of all of the base and emerging technologies identified and discussed in the PM, PM₁₀ and PM_{2.5} BACT reviews and in other documents submitted to MDEQ during the permitting process.

¹ Best Available Control Technology (BACT) for Particulate Matter Less than 2.5 microns Application No. 317-07

² Please note that WCEV is voluntarily supplementing our September 2008 BACT document, and WCEV reserves its legal right regarding the applicability of and necessity for a PM_{2.5} BACT review in connection with WCEV's application for a permit for this project.

The variant and emerging technologies shown in Table 1 were considered in the WCEV September 2008 PM_{2.5} BACT determination, but were excluded because they either do not enhance the removal of a given pollutant, or the technologies are not yet demonstrated in practice and do not warrant further consideration. Discussion of each of the base technologies and variant technology was included in various documents in the permit record. The document including the discussion for a particular pollutant is identified in Table 1.

Table 1 PM Air Pollution Control Devices Identified in BACT Review

Base Technology	Variant/Emerging Technology	Considered and Excluded
Fuel	None	Supplement to Application No. 317-07 Fuel BACT Review – June 2009
Fuel Washing	None	Memorandum - Wolverine Clean Energy Venture (PTI No. 317-07) Coal Washing – December 2008
Dry ESP		Permit to Install Application No. 317-07 September 2007
	Electrostatic Centrifuge (ElectroCore®)	Best Available Control Technology (BACT) for Particulate Matter Less than 2.5 microns Application No. 317-07 – September 2008
	Electrostatic Fabric Filter (Max-9™)	Best Available Control Technology (BACT) for Particulate Matter Less than 2.5 microns Application No. 317-07 – September 2008
	Indigo Bi-Polar Agglomerator	Best Available Control Technology (BACT) for Particulate Matter Less than 2.5 microns Application No. 317-07 – September 2008
	Laminar Flow ESP	Best Available Control Technology (BACT) for Particulate Matter Less than 2.5 microns Application No. 317-07 – September 2008
WESP		Permit to Install Application No. 317-07 September 2007
	Membrane Wet ESP	Best Available Control Technology (BACT) for Particulate Matter Less than 2.5 microns Application No. 317-07 – September 2008
	Electro-Catalytic Oxidation	Best Available Control Technology (BACT) for Particulate Matter Less than 2.5 microns Application No. 317-07 – September 2008
Fabric Filter		Permit to Install Application No. 317-07 September 2007
	Electrostatic Fabric Filters	Best Available Control Technology (BACT) for Particulate Matter Less than 2.5 microns Application No. 317-07 – September 2008
	Polytetrafluoroethylene membrane bag	Best Available Control Technology (BACT) for Particulate Matter Less than 2.5 microns Application No. 317-07 – September 2008
FGD	Polishing Scrubber	Permit to Install Application No. 317-07 September 2007
	Wet Scrubber	Permit to Install Application No. 317-07 September 2007

Development of PM 2.5 Emission Rate

The following is an explanation of the breakdown of the filterable and condensable portions of the overall PM_{2.5} emission rate from the CFB boilers at the WCEV facility. The proposed PM₁₀ limit for WCEV is 0.026 lb/MMBtu. A best engineering judgment estimate of the portion of filterable PM₁₀ emissions from WCEV that represents PM_{2.5} was developed by Burns and Roe Enterprises (BRE). Based on review of available data and through discussions with the boiler vendors, BRE estimates that controlled filterable PM_{2.5} represents approximately 80% of the controlled filterable PM₁₀, or 0.008 lb/MMBtu. Assuming that all of the controlled condensable PM₁₀ is PM_{2.5}, then it is estimated that the controlled emission rate of PM_{2.5} from the WCEV project consists of 0.008 lb/MMBtu filterable PM_{2.5} and 0.016 lb/MMBtu of condensable PM_{2.5} for an estimated total PM_{2.5} emission rate of 0.024 lb/MMBtu. The calculation of the apportioning of the PM_{2.5} emissions is as follows:

$$\begin{aligned} \text{Filterable PM}_{2.5} &: & 0.80 \times 0.01 \text{ lb/MMBtu} &= 0.008 \text{ lb/MMBtu} \\ \text{Condensable PM}_{2.5} &: & 1.00 \times 0.16 \text{ lb/MMBtu} &= 0.16 \text{ lb/MMBtu} \end{aligned}$$

Southern Montana Electric Generation and Transmission Cooperative (SME) submitted a PM_{2.5} BACT review for the proposed Highwood Generating Station (Highwood), and the Montana Department of Environmental Quality issued a permit (based in part on the PM_{2.5} BACT submitted) in November 2008. This is the only PM_{2.5} BACT technology assessment that we are aware of for an analogous project. The Highwood facility has not been built and therefore will not support a demonstrated BACT limit. The design fuel for the Highwood plant is Powder River Basin (PRB) coal with less than 1% sulfur by weight. SME estimated the filterable portion of the PM_{2.5} emissions at 0.008 lbs/MMBtu³. Table 2 presents a comparison summary of the SME PM₁₀ and PM_{2.5} emission rate estimates for Highwood to the PM₁₀ and PM_{2.5} emission rate estimates for the WCEV.

Table 2 Comparison of Proposed WCEV Emission Limits and Highwood Permit Application Values

Facility	PM ₁₀ (lb/MMBtu)			PM _{2.5} (lb/MMBtu)		
	Filterable	Condensable	Total	Filterable	Condensable	Total
WCEV	0.010	0.016	0.026	0.008	0.016	0.024
Highwood	0.012	0.014	0.026	0.008	0.014	*,**

* Highwood final air permit #3423-01, Section II,B,17 - Not later than 18 months after reference test methods for PM_{2.5} are promulgated final by EPA, SME shall submit to the Department an application for permit modification to establish a PM_{2.5} emission limit. PM_{2.5} limits shall be requested and established based on measured PM_{2.5} emission rates that correspond with operational practices that are in compliance with the condition at Section II.C.20 (ARM 17.8.749).

** Highwood final air permit #3423-01, Section II,B,19 - To control emission of PM_{2.5}, from the CFB Boiler, SME shall install an Flue Gas Desulfurization (polishing scrubber) followed by a Fabric Filter-Baghouse technology.

In addition, a difference between Highwood and WCEV that affects the PM_{2.5} emissions is the planned fuel. Given its location, the Highwood design fuel is exclusively low sulfur PRB coal. The WCEV design

³ Addendum to Application for Air Quality and Operating Permits, Southern Montana Electric Generation and Transmission Cooperative, June 2008

fuel has a higher sulfur content.⁴ The differences in elemental contents between fuel blends are addressed in the WCEV's Fuel BACT analysis, submitted previously to MDEQ. This difference in fuel blend accounts for the 0.002 lb/MMBtu difference in the estimated condensable portion of the estimated PM_{2.5} emission rate.

Selection of BACT

As noted in the Table 2 footnotes, the final SME Highwood permit does not include a PM_{2.5} limit. The Highwood permit requires that a polishing scrubber and fabric filter be installed for PM_{2.5} control and that a PM_{2.5} limit is developed through testing the unit within 18 months of promulgation of an approved USEPA PM_{2.5} test method. Requiring that a BACT limit be developed following development of a USEPA test method is not a BACT limit for current consideration. However, SME's Highwood permit application considers the technologies identified in Table 1 in great detail. Included in the Highwood analysis is an estimate of the over all control efficiency of various combinations of control equipment. The result of that analysis supports the use of a polishing scrubber and fabric filter as the BACT level control equipment for Highwood.

The initial WCEV PM_{2.5} BACT review includes an estimate of the incremental cost of control of a WESP placed after the fabric filter and that cost was shown to be in excess of what is considered BACT. Attached to this memorandum is a revised cost analysis, modeled after the Highwood analysis, considering the overall cost of control accounting for the PM_{2.5} provided by the polishing scrubber, fabric filter, followed by a WESP. The estimated cost per ton of control for a polishing scrubber, fabric filter, and WESP in series is \$10,100 lb/ton. This cost is excessive and higher than what is considered to represent BACT for the WCEV project.

All base control technologies for PM_{2.5} have been considered, as well as emerging variants on those base technologies. Where warranted, those technologies were carried forward through the further steps of analysis associated with a "top-down" BACT evaluation. A polishing scrubber coupled with a highly efficient fabric filter is selected as the appropriate technology with a limit proposed at 0.024 lbs/MMBtu proposed as BACT.

⁴ The design fuel for Highwood is less than 1% sulfur and the design fuel for WCEV is approximately 3.5% sulfur.

Wolverine Clean Energy Venture - PM2.5 BACT Analysis
Polishing Scrubber - Baghouse - Wet Electrostatic Precipitator for Control of PM2.5
CFB Boiler

Control Efficiency (%)	99
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Facility Input Data

Item	Value
Operating Schedule	
Shifts per day	3
Hours per day	24
Days per week	7
Total Hours per year	8760
Economic Life, years	30
Interest Rate (%)	7
Source(s) Controlled	CFB Boiler
Temperature (F)	127
Total Flowrate (scfm)	1,350,000
Uncontrolled PM2.5 Emissions (tpy) ¹	3,343
Site Specific Electricity Cost (\$/kWh)	0.050
Site Specific Operating Labor Cost (\$/hr)	\$37.00
Site Specific Maint. Labor Cost (\$/hr)	\$37.00

Capital Costs

	Value	Basis
Direct Costs		
1.) Purchased Equipment Cost		
a.) Equipment cost + auxiliaries	\$33,750,000	Published data ² (\$25/scfm), A
b.) Instrumentation	\$3,375,000	0.10 x A
c.) Sales taxes	\$2,362,500	0.07 x A
d.) Freight	\$1,687,500	0.05 x A
Total Purchased equipment cost, (PEC)	\$41,175,000	B = 1.22 x A
2.) Direct installation costs		
a.) Foundations and supports	\$3,294,000	0.08 x B
b.) Handling and erection	\$5,764,500	0.14 x B
c.) Electrical	\$1,647,000	0.04 x B
d.) Piping	\$823,500	0.02 x B
e.) Insulation for ductwork	\$411,800	0.01 x B
f.) Painting	\$411,800	0.01 x B
Total direct installation cost	\$12,352,600	0.30 x B
3.) Site preparation	NA	As Required, SP
4.) Buildings	NA	As Required, Bldg.
Total Direct Cost, DC	\$53,527,600	1.30B + SP + Bldg.
Indirect Costs (installation)		
5.) Engineering	\$4,117,500	0.10 x B
6.) Construction and field expenses	\$2,058,800	0.05 x B
7.) Contractor fees	\$4,117,500	0.10 x B
8.) Start-up	\$823,500	0.02 x B
9.) Performance test	\$411,800	0.01 x B
10.) Contingencies	\$1,235,300	0.03 x B
Total Indirect Cost, IC	\$12,764,400	0.31B + Other
Total Capital Investment - Polishing Scrubber, and Baghouse	\$110,000,000	BRE Estimate
Total Capital Investment (TCI) = DC + IC	\$176,292,000	1.61B + SP + Bldg. + Other

Wolverine Clean Energy Venture - PM2.5 BACT Analysis
Polishing Scrubber - Baghouse - Wet Electrostatic Precipitator for Control of PM2.5
CFB Boiler

Annual Costs

Item	Value	Basis	Source
1) Electricity			
Fan Power Requirement (kW)	800		
Wet ESP Power Requirement (kW)	400		
Electric Power Cost (\$/kWh)	0.05	Local Utility Price	Utility
Cost (\$/yr)	\$525,600		
2) Operating Costs			
Operating Labor Requirement (hr/shift)	0.5	1/2 hour per shift	OAQPS
Unit Cost (\$/hr)	\$37.00	Facility Data	Estimate
Labor Cost (\$/yr)	\$20,200		
Water Requirements (1000 Gal/hour)	0		
Water cost (\$/1000 gal)	\$0.80		
Annual Water Cost (\$/yr)	\$0		
Disposal Costs (\$/ton)	\$12		
Tons Disposal required (tons/year)	0	No waste to dispose	
Disposal Costs (\$/year)	\$0		
Total Operating Costs	\$545,800		Vendor
3) Supervisory Labor			
Cost (\$/yr)	\$3,030	15% Operating Labor	OAQPS
4) Maintenance			
Labor Cost (\$/yr)	\$535,280	1% of installed cost	Estimate
Material Cost (\$/yr)	\$535,280	100% of Maintenance Labor	OAQPS
Total Cost (\$/yr)	\$1,070,560		
Annual O&M - Polishing Scrubber, and Baghouse		\$10,000,000	BRE Estimate
5) Indirect Annual Costs			
Overhead	\$656,270	60% of O&M Costs	OAQPS
Administration	\$3,525,840	2% of Total Capital Investment	OAQPS
Property Tax	\$1,762,920	1% of Total Capital Investment	OAQPS
Insurance	\$1,762,920	1% of Total Capital Investment	OAQPS
Capital Recovery	\$14,206,740	30 yr life; 7% interest	OAQPS
Total Indirect (\$/yr)	\$21,914,690		
Total Annualized Cost (\$/yr)	\$33,534,100		
Total Controlled (tpy)	3310		
Cost Effectiveness (\$/ton)	\$10,100		

¹ Uncontrolled filterable PM2.5 estimate based on AP42 Table 1.1-4 as described in memorandum. Uncontrolled condensable PM2.5 estimate based on AP42 Table 1.1-5 as follows:

$$0.04 \text{ lb/MMBtu} \times 6060 \text{ MMBtu/hr} \times 8760 \text{ hr/yr} / 8760.$$

² USEPA Air Pollution Control Fact Sheet - EPA 425/F-03-030, Low value of capital cost (\$20/scfm) used and adjusted from 2002 dollars to 2008 dollars using the Engineering News Record Construction Cost Index, $(\$20/\text{scfm}) \times (1.24) = \$25/\text{scfm}$.