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FEB 25 2008
AIR QUALITY DIV.

February 22, 2008
Project No. G06783B

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

Re: Wolverine Power Supply Cooperative's (Wolverine's) Air Use Permit to Install
Application No. 317-07
Response to MDEQ Additional Information Request

Dear Ms. Byrnes:

On behalf of Wolverine, Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H) is submitting a response to your letter dated February 14, 2008, requesting additional information on the Air Use Permit to Install Application No. 317-07 for a 600 megawatt (net) steam electric power plant.

Enclosed is a memorandum prepared by ENSR responding to each of your additional seven questions. Through the original application text, Appendix E of the application, our supplemental information provided at our meeting on February 6, and this letter, we consider there is a full and complete response to the MDEQ's IGCC BACT checklist in the record.

Should you have any immediate questions or concerns, please contact me at (517) 622-6126.

Sincerely,

FISHBECK, THOMPSON, CARR & HUBER, INC.

John F. Caudell, P.E.

tc
Enclosures
By FedEx
cc/enc: Ms. Janice Denman – MDEQ (by FedEx)
Ms. Mary Ann Dolehanty – MDEQ (by FedEx)
Mr. Brian L. 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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# Memorandum

Date: February 21, 2008

To: David Yanochko/FTC&H

From: Michael Zebell/ENSR

Subject: Response to MDEQ Letter Dated February 14, 2008

Distribution: Steven Kohl/WNJ Brian Warner/Wolverine Power William Campbell/ENSR

This memorandum responds to the MDEQ's letter of February 14, 2008, to Mr. Brian Warner of Wolverine Power Supply Cooperative relating to the application for Permit to Install No. 317-07. The letter posed seven separate questions relative to the treatment of IGCC technology in the BACT analysis. ENSR assisted in the development of the BACT analysis contained in the application, and presents this response to the questions raised in the letter. Through the original application text, Appendix E of the application, the supplemental information provided to the MDEQ on February 6, and this letter, the record contains information fully responsive to the MDEQ's checklist which accompanied the February 14 correspondence.

**1. Explain the difference in parasitic loads. What are the heat rates for each? Were all the loads accounted for?**

The parasitic load is the electrical load necessary to operate the plant. It includes the load to operate equipment like pumps, blowers, and pollution control equipment. In theory IGCC operates at a lower parasitic load than does a CFB boiler. The load for operating one technology versus operating another is accounted for when "net" generation is used for comparison. The difference between "gross" generation and "net" generation is the amount of power or parasitic load consumed by the power plant to produce the electricity transmitted to the grid from the plant. The more electrical power produced per unit of coal, the more efficient the process is and the lower the heat rate is for that process. Thus a comparison of heat rates accounts for the parasitic loads from these two different processes and gives a fair comparison of the power produced by each.

The heat rate is a measure of the thermal efficiency of a generating unit. It is computed by dividing the total Btu content of fuel burned for electric generation by the resulting net kWh generation. By definition, the heat rate accounts for the parasitic load created by energy consuming support equipment. The heat rate used in our analysis for each of the IGCC facilities considered is between 9,200 and 9,637 Btu/kWh (9,200 Btu/kWh for Wabash, 9,637 Btu/kWh for Polk, and 9,379 Btu/kWh for Mesaba) and the heat rate for the proposed CFB facility is 9,222 Btu/kWh.

Our BACT technology comparison analysis employed "net" generation comparisons and therefore accounted for parasitic load differences in technologies.

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**2. Include comparisons for recently permitted IGCC plants: Cash Creek Generation in Kentucky and Taylorville Energy Center in Illinois, along with the Wabash River plant in Illinois which was already included.**

Table 1 attached to this memorandum provides a summary of the Wabash, Taylorville, Cash Creek, and Edwardsport permits. We were unable to find cost information for the Taylorville, Cash Creek, and Edwardsport projects; therefore, these projects are not included in the economic comparison presented in the permit application. The Mesaba project is partially funded by the U.S. Department of Energy (USDOE), so capital cost information is available.

**3. Explain in greater detail the IGCC configuration chosen.**

The configuration proposed for the IGCC facility at Rogers City is a net 600 MW facility consisting of 3-50% gasifiers followed by two syngas cleanup trains followed by two complete combined cycle (CC) trains. Each CC train is composed of a GE 7FA (Equivalent) gas turbine, followed by a heat recovery steam generator (HRSG) and a stack. Steam from the gasifiers and the HRSGs is taken to a single steam turbine/generator set. A single air separation plant is included to provide oxygen to the gasifiers. Other auxiliary equipment to comprise a complete operating facility is also included such as cooling towers, auxiliary boilers, emergency diesel generators, diesel engine fire pumps and material handling equipment for coal and combustion byproducts. See Figure 1 attached to this letter for a process flow diagram.

Historically IGCC gasification units have not demonstrated the reliability of 95% needed for baseload electrical generation. To solve this problem and to present a balanced analysis, a spare 50% capacity gasifier is included with the IGCC configuration as was done for the Taylorville permit. An option of burning natural gas (as proposed by the Edwardsport permit) or oil has been considered, but merely transfers the cost from capital to operating cost. Natural gas is not available on the Rogers City site and burning oil in the combustion turbines would require duel fuel turbines and additional oil storage on site. The decision was made to go with the spare gasifier to keep the fuel consistent for each facility.

The combined cycle portion of this facility is a standard 2 on 1 design by GE to achieve 600 MW of electrical production. Two standard turbines are required to provide the needed power.

**4. Are treatment and cost of all wastes included?**

The treatment costs of all wastes are included in the factors used, understanding that these are estimates and some site conditions may provide an advantage for one technology over the other, such as a source of high quality limestone nearby. The non-fuel costs are adapted from the fixed and variable cost estimates made by Burns and Roe Enterprises, Inc. (BRE), and the ratio of IGCC/CFB for fixed and variable O&M costs from Table 1-6 of Clean Coal Technology Selection Study – Final Report (Black & Veatch, January 2007). IGCC fuel costs were scaled using the CFB fuel cost from the BRE fuel study and the unit heat input to the boiler or gasification unit. The numbers are included below in answer to question 6.

**5. Are annualized capital costs included?**

Annualized capital costs are included in Appendix E of the initial air permit application submission to the MDEQ.

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**6. Are the fixed operating and maintenance (O & M) costs included? Calculated? Fully explained?**

The following is an explanation of how we arrived at the cost estimates for capital and operation and maintenance (O&M).

**Capital Cost Estimates**

The capital costs of the IGCC were derived from the Wabash River demonstration project and the Mesaba Energy Project as reported by the USDOE. The Wabash River project cost information is reported in the report entitled Wabash River Coal Gasification Repowering Project – Project Performance Summary (DOE/FE-0448, July 2002). The Mesaba cost estimates are provided in the report Clean Coal Technology Programs: Program Update 2006 (DOE/FE-0503, September 2006). Costs were adjusted using the Engineering News Record (ENR) Construction Cost Index (CCI). The following is the calculation of the capital costs:

**Wabash**

Capital cost reported in 1994 dollars on Page 5 of the Wabash report is 1,590 $/kW;

The ENR CCI for 1995 is 5536 and for 2007 is 7888;

The cost adjustment factor is given by (7888/5536) = 1.4248

The adjusted cost is 2,265 $/kW

**Polk**

Capital cost reported in 2001 dollars on Page 4-2 of the Polk report is 1,650 $/kW;

The ENR CCI for 2001 is 6241 and for 2007 is 7888;

The cost adjustment factor is given by (7888/6241) = 1.2639

The adjusted cost is 2,085 $/kW

**Mesaba**

Capital cost reported in 2006 dollars on Page 3-44 of the Mesaba report is $2,155,680,783;

The plant is 600 MW net;

This leads to the ($2,155,680,783/600,000 kW) = 3,593 $/kW.

**Operation & Maintenance Cost Estimates**

The (O&M) costs were calculated by adjusting the CFB costs provided by BRE by using the ratio of IGCC/CFB for fixed and variable O&M costs from Table 1-6 of Clean Coal Technology Selection Study – Final Report (Black & Veatch, January 2007). IGCC fuel costs were scaled using the CFB fuel cost from the Burns and Roe fuel study and the unit heat input to the boiler or gasification unit.

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**Wabash**

Fuel
(5,520.0 MMBtu/hr / 5,533 MMBtu/hr)X(22.65 $/MWhr) = 22.60 $/MWhr
Fixed O&M
25.43/19.54 = 1.30
1.30 x 6.66 = 8.66 $/MWhr
Variable O&M
6.07/4.44 = 1.37
1.37 x 5.62 = 7.70 $/MWhr
Sum equals 38.96 $/MWhr

**Polk**

Fuel
(5,782 MMBtu/hr / 5,533 MMBtu/hr)X(22.65 $/MWhr) = 23.67 $/MWhr
Fixed O&M
25.43/19.54 = 1.30
1.30 x 6.66 = 8.66 $/MWhr
Variable O&M
6.07/4.44 = 1.37
1.37 x 5.62 = 7.70 $/MWhr
Sum equals 40.03 $/MWhr

**Mesaba**

Fuel
(5,627 MMBtu/hr/5,533 MMBtu/hr)X(22.65 $/MWhr) = 23.03 $/MWhr
Fixed O&M
25.43/19.54 = 1.30
1.30 x 6.66 = 8.66 $/MWhr
Variable O&M
6.07/4.44 = 1.37
1.37 x 5.62 = 7.70 $/MWhr
Sum equals 39.39 $/MWhr

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**7. Provide explanation of supporting background documentation (received on February 6, 2008) and how it relates to the IGCC BACT analysis.**

Table 2 shows the files that were transmitted to the MDEQ. A brief description of each file is included. All of these reports and presentations were used; however, data was directly obtained from those reports with a note in the comments.

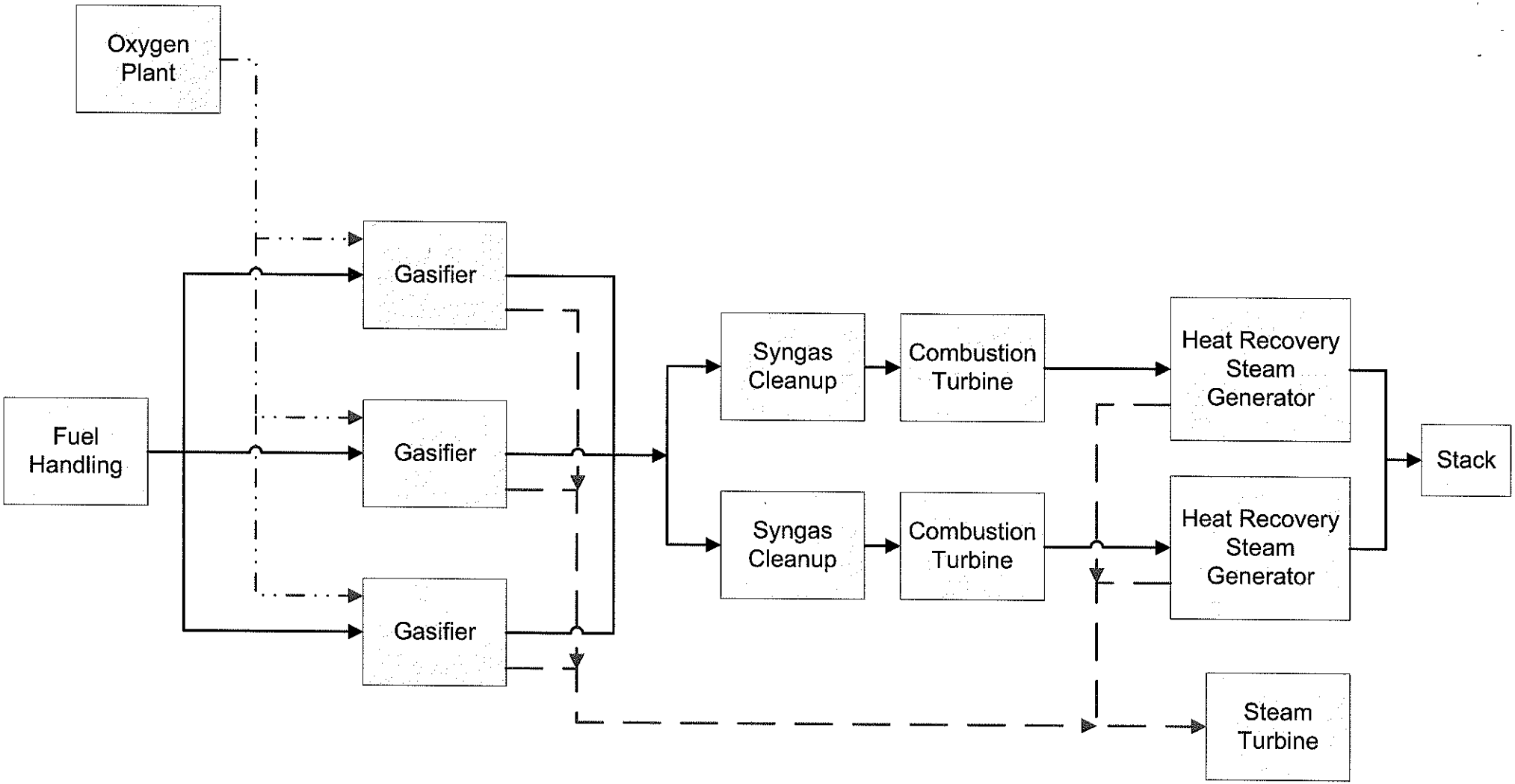


**Figure 1 Conceptual Process Diagram for 600 MW IGCC**

**Table 1 - IGCC Comparison Chart** (See pg. 5-68)

| Facility Name | Location | Configuration [4] | Size | Fuel | $SO_2$ (lb/MMBtu) | NOx (lb/MMBtu) | Total PM (lb/MMBtu) | CO (lb/MMBtu) | Hg (lb/GWhr) |
|---|---|---|---|---|---|---|---|---|---|
| Wabash River Coal Gasification Repowering Project Joint Venture | Indiana | 1 Gasifier, 1 Syngas Cleanup Trains, 1 CCCT, 1 ST | 262 MW (net) | Syngas | 0.1 | 0.15 | 0.05 | | |
| Taylorville Energy Center | Illinois | 3 Gasifiers (2 active/1 spare), 2 Syngas Cleanup Trains, 2 CCCTs, 1 ST | 630 MW (net) | Syngas & Natural Gas | 0.016 | 0.034 | 0.011 | 0.049 | 0.02 |
| Edwardsport Generating Station [1] | Indiana | 2 Gasifiers, 1 Syngas Cleanup Trains, 2 CCCTs, 1 ST | 630 MW (net) | Syngas & Natural Gas | 0.039 [2] | 0.23 [3] | 0.019 | 0.046 | 0.02 |
| Cash Creek | Kentucky | 2 Gasifiers, 1 Syngas Cleanup Trains, 2 CCCTs, 1 ST | 630 MW (net) | Syngas & Natural Gas | 0.0158 | 0.0331 | 0.0217 | 0.0485 | 0.02 |

1. The Edwardsport permit includes limits for various unit operations at an IGCC plant; where as, the other plants have limits that apply to the combined cycle combustion turbine (CCCT). The PM and CO limits shown for Edwardsport are taken directly from the permit for the CCCT. The $SO_2$ and NOx limits are calculated as explained in the following footnotes.
2. The facility avoided PSD for $SO_2$ by netting and accepting a plant-wide limit on $SO_2$ of 358.5 TPY. The $SO_2$ limit is calculated by taking the plant-wide $SO_2$ limit in TPY and expressing it in lb/MMBtu, assuming 2106 MMBtu/hr syngas firing 8760 hours per year.
3. The facility avoided PSD for NOx by netting and accepting a plant-wide limit on NOx of 2,121.5 TPY. The NOx limit is calculated in the same manner as the $SO_2$ limit.
4. Acronyms as follows: CCCT - Combined Cycle Combustion Turbine; ST - Steam Turbine.

**Table 2 - Contents of CD**

| File Name | Contents | Comment |
|---|---|---|
| 2006 program update | USDOE Clean Coal Technology Programs: Program Update 2006 | Project costs on page 3-44 |
| B&V FPL Coal Tech Study - Final Report | Clean Coal Technology Selection Study, January 2007 | Ratio of IGCC to CFB O&M costs, Table 1-6 |
| Bechtel | Technology Assessment, September 2002 | |
| Burns & Mac VECTERN Technology Assessment | Vectren Corporation Technology Assessment FINAL, October 2005 | |
| CH2M Hill Dairyland Technology Assessment | Alternative Evaluation Study, January 2004. | |
| ConocoPhilips | Workshop on Gasification Technologies June 8-9, 2004 | |
| Duke IGCC Presentation | The Case for IGCC - Duke Energy Presentation - June 20, 2006 | |
| ENSR Desert Rock IGCC CFB | Desert Rock Energy Project Design Comparison - IGCC and CFB, September 2005 | |
| Example IGCC Application PMEC | Pacific Mountain Energy Center - Appendix to Application, September 2006 | |
| Excelsior Energy MPCA comments | Minnesota Pollution Control Agency Response to Comments on Excelsior Energy | |
| ExistingIGCCemission rates (2) | An Environmental Assessment of IGCC Power Systems | |
| NETL Gasification Description | Presentation on Gasification by National Energy Technology Laboratory | |
| NYKOMB IGCC summary | Nykomb Synergentics Summary | |
| Selexol | Use of Selexol Process in Coke Gasification to Ammonia Project | |
| Taylorville Permit | Taylorville Energy Center Permit, June 2007 | |
| USDOE IGCC Report | Major Environmental Aspects of Gasification-Based Power Generation Technologies, December 2002 | |
| USDOE Tampa Final | Tampa Electric Polk Power Station – Final Technical Report, August 2002 | Capital cost on page 4-2 |
| USDOE Wabash | Wabash River Coal Gasification Repowering Project – Project Performance Summary, July 2002 | Capitol cost on page 5 |
| USEPA Environmnetal Footprints | Environmental Footprints and Costs of Coal-Based IGCC and PC Technologies, July 2006. | |
| White Nevada IGCC Comparison | White Pine Energy Associates IGCC Comparison | |