EERC
Energy & Environmental Research Center

UNIVERSITY OF NORTH DAKOTA
15 North 23rd Street — Stop 9018 / Grand Forks, ND 58202-9018 / Phone: (701) 777-5000 Fax: 777-5181
Web Site: www.undeerc.org

April 28, 2009

Mr. Timothy Edman
Manager, Regulatory Administration
Xcel Energy, Inc.
414 Nicollet Mall
Minneapolis, MN 55401

Dear Mr. Edman:

Subject: Quarterly Progress Report Entitled "Indirect Liquefaction of Wood Waste for Remote Power Generation Fuel"; Contract No. RD3-66; EERC Fund No. 9968

Enclosed please find the subject report. If you have any questions, please contact me by phone at (701) 777-5159 or by e-mail at jhurley@undeerc.org.

Sincerely,

John Hurley

John P. Hurley
Senior Research Advisor

JPH/sah

Enclosure

Energy & Environmental Research Center University of North Dakota
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

Project Title: Indirect Liquefaction of Wood Waste for Remote Power Generation Fuel

Contract Number: RD3-66 Milestone Number: 1 Report Date: April 28, 2009

Principal Investigator: John Hurley Contract Contact: Tobe Larson
(701) 777-5159 (701) 777-5271

Congressional District: Not Applicable

Congressional District: Not Applicable

MILESTONE REPORT

Executive Summary: During this milestone period, a three dimensional model of the trailer-mounted indirect liquefaction system was initiated using the software program AutoCAD® Inventor. Permitting for pilot work in North Dakota is complete, and a permit applicability request for the demonstration project in Minnesota has been submitted (Appendix A). The project is expected to be exempt from air quality permitting. Laboratory testing of syngas conversion systems was initiated through the construction of a syngas reactor system. Construction of a pilot-scale gas cleanup system was initiated under a separately funded project. Results from that separately funded work will be used to determine the best gas cleanup solutions for RD3-66 technology, so our cleanup system design has been postponed for several months awaiting the results of that work. Testing in the separately funded project will begin in the next quarter. A fully executed subcontract has been received from IdaTech of Bend, Oregon, for testing the methanol produced in the trailer-mounted system in IdaTech's fuel cell-based power systems (Appendix B). The subcontract from the University of Minnesota – Duluth (UMD) has been requested but has not yet been received. Through discussions with UMD's Mr. Bill Berguson, it was decided that the work originally planned in the proposal to be performed by a graduate student intern from UMD based at the Coleraine Minerals Research Laboratory, through a subcontract to UMD, will instead be performed by Energy & Environmental Research Center personnel. The decision was made because of the extended work scope to the program as a result of the matching funding being provided by the U.S. Department of Energy and the difficulty in scheduling a graduate student intern over portions of the school year. Therefore, the UMD work will involve analysis of wood waste resources rather than actual work on the trailer-mounted indirect liquefaction system, so no subcontract is required from Coleraine. A formal letter of invitation has been obtained from Valley Forest Wood Products agreeing to supply us with fuel and to serve as the host site for the field demonstration of the system at their Marcell, Minnesota, pellet plant (see Appendix C).

Technical Progress:

System Design

The software program AutoCAD Inventor is being used to generate three-dimensional models of the components of the biomass gasification. The individual component models, such as the gasifier, scrubber, feed system, etc., are then assembled onto a model of the truck trailer to determine the most suitable location and orientations for the processes.

State Permitting
Permitting for pilot work in North Dakota is complete, and a permit applicability request for the demonstration project in Minnesota has been submitted. The project is expected to be exempt from air quality permitting. See Appendix A for a copy of the North Dakota air quality exemption and the submission to the Minnesota Pollution Control Agency (MPCA).

Trailer
A search for appropriate semitruck trailers led to the decision of using a typical storage trailer. The recommended trailer is a reefer-type, 48–53 feet long, with a height of 8.5 feet. To allow for the larger components of the gasification units, this trailer will have the front reefer cooling unit removed and have roof/side hatches installed that are fit to our requirements. Used reefer trailers are easily supplied from Jim Hawk Trucking for a price of $5,000 to $15,000, with the modifications being performed in-house for an extra charge.

Gas-to-Liquids Conversion
The methanol synthesis reactor for the project is currently being designed. As a first step toward finalizing the design, various reactor operating parameters and expected syngas composition from the integrated biomass gasifier are being experimentally evaluated in a specially designed modular reactor system. A picture of the system is shown in Figure 1. It consists of three main subsystems: 1) a synthetic syngas supply system, 2) a methanol synthesis reactor and heat management system, and 3) a purge gas analysis system.

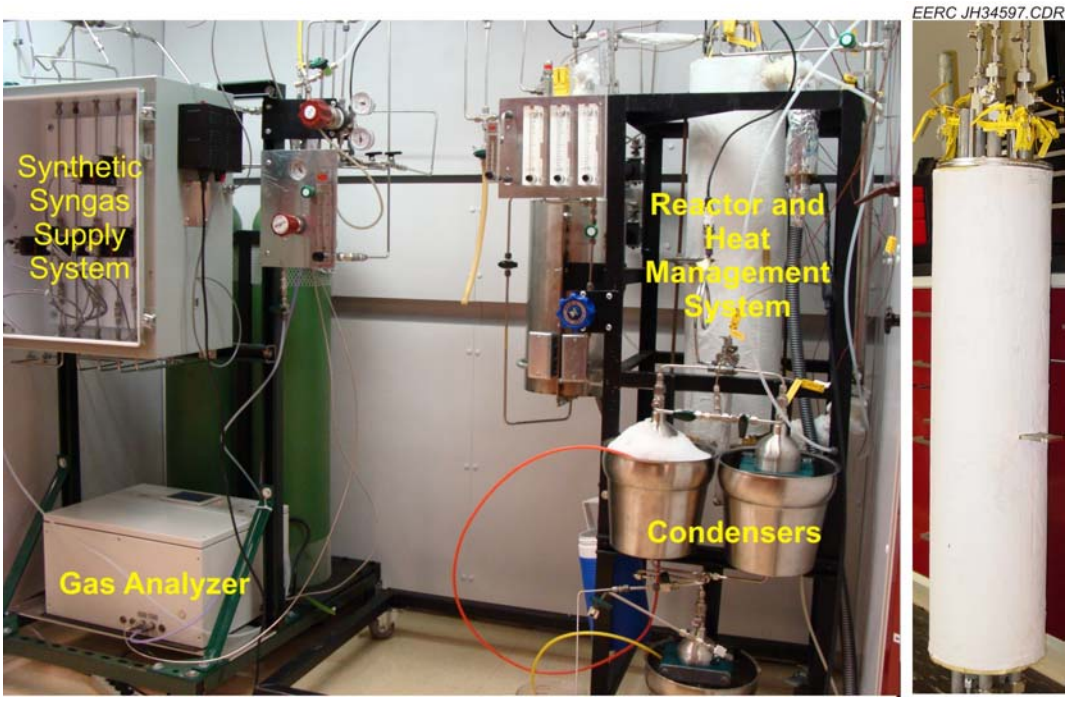

Figure 1. Syngas-to-methanol test setup showing syngas supply system, synthesis reactor, liquid condenser, and online gas analyzer.

The operating pressure of the system ranges between 100 and 1000 psig. It is designed to maintain a constant reactor temperature of 40°–300°C, achieved by direct as well as indirect heat-transfer using air, nitrogen, and syngas as heat-transfer mediums. The synthesis reaction is mildly exothermic, and the heat management system ensures constant catalyst bed temperature under steady-state operation. The maximum design syngas flow rate is 70 L/min. The initial parametric study will be conducted at flow rates of 3.5 and 5 L/min. These experiments will be conducted at operating temperatures and pressures ranging from 200°–300°C

and 300–600 psig, respectively. The syngas composition range is based on prior high-moisture biomass gasification data that are H_2=20%–35%, CO=20%–35%, CO_2=8%, N_2=22%–52%. A total of 34 experiments will be required to complete a parametric study that will help develop an understanding of reactor and catalyst performance. The highest methanol yield will be one of the primary criteria for the selection of operating parameters. This approach is critical to arrive at a reactor design that can be integrated with the gasifier without requiring extensive gas balance equipment that is inevitable with most large-scale methanol synthesis processes.

Biomass Resources at the Demonstration Site

The feedstock for the indirect liquefaction system will be the available waste material at the Valley Forest Wood Products pellet processing plant near Marcell, Minnesota. Figure 2 shows selected photos of the site including a pile of accumulated biomass that is currently land filled. There are primarily three wood waste types available for the current project utilization: 1) coarse chips, 2) sawdust, and 3) fine chips.

Figure 2. Selected photos of the site and pile of land-filled biomass expected to be used in the biomass-to-methanol demonstration system.

Figure 3 depicts a direct picture of the three wood feedstocks. Table 1 shows the ultimate and proximate analysis of the fuel. The sulfur and ash content in all three biomass is found to be low. Although the moisture content of the biomass ranged from 5% to 7%, it is expected to vary from season to season as is the depth of the biomass pile.

Figure 3. Direct pictures of the three biomass feedstocks.

Table 1. Proximate and Ultimate Analysis of the Feedstock Available at the Indirect Liquefaction Demonstration Site

	Biomass Chips, coarse		Sawdust		Biomass Chips, fine	
Ultimate Analysis	Fuel as Received, wt%	Ash and Moisture-Free Basis, wt%	Fuel as Received, wt%	Ash and Moisture-Free Basis, wt%	Fuel as Received, wt%	Ash and Moisture-Free Basis, wt%
Hydrogen	6.25	5.91	6.14	6.0	6.26	6.03
Carbon	47.33	51.18	47.41	51.8	48.56	51.45
Nitrogen	0.26	0.28	0.29	0.32	0.29	0.31
Sulfur	0.04	0.04	0.06	0.06	0.04	0.04
Oxygen	45.62	42.58	43.44	41.82	44.32	42.17
Ash	0.05	N/A*	2.66	N/A	0.53	N/A
Proximate Analysis						
Moisture	7.00	N/A	5.8	N/A	5.1	N/A
Volatile Matter	76.19	82.38	76.29	83.35	77.37	85.0
Fixed Carbon	16.31	17.62	15.25	16.65	17.0	15.0
Ash	0.50	N/A	2.66	N/A	0.53	N/A
Heating Value, Btu/lb (MJ/kg)	8478 (19.71)	9168 (21.32)	7922 (18.42)	8655 (20.13)	8170 (19.00)	8656 (20.13)

* Not applicable.

Gas Cleaning

Although we are awaiting the test results of the separately funded pilot-scale gasification system, we have begun literature surveys of possible gas cleaning systems that could be installed with the trailer-mounted indirect liquefaction system that will be constructed under RD3-66. The gasifier will output a syngas stream of approximately 150 scfm. This stream will contain various impurities that need to be removed. The composition of the syngas stream is estimated in Table 2. The values are estimates from a bench-scale model of a likely gasifier design.

Table 2. Gasifier Syngas Stream Composition

Substance	Amount	Unit
Moisture	12	%
Carbon Monoxide	25	%
Hydrogen	25	%
Nitrogen	30	%
Carbon Dioxide	8	%
Hydrogen Sulfide	20	ppm
Ash (particulate)	100	ppm
Tars	100	ppm

Removal of the various impurities will take place in several stages. Each stage type and size will depend on the properties of the feedstock and operation of the gasifier. We are investigating several scenarios. As an example, if large particulate matter is an issue, a cyclone will be the first gas cleanup stage. Cyclones use gravity and inertial vortex separation to remove large particles. The next cleanup stage may use an ejector venturi scrubber. This type of scrubber sprays water into the hot-gas stream to remove water-soluble gases (such as hydrogen sulfide), ash, and condensate tars. These first stages will remove most of the impurities from the gas and will be

regenerable. Later stages are for polishing and may include nonregenerable items such as activated carbon or HEPA filters to remove volatile organic compounds or fine particulate matter remaining in the gas stream.

The gas cleanup process described above produces two significant waste streams. The first is the water from the ejector scrubber. With the assistance of MPCA, two options have been identified for disposing of this wastewater. The first option is to simply dump the water onto the ground. This would require that the wastewater meet the drinking water requirements provided by the U.S. Environmental Protection Agency. If the wastewater does not immediately meet these requirements, further wastewater cleanup would be required such as filtering through activated carbon. The second option is to arrange an agreement with a nearby publicly owned water treatment facility. The closest such plant is located in Grand Rapids, Minnesota.

The second waste product is the activated carbon. This material can be regenerated and used again. Several companies, such as Carbtrol®, offer this service to their customers for both hazardous and nonhazardous activated carbon.

Additional Milestones: None.

Project Status: The project is currently on schedule and within budget. However, it is expected that system design, bidding of equipment, and purchasing of equipment listed for Milestone 2 will be delayed by several months because of the opportunity to refine our system design based on results of pilot-scale testing that will be performed in the April through June time frame under a separately funded project. That project involves construction and testing of a new gasifier design and syngas cleanup technologies that may be very advantageous to RD3-66. Therefore, we would like to wait and learn from that program before continuing with the RD3-66 system design.

Appendices: Enclosed is a copy of the North Dakota air quality exemption and the submission to MPCA (Appendix A). Also included is the letter subcontract to IdaTech for methanol testing (Appendix B) and the letter of invitation from Valley Forest Wood Products to serve as the host site for the field demonstration and to supply the wood chip fuel (Appendix C).

APPENDIX A

STATE PERMITTING DOCUMENTS

NORTH DAKOTA
DEPARTMENT of HEALTH

ENVIRONMENTAL HEALTH SECTION
Gold Seal Center, 918 E. Divide Ave.
Bismarck, ND 58501-1947
701.328.5200 (fax)
www.ndhealth.gov

February 19, 2009

Mr. Ken Grohs
Facilities & Safety Coordinator
Energy & Environmental Research Center
15 North 23rd Street - Stop 9018
Grand Forks, ND 58202-9018

Re: Operation of 200 lb/hr Portable Biomass Gasification System

Dear Mr. Grohs:

In your letter dated February 6, 2009, you requested a determination of the permitting requirements for the temporary operation of a 200 lb/hr portable biomass gasification system as a research unit at the EERC facility in Grand Forks. Your request indicated the gasifier would convert wood chips to synthetic gas and any gas not compressed for storage would be flared. The gas production rate will equate to approximately 1.3 million Btu/hr, and operations are expected to total 300 hours over the 2009 to 2011 period. The only air emissions will be from the flare and will total less than 250 pounds per pollutant for the entire operation.

Based on the information you provided, the Department has determined the biomass gasification system to be a source of minor significance and no Permit to Construct will be required (NDAC 33-15-14-02.13n). In addition, portable sources not subject to Prevention of Significant Deterioration requirements are exempt from requirements to obtain a Permit to Construct (NDAC 33-15-14-02.16). Due to the minimal rates of emissions, the gasifier may be operated simultaneously with any other EERC source units or approved unit combinations. Because operation of the unit will be temporary, it will not be necessary to add the gasifier to the EERC Permit to Operate. Report any emissions on your Annual Emission Inventory Reports.

Please ensure the gasifier is operated in compliance with all applicable air pollution control rules and does not pose a nuisance to the surrounding community. If you have any questions, please contact Lew Dendy of my staff at (701)328-5188.

Sincerely,

Terry L. O'Clair, P.E.
Director, Division of
Air Quality

TLO/LD:csc
Enc:
cc: John Hurley
Darren Schmidt
Greg Weber

Date: 4/2/09

Paula Connell
Title: Air Quality Permits 2
Division: Industrial
Section: Air Quality Permits
Phone: 651/757-2285
Fax: 651/296-8717
Location:
paula.connell@pca.state.mn.us

Dear Ms. Connell:

Subject: Applicability Request for a Research Project for Temporary Operation of a Fuel Production Wood Gasification System located near Marcell, MN.

The Energy & Environmental Research Center (EERC) is under contract with Xcel Energy as part of the Renewable Development Fund Research Program to complete a research demonstration project investigating the production of liquid fuels from the gasification of wood (biomass gasification). The project is expected to occur between 1/1/2009 and 12/31/2010 and will be located in or near Marcell, MN. A site selection procedure is in process, however preliminary permitting determination is required at this time. The EERC is submitting this letter to the Minnesota Pollution Control Agency (MPCA) for determination of air quality permit applicability. If formal permitting is required an application would be submitted.

The EERC had submitted a separate but similar previous request to MPCA relative to a demonstration project located in Williams, MN at Northern Excellence where the project was determined exempt from permitting. A copy of the previous exemption is attached for reference.

Previous considerations indicate that the installation is possibly exempt since the size is relatively small (<10tons/yr for individual criteria pollutants). The attachments to this letter provide the site information and system specifications to enable an evaluation. The project at is expected to begin construction in the summer and is targeting startup near the end of 2009. Please contact Darren D. Schmidt, Senior Research Advisor, EERC, @ (701) 777-5120, dschmidt@undeerc.org, for any questions.

Minnesota Pollution Control Agency
520 Lafayette Road North | St. Paul, MN 55155-4194 | 651-296-6300 | 800-657-3864 | 651-282-5332 TTY | www.pca.state.mn.us

September 4, 2008

Mr. Darren Schmidt
Energy & Environmental Research Center
15 North 23rd Street
P.O. Box 9018
Grand Forks, ND 58202-9018

RE: Response to Applicability Request for an Engine Generator/Wood Gasification System Installation at Northern Excellence Located in Williams, Minnesota

Dear Mr. Schmidt:

I have reviewed the material that you submitted in the Applicability Request, received May 15, 2008 as well as the additional information you provided in an e-mail dated July 29, 2008. The applicability request is regarding air quality permit applicability for a generator/gasification system to be installed at the Northern Excellence facility located in Williams, Minnesota.

The information you provided on the process, i.e. gasification of gas seed screenings to produce a gas which would be cleaned and then fired in an engine generator for electrical production, as well as the information on the quality of the gas produced, and on the capacity of the engine indicates that the potential emissions from the facility are below the thresholds for needing a permit. Therefore, based on the information you have provided, the facility does not need an air emissions permit for the process described. The facility should maintain the information demonstrating that a permit is not needed; this information should be kept on-site.

Feel free to contact me at 651-282-2605 or via e-mail at paula.connell@pca.state.mn.us if you have any additional questions.

Sincerely,

Paula J. Connell, P.E.
Principal Engineer
Air Quality Permits Section
Industrial Division

PJC:lao

cc: AQ File No. 4405

INDIRECT LIQUIFACTION OF WOOD
XCEL ENERGY RESEARCH DEMONSTRATION

GENERAL DESCRIPTION

The Energy & Environmental Research Center (EERC) wishes to operate a temporary portable liquid fuel production system located in or near Marcell, Minnesota. The system comprises a wood gasification system that will produce a synthetic gas for conversion to liquid fuels. The gasifier is operated by drawing air through the unit, and the gasifier is indirectly heated. The gas, drawn out of the gasifier, is cleaned, cooled, and compressed. The compressed gas is converted to a liquid fuel using a catalytic reactor system. The only emission point is the process gas flare. A process flow diagram is provided in Figure A-1. A map of one potential site location is provided in Figure A-2.

Gasification Unit Specifications:
Fuel: Wood chips
Heating Value: 7500 Btu/lb, 1% ash, 20% moisture
Fuel Consumption Rate: 200 lb/hr
Gas Production Rate: 1,341,400 Btu/hr
Gasifier Efficiency: 75%
Higher Heating Value of Product Gas: 220 Btu/scf
Operating Pressure: −10 in w.g.

Schedule of Operation
Delivery of the trailer is estimated to be no earlier than July 2009. Operation at the site will be through December 2011. Operation is planned for 8-hour-per-day shifts.

Fuel and Emission Points
Fuel for the gasifier is primarily softwood chips. Air emissions are generated from the combustion of syngas in a process gas flare. The gasifier unit is equipped with a process gas flare. The flare will be an enclosed unit, shielded from wind, and induced combustion air provided. The pipe diameter will be approximately 8", providing a draft of at least 120–50 ft/s. A continuous ignition source is provided.

Table A-1. Emissions[1], tons/yr

Pollutant	
Particulate	0.00042
Sulfur Dioxide	3.4
Nitrogen Oxide	0.4
Carbon Monoxide	3.1
Hazardous air pollutants (HAPs)	0.016
Volatile Organic Compounds (VOCs)	0.032

[1] These data assume a potential to emit of 8760 hr/yr; however, this project will operate significantly less than 8760 hr/yr.

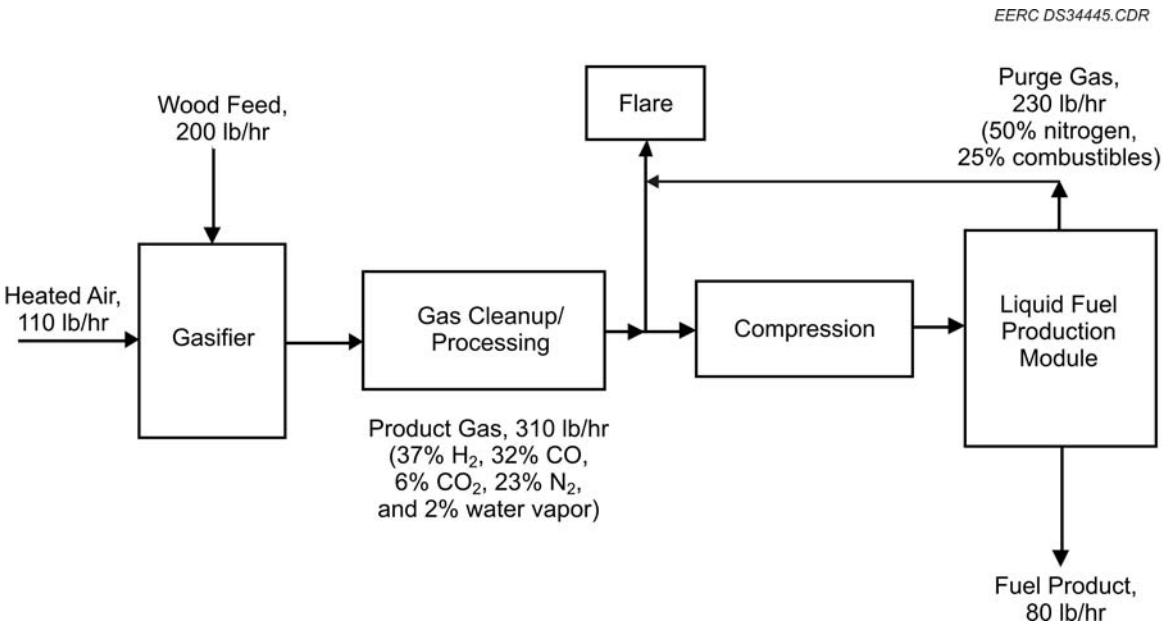

Figure A-1. Process flow diagram.

Figure A-2. Site location.

EMISSION CALCULATIONS

Flare

The flare for the proposed biomass-to-energy facility will be designed according to standard practices for gas burners designed to achieve high levels of destruction efficiency. Design criteria offered in Cooper and Alley provide for destruction efficiencies of 99.5% and better for CO and particulate matter (PM) (1). NO_x emissions are estimated at 0.068 lb/MMBtu according to U.S. Environmental Protection Agency AP42 (2). The exhaust flow rate is 6097 scfh (1.3 MMBtu/hr). PM concentrations in the raw product gas were measured at 50 mg/m^3 by the EERC (3). An example of a low-Btu flare (2.3 MMBtu/hr) is shown in Figure A-1.

Figure A-3. Low-Btu flare at the EERC.

NO_x

0.068 lb/MMBtu*1.3414 MMBtu/hr * 8760 hr/yr * 1 ton/2000 lb = 0.4 tons/yr

CO

Gas Flow Rate = 102 scfm
CO Concentration = 32%
Density of CO = 0.074 lb/ft^3

102 ft^3/min * 60 min/hr * 0.32 * 0.005 * 0.074 lb/ft^3 * 1 ton/2000 lb * 8760 hr/yr =
3.1 tons/yr CO

PM and PM_{10}

50 mg/m^3 [3] * 1 kg/1,000,000 mg * 2.2 lb/kg * 1 m^3/35.3 ft^3 * 6097 scfh *
(1 ton/2000 lb) * 8760 hr/yr * 0.005 = 4.2×10^{-4} tons/yr

SO_2

Sulfur content in the fuel and charcoal was determined from ASTM International Method D4239-02 (3). The values are 0.2% and 0.02%, respectively.

The Potential to Emit SO_2

Fuel Rate = 876 tons/yr
Charcoal Rate = 17.5 tons/yr

Sulfur remaining in gas
(876 tons/yr * 0.002) – (17.5 tons/yr * 0.0002) = 1.7 tons/yr sulfur

Assume all sulfur coverts to SO_2
1.7 tons S/yr * 2 tons SO_2/1 ton S = 3.4 tons/yr SO_2

HAPs

Gas contaminant (tar vapor) concentrations in the product gas have been determined at the EERC's pilot facility to be less than 500 mg/m^3 (3). Gas chromatograph analysis of the contaminants identified that of the 500 mg/m^3 contamination, 40.8% consist of HAPs and the remainder are non-HAP classified components. The HAP composition is as follows:

- benzene 46%
- toluene 38%
- m-xylene 4%
- p-xylene 7%
- o-xylene 5%

The Potential to Emit HAPs

Concentration of contaminants
Producer Gas Flow Rate = 102 scfm

500 mg/m^3 * 1 g/1000 mg * 1 kg/1000 g *2.2 lb/kg * 1 m^3/35.3 ft^3 * 102 scfm * 60 min/hr *
0.408 HAPs * 8760 hr/yr * (1 ton/2000 lb) = 0.3 tons/yr HAPs in raw gas

Conservative flare combustion efficiency 95%

0.3 tons/yr * 0.05 = 0.016 tons/yr HAPs

VOC

The expected VOC emission destruction efficiency is 98% and can be as low as 90% for adverse conditions (4).

The Potential to Emit VOCs

0.3 tons/yr * 0.1 = 0.03 tons/yr VOCs

REFERENCES

1. Cooper, C.D.; Alley, F.C. *Air Pollution Control*; Waveland Press; 2002; ISBN 1-57766-218-0.

2. EPA AP42, Section 13.5 Industrial Flares. www.epa.gov/ttnchie1/ap42/ (accessed March 2009).

3. Schmidt, D.D.; Martin, K.E.; Patel, N.; Richter, J.J. *Portable Biomass Gasification Testing*; Topical Report for U.S. Department of Energy Cooperative Agreement No. DE-FC36-03GO13055; Energy & Environmental Research Center: Grand Forks, ND, July 2005.

4. Levy, R.E.; Randel, L.; Healy, M.; Weaver, D. *Reducing Emissions from Plant Flares*; Industry Professionals for Clean Air, Houston, TX, April 24, 2006; Paper 61.

APPENDIX B

LETTER SUBCONTRACT WITH IDATECH

Katherine

Purchase Order

University of North Dakota
264 CENTENNIAL DRIVE STOP 8356
GRAND FORKS ND 58202-8356
United States

Vendor: 0000110804
IDA TECH LLC
63065 NE 18TH ST
BEND OR 97701

Dispatch via Print

Purchase Order	Date	Revision	Page
UND01-0000007165	01/07/2009		1
Payment Terms	**Freight Terms**		**Ship Via**
30 PO	FOB DEST, FRT PREPAID		Common
Buyer	**Phone**		**Currency**
*Albrecht,JoAnn S.	701/777-2681		USD

Ship To: EERC Admin
15 NORTH 23RD STREET
GRAND FORKS ND 58202-9018
United States

Bill To: EERC
PO BOX 9018
GRAND FORKS ND 58202-9018
United States

Tax Exempt? Y **Tax Exempt ID:** E-2001 **Replenishment Option:** Standard

Line-Sch	Item/Description	Mfg ID	Quantity UOM	PO Price	Extended Amt	Due Date
1- 1	CONSULTING SERVICES		1.00 EA	10,000.00	10,000.00	01/21/2009

Item Total 10,000.00

PR # 2282
ORDER FAXED IN, DO NOT DUPLICATE
EERC

Total PO Amount 10,000.00

623025 41000 1120 UNP01322.1

SFN 2023(REV 12/02)

Authorized Signature
*Satter,Sara E.

IdaTech Participation in Mobile Indirect Liquefaction Demonstration
Scope of Work and Budget

Task Description

IdaTech shall participate in discussions about the commercialization pathway of the mobile indirect wood waste liquefaction system being built and demonstrated under funding from the U.S. Department of Energy and the Xcel Energy Renewable Development fund. In addition, IdaTech will test methanol-based fuels produced in the liquefaction system in a small IdaTech power system to determine what modifications to the fuel will be necessary in order for it to be used commercially in the IdaTech systems. The estimated budget includes one trip for one person to the Energy & Environmental Research Center in Grand Forks, North Dakota. Direct Labor rates are fully burdened to include labor, fringe, overhead, G&A, and fees.

Deliverable

At the end of the laboratory testing of the methanol-based fuels, IdaTech will provide a short written report, for inclusion in the final project report, describing the results of the testing of the fuels and suggestions for modifications necessary to make the fuels more commercially acceptable. The deadline for this report shall be 1 month before the end of the overall project, currently planned for October 31, 2010.

Cost Estimate

Labor	60 hours at $100/hour	$ 6,000
Supplies		$ 1,000
Travel		$ 3,000
Total		$10,000

APPENDIX C

INVITATION LETTER FROM VALLEY FOREST WOOD PRODUCTS TO SERVE AS DEMONSTRATION SITE AND PROVIDE WOOD CHIPS FOR FUEL

Dear John, 3/18/09

As owner of Valley Forest Wood Products (VFWP), I agree to allow the University of North Dakota Energy & Environmental Research Center (EERC) to field test its mobile indirect wood waste liquefaction system at the VFWP pellet processing plant near Marcell , Minnesota . I understand that the field test is being funded by the Xcel Energy Renewable Development Fund and the U.S. Department of Energy. VFWP agrees to provide space for the test equipment, access to the site and to utilities, and to fill the feed hoppers with wood chips as needed for the demonstration.

I understand that the rate of wood consumption may be as high as 200 lb/hour while the gasifier is running. VFWP will charge the EERC for the wood chips at a rate of $35.00 per ton used when the testing is completed, but will otherwise not charge the EERC any other costs for the demonstration. Although VFWP will allow the EERC to connect to the electric power grid and water supply system at the pellet plant, the EERC will be responsible to arrange and pay for the connections and disconnections and for the electric power and water consumed.

VFWP will not assume any other cost in hosting this demonstration. The EERC will be responsible for all construction, operation, and takedown, leaving the site essentially as it was found when the testing is complete. VFWP and the EERC will each be responsible for their own employees and their work activities. I understand that the testing is scheduled for the spring, summer, and fall of 2010.

Finally, VFWP agrees that the technology being developed in the demonstration is the sole property of the EERC, and VFWP will not claim or disclose information about the technology, or allow others access to the equipment without the written consent of the EERC.

Sincerely,

Tink Birchem

Tink Birchem