EERC
Energy & Environmental Research Center

UNIVERSITY OF NORTH DAKOTA
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Web Site: www.undeerc.org

December 29, 2010

Ms. Karlene Fine
Executive Director
North Dakota Industrial Commission
State Capitol – 14th Floor
600 East Boulevard Avenue, Department 405
Bismarck, ND 58505-0840

Dear Ms. Fine:

Subject: EERC Proposal No. 2011-0136

The Energy & Environmental Research Center (EERC) of the University of North Dakota is pleased to submit the subject proposal to the North Dakota Industrial Commission Renewable Energy Program. The EERC is committed to completing the project as described in this proposal if the Commission makes the requested grant.

Enclosed please find an original and one copy of the proposal entitled "Pilot-Scale Testing to Evaluate the Effects of Biomass Cofiring Combustion on CMMs at Low Mercury Concentrations." Also enclosed is the $100 application fee. The EERC, a research organization within the University of North Dakota, an institution of higher education within the state of North Dakota, is not a taxable entity; therefore, it has no tax liability.

If you have any questions, please contact me by telephone at (701) 777-5268 or by e-mail at jpavlish@undeerc.org.

Sincerely,

for

John H. Pavlish
Senior Research Advisor

Approved by:

12/29/10

Dr. Gerald H. Groenewold, Director
Energy & Environmental Research Center

JHP/kal

Enclosure

Renewable Energy Program

North Dakota Industrial Commission

Application

Project Title: Pilot-Scale Testing to Evaluate the Effects Of Biomass Cofiring Combustion on CMMs at Low Mercury Concentrations

Applicant: Energy & Environmental Research Center

Principal Investigator: John H. Pavlish

Date of Application: December 29, 2010

Amount of Request: $247,000

Total Amount of Proposed Project: $494,000

Duration of Project: 12 months

Point of Contact (POC): John H. Pavlish

POC Telephone: (701) 777-5268

POC Email: jpavlish@undeerc.org

POC Address: 15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

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ABSTRACT

As a result of a court consent decree, in November 2011, the U.S. Environmental Protection Agency will finalize a National Emission Standard for Hazardous Air Pollutants (NESHAP) for the utility industry, including plants that cofire with biomass. The mercury emission limits set forth by this NESHAP will be determined using the maximum achievable control technology basis under Section 112 of the 1990 Clean Air Act Amendments. As a result, it is expected that the new mercury emission limits will be much lower than the court-vacated Clean Air Mercury Rule emission limits. All plants, including plants that cofire with biomass, will likely have to continuously measure stack mercury concentrations below 1.0 µg/dNm3(at 3% O_2) in order to comply with the NESHAP rule. Continuous mercury monitor (CMM) measurements at this level during normal coal combustion have identified instrument limitations based on previous work conducted at the Energy & Environmental Research Center (EERC). Cofiring with biomass or 100% biomass combustion significantly changes major and trace element flue gas concentrations and may also interfere with low-level CMM measurements.

Objective:

This project will determine the possible effects of biomass and biomass cofiring on the ability of CMMs to accurately measure mercury concentrations <1.0 µg/dNm^3 at 3% O_2.

Expected Results:

Results include 1) identification of any CMM or sorbent trap biases associated with combusting biomass blends or 100% biomass; 2) possible remedies to improve low-level measurements should issues be identified; 3) a final report that presents data and findings; and 4) dissemination of key results and findings at conferences.

Duration:

12 months

Total Project Cost:

$494,000

Participants:

North Dakota Industrial Commission (NDIC), EERC, U.S. Department of Energy, and Center for Air Toxic Metals® (CATM®) Affiliates Program.

PROJECT DESCRIPTION

Objectives:

The overall goal of this project is to determine the effects of biomass cofiring on the ability of continuous mercury monitors (CMMs) to accurately measure mercury concentrations <1.0 µg/dNm^3 at 3% O_2. The objectives include the following:

- Establish measurement certainty, and determine the accuracy and variability of the CMM measurements while natural gas is burned, with mercury added under controlled conditions.
- Determine the accuracy and variability of the CMM measurements while burning biomass–coal blends, with mercury control to levels <1.0 µg/dNm^3 at 3% O_2.

Verify the accuracy of CMM measurements using sorbent trap measurements via quadtrain sampling and spiked traps while sampling biomass cofired flue gas for mercury.

Methodology:

The proposed scope of work for this project will be divided into the following tasks.

Task 1 – Verify the Accuracy of the Mercury-Spiking Systems and Sorbent Trap Measurements. The initial task is designed to ensure that all of the equipment is operating at the highest level. The mercury-spiking systems include a system for spiking of mercury into the combustor (10 µg/dNm^3 at 3% O_2 flue gas equivalent), and spiking of mercury into the flue gas downstream of the scrubber (0–1 µg/dNm^3 at 3% O_2). Both mercury-spiking systems will use elemental mercury. The spiking systems will be set up and shaken down prior to testing. It is critical that a constant temperature be maintained in the housing for each of the mercury-spiking systems. This will include having the ovens and condensers at temperature and stabilized and flow of uninterrupted sweep gas initialized several weeks prior to testing. The quantity of mercury generated will be analyzed at the Energy & Environmental Research Center (EERC) using an OhioLumex instrument that passes the requirements of U.S. Environmental Protection Agency (EPA) Method 30B.

As part of the test program, Tekran and Thermo Scientific CMM systems will be used, including both Hg^0 and Hg^{2+} calibrators. Both companies are actively working on developing low-level calibration systems. Prior to testing, each of the instruments will be calibrated to the highest possible level of accuracy for the low-level measurements. Previous testing has shown accurate calibration of these systems at 1.0 µg/dNm^3 at 3% O_2, with working ranges to below 0.5 µg/dNm^3 at 3% O_2 (1).

Task 2 – Determine the Accuracy and Variability of the CMM Measurements While Natural Gas Is Burned, with Mercury Added under Controlled Conditions. The test runs for this task will be conducted at the EERC on the particulate test combustor (PTC) furnace. Natural gas was chosen as a fuel for the initial tests rather than biomass blends so that there will be little variation in mercury concentration as a result of the fuel mercury content. Combustion of natural gas on the PTC typically results in 150–200 ppm NO_x and 18% water vapor.

During the first week of testing, natural gas will be used as the fuel to generate combustion flue gas. During natural gas combustion, mercury will be spiked into the PTC. It is expected that the natural gas testing will be completed over a 5-day period. The PTC is typically operated 24 hours a day, but sampling is only planned for two shifts. CMM sampling will continue between the tests to ensure the CMMs are measuring "zero" before the next test condition begins. The CMMs will operate continuously, and at least two quadtrain sorbent trap samples will be taken for each test condition. Sorbent trap samples will be analyzed by the EERC using the OhioLumex analyzer. Initially, sorbent trap sampling will include spiked traps for verification.

Test 1. To ensure measurement certainty, mercury will be added to the PTC using the EERC spiking system while firing natural gas. Previous tests have shown the PTC to be nearly mercury-free while combusting natural gas (<0.1 μg/m^3 and typically <0.03 μg/m^3). This will allow spiking of the combustor to produce a level of Hg in the flue gas in the range of 0.5–1.0 μg/dNm^3 at 3% O_2. As the sorbent trap samples are collected, the EERC Analytical Research Laboratory will be on alert, so next-day results will be possible.

Task 3 – Determine the Accuracy and Variability of the CMM Measurements While Burning Biomass–Coal Blends, with Mercury Control to Levels <1.0 μg/dNm^3 at 3% O_2. For the second week of testing, biomass and coal/biomass blends will be fired in the PTC. Biomass blends of 20%, 50%, and 100% biomass will be tested. The flue gas will pass through an electrostatic precipitator (ESP) to remove particulate matter followed by a scrubber. It is expected that the biomass-blended fuels used for this test will have a mercury concentration between 0.05 and 0.10 ppm (dry).

The test firing with the biomass blends will be conducted over a 5-day period, with the first three tests requiring 1 day each and the other test requiring 2 days to complete. The test coal used for Test 2 and the biomass blends will be a North Dakota lignite. The biomass to be blended is planned to be either wood or grass and will be decided on based on input from the North Dakota Industrial Commission (NDIC). The exact same sampling procedure will be used for the biomass blend tests. The CMMs will be operating continuously, and at least two quadtrain sorbent trap samples will be taken during each test.

Test 2. This test will be conducted on 100% lignite coal and will provide a baseline set of data that will be used for comparative purposes. Both CMM and quadtrain sorbent trap data will be collected during steady-state conditions.

Test 3. This test will determine the effects on low-level CMM measurements while firing a 20% biomass blend into the PTC furnace. Both CMM and quadtrain sorbent trap data will be collected during steady-state conditions.

Test 4. This test will determine the effects on low-level CMM measurements while firing a 50% biomass blend into the PTC furnace. Both CMM and quadtrain sorbent trap data will be collected during steady-state conditions.

Test 5. This test will determine the effects on low-level CMM measurements while firing a 100% biomass fuel into the PTC furnace. Both CMM and quadtrain sorbent trap data will be collected during steady-state conditions.

Anticipated Results:

The anticipated results will identify whether cofiring or combusting 100% biomass introduces any biases to low-level mercury measurements by CMMs. The results will also demonstrate the reproducibility of sorbent trap measurements via quadtrain sorbent trap sampling. These results will be used by utilities that are or are considering cofiring biomass to ensure their compliance with upcoming NESHAP regulations.

Facilities:

The majority of work for this project will be conducted at the EERC in Grand Forks, North Dakota. Since its founding in 1949, the EERC has conducted research, testing, and evaluation of fuels, combustion and gasification technologies, emission control technologies, ash use and disposal, analytical methods, groundwater, waste-to-energy systems, and advanced environmental control systems. The main EERC facilities, with 245,000 square feet of technology demonstration facilities, fuel preparation facilities, analytical laboratories, and office space, are located on the southeast corner of the University of North Dakota (UND) campus. State-of-the-art laboratory- and pilot-scale equipment is available for evaluating various fuels, including coal, biomass, and refuse-derived fuel.

Resources:

The following pilot-scale combustor, fuel preparation facilities, and laboratories within the EERC will be utilized in this project.

Particulate Test Combustor. The PTC is a 550,000-Btu/hr unit designed to generate fly ash and flue gas representative of that produced in a full-scale utility boiler. A schematic of the PTC is shown in Figure 1. The combustor is oriented vertically and has a refractory lining that helps to ensure adequate flame temperature for complete combustion. The fuel nozzle of the PTC fires axially upward from the bottom of the combustor, and secondary air is introduced concentrically to the primary air with turbulent mixing. An electric air preheater is used for precise control of the combustion air temperature. The PTC uses annular heat exchangers specially designed to provide flue gas temperature control while minimizing the potential for mercury deposition on the walls of the piping.

PTC instrumentation permits system temperatures, pressures, flow-rated flue gas constituent concentrations, and operating data to be monitored continuously and recorded by the unit's data acquisition system. Flue gas samples can be taken at any combination of two of the three available system sampling points: the furnace exit, the particulate control device inlet, and the particulate control device outlet. After passing through sample conditioners to remove the moisture, the flue gas is typically analyzed for O_2, CO, CO_2, SO_2, and NO_x. Each constituent is normally analyzed at both the furnace exit and the outlet of the particulate control device simultaneously, using two analyzers. The concentration

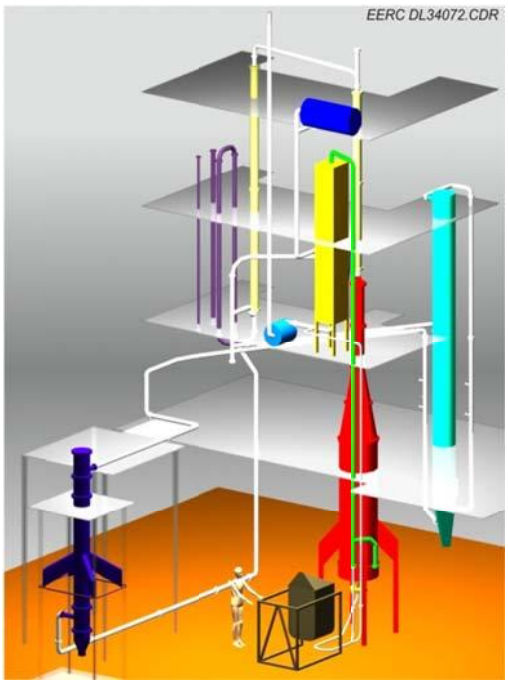

Figure 1. Schematic of the PTC.

values from all on the instruments are recorded continuously. In addition, data are manually recorded at set time intervals. NO_x is determined using a pair of Rosemount Analytical NO_x chemiluminescent analyzers. SO_2 is measured using a pair of Ametek Instruments photometric gas analyzers. The remaining gases are measured by a pair of Rosemount Analytical multigas continuous emission monitors. Each of these analyzers is regularly calibrated and maintained to provide accurate flue gas concentration measurements.

Fuel Preparation Facility. The EERC has conducted numerous resource assessments on a variety of biomass types, including wheat straw, rice straw, alfalfa, flax straw, animal manures or litter, corn stover, switchgrass, beet tailings, potato residues, hybrid poplar, sunflower hulls, municipal solid waste, sewage sludge, paper mill sludge, lignin from cellulosic ethanol processing, and many types of wood residue. The fuel preparation facility includes a walk-in trailer for biomass hauling and temporary storage; a batch autoclave that operates up to 2200 psi; a 7.5-ton/day coal or biomass continuous process development unit; and complete fuel-handling, crushing, shredding, and chipping preparation facilities for developing and testing process methods for fuel preparation.

Analytical Research Laboratory. The Analytical Research Laboratory (ARL) is equipped for routine and specialized analyses of inorganic and organic constituents, which are performed using state-of-the-art instrumental procedures as well as classical wet chemistry. Established analytical techniques allow for the chemical characterization of a variety of environmental and biological sample types, including fossil fuels, biomass, combustion by-products, geologic materials, fine particulate matter, groundwater, wastewater, fish tissue, and plant materials. Particular attention is directed toward major, minor, and trace element chemical analysis. Major instrumentation includes VG PQ ExCell inductively coupled

plasma-mass spectrometer (ICP–MS) with collision cell technology, Perkin Elmer Optima 2100 ICP-atomic emission spectrometer (AES), CETAC M6000A cold-vapor atomic absorption spectrometer (CVAAS) mercury analyzer, PS Analytical Millennium Merlin cold-vapor atomic fluorescence spectrometer (CVAFS), PS Analytical Millennium Excalibur hydride generation atomic fluorescence spectrometer (HGAFS), Varian Spectra AA-880Z graphite furnace atomic absorption spectrometer (GFAAS), Mitsubishi TOX-100 chlorine analyzer with oxidative hydrolysis microcoulometry, and Dionex ISC3000 ion chromatograph (IC) with conductivity detection.

Fuels and Materials Research Laboratory. The Fuels and Materials Research Laboratory (FMRL) is an integrated and fully equipped laboratory designed for testing of fuel quality parameters. The laboratory provides support for many EERC research programs. In addition to performing standard ASTM International fuel testing such as proximate–ultimate analyses and heating value, the FMRL provides a wide variety of other testing: surface area determination, laser particle sizing, dry and wet sieve analysis, and ash fusion. Major and minor equipment includes a Leco TGA-701 analyzer for the determination of moisture, volatile matter, and ash analysis; Leco TruSpec CHN analyzer for the determination of carbon, hydrogen, and nitrogen, which is part of the ultimate analysis for fuels; Leco TruSpec Sulfur analyzer; Leco AC-350 isoperibol calorimeter to determine heating values in fuels; Malvern 2600 particle-size analyzer to detect particles in the range of 0.5 to 564 µm; fusibility of coal and coke ash furnace to predict the deformation properties of the ash; facilities for sieving, grinding, and sample preparation. The lab utilizes a variety of equipment to prep samples for analysis, including several types of grinders, pulverizers, and a Micron Powder system for typical combustion prep. Physical tests are also performed, including wet-sieve analysis, dry-sieve analysis, and bulk density.

Techniques to Be Used, Their Availability and Capability:

Table 1 lists all the sampling and fuel analysis parameters that will be tested in this project. All equipment required for this testing is available in the laboratories at the EERC along with experienced and proficient staff to conduct the analyses. Tests as proposed are of similar nature to tests that the EERC has conducted in the past. Consequently, the EERC is confident that the tests can be completed as proposed.

The CMMs used for this project are from Tekran and Thermo Scientific, the main two vendors of CMM instruments. These two vendors account for over 95% of the CMM market. Both systems utilize a CVAFS analyzer in conjunction with a dry conversion probe to measure speciated mercury in a flue gas stream. The Tekran CMM uses gold preconcentration and produces a data point every 2.5 minutes. The Thermo Scientific system uses a continuous measurement detector and is able to obtain a data point at intervals ranging from 30 s to 3 minutes.

Environmental and Economic Impacts while Project is under Way:

The use of the pilot-scale system has minimal impacts because of the pollution control devices that are being used. The ESP and scrubber reduce the particulate and SO_2 emissions to below compliance levels. The use of reagents and chemicals needed during this project will be properly handled and disposed of according to UND's Waste Disposal Management System.

Table 1. Chemical and Fuel Quality Parameters to Be Determined

Parameter	Technique
Proximate (moisture, ash, volatile matter, fixed carbon)	Automated TGA[1]
Carbon, Hydrogen, Nitrogen	High-temperature combustion followed by IR[2] detection for carbon and hydrogen, and TC[3] detection for nitrogen
Sulfur	High-temperature combustion followed by IR detection
Halogens (bromine, chlorine, and fluorine)	Pyrohydrolysis followed by IC
Heating value	Isoperibol calorimeter
Sorbent Trap Analysis	OhioLumex RA 915+ analyzer
Flue Gas Mercury	CMMs

[1] Thermogravimetric analysis.
[2] Infrared.
[3] Thermal conductivity.

Ultimate Technological and Economic Impacts:

The information collected from this project will provide measurement data that will identify any challenges associated with low-level mercury measurements during biomass cofiring or biomass combustion. This information is critical to ensure compliance with expected future NESHAP regulations, providing critically needed data to maintain and promote the use of biomass while, at the same time, reducing greenhouse gas emissions. The increased use of biomass will promote rural economic health and growth and help address required greenhouse gas reductions.

Why the Project Is Needed:

It is expected that when the final NESHAP rules for the utility industry and small boilers are promulgated, substantial reductions in mercury will be required. As a result, many utilities burning coal, biomass, and coal–biomass blends and those that will in the future will likely be required to achieve mercury removals around 90%. For most fuels, 90% mercury removal requires consistently measuring stack mercury emissions in the 0.5–1.0 μg/dNm^3 at 3% O_2 range. It is critical that mercury measurements at these levels are accurate to ensure compliance with new mercury rules and to provide reliable continuous data that allow plant operators to optimize control (and minimize cost) of mercury reductions. This project is designed to address these issues when biomass or biomass blends are combusted.

STANDARDS OF SUCCESS

The deliverables of this project will include the report that will be generated and presentation of the results. It is expected that the results will have considerable interest in the utility and small boiler industries, which makes the presentation of the results very timely and important.

The key industries in North Dakota that will benefit from the results of this project are the utility and small boiler industries. The dissemination of the results to these industries will aid in their decision making regarding future fuel decisions and meeting emission regulations. Presenting the data at conferences will provide utilities from North Dakota and the rest of the United States with key mercury measurement data that will aid in their future fuel decisions. The increased use of biomass in North Dakota will result in newly created jobs by expanding the industry.

BACKGROUND/QUALIFICIATIONS

The EERC is one of the world's major energy and environmental research organizations. Since its founding in 1949, the EERC has conducted research, testing, and evaluation of fuels, combustion and gasification technologies, emission control technologies, ash use and disposal, analytical methods, groundwater, waste-to-energy systems, and advanced environmental control systems. The EERC has established working relationships with nearly 1100 clients in 51 countries and all 50 states, including federal and state agencies, universities, coal companies, utilities, research and development firms, equipment vendors, architecture and engineering firms, chemical companies, and agricultural products companies. The EERC emphasizes true working partnerships among private industry, government agencies, academic institutions, and the research community. Thus the EERC is committed to a partnership team approach for energy and environmental technologies.

The EERC is regarded as world-renowned expert in mercury measurement and control, completing thousands of tests and projects on the topic. The tests that are proposed are of similar nature to the tests the EERC has completed in the past. Consequently, the EERC is confident it will successfully complete the project.

The Centers for Renewable Energy and Biomass Utilization are a designated Center of Excellence located at the EERC. The Centers conduct critical research, development, demonstration, and commercial deployment of technologies utilizing biomass, wind, solar, geothermal, and hydroelectric energy sources. Under its Center for Biomass Utilization®, the EERC offers the most comprehensive approach to biomass conversion research.

MANAGEMENT

John Pavlish, Senior Research Advisor, will serve as project manager for this project. He will have the overall responsibility for the contract and will communicate regularly with all project sponsors and participants. He will also be responsible for contractual reporting to the NDIC Renewable Energy Program (REP) and the U.S. Department of Energy (DOE). Other members of the project management team will include Nicholas Lentz and Lucinda Hamre. Resumes of key personnel are in Appendix A.

Internal project review meetings will be scheduled to ensure that all analytical activities in this project are completed in a timely manner according to the project schedule. Quarterly reports will be prepared for project sponsors with updated results as well as a final report at project completion. Information will also be disseminated through presentations at conferences.

Personnel

John Pavlish, Senior Research Advisor and Director of EERC's Center for Air Toxic Metals® (CATM®) program will serve as project manager for this project. Mr. Pavlish's principal areas of interest and expertise include air toxic issues; HAPs with special emphasis on mercury; coal combustion processes and power plant system performance, including economic and feasibility analyses; advanced emission control technologies; gasification; and energy conversion systems. He has over 25 years of experience with advanced combustion systems, with expertise in regulatory issues regarding air toxics (especially mercury), international consulting, and research into advanced emission control technologies. Mr. Pavlish has led several large projects across North America and has overseen complex programs that orchestrate several disciplines of research toward a common goal of understanding and remediating mercury and other trace metal issues.

Dr. Nicholas Lentz, Research Scientist, will serve as the principal investigator for this project and will be responsible for pilot-scale test runs and subsequent data reduction. His areas of expertise and interest include the identification and development of new analytical methods for the advancement of elemental analysis in biological tissues and nonbiological samples, including coal and coal by-products; analysis for combustion flue gas, fuel oil, and biowaste; and experimental design and analysis related to control technologies to remove mercury and other elements from combustion systems. Dr. Lentz is particularly interested in applying analytical techniques from various research sectors to the energy and environmental sectors to develop more sensitive methods that are robust and applicable across a wide variety of applications. He is currently involved in mercury and trace metal work at the pilot and bench scale and has been involved in full-scale field demonstrations of mercury control technologies.

Ms. Lucinda Hamre, Research Specialist, will provide assistance to Mr. Pavlish in day-to-day management and technical support. Ms. Hamre's principal areas of expertise include technical and management support for emission control research for coal-fired power systems. She has been involved in ongoing research projects for public and private entities, which have been primarily focused on mercury control. For the past 6 years, Ms. Hamre has assisted with the management of the CATM Program and has been involved in several projects from bench-scale testing through full-scale demonstrations of emerging mercury control technologies and assists in technology transfer research and community outreach programs and publication development.

TIMETABLE

Table 2 outlines the schedule of project activities.

Table 2. Schedule of Project Activities

Activity	1	2	3	4	5	6	7	8	9	10	11	12
Initiate and Finalize Contract	◄	►										
Fuel Acquisition and Preparation			◄	►								
Task 1				◄	►							
Task 2						◄	►					
Task 3								◄	►			
Data Reduction			◄	—	—	—	—	—	—	—	—	►
Interim/Quarterly Reports			X			X			X			X
Final Report to Project Sponsors												X

BUDGET

Project Associated Expense	NDIC Share	CATM Share (Cash)	DOE Share (Cash)
Total Direct Salaries	$ 60,966	$ 11,880	$ 75,628
Total Fringe	$ 32,922	$ 6,415	$ 40,839
Total Labor	$ 93,888	$ 18,295	$ 116,467
Travel	$ 5,561	$ -	$ 1,823
Supplies	$ 5,029	$ 223	$ 13,699
Communication	$ 200	$ 30	$ 220
Printing & Duplicating	$ 200	$ 25	$ 225
Food	$ 200	$ -	$ -
Operating Fees and Services	$ 49,297	$ 177	$ 12,232
Total Direct Costs	$ 154,375	$ 18,750	$ 144,666
Total Indirect Costs (F&A)	$ 92,625	$ 11,250	$ 72,334
Total Project Cost	$ 247,000	$ 30,000	$ 217,000

The total project cost is $494,000. The EERC is requesting $247,000 from the NDIC REP, with additional funding to be secured from DOE in the amount of $217,000 and the remaining amount of $30,000 to be provided from the EERC CATM Affiliates Program. This budget is necessary to adequately address the proposed tasks in this project. The scope of work developed for the overall project funding assumes funding is received from NDIC, CATM Affiliates, and DOE. Initiation of the proposed work is contingent upon the execution of mutually negotiated agreements or modifications to existing agreements between EERC and each of the participating organizations. A detailed budget and accompanying budget notes are enclosed in Appendix B. Letters of commitment for cost-share participants can be found in Appendix C.

CONFIDENTIAL INFORMATION

No confidential information is included in this proposal.

PATENTS/RIGHTS TO TECHNICAL DATA

It is not anticipated that any patents will be generated during this project. The rights to technical data generated will be held jointly by the EERC and project sponsors.

Tax Liability

The EERC—a research organization within UND, which is an institution of higher education with the state of North Dakota—is not a taxable entity.

References

1. Laudal, D.; Thompson, J.; Dene, C.; Pavlish, J.; Botha, F.; Aurelia, I.A. Determining the Variability of continuous Mercury Monitors (CMMs) at Low Mercury Concentrations. Electric Power Research Institute, Expected Publication Date: Nov 2010.

APPENDIX A

RESUMES OF KEY PERSONNEL

JOHN H. PAVLISH
Senior Research Advisor
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
Phone: (701) 777-5268, Fax: (701) 777-5181, E-Mail: jpavlish@undeerc.org

Principal Areas of Expertise

Mr. Pavlish is a Senior Research Advisor and the Director of the multiyear, multimillion dollar Center for Air Toxic Metals® (CATM®) Program at the EERC. He has over 26 years of experience with advanced and conventional combustion systems to solve operational and environmental problems. His principal areas of interest and expertise include air toxic issues; hazardous air pollutants (HAPs) with special emphasis on mercury; CO_2 capture; and coal combustion process and power plant system performance, including economic and feasibility analyses.

Qualifications

B.S., Mechanical Engineering, North Dakota State University, 1984.
A.A.S., Power and Machinery, University of Minnesota – Crookston, 1979.
P.E., Kansas.

Professional Experience

2000–Present: Center for Air Toxic Metals Director, EERC, UND. Mr. Pavlish is a Senior Research Advisor and the Director of the multiyear, multimillion dollar CATM Program. His responsibilities include developing and managing an array of projects involving air toxic metals (mercury), fuel impacts on energy conversion systems, emission control technologies for power plant applications, biomass utilization, fuel cell applications, and technical and economic evaluations of various advanced emission control and energy conversion systems.

1994–2003: Senior Research Manager, EERC, UND. Mr. Pavlish's responsibilities included managing research programs related to emissions and control of air toxic substances. In an advisory role, Mr. Pavlish provided direction, vision, and technical review of future research programs. His responsibilities also included supervising research on the effects of fuel quality on combustion and gasification system performance; laboratory, pilot, and field testing; planning and performing specific research projects; evaluating the effects of coal quality and ash on power plant performance, generation recovery, steam generator performance and reliability, formation of HAPs, assessment of various control technologies, and flue gas-processing equipment; creating, developing, maintaining, testing, and validating innovative computer programs; identifying research opportunities and writing proposals and reports to meet client needs; and managing budgets and personnel on multiple projects.

1993–1994: Research Manager, Fuels and Materials Science, EERC, UND. Mr. Pavlish's responsibilities included supervising research on the effects of coal quality on coal combustion and gasification system performance; laboratory, pilot, and field testing; planning and performing specific research projects; evaluating the effects of coal quality and ash on power plant performance, generation recovery, steam generator performance and reliability, formation of HAPs, assessment of various control technologies, and flue gas-processing equipment; creating, developing, maintaining, testing, and validating innovative computer programs; identifying research opportunities and writing proposals and reports to meet client needs; and managing budgets and personnel on multiple projects.

1984–1993: Unit Leader/Systems Engineer, Black & Veatch Engineers–Architects. Mr. Pavlish's responsibilities included providing engineering/technical advice; determining and managing resources; developing and monitoring budgets; developing, overseeing, and maintaining project schedules; conducting formal/informal presentations to clients and at technical conferences; writing the technical scope of work, preparing cost estimates, and providing the supervision and organization of the proposal effort; assisting in the preparation and presentation of appropriate marketing material; planning, performing, and coordinating numerous coal quality impact studies; and creating, developing, maintaining, teaching, and validating innovative computer-based programs for evaluating the impacts that coal/ash constituents have on the combustion process, power plant equipment, overall plant performance, and unit/plant/system generation costs.

1979–1981: Diesel Power Technician, Crookston Implement, Inc., Crookston, Minnesota.

Professional Memberships

U.S. Representative, Mercury Emissions from Coal International Experts Working Group on Reducing Emissions from Coal, in association with the International Energy Agency Clean Coal Centre, 2004–present
United Nations Environment Programme Global Mercury Partnership, Reduction of Mercury Releases from Coal Combustion
Advisory Member, BiNational Strategy Utility Mercury Reduction Committee
Advisory Member, Minnesota Pollution Control Agency Research Advisory Committee
Advisory Member, Minnesota Taconite Mercury Control Advisory Committee
Advisory Member, Advanced Emissions Control Development Program
American Society of Mechanical Engineers
Air & Waste Management Association

Patents, Publications, and Presentations

Has authored and coauthored over 200 publications and presentations and holds several patents.

DR. NICHOLAS B. LENTZ
Research Scientist
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15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
Phone: (701) 777-5337, Fax: (701) 777-5181, E-Mail: nlentz@undeerc.org

Principal Areas of Expertise

Dr. Lentz's principal areas of expertise are the identification and development of new analytical methods for the advancement of elemental analysis in biological tissues and nonbiological samples, including coal and coal by-products; analysis for combustion flue gas, fuel oil, and biowaste; and experimental design and analysis related to control technologies to remove mercury and other elements from combustion systems.

Qualifications

Ph.D., Analytical Chemistry, Iowa State University, Ames, Iowa.
B.S., Chemistry, Bemidji State University, Bemidji, Minnesota.

Proficient in the use of Word, Excel, and PowerPoint.

Professional Experience

2007–Present: Research Scientist, EERC, UND. Dr. Lentz's responsibilities include identification and development of new analytical methods required for the advancement of elemental analysis in biological tissues and nonbiological samples including coal and coal by-products, as well as analysis for combustion flue gas, fuel oil, and biowaste. His work also involves experimental design and analysis related to control technologies to remove mercury and other elements from combustion systems. Dr Lentz manages a portfolio of ongoing measurement research projects by serving as a program area manager for the EERC's Center for Air Toxic Metals® Program.

2002–2007: Research Assistant, Iowa State University, Ames, Iowa. Dr. Lentz's responsibilities included performing chemical research in pursuit of a graduate degree.

2005–2006: Teaching Assistant, Iowa State University. Dr. Lentz's responsibilities included teaching three physical chemistry laboratory sections, grading laboratory reports and problem sets, recording scores and helping to prepare final examinations, and maintaining three lab instruments.

2002–2003: Teaching Assistant, Iowa State University. Dr. Lentz's responsibilities included teaching general chemistry recitations and laboratory sections, proctoring exams and recording scores, grading of homework and examinations, and conducting weekly office hours at the chemistry help center.

2001–2002: Lab Assistant, Bemidji State University. Dr. Lentz's responsibilities included preparing samples and standards for general chemistry labs, performing quality control checks on undergraduate laboratories, collecting hazardous waste from laboratories and filling out necessary manifest forms, and organizing and taking inventory of all chemicals used in the stockroom.

2001–2001: Undergraduate Researcher, Bemidji State University. Dr. Lentz's responsibilities included collecting water samples from Lake Bemidji and the Mississippi River for ion chromatograph analysis as well as analyzing fuel samples for the Petroleum Products Research Laboratory.

Publications and Presentations
Has coauthored several professional publications.

LUCINDA L. HAMRE
Research Specialist
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
Phone: (701) 777-5059, Fax: (701) 777-5181, E-Mail: lhamre@undeerc.org

Principal Areas of Expertise

Ms. Hamre's principal areas of interest and expertise include technical and management support for research focusing on emission control for coal-fired power systems. She has been involved in ongoing research projects for public and private entities, which have primarily focused on mercury control. For the past 6 years, Ms. Hamre has assisted with the management of the EPA-funded Center for Air Toxic Metals® (CATM®) Program, which conducts basic and applied research into the effects of potentially toxic trace metals.

Qualifications

Master's-Level Certificate, Public Administration, North Dakota State University, 2004.
B.S., Technology Assessment and Management, St. Cloud State University, 1998.
B.S., Speech Communication, St. Cloud State University, 1998.
A.A., Prenursing, Willmar Community College, 1989.

Professional Experience

2002–Present: Research Specialist, EERC, UND, Grand Forks, North Dakota. Ms. Hamre's responsibilities include project management activities, including those for the CATM Program, at the EERC and oversight of small research projects. She prepares research reports and assists with the CATM Annual Report; assists with writing peer-reviewed journal articles; develops proposals, tracks budgets and project progress; and assists with contractual and funding issues. In addition, she serves as a liaison between project managers and clients, disseminating information and otherwise keeping sponsors, subcontractors, and other EERC groups informed of project activities. She also develops presentation materials, prepares the CATM Technical Newsletter, and maintains the CATM Web site. Ms. Hamre performs sample and data collection, tracking, and submission of samples for analysis; creates, manipulates, maintains, and archives spreadsheets and databases for data reduction; assists in the development of site-specific test plans and quality assurance/quality control plans; designs graphical tools for presentation of data; and performs literature searches for project-related information; and otherwise assists CATM and researchers in accomplishing project objectives.

1998–2002: Research Information Associate, Administrative Resources, EERC, UND, Grand Forks, North Dakota. Ms. Hamre provided administrative and technical support to a Senior Research Advisor and associated team members to carry out project activities for field research projects. Ms. Hamre assisted with the preparation of proposals; writing research test plans, journal articles, and reports; and preparing presentation materials. She also assisted researchers with research sample inventory, cataloguing and inventory, data entry, spreadsheet preparation, data interpretation, and other responsibilities as needed. Project management assistance included interaction with accountants, contract specialists, project sponsors, and other external participants as needed.

1997–1998: Executive/Administrative Clerk, Computer Department, UND Bookstore, Grand Forks, North Dakota. Ms. Hamre provided professional support for University staff and students to procure technical products. She negotiated contracts for technical products with outside vendors, processed

receivables for payment, and prepared financial reports. She planned and implemented marketing campaigns, developed marketing materials, and prepared financial reports and projections.

1996–1997: Territory Representative, Devils Lake Journal, Devils Lake, North Dakota. Ms. Hamre's responsibilities included developing new business in a rural sales region for two newspapers, one weekly and one daily, and servicing accounts. She planned and carried out marketing and advertising campaigns, including advertising themes, ad design, customer proof, and layout.

1992–1994: Interim Assistant Director, Higher Education Manufacturing Process Applications Consortium, St. Cloud, Minnesota. Ms. Hamre's responsibilities included providing ongoing direction and support for a $10.6 million grant ($2.5 million federal) for manufacturing improvement by disseminating lean manufacturing engineering principles to company management through front-line employees. This joint venture project included leaders from government, higher education, and private industry. Her responsibilities included project management activities, developing and delivering training in engineering practices, advanced-level technical writing, marketing outreach, conference development, and public relations.

1984–1991: Estimator/Head of Sales Department, Print House, Willmar, Minnesota. Ms. Hamre consulted with government, nonprofits, and private industry to develop and produce marketing campaign materials and printed business materials. She was involved in contract interpretation and negotiation, consultations, and debt collection. In addition, Ms. Hamre's responsibilities included oversight of internal sales people, including training, accounting practices, and planning future staffing needs.

Publications and Presentations
Has authored or coauthored several publications.

APPENDIX B

BUDGET AND BUDGET NOTES

PILOT-SCALE TESTING TO EVALUATE THE EFFECTS OF BIOMASS COFIRING COMBUSTION ON CMMS AT LOW MERCURY CONCENTRATIONS
NDIC RENEWABLE ENERGY PROGRAM
PROPOSED PROJECT START DATE: 5/1/11
EERC PROPOSAL #2011-0136

BUDGET

CATEGORY			TOTAL		NDIC SHARE		CATM AFFILIATES SHARE		DOE SHARE	
LABOR		Rate	Hrs	Cost	Hrs	Cost	Hrs	Cost	Hrs	Cost
Pavlish, J.	Project Manager	$ 76.55	465	$ 35,596	180	$ 13,779	70	$ 5,359	215	$ 16,458
Lentz, N.	Principal Investigator	$ 30.38	560	$ 17,013	198	$ 6,015	40	$ 1,215	322	$ 9,783
Hamre, L.	Research Scientist/Engineer	$ 29.90	400	$ 11,960	180	$ 5,382	40	$ 1,196	180	$ 5,382
----------	Senior Management	$ 74.19	162	$ 12,019	32	$ 2,374	1	$ 74	129	$ 9,571
----------	Research Scientists/Engineers	$ 39.47	875	$ 34,536	293	$ 11,565	75	$ 2,960	507	$ 20,011
----------	Research Technicians	$ 25.94	181	$ 4,695	-	$ -	-	$ -	181	$ 4,695
----------	Technology Dev. Mechanics	$ 30.94	850	$ 26,299	620	$ 19,183	20	$ 619	210	$ 6,497
----------	Technical Support Services	$ 21.50	30	$ 645	15	$ 323	-	$ -	15	$ 322
				$ 142,763		$ 58,621		$ 11,423		$ 72,719
Escalation Above Base		4%		$ 5,711		$ 2,345		$ 457		$ 2,909
TOTAL DIRECT HRS/SALARIES			3,523	$ 148,474	1,518	$ 60,966	246	$ 11,880	1,759	$ 75,628
Fringe Benefits - % of Direct Labor - Staff		54%		$ 80,176		$ 32,922		$ 6,415		$ 40,839
TOTAL FRINGE BENEFITS				$ 80,176		$ 32,922		$ 6,415		$ 40,839
TOTAL LABOR				$ 228,650		$ 93,888		$ 18,295		$ 116,467
OTHER DIRECT COSTS										
TRAVEL				$ 7,384		$ 5,561		$ -		$ 1,823
SUPPLIES				$ 18,951		$ 5,029		$ 223		$ 13,699
COMMUNICATION - LONG DISTANCE & POSTAGE				$ 450		$ 200		$ 30		$ 220
PRINTING & DUPLICATING				$ 450		$ 200		$ 25		$ 225
FOOD				$ 200		$ 200		$ -		$ -
OPERATING FEES & SVCS										
Fuels & Materials Research Lab.				$ 2,721		$ -		$ -		$ 2,721
Analytical Research Lab.				$ 3,682		$ -		$ -		$ 3,682
Combustion Test Svcs.				$ 20,738		$ 20,738		$ -		$ -
Particulate Analysis				$ 27,354		$ 27,354		$ -		$ -
Fuel Prep. and Maintenance				$ 4,784		$ -		$ -		$ 4,784
Graphics Support				$ 1,048		$ 200		$ 150		$ 698
Shop & Operations Support				$ 1,379		$ 1,005		$ 27		$ 347
TOTAL DIRECT COST				$ 317,791		$ 154,375		$ 18,750		$ 144,666
FACILITIES & ADMIN. RATE - % OF MTDC			VAR	$ 176,209	60%	$ 92,625	60%	$ 11,250	49%	$ 72,334
TOTAL PROJECT COST - US DOLLARS				$ 494,000		$ 247,000		$ 30,000		$ 217,000

Due to limitations within the University's accounting system, bolded budget line items represent how the University proposes, reports and accounts for expenses. Supplementary budget information, if provided, is for proposal evaluation.

PILOT-SCALE TESTING TO EVALUATE THE EFFECTS OF BIOMASS COFIRING COMBUSTION ON CMMS AT LOW MERCURY CONCENTRATIONS
EERC PROPOSAL #2011-0136

BUDGET - TRAVEL

RATES USED TO CALCULATE ESTIMATED TRAVEL EXPENSES

DESTINATION	AIRFARE	PER MILE	LODGING	MEALS	CAR RENTAL	REGIST.
Unspecified Destination (USA)	$ 900	$ -	$ 200	$ 71	$ 85	$ 575
Bismarck, ND	$ -	$ 0.33	$ 75	$ 25	$ -	$ -
Morgantown, WV (via Pittsburgh, PA)	$ 1,100	$ -	$ 150	$ 46	$ 75	$ -

PURPOSE/DESTINATION	NUMBER OF TRIPS	PEOPLE	MILES	DAYS	AIRFARE	MILEAGE	LODGING	MEALS	CAR RENTAL	MISC.	REGIST.	TOTAL
Conference/Unspecified Dest. (USA)	1	2	-	4	$ 1,800	$ -	$ 1,200	$ 568	$ 340	$ 160	$ 1,150	$ 5,218
NDIC Meeting/Bismarck, ND	1	1	600	2	$ -	$ 198	$ 75	$ 50	$ -	$ 20	$ -	$ 343
Review Meeting/Morgantown, WV (Pittsburgh, PA	1	1	-	3	$ 1,100	$ -	$ 300	$ 138	$ 225	$ 60	$ -	$ 1,823
TOTAL ESTIMATED TRAVEL												$ 7,384

PILOT-SCALE TESTING TO EVALUATE THE EFFECTS OF BIOMASS COFIRING COMBUSTION ON CMMS AT LOW MERCURY CONCENTRATIONS
EERC PROPOSAL #2011-0136

DETAILED BUDGET - EERC RECHARGE CENTERS

			TOTAL
Fuels & Materials Research Lab.	Rate	#	$Cost
Moisture %	$67	8	$ 536
Proximate Ultimate	$260	8	$ 2,080
Subtotal			$ 2,616
Escalation		4%	$ 105
Total Fuels & Materials Research Lab.			$ 2,721
Analytical Research Lab.	Rate	#	$Cost
Coal Digestion	$175	6	$ 1,050
CVAA	$34	6	$ 204
IC	$43	12	$ 516
IC Prep	$15	12	$ 180
Miscellaneous (Sample)	$53	30	$ 1,590
Subtotal			$ 3,540
Escalation		4%	$ 142
Total Analytical Research Lab.			$ 3,682
Combustion Test Services	Rate	#	$Cost
PTC (daily)	$1,994	10	$ 19,940
Subtotal			$ 19,940
Escalation		4%	$ 798
Total Combustion Test Services			$ 20,738
Particulate Analysis	Rate	#	$Cost
EPA Dust Loading	$385	6	$ 2,310
Appendix K/Method 30B	$194	80	$ 15,520
Ohio Lumex Usage	$84	80	$ 6,720
Wet Chemistry	$292	6	$ 1,752
Subtotal			$ 26,302
Escalation		4%	$ 1,052
Total Particulate Analysis			$ 27,354
Fuel Preparation & Maintenance	Rate	#	$Cost
Fuel Preparation & Maintenance (Hourly/unit equipment)	$46	100	$ 4,600
Subtotal			$ 4,600
Escalation		4%	$ 184
Total Fuel Prep. & Maintenance			$ 4,784
Graphics Support	Rate	#	$Cost
Graphics (hourly)	$63	16	$ 1,008
Subtotal			$ 1,008
Escalation		4%	$ 40
Total Graphics Support			$ 1,048
Shop & Operations Support	Rate	#	$Cost
Technical Development Hours	$1.56	850	$ 1,326
Subtotal			$ 1,326
Escalation		4%	$ 53
Total Shop & Operations Support			$ 1,379

BUDGET NOTES

ENERGY & ENVIRONMENTAL RESEARCH CENTER (EERC)

BACKGROUND

The EERC is an independently organized multidisciplinary research center within the University of North Dakota (UND). The EERC receives no appropriated funding from the state of North Dakota and is funded through federal and nonfederal grants, contracts, and other agreements. Although the EERC is not affiliated with any one academic department, university faculty may participate in a project, depending on the scope of work and expertise required to perform the project.

INTELLECTUAL PROPERTY

If federal funding is proposed as part of this project, the applicable federal intellectual property (IP) regulations may govern any resulting research agreement. In addition, in the event that IP with the potential to generate revenue to which the EERC is entitled is developed under this agreement, such IP, including rights, title, interest, and obligations, may be transferred to the EERC Foundation, a separate legal entity.

BUDGET INFORMATION

The proposed work will be done on a cost-reimbursable basis. The distribution of costs between budget categories (labor, travel, supplies, equipment, etc.) is for planning purposes only. The project manager may, as dictated by the needs of the work, incur costs in accordance with Office of Management and Budget (OMB) Circular A-21 found at www.whitehouse.gov/omb/circulars. If the Scope of Work (by task, if applicable) encompasses research activities which may be funded by one or more sponsors, then allowable project costs may be allocated at the Scope of Work or task level, as appropriate, to any or all of the funding sources. Financial reporting will be at the total-agreement level.

Escalation of labor and EERC recharge center rates is incorporated into the budget when a project's duration extends beyond the current fiscal year. Escalation is calculated by prorating an average annual increase over the anticipated life of the project.

The cost of this project is based on a specific start date indicated at the top of the EERC budget. Any delay in the start of this project may result in a budget increase. Budget category descriptions presented below are for informational purposes; some categories may not appear in the budget.

Salaries: The EERC employs administrative staff to provide required services for various direct and indirect support functions. Salary estimates are based on the scope of work and prior experience on projects of similar scope. The labor rate used for specifically identified personnel is the current hourly rate for that individual. The labor category rate is the current average rate of a personnel group with a similar job description. Salary costs incurred are based on direct hourly effort on the project. Faculty who work on this project will be paid an amount over their normal base salary, creating an overload which is subject to limitation in accordance with university policy. Costs for general support services such as contracts and intellectual property, accounting, human resources, purchasing, shipping/receiving, and clerical support of these functions are included in the EERC facilities and administrative cost rate.

Fringe Benefits: Fringe benefits consist of two components which are budgeted as a percentage of direct labor. The first component is a fixed percentage approved annually by the UND cognizant audit agency, the Department of Health and Human Services. This portion of the rate covers vacation, holiday, and sick leave (VSL) and is applied to direct labor for permanent staff eligible for VSL benefits. Only the actual approved rate will be charged to the project. The second component is estimated on the basis of historical data and is charged as actual expenses for items such as health, life, and unemployment insurance; social security; worker's compensation; and UND retirement contributions.

Travel: Travel is estimated on the basis of UND travel policies which can be found at www.und.edu/dept/accounts/policiesandprocedures.html. Estimates include General Services Administration (GSA) daily meal rates. Travel may include site visits, field work, meetings, and conference participation as indicated by the scope of work and/or budget.

Equipment: If equipment (value of $5000 or more) is budgeted, it is discussed in the text of the proposal and/or identified more specifically in the accompanying budget detail.

Supplies – Professional, Information Technology, and Miscellaneous: Supply and material estimates are based on prior experience and may include chemicals, gases, glassware, nuts, bolts, and piping. Computer supplies may include data storage, paper, memory, software, and toner cartridges. Maps, sample containers, minor equipment (value less than $5000), signage, and safety supplies may be necessary as well as other organizational materials such as subscriptions, books, and reference materials. General purpose office supplies (pencils, pens, paper clips, staples, Post-it notes, etc.) are included in the facilities and administrative cost.

Subcontracts/Subrecipients: Not applicable.

Professional Fees/Services (consultants): Not applicable.

Other Direct Costs

Communications and Postage: Telephone, cell phone, and fax line charges are generally included in the facilities and administrative cost. Direct project costs may include line charges at remote locations, long-distance telephone, postage, and other data or document transportation costs.

Printing and Duplicating: Photocopy estimates are based on prior experience with similar projects. Page rates for various photocopiers are established annually by the university's duplicating center.

Food: Food expenditures for project meetings, workshops, and conferences where the primary purpose is dissemination of technical information may include costs of food, some of which may exceed the institutional limit.

Professional Development: Fees are for memberships in technical areas directly related to work on this project. Technical journals and newsletters received as a result of a membership are used throughout development and execution of the project by the research team.

Fees and Services – EERC Recharge Centers, Outside Labs, Freight: EERC recharge center rates for laboratory, analytical, graphics, and shop/operation fees are established and approved at the beginning of the university's fiscal year.

Laboratory and analytical fees are charged on a per sample, hourly, or daily rate, depending on the analytical services performed. Additionally, laboratory analyses may be performed outside the university when necessary.

Graphics fees are based on an established per hour rate for production of such items as report figures, posters, and/or PowerPoint images for presentations, maps, schematics, Web site design, professional brochures, and photographs.

Shop and operation fees are for expenses directly associated with the operation of the pilot plant facility. These fees cover such items as training, personal safety (protective eyeglasses, boots, gloves), and physicals for pilot plant and shop personnel.

Freight expenditures generally occur for outgoing items and field sample shipments.

Facilities and Administrative Cost: Facilities and administrative (F&A) cost is calculated on modified total direct costs (MTDC). MTDC is defined as total direct costs less individual capital expenditures, such as equipment or software costing $5000 or more with a useful life of greater than one year, as well as subawards in excess of the first $25,000 for each award. The F&A rate for commercial sponsors is 60%. This rate is based on costs that are not included in the federally approved rate, such as administrative costs that exceed the 26% federal cap and depreciation/use allowance on buildings and equipment purchased with federal dollars.

APPENDIX C

LETTERS OF COMMITMENT

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

December 29, 2010

Ms. Karlene Fine
Executive Director
Attn: Renewable Energy Program
North Dakota Industrial Commission
State Capitol – Fourteenth Floor
600 East Boulevard Avenue
Bismarck, ND 58505

Dear Ms. Fine:

Subject: Cost Share for EERC Proposal No. 2011-0136 Entitled "Pilot-Scale Testing to Evaluate the Effects of Biomass Cofiring Combustion on CMMs at Low Mercury Concentrations"

The Energy & Environmental Research Center (EERC) is conducting complementary research and development efforts under a multimillion-dollar 5-year Cooperative Agreement with the U.S. Department of Energy (DOE) entitled "Joint Program on Research and Development for Fossil Energy-Related Resources." Through this joint program, nonfederal entities can team with the EERC and DOE on projects that address the goals and objectives of DOE's Office of Fossil Energy.

The proposed project to the North Dakota Industrial Commission Renewable Energy Program (NDIC REP) entitled "Pilot-Scale Testing to Evaluate the Effects of Biomass Cofiring Combustion on CMMs at Low Mercury Concentrations" is a viable candidate for funding under this program. Therefore, the EERC intends to secure $217,000 in cash cost share from DOE through the cooperative agreement and $30,000 from the Center for Air Toxic Metals® (CATM®) Affiliates Program as cash cost share.

Once the EERC has received formal commitment from all nonfederal participating project sponsors, the EERC will submit a proposal to DOE for its concurrence. Initiation of the proposed work is contingent upon the execution of mutually negotiated agreements or modifications to existing agreements between the EERC and all participating project sponsors. If you have any questions, please contact me by phone at (701) 777-5157 or by e-mail terickson@undeerc.org.

Sincerely,

Thomas A. Erickson
Associate Director for Research

TAE/kal

Enclosures

c: John Hendrikson, EERC
Lucinda Hamre, EERC

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

December 29, 2010

North Dakota Industrial Commission
State Capitol – 14th Floor
600 East Boulevard Avenue, Department 405
Bismarck, ND 58505-0840

Dear Review and Selection Committee:

Subject: CATM Commitment for EERC Proposal No. 2011-0136 Entitled "Pilot-Scale Test to Evaluate the Effects of Biomass Cofiring Combustion on CMMs at Low Mercury Concentrations"

As Director of the Center for Air Toxic Metals® (CATM®) Program, I am pleased to commit $30,000 of funding from the CATM Affiliates Program to support this project, provided that the North Dakota Industrial Commission Renewable Energy Program (NDIC REP) and the U.S. Department of Energy (DOE) through the DOE–EERC Joint Program on Research and Development for Fossil Energy-Related Resources also approve funding. The CATM Affiliates Program, comprising industrial partners, is an ongoing program within the EERC that has been in existence since 1993. The funds that are committed toward this project are available now and have been reserved and allocated toward the support of this project. They will be immediately released and made available to the project on notice of award by NDIC.

The CATM Affiliates Program has a history of funding research projects that involve air toxics, in particular mercury. Assessing the impact that mercury control strategies, especially in biomass cofiring environments, have on measurement validity is a priority research area for members of the CATM Affiliates Program. The approach and concepts outlined in the proposed project should provide the data and information needed to address critical questions that remain unanswered and allow biomass to play a larger role as greenhouse gas issues are addressed.

I am hopeful that both the NDIC REP and DOE view this proposal favorably and look forward to supporting and participating in this project.

If you have any questions, please feel free to contact me by phone at (701) 777-5268, by fax at (701) 777-5181, or by e-mail at jpavlish@undeerc.org.

Sincerely,

John H. Pavlish
Senior Research Advisor

JHP/kal

Enclosures

c: John Hendrikson, EERC
Lucinda Hamre, EERC