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April 1, 2011

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. 2011-0215 Entitled "Field Evaluation Of Novel Approach For Obtaining Metal Emission Data"

The Energy & Environmental Research Center (EERC) of the University of North Dakota is pleased to submit the subject proposal. Enclosed please find an original and one copy of the proposal entitled "Evaluation of Novel Technologies for CO_2 Capture." Also enclosed is the $100 application fee. The EERC is committed to completing the project as described in this proposal if the Commission makes the requested grant.

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

Sincerely,

John H. Pavlish
Senior Research Manager

Approved by:

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

JHP/kal

Enclosures

FIELD EVALUATION OF NOVEL APPROACH FOR OBTAINING METAL EMISSION DATA

EERC Proposal No. 2011-0215

Submitted to:

Karlene Fine

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

Amount of Request: $235,120
Total Amount of Proposed Project: $573,000
Duration of Project: 12 months

Submitted by:

John H. Pavlish

Energy & Environmental Research Center
University of North Dakota
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John H. Pavlish, Project Manager

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

April 2011

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ABSTRACT

The proposed U.S. Environmental Protection Agency (EPA) Utility Maximum Achievable Control Technologies (MACT) standard will have a significant cost impact on North Dakota power utilities. Increased costs associated with stack emission testing to verify continuous emission monitors and/or to determine emission concentrations are a significant part of the cost impact because of the expensive sampling methods needed to perform compliance testing. Participants at recent national conferences have expressed a need for simpler, more cost-effective methods to obtain the data required under the upcoming Utility MACT standard.

The Energy & Environmental Research Center (EERC), through the Center for Air Toxic Metals®, has developed a multielement sorbent trap (ME-ST) sampling method for trace metals and/or halogen emissions; it is a much simpler sampling procedure that reduces personnel hours for sampling and eliminates the need for chemicals and solvents in the field, resulting in a method which is much easier and robust, while also offering significant cost savings over the comparable EPA Methods 29 (M29) and 26a (M26a).

The goal of the proposed project is to evaluate the EERC-developed ME-ST technology at two lignite-fired full-scale test sites located in North Dakota and compare the results to EPA M29 and M26a data, as well provide much needed stack emission data.

The estimated cost for the 12-month project is $573,000. Of this amount, the EERC requests $235,120 from NDIC, with the remaining amount of $117,675 to be provided by industry in the form of cash. The industry cost-share match is anticipated to come from North Dakota utilities as well as other industry utilities and organizations. In addition the EERC will seek approval from DOE for the remaining $220,205.

FIELD EVALUATION OF NOVEL APPROACH FOR OBTAINING METAL EMISSION DATA

PROJECT SUMMARY

Adherence to the proposed U.S. Environmental Protection Agency (EPA) Utility Maximum Achievable Control Technologies (MACT) standard will lead to a significant increase in EPA Method 29 (M29) and 26a (M26a) sampling to show compliance with regulatory reductions of hazardous air pollutant (HAP) metal and halogen emissions. M29 and M26a sampling will be required to certify and validate continuous emission monitors (CEMs) and to provide data to show plant regulatory compliance. M29 and M26a sampling may be needed as often as every 2 months, depending on the reporting criteria selected by a utility. Because of the high expense, personnel hours related to sampling, and the complicated setup and recovery involved with both M29 and M26a, a need exists for a simpler, cheaper, and more robust sampling method for measuring trace element and/or halogen emissions (1, 2).

The Energy & Environmental Research Center (EERC), through the Center for Air Toxic Metals® (CATM®), has developed a multielement sorbent trap (ME-ST) sampling method that can be utilized for trace metal and/or halogen sampling. Initial data have demonstrated the feasibility of the method when trace element data are compared to M29 trace element data collected concurrently over the same time duration and at the same sampling location.

The overall goal of this project is twofold: 1) to evaluate the EERC-developed ME-ST technology at two lignite-fired full-scale test sites located in North Dakota and 2) to provide lacking (and much needed) metal and halogen emission data that can be used by North Dakota utilities to develop strategies to comply with the Utility MACT standards. Coal-to-stack percent removals for each metal and halogen will be calculated to assist North Dakota utilities in determining appropriate reduction and compliance strategies.

The end result of the ME-ST evaluation is to provide a sorbent trap based multielement- and/or total halogen-sampling method complete with laboratory analysis procedures with equivalent detection limits to EPA M29 and M26a. The ME-ST method has the potential to significantly reduce on-site sampling costs associated with personnel, solvents, and supplies, while providing equivalent or better detection limits compared to M29 and M26a. In order to more fully evaluate the applicability of this technology and progress toward a validated and approved method, additional full-scale data must be collected.

PROJECT DESCRIPTION

Goals and Objectives

The overall goal of this project is twofold: 1) to evaluate the EERC-developed ME-ST technology at two lignite-fired full-scale test sites located in North Dakota and 2) to provide lacking (and much needed) metal and halogen emission data that can be used by North Dakota utilities to develop strategies to comply with the Utility MACT standards. Coal-to-stack percent removals for each metal and halogen will be calculated to assist North Dakota utilities in determining appropriate reduction and compliance strategies.

The end result of the ME-ST evaluation process is to provide a sorbent trap-based multielement and/or total halogen sampling method, complete with laboratory analysis procedures, that can achieve equivalent detection limits to EPA M29 and M26a. In order to achieve the goals of this project, several objectives have been defined:

- Determine/select two lignite-fired North Dakota test units for testing.
- Conduct a site visit to assess site needs and possible impediments to testing.
- Prepare a site-specific test plan (SSTP) for each test site with the guidance and assistance of utility office and plant personnel.

- Bring a mobile laboratory to the test sites in order to perform on-site sample train construction and recovery of the M29 and M26a sample trains.
- Conduct M29, M26a, and ME-ST sampling at the stack sampling location.
- Collect and analyze coal samples.
- Apply quality measures to the data obtained during the testing periods.
- Statistically compare the trace element ME-ST data to the M29 data and the halogen ME-ST data to the M26a data.
- Estimate ME-ST cost per sample and compare to M29 and M26a.
- Provide a report to NDIC that summarizes the test results.

In order to achieve these objectives, five main tasks have been identified:

- Task 1 – Determine Test Host Sites, Conduct a Site Visit, and Prepare a SSTP for each Host Site
- Task 2 – Perform Testing at Site 1
- Task 3 – Perform Testing at Site 2
- Task 4 – Data Analysis and Reduction
- Task 5 – Project Management and Reporting

Statement of Work

Task 1 – Determine Test Host Sites, Conduct a Site Visit, and Prepare a SSTP for Each Host Site. Task 1 involves determining the test host sites, conducting site visits, and developing a SSTP with each host site. Two subtasks have been defined in order to complete Task 1.

Subtask 1.1 – Determine Test Host Sites and Conduct a Site Visit at each Host Site. In this subtask, the EERC will identify two test host sites to perform the ME-ST, M29, and M26a stack sampling and will conduct site visits at each host site. The host sites will be located in the state of North Dakota and be lignite-fired boilers. The test sites will be chosen based on utility interest, site availability, and need for the data that will be obtained from the proposed work.

During the site visit, necessary data will be gathered to assess the availability of testing needs. The stack sampling locations will be assessed for space, power, ports, and access. Additionally, the available locations for parking a laboratory trailer will be assessed; the information to establish coal-sampling protocols will be gathered; and necessary schematics will be obtained. During the site visit, modifications to the sampling locations and site will be indentified and discussed with plant personnel to ensure that the site is adequately prepared before the EERC arrives on-site and testing begins. This may include additions of sampling ports, scaffolding, railing, electrical access, and leveling of site for placement of the laboratory trailer, etc.

Subtask 1.2 – Prepare a SSTP for Each Host Site. The EERC will take the lead, along with the input of each host site office and plant personnel, to develop a SSTP from the information gathered during the site visit; this is intended to be a living document that guides preparation and testing phases of this project. The SSTP will outline the details of operations and testing to be completed during on-site testing. This will include a sampling matrix and a test schedule for the entire test duration. The details and requirements for each sampling location and the laboratory trailer will be enumerated. The SSTP document will include contact information for all project participants from all parties and a list of personnel anticipated to be on-site during the sampling phase. This will serve as a working document for all participants and will foster communication prior to and during sampling as necessary for the successful completion of the test program.

Task 2 – Perform Testing at Site 1. During this task, the EERC will travel to the first host test site and perform ME-ST, M29, and M26a sampling at the stack sampling location. Table 1 displays the test schedule for the planned sampling at Site 1. Trace element stack emission data for the eleven HAP metals (Sb, As, Be, Cd, Cr, Co, Pb, Mn, Hg, Ni, and Se) will be collected using both EPA M29 and the EERC ME-ST method. In order to obtain more data and to determine the reproducibility of the ME-ST method, dual ME-ST samples will be collected for each test. The M29 and ME-ST samples will be sampled for the same sample duration and in either the same port or adjacent ports. The probe depth will be similar for each test method to ensure that the two methods are sampling similar and representative flue gas. At Site 1, nine M29 and nine dual ME-ST samples (eighteen total) will be collected over a 3-day period.

At the same stack sampling area as the M29 and ME-ST trace element sampling, M26a and an additional set of dual ME-ST samples will be collected and analyzed for F, Cl, and Br halogen emissions. The trace element and halogen sampling will be conducted at the same time if enough ports are available at the stack sampling location. As with the trace element ME-ST samples, the halogen ME-ST samples will be dual ME-ST samples in order to obtain more data and to determine the reproducibility of the ME-ST method. The M26a and ME-ST samples will be sampled for the same sample duration and in either the same port or adjacent ports. The probe depth will be similar for each test method to ensure that the two methods are sampling similar

Table 1. Site 1 Test Schedule

Day	Description
Sunday	Travel to Site 1 and begin setup
Monday	Setup
Tuesday	Sampling Day 1
Wednesday	Sampling Day 2
Thursday	Sampling Day 3
Friday	Teardown and travel back to the EERC

flue gas. At Site 1, nine M26a and nine dual ME-ST samples (eighteen total) will be collected over a 3-day period.

Table 2 displays the daily testing summary for the data to be collected at Site 1. The sampling in Table 2 will be conducted for three consecutive days at Site 1. Three sets of each data set will be collected during each of the test days. In addition to the stack metal and halogen emission data, coal samples will be taken twice a day (morning and evening) and analyzed for the eleven HAP metals and halogens. The coal data combined with the emission data will determine the percent removal for each of the eleven HAPs and halogens on a coal-to-stack basis.

Task 3 – Perform Testing at Site 2. During Task 3, the EERC will travel to the second test site and perform ME-ST, M29, and M26a sampling at the stack sampling location. The testing at Site 2 will be performed approximately 2–3 weeks after the testing at Site 1 so that all of the M29 and M26a glassware can be thoroughly cleaned at the EERC and so that fresh solutions and standards can be purchased and/or created. Table 3 displays the test schedule for the sampling at Site 2. Trace element stack emission data for the eleven HAP metals (Sb, As, Be, Cd, Cr, Co, Pb, Mn, Hg, Ni, and Se) will be collected using both EPA M29 and the EERC ME-ST method. In order to obtain more data and to determine the reproducibility of the ME-ST method, dual ME-

Table 2. Daily Test Matrix and Associated Sampling

Sample Type	Sample Duration, hr	Sampling Location	Unit Operation	Coal Sampling	Gas Analyzer
M29-a, ME-ST-a M26a-1, ME-ST-1	2 1–2	Stack	Full load	Twice daily	During each sample period
M29-b, ME-ST-b M26a-2, ME-ST-2	2 1–2	Stack	Full load	Twice daily	During each sample period
M29-c, ME-ST-c M26a-3, ME-ST-3	2 1–2	Stack	Full load	Twice daily	During each sample period

Table 3. Site 2 Test Schedule

Day	Description
Sunday	Travel to Site 1 and begin setup
Monday	Setup
Tuesday	Sampling Day 1
Wednesday	Sampling Day 2
Thursday	Sampling Day 3
Friday	Teardown and travel back to the EERC

ST samples will be collected for each test. The M29 and ME-ST samples will be sampled for the same sample duration and in either the same port or adjacent ports. The probe depth will be similar for each test method to ensure that the two methods are sampling similar flue gas. At Site 1, nine M29 and nine dual ME-ST samples (eighteen total) will be collected over a 3-day period.

At the same stack sampling area as the M29 and ME-ST trace element sampling, M26a and an additional set of dual ME-ST samples will be collected and analyzed for F, Cl, and Br halogen emissions. The trace element and halogen sampling will be conducted at the same time if enough ports are available at the stack sampling location. As with the trace element ME-ST samples, the halogen ME-ST samples will be dual ME-ST samples in order to obtain more data and to determine the reproducibility of the ME-ST method. The M26a and ME-ST samples will be sampled for the same sample duration and in either the same port or adjacent ports. The probe depth will be similar for each test method to ensure that the two methods are sampling similar flue gas. At Site 2, nine M26a and nine dual ME-ST samples (eighteen total) will be collected over a 3-day period.

Table 4 displays the daily testing summary for the data to be collected at Site 2. The sampling in Table 4 will be conducted for three consecutive days at Site 2. Three sets of each data set will be collected during each of the test days. In addition to the stack trace element

Table 4. Daily Test Matrix and Associated Sampling

Sample Type	Sample Duration, hr	Sampling Location	Unit Operation	Coal Sampling	Gas Analyzer
M29-a, ME-ST-a	2	Stack	Full load	Twice daily	During each
M26a-1, ME-ST-1	1–2				sample period
M29-b, ME-ST-b	2	Stack	Full load	Twice daily	During each
M26a-2, ME-ST-2	1–2				sample period
M29-c, ME-ST-c	2	Stack	Full load	Twice daily	During each
M26a-3, ME-ST-3	1–2				sample period

and halogen emission data, coal samples will be taken twice a day (morning and evening) and analyzed for the eleven HAP metals and halogens. The coal data combined with the emission data will determine the percent removal for each of the eleven HAPs and halogens on a coal-to-stack basis.

Task 4 – Data Analysis and Reduction. Once the test team arrives back at the EERC, the M29, M26a, and ME-ST samples will be sent to the EERC's Analytical Research Laboratory (ARL) for analysis. The ARL is equipped with all of the necessary laboratory instrumentation required for the analysis of all samples in the proposed work. A complete description of the ARL's facility and resources is provided in Appendix A. The M29 and M26a samples will be analyzed according to the instructions in their corresponding method. The trace element and halogen ME-ST samples will be analyzed by proprietary EERC-developed methods. Over 2500 data points will be generated from the stack sampling at the two sites. All of the trace element data will be reported on a $\mu g/dNm^3$ at 3% O_2 basis so that the data from both the M29 and ME-ST methods can be directly compared. The halogen data will be reported on a ppmv basis and will allow for a direct comparison between the halogen ME-ST and M26a data.

After the samples are analyzed in the ARL, the data will be incorporated into spreadsheets along with the relevant sampling data such as flue gas volume, stack moisture, percent O_2, etc., designed for each specific method. The spreadsheets will combine the laboratory data with the sampling data in order to calculate the flue gas concentrations for each analyte.

After all of the data are in their final reduced state, a statistical analysis will be performed on each data set. The statistical analysis will include the average, range, and standard deviation for each data set. In addition, the relative difference between the trace element ME-ST and M29 data will be determined. The relative difference between the halogen ME-ST and M26a data will also be determined in a similar manner. Plots will be generated from the statistical data as well as the results from the data comparison between the EPA methods and the ME-ST trace element and halogen methods. In addition, an estimated ME-ST cost per sample will be compared to M29 and M26a. All data will be presented in a format that allows utilities to evaluate percent removal and stack emissions. This will allow North Dakota utilities to determine what level of reduction is needed to comply with limits proposed by the Utility MACT.

Task 5 – Project Management and Reporting. Task 5 is the management and reporting task of the proposed work. The success of this task will be demonstrated by the timely and cost-effective accomplishment of contractual deliverables and milestones as outlined in the Project Management Plan (described in more detail in later section). Task 5 includes three main subtasks:

1. *Management and Quarterly Progress Reporting*: Quarterly reports will be provided as required. Additionally, regular conference calls with project participants will be conducted to allow for the exchange of information and input on test plans.
2. *Presentation at a National Conference*: In order to disseminate the data and results to a wide audience, a presentation will be given at a national conference after all of the data are collected and the results analyzed.

3. *Final Report*: This subtask will provide a detailed final report discussing all of the project results.

Deliverables

The main deliverable of this project will be a final report that will include the results of the tasks discussed above. The final report will include the following:

- Metal and halogen ME-ST, M29, and M26a stack emission data for two North Dakota lignite-fired units.
- Over 2500 metal and halogen stack emission data points.
- Coal-to-stack trace element and halogen percent removals.
- Statistical data showing the average, range, and standard deviation of each method data set.
- Relative differences between the ME-ST data and the M29 and M26a data.
- Feasibility of the ME-ST method for the analysis of trace metals and halogens.

STANDARDS OF SUCCESS

The successful outcome of this project will be to provide metal and HCl emission data from two North Dakota lignite-fired power plants that can be used by North Dakota utilities to determine the implications of the newly proposed EPA Utility MACT. These data will allow North Dakota utilities to determine the best regulatory strategy to implement to address the limits proposed by the rule. The data generated for the Utility MACT was limited, or nonexistent. Consequently, data generated under this project will be invaluable to assist utilities in determining which alternative nonmercury metals standard to select for compliance, what reductions may be required to meet compliance, and what method of compliance monitoring is most cost-effective. The data collected using EPA M29 and M26a and the novel ME-ST method will be of high quality and subject to all quality assurance/quality control standards, as defined by EERC's quality assurance program. Details of the EERC's quality assurance program are available on request.

Data collected from the novel ME-ST method will be compared to EPA M29 and M26a data for precision and accuracy. Data collected using the ME-ST method determined to be within 50% of EPA M29 and M26a data will be deemed acceptable and meet the standards of success defined for this project. Given the pilot-scale data gathered to date, the goal will be to achieve data agreement within 20%, but it should be recognized that trace metal concentrations are highly variable and at extremely low concentrations—ppb levels. Historically, agreement within 50% has been challenging and is considered acceptable.

BACKGROUND

Over the past two decades, emissions of mercury, nonmercury metals, and acid gases from energy generation and chemical production have become of increasing environmental concern. To develop a better understanding of concerns and issues related to these emissions, a Center for Air Toxic Metals® (CATM®) Program was established at the EERC in 1992 (www.undeerc.org/catm/). Since its establishment in 1992, CATM has answered many critical questions and continues to address issues related to transformations and pathways; sampling, measurement, and analysis of emissions; control technologies; computer modeling; and health risks.

On March 16, 2011, EPA proposed the first national standard to reduce mercury, nonmercury metals, and HCl emissions from coal-fired power plants (3). After implementation, EPA estimates that the standard will prevent serious illnesses and health problems for thousands of Americans including up to 17,000 premature deaths, 11,000 heart attacks, 120,000 asthma attacks, 12,200 hospital and emergency room visits, 4500 cases of chronic bronchitis, and 5.1 million restricted activity days (3).

Power plants are estimated to be the largest emitters of mercury (50%), acid gases (over 50%), and toxic metals (over 25%) in the United States, as shown in Table 5.

Additionally, as shown in Table 6, coal- and oil-fired electric utility steam-generating units (EGUs) contribute a large proportion of metal emissions compared to the total estimated anthropogenic metal emissions.

Table 5. Nationwide Emissions for Six Priority HAPs, tpy (3)

	Coal		Oil		Natural Gas	
HAP	1990	2010	1990	2010	1990	2010
Arsenic	61	71	5	3	0.15	0.25
Chromium	73	87	4.7	2.4	–	–
Mercury	46	60	0.25	0.13	0.0015	0.024
Nickel	58	69	390	200	2.2	3.5
HCl	143,000	155,000	2900	1500	NM	NM
HF	20,000	26,000	140	73	NM	NM

Table 6. Summary of Metal Emissions from EGU Sources (3)

2005 Metal HAP Emissions from the Inventory Used for the National Air Toxics Assessment (NATA), tpy

	U.S. EGU Emissions	Non-EGU Emissions	Total U.S. Anthropogenic Emissions in 2005, %
Antimony	19	83	0
Arsenic	200	120	62
Beryllium	10	13	44
Cadmium	25	38	39
Chromium	120	430	22
Cobalt	54	60	47
Manganese	270	1800	13
Nickel	320	840	28
Selenium	580	120	83

Under the proposed rule, EPA is establishing national emission standards for HAPs (National Emission Standards for Hazardous Air Pollutants [NESHAP]) from EGUs under Section 112 (d) of the Clean Air Act and proposing revised New Source Performance Standards (NSPS) under Section 111(b). More specifically, the proposed rule sets limits on mercury, nonmercury metals, and acid gas emissions from coal-fired plants. For nonmercury metals (as shown in Table 6), the rule proposes several alternative standards, as follows:

1) Limits on metals emissions using particulate matter as a surrogate.
2) Individual nonmercury metals (shown in Table 7).
3) Total nonmercury metals (shown in Table 7).

Owner and operators of EGUs may select from any of the above three alternatives, but must demonstrate compliance with these limits either using CEMs or frequent sampling using EPA-approved methods, such as EPA M29 and M26a. For units that elect to use CEMs, the CEMs must be certified and validated using EPA-approved methods (e.g., M29, M26a). For units that elect to comply with the total or individual nonmercury metal emissions, the unit must conduct metal emission testing every 2 months using EPA Method 29. Sampling with M29 can be timely and costly.

An example of the complexity of M29 is provided in Figure 1, which represents only the sample recovery scheme for M29. This scheme does not include any of the solution preparation or impinger preparation that must be performed in the field. There is also a lot of laboratory glassware such as volumetric flasks that are required to accurately dilute the samples to specific volumes. Since these recovery steps are done in the field and not in a clean laboratory, each step is a possible source for sample bias or contamination from the environment surrounding the

Table 7. Alternative Emission Limitations for Existing Coal- and Oil-Fired EGUs (3)

Subcategory	Coal-Fired Unit Designed for Coal ≥ 8300 Btu/lb	Coal-Fired Unit Designed for Coal < 8300 Btu/lb	IGCC* lb/TBtu (lb/GWh)	Liquid Oil, lb/TBtu (lb/GWh)	Solid Oil-Derived
SO_2	0.20 lb/MMBtu (2.0 lb/MWh)	0.20lb/MMBtu (2.0 lb/MWh)	NA	NA	0.40 lb/MMBtu (5.0 lb/MWh)
Total Non-Hg Metals	0.000040 lb/MMBtu (0.00040 lb/MWh)	0.000040 lb/MMBtu (0.00040 lb/MWh)	5.0 (0.050)	NA	0.000050 lb/MMBtu (0.00040 lb/MWh)
Antimony, Sb	0.60 lb/TBtu (0.0060 lb/GWh)	0.60 lb/TBtu (0.0060 lb/GWh)	0.40 (0.0040)	0.20 (0.0030)	0.40 lb/TBtu (0.0070 lb/GWh)
Arsenic, As	2.0 lb/TBtu (0.020 lb/GWh)	2.0 lb/TBtu (0.020 lb/GWh)	2.0 (0.020)	0.60 (0.0070)	0.40 lb/TBtu (0.0040 lb/GWh)
Beryllium, Be	0.20 lb/TBtu (0.0020 lb/GWh)	0.20 lb/TBtu (0.0020 lb/GWh)	0.030 (0.0030)	0.060 (0.00070)	0.070 lb/TBtu (0.00070 lb/GWh)
Cadmium, Cd	0.30 lb/TBtu (0.0030 lb/GWh)	0.30 lb/TBtu (0.0030 lb/GWh)	0.020 (0.0020)	0.10 (0.0020)	0.40 lb/TBtu (0.0040 lb/GWh)
Chromium, Cr	3.0 lb/TBtu (0.030 lb/GWh)	3.0 lb/TBtu (0.030 lb/GWh)	3.0 (0.020)	2.0 (0.020)	2.0 lb/TBtu (0.020 lb/GWh)
Cobalt, Co	0.80 lb/TBtu (0.0080 lb/GWh)	0.80 lb/TBtu (0.0080 lb/GWh)	0.60 (0.0040)	3.0 (0.020)	2.0 lb/TBtu (0.020 lb/GWh)
Lead, Pb	2.0 lb/TBtu (0.020 lb/GWh)	2.0 lb/TBtu (0.020 lb/GWh)	29.0 lb/MMBtu (0.30 lb/MWh)	2.0 (0.030)	11.0 lb/TBtu (0.020 lb/GWh)
Manganese, Mn	5.0 lb/TBtu (0.050 lb/GWh)	5.0 lb/TBtu (0.050 lb/GWh)	3.0 (0.020)	5.0 (0.050)	3.0 lb/TBtu (0.040 lb/GWh)
Mercury, Hg	NA	NA	NA	0.050 lb/TBtu (0.000780 lb/GWh)	NA
Nickel, Ni	4.0 lb/TBtu (0.040 lb/GWh)	4.0 lb/TBtu (0.040 lb/GWh)	5.0 (0.050)	8.0 (0.080)	9.0 lb/TBtu (0.090 lb/GWh)
Selenium, Se	6.0 lb/TBtu (0.060 lb/GWh)	6.0 lb/TBtu (0.060 lb/GWh)	22.0 lb/TBtu (0.20)	2.0 (0.20)	2.0 lb/TBtu (0.020 lb/GWh)

* Integrated gasification combined-cycle system.

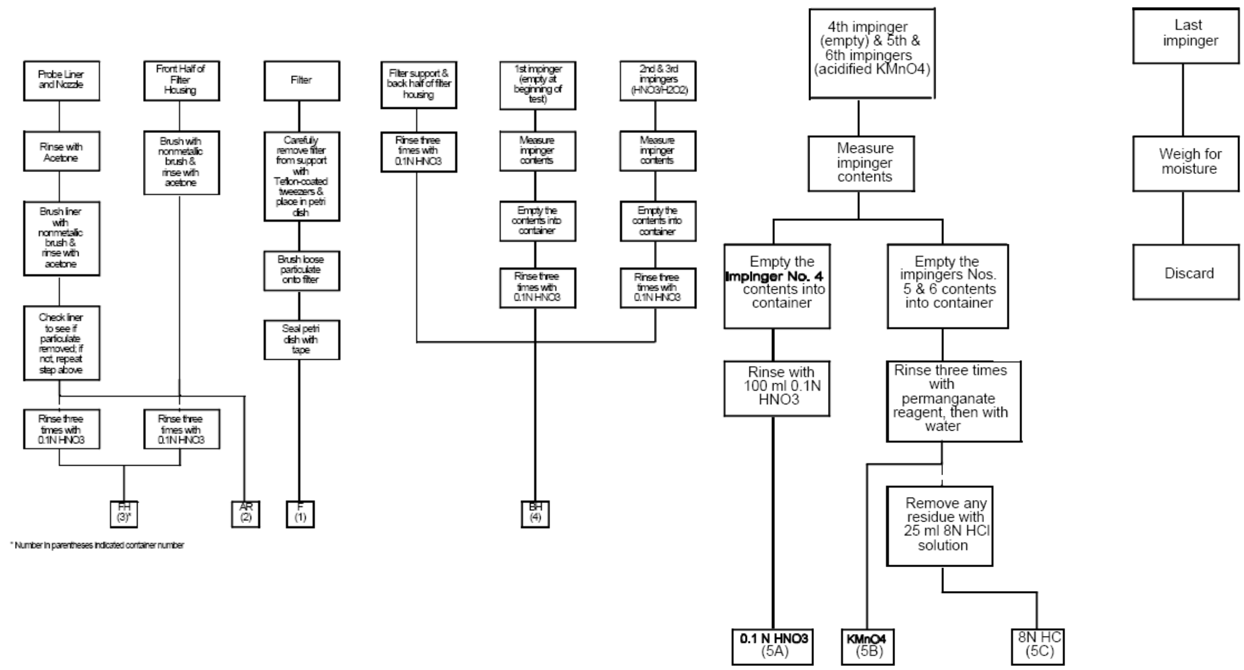

Figure 1. M29 field sample recovery scheme (2).

recovery area. The field recovery scheme also requires acetone, 0.1 N HNO_3, D.I. water, permanganate reagent, and 8 N HCl. All of these chemicals have to be shipped or transported to the field site, and typically solutions have to be made from more concentrated solvents to ensure fresh, stable solutions.

As an alternative to M29 (and M26a), the EERC has developed a novel sorbent trap-based method that can sample for trace elements and/or halogens. This method is designed to be a simpler and more cost-effective alternative to M29 and M26a. The simplicity of the ME-ST method in the field is shown in Figure 2, which displays the ME-ST field sample recovery scheme. The ME-ST field sample recovery process only involves two simple steps. No solvents or other glassware are involved in the process. The reduction in steps also significantly reduces the chances for the introduction of biases and sample contamination from the surrounding environment. Since the sorbent trap is not composed of hazardous substances, it can be shipped

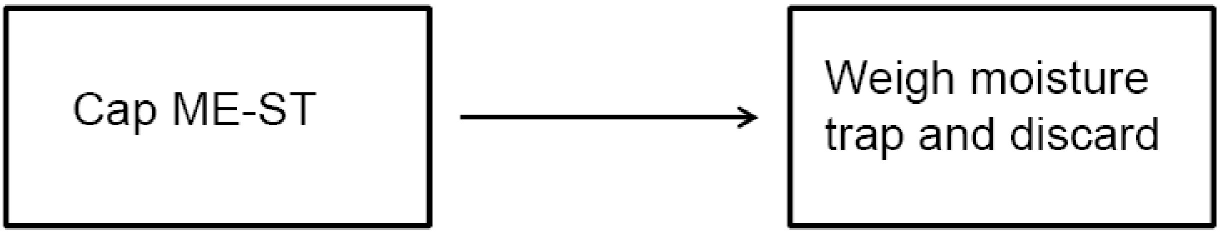

Figure 2. ME-ST field sample recovery scheme.

via an overnight courier to a laboratory for analysis. This allows the results to become available much faster than M29 or M26a.

This method can easily be deployed in the field without the use of strong acids, bases, or solvents. In fact, no solvents are required to be in the field for the whole ME-ST sampling process. In addition, this method is safer and more flexible than the approved M29 method for multimetal sampling; the resulting sorbent trap can easily be sent for analysis since no hazardous materials are involved. This novel approach has shown good comparison with M29 in side-by-side comparisons and has some comparative data with the Ontario Hydro (OH) method and continuous mercury monitor (CMM) data.

Figure 3 displays trace element ME-ST data collected during a CATM-sponsored project on an EERC pilot-scale combustor while a Powder River Basin (PRB) and an Illinois bituminous coal were fired. The results on the left were obtained while a PRB coal was fired, and the results on the right were obtained while the Illinois bituminous coal was fired. The M29 data were collected at the same location, electrostatic precipitator outlet, and sample duration. The results show that the ME-ST data are generally in good agreement with the M29 data and demonstrate the feasibility of the method in a combustion setting.

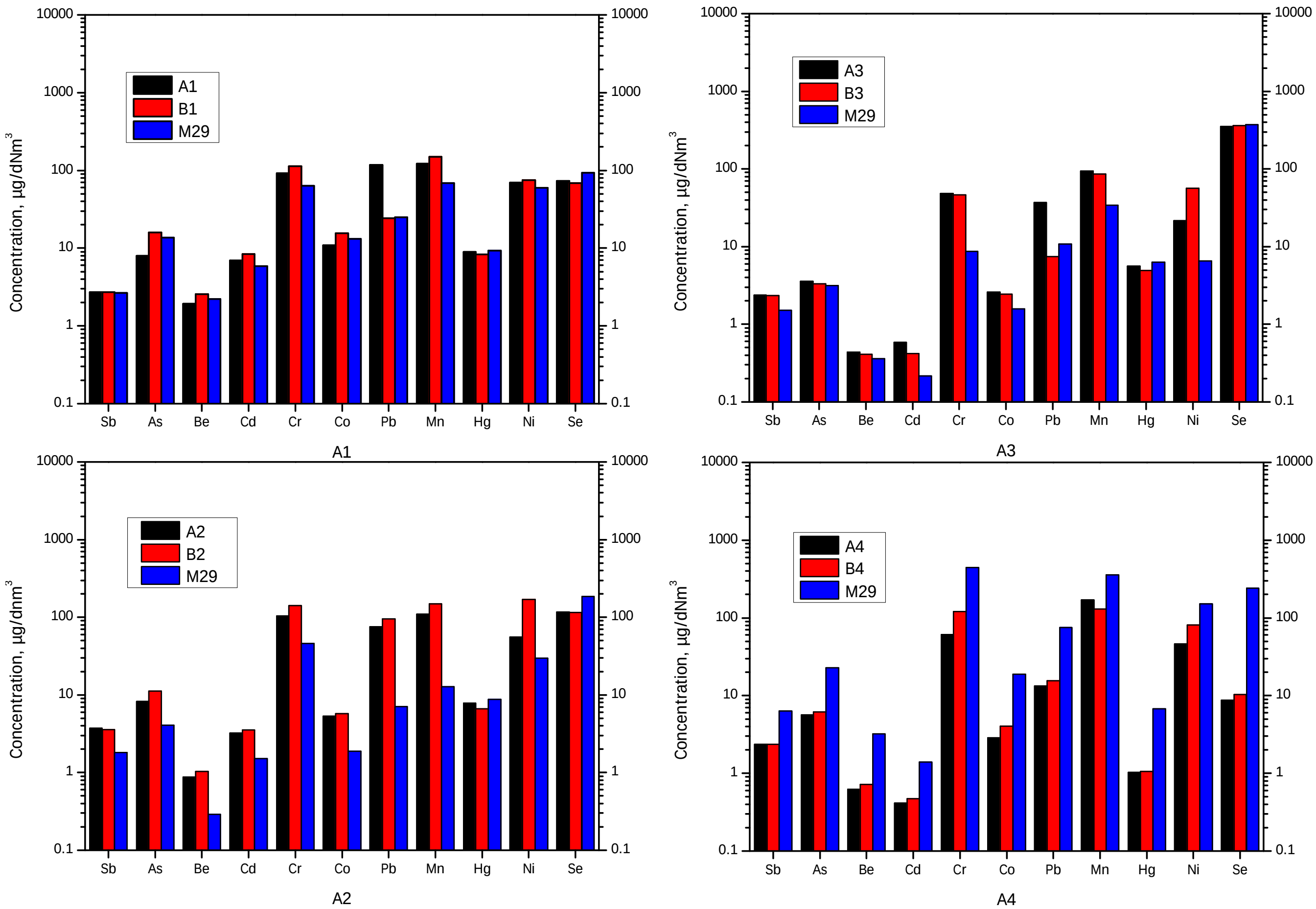

Figure 3. Comparison of ME-ST (A and B data) and M29 data collected during a pilot-scale test run.

In addition to combustion data, to demonstrate robustness of the method, a limited ME-ST data set has been collected on the EERC's high-pressure fluidized-bed gasifier while gasifying a PRB coal. Traditionally, solution-based sampling methods have not performed well in the reducing environments of a gasifier. The data presented in Figure 4 display the ME-ST trace element data for six samples. All of the samples were collected under similar operational conditions. The data were fairly consistent for the majority of the trace elements for all six samples, with the exception of Ni. The trace metals without any data points had values below the method detection limit.

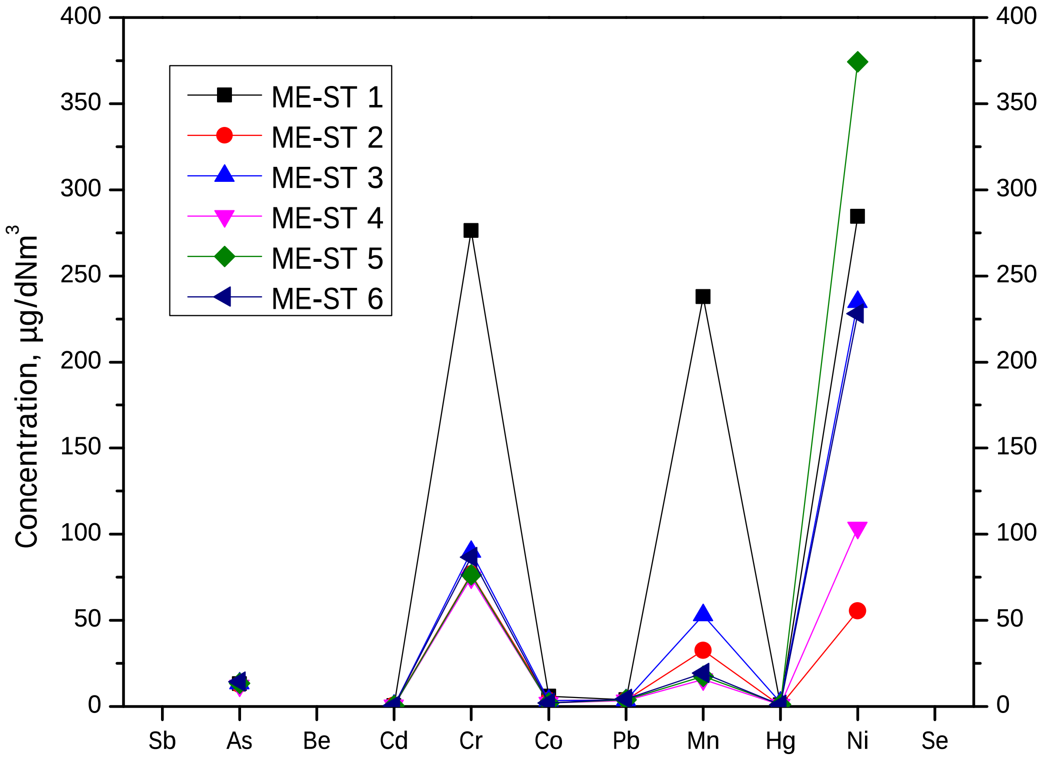

Figure 4. ME-ST data collected during the gasification of a PRB coal.

While the EERC has obtained limited data in smaller, controlled settings including pilot-scale facilities, testing is still needed at full-scale facilities. Results to date have shown overall good agreement with M29 and show promise as an alternative method for multimetal sampling for utilities. This need has become more acute with the release of the draft Utility MACT rule. Therefore, the EERC is submitting a proposal to the North Dakota Industrial Commission (NDIC) for funding, with support from the U.S. Department of Energy (DOE) through the existing EERC–DOE Joint Program on Research and Development for Fossil Energy-Related Resources Program, North Dakota utilities (and possibly other utilities), and others interested in the development/demonstration of this method. Additionally, the proposed testing will provide

North Dakota utilities with much needed metals and halogen emission data to assist them in developing compliance strategies.

QUALIFICATIONS

The EERC is one of the world's major energy and environmental research organizations. It operates as a business unit of the University of North Dakota. In FY09, the EERC had >$43.9 million in annual contract awards and has worked with over 1100 clients in all 50 states and 51 countries. Of the 345-plus people associated with the Center, two-thirds are technical staff from a diverse multidisciplinary spectrum of expertise that is applied to a wide range of energy and environmental projects. Special emphasis has been placed on lignite properties and characteristics in power-generating systems. Originally established as a federal laboratory to focus on low-rank fuels (nearly 60 years), it has become one of the world's leading research facilities focused on mercury and other trace metals.

CATM is one of the EERC's designated Centers of Excellence; it has had a primary mission of understanding and developing control strategies for potentially toxic trace metals. Over nearly two decades, CATM researchers have provided research on the fate and formation of trace metals, evaluated and developed sampling methods, tested and refined control technologies, and performed many projects to evaluate the role of trace metals in the environment.

The EERC, especially through CATM, has placed a great deal of emphasis on developing reliable and valid measurement and analytical methods and instruments. From the beginning of the CATM program, it has worked as a partner with key stakeholders, including the research community, regulators, vendors, and end users to evaluate various sampling and analytical methods and develop better methods:

1. The EERC, through CATM, brings over 15 years of experience in characterization, measurement, development, and testing of measurement and control technologies for trace metals, especially for mercury.
2. For nearly 20 years, the EERC and CATM have worked with every major CMM vendor to develop and refine continuous emission sampling methods and eliminate biases and interferences.
3. The EERC validated the OH mercury speciation method and authored ASTM International Method D6784-02.
4. CATM conducted extensive evaluations of EPA M29 and its benefits and shortcomings.
5. The EERC was an early evaluator and adopter of sorbent trap methods, from Appendix K and EPA Method 30B through current adaptations.
6. Through CATM, this novel sorbent trap method has been developed and is being evaluated as an alternative method for trace metal sampling.

VALUE TO NORTH DAKOTA

North Dakota power utilities will be significantly impacted by the recently proposed EPA Utility MACT (also referred to as Utility NESHAP) standards. To comply with these standards, North Dakota utilities will be required to spend millions of dollars both in installing emission reduction technologies and in addressing compliance monitoring requirements and reporting. The data needed to fully evaluate and determine the implications of the Utility MACT are limited, missing, or nonexistent. This project proposes to generate the lacking data and to improve on measurement methods that have the potential of being simpler to use and more cost-effective (significantly lower in cost), which will be of value and benefit to North Dakota utilities. The proposed project will provide nonmercury metal and HCl emission data from two North Dakota coal-fired power plants that can be used by North Dakota utilities to determine the implications of the newly proposed EPA Utility MACT. The data generated under this project will be invaluable to assist North Dakota utilities in determining which alternative nonmercury metals standard to select for compliance, what reductions may be required to meet compliance, and what method of compliance monitoring is most cost-effective. The data collected will be of high quality, providing North Dakota utilities with confidence in their decisions.

The project also provides North Dakota utilities with the opportunity to evaluate a novel method that the EERC has been developing for over 2 years to measure metals and HCl emissions. Should the method prove successful, as is expected based on data collected to date, it will provide North Dakota utilities with a simpler method that plant personnel can be trained to use. Comparable EPA methods (M29 and M26a), which are required for compliance, are complicated and difficult. These methods are not practical for plant personnel and require contracting with an experienced stack testing company. Thus, cost savings by a simpler method such as the ME-ST can be significant.

MANAGEMENT AND ORGANIZATION

The overall project is organized as shown in Figure 5 with the roles and responsibilities defined as follows.

EERC

The EERC will manage the overall project and coordinate all field sampling activities as described above. The two host sites (plants) at which the EERC will perform sampling will be determined and selected based on NDIC and project sponsor input. The EERC has worked with all of the North Dakota utilities and has performed sampling at most, if not all, of the plants within North Dakota.

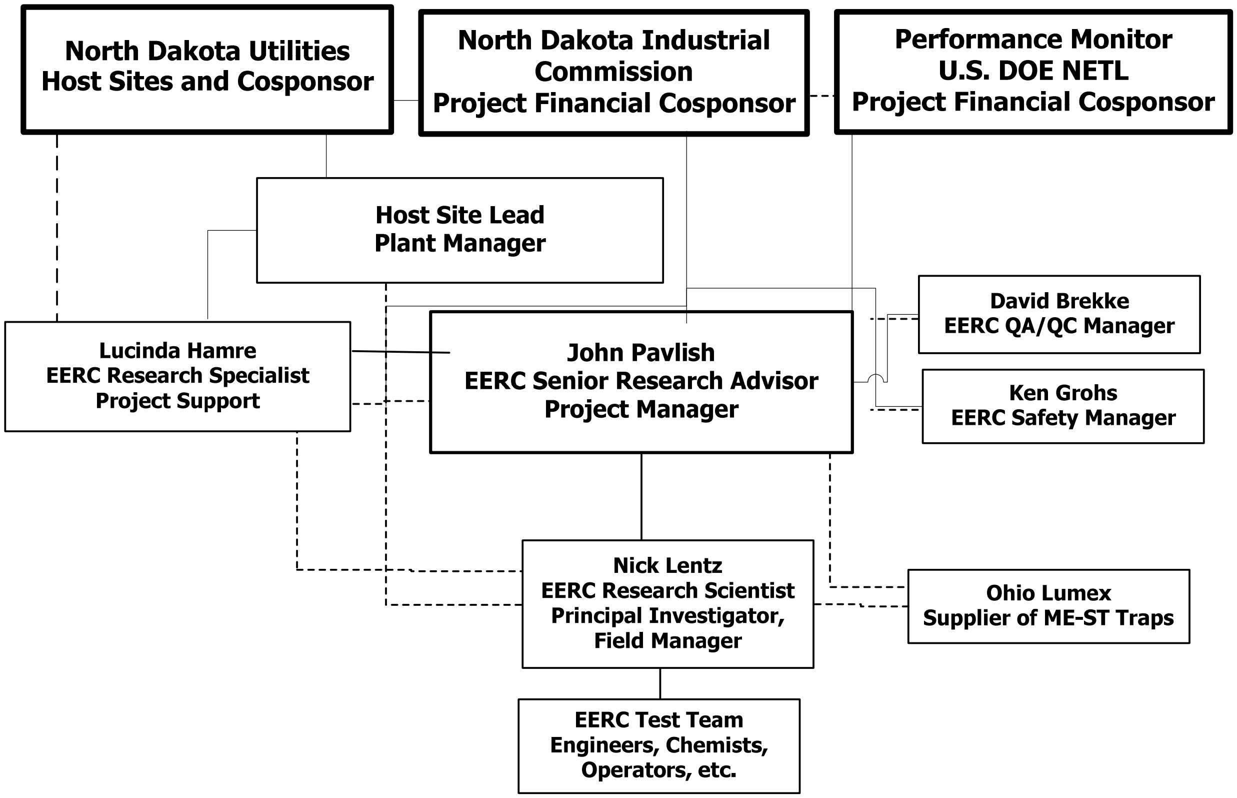

Figure 5. Organization of the EERC project team.

Consequently, the EERC is quite familiar with the plant configurations and sampling locations and does not foresee any issues with completing the sampling as described above and securing host sites, as several utilities have expressed interest in the project, as shown in Appendix B. The EERC project manager will communicate directly with sponsors and plant personnel to ensure that the project goals are being met and that plant personnel are fully aware of all test plans and requirements. Several individuals from the EERC will be on-site through the duration of on-site sampling.

The EERC Principal Investigator acts as a site lead to manage day-to-day activities to carry out the test plan and perform data reduction on-site. The site lead will be in communication with the project manager and other team members on a regular basis. For the test to be a success, a number of items and on-site activities must be coordinated and accomplished by both the EERC and the host site, which will be addressed in planning discussions, conference calls, and a site-specific sampling plan. The EERC will assist in the development of the test plan which will occur in close dialogue with all partners. The EERC will facilitate the creation of the test plan document to ensure that all testing/sampling is sufficiently planned, that resources are allocated in a timely manner, and to prepare for necessary analyses. The SSTP will be distributed to all partners for approval prior to beginning on-site sampling.

Host Sites

The EERC will identify appropriate candidates to serve as host sites and will work with them to agree to provide access to the plant to conduct the sampling activities discussed above. The EERC will work with the host sites to assist the EERC by providing access to sampling ports, necessary scaffolding, power, and a supply of house air.

NDIC

NDIC will assign a performance monitor who will be involved in the discussions and plans related to this project, as well as ongoing evaluation of the sampling results. This involvement will include finalizing details for the test plan, participation in regular conference calls to update the team on project progress, and receiving and reviewing regular reports. It is possible that the NDIC representative may choose to conduct a site visit during the course of sampling, which will be coordinated by the EERC with the host site.

DOE

DOE will assign a performance monitor who will be involved in the discussions and plans related to this project, as well as ongoing evaluation of the sampling results. This involvement will include finalizing details for the test plan, participation in regular conference calls for updates on project progress, and receiving and reviewing regular reports. It is possible that the DOE performance monitor may choose to conduct a site visit during the course of testing, which will be coordinated by the EERC and host site. It is also expected, as part of this agreement, that DOE will require participation in an annual DOE Review Meeting in Pittsburgh, Pennsylvania.

OhioLumex

OhioLumex has been involved in the evaluation of this method at the EERC. As a vendor, it is particularly interested in providing this method for the power industry. OhioLumex will be available for technical guidance and will provide custom sorbent traps for this project.

Regular meetings via conference calls will be held to share information, facilitate communication among all project participants, and guide project decisions. Reports and presentations will be issued to update the project participants on project status and results. Based on test milestones, periodic review meetings will be held to present data and allow participants to provide feedback and direction.

KEY PERSONNEL

The following are the key personnel involved in the project; more detailed resumes and relevant publications are found in Appendix C of this proposal.

Mr. John Pavlish, EERC Senior Research Advisor, will serve as manager of the project and also serves as the Director of the EERC's CATM. Mr. Pavlish has over 25 years of advanced engineering experience in the coal-fired power sector, 17 of which are directly related to metals research, and has been the project manager for several emission control projects in both the United States and Canada at all scales of testing. Prior to his employment at the EERC, he was a key consultant in advanced power systems at Black & Veatch, where he was responsible for plant performance and emission evaluations for coal-fired power generators.

He has several patent applications for mercury control technologies or other emission control technologies. Through the CATM Program, he has been responsible for overseeing both fundamental and applied research that has included numerous mercury-related research activities.

Dr. Nick Lentz is an Analytical Chemist and Program Area Manager for CATM. He has 4 years of field research experience and has been the Principal Investigator for a number of large field projects under Mr. Pavlish's leadership. A key on-site project manager, he is responsible to coordinate research activities between the EERC research staff and those of the host facilities. He also oversees all on-site chemical analysis and instrumentation. He will also be responsible for data compilation, reduction, evaluation of data, and reporting.

Ms. Lucinda Hamre has 8 years of research experience and will assist Mr. Pavlish and the project team with project-related management and reporting functions, as well as technical support.

TIMETABLE

The project time frame for this proposed work is estimated to be 12 months, with an active field sampling period of 1–3 months (depending on site selection), as is proposed in Table 8. Sampling activities and the project schedule can be accelerated should project sponsors want tasks completed sooner.

BUDGETED COSTS

The EERC is requesting $235,120 from the NDIC to support this effort to test at two full-scale utilities, with preference being given to North Dakota utilities as host facilities. The total estimated cost for this project is $573,000. Of this amount, $220,205 is committed through the existing EERC–DOE Joint Program on Research and Development for Fossil Energy-Related

Table 8. Project Schedule

	2011-2012											
Project Activity	J	A	S	O	N	D	J	F	M	A	M	J
Award by NDIC												
Contract negotiations leading to signed agreement with project sponsors		a										
Task 1, Site Visit		A										
Task 2, Host Site – Plant 1 Sampling			B	b								
Task 3, Host Site – Plant 2 Sampling				B	c							
Task 4, Data Analysis and Reduction												
Task 5, Management and Reporting			d			d			dC	e		df

Milestones		Decision Points	
a	Contracts Signed	A	Finalize Host Site Selection
b	Complete Site Sampling at First Test Site	B	Develop Detailed Sampling Plan
c	Complete Site Sampling at Second Test Site	C	Finalize Detailed Sampling Plans
d	Issue Quarterly Reports		
e	Issue Draft of Final Report		
f	Issue Final Report		

Resources Program, with final approval by DOE officials. The remaining cash portion of the cost share in the amount of $117,675 will consist of funding through a consortium of industrial participants. Additional in-kind cost share will be provided by OhioLumex in the form of approximately 80 custom sorbent traps, with an approximate value of $4000, although this will not constitute formal cost share. If the full cost share is not secured, the scope of work will be amended commensurate with the funding available. Initiation of the proposed work is contingent upon the execution of a mutually negotiated agreement or modification to an existing agreement between the EERC and each of the project sponsors. If project funding cannot be secured through the current industrial consortium members, this would delay the start of the project until new consortium members can be found, but the EERC does not anticipate this will be a problem. Letters of interest and/or commitment showing support for this project are found in Appendix B.

The EERC will continue to secure more solid commitments, which will be in place prior to award should NDIC fund this project. A detailed budget and budget notes for the proposed project can be found in Appendix D.

MATCHING FUNDS

The total cost for the project is estimated to be $573,000. The funding requested from NDIC is $235,120. Once a commitment is obtained from NDIC, formal approval will be requested from DOE to request allocation of $220,205 from the existing EERC–DOE Joint Program on Research and Development for Fossil Energy-Related Resources Program. The remaining $117,675 will be requested from industry participants in the form of cash and /or in-kind cost share. The EERC will seek funding support from the following potential sponsors:

- Basin Electric Power Cooperative
- Great River Energy
- Otter Tail Power Company
- Minnkota Power Cooperative
- SaskPower
- Minnesota Power
- Montana–Dakota Utilities Company
- Xcel Energy
- Other utilities
- Electric Power Research Institute
- Stack sampling companies
- OhioLumex, a sorbent trap vendor, will supply approximately 80 custom traps as in-kind, noncash informal cost share for this project, with an approximate value of $4000.

TAX LIABILITY

The EERC does not have an outstanding tax liability owed to the state of North Dakota or any of its political subdivisions.

CONFIDENTIAL INFORMATION

This proposal describes a proprietary method that is still in development. A provisional application has been submitted, but a patent application has not yet been filed. As such, all disclosures are general in nature and do not contain specific details.

REFERENCES

1. U.S. Environmental Protection Agency. Method 26A – Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources—Isokinetic Method. 40 CFR Part 60 Appendix A-8, Meth26A. Issued March 3, 1994.
2. U.S. Environmental Protection Agency. Method 29 – Determination of Metals Emissions from Stationary Sources. 40 CFR Part 60 Appendix A-8, Meth29. Issued June 25, 1996.
3. U.S. Environmental Protection Agency. Draft Rule – National Emission Standards for Hazardous Air Pollutants from Coal- and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units. 40 CFR, Parts 60 and 63. Draft released March 16, 2011.

APPENDIX A

ARL FACILITY AND CAPABILITIES

Analytical Research Laboratory

Laboratory Capabilities

The Analytical Research Laboratory (ARL) provides quality data, flexibility, and rapid turnaround time in support of research activities at the Energy & Environmental Research Center (EERC). The lab is equipped for routine and specialized analyses of inorganic and organic constituents, which are performed using classical wet-chemistry and state-of-the-art instrumental procedures. 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 trace element analysis, including arsenic, mercury, and selenium.

Quality Assurance

The EERC laboratory staff follows U.S. Environmental Protection Agency (EPA), ASTM International, and other standard methods for the analysis of samples. Analytical methods are routinely monitored for precision and accuracy with certified reference materials from the National Institute of Standards and Technology (NIST), the South African Bureau of Standards (SABS), the International Atomic Energy Agency (IAEA), and other sources. The ARL analyzes certified parameters annually in a water pollution study acquired from a NIST/National Voluntary Laboratory Accreditation Program (NVLAP)-accredited provider. Additional external quality assurance is maintained by participating in interlaboratory studies and proficiency programs such as the Coal and Ash Sample Proficiency Exchange™ (CANSPEX™). This participation allows the ARL to demonstrate competence in methods of analysis by comparing analytical results and techniques with other laboratories throughout the United States and Canada.

Research Activities

- Mercury: The ARL plays a major role in the support of mercury research at the EERC. With several EERC projects focusing on the occurrence and fate of mercury in combustion systems, as well as the evaluation of mercury control technologies, the ARL staff has gained considerable experience in mercury chemistry and analytical techniques for providing precise and accurate data.
- Center for Air Toxic Metals® (CATM®): The analytical efforts that support CATM projects include nickel speciation of particulate matter emitted from oil-fired units; mercury determination in alternative fuel sources such as biomass, oil/tar sands, and oil shale; low-level halogen determination in coal; and mercury and selenium determination in biological matrices to help evaluate the effect of selenium on mercury toxicity.
- Measurement of hazardous air pollutants (HAPs) from combustion systems: The ARL supports research at the EERC related to the fate of HAPs in combustion systems by thoroughly characterizing the fuel, ash by-products, and stack emissions. Several EERC projects have evaluated the impact of mercury control technologies on the fate of other inorganic HAPs which include As, Be, Cd, Co, Cr, Mn, Ni, Pb, Sb, and Se.
- Solid waste characterization: toxicity characteristic leaching procedure (TCLP) and other leaching procedures are employed for determining the leachability of RCRA (Resource Conservation and Recovery Act) metals and other constituents of environmental concern.

- Biomass characterization: The ARL employs a variety of sample preparation and analytical techniques for the determination of major, minor, and trace constituents in biomass materials such as wood chips, switchgrass, and corn stover.
- Biological sample analysis: To support research related to the health impacts of environmental pollutants, the ARL has capabilities for the preparation and analysis of biological tissues such as hair, blood, fish, and plant materials.

Laboratory Equipment

- 4200-ft^2, fully equipped, clean laboratory with seven fume hoods
- VG PQ ExCell inductively coupled plasma mass spectrometer (ICP–MS) with collision cell technology
- Perkin Elmer Optima 2100 ICP–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)
- Spectra AA-880Z graphite furnace atomic absorption spectrometer (GFAAS)
- Mitsubishi TOX-100 chlorine analyzer with oxidative hydrolysis microcoulometry
- Dionex ISC3000 ion chromatograph (IC) with conductivity detection.
- Dionex 2020i ion chromatograph (IC) with UV–VIS, conductivity, and electrochemical detection
- CEM MDS 2100 microwave with temperature and pressure control
- Pyrohydrolysis/ion-specific electrode for fluorine analysis of fossil fuels

- Agilent 1200/Applied Biosystems API 2000 triple quadrupole LC–MS system with a degasser, autosampler, column compartment, binary pump, and DAD detector. The MS has a scan range of 5-1800 m/z and is equipped with both ESI and APCI sources.

APPENDIX B

LETTERS OF SUPPORT

From: Bob Eriksen [mailto:beriksen@bepc.com]
Sent: Thursday, March 31, 2011 4:03 PM
To: Pavlish, John H.
Cc: Lyle Witham; Cris Miller
Subject: Metal Emissions Data Project Interest and Support

Dear John,

Basin Electric Power Cooperative is interested in the project "Field Evaluation of a Novel Approach for Obtaining Metal Emissions Data" that the EERC is proposing to the North Dakota Industrial Commission (NDIC) to perform metal and halogen stack measurements at several North Dakota power plants. We understand that this project would include the current EPA-approved methods as a comparison to the novel method.

We have a particular interest in the novel method that the EERC is developing to measure metals and halogens if it would significantly simplify and reduce the cost of compliance measurement as required by the Utility MACT, compared to EPA methods.

We look forward to participating in the project and hope that the NDIC gives serious consideration to funding the project.

Sincerely,

Bob

Robert L. Eriksen, P.E.
Sr. Environmental Compiance Administrator
Basin Electric Power Cooperative
1717 East Interstate Avenue
Bismarck, ND 58503
701-557-5654
beriksen@bepc.com

BASIN ELECTRIC POWER COOPERATIVE
A Touchstone Energy® Cooperative

From: Archer, Gregory GRE-MG [mailto:garcher@GREnergy.com]
Sent: Friday, April 01, 2011 3:14 PM
To: Pavlish, John H.
Subject: RE: Project Interest

Dear John,

Great River Energy is interested in the project "Field Evaluation of a Novel Approach for Obtaining Metal Emissions Data" that the EERC is proposing to the North Dakota Industrial Commission (NDIC) to perform metal and halogen stack emission measurements at two North Dakota power plants. We understand that this project would include the current EPA-approved methods as a comparison to the novel method. The data generated as part of the project is very important to GRE as we evaluate how best to address compliance with the EPA Utility MACT.

We have a particular interest in the novel method that the EERC is developing to measure metals and halogens as it would significantly simplify and reduce the cost of compliance measurement as required by the Utility MACT, compared to EPA methods.

We look forward to learning more about project specifics and hope that the NDIC gives serious consideration to funding the project.

Sincerely,

Greg Archer

Greg Archer | Environmental Administrator
Great River Energy
12300 Elm Creek Blvd | Maple Grove, MN 55369-4718
P: 763.445.5206 | F: 763.445.5237 | C: 612.232.0416
E: garcher@grenergy.com | www.greatriverenergy.com

Ohio Lumex Company
9263 Ravenna Rd. Unit A-3
Twinsburg, Ohio 44087
Toll Free (888) 876 2611, (330) 405 0837, Fax. (330) 405 0847
www.ohiolumex.com

April 1, 2011

Mr. John Pavlish
University of North Dakota
Energy & Environmental Research Center
Mailstop 9018
Grand Forks, ND 58201-9018

Dear John:

Subject: Letter of Interest for EERC Project Titled "Field Evaluation of Novel Method for Obtaining Metal Emissions Data"

I am pleased to submit this letter of interest and support to participate in the project "Field Evaluation of Novel Method for Obtaining Metal Emissions Data" that the Energy & Environmental Research Center (EERC) is submitting to the North Dakota Industrial Commission (NDIC) for funding consideration. We, like the EERC, believe that a much more simpler and alternative approach is need to replace the U.S. Environmental Protection Agency's Method 29 (M29) for measurement of multi-metal emissions. We continue to look for more cost effective approaches, as we serve those in the power generation and industrial sectors. As we have discussed the potential benefits of this approach and the success that the EERC is achieving, we have received very positive feedback. We believe this project will provide utilities and other end users with an alternative method to M29 sampling that will save money and be much easier to use, while providing high quality data.

We understand that the proposed project will involve full-scale evaluation at a North Dakota utility and would like to express our support for this effort. The need for a method that provides the potential benefits shown by this method is especially important with the release of EPA's proposed Utility MACT. We believe this project will lead to a tool for many in the power industry and those who serve them.

We understand that the project is being proposed to the NDIC and will involve utilities, including those from North Dakota, as well as the Department of Energy. If this project is funded, we are willing to provide technical support and approximately 50 custom sorbent traps to support testing activities. As a vendor, we are very interested in seeing this method further developed and encourage the NDIC to fund the proposed project.

Sincerely,

J. Siperstein

Joseph Siperstein
President
Ohio Lumex Company

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 1, 2011

Ms. Karlene Fine
Executive Director
Attn: Renewable Energy Program
North Dakota Industrial Commission
State Capitol – Fourteenth Floor
600 East Boulevard Avenue, Department 405
Bismarck, ND 58505

Dear Ms. Fine:

Subject: Cost Share for EERC Proposal No. 2011-0215; Entitled "Field Evaluation of Novel Approach for Obtaining Metal Emission Data"

This letter is in regard to the cost share to be provided by the Energy & Environmental Research Center (EERC) for the proposal named above for submission to the North Dakota Industrial Commission (NDIC) Lignite Energy Council. The EERC will conduct the proposed project 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. Through this joint partnership, the EERC intends to secure $220,205 toward the total project cost of $573,000, provided that NDIC commits $235,000 and $117,675 are secured from other industry partners.

DOE is interested in funding research projects that are consistent with its goals to advance technologies related to clean coal. As such, I believe this project is a viable candidate for funding under this program. Upon receiving commitment from all nonfederal partners, EERC will seek concurrence from DOE for this project. While the EERC cannot guarantee that DOE will approve funding, DOE has funded 99% of those proposals that meet its criteria. As such, I am confident that DOE will approve this project.

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 partners. If you have any questions, please contact me by phone at (701) 777-5215 or by e-mail jhendrikson@undeerc.org.

Sincerely,

for

John G. Hendrikson
Associate Director for Business and Operations

JGH/kal

APPENDIX C

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
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) 777-5337, 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
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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 D

BUDGET AND BUDGET NOTES

FIELD EVALUATION OF NOVEL APPROACH FOR OBTAINING METAL EMISSION DATA
NDIC LIGNITE ENERGY COUNCIL
PROPOSED PROJECT START DATE: 7/1/11
EERC PROPOSAL #2011-0215

BUDGET

CATEGORY		Rate	TOTAL Hrs	TOTAL Cost	NDIC SHARE Hrs	NDIC SHARE Cost	INDUSTRY SHARE Hrs	INDUSTRY SHARE Cost	FEDERAL SHARE Hrs	FEDERAL SHARE Cost
LABOR										
Pavlish, J.	Project Manager	$ 76.55	430	$ 32,917	115	$ 8,803	150	$ 11,483	165	$ 12,631
Lentz, N.	Principal Investigator	$ 30.38	700	$ 21,266	200	$ 6,076	220	$ 6,684	280	$ 8,506
Hamre, L.	Research Scientist/Engineer	$ 29.90	350	$ 10,465	150	$ 4,485	125	$ 3,738	75	$ 2,242
--------------	Senior Management	$ 74.19	170	$ 12,612	26	$ 1,929	5	$ 371	139	$ 10,312
--------------	Research Scientists/Engineers	$ 39.47	428	$ 16,893	222	$ 8,762	172	$ 6,789	34	$ 1,342
--------------	Research Technicians	$ 25.94	203	$ 5,266	-	$ -	-	$ -	203	$ 5,266
--------------	Technology Dev. Mechanics	$ 30.94	800	$ 24,752	520	$ 16,089	260	$ 8,044	20	$ 619
--------------	Technical Support Services	$ 21.50	50	$ 1,075	8	$ 172	10	$ 215	32	$ 688
				$ 125,246		$ 46,316		$ 37,324		$ 41,606
Escalation Above Base		5%		$ 6,262		$ 2,316		$ 1,866		$ 2,080
TOTAL DIRECT HRS/SALARIES			3,131	$ 131,508	1,241	$ 48,632	942	$ 39,190	948	$ 43,686
Fringe Benefits - % of Direct Labor - Staff		55.0%		$ 72,329		$ 26,748		$ 21,555		$ 24,026
TOTAL FRINGE BENEFITS				$ 72,329		$ 26,748		$ 21,555		$ 24,026
TOTAL LABOR				$ 203,837		$ 75,380		$ 60,745		$ 67,712
OTHER DIRECT COSTS										
TRAVEL				$ 18,412		$ 13,900		$ -		$ 4,512
SUPPLIES				$ 20,000		$ 7,800		$ 8,600		$ 3,600
COMMUNICATION - LONG DISTANCE & POSTAGE				$ 200		$ 39		$ 41		$ 120
PRINTING & DUPLICATING				$ 130		$ 35		$ 40		$ 55
FOOD				$ 200		$ 200		$ -		$ -
OPERATING FEES & SVCS										
Fuels & Materials Research Lab.				$ 4,120		$ -		$ 4,120		$ -
Analytical Research Lab.				$ 70,539		$ -		$ -		$ 70,539
Particulate Analysis				$ 47,534		$ 47,534		$ -		$ -
Graphics Support				$ 265		$ -		$ -		$ 265
Shop & Operations Support				$ 1,310		$ 1,310		$ -		$ -
Remote Sampling Trailer				$ 752		$ 752		$ -		$ -
TOTAL DIRECT COST				$ 367,299		$ 146,950		$ 73,546		$ 146,803
FACILITIES & ADMIN. RATE - % OF MTDC			VAR	$ 205,701	60%	$ 88,170	60%	$ 44,129	50%	$ 73,402
TOTAL PROJECT COST - US DOLLARS				$ 573,000		$ 235,120		$ 117,675		$ 220,205

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.

FIELD EVALUATION OF NOVEL APPROACH FOR OBTAINING METAL EMISSION DATA
EERC PROPOSAL #2011-0215

BUDGET - TRAVEL

SITE VISIT - Bismarck, ND area

				AIRFARE		PER DIEM			CAR		
				RND TRP	1-WAY	HOTEL	MEALS	MISC	RENTAL	MILEAGE	
NAME	**# DAYS**	**# NIGHTS**	**# MILES**	$ 950	$ 975	$ 120	$ 25	$ 10	$ 75	$ 0.85	**TOTAL**
Person 1 - Site Visit	3	2	1,000	$ -	$ -	$ 240	$ 75	$ 30	$ -	$ 850	$ 1,195
Person 2 - Site Visit	3	2	-	$ -	$ -	$ 240	$ 75	$ 30	$ -	$ -	$ 345
Total - Site Visit											$ 1,540

SAMPLING - Bismarck, ND area

Site 1 Sampling				AIRFARE		PER DIEM			CAR		
				RND TRP	1-WAY	HOTEL	MEALS	MISC	RENTAL	MILEAGE	
NAME	**# DAYS**	**# NIGHTS**	**# MILES**	$ 650	$ 350	$ 130	$ 25	$ 10	$ 30	$ 0.85	**TOTAL**
Nick Lentz - Sampling	6	5	1,200	$ -	$ -	$ 650	$ 150	$ 60	$ -	$ 1,020	$ 1,880
Op 1 - Sampling	6	5	-	$ -	$ -	$ 650	$ 150	$ 60	$ -	$ -	$ 860
Op 2 - Sampling	6	5	-	$ -	$ -	$ 650	$ 150	$ 60	$ -	$ -	$ 860
Op 3 - Sampling	6	5	-	$ -	$ -	$ 650	$ 150	$ 60	$ -	$ -	$ 860
Op 4 - Sampling	6	5	-	$ -	$ -	$ 650	$ 150	$ 60	$ -	$ -	$ 860
Chemist - Sampling	6	5	-	$ -	$ -	$ 650	$ 150	$ 60	$ -	$ -	$ 860
Total - Sampling											$ 6,180

SAMPLING - Bismarck, ND area

Site 2 Sampling				AIRFARE		PER DIEM			CAR		
				RND TRP	1-WAY	HOTEL	MEALS	MISC	RENTAL	MILEAGE	
NAME	**# DAYS**	**# NIGHTS**	**# MILES**	$ 800	$ 1,030	$ 130	$ 25	$ 10	$ 30	$ 0.85	**TOTAL**
Nick Lentz - Sampling	6	5	1,200	$ -	$ -	$ 650	$ 150	$ 60	$ -	$ 1,020	$ 1,880
Op 1 - Sampling	6	5	-	$ -	$ -	$ 650	$ 150	$ 60	$ -	$ -	$ 860
Op 2 - Sampling	6	5	-	$ -	$ -	$ 650	$ 150	$ 60	$ -	$ -	$ 860
Op 3 - Sampling	6	5	-	$ -	$ -	$ 650	$ 150	$ 60	$ -	$ -	$ 860
Op 4 - Sampling	6	5	-	$ -	$ -	$ 650	$ 150	$ 60	$ -	$ -	$ 860
Chemist - Sampling	6	5	-	$ -	$ -	$ 650	$ 150	$ 60	$ -	$ -	$ 860
Total - Sampling											$ 6,180

OTHER TRAVEL

				AIRFARE		PER DIEM			CAR			
				RND TRP	1-WAY	HOTEL	MEALS	MISC	RENTAL	MILEAGE	REGISTR.	
NAME – PURPOSE	**# DAYS**	**# NIGHTS**	**# MILES**	$ 950	$ 975	$ 175	$ 71	$ 20	$ 75	$ 0.62	$ 575	**TOTAL**
Person 1 - Conference	5	4	-	$ 950	$ -	$ 700	$ 355	$ 100	$ 375	$ -	$ 575	$ 3,055
Person 1 - DOE Review Meeting	2	1	-	$ 950	$ -	$ 175	$ 142	$ 40	$ 150	$ -	$ -	$ 1,457
Total - Other Travel												$ 4,512

TOTAL ESTIMATED TRAVEL	$ 18,412

FIELD EVALUATION OF NOVEL APPROACH FOR OBTAINING METAL EMISSION DATA
EERC PROPOSAL #2011-0215

DETAILED BUDGET - EERC RECHARGE CENTERS

Fuels & Materials Research Lab.	Rate	#	$Cost
Moisture %	$67	12	$ 804
Proximate Ultimate	$260	12	$ 3,120
Subtotal			$ 3,924
Escalation		5%	$ 196
Total Fuels & Materials Research Lab.			$ 4,120

Analytical Research Lab.	Rate	#	$Cost
Chlorine	$55	12	$ 660
Coal Digestion	$175	12	$ 2,100
CVAA	$34	120	$ 4,080
ICP - MS	$52	950	$ 49,400
Miscellaneous (Sample)	$53	100	$ 5,300
Trace Element Digestion	$60	94	$ 5,640
Subtotal			$ 67,180
Escalation		5%	$ 3,359
Total Analytical Research Lab.			$ 70,539

Particulate Analysis	Rate	#	$Cost
101-A & Bench Scale Method 29/Ontario Hydro	$434	4	$ 1,736
EPA Dust Loading	$385	18	$ 6,930
EPA Method 29/Ontario Hydro	$855	18	$ 15,390
Gas Analyzer Maintenance (Daily)	$115	6	$ 690
Trailer Maintenance (Weekly)	$358	2	$ 716
Appendix K/Method 30B	$194	72	$ 13,968
Wet Chemistry	$292	20	$ 5,840
Subtotal			$ 45,270
Escalation		5%	$ 2,264
Total Particulate Analysis			$ 47,534

Graphics Support	Rate	#	$Cost
Graphics (hourly)	$63	4	$ 252
Subtotal			$ 252
Escalation		5%	$ 13
Total Graphics Support			$ 265

Shop & Operations Support	Rate	#	$Cost
Technical Development Hours	$1.56	800	$ 1,248
Subtotal			$ 1,248
Escalation		5%	$ 62
Total Shop & Operations Support			$ 1,310

Remote Sampling Trailer	Rate	#	$Cost
Remote Sampling Trailer (per week)	$358	2	$ 716
Subtotal			$ 716
Escalation		5%	$ 36
Total Remote Sampling Trailer			$ 752

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: 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.

Operating 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: The facilities and administrative rate (indirect cost rate) included in this proposal is approved by the Department of Health and Human Services. Facilities and administrative 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.