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June 28, 2002

Ms. Karlene Fine
Executive Director
North Dakota Industrial Commission
600 East Boulevard Avenue
State Capitol, 10th Floor
Bismarck, ND 58505-0310

Dear Ms. Fine:

Subject: EERC Proposal No. 2002-0157 – Long-Term Mercury Monitoring at North Dakota Power Plants

The Energy & Environmental Research Center (EERC) is pleased to submit for your consideration the proposal entitled "Long-Term Mercury Monitoring at North Dakota Power Plants." The proposed effort will:

- Characterize the emission levels of mercury.
- Determine the distribution of oxidized versus elemental mercury.
- Determine the variability of mercury emissions with respect to plant configuration.
- Determine the variability of mercury emissions with respect to operational variations and coal variability.

The EERC proposes to perform long-term mercury monitoring at the Milton R. Young and R.M. Heskett power plants for a duration of 20 days each. Near real-time mercury measurement will be taken at the inlet and outlet (stack) of the respective emissions control devices at these plants. Limited samples will be collected using the Ontario Hydro method to provide speciation data and validate the continuous mercury monitoring measurements. Data collected as part of this project will be combined with available data from sponsors to provide a complete description of mercury emissions and speciation as a function of plant type and coal variability. Please note that the work proposed herein is to be jointly funded by the North Dakota Industrial Commission ($129,000), North Dakota industry partners ($129,000), and the EERC ($172,000) through the EERC–U.S. Department of Energy Jointly Sponsored Research Program for a total program cost of $430,000.

The EERC looks forward to working with you on this important and timely issue. If you have any questions or comments, please contact me by telephone at (701) 777-5276, by fax at (701) 777-5181, or by e-mail at mholmes@undeerc.org.

Sincerely,

Michael J. Holmes
Senior Research Advisor

MJH/llh

Enclosure

c/enc: Harvey Ness, NDIC

Exhibit A

Energy & Environmental Research Center

LONG-TERM MERCURY MONITORING AT NORTH DAKOTA POWER PLANTS

EERC Proposal No. 2002-0157

Submitted to:

Ms. Karlene Fine

Executive Director
North Dakota Industrial Commission
600 East Boulevard Avenue
State Capitol, 10th Floor
Bismarck, ND 58505-0310

Submitted by:

Michael J. Holmes
John H. Pavlish
Steven A. Benson
Dennis L. Laudal

Energy & Environmental Research Center
University of North Dakota
PO Box 9018
Grand Forks, ND 58202-9018

Michael J. Holmes, Project Manager

W.D. Gosnold Jr.

Dr. William D. Gosnold Jr., Interim Director
Office of Research and Program Development

Amount Requested: $129,000

June 2002

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LONG-TERM MERCURY MONITORING AT NORTH DAKOTA POWER PLANTS

ABSTRACT

Based on health, emissions, and scientific data, the U.S. Environmental Protection Agency (EPA) has determined that mercury emitted from utility power plants should be reduced. U.S. power plants burning lignite have shown higher elemental mercury (Hg^0) emissions than plants burning bituminous coals. This form of mercury is more difficult to remove than oxidized forms and requires innovative measures to control the emissions from the range of combustion and environmental control systems in North Dakota (ND).

As part of North Dakota's overall mercury reduction strategy, the Energy & Environmental Research Center (EERC) is proposing to compile and evaluate mercury speciation and emissions data for several power plant configurations within North Dakota. A large part of the proposed effort is directed toward expanding this data set by performing long-term mercury monitoring at two ND power plants. The information gained through this project will provide data and insight necessary to identify, evaluate, and demonstrate the technologies that are most appropriate and applicable to ND power plants. This approach will help maintain the viability of lignite-fired energy production by providing ND utilities with baseline mercury emissions data and leading toward lower-cost control options for meeting future mercury regulations. The ND utilities and coal companies have shown a proactive commitment to the development of this program and planning ahead for field demonstrations of mercury control. This commitment shows the importance of the proposed scope of work to the lignite-fired power industry.

The requested level of funding from the North Dakota Industrial Commission is $129,000. The required match includes $129,000 from ND industry partners and $172,000 from the EERC through the EERC–U.S. Department of Energy Jointly Sponsored Research Program for a total project funding level of $430,000.

LONG-TERM MERCURY MONITORING AT NORTH DAKOTA POWER PLANTS

PROJECT SUMMARY

Based on health, emissions, and scientific data, the U.S. Environmental Protection Agency (EPA) has determined that mercury emitted from utility power plants should be reduced. U.S. power plants burning lignite have shown higher elemental mercury (Hg^0) emissions than plants burning bituminous coals (1). This form of mercury is more difficult to remove than oxidized forms and requires innovative measures to control the emissions from the range of combustion and environmental control systems in North Dakota (ND). The data generated and compiled by the Energy & Environmental Research Center (EERC) as part of this project will provide information that can be used to more accurately estimate mercury emissions from ND power plants and begin formulating a comprehensive strategy that will address critical issues related to mercury control.

As part of North Dakota's overall mercury reduction strategy, the EERC is proposing to compile and evaluate mercury speciation and emissions data for several power plant configurations within North Dakota. A large part of the proposed effort is directed toward expanding this data set by performing long-term mercury monitoring at two ND power plants. The information gained through this project will provide data and insight necessary to identify, evaluate, and demonstrate the technologies that are most appropriate and specific to ND power plants. This approach will help maintain the viability of lignite-fired energy production by providing ND utilities with baseline mercury emissions data and leading toward lower-cost control options for meeting future mercury regulations.

PROJECT DESCRIPTION

Background

Mercury is an immediate concern for the U.S. electric power industry because of EPA's December 2000 decision that regulation of mercury from coal-fired electric utility steam-generating units is appropriate and necessary under Section 112 of the Clean Air Act. EPA determined that mercury emissions from power plants pose significant hazards to public health and must be reduced. The EPA *Mercury Study Report to Congress* (1997) (2) and the *Utility Hazardous Air Pollutant Report to Congress* (1998) (3) both identified coal-fired boilers as the largest single category of atmospheric mercury emissions in the United States, accounting for about one-third of the total anthropogenic emissions. EPA is scheduled to propose regulations by December 2003 and promulgate them by December 2004, with full compliance expected by 2007. The exact form of regulation is uncertain at this time. While EPA is developing a regulation based on a maximum achievable control technology approach, Congress is discussing multipollutant (SO_x, NO_x, and Hg) approaches such as the Jeffords Bill and the Bush Clear Skies Initiative. All of the regulatory approaches currently under discussion will likely require at least a 70%–90% reduction.

Recent findings indicate that several factors impact mercury control and that understanding the quantity and species of mercury is critical to determining appropriate control levels and applying appropriate control technologies.

Goal and Objectives

The overall goal of the project is to compile key information on the abundance and variability of mercury species in flue gases from ND power plants before and after air pollution control systems. Specific objectives of the project are as follows:

- Determine the emission levels of mercury
- Determine the distribution of oxidized versus elemental mercury

- Determine the variability of mercury emissions with respect to plant configuration
- Determine the variability of mercury emissions with respect to operational variations and coal variability

In meeting the objectives, the proposed scope of work will provide inputs required for effectively defining field demonstration needs. The ultimate goal of the ND efforts in mercury measurement and control is to prepare the industry to meet future mercury regulations in a more cost-effective manner.

Statement of Work

Data will be collected to adequately determine and/or accurately estimate the species and emissions of mercury from selected power plants burning lignite within North Dakota. A large part of the proposed effort will be conducted to obtain near real-time mercury levels in flue gases from Milton R. Young Unit 2 and R.M. Heskett Unit 2. Mercury monitoring will be performed at these two units to address emission levels, speciation, and variability of mercury in the respective flue gases. Specific details of the monitoring plans are described below. The EERC also understands that several ND utilities already have some mercury-monitoring data available for a select number of plants. The EERC assumes that this information will be provided to the EERC for review and evaluation, and, assuming data that meet EERC data quality review will be incorporated into the overall data set of mercury for North Dakota. The data available from Great River Energy includes between 7 and 21 days of baseline emissions data for Stanton Station and, possibly, 10 days for Coal Creek Station. The range in the measured mercury levels was from 4 to 18 $\mu g/Nm^3$ in flue gas for Stanton and 7–11 $\mu g/Nm^3$ for Coal Creek Station (4). The final set of data will be compared to data collected under EPA's information collection request (ICR).

The EERC will conduct mercury sampling and continuous monitoring for approximately 3 weeks at the following two plants:

- Milton R. Young No. 2, Center, North Dakota, 440 MW, cyclone-fired, cold-side electrostatic precipitator (ESP) followed by a wet scrubber
- R.M. Heskett Unit No. 2, Mandan, North Dakota, 85 MW, B&W fluidized bed, cold-side ESP

Prior to testing, a site visit will be conducted at each plant. Following the site visit, a site-specific test plan will be developed. Once that plan has been approved by the project team, mercury speciation testing and sampling will begin. At each unit, sampling will be conducted at two locations (depending on the plant configuration and port access): the inlet to the ESP and the outlet of the last control device or at the stack.

It is envisioned that the primary sampling will be conducted over a 3-week sampling period using the Ontario Hydro (OH) mercury speciation sampling method and continuous mercury monitors (CMMs). CMM data will be logged over a period of approximately 20 days. During this period, the EERC will likely sample at different plant conditions in an attempt to capture load, operational, and coal variabilities. OH sampling will be limited to three inlet and three outlet samples at the beginning and three more at the inlet and outlet towards the end of the sampling period. These samples will be taken coincident with CMM sampling near the CMM locations during the day shift. The CMM at the inlet to the particulate control device (PCD) is expected to operate 6–10 hours a day depending on site-specific maintenance requirements. The CMM located at the stack or duct at the outlet of the last PCD is expected to operate 24 hours per day during the entire sampling period, assuming difficulties do not arise. The EERC will sample each plant based on a predetermined schedule as determined by the project team and/or plant manager. During OH sampling, it is expected that the units will be operating at or near normal conditions. It is expected that operating conditions (i.e., load, excess O_2, NO_x, etc.) will be logged by plant personnel during the entire sampling period and made available to the EERC in an agreed-upon format. The EERC assumes that mercury data and similar operating data will be made available in a suitable format for two or three other plants within

North Dakota. These data will be reviewed for quality and appropriateness, interpreted, and compiled along with the data collected at the two above-mentioned plants.

During each sampling period, coal, fly ash, scrubber sludge, etc., will also be sampled on a daily basis. Samples can be taken more frequently if determined necessary and beneficial. The EERC assumes that plant personnel will be available to collect these samples. Although a rigorous mass balance is not planned as part of this project, these samples allow an approximate mercury balance to be determined for quality assurance/quality control (QA/QC) purposes. Chemical characterization of the coal, fly ash, and scrubber sludge will be completed by the EERC.

A total of four people will be necessary at times to conduct the proposed tests. The functions of these people are follows:

- One person to operate the CMM(s). This person will remain on-site at all times.
- Three people to assist in CMM setup and conduct the OH sampling.
- An additional person to collect solid samples such as fly ash, coal, and scrubber sludge samples. It is assumed for purposes of this proposal that someone at the plant can perform this function.

For each plant to be tested, the EERC will bring one trailer on-site to house the CMMs. It is assumed that the plant will provide a suitable location (to park the trailer) and all electrical requirements. Two days will be necessary to set up at the plant and 1 day to tear down. A typical sampling plan is shown in Table 1.

Table 1. Flue Gas-Sampling Parameters for Each Sampling Period

Condition:

Sampling Location	OH Method[a]	CMM
ESP Inlet	6	Daily
PCD Outlet/Stack	6	Continuous

[a] Half at the beginning and half at the end of the sampling period.

Since the EERC will be testing for relatively long periods of time with several CMMs, large amounts of data will be generated and in need of coordination, compilation, and interpretation. Short interim reports will be prepared for each power plant following testing that will include the mercury results at that plant. Data will be interpreted and presented in terms of mercury concentration and speciation at each location over the sampling period.

For data that are either collected or provided, the EERC will attempt to correlate operating conditions along with mercury speciation/emissions data to infer possible relationships. Mercury collection efficiency will be calculated based on coal inlet concentrations as well as inlet and outlet measurements. If possible, assuming adequate data are available, approximate mercury mass balances will be performed and presented. Mercury levels and variability in the flue gas will be compared to the mercury content of the coal. Note, the above effort of data reduction, review, and interpretation will depend on the quality and availability of data supplied to the EERC.

Measurement and Sampling Procedures

Flue Gas Constituent Concentrations. To determine the O_2 levels at each sample location, an ECOM-America portable O_2 analyzer will be used. This portable O_2 analyzer's linearity is verified prior to use using EPA Protocol 1 certified gas standards. Flue gas velocity, moisture, and flow rate determinations will be performed according to EPA Methods 2 and 4 in conjunction with the OH method. The particulate matter at each location will be measured in either an EPA Method 17 or EPA Method 5 configuration as part of the OH train.

Other flue gas constituents such as CO_2, NO_x, SO_2, and CO will be obtained with the same portable analyzer used to measure O_2 and/or from plant CEMs (continuous emission monitors).

Ontario Hydro Mercury Speciation Method. Speciated mercury analyses will be performed using the OH mercury speciation method, which was the method selected by EPA for its ICR. The OH method has been extensively tested by the EERC and others and has been shown to provide the

best mercury speciation data for coal-fired boilers (3). The method has been approved by American Society for Testing and Materials (ASTM) Subcommittee D22.03.01. A detailed description of the OH method in the ASTM format is available on the EPA Web site at http://www.epa.gov/ttn/emc under "preliminary methods."

Coal, Fly Ash, and Scrubber Sludge. The EERC has an automated direct mercury analyzer (DMA-80, Milestone, Inc.) that was recently validated as EPA Method 7473, "Mercury in Solids and Solutions by Thermal Decomposition Amalgamation and Atomic Absorption Spectrophotometry." Method 7473 integrates thermal decomposition sample preparation, amalgamation preconcentration, and atomic absorption detection, thus reducing the total analysis time of most samples to <5 min. The analyzer has an automated sample system that allows multiple samples to be analyzed consecutively.

The following analyses will be performed on selected samples of coal and fly ash collected from the baghouse or ESP hoppers.

Coal

- Mercury
- Chlorides
- Ultimate/proximate
- Btu
- XRF (major and some trace elements)

Fly Ash and/or Scrubber Sludge

- Mercury
- Loss on ignition (carbon content)
- X-ray fluorescence (XRF) (major elements and some trace elements)
- Leaching tests

Mercury CMMs. Three different types of mercury CMMs are available for these tests: the Semtech Hg 2000, the PS Analytical Sir Galahad, and the Tekran. These instruments, when used in conjunction with the EERC conversion system, are able to measure speciated mercury. The instruments are briefly described below.

PS Analytical Sir Galahad. The Sir Galahad analyzer was initially used to monitor total mercury continuously in the urban environment and natural gas, but it can also be used in a variety of gaseous media including combustion flue gas. The analyzer is based on the principle of atomic fluorescence which provides an inherently more sensitive signal than atomic absorption. The system uses a gold-impregnated silica support for preconcentrating the mercury and separating it from potential interferences that degrade sensitivity.

The Sir Galahad requires a 4-step process to obtain a flue gas mercury measurement. In the first step, 2 L of flue gas is pumped through a gold trap which is maintained at a constant temperature. Before the mercury is desorbed from the gold trap, a flushing step is initiated to remove any flue gas that may be present, because it has a damping effect on the mercury fluorescence. When this is completed, the analysis step begins. The heating coil is activated, and the gold trap is heated to approximately 500°C. This desorbs the mercury from the trap, and the mercury is carried into the fluorescence detector. The gold trap is cooled rapidly by pumping argon over it, in preparation for the next sample. The total time for the entire process is about 5 minutes.

The system is calibrated using Hg^0 as the primary standard. The Hg^0 is contained in a closed vial which is held in a thermostatic bath. The temperature of the mercury is monitored, and the amount of mercury is measured using vapor pressure calculations. Typically, the calibration of the unit has proven stable over a 24-hour period.

Tekran. The Tekran analyzer was initially used primarily to monitor ambient mercury, but it can also be used in a variety of gaseous media including combustion flue gas. The analyzer is based on

the principle of atomic fluorescence which provides an inherently more sensitive signal than atomic absorption.

Semtech Hg 2000. The commercial Semtech Hg 2000 mercury analyzer (Semtech Metallurgy AB, Lund, Sweden) is essentially a portable Zeeman-modulated cold-vapor atomic absorption (CVAA) spectroscope that can monitor Hg^0 continuously. The analyzer uses Zeeman effect background correction by applying a modulated magnetic field to a mercury lamp to minimize interferences from the presence of SO_2, hydrocarbons, and fine particulate in the flue gas sample. The operating range of the analyzer is 0.3 $\mu g/Nm^3$ to 20 mg/Nm^3 Hg^0, as specified by Semtech Metallurgy AB. The Semtech Hg 2000 has also been certified by TUEV Rheinland for determining compliance with the German legal limit of 50 $\mu g/Nm^3$ for total mercury from waste incinerators.

Quality Assurance/Quality Control

An overall QA/QC program in place at the EERC is designed to maintain overall data integrity. However, additional procedures will be instituted specifically for this project. A target of 100% completeness is set for all measurements. If, during either sampling or analysis, an invalid or incomplete sample is identified, it will be reviewed and repeated, if necessary. Whether a test is failed or incomplete will be determined by the sampling manager in consultation with the project team.

The QA/QC plan for the project will follow the procedures detailed in the *Quality Assurance Project Plan,* which the EERC developed for the ICR sampling program. The plan was approved by EPA and is available upon request. Some of the features of this plan are discussed below.

Instrument Setup and Calibration. The instrument to be used for mercury determination for the OH Method is a Leeman Labs PS200 CVAA. Each day, a 4-point calibration curve is completed using matrix-matched standards. A QC standard of a known analyte concentration is analyzed immediately after an instrument is standardized in order to verify the calibration. The values obtained

must read within 5% of the true value. After the initial QC standardization has been completed, standards are run every five samples to check the slope of the calibration curve. The check standards must read within 10% of the expected value. One in every ten samples is spiked to verify analyte recovery.

Presampling Preparation. To ensure a chain of custody for the samples, all data sheets, volumetric flasks, and petri dishes used for sample recovery will be marked with preprinted labels. The liquid samples will be recovered into premarked volumetric flasks and logged. The filter samples will be placed in premarked petri dishes. The labels will contain identifying data to include date, time, run number, sample port location, and sampler.

Analytical Reagents. All acids used for the analytical methods that pertain to trace metal analysis including mercury are trace metal-grade. Other chemicals used in the preparation of analytical reagents are analytical reagent-grade. The calibration standards used for instrument calibration and the QC standards used for calibration verification are purchased commercially and certified to be accurate within ±0.5% and are traceable to National Institute of Standards and Technology (NIST) standard reference materials.

Field Blanks and Spikes. As part of the QA/QC, an OH field blank and a field spike will be done each day during the initial setup and verification of the CMMs. A field blank is defined as a complete impinger train, including all glassware and solutions, that is taken out to the field during sampling and exposed to ambient conditions. This train is then taken apart and the solutions recovered and analyzed in the same way as those used for sampling. If the field blank shows contamination above instrument background, steps must be taken to eliminate or reduce the contamination to below background levels. If the contamination cannot be eliminated, the magnitude of the contamination must be considered when the concentration of mercury in the samples is calculated. It is important to note that contamination of field blanks is generally not a problem.

In order to ensure that adequate levels of accuracy are maintained, field-spiked samples will also be submitted for analyses. These samples will be made up independently of the chemist doing the analyses. These spikes must be within 20% of the true value. Accuracy is reported as percent recovery of the spike added. The solution used for spiking is from a separate stock than the calibration standards.

STANDARDS OF SUCCESS

The standards of success for this project will be measured on the ability to successfully collect, reduce, compile, evaluate, and document key information on the abundance and variability of mercury species in flue gases from ND power plants as measured before and after the air pollution control systems. A measure of success will be a documented data set of information relevant to ND power plants that contains mercury emission levels and characteristics (oxidized versus elemental mercury) with respect to plant configuration and variability with respect to operational and coal variations. The success of the project in part relies on the quality of the data that are currently available and that will be provided to the EERC by various industry sponsors. The data collected by the EERC at the Milton R. Young and R.M. Heskett stations will be judged for quality based on comparison to OH data, ICR data, and other data provided by the plant owner/operator.

The overall success of the project should be gauged by providing adequate data to guide the identification, evaluation, selection, and demonstration of appropriate and cost-effective technologies that can be applied to ND power plants as well as provide baseline emissions data which can be used to establish an accurate mercury emissions inventory within North Dakota.

BACKGROUND

The EERC has been a leader in mercury research for several years and is viewed as an expert in the field. Additionally, the EERC has over 50 years of experience with low-rank coals and has a track record as a leading research, development, demonstration, and commercialization organization. In recent years, EERC researchers have been in the forefront of advancing the understanding of mercury chemistry, measurement, transformations, solid–gas interactions, and development of control technologies. Progress has been made towards the development of more accurate and robust techniques for measuring mercury in complex gas matrices, such as those found in power plants. The EERC has led the way in development of these sampling and measurement techniques as demonstrated by authorship of the OH method which has recently been approved by the ASTM Subcommittee D22.03.01 and is the defacto standard used by industry. The EERC has been actively involved with the development and advancement of real-time (or near-real-time) continuous mercury sampling and measurement (5). Throughout the years, the EERC has designed and tested several different techniques for separation and quantification of mercury species such as particulate-bound mercury, oxidized mercury, and elemental mercury. Additionally, the EERC has applied these advanced methods at numerous electric utility plants to obtain continuous mercury emissions data, making the EERC a recognized leader in long-term monitoring efforts. Most of these plants are coal-fired plants within the United States. Figure 1 provides a sample of CMM and OH data during a recent field monitoring program (6). This graph also shows the level of agreement that can be obtained between the CMM and OH techniques.

QUALIFICATIONS

Mr. Mike Holmes will act as project manager with the assistance of Mr. John Pavlish, Dr. Steve Benson, and Mr. Dennis Laudal.

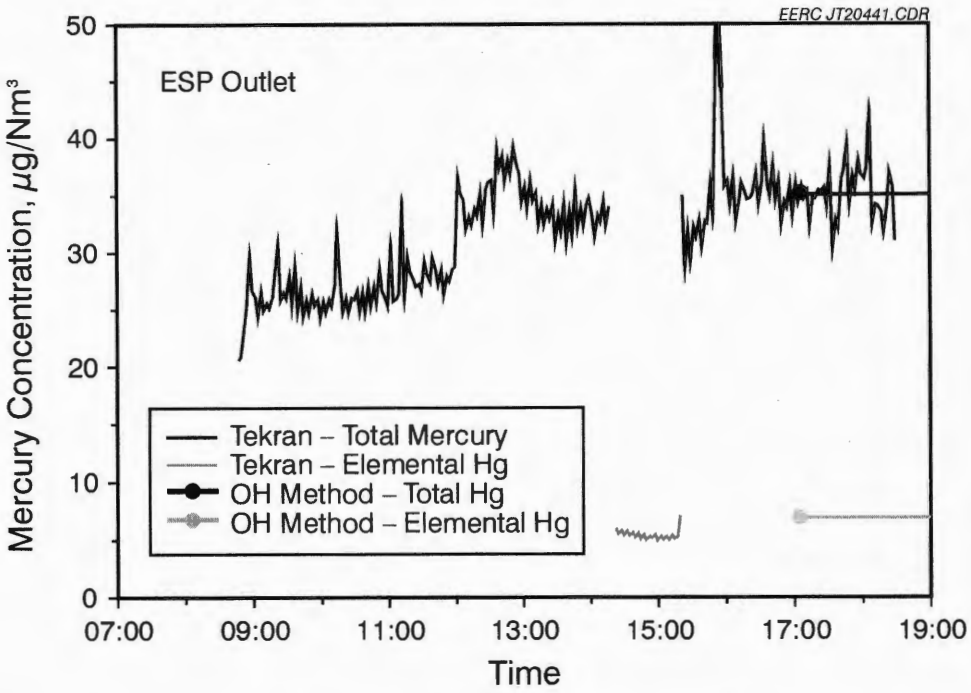

Figure 1. Comparison of CMM and OH data from a recent field research program.

Mr. Holmes is an expert in the field of mercury and flue gas emissions control. Mr. Holmes has 16 years of experience in energy and environmental research and development (R&D) working at Babcock & Wilcox and the EERC. He has managed numerous projects involving sorbent testing and development for mercury control as well as duct injection, dry scrubbing, and wet scrubbing projects for the control of mercury and SO_2 emissions.

Mr. Pavlish, EERC Senior Research Manager, has over 15 years of experience working with various power plant systems. He is also the Director of the Center for Air Toxic Metals (CATM) program at the EERC. CATM is a multiyear, multimillion dollar program aimed at researching critical issues involving trace metals, in particular, mercury.

Dr. Benson is an expert in the field of fuel conversion, ash behavior issues, and the fate and formation of toxic trace elements. Dr. Benson previously served as director of CATM and is very knowledgeable on mercury issues. He has over 20 years of experience in energy research. His

primary duties to the project will be to oversee and lead the technology development efforts, with an emphasis on fundamental research that will lead to design of effective control technologies.

Mr. Dennis Laudal will be the principal investigator for the field monitoring task. Mr. Laudal is a Senior Research Advisor at the EERC. Mr. Laudal is considered a leading authority on mercury measurement in flue gas. In 1999, he authored for ASTM what is now referred to as the Ontario Hydro (OH) mercury speciation method (7). Mr. Laudal currently manages several projects involving extensive use of CMMs at power plants, including continuous monitoring for up to 1 month. Mr. Laudal has authored or coauthored more than 100 publications and contract reports, including several on the state-of-the-art of CMMs.

Resumes for key personnel are included in Appendix A.

VALUE TO NORTH DAKOTA

The project will focus on collecting and assembling data and information needed to guide decisions related to developing effective mercury control technologies for conventional power plants firing lignite coals equipped with ESPs, fabric filters, scrubbers, and with or without low-NO_x burners. It is anticipated that key information will be delivered to consortium members throughout the duration of the project, with all results and deliverables transferred to project sponsors by the end of the project. Key deliverables that will be realized by participants include:

- Information on how mercury transforms and potentially interacts with fly ash and flue gas components within lignite-fired ND power plants.
- Data on mercury emissions, both total quantity and species.
- Data that can be used to guide decisions related to technology selection, performance, and cost. Data generated and compiled will be directly applicable to coals and plants that are part of this project.

- Collaborative research and interaction between stakeholders with an interest in developing accurate mercury emissions inventory and cost-effective control technologies.
- Immediate access to comprehensive reports.
- Access to presentations and peer-reviewed technical journal articles prior to publication. The project team will be involved in authoring or coauthoring publications.

In North Dakota, over 18,000 jobs, $1.3 billion in business volume, and $60 million in tax revenue are generated by the lignite industry each year. North Dakota produces over 30 million tons of lignite annually, and thousands of tons of lignite are fired by ND power plants daily (8). North Dakota's economy depends on lignite production and use. Determining cost-effective technologies that will increase its efficient and environmentally safe use will ultimately lead to the demand for greater production. Increased lignite production and use in North Dakota will result in more jobs in all lignite-related industries in the state.

MANAGEMENT

The proposed project is organized as a consortium; therefore, each participant will have equitable input into the direction and access to the deliverables of the project. Regular meetings will be held to share information, facilitate communication among all project participants, and guide project decisions. The project will be executed by the EERC, with project management responsibilities under Mr. Mike Holmes. Mr. Holmes will receive technical support, as well as assistance in management of the project, from Mr. John Pavlish, Dr. Steve Benson, and Mr. Dennis Laudal.

TIMETABLE

It is expected that the sampling aspects of the project will be completed within 4 months and all reporting requirements finished within 10 months. Prior to sampling, a site visit will be conducted

for each plant. Results will be issued to the project team in draft form as they become available. A draft report will be issued for review and comment from project sponsors near the end of the project. A preliminary project schedule is shown in Table 2.

Table 2. Project Schedule

Date	Milestones
August 1, 2002	Project start date
August, Week 1	Project kickoff/planning
August, Week 2	Site visit to plants
August Weeks 3–4	Sampling plan developed, reviewed, and approved for both plants
September Weeks 1–4[a]	Sampling at first plant
October Weeks 1–4[a]	Sampling at second plant, reducing data from first plant
November	Reducing/interpreting data
December	Draft report
January–March 2003	Draft report review, incorporate comments, issue final report

[a] Exact schedule and sequence of plant sampling will be based on planned plant outages, preferred operating conditions, and other plant considerations.

BUDGET

The budget includes all funding necessary to complete the work. The budget includes preparing site-specific test plans; a site visit; all sampling activities including longer-term monitoring at each facility; data compilation, reduction, and interpretation; and completion of interim and final reports.

The cost estimate for the proposed effort is estimated at $430,000. A detailed budget and budget notes follow.

MATCHING FUNDS

The requested level of funding from the North Dakota Industrial Commission is $129,000. The required match includes $129,000 from ND industry (Basin Electric Cooperative, Great River Energy, Minnkota Power Cooperative, Montana-Dakota Utilities, and Otter Tail Power Company)

and $172,000 from the EERC through the EERC–U.S. Department of Energy Jointly Sponsored Research Program for a total project funding level of $430,000.

Once we have a commitment from NDIC and the ND industrial sponsors, we will submit the proposal to DOE, requesting approval of its share of the funding. Three items are required from NDIC for inclusion in our proposal to DOE:

- A formal commitment to the project. This can be a letter of commitment, a purchase order, or a signed contract.
- A biographical sketch or resume for NDIC's project manager or key technical contributor.
- A short overview of NDIC.

TAX LIABILITY

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

CONFIDENTIAL INFORMATION

It is not expected that any confidential information, material, or data will result from this project.

REFERENCES

1. Laudal, D.L; Kurz, M.D.; Sorensen, J.A.; Bolles, B.A.; Gunderson, L.L. *Mercury Formation and Fate*; Final Report for EPRI Purchase Order No. WO9002-23, Cooperative Power Association Purchase Order No. PO2002350-000, Minnkota Power Cooperative Purchase Order No. PO 97-4630, U.S. Department of Energy Cooperative Agreement No. DE-FC21-93MC30098, and Industrial Commission of North Dakota Purchase Order No. FY98-XXVIII-79; EERC Publication 99-EERC-01-02, Energy & Environmental Research Center: Grand Forks, ND, Jan 1999.

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SUMMARY BUDGET

LONG-TERM MERCURY MONITORING AT ND POWER PLANTS
NDIC/DOE/ND UTILITIES
PROPOSED START DATE: AUGUST 1, 2002
EERC PROPOSAL #2002-0157

CATEGORY		TOTAL HRS	TOTAL $COST	NDIC SHARE HRS	NDIC SHARE $COST	ND UTILITES SHARE HRS	ND UTILITES SHARE $COST	EERC JSRP SHARE HRS	EERC JSRP SHARE $COST
TOTAL DIRECT LABOR		3,405	$ 92,329	1,519	$ 40,865	1,167	$ 30,955	719	$ 20,509
FRINGE BENEFITS - % OF DIRECT LABOR	54%		$ 49,858		$ 22,067		$ 16,716		$ 11,075
TOTAL LABOR			$ 142,187		$ 62,932		$ 47,671		$ 31,584
OTHER DIRECT COSTS									
TRAVEL			$ 27,222		$ 10,000		$ 7,700		$ 9,522
COMMUNICATION - PHONES & POSTAGE			$ 200		$ 75		$ 75		$ 50
OFFICE (PROJECT SPECIFIC SUPPLIES)			$ 678		$ 230		$ 230		$ 218
REPAIRS			$ 1,000		$ 339		$ 339		$ 322
SUPPLIES			$ 9,804		$ 4,500		$ 4,500		$ 804
GENERAL (FREIGHT, FOOD, MEMBERSHIPS, ETC.)			$ 400		$ 180		$ 190		$ 30
EQUIPMENT > $5000			$ 100,000		$ -		$ -		$ 100,000
FEES			$ 33,208		$ 4,436		$ 21,987		$ 6,785
TOTAL OTHER DIRECT COST			$ 172,512		$ 19,760		$ 35,021		$ 117,731
TOTAL DIRECT COST			$ 314,699		$ 82,692		$ 82,692		$ 149,315
FACILITIES & ADMIN. RATE - % OF MTDC		VAR	$ 115,301	56%	$ 46,308	56%	$ 46,308	46%	$ 22,685
TOTAL ESTIMATED COST			$ 430,000		$ 129,000		$ 129,000		$ 172,000

NOTE: Due to limitations within the University's accounting system, the system does not provide for accumulating and reporting expenses at the Detailed Budget level. The Summary Budget is presented for the purpose of how we propose, account, and report expenses. The Detailed Budget is presented to assist in the evaluation of the proposal.

DETAILED BUDGET

LONG-TERM MERCURY MONITORING AT ND POWER PLANTS
NDIC/DOE/ND UTILITIES
PROPOSED START DATE: AUGUST 1, 2002
EERC PROPOSAL #2002-0157

					NDIC SHARE		ND UTILITES SHARE		EERC JSRP SHARE	
LABOR	LABOR CATEGORY	HOURLY RATE	HRS	$COST	HRS	$COST	HRS	$COST	HRS	$COST
HOLMES, M.	PROJECT MANAGER	$ 42.18	380	$ 16,028	129	$ 5,441	129	$ 5,441	122	$ 5,146
PAVLISH, J.	PRINCIPAL INVESTIGATOR	$ 44.47	230	$ 10,228	78	$ 3,469	78	$ 3,469	74	$ 3,290
BENSON, S.	PRINCIPAL INVESTIGATOR	$ 48.02	40	$ 1,921	14	$ 672	14	$ 672	12	$ 577
LAUDAL, D.	RESEARCH SCIENTIST/ENGINEER	$ 43.06	160	$ 6,890	54	$ 2,325	54	$ 2,325	52	$ 2,240
DUNHAM, G.	RESEARCH SCIENTIST/ENGINEER	$ 31.48	150	$ 4,722	51	$ 1,605	51	$ 1,605	48	$ 1,512
----------	SENIOR MANAGEMENT	$ 48.20	117	$ 5,639	53	$ 2,555	23	$ 1,109	41	$ 1,975
----------	RESEARCH SCIENTIST/ENGINEER	$ 26.89	1,071	$ 28,799	651	$ 17,505	351	$ 9,438	69	$ 1,856
----------	RESEARCH TECHNICIAN	$ 18.07	172	$ 3,108	72	$ 1,301	50	$ 904	50	$ 903
----------	TECHNOLOGY DEV. OPER.	$ 18.49	450	$ 8,321	200	$ 3,698	200	$ 3,698	50	$ 925
----------	TECHNOLOGY DEV. MECH.	$ 20.79	40	$ 832	15	$ 312	15	$ 312	10	$ 208
----------	UNDERGRAD-RES.	$ 7.47	400	$ 2,988	136	$ 1,016	136	$ 1,016	128	$ 956
----------	TECHNICAL SUPPORT SERVICES	$ 14.63	195	$ 2,853	66	$ 966	66	$ 966	63	$ 921
			3,405	$ 92,329	1,519	$ 40,865	1,167	$ 30,955	719	$ 20,509
ESCALATION ABOVE CURRENT BASE		0%		$ -		$ -		$ -		$ -
TOTAL DIRECT LABOR				$ 92,329		$ 40,865		$ 30,955		$ 20,509
FRINGE BENEFITS - % OF DIRECT LABOR		54%		$ 49,858		$ 22,067		$ 16,716		$ 11,075
TOTAL LABOR				$ 142,187		$ 62,932		$ 47,671		$ 31,584
OTHER DIRECT COSTS										
TRAVEL				$ 27,222		$ 10,000		$ 7,700		$ 9,522
COMMUNICATION - PHONES & POSTAGE				$ 200		$ 75		$ 75		$ 50
OFFICE (PROJECT SPECIFIC SUPPLIES)				$ 678		$ 230		$ 230		$ 218
REPAIRS				$ 1,000		$ 339		$ 339		$ 322
SUPPLIES				$ 9,804		$ 4,500		$ 4,500		$ 804
GENERAL (FREIGHT, FOOD, MEMBERSHIPS, ETC.)				$ 400		$ 180		$ 190		$ 30
EQUIPMENT > $5000				$ 100,000		$ -		$ -		$ 100,000
NATURAL MATERIALS ANALYTICAL RES. LAB.				$ 5,760		$ -		$ 5,760		$ -
FUELS & MATERIALS RESEARCH LAB.				$ 4,320		$ -		$ 4,320		$ -
ANALYTICAL RESEARCH LAB.				$ 12,584		$ 3,506		$ 8,248		$ 830
PROCESS CHEM. & DEV. LAB.				$ 1,960		$ 664		$ 664		$ 632
PARTICULATE ANALYSIS				$ 6,552		$ -		$ 2,729		$ 3,823
GRAPHICS SUPPORT				$ 1,248		$ -		$ -		$ 1,248
SHOP & OPERATIONS SUPPORT				$ 784		$ 266		$ 266		$ 252
TOTAL OTHER DIRECT COST				$ 172,512		$ 19,760		$ 35,021		$ 117,731
TOTAL DIRECT COST				$ 314,699		$ 82,692		$ 82,692		$ 149,315
FACILITIES & ADMIN. RATE - % OF MTDC				$ 115,301	56%	$ 46,308	56%	$ 46,308	46%	$ 22,685
TOTAL ESTIMATED COST				$ 430,000		$ 129,000		$ 129,000		$ 172,000
						30.00%		30.00%		40.00%

DETAILED BUDGET - TRAVEL

LONG-TERM MERCURY MONITORING AT ND POWER PLANTS
EERC PROPOSAL #2002-0157

RATES USED TO CALCULATE ESTIMATED TRAVEL EXPENSES

DESTINATION	AIRFARE	PER MILE		LODGING	PER DIEM	CAR RENTAL	REGIST.
Unspecified Destination (USA)	$ 1,524	$ -		$ 125	$ 46	$ 50	$ 400
Bismarck, ND	$ -	$ 0.28		$ 50	$ 20	$ -	$ -
Washburn, ND & Area	$ -	$ 0.39	*	$ 30	$ 20	$ -	$ -
Morgantown, WV (via Pittsburgh, PA)	$ 1,060	$ -		$ 65	$ 34	$ 50	$ -

PURPOSE/DESTINATION	NUMBER OF TRIPS	PEOPLE	MILES	VEHICLES	DAYS	AIRFARE	MILEAGE	LODGING	PER DIEM	CAR RENTAL	MISC.	REGIST.	TOTAL
Conference/Unspecified Dest. (USA)	1	1	0	0	3	$ 1,524	$ -	$ 250	$ 138	$ 150	$ 60	$ 400	$ 2,522
Field Sampling/Washburn, ND	9	2	2300	2	14	$ -	$ 8,073	$ 7,020	$ 5,040	$ -	$ 2,520	$ -	$ 22,653
Presentations/Bismarck, ND	1	3	550	0	2	$ -	$ 215	$ 150	$ 120	$ -	$ 60	$ -	$ 545
Review Mtg/Morgantown, WV (Pittsburgh, PA)	1	1	0	0	3	$ 1,060	$ -	$ 130	$ 102	$ 150	$ 60	$ -	$ 1,502
TOTAL ESTIMATED TRAVEL TASK 1													$ 27,222

* An average of $0.39 was used in estimating the mileage as two vehicles will be used.
A van will be used at a rate of $0.50/mile and a car at $0.28/mile.

DETAILED BUDGET - EQUIPMENT

DESCRIPTION	QTY	UNIT	$COST
Continuous mercury monitor to include conditioning system	2	$ 50,000	$ 100,000

DETAILED BUDGET - FEES

LONG-TERM MERCURY MONITORING AT ND POWER PLANTS
EERC PROPOSAL #2002-0157

NATURAL MATERIALS ANALYTICAL RES. LAB.	RATE	#	$COST
XRFA	$144	40	$ 5,760
SUBTOTAL			$ 5,760
ESCALATION		0%	$ -
TOTAL NATURAL MATERIALS ANALYTICAL RES. LAB.			$ 5,760

FUELS & MATERIALS RESEARCH LAB.	RATE	#	$COST
BTU	$46	20	$ 920
LOSS ON IGNITION (LOI)	$37	40	$ 1,480
PROXIMATE ANALYSIS	$52	20	$ 1,040
SULFUR	$44	20	$ 880
SUBTOTAL			$ 4,320
ESCALATION		0%	$ -
TOTAL FUELS & MATERIALS RESEARCH LAB.			$ 4,320

ANALYTICAL RESEARCH LAB.	RATE	#	$COST
ACID EXTRACTABLE MERC	$24	24	$ 576
COAL DIGESTION	$144	24	$ 3,456
CVGAA	$26	144	$ 3,744
FILTERING	$10	24	$ 240
MISCELLANEOUS	$36	2	$ 72
Hg PREP - DIGESTION	$30	80	$ 2,400
IC	$24	24	$ 576
IC PREP	$10	24	$ 240
LEACHING	$109	8	$ 872
MIXED ACID DIGESTION	$34	12	$ 408
SUBTOTAL			$ 12,584
ESCALATION		0%	$ -
TOTAL ANALYTICAL RESEARCH LAB.			$ 12,584

PARTICULATE ANALYSIS	RATE	#	$COST
EPA METHOD 29/ONTARIO HYDRO	$273	24	$ 6,552
SUBTOTAL			$ 6,552
ESCALATION		0%	$ -
TOTAL PARTICULATE ANALYSIS			$ 6,552

PROCESS CHEM. & DEV. LAB.	RATE	#	$COST
PREP/GC/CHN	$49	40	$ 1,960
SUBTOTAL			$ 1,960
ESCALATION		0.0%	$ -
TOTAL PROCESS CHEM. & DEV. LAB.			$ 1,960

GRAPHICS SUPPORT	RATE	#	$COST
GRAPHICS (HOURLY)	$39	32	$ 1,248
SUBTOTAL			$ 1,248
ESCALATION		0%	$ -
TOTAL GRAPHICS SUPPORT			$ 1,248

SHOP & OPERATIONS SUPPORT	RATE	#	$COST
TECHNICAL DEVELOPMENT HOURS	$1.60	490	$ 784
SUBTOTAL			$ 784
ESCALATION		0%	$ -
TOTAL SHOP & OPERATIONS SUPPORT			$ 784

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, or other agreements. Although the EERC is not affiliated with any one academic department, university academic faculty may participate in a project, depending on the scope of work and expertise required to perform the project.

The proposed work will be done on a cost-reimbursable basis. The distribution of costs between budget categories (labor, travel, supplies, equipment, subcontracts) is for planning purposes only. The principal investigator may, as dictated by the needs of the work, reallocate the budget among approved items or use the funds for other items directly related to the project, subject only to staying within the total dollars authorized for the overall program. The budget prepared for this proposal is based on a specific start date; this start date is indicated at the top of the EERC budget or identified in the body of the proposal. Please be aware that any delay in the start of this project may result in an increase in the budget. Financial reporting will be at the total project level.

Salaries and Fringe Benefits

As an interdisciplinary, multiprogram, and multiproject research center, the EERC employs an administrative staff to provide required services for various direct and indirect support functions. Direct project salary estimates are based on the scope of work and prior experience on projects of similar scope. Technical and administrative salary charges are based on direct hourly effort on the project. 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. For faculty, if the effort occurs during the academic year and crosses departmental lines, the salary will be in addition to the normal base salary. University policy allows faculty who perform work in addition to their academic contract to receive no more than 20% over the base salary. Costs for general support services such as grants and contracts administration, accounting, personnel, and purchasing and receiving, as well as clerical support of these functions, are included in the EERC facilities and administrative cost.

Fringe benefits are estimated on the basis of historical data. The fringe benefits actually charged consist of two components. The first component covers average vacation, holiday, and sick leave (VSL) for the EERC. This component is approved by the UND cognizant audit agency and charged as a percentage of direct labor for permanent staff employees eligible for VSL benefits. The second component covers actual expenses for items such as health, life, and unemployment insurance; social security matching; worker's compensation; and UND retirement contributions.

Travel

Travel is estimated on the basis of UND travel policies, which include estimated General Services Administration (GSA) daily meal rates. Travel includes scheduled meetings and conference participation as indicated in the scope of work.

Communications (phones and postage)

Monthly telephone services and fax telephone lines are generally included in the facilities and administrative cost. Direct project cost includes line charges at remote locations, long-distance telephone, including fax-related long-distance calls; postage for regular, air, and express mail; and other data or document transportation costs.

Office (project-specific supplies)

General purpose office supplies (pencils, pens, paper clips, staples, Post-it notes, etc.) are provided through a central storeroom at no cost to individual projects. Budgeted project office supplies include items specifically related to the project; this includes duplicating and printing.

Data Processing

Data processing includes items such as site licenses and computer software.

Supplies

Supplies in this category include scientific supply items such as chemicals, gases, glassware, and/or other project items such as nuts, bolts, and piping necessary for pilot plant operations. Other items also included are supplies such as computer disks, computer paper, memory chips, toner cartridges, maps, and other organizational materials required to complete the project.

Instructional/Research

This category includes subscriptions, books, and reference materials necessary to the project.

Fees

Laboratory and analytical fees are established and approved at the beginning of each fiscal year, and charges are based on a per sample or hourly rate depending on the analytical services performed. Additionally, laboratory analyses may be performed outside the University when necessary.

Graphics services fees are based on an established per hour rate for overall graphics production such as report figures, posters for poster sessions, standard word or table slides, simple maps, schematic slides, desktop publishing, photographs, and printing or copying.

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

General

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

Membership fees (if included) 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 as well as by the research team directly involved in project activity.

General 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), transportation, rental of facilities, and other items incidental to such meetings or conferences.

Facilities and Administrative Cost

The facilities and administrative rate (indirect cost rate) included in this proposal is the rate that became effective July 1, 2001. Facilities and administrative cost is calculated on modified total direct costs (MTDC). MTDC is defined as total direct costs less individual items of equipment in excess of $5000 and subcontracts/subgrants in excess of the first $25,000 of each award.