



**Energy &  
Environmental  
Research  
Center**

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**CENTER FOR AIR TOXIC METALS  
AFFILIATES PROGRAM – CONTINUATION OF  
MEMBERSHIP**

EERC Proposal No. 99-0018

**Total Funds Requested: \$75,000**

*Submitted to:*

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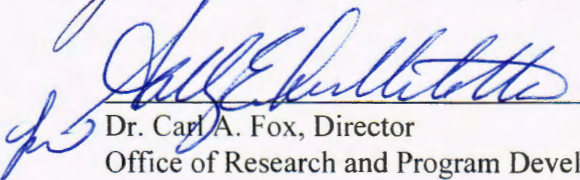
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## CATM AFFILIATES PROGRAM – CONTINUATION OF MEMBERSHIP

### ABSTRACT

Worldwide, concern is growing over emissions of trace metals considered to be air toxics. More stringent metal emission regulations have been promulgated for many industries and are expected to be further implemented in Europe, the United States, and elsewhere. To help address these issues, the EPA established the Center for Air Toxic Metals (CATM) program at the EERC in 1992. Since then, CATM has answered many critical questions related to health risks, toxic metal transformations and pathways, sampling and measurement of toxic metal emissions, and related toxic metal control technologies. CATM work has furthered our understanding of air toxic issues and resolved many key questions put forth by affiliate sponsors. Affiliate partners have been kept informed of CATM progress and results through numerous mailings and regular meetings.

Without question, the demand for a strong research program targeting critical and timely air toxic issues is greater now than ever before. In December 1997, the *Mercury Study Report to Congress* was released and in February 1998, the *Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units – Final Report to Congress*. As highlighted in these reports, additional research is still needed on air toxic metals. Consequently, the main focus of the CATM program in coming years will be on the ever-increasing issues and concerns related to mercury. Many of the planned research activities target mercury, and this emphasis will increase until mercury issues are resolved.

CATM takes a comprehensive "cradle-to-grave" approach to solving air toxic metal emission problems. Deliverables are transformation mechanisms of air toxic metals, sampling methodologies, analytical methods, control technologies, computer modeling, technology transfer, workshops, conferences, training material and courses, and support for general public outreach and education.

In addition to NDIC participation, other organizations in the CATM Affiliates Program are EPRI, Otter Tail Power Company, NSP, and TVA. The program is ongoing, and affiliates are asked to contribute \$25,000 a year for membership. Membership is optional year by year; however, to address long-term issues, we encourage a minimum commitment of 3 to 5 years, for a total of \$75,000 to \$125,000, respectively.

# **CENTER FOR AIR TOXIC METALS AFFILIATES PROGRAM – CONTINUATION OF MEMBERSHIP**

## **PROJECT SUMMARY**

The Center for Air Toxic Metals (CATM) was initiated in 1992 at the Energy & Environmental Research Center (EERC) of the University of North Dakota through the U.S. Environmental Protection Agency (EPA) Office of Environmental Engineering and Technology Demonstration. CATM is a partnership among government, industry, and academia that is focused on pollution prevention and control technologies. As part of ongoing research activities at the EERC, CATM strives to develop and provide critical data and predictive methodologies to industry and EPA in order to help better define regulations and provide a forum for industry input and interaction. The CATM focus is on furthering the current understanding of the behavior of potentially toxic metals in coal-fired utilities, other fossil fuel systems, waste-to-energy systems, and waste incinerators. CATM goals are to develop methods to prevent or reduce air toxic metal emissions, predict the fate of metals, determine the effectiveness of control devices, identify new control technologies, and inform affiliate members and the public of research findings.

A CATM Affiliates Program (CATMAP) that has been organized and maintained over the last 5 years allows the participation of organizations as partners in various technical program areas. These partnerships provide the necessary direction to ensure that the research conducted meets both short- and long-term goals and needs. The cost for becoming or continuing as a member of CATMAP is \$25,000 per year. Other membership alternatives (discussed below) are available on a limited basis, depending on the type of organization and potential in-kind contributions. The benefits of membership include:

- Direct access to EERC personnel who can provide technical advice on solving problems associated with air toxic metals.

- Rapid access to state-of-the-art research on air toxic metal sampling, analysis, control, and predictive techniques.
- Research and development at a fraction of the cost available to a single organization.
- Interaction with other affiliates, regulatory agencies, and research institutions interested in air toxic metals.
- Discounted rates on computer software developed through CATM as well as on CATM-sponsored workshops, educational courses, and conferences.
- Up-to-date source of information, publications, and reports.
- Affiliate representation within CATM. Each member organization has an advisor who participates in meetings that assist in defining the direction and scope of research activities related to air toxic metals.
- Access to jointly sponsored research program funds. Sponsorship for CATM and the CATMAP and Jointly Sponsored Research Program has integrated funds available from EPA, the U.S. Department Of Energy, the Electric Power Research Institute (EPRI), Gas Research Institute, multiclient consortia, and individual sponsors.

CATM is positioned to meet the many challenges facing regulatory agencies, government, and industry. The EERC is a world leader in research on energy production, environmental control technologies, and other environmental issues. Staffed with a multidisciplinary team of engineers, scientists, and technicians and equipped with state-of-the-art facilities, the EERC has solved numerous problems related to energy and the environment for industrial and government sponsors worldwide. The EERC is ideally suited to coordinate and conduct research and development programs related to issues on air toxic metals, with its internationally recognized expertise on combustion, gasification, ash behavior, ash utilization, ash disposal, and groundwater and its partnerships with industry. CATM builds on the foundation of over 45 years of research at the EERC.

The anticipated deliverables of the CATM Program include the following:

- Elucidation of air toxic transformation mechanisms and pathways in energy-producing and incinerating systems.
- Development and demonstration of technologies to control metals behavior and emissions.
- Development and demonstration of environmentally sound methods to utilize and dispose of residuals.
- Development and validation of methods to sample and analyze air toxics.
- Development of predictive tools and databases.
- Development of partnerships with industry.
- Development of environmental awareness and pollution prevention programs through education.
- Commercialization of results and technologies.
- Increased awareness of environmental issues through education via university courses, workshops, conferences, seminars, and 1-day courses.

## **PROJECT DESCRIPTION/CATM WORK PLAN**

The approach taken to meet the goals and objectives of CATM involves developing partnerships with government, industry, and academia to conduct practically oriented research that will facilitate the prevention and control of air toxic metal emissions. The EERC and others are conducting research on air toxic metals behavior; many of the EERC programs are described in Appendix B: EERC Related Research Programs and Experience. The cradle-to-grave approach related to the production of energy from fossil fuels or wastes in an environmentally responsible manner involves developing detailed knowledge of fuel composition and characteristics, transformation of components during conversion, effective control technologies, and methodologies to utilize and dispose of residuals. CATM is

organized into five integrated program areas. The program areas are coupled to predictive modeling and development of databases that allow for data accessibility and interpretation. In addition, the overall effort is coordinated with technology transfer and education.

The first program area, Air Toxic Metals Transformation Mechanisms, is focused on the determination of the chemical and physical transformations of air toxic metals as a function of the association and abundance of the metal in the fuel and system design and operating conditions. The second program area, Analytical Methods Development, involves the enhancement of existing methods and application of new sampling/analytical methods to effectively speciate and determine the abundance of air toxic metals in fuels and process streams. The third program area, Control Technologies, is focused on evaluating and enhancing currently used emissions control technologies for air toxic metals. In addition, efforts will be made to identify new methods to prevent and control emissions based on a more fundamental understanding of the transformation mechanisms determined in Program Area 1.

The fourth program area, Modeling and Database Development, involves the development, enhancement, and support of tools to predict the fate of air toxic metals in combustion, gasification, and incineration systems. This task utilizes information generated in Program Areas 1–3 in the development of models and databases. In turn, these models and databases are used for experimental design and identification of opportunities to prevent and control metals emissions. The final program area, Technology Commercialization and Education, involves the development of partnerships through the transfer of information from CATM to industrial sponsors as well as to academic and government partners through newsletters, education programs, and annual meetings. A more detailed discussion of each program area follows.

#### **Program Area 1 – Air Toxic Metals Transformation Mechanisms**

Program Area 1, Air Toxic Metals Transformation Mechanisms, is a vital part of CATM, since it is designed to develop fundamental data that will lead to strategies for pollution prevention and



control. As a result of gaining knowledge about trace metal transformation mechanisms, the following CATM goals can be accomplished: 1) development of air toxic metals pollution prevention methodologies, 2) development of models that predict trace element emissions, and 3) development of effective strategies to control air toxic metal emissions. The initial forms and associations of trace metals in combustible fossil fuel or waste material result in markedly different forms during the fuel-to-energy or waste-to-energy conversion processes. The type and quantity of trace elements emitted from the system are a function of conversion system, operating conditions, and fuel composition. System conditions such as reducing and oxidizing environments, gas-phase composition, pressure, and temperature influence the partitioning of the air toxics. Program Area 1 is devoted to determining the degree to which toxic metals are transformed and partitioned into inorganic vapors, liquids, and solids as a function of fuel composition and system conditions.

#### **Program Area 2 – Analytical Methods Development**

Program Area 2, Analytical Methods Development, includes the development of methods to determine the abundance and association of air toxic metals in a variety of fuel resources and wastes, measuring and speciating the metals in the various process streams of the combustion and gasification systems, performing in situ measurements, and providing analytical support for the other program areas. The long-term goal of this program area is to develop sufficiently versatile instrumentation methods and sampling procedures to detect and measure atomic and molecular species, solid or gaseous, that are present at a variety of locations throughout bench-, pilot-, and commercial-scale conversion systems. Developing better, more accurate, flexible, and low-cost sampling and analytical instruments that can be applied and utilized at full-scale plants is the ultimate goal.

#### **Program Area 3 – Control Technologies**

Program Area 3, Control Technologies, is focused on pursuing and identifying opportunities for minimizing and controlling trace element emissions in combustion and gasification systems, including

prevention and minimization of toxic element formation (i.e., fuel-to-energy conversion efficiency improvements and recycling); capture by sorbents using precombustion, combustion, and postcombustion injection techniques in conjunction with high-efficiency fine-particle control; and development, demonstration and implementation of new, innovative technologies. Prevention or minimization of emissions of air toxic elements includes many factors, ranging from improvements in process operation to retrofitting or installing new high-efficiency collection equipment.

Developing low-cost control alternatives such as sorbent technologies will continue to be a priority. Fundamental data are needed to develop new sorbents or to extend the effectiveness of existing commercially available sorbents. Efforts will focus on determining air toxic metal sorbent interactions, the characteristics of the sorbent material, the optimal location for injection into the system, the mechanisms of formation/transformation and metal speciation, the influence of system conditions (operating and physical state), and cost effectiveness.

Ash production is inevitable from combustion and gasification systems, and although the amount of ash produced is variable depending on the fuel, the solid residue requires consideration regardless of the quantity. Coal and other fuels produce a high volume of solid residues in varying forms containing different metal concentrations. Developing proper management options for these residues, whether they are disposed of or utilized, is essential and is a CATM goal.

#### **Program Area 4 – Modeling and Database Development**

Program Area 4, Modeling and Database Development, focuses on providing practical and fundamental computer tools that are easily accessible by the user community, functional across many industries, and can be used to evaluate data trends and relationships relative to fuel type and plant configuration. Areas of continued focus are 1) the development, enhancement, and support of a database for archiving and retrieving air toxic metal concentrations and system data; 2) the enhancement and support of a user-friendly graphical interface that is freely accessible through the Internet; 3) a continued

effort to expand database capabilities and data records as new data becomes available; 4) the development and enhancement of models and algorithms (nomograms) for predicting trace metals partitioning, emissions, and control efficiencies.

### **Program Area 5 – Technology Commercialization and Education**

Program Area 5, Technology Commercialization and Education, focuses on disseminating technical information concerning trace metals produced by CATM to the affiliate members and other sponsoring agencies, as well as providing training opportunities for both students and professionals. Major activities include 1) continuing to prepare and distribute the *CATM Newsletter*; 2) offering of the short course training program; 3) coordination of CATM annual meetings with EPA as the invited party, program affiliates, and the Research Advisory Committee (RAC); 4) continuing efforts of the Environmental Education Committee (EEC); 5) coordination of research planning activities through the RAC and coordination of research review by the Science Advisory Committee (SAC); and 6) overall administration of CATMAP.

### **DELIVERABLES**

The following program deliverables are expected:

- Identification of air toxic metal pollution prevention options
- Determination of air toxic transformation mechanisms in fossil fuel and waste incineration systems
- Development of technologies to monitor and control metals behavior and emissions
- Development of environmentally sound methods to utilize and dispose of residuals
- Development of methods to sample and analyze air toxics
- Development of predictive tools and databases
- Development of training and educational courses
- Commercialization of results and technologies

## **BACKGROUND/CATM PROGRAM: MISSION AND GOAL**

The mission of CATM is to provide a nationally coordinated and practically oriented multidisciplinary research and development and training program on the prevention, formation, behavior, and control of potentially toxic metal emissions from energy-producing and incinerating systems and on preventing and minimizing the effect of these metals on the environment through partnerships developed with industry, academia, and government.

The primary goal of CATM is to develop key information on the behavior of air toxic substances that allows for the prediction of the fate of air toxic metals, the enhancement of existing control technologies, the identification of new control technologies, the demonstration of advanced control technologies, the optimization of utilization and disposal of residuals, and pollution prevention.

To accomplish the mission and goal of CATM, the EERC fosters partnerships through relationships with industry, academia, and government. CATM is at the focal point or hub of these partnerships, which are key to effective research and development programs, as depicted in Figure 1. The EERC has an excellent reputation for developing multidisciplinary, multi-client research and development programs that are focused on solving near- and long-term problems related to energy and environment.

## **QUALIFICATIONS**

### **Program Area Managers and Principal Investigators**

The project management plan has been assembled in such a way as to take full advantage of the multidisciplinary nature of the EERC research team. The plan is modular in design and fully integrated to facilitate the efficient interaction and cooperation of the very diverse team of experts needed to perform the research on air toxic metals.

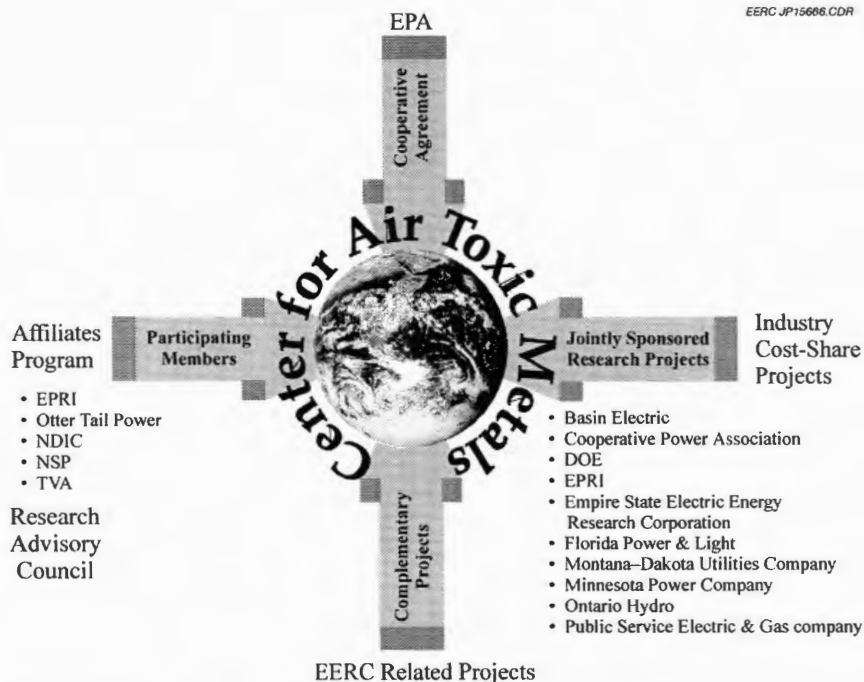


Figure 1. CATM – a multiclient program at the focal point of metals research.

Qualified managers for each of the five parallel program areas (air toxic metal transformation mechanisms, analytical methods development, control technologies, computer modeling and database, and technology commercialization and education), are shown in Table 1 of Appendix A.

**Research Advisory Council**

The CATM Research Advisory Council (RAC) consists of two committees, referred to as the Partners Advisory Council (PAC) and Science Advisory Council (SAC). The role of the PAC is to identify and prioritize research needs and ideas. Each organization participating as an affiliate member is represented on the PAC and is allowed a voice in the direction of CATM's research. The role of the SAC, which consists of members from industry, government, and academia, is to ensure that the research activities that are proposed and conducted through the CATM are scientifically valid, have a strong experimental plan, utilize appropriate analytical techniques, and meet overall quality control guidelines.

## **VALUE TO NORTH DAKOTA**

### **What is the Affiliates Program?**

The CATM Affiliates Program is designed to meet the many challenges facing industry and government and will aid industry in interfacing with regulatory agencies and government in a constructive manner. Membership immediately and continuously provides the participant with access to an air toxics research program. Proactive organizations seeking to minimize risk and provide input into long- and short-term planning will benefit greatly from this program.

### **Benefits of Becoming a Member**

The consortium established by CATMAP represents a unique opportunity to leverage limited research dollars in order to deal with toxic metal emission issues in an efficient and cost-effective manner. Partnerships established with government agencies and other affiliates will result in opportunities to implement cost-effective solutions to emissions problems facing industry today. CATMAP provides access to EPA personnel and contractors involved in the research and development on air toxic emissions mandated by the Clean Air Act Amendments and provides a forum for members to voice concerns and keep current on the latest EPA studies and strategies.

The primary benefits of sponsorship include:

- Involvement in and development of sponsor-selected research activities that complement CATM fundamental research areas.
- Rapid access to state-of-the-art research on air toxic metal sampling, analysis, control, and predictive techniques.
- Research and development at a fraction of the cost available to a single organization.
- The development of partnerships and rapport with other organizations interested in air toxic metals issues.

- Direct access to EERC personnel who can assist in providing technical advice and in solving problems associated with air toxic metals.
- Discounted rates on computer software developed through CATM.
- Discounted rates on workshops and educational courses offered through CATM.
- Reports and technical documents published by CATM.
- Affiliate representation within CATM. The advisor will participate in meetings that assist in defining the direction and scope of CATM research activities.
- Participation at annual meetings.

### **Requirements of Becoming a Member**

Several alternatives are available by which an organization may become an affiliate member of CATM. These options are listed below in order of preference:

- Option 1. The organization may join or continue membership by contributing \$25,000 per year to the CATMAP research fund. These funds will then be used to perform specific research in the areas that are of interest to CATMAP members and that meet overall CATM goals and objectives.
- Option 2. The organization may join by contributing over \$25,000 per year in “in-kind” contributions to CATMAP. This type of membership will be on a limited case-by-case basis and will be subject to approval by the EERC after review of proposed in-kind contributions.
- Option 3. A representative from a given organization may be invited to join CATMAP. Under this option, the representative must have several years of experience, published journals/documents/papers, and demonstrated expertise in an area pertaining to air toxic research. Some level of in-kind contribution and participation will be required and established by mutual agreement between the EERC and the interested party. This option is mainly

intended for nonprofit institutions such as universities. Consequently, membership through this option is extremely limited, by invitation only.

Funds provided by CATMAP members are used to support research activities that are of interest to the members and that support the overall research goals of CATM. Specific research tasks are identified and prioritized at annual meetings. It is understood that EERC and EPA representatives are members of CATMAP and are not subject to annual contributions (fees) since administration and base-level funding for this program are provided through the EPA/EERC. It is further understood that specific research of interest to CATMAP members is subject to review and approval by EPA.

## OVERALL MANAGEMENT STRUCTURE

The overall organizational structure of CATM is illustrated in Figure 2. Overall project management and coordination of efforts will be the responsibility of the CATM Director, Dr. Steven A. Benson. Dr. Benson has more than 15 years of experience in energy and environmental research. He has

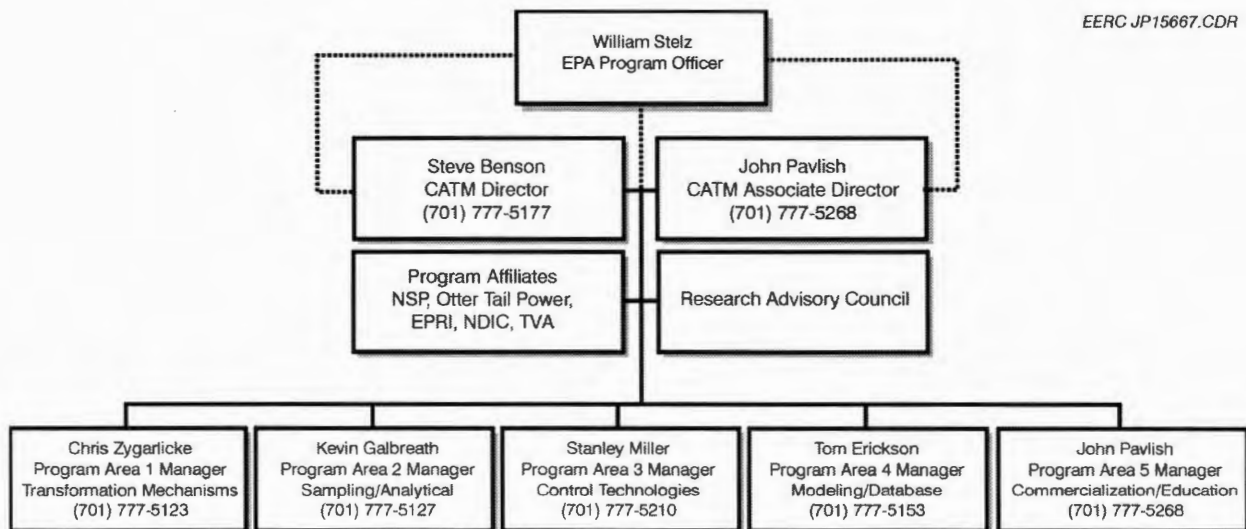


Figure 2. CATM organizational structure.



extensive experience in developing and managing multiclient jointly sponsored research programs involving academia, industry, and government. Dr. Benson has published over 100 technical papers and is the editor of two books. He has also organized several international conferences and workshops in the areas of energy and environment. Dr. Benson will be assisted by John Pavlish, the CATM Associate Director. Mr. Pavlish has over 10 years of power plant experience related to pollution control and has published numerous publications. Together their management efforts will be guided by three management groups: CATMAP members, EPA project management, and the RAC.

### **TIMETABLE**

Membership dues are payable on an annual basis; however, a 3–5–year commitment of participation is strongly encouraged. A multiyear commitment allows continuity of research activities and the ability for CATM researchers to address long-term research needs. An annual report summarizing research results is generated and made available to all members at the end of each year.

### **BUDGET EXPLANATION**

A detailed budget is not provided since CATM is an ongoing program and funding is from several sources. The cost of becoming an affiliate member of the CATM program is \$25,000 per year for 3 years. Affiliate members are allowed to direct research activities performed by the EERC through participation at annual meetings. Critical research needs identified and prioritized at these meetings are submitted to the SAC for review and approval.

Five companies, EPRI, the North Dakota Industrial Commission (NDIC), Otter Tail Power Company, Northern States Power Company (NSP), and the Tennessee Valley Authority (TVA) are current CATMAP members and have been since the inception of the program. Based on participation of these five companies, NDIC's \$25,000 is a portion of the \$125,000 from the five companies. The

affiliates program is being matched to EPA CATM funding. In addition to the affiliates program, the EPA has provided a base funding of over \$5.3 million and continues to fund CATM with over \$1.25 million annually. Consequently, membership funding is highly leveraged, by a multiplication factor of 40 ( $\$1.25/\$0.025$ ). Expenditures may be included as described in the Budget Notes below.

## **BUDGET NOTES**

### **Background**

The EERC is an independently organized multidisciplinary research center within the University of North Dakota. 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 based on the scope of work and expertise required to perform the project.

The proposed work will be done on a fixed-price basis. The budget for this proposal has been prepared based on a specific start date; this start date is indicated at the top of the EERC detail 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.

### **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 salaries are estimated based on the scope of work and prior experience on projects of similar scope. Technical and administrative salaries are charged based on direct hourly effort on the project. 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, purchasing and receiving, as well as clerical support of these functions, are included in the indirect cost of the EERC.

Fringe benefits are estimated based on 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 on 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 based on UND travel policies, which include estimated 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 included in indirect cost. Direct project cost includes 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: special research notebooks, binders, and other project organizational materials; duplicating, printing, special covers or paper, and binding of reports; project data forms, transparencies or other presentation materials; literature searches and technical information procurement, including subscriptions; manuals, computer diskettes, memory chips, laser printer paper, and toner cartridges; and other miscellaneous supplies required to complete the project.

### **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, and glassware and/or other such as: items nuts, bolts, and piping necessary for pilot plant operations.

### **Fees**

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

Engineering support fees are based on an established per hour rate for drafting services related to the production of drawings as part of EERC's quality assurance/quality control program for complying with piping and pressure vessel codes.

Graphic services fees are based on an established per hour rate for overall graphics production such as report figures, 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**

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 workshops and conferences may include such items as food (some of which may exceed the institutional established limits), room amenities (e.g., place cards, music, banners, floral arrangements), speaker gifts, security, interpreters, technical tour transportation, and room and equipment rental necessary to conduct workshops and conferences.

#### **Indirect Cost**

The indirect cost rate included in this proposal is the rate which became effective July 1, 1995. Indirect cost is calculated on modified total direct costs (MTDC). MTDC is defined as total direct costs less individual items of equipment in excess of \$750 and subcontracts/subgrants in excess of the first \$25,000 of each award.

#### **MATCHING FUNDS/CURRENT AFFILIATE MEMBERSHIP**

CATM has performed several research activities since it was established over 6 years ago. Over \$5.3 million in base-level funding for these activities has been provided through EPA, with a continued funding level of over \$1.25 million. Membership funds of \$25,000/year are matched by a factor of 40 compared to base-level funding. Specific research, directed by the affiliate members and the PAC, is formulated, prioritized, and initiated annually. Current CATMAP members are EPRI, NDIC, Otter Tail Power Company, NSP, and TVA.

#### **TAX LIABILITY**

The EERC is an organized research center within the University of North Dakota. The University of North Dakota is an institution of higher education within the state of North Dakota and is not a taxable entity.

#### **CONFIDENTIAL INFORMATION**

No confidential information is contained within this proposal.