REQUEST FOR PROPOSAL
Analysis of Winter Nitrate Study Data

The Lake Michigan Air Directors Consortium (LADCO) is seeking contractor assistance to analyze the ambient measurements from LADCO’s Winter Nitrate Study, and the Southeastern Aerosol Research and Characterization (SEARCH) network sites, to produce a conceptual model of wintertime PM-nitrate formation in the upper Midwest and to propose a new chemical mechanism for PM-nitrate formation, if needed, for use in photochemical models.

You are invited to submit a proposal for this project. Proposals must be received no later than 5 p.m. CDT on August 28, 2009. An electronic version (WordPerfect or Word) of the proposal is required (paper copies optional) and should be sent via e-mail (preferred) or regular mail to:

Mr. Michael Koerber
Executive Director
Lake Michigan Air Directors Consortium
9501 West Devon Avenue, Suite 701
Rosemont, IL 60018
e-mail: koerber@ladco.org

No late proposals will be accepted, and the offer shall remain effective for a period of 30 days from the date of the mailing.

Your response to this Request for Proposal (RFP) should include a complete technical proposal to describe your approach to accomplishing the tasks outlined below in the Scope of Work. The response should include a draft work plan, which clearly describe your technical activities, schedule, and deliverables, and should include a summary of your organization's capability and experience in the field of work. Please limit the draft work plan to 20 pages (12-point font). In addition, please also provide a complete cost proposal with a detailed breakdown of projected expenditures by task (and, for Task 2, by subtask), including person hours by labor category, travel, and other direct charges.

The contract will be issued and managed by LADCO. It is anticipated that LADCO will award a cost plus fixed fee type contract as a result of this solicitation. LADCO may consider awarding another type of contract, provided that its use is consistent with the objectives and interests of the States. Potential contractors are encouraged to bid on one or more of the tasks identified in the statement of work. LADCO will consider issuing one contract covering all tasks or multiple contracts covering only certain tasks.

All information and data delivered under this contract will be in the public domain.

All inquiries regarding this RFP should be directed to Michael Koerber either in writing at the above address or via e-mail at koerber@ladco.org. Written responses to inquiries will be sent
to all organizations on the interested bidders list for this project. If your organization would like to be added to the interested bidders list for this project, then please send an e-mail by August 17, 2009 to koerber@ladco.org with your e-mail address and contact information.

Background
Wintertime PM$_{2.5}$ episodes in the northern Midwest states are characterized by high concentrations of ammonium nitrate (as well as high concentrations of ammonium sulfate). A measurement study was conducted from December 1, 2008 through March 31, 2009 to improve our understanding of the role of ammonia and meteorological conditions during these episodes.

Measurements were collected at two sites in Wisconsin: Milwaukee and Mayville (see Figure 1). These two sites constitute an urban-rural pair, which helps us examine the influence of local vs. regional pollutants. Wintertime winds in this region are predominantly W and NW, so Mayville is well sited to characterize air upwind of Milwaukee. Milwaukee is the northernmost large urban area in the LADCO region, and both sites experience frequent high wintertime nitrate concentrations.

The Milwaukee and Mayville (see Figure 2) sites collected a full suite of PM$_{2.5}$ mass and speciation data, as well as criteria gases and meteorology. Special study measurements include ammonia, nitric acid, NOy, and continuous nitrate and sulfate. A database with these measurements is available from LADCO.
In addition, data from the SEARCH network will be analyzed to complement the analyses for the data from the Winter Nitrate Study. The SEARCH network is a public-private collaboration designed to improve understanding of PM$_{2.5}$. Building on the Southern Oxidants Study field campaign, Southern Company and the Electric Power Research Institute (EPRI) established a highly instrumented eight-station network in the states of Alabama, Florida, Georgia and Mississippi. A full suite of PM$_{2.5}$, gas, and meteorology measurements have been made in the network continuously since 1998. The network was designed with urban-rural pairs of cities, which help to examine the influence of local vs. regional pollutants. The reactive nitrogen data relevant for the analyses identified here were collected with the same analytical methods in both SEARCH and the Winter Nitrate Study. This will allow for chemical mechanism assessment under different geographic conditions. Winter data from the Atlanta and Yorkville urban-rural site pair of the SEARCH network for the same time period as the Milwaukee-Mayville data (December 1, 2008 to March 31, 2009) will be used. A database with these measurements will be made available to the contractor by EPRI.

Introduction
Analyses of the ambient measurements from the Winter Nitrate Study are needed to produce a conceptual model of wintertime PM-nitrate formation in the upper Midwest. Additional analyses for the SEARCH network sites will allow for more robust conclusions. This information, in conjunction with other analyses (e.g., photochemical modeling), will be used to identify effective control strategies and answer the following policy-relevant questions:

- What is the typical chemical composition during winter-time episodes (i.e., amount of sulfates, nitrates, etc.) and how does that chemical composition compare to the chemical composition on days when lower concentrations are measured?

- Are there significant differences in PM$_{2.5}$ concentrations (frequency and severity), chemical composition, and source regions (emissions and geographic) during winter-time episodes between rural and urban sites?

- What are the primary emission sources during winter-time episodes? Are these sources local or regional in nature?

- What meteorological conditions favor these winter-time episodes? How can we best use this information to improve wintertime episode forecasting?

- What do the data tell us about particle chemistry?

- Can photochemical modeling accurately predict PM$_{2.5}$ concentrations during the observed winter-time episodes?

The conceptual model will describe our understanding of PM-nitrate formation with respect to current conditions, data variability (spatial, temporal, and chemical), the influence of
meteorological conditions, precursor sensitivity, and the contribution from different emissions sources. In addition, the analyses performed in this study can help improve our understanding of reactive nitrogen chemistry in the atmosphere and its representation in air quality models.

Scope of Work
There are three main tasks for this work:

Task 1 Data Acquisition and Validation: Acquire (from LADCO, EPRI’s contractor, LADCO’s contractor during the Winter Nitrate Study – i.e., ARA, and the State of Wisconsin) all relevant data from the Winter Nitrate Study and the SEARCH network. Validate the ambient and meteorological measurements using a number of analyses, including comparison with other co-located measurements (e.g., denuder ammonia data from the Illinois State Water Survey). Evaluate the uncertainty of the reactive nitrogen data collected specifically for the winter nitrate study, and compare to the uncertainty in alternate measurements.

Task 2 Data Analyses: Conduct analyses of the Winter Nitrate Study data (as well as data from the Atlanta-Yorkville urban-rural site pair from the SEARCH network), such as those identified below and others you wish to suggest and provide, as appropriate, graphical and statistical results. The analyses will help answer the policy-relevant questions above and provide the basis for a conceptual model of wintertime PM-nitrate formation in the upper Midwest. The analyses will also help identify local and regional air quality episodes and the local and regional contribution to PM$_{2.5}$ and PM$_{2.5}$ components during the episodes. Some of the data analyses have already been performed for SEARCH for a prior time period (e.g., Edgerton, E. S.; Hartsell, B. E.; Saylor, R. D.; Jansen, J. J.; Hansen, D. A.; Hidy, G. M., The Southeastern Aerosol Research and Characterization Study, part 3: Continuous measurements of fine particulate matter mass and composition. Journal of the Air & Waste Management Association 2006, 56, (9), 1325-1341.).

(a) Use wind sector analysis (e.g., conditional probability analysis) to help identify various upwind and local influences on ambient concentrations. Combine with information from emission inventories to identify potentially important sources.

(b) Examine diurnal variations of particulate nitrate. Determine the relative importance of daytime and nighttime nitrate formation pathways.

As noted by AER in their report to LADCO, “diurnal variations of nitrate concentrations may indicate the dominant process for nitrate production.” Daytime nitrate formation is typically associated with OH reactions, whereas nighttime nitrate formation is associated with O$_3$ reactions aloft. (see “Analyses of Recent Regional
(c) Assess the role of ammonia in forming particulate nitrate.

Ammonia emissions and concentrations are generally quite low during the wintertime due to snow cover, lower ambient temperatures, and reduced activity (e.g., no fertilizer application). Emissions from animal feeding operations are lower because of the reduced temperatures as well. Because ammonia reacts preferentially with sulfuric acid to form particulate sulfate, excess ammonia is needed to form particulate nitrate. The Winter Nitrate Study provides information on ammonia levels during periods of higher nitrate concentrations and, perhaps, by exploring associations with meteorological variables, provides information on likely sources. In particular, the role of snow cover, frontal passages, and rising temperatures are of interest. A comprehensive description of the nitrate episodes experienced during the study that explores these meteorological conditions would be very useful.

(d) Examine urban excess in particulate nitrate.

Comparisons of PM$_{2.5}$ speciation data from urban and representative upwind rural sites across the Midwest shows, in general, that 25% to 50% of particulate nitrate is associated with local urban sources on an annual average basis (see “PM$_{2.5}$ in Urban Areas in the Upper Midwest”, LADCO, February 12, 2004). http://www.ladco.org/reports/pm25/pre2008/pm2.5_in_the_urban_areas_in_the_upper_midwest.pdf

This estimate should be qualified given limited spatial information (i.e., approximate nature of the urban-rural pairing) and limited temporal information (i.e., comparisons limited to annual average concentrations). The Winter Nitrate Study provides data for a well-sited urban-rural pair of monitoring sites and for shorter averaging periods. A comparison of the data for the two sites examining the differences (and considering wind direction to establish periods when one site clearly was upwind or downwind of the other) could quantify the urban influence more precisely. Related urban-rural differences in ammonia and nitric acid are of interest as well.

(e) Evaluate the variability of the ammonium-nitrate-sulfate equilibrium. Determine the relative effectiveness of reductions in ammonia and nitric acid concentrations on PM$_{2.5}$ concentrations. Perform a sensitivity analysis using thermodynamic equilibrium models (e.g., ISORROPIA, SCAPE2, AIM) to predict changes in PM$_{2.5}$ due to changes in ambient concentrations of precursors.

An initial analysis was conducted with daily data from 6 sites in the MARCH-Midwest study for the period Aug-Sep 1999 and Jan-Feb 2000 (“The Effects of Changes in Sulfate, Ammonia, and Nitric Acid on Fine PM Composition at Monitoring Sites in Illinois, Indiana, Michigan, Missouri, Ohio, and Wisconsin, 2000-2002”, Blanchard and Tannenbaum, February 20, 2003). A second analysis was conducted with 1-in-6 day data for 10 sites in the Midwest for the period from Nov 2003 – Dec 2004 (“Draft Final Technical Memorandum Analysis of Data from the Midwest Ammonia Monitoring Project”, Blanchard and Tannenbaum, March 31, 2005). A third analysis

(f) Perform box model simulations to assess the sensitivity of PM-nitrate formation to different factors and chemical processes identified in the conceptual model and in the literature review and compare with measurements during the Winter Nitrate Study and the SEARCH network.

(g) Review state of the science of PM-nitrate formation, including (but not limited to) recent advances in our understanding of HONO chemistry, HNO₃ photolysis, nitrate formation on dust aerosol, nighttime chemistry of the nitrate radical with VOC, and factors influencing N₂O₅ hydrolysis rates.

(h) Assess whether the PM-nitrate chemistry currently used in photochemical modeling (i.e., CMAQ and CAMx) can adequately represent the conceptual model and recommend possible improvements.

To complement the above tasks, LADCO will conduct the following analyses for the Winter Nitrate Study:

- Back trajectories: HYSPLIT-based trajectories should be prepared to determine transport patterns and identify upwind source regions.
- CART analyses: By examining several dozen meteorological variables, those variables associated with elevated PM-nitrate levels can be identified.
- Photochemical modeling with CAMx for the period covered by the Winter Nitrate Study.

LADCO will provide the results of these analyses to the contractor.

**Task 3 Reporting:** To document the work performed pursuant to this project, the following items are required:

- Final work plan
- Periodic conference calls to review latest work products
- Technical report summarizing the monitoring data base, ambient data analysis, and the conceptual model

**Deliverables**
A kick-off conference call will be held after the contract is awarded to review the scope of work and schedule for this project. A final work plan will be due two weeks after the kick-off call. An electronic copy (WordPerfect or Word) of the work plan shall be delivered to LADCO’s Executive Director.
In lieu of written progress reports, periodic conference calls will be held to review the status of
the work and discuss any outstanding issues.

Five (5) paper copies and one electronic copy (WordPerfect or Word) of the draft and final
technical reports shall be delivered to LADCO’s Executive Director.

Any programs (or “tools”) developed pursuant to this project shall also be delivered to
LADCO’s Executive Director, upon completion of the project.

In your proposal, please provide a schedule for completion of the three tasks, including
delivery of the draft and final technical reports.

Key Personnel
The proposer shall identify the key personnel and their responsibilities for this work. The
proposer must specify the amount of time that each of the key personnel will dedicate to the
project (by task). Any change in key personnel shall be made only with prior approval of
LADCO's Executive Director.

Evaluation Criteria
Evaluation and rating of proposals will be based on the following criteria:

1. The proposer’s understanding of the overall objectives of this project.

2. The proposed technical approach, completeness of coverage of the draft work
plan, responsiveness to the available project resources, and adherence to the
project schedule.

3. The experience, expertise, and other qualifications of the principal investigator
and other key personnel assigned to the project, and the level of effort
proposed for the principal investigator and other key personnel.