COORDINATING RESEARCH COUNCIL, INC.
3650 MANSELL ROAD, SUITE 140
ALPHARETTA, GA 30022
TEL: 678/795-0506 FAX: 678/795-0509
WWW.CRCAO.ORG

April 24, 2012
In reply, refer to:
CRC Project No. E-99

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for "Very Low PM Mass Measurement " (CRC Project No. E-99). A description of the project is presented in Exhibit A, "Statement of Work."

Please indicate by letter, fax, or email by **May 4th, 2012** if you or your organization intends to submit a written proposal for this research program. CRC will answer technical questions regarding the Request for Proposal if they are submitted in writing. CRC will then return written answers to all of the bidders, along with a copy of the original questions.

A CRC technical group composed of industry representatives will evaluate your proposal. CRC reserves the right to accept or reject any or all proposals.

The reporting requirements will be monthly progress reports and a summary technical report at the end of the contractual period. The reporting requirements are described in more detail in the attachment entitled "Reports" (Exhibit B).

The proposal must be submitted as two separate documents. The technical approach to the problem will be described in part one, and a cost breakdown that is priced by task will be described in part two. The cost proposal document should include all costs associated with conducting the proposed program. The technical proposal shall not be longer than 10 pages in length.

CRC expects to negotiate a cost-plus fixed fee or cost reimbursement contract for the research program.

Contract language for intellectual property and liability clauses is presented in Exhibit C and in Exhibit D, respectively.

Important selection factors to be taken into account are listed in Exhibit E. CRC evaluation procedures require the technical group to complete a thorough technical evaluation before considering costs. After developing a recommendation based on technical considerations, the costs are revealed and the recommendation is modified as needed.

Electronic copies of the technical and cost proposals should be submitted to:

Dr. Chris Tennant
Coordinating Research Council
3650 Mansell Road, Suite 140
Alpharetta, GA 30022

Phone: 678-795-0506
Fax: 678-795-0509
E-mail: ctennant@crcao.org

The deadline for receipt of your proposal is **May 21, 2012.**

Yours truly,

Chris Tennant
Deputy Director

EXHIBIT A

Statement of Work - Request for Proposal

Project E-99

Very Low PM Mass Measurement

Objective

Examine modifications to gravimetric PM mass measurement that preserve the integrity of the method but decrease the variability and gaseous adsorption artifacts that limit the usability of this method at LEV III / Tier 3 emissions standards.

Background

Present motor vehicle PM emissions measurement regulations (CFR 40 Part 1065, 1066) require gravimetric determination of particulate matter collected onto filter media from diluted exhaust. But with current sampling practices, the method is reaching its limit of detection at the proposed 3 mg/mi PM emissions standard. The combined effects of the more stringent PM standard and CFR minimum dilution requirements have reduced typical filter loading to 5 – 10 μg, depending on CVS tunnel flow. At the same time, a number of studies show that filters, including Teflon membrane, are susceptible to gaseous adsorption artifacts that can contribute a 5 – 10 μg weight gain even in the absence of a test vehicle (i.e., tunnel and trip blanks). This artifact itself has high variability, ~100%, and is susceptible to facility to facility variation. The impact on vehicle emissions testing could be increased measurement uncertainty, cost, and, ultimately, exposure to liability .

The artifact was already known at the time of the 2007 upgrades to the PM measurement methodology, which formed the basis for CFR Part 1065 changes to the gravimetric method. These upgrades considerably improved measurement practices, sufficiently so that the adsorption effects became observable. The artifact impact is rather small, ~1 mg/mi in light duty testing (somewhat below 1 mg/bhp-hr in HD testing). This represents ~10% of the 2007 PM standard, and so does not present a major hurdle for engine / aftertreatment development and vehicle / engine certification at the current emissions standard. But it represents a significant fraction of the proposed LEV III / Tier 3 light duty standards and beyond, which could result in unintended consequences; for example it could indicate the need for a gasoline particulate filter (GPF) not because the emissions fail the standard, but because the method is insufficiently reliable to indicate that the vehicle passes without a GPF.

An effective use of the gravimetric method at LEV III / Tier 3 PM standard levels is desired. One possibility is to increase the signal to noise. It could be achieved by decreasing the noise level. Noise is difficult to reduce due to subtracting two large mass readings (filter & PM – filter) to record a very small PM mass. There is a theoretical possibility to reduce noise by eliminating the artifact. Another possibility is to increase the signal, or the emitted PM collected on the filter. Proposals for methods to achieve an increased signal to noise ratio are requested. Other possibilities to achieve an effective use of the gravimetric method will be accepted for this proposal.

Purpose

The susceptibility of filter media to gaseous adsorption poses a lower limit to the mass gain that can be measured that is independent of improvements to the weighing process itself. The purpose of the present project therefore is to demonstrate the current baseline capability and explore measures to adopt within the spirit of the gravimetric method to increase the reliability of collecting and measuring emitted PM onto the filter during the FTP test cycle. Possibilities include:

1) Reduce exhaust dilution
2) Combine filter usage during test phases (1 or 2 filters instead of 3)
3) Increase filter face velocity
4) Reduced filter artifact
5) Other proposed possibilities will be considered

At first glance, increasing sample volume, i.e., using a larger diameter filter, would seem to be another option. But the increase in PM collected would be offset by the increase in filter surface area for adsorption.

Combining FTP test phases onto one filter helps reduce the artifact and variability because the artifact would occur on only one filter per FTP instead of on three filters (one per test phase), and the weighing error (pre versus post) would occur once rather than three times.

Further, an attractive approach would be to retain the 3 bag FTP and increase filter loading by decreasing dilution and by collecting the entire FTP test onto a single filter, adjusting dilution and filter face velocity to achieve proper phase weighting. Alternative approaches can also be explored that don't require dilution and face velocity changes, for example a four phase approach collecting PM from a cold bag 1&2 followed by a hot bag 1&2 onto a single filter, or a three phase test where one filter combines bags 1&2 and a second combines bags 2&3, i.e. a 2 filter test.

Reducing dilution ratio will presumably increase the fraction of PM collected by the filter. But a potential tradeoff here is that too little dilution incurs water condensation, which can lead to incorrect measurements. Reduced dilution could also impact semivolatile gas to particle partitioning. Subsequently, areas of investigation are: 1.) Confirm the signal to noise effect of lower dilution and 2.) Identify the extent that dilution can be changed before the integrity of the PM determination is compromised.

Similarly, another possible investigation area is to determine if the filter face velocity is optimally set. Higher face velocity increases the rate of PM accumulation, but risks evaporation of semi-volatile material from the filter over the course of the emissions test (as PM is operationally defined as the material collected at 47±5 C from diluted exhaust).

Other possible areas of investigation include dilution tunnel background levels and preconditioning and improved PM filter preparation and handling procedures.

Suggestions of other methods to decrease artifact and variability are encouraged with some constraints: Changes to the present method need to maintain the integrity of the PM mass method, i.e., not grossly affect sampling, filter temperature, flow measurements, etc. They should minimize undue additional cost, time, and complexity in the measurement process. They should be applicable to both full flow and partial flow dilution systems. And finally, consideration needs to be given to possible unintended consequences of any changes to current methods. For example, changing the dilution ratio will affect gas-particle partitioning, and such consequences need to be accounted for and dealt with.

For experimentation baseline purposes, a constant exhaust particle flow may be desirable to determine the effects of dilution ratio, test duration, filter quantity, filter face, etc. After the constant exhaust flow effects are determined then a second phase of particle testing using FTP may be conducted. The method to control FTP exhaust flow variability between tests will need to be described in the proposal.

Once a list of possible method changes to decrease filter PM loading variability have been identified, a test plan is needed that evaluates the results of each change and verifies that solid and semi-volatile PM components are representatively sampled. The purpose of the test plan is to define sampling procedures that will produce a data set that allows quantification of the results for each proposed change. There are a few aspects of this. One aspect is to document changes to the artifact on the final emissions rate (mg/mi or mg/bhp-hr). Ambient and tunnel environmental information should be measured and recorded. Another is to demonstrate the impact to measurement variability. Finally, the test plan must include the capability to determine the impact any changes to the gravimetric method have on the integrity of the data. The idea is to provide a "cost / benefit" analysis of PM emissions accuracy gains afforded by any method modifications, where by "cost" we mean potential adverse effects to the quality of the PM data.

An additional PM measurement method is already required by some regulating agencies (PM number count), but number count may be insufficient to provide the assistance likely required for success of this project. If a potential contractor believes that particle size distribution and concentration, or other particle measurement methods would be helpful to assist with interpretation of low PM mass measurement, then plans and benefits should be included in the proposal, but only as an addendum to the main request for filter-based improvements. The objective of this project is not to identify a replacement for filter-based measurement, but to improve filter-based measurement, and if necessary, propose additional means of assisting with filter-based results interpretation.

The proposal should include a way to ensure any improvements are robust across a range of vehicle / engine technologies. Possibilities would include performing testing on a small fleet of vehicles. A suggested minimum set would include a DPF equipped diesel, a gasoline direct injection, and a gasoline port fuel injection vehicle. Other technologies, or multiple vehicles, can be included, depending on cost. Their emissions levels should be targeted at or below 3 mg/mi weighted over the FTP cycle so as to be relevant at the upcoming emissions standards. The fuel choice is certification fuel, but the prospective contractor can suggest another if they believe there to be a benefit. Perhaps more important, the test matrix should be such that it covers a

range of EC/OC in PM composition. This is needed to verify that any contemplated changes are robust over a range of PM composition emitted by the current range of vehicle technologies.

In preparing proposals in response to this RFP, bidders should show familiarity with CFR Part 1065 PM measurement procedures and demonstrate their qualifications by discussing the rationale for proposed method changes, expected proof and results for such changes and possible means of mitigating possible unintended consequences.

Details

Based on the above background and purpose, project proposals should specify how the following tasks and project deliverables will be accomplished: The proposed program must be approved by the CRC review committee prior to implementation.

Tasks

1. Identify hypothesized method modifications that will reduce variability of PM mass test results.
2. Prepare and submit the project test plan for CRC committee review and approval. The test plan should statistically demonstrate how method changes affect test measurement capability. The matrix should include test method, test engines/vehicles, test cycles, and fuels. Include parameters to measure environmental conditions, such as ambient outside air, ambient chamber air, ozone level, tunnel air, tunnel wind velocity, and dew point of diluted exhaust mixture, reporting frequency (e.g., 1 Hz), and the methods used to measure and calculate these parameters.
   Note: The selected project proposer is expected to collaborate with CRC project panel to refine test plan.
3. Perform testing according to test plan. Provide EC/OC data. Change plan accordingly to ensure a sufficient number of tests and repeatability. Provide a statistical assessment. Identify and quantify any ancillary impacts of the method modifications.
4. Analyze data set and produce final report.

Project Deliverables

1. Hypothesis
2. Test plan
3. Raw data set
4. Milestone progress reports
5. Final report

Timing

1. Hypothesis and test plan – Q2 2012
2. Testing – Q2 – Q4 2012
3. Data analysis & final report – Q4 2012 – February 28, 2013

EXHIBIT B

REPORTS

MONTHLY TECHNICAL PROGRESS REPORTS

The contractor shall submit a monthly technical progress report covering work accomplished during each calendar month of the contract performance. An electronic Microsoft® Word compatible file (<1 MB) of the monthly technical progress report shall be distributed by the contractor within ten (10) calendar days after the end of each reporting period. The report shall contain a description of overall progress, plus a separate description for each task or other logical segment of work on which effort was expended during the reporting period.

FINAL REPORT

The contractor shall submit to or distribute for CRC an electronic pdf-compatible copy transmittable via email) of a rough draft of a final report within thirty (30) days after completion of the technical effort specified in the contract. The report shall document, in detail, the test program and all of the work performed under the contract. The report shall include tables, graphs, diagrams, curves, sketches, photographs and drawings in sufficient detail to comprehensively explain the test program and results achieved under the contract. The report shall be complete in itself and contain no reference, directly or indirectly, to the monthly report(s).

Within thirty (30) days after receipt of the approved draft copy of the final report, the contractor shall make the requested changes and deliver to CRC thirty (30) hardcopies including a reproducible master copy of the final report. The final report shall also be submitted as an electronic copy in a pdf or pdf-convertible file format. The final report may be prepared using the contractor's standard format, acknowledging author and sponsors. An outside CRC cover page will be provided by CRC. The electronic copy will be made available for posting on the CRC website.

EXHIBIT C

INTELLECTUAL PROPERTY RIGHTS

Title to all inventions, improvements, and data, hereinafter, collectively referred to as ("Inventions"), whether or not patentable, resulting from the performance of work under this Agreement shall be assigned to CRC. Contractor X shall promptly disclose to CRC any Invention which is made or conceived by Contractor X, its employees, agents, or representatives, either alone or jointly with others, during the term of this agreement, which result from the performance of work under this agreement, or are a result of confidential information provided to Contractor X by CRC or its Participants. Contractor X agrees to assign to CRC the entire right, title, and interest in and to any and all such Inventions, and to execute and cause its employees or representatives to execute such documents as may be required to file applications and to obtain patents covering such Inventions in CRC's name or in the name of CRC's Participants or nominees. At CRC's expense, Contractor X shall provide reasonable assistance to CRC or its designee in obtaining patents on such Inventions.

To the extent that a CRC member makes available any of its intellectual property (including but not limited to patents, patent applications, copyrighted material, trade secrets, or trademarks) to Contractor X, Contractor X shall have only a limited license to such intellectual property for the sole purpose of performing work pursuant to this Agreement and shall have no other right or license, express or implied, or by estoppel. To the extent a CRC member contributes materials, tangible items, or information for use in the project, Contractor X acknowledges that it obtains only the right to use the materials, items, or information supplied for the purposes of performing the work provided for in this Agreement, and obtains no rights to copy, distribute, disclose, make, use, sell or offer to sell such materials or items outside of the performance of this Agreement.

EXHIBIT D

LIABILITY

It is agreed and understood that _____ is acting as an independent contractor in the performance of any and all work hereunder and, as such, has control over the performance of such work. _____ agrees to indemnify and defend CRC from and against any and all liabilities, claims, and expenses incident thereto (including, for example, reasonable attorneys' fees) which CRC may hereafter incur, become responsible for or pay out as a result of death or bodily injury to any person or destruction or damage to any property, caused, in whole or in part, by _____'s performance of, or failure to perform, the work hereunder or any other act of omission in connection therewith.

EXHIBIT E

PROPOSAL EVALUATION CRITERIA

1) Merits of proposed technical approach.
2) Previous performance on related research studies.
3) Personnel available for proposed study – related experience.
4) Timeliness of study completion.
5) Cost.