



## COORDINATING RESEARCH COUNCIL, INC.

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**October 27, 2021**

In reply, refer to:  
CRC Project No. E-134a

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for “Design of Experiments for Light Duty PEMS Phase 3: Altitude, Grade, and Low Temperature Impacts on PEMS Performance Test Program” (CRC Project No. E-134a). A description of the project is presented in Exhibit A, “Statement of Work.”

Please indicate by letter, fax, or email by **November 12, 2021** 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 at least one week before the proposal submission deadline. CRC will then return written answers to all of the bidders, along with a copy of the original questions. Questions submitted within a week of the deadline may not be answered before the proposal submission deadline.

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, not including key personnel descriptions and references. Please include all relevant technical information, including the project timeline, in the technical proposal.

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:

Amber B. Leland  
Coordinating Research Council  
5755 North Point Parkway, Suite 265  
Alpharetta, GA 30022

Phone: 678-795-0506  
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The deadline for receipt of your proposal is **November 30, 2021**.

Yours truly,

Amber B. Leland  
Deputy Director

# **Design of Experiments for Light Duty PEMS Phase 3: Altitude, Grade and Low Temperature Impacts on PEMS Performance Test Program**

## **CRC Project No. E-134a**

### **Background**

With Europe adopting the use of portable emissions measurement systems (PEMS) to determine light duty real world emissions, there is a greater interest in PEMS functionality and use. The California Air Resources Board (CARB) and the Environmental Protection Agency (EPA) are also conducting tests here in the United States with light duty vehicles to determine their viability to measure real world on-road emissions. This is in addition to the normal Federal Test Procedure (FTP-75), Highway Fuel Economy Test (HWFET), and US06 Supplemental Federal Test Procedures (SFTP) chassis dynamometer testing. There are several PEMS manufacturers producing these units and some studies have been conducted to understand how they perform compared to normal chassis dynamometer testing. This project investigates the use of multiple engine technologies and different fuel properties at altitude, steep grades and at low temperatures to determine PEMS performance in measuring emission changes during on road and chassis roll tests.

### **Objective**

The objective the experimental work conducted in Project E-134 is to use an on-road cycle, to be developed for this project which incorporates city, urban and highway driving. This study is to be conducted at altitude utilizing steep grades for the test cycle under Winter low temperature conditions. The same test cycle with grades should be then be conducted on a chassis roll for comparison. Emissions measurements should be taken at the tailpipe including all gaseous emissions and gravimetric particulate matter (PM) emissions. Simultaneously PEMS emissions should be taken. Measures are to be taken to make sure the vehicle exhaust system is kept at ambient pressure at the tailpipe at all times on the chassis roll during testing.

Several engine technologies will be used for testing along with different fuel properties to investigate how well PEMS can detect fuel properties impacts on emissions. This test program would use two Winter fuels a low and high Particulate Matter Index (PMI), as described by the Honda method. A total of two fuels could be run on each of the four vehicles five times to determine the variation in emissions that occurs and how they change on the same route on a daily basis. One PEMS unit will be used to measure the tailpipe emissions. Five repeats will be run on the chassis roll for repeatability and comparison to the PEMS unit. The PEMS unit will also measure emissions at the same time on the chassis roll for direct comparison.

The on-road vehicle PEMS testing could occur in a different location to find the proper grades. The contractor would be required to determine the on-road location consisting of 1/3 city, 1/3 highway, and 1/3 rural driving conditions. The total test time would be no more than 45 minutes. The drive route would be duplicated on the chassis roll including grade.

- Develop a design of experiments to maximize the emissions data which provides a 95% confidence level
- Determine how many tests on each fuel-vehicle combination should be run
- Determine how many repeats on each fuel day after day should be conducted
- If fuel changes should be made to acquire a true new data point on that fuel
- Determine the repeatability of the chassis roll testing to compare to the PEMS unit
- Determine repeatability and accuracy of PEMS unit under real on road driving conditions and changing ambient temperatures
- Determine if PEMS unit can measure differences in PMI of fuel for gaseous and PM emissions
- Determine how exhaust flow measurement from the individual PEMS system correlates with the direct vehicle exhaust flow meter from the test cell and with the CVS bags based on CO<sub>2</sub>.

## **Scope of Work**

### Project Management

CRC and its project technical panel will provide management and oversight for this project. These entities are here after referred to collectively as the project sponsor.

### Vehicles

Vehicle selection will be determined by the project sponsor. There will be four light duty gasoline vehicles used for testing. Three vehicles will be provided by CRC, the other vehicle for testing will need to be purchased as part of this work, also determined by the project sponsor. Engine parameters from the vehicle including airflow and fuel rates should be measured to calculate exhaust flow for each test.

The contractor shares with project sponsor how the PEMS unit will be installed based on PEMS manufactures recommendations for exhaust flow measurements prior to testing.

### Fuels

There will be two Winter 87 AKI E10 market fuels used for testing. One high and one low particulate matter index (PMI) as described by the Honda method. The contractor will be required to obtain and test the fuels for specific fuel properties listed in Appendix A. The contractor will need to obtain a jobber to acquire the four fuels for testing from

a terminal and have the fuels drummed for storage at their testing facility. The facility should be temperature and humidity controlled. Drum quantities are:

- 20 drums of Winter high PMI
- 20 drums of Winter low PMI

### Real World Drive Cycle

The objective is to develop an on-road cycle, which incorporates city, urban and highway driving. The cycle will be conducted in Winter climate using each of the fuels. Testing at altitude using steep grades as part of the driving route. The total drive time is 45 minutes consisting of 1/3 City, 1/3 highway and 1/3 rural driving.

### Emissions

The chassis dynamometer test cell should be 40 CFR Part 1065/1066 compliant and will measure both second by second and bag gaseous emissions including CO<sub>2</sub> as well as filter based particulate matter (PM) emissions. The PEMS unit will measure TP gaseous and PM emissions. The PEMS unit will be supplied by CRC. Additionally, a direct vehicle exhaust flow meter from the chassis dynamometer will be used for modal measurements and exhaust flow rate comparison to the PEMS.

### Test Procedure

1. Use the fuel change, EVAP canister loading, fuel drain and fill procedures from the CRC E-122 test program for each vehicle and test fuel.
2. Conduct chassis roll emissions testing with measurements from the chassis dynamometer emissions and simultaneous PEMS measurements. Conduct five tests. Each test is a cold start with a soak time of at least 8 hours. All ambient conditions should be measured, air temperature, humidity, rain, etc..
3. Conduct testing with PEMS unit on real road with same drive cycle as on dynamometer five times. Each test is a cold start with a soak time of at least 8 hours. All ambient conditions should be measured, air temperature, humidity, rain, etc.
4. Change fuels using fuel change procedure from CRC E-94-2 and CRC E-122.

### Statistics

The Contractor selected under E-134a will support the design of experiments of the above-described project and will participate throughout the duration of the E-134 project to conduct statistical analysis on all test data. At the halfway point of the E-134 test program, some statistical analysis will be conducted to determine how the program is going. Complete statistical analysis will be conducted on completion of the test program.

### **Deliverables**

The statistician will deliver a interim report detailing a design of experiments for work to be conducted as CRC Project E-134. After initiation of Project E-134, the statistician will

be required to call in on all of the project calls to help make decisions as the project progresses as well as make sure they understand all of the data as it is being taken. As outlined in the subsequent "Exhibit" section, the contractor should submit monthly reports in addition to the draft and final reports. Monthly reports should contain all data acquired during the report month using the scan tool, shown in MS Excel chart format when appropriate. Emission test results and drivability notes should also be included. Depending on the final program schedule, the contractor may be requested to issue an interim report. This interim report would be structured in a format similar to the final report, and would address all vehicles that had completed testing to that point.

## **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 (Microsoft Word) 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).

The draft report must have appropriate editorial review corrections made by the contractor prior to submission to CRC to avoid obvious formatting, grammar, and spelling errors. The report should be written in a formal technical style employing a format that best communicates the work conducted, results observed, and conclusions derived. Standard practice typically calls for a CRC Title Page, Disclaimer Statement, Foreword/Preface, Table of Contents, List of Figures, List of Tables, List of Acronyms and Abbreviations, Executive Summary, Background, Approach (including a full description of all experimental materials and methods), Results, Conclusions, List of References, and Appendices as appropriate for the scope of the study. Reports submitted to CRC shall be written with a degree of skill and care customarily required by professionals engaged in the same trade and /or profession.

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 ten (10) hardcopies including a reproducible master copy of the final report. The final report shall also be submitted as electronic copies in a pdf and Microsoft Word 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.