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November 8, 2018
In reply, refer to:
CRC Project No. E-122-2

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for "Light Duty PEMS Phase 2: Engine Technology and Fuel Property Investigation" (CRC Project No. E-122-2). A description of the project is presented in Exhibit A, "Statement of Work."

Please indicate by letter, fax, or email by **November 21, 2018** 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 (not including resumes). The schedule / timeline information should be included 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 Leland
Coordinating Research Council
5755 North Point Parkway, Suite 265
Alpharetta, GA 30022

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

The deadline for receipt of your proposal is **December 7, 2018.**

Yours truly,

Amber Leland

Deputy Director

Exhibit A: Statement of Work
Light Duty PEMS Phase 2: Engine Technology and Fuel Property Investigation

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 to determine PEMS performance in measuring emission changes during on-road and chassis roll tests.

Objective

The objective is to use the on-road cycle developed in the E-122 project which incorporates city, urban and highway driving. 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. Summer and winter fuels, each having a low and high Particulate Matter Index (PMI), as described by the Honda method, will be used for testing. A total of four fuels will be run on each vehicle five times to understand the variation in emissions that occur 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.

- 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 detect differences in gaseous and PM emissions related to PMI of fuel
- Determine if Reid Vapor Pressure (RVP) differences in fuel impact PEMS gaseous and PM emissions measurements
- 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 test cell emissions measurement system based on a carbon balance.

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 at least one light duty gasoline direct inject vehicle used for testing provided by CRC. The other vehicles for testing will need to be purchased as part of this work, also determined by the project sponsor. Four vehicles will be purchased and a total of five vehicles will be used for testing. However, a quote for purchase of a sixth vehicle and the amount of extra fuel is also required as a separate line item on the quote. The contractor will measure engine parameters from the vehicle for airflow and fuel rates to calculate exhaust flow for each test.

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

Fuels

There will be four fuels used for this project. The fuels will be 87 AKI E10 market fuels. Two Summer fuels with one high and one low PMI as well as two Winter fuels with one low and one high PMI will be used for testing. The contractor will be required to obtain and test the fuels for specific fuel properties listed in Appendix 1. CRC will guide the contractor on when and what terminal to acquire the fuel from. The contractor will need to hire 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. Additionally, Tier II certification fuel will need to be purchased for this project. Drum quantities are shown below. Note additional 4 drums of each fuel for the sixth vehicle.

- 20 drums of Winter high PMI
- 20 drums of Winter low PMI
- 20 drums of Summer high PMI
- 20 drums of Summer low PMI
- 25 drums of Tier II certification fuel E0

For a sixth vehicle the fuel quantity is:

- 24 drums of Winter low PMI
- 24 drums of Summer high PMI
- 24 drums of Summer low PMI
- 29 drums of Tier II certification fuel E0

Real World Drive Cycle

The objective is to use the on-road cycle, developed in the E-122 project, which incorporates city, urban and highway driving. The cycle will be conducted in both winter and summer climates using the fuel which corresponds to each season. The cycle will need to be created in the location near the contractor to match the required portions of the drive cycle, city, urban and highway.

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_2 as well as filter based particulate matter (PM) emissions. The PEMS unit will measure tailpipe gaseous and PM emissions. 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, evaporative canister loading, fuel drain and fill procedures from the CRC E-94-2, referenced in Appendix 2 and 3 and 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. The following vehicle parameters should be recorded for each test, on-road and on-chassis testing.
    - Engine Coolant Temp.
    - Fuel Flow Rate
    - Engine Speed
    - Vehicle Speed
    - Intake Air Temp.
    - Mass Air Flow Rate
    - Fuel Rail Pressure
    - Barometric Pressure
    - Ambient Air Temp.
    - Engine Oil Temp.
    - Engine Fuel Rate
    - Lambda
    - Engine Load
    - Torque
    - Pedal Position
4. 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.

5. Change fuels using fuel change procedure from CRC E-94-2 and CRC E-122 as shown in Appendix 2 and 3.[1]

Statistics

Contractor will supply data to a statistician identified by CRC for conducting statistical analysis on all test data.

Quote

Please provide a quote on a per vehicle per fuel basis, i.e., one vehicle with one fuel.

Deliverables

As outlined in the subsequent "Exhibit" section, the contractor should submit monthly reports in addition to the draft and final reports. Monthly reports should by accompanied by 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 format of a final report, and would address all vehicles that had completed testing to that point.

[1] E-122-2 Report can be found at https://crcao.org/reports/recentstudies2018/E-122/CRC%20Project%20E-122%20Final%20Report_June2018.pdf . The E-94-2 Report can be found at https://crcao.org/reports/recentstudies2017/E-94-2/CRC_2017-3-21_03-20955_E94-2FinalReport%20Rev1b.pdf

Tasks and Responsibilities

RASIC Roles & Responsibilities

LEGEND: **C**= CRC **R**= Responsible, **A**= Approval
S= Supplier **S**= Support, **I**= Inform, **C**= Consult

WHAT / ROLES	R	A	S	I	C
1. Purchase 4 new vehicles for testing, a list will be provided by CRC	S	C			
2. Conduct vehicle checks and update software on vehicles as needed	S	C			
3. Conduct cold start FTP on Tier II E0 certification fuel to determine if vehicles emissions systems are properly working and meeting their certification emissions	S		C		
4. Provide certification data to CRC for approval of vehicles for test program	S	C			
5. Change oil and filter and accumulate 500 miles on each vehicle before starting test program	S	C			
6. Acquire all test fuels for testing of vehicles, provide samples to CRC members for fuels testing	S	C			
7. Conduct chassis roll LA92 testing on each vehicle with PEMS unit at the same time	S	C			
8. Develop strategy to maintain ambient pressures at tailpipe during chassis roll testing of all vehicles and fuels.	S	C			
9. Provide data to statistician on a regular basis in a format proposed by the statistician for easiest analysis	S	C			
10. Provide data and presentation to CRC on weekly basis on project calls	S	C			
11. Provide written monthly reports to CRC using Word document provided by CRC	S	C			
12. Provide written report after completion of project including statistics portion with final approval by CRC	S	C			

Appendix 1

	Methods
RON	D2699
MON	D2700
AKI	(R+M)/2
Sensitivity	R-M
Aromatic, vol%	D6729
PMI Honda Eq	PMI Tool
RVP @ 100˚F, psi	D5191
Ethanol, vol%	D4815
Sulfur, ppm w/w	D5453
Benzene, vol%	D6729
Olefins, vol%	D6729
Distillation, IBP °F	D86
Distillation, 5% °F	D86
Distillation, 10% °F	D86
Distillation, 20% °F	D86
Distillation, 30% °F	D86
Distillation, 40% °F	D86
Distillation, 50% °F	D86
Distillation, 60% °F	D86
Distillation, 70% °F	D86
Distillation, 80% °F	D86
Distillation, 90% °F	D86
Distillation, 95% °F	D86
Distillation, DP °F	D86
Recovery, vol %	D86
Residue, vol %	D86
Loss, vol%	D86
DI Index	D4814
C10+ Aromatics, vol%	D6729
Existent Gums washed, mg/100 ml	D381
Unwashed Gums, mg/100 ml	D381
Specific Gravity @ 60°F	D4052
Density @ 60°F, g/ml	D4052
API Gravtiy	D4052
Net Heating Value, MJ/kg	--
Carbon, wt. %	--
Hydrogen, wt.%	--
Oxygen, wt.%	--

Appendix 2 - Fuel Change

1. Drain vehicle fuel completely via fuel rail whenever possible.
2. Turn vehicle ignition to RUN position for 30 seconds to allow controls to allow fuel level reading to stabilize. Confirm the return of fuel gauge reading to zero.
3. Turn ignition off. Fill fuel tank to 40% with next test fuel in sequence. Fill-up fuel should be at an appropriate temperature to prevent loss of volatiles, approximately 50°F.
4. Start vehicle and execute catalyst sulfur removal procedure described in Attachment B. Apply side fan cooling to the fuel tank to alleviate the heating effect of the exhaust system. Engine oil temperature in the sump will be measured and recorded during the sulfur removal cycle.
5. Perform four vehicle coast downs from 70 to 30 mph, with the last two measured. The vehicle will be checked for any obvious and gross source of change in the vehicle's mechanical friction if the individual run fails to meet the following repeatability criteria: 1) maximum difference of 0.5 seconds between back-to-back coast down runs from 70 to 30 mph; and 2) maximum ±7 percent difference in average 70 to 30 mph coast down time from the running average for a given vehicle.
6. Drain fuel and refill to 40% with test fuel. Fill-up fuel should be at approximately 50°F.
7. Drain fuel again and refill to 40% with test fuel. Fill-up fuel should be at approximately 50°F.
8. Soak vehicle for at least 12 hours to allow fuel temperature to stabilize to the test temperature.

Appendix 3 – Vehicle Conditioning

1. Move vehicle to test area without starting engine. Start vehicle and perform UDDS followed by two HWYFET followed by a US06 test. During these prep cycles, apply side fan cooling to the fuel tank to alleviate the heating effect of the exhaust system. Following the first two prep cycles, allow vehicle to idle in park for two minutes, then shut-down the engine for 2-5 minutes. Following the last prep cycle, allow the vehicle to idle for two minutes, then shut down the engine in preparation for the soak.
2. Move vehicle to soak area without starting the engine.
3. Park vehicle in soak area at proper temperature (75 °F) for 12-36 hours. During the soak period, maintain the nominal charge of the vehicle's battery using an appropriate charging device.
4. Move vehicle to test area without starting engine.
5. Conduct LA-92 prep cycle. And then soak vehicle for 12-36 hours.

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.