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July 21, 2021
In reply, refer to:
CRC Project No. AVFL-39

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for "Lube Effect on Catalyst and Gasoline Particulate Filter Aging – Literature Review" (CRC Project No. AVFL-39). A description of the project is presented in Exhibit A, "Statement of Work."

Please indicate by letter, fax, or email by **August 4, 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.

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. Christopher J. Tennant
Coordinating Research Council
5755 North Point Parkway, Suite 265
Alpharetta, GA 30022

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

The deadline for receipt of your proposal is **August 20, 2021.**

Yours truly,

Dr. Christopher J. Tennant
Executive Director

EXHIBIT A: STATEMENT OF WORK

"Lube Effect on Catalyst and Gasoline Particulate Filter Aging – Literature Review"

Background

Phosphorous is present in engine oil as zinc dialkyl dithiosphosphate (ZDDP) which is a very effective and affordable antiwear and antioxidant additive. Phosphorous is also known as a catalyst poison. Phosphorous (P) enters into the aftertreatment system when engine oil leaks past the piston rings or through the crankcase ventilation system and burns in the combustion chamber and leaves through the exhaust stream. Therefore, reduction in ZDDP level in engine oil to reduce the effect on exhaust aftertreatment, must be supplemented with other antiwear and antioxidant additive compound(s). There has been a lot of research in developing supplemental antiwear additives but none have been readily accepted to replace ZDDP. The P level in engine oil remained at 0.08 mass% maximum (by test method ASTM D4951, 850 ppm max with ASTM rounding or 849 ppm max with "normal" rounding) since implementation of GF-4 oil in 2004. However, in GF-5 oils, P volatility index was introduced to limit P volatilizing from engine oil and poisoning catalyst and it was achieved by using higher molecular weight ZDDP. GF-6 oils maintained the same level of volatility index as it was in GF-5.

The emission level is projected to be stricter in the future. The 2021 MY fleet avg requirement is 0.058 g/mi (NMOG + NOx). This number will be 0.03 g/mile in 2025 MY. GF-6 oils became available in May 2020 and it is not clear when potential GF-7 is targeted. It may be reasonable to expect that by the time GF-7 is released the emission standard may be required to meet a 0.03 g/mile (NMOG+NOx) standard. In addition, the PM (particulate matter) standard at present is 3 mg/mile and will be reduced to 1 mg/mile in California starting with the 2025 model year. Meeting this standard may require Gasoline Particulate Filter (GPF). The knowledge gained through this investigation could be an enabler for defining GF-7 specification.

Objective

Find information about 1) Effect of lube phosphorus level on catalyst efficiency. 2) Effect of lube additives on ash accumulation in Gasoline Particulate Filter (GPF), pressure drop across GPF, and fuel economy. 3) Comparison of test methods for lube additive effects on catalyst and GPF. 4) Combination of the effects of engine operating mode and lube additive effect on catalyst/GPF efficiency. 5) Effect of soot level, soot deposition rate, and soot morphology on ash deposition in catalyst and GPF. More details on these objectives are provided in the Scope of Work below.

Scope of Work

Perform a literature review of publicly-available articles or reports of research in industry, academic, or government settings. Topics for review include:

- Effect of lube oil formulation on catalyst/GPF efficiency.
    - Lube oil formulation effects of interest include primarily those resulting from additive phosphorus level, but may also include effects of additives not containing phosphorus, base oil, and viscosity.
    - Efficiency effects include conversion efficiency of criteria pollutants (CO, hydrocarbon, NOx, Particulate Matter (PM), and Particulate Number (PN)).
    - Efficiency effects include changes of conversion efficiency as catalyst/GPF ages to the expected useful life of the emissions control system (150,000 miles).
    - Efficiency effects include changes resulting from catalyst poisoning, ash deposits blocking active sites, and ash deposits increasing pressure drop.
- Effect of lube additives on ash accumulation in the GPF, the effect of ash on pressure drop across the GPF, and the effect of pressure drop on fuel economy.
    - Do all lube additives deposit ash in a similar manner and produce similar pressure drop?
- A comparison of various test methods for lube additive effects on catalyst and GPF.
    - Evaluate strengths and weaknesses of the various test methods.
    - Assess level of development of various test methods.
    - List of vendors offering each test method. This does not need to be a comprehensive list.
    - Examples of test methods for consideration are discussed in reference #1 below and include:
        1. Vehicle tests
        2. Engine tests with oil-in-fuel doping
        3. Engine tests with piston ring modification
        4. Aerosol synthesis deposition (ASD) reactor
        5. Burner with oil-in-fuel doping
        6. Burner with separate oil injection (separate from fuel)
        7. Burner with separate oil injection and independent control of catalyst temperature, oil injection rate, and oil droplet size
    - Additional test methods not listed above may also be included.
    - What types of test methods are available and what are the pros and cons thereof?
    - What types of oil deposition methods are used in these tests and what are the pros and cons thereof?
    - How realistic are the various accelerated test methods compared to emissions performance of real vehicles on the road?
    - What changes may improve realism of existing accelerated test methods compared to real vehicle performance?
- Combination of the effects of engine operating mode and lube additive effect on catalyst/GPF efficiency.

    - Operating modes of particular interest include those associated with conventional vehicles verses Plug-in Hybrid Electric Vehicles (PHEV). Reference #2 below discusses different operating modes of interest.
    - Do certain types of lube additives produce ash that is more challenging in PHEV operating modes than conventional modes or vice versa?
- Effect of soot level, soot deposition rate, and soot morphology on ash deposition in catalyst and GPF.
    - Does soot level, soot deposition rate, and soot morphology affect ash deposits which then affect catalyst/GPF efficiency and pressure drop?

The time period covered is 2013 to the present. Documents published prior to 2013 may be included if they are considered exceptionally valuable either as a 'seminal" document or as discussing important research areas not included in the modern time period.

Please check with Manufacturers of Emission Controls Association (MECA) as a good source of information.

Schedule

Expected to require no more than 6 months.

Deliverables

Deliverables include:

- A kickoff call with the CRC project panel and contractor to discuss project scope and align expectations.
- A mid-project call with the CRC project panel and contractor to discuss preliminary results and identify any information gaps before finalizing findings and starting the final report.
- The CRC project panel may schedule additional calls with the contractor as needed during the project duration to discuss issues that arise.
- Brief written monthly progress reports to inform the CRC project panel. These reports describe at a high level what was done in the previous month, what is planned for the next month, and problems encountered, if any.
- A final report, the draft of which will be reviewed by the CRC project panel and AVFL committee before final release.

References

1. S. Sterlepper, J. Claben, S. Pischinger (Aachen U), J. Cox, M. Gorgen, H. Lehn, J. Scharf (FEV), Design of a Novel Gasoline Particulate Filter Aging Method, Emiss. Control Sci. Tech., 6, p. 151-162, 2020
2. Q. Fan, Y. Wang, J. Xiao, Z. Wang, W. Li, T. Jia, B. Zheng, R. Taylor, Effect of Oil Viscosity and Driving Mode on Oil Dilution and Transient Emissions Including Particle Number in Plug-In Hybrid Electric Vehicle, SAE 2020-01-0362, 2020

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.