**COORDINATING RESEARCH COUNCIL, INC.**
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ALPHARETTA, GA 30022
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WWW.CRCAO.ORG

**June 22, 2021**
In reply, refer to:
CRC Project No. E-136

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for "Engine, Aftertreatment, and Fuel Quality Achievements to Lower Gasoline Vehicle PM Emissions: Literature Review and Future Prospects," (CRC Project No. E-136). A description of the project is presented in Exhibit A, "Statement of Work."

Please indicate by letter, fax, or email by **July 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. In this case, we request the quotation be provided on a per-vehicle/ per-fuel basis as the CRC panel may request that additional vehicles or fuels may be added to the program. 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:

Amber B. 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 **July 28, 2021.**

Yours truly,

Amber B. Leland
Deputy Director

# CRC Project Statement of Work
## Engine, Aftertreatment, and Fuel Quality Achievements to Lower Gasoline Vehicle PM Emissions: Literature Review and Future Prospects

### CRC Project Number: E-136

## Background

EPA's Tier 2 motor vehicle emissions standards and gasoline sulfur requirements, implemented starting in 2004, marked the beginning of a significant effort to limit light-duty vehicle emissions via a tandem approach involving more stringent vehicle standards as well as requirements on gasoline fuel sulfur content. The implementation of the California LEV III and EPA federal Tier 3 programs is focusing further efforts on the control of light-duty vehicle particulate matter (PM). A 3 mg/mi FTP PM standard began in 2017 for both LEV III and Tier 3 and will be fully phased-in by 2021 for LEV III and by 2022 for Tier 3. The LEV III regulations will continue to tighten to a 1 mg/mi FTP standard beginning in 2025, with a 4-year phase-in across the fleet. Furthermore, to support the use of more advanced emissions controls and technologies, the EPA limited gasoline sulfur (a naturally occurring component in fuel that can adversely impact the effectiveness of aftertreatment technology) content to a maximum of 10 ppm as part of the Tier 3 program starting in 2017[1].

## Objective

The objective of this review is to highlight achievements, in addition to ongoing research, that have been made in engine technology, aftertreatment systems, and fuels to meet both 3 mg/mi and 1 mg/mi regulations. The review should capture the various concepts/approaches taken, how they have fared against past and upcoming regulations, how they evolved, and near-future technologies. The current status of gasoline vehicle contributions to ambient PM should be assessed along with the prospects for achieving "zero PM emission" gasoline vehicles.

In addition to providing an overview of new engine, aftertreatment, and fuel technologies that have been developed to meet the increasingly stringent PM standards, this review seeks to provide a comprehensive understanding of the interaction between these respective technologies and PM properties. As vehicles continue to reach lower levels of PM (thereby, reaching the lower detection limit of widely used PM measurement methods), it becomes imperative to understand the fundamental impacts of the technologies on PM to better gauge effectiveness and thus, the basis for these technology improvements. This will be accomplished by providing a review of the chemical and physical processes that impact soot formation and subsequent modification via a detailed characterization of soot properties. For example:

- How does catalyst technology impact the physical and chemical properties of PM?
- How does engine technology impact the formation of PM?
- How does fuel composition impact PM formation during combustion in the engine, and consequently, what are the resulting impacts of the aftertreatment technology?

[1] EPA Gasoline Standards - Website

In summary, this study investigates the current status and prospects of PM control technology for gasoline vehicles by understanding the relative contributions and impacts from engine, aftertreatment, and fuel on PM.

**Scope of Work**

To understand how technology advances have helped reduce PM, perform a literature review of publicly available articles, reports, and presentations of research in industry, academic, or government settings. Topics for review must include, at a minimum:

- Fuels technologies: Impact of lowered fuel sulfur levels on effectiveness of emissions control systems, lubricant formulations, current and near-term market fuel formulations (e.g. impact on engine and tailpipe PM), fuel additives, etc.
- Aftertreatment: catalyst developments, impact of TWC on emissions profile and PM formation, gasoline particulate filters (GPFs), etc. Please include control strategies and environmental effects (e.g. GPF regeneration, cold conditions, light-off strategies, etc.
- Engine: injection timing, high pressure fuel injection systems, dual DI/PFI combination fuel injection, spray guided DI, enrichment and rich "excursions" during transient operation, control strategies (e.g. individual cylinder air-fuel ratio control), coolant temperature, cooled EGR, etc.
- Measurement: discuss the ability of measurement technologies to resolve the emission levels associated with Tier 3/LEV III vehicles as needed.

The time period covered is that associated with the development and implementation of technologies and strategies designed to meet Tier 3/LEV III vehicle emissions control requirements. Documents published and not directly relating to Tier 3 /LEV III (e.g., relating to EU regulations and adopted technologies) may be included if they are considered exceptionally valuable either as a formative document or in discussing important research areas not included in the specified time period. In addition, technical interviews that provide insight into technology advancements are encouraged where appropriate.

**Schedule**

Please propose an appropriate timeline. However, this is not expected to extend beyond 1 year.

**Deliverables**

Deliverables include:

- A kickoff call with the CRC project panel and contractor to discuss project scope and align expectations.
- Tri-annual progress presentations to the CRC Emissions Committee to highlight recent progress and clarify project direction as well as monthly calls with the CRC project panel and contractor to discuss preliminary results and identify any information gaps before finalizing findings and starting the final report.
- A final report, the draft of which will be reviewed by the CRC project panel and Emissions committee before final release

## 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.