



COORDINATING RESEARCH COUNCIL, INC.

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May 15, 2019

In reply, refer to:

CRC Project No. AVFL-35

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for “Advanced Combustion Literature Survey” (CRC Project No. AVFL-35). A description of the project is presented in Exhibit A, “Statement of Work.”

Please indicate by letter, fax, or email by **May 29, 2019** 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). 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.

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.

The technical and cost proposals should be submitted to:

Christopher J. Tennant Email: ctennant@crcao.org

The deadline for receipt of your proposal is **June 14, 2019**.

EXHIBIT A

Statement of Work

Background

The regulatory environment for internal combustion engines is becoming more challenging; efficiency must increase while criteria emissions are reduced. Advanced combustion concepts can potentially address both of these issues. Many such concepts are under study, and one – Mazda's SKYACTIV-X – is slated to enter commercial production in late 2019.¹

A literature survey regarding advanced combustion was performed for the CRC (Coordinating Research Council) in 2006 as part of the AVFL-13 project examining ethanol impact on HCCI.² However, this survey focused specifically on gasoline chemistry effects in HCCI, and is now somewhat dated; the most recent reference cited in this work is 14 years old. The advanced combustion research space has seen significant expansion and advancement in the ensuing period – new combustion concepts have been developed, along with a greater understanding of the combustion fundamentals and key effects at play. As new concepts mature, research expands to include examination of how fuels and fuel properties impact operation, efficiency and emissions.

Objectives

The goal of this project is to obtain an understanding of (1) current, state-of-the-art advanced combustion concepts – approaches, limitations, and performance, (2) how fuel properties affect operation of the different concepts, and (3) the key supporting literature references.

Scope of Work

The project will consist of a literature search along with a summary of findings and analysis of the specific combustion techniques. With the breadth of different concepts (and acronyms) falling into the advanced combustion area, concepts should be curated and grouped as appropriate to highlight key trends. The contractor is to propose a method for accomplishing this, and the relevant concepts that are to be explored and documented in detail. A partial list of interest is shown below. These generally utilize low-temperature combustion and/or lean-burn combustion, though that is not a specific requirement.

- **HCCI** – Homogeneous Charge Compression Ignition
- **HLSI** – Homogeneous Lean Charge Spark Ignition (combination of HCCI and lean-burn technology)
- **PPC, GCI** – Partially Premixed Combustion, Gasoline Compression Ignition
- **RCCI** – Reactivity-Controlled Compression Ignition, and other dual-fuel approaches
- **SACI/SPCCI** – Spark-Assisted Compression Ignition (e.g., SKYACTIV-X)

In addition to the concepts examined in detail, a more open “other” category should be included highlighting unique approaches which are notable but may not require the same depth of analysis or may not be mature enough to provide details.

Given the broad scope of literature covering advanced combustion research topics, the contractor will need to curate the literature, separating out relevant papers and distilling into a key set of publications and related findings.

A suggested format includes the following for each concept:

- **Summary of Concept** – Description of basic concept functionality
- **Engine Hardware Characteristics** – Description of engine features, designs, or components central to engines operating using this combustion concept
- **Performance Characteristics** – Operating characteristics, benefits, and challenges of the specific concept. Relevant areas include performance, efficiency, engine-out emissions, operable load range, and factors limiting operation.
- **Key Technical Challenges** – What are the concept’s primary limitations, hurdles for implementation, and key focus areas for ongoing research and development? What is the potential for commercial introduction?
- **Fuel Property Impact** – How do fuel properties impact the operation and performance characteristics of the specific concept? Properties of interest include, but are not limited to, octane (RON, MON, Sensitivity, and/or other parameters related to autoignition), volatility (D86 parameters, RVP, etc.), and composition (compound class, alcohols or other biofuels). Note that fundamental combustion studies (e.g. non-engine based) may provide relevant information on fuel property impact.
- **Primary References (cited)** – List of key papers on a given combustion concept cited within, and forming the basis for, previous sections
- **Other relevant references (non-cited)** – List of on-topic papers based on curated literature hits, but not cited or highlighted within analysis section

In addition, an overall summary and analysis of the different concepts and technical landscape should be included:

- **Analysis of Different Advanced Combustion Approaches** – Comparison of benefits, challenges (including technical and market), performance characteristics, operating strategy (operate over entire engine map?), concept maturity (tested in multi-cylinder engines or in vehicles?), and other key factors of the various Advanced Combustion concepts.
- **Analysis of Fuel Property Effects** – Comparison of the scope of understanding in the literature on fuel property impacts between the different concepts. Are there universal trends across all concepts? Are fuel property impacts understood well for some concepts and not others? Are there any clear gaps?

The organization of the analysis section is at the discretion of the contractor, but it should be documented in the proposal. Included in the final report should be a summary of the methodology used by the contractor to complete the literature review.

The timeframe for the literature review should be 2005 to current.

Project Deliverables

The primary deliverable of the project is a final report detailing the results of the literature survey.

Periodic status reports, including a project timeline, are to be submitted to CRC. The timing of these reports is to be proposed by the contractor reflecting their overall project timeline.

References

1. Johnson, T., Joshi, A, "Review of Vehicle Engine Efficiency and Emissions," SAE Technical Paper 2018-01-0329, 2018.
2. Szybist, J., Bunting, B., "Chemistry Impacts in Gasoline HCCI: Appendix A, Literature Review for CRC Project AVFL-13," Coordinating Research Council, 2006.

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. Periodic conference calls may also be requested by CRC to update the technical committee overseeing the project.

FINAL REPORT

The contractor shall submit to CRC a draft final report. The report shall document the test procedure, document details of each test iteration, and explain any observations noted. The test data will be recorded and reviewed, and the final report will include a certification that the test procedures were followed, noting any exceptions. The detailed data will also be supplied electronically to CRC.

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. Incomplete draft reports or reports of poor quality requiring additional outside editorial review may have outside editorial services charged back to the project budget.

Comments regarding the report shall be furnished by the CRC committee to the contractor within one (1) month after receipt of the draft copy. Additional rounds of review may be required.

Within thirty (30) days after receipt of comments, the contractor shall make the requested changes and submit an electronic copy of the draft final report in both Microsoft Word and Adobe pdf file format. Once accepted, the contractor shall deliver five (5) hard copies of the final report to CRC. 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.