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July 28, 2016
In reply, refer to:
CRC Project No. E-118

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for "Well to Tank Analysis of Select Octane Number Fuels," (CRC Project No. E-118). A description of the project is presented in Exhibit A, "Statement of Work."

Please indicate by letter, fax, or email by **August 11, 2016** 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.

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 25, 2016.**

Yours truly,

Christopher J. Tennant
Deputy Director

EXHIBIT A

Statement of Work

Well to Tank Analysis of Select Octane Number Fuels

Background

Corporate Average Fuel Economy (CAFE) standards established by the National Highway Transportation Safety Administration (NHTSA) are projected to require a fleet average fuel economy of 54.5 mpg for model year 2025. The Greenhouse Gas (GHG) standards established by the U.S. Environmental Protection Agency (EPA) have been harmonized with the CAFE standards and are projected to require fleet average CO_2 emissions of 163 grams/mile for model year 2025. Automotive manufacturers have been developing and implementing advanced engine and vehicle technologies to meet these strict fuel economy and emissions standards. The focus on improved engine design to achieve enhanced fuel economy is highlighted by the increase in average compression ratio of spark ignition (SI) engines over time as illustrated in Figure 1. A higher compression ratio translates to increased thermodynamic efficiency, thereby facilitating achievement of a higher fuel economy.

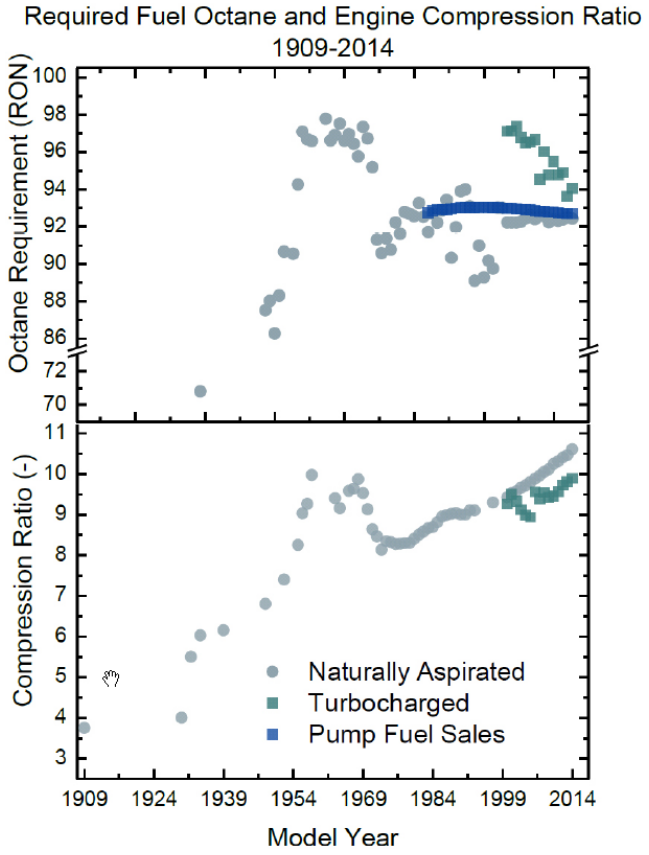

Figure 1: Progression of engine compression and fuel octane for the U.S. market[1]

[1] Pawlowski, A. and Splitter, D., 2015, "SI Engine Trends: A Historical Analysis with Future Projections," SAE Technical Paper 2015-01-0972

Over the last 3 decades engine compression ratio has been increased while the knock resistance of Regular unleaded gasoline has effectively remained steady (91-94 RON). As improved knock resistance is a key enabler for increasing compression ratio, SI engines designed and optimized for a higher octane (RON) fuel can help achieve higher vehicle fuel economy and reduce tailpipe GHG emissions. However, the production of higher octane number fuels in volumes greater than current levels has the potential to increase refinery GHG emissions. Thus, the co-optimization of fuel octane and engine design is critical for reducing overall GHG emissions. The trade-offs between GHG emissions from vehicles and refineries are being actively studied[2,3] but are not well understood and further exploration is required to better comprehend the overall societal impact on a Well-to-Wheel (WTW) basis.

The proposed study will develop and compare estimates of potential GHG emissions from U.S. refinery production of select high octane fuels versus a base case that assumes no change in the octane rating of gasoline currently used in the U.S. Thus, the focus of this proposed study would be to assess the impact of select high octane fuels, described later in this document, on Well-to-Tank (WTT) GHG emissions. The WTT analysis will include greenhouse gas emissions from crude extraction and distribution as well as finished product distribution to terminals and stations. The final results from the current study will eventually be used to assess the overall impact of the chosen high octane fuels on Well-to-Wheel GHG emissions.

Objectives

The major objectives are as follows:

- Conduct a base case GHG assessment of producing in each PADD the EIA forecasted fuel product slate in the year 2040.
- Conduct a GHG assessment of producing in each PADD fuels over a 95-101 RON range. For these cases a floating MON value (subject to a min of 82 MON) would be allowed with an ethanol concentration of 10%.
- Estimate the difference in GHG emissions between the base and higher RON cases.

Key Modeling Assumptions

The regional variation in U.S. refining technology and distribution capabilities makes any assessment of the impact of high octane fuel production on refinery emissions a complex task. In addition, the characteristics of the crude oil input to a refinery can have a significant impact on the results. Base case assumptions regarding crude slates and volumes for 2040 will be determined by projections obtained from the EIA Annual Energy Outlook (AEO) and will remain unchanged for the higher RON cases evaluated in this study. In addition, the volume of crude used for each RON case will be allowed to change based on

[2] Speth, R., Chow, E., Malina, R., Barrett, S., Heywood, J., and Green, W., 2014, "Economic and Environmental Benefits of Higher-Octane Gasoline", Environmental Science and Technology **48** (12), pp 6561-6598

[3] ANL – Han, J., Elgowainy, A., Wang, M., and DiVita, V., 2015, "Well-to-Wheels Greenhouse Gas Emissions Analysis of High-Octane Fuels with Various Market Shares and Ethanol Blending Levels", ANL/ESD-15/10, Argonne National Laboratory

model optimization, but the slate composition will remain fixed, such that the greenhouse gas from extraction and distribution to refiners will have a constant value expressed in grams of CO_2 per barrel of oil.

All of the cases analyzed will assume no new regulatory changes (i.e. Ozone NAAQS, EPA MSAT, etc.) and full implementation of the EPA Tier 3 gasoline specifications. GHG emissions generated during fuel distribution from the refinery gate to the retail pump will be included in the WTT analysis. As this phase of the study assumes that the maximum concentration of ethanol in gasoline for 2040 will be 10% by volume (E10), these emissions will be assumed to be constant across all of the RON cases analyzed. A subsequent phase of the study will address changes in GHG emissions associated with the impact of higher ethanol content (E10 +) fuels on the fuel distribution infrastructure. The greenhouse gas value associated with ethanol production for E10 may be selected from the EPA RFS2 final rule.

Tasks

1. The crude slate will be determined through the EIA energy outlook data for the year 2040. The greenhouse gas value associated with the crude slate extraction and distribution should be estimated by using models such as OPGEE.
2. Perform a LP refinery model base case assessment in the year 2040. The contractor should consult with the CRC project panel on the EIA energy outlook estimates to be employed in the study. This base case includes projected market demand of the current fuel slate [Regular (85 and 87 AKI) and Premium fuel grades with 10% blended ethanol]. This estimate should match the total gasoline demand in the EIA annual energy outlook in 2040. It will also be assumed that the minimum MON will be 82 as stated in the assumptions section. The contractor should determine the overall Regular and Premium fuel grade RON values based on current market availability. All market fuel grade assumptions should be distributed to the panel for approval.
3. Perform a LP refinery model assessment of increasing the octane number RON value to 95, 96.5, 98, and 101 in 2040 of the finished fuel. It will be assumed that the fuels will contain 10% by volume ethanol.
    a. For each higher RON fuel case, scenarios with refinery investment should be considered.
    b. The model should optimize for cost associated with producing fuels with the specified RON values. If possible, the model should allow gasoline product to move freely between regions and PADDs.
    c. Will assume this new fuel makes up the entire Regular and Premium gasoline energy demand determined in the base case.
4. The ethanol production and blending with the gasoline greenhouse gas value may be determined through the EPA RFS2 final rule.
5. The integration of the crude extraction and distribution, refinery production, ethanol blending, and final product distribution to the pump will be conducted to determine the total WTT greenhouse gas emissions value for each case.
    a. GHG emissions for each case's gasoline can be estimated by assuming a reference GHG value for base gasoline. The reference GHG value could be based on a public source such as the EPA RFS2 final rule. The difference between the base case and each case can be

compared to the reference gasoline value to determine the GHG value for each case gasoline.

   b. The results should be determined for each refining PADD (if possible) as each PADD will have varying results that allow for a more in depth analysis of the data.

6. Provide all results in the form of a report.
   a. The report should include sufficient detail on the modeling methodologies, assumptions, and approach to the study.
   b. The authors would be encouraged to report results from each refining PADD if the authors approach allows for this type of determination.
   c. Report the differences in the refinery GHG emissions between the base case (Task 1) and each RON value fuel specified in Task 2.

Deliverables

- Provide monthly status reports in the form of documents and/or teleconferences to the project panel that include major progress and issues.
- Contractor should facilitate a project "kick-off" meeting to give further information and guidance from the project panel on the program objectives and expectations.
- On the completion of the study provide a report that includes all major findings and conclusions. The project panel will give feedback for the contractor to consider in the revision of the report.
  - The contractor will not be allowed to publicly distribute the project report or major findings and conclusions, even when the report is approved, without written permission from CRC.

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 thirty (30) 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.