COORDINATING RESEARCH COUNCIL, INC.
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November 11, 2025

In reply, refer to:
CRC Project No. CM-137-25/ E-147

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for "AKI Study at Altitude with Modern Vehicles" (CRC Project No. CM-137-25/ E-147). A description of the project is presented in Exhibit A, "Statement of Work."

Please indicate your intention to bid at this link on or before **December 3, 2025** 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 here: Q & A Link. 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:

Amber Leland
Coordinating Research Council
1 Concourse Parkway, Suite 800
Atlanta, GA 30328

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

The deadline for receipt of your proposal is **December 19, 2025.**

Yours truly,

Amber B. Leland
Deputy Director

EXHIBIT A

CM-137-25/ E-147 STATEMENT OF WORK
"AKI Study at Altitude with Modern Vehicles"

1. Background

The specifications for gasoline used in spark-ignition automobile engines in the United States are detailed in ASTM International's, "Standard Specification for Automotive Spark-Ignition Engine Fuel", commonly referred to as ASTM D4814. Although ASTM D4814 does not explicitly list mandatory minimum specifications for antiknock/octane number ratings, it does provide non-mandatory information in its Appendix describing the effects of altitude on vehicle antiknock requirements for pre-1984 vehicles. These older vehicles lack sophisticated closed-loop computerized engine control module controls and are predominantly large cylinder bored, carbureted, naturally aspirated designs having emissions certifications much less stringent than today's vehicles. Additionally, the D4814 Appendix shows areas in the western United States where reduced antiknock requirements for pre-1984 vehicles are applicable based on the altitude of the area. Therefore, ASTM D02, Sub-committee A is seeking to update D4814 based on controlled vehicle performance studies and data. The importance of fuel antiknock quality is highlighted by its impact on vehicle design and performance. Modern day automobile engines are calibrated for maximum fuel economy and performance, while minimizing emissions using the octane grade of gasoline that the manufacturer recommends or requires for use in the vehicle's owner's manual. However, to avoid engine damage in case a lower fuel octane than specified in the owner's manual is used, the engine must be "protected" for the minimum octane fuel available in the market of sale. Consequently, engine design and calibration are constrained by the lowest anti-knock index fuel commercially available.
In recent years, with more sophisticated engine design and calibration, new vehicles may be able to take advantage of higher AKI fuels. This allows the vehicle to optimize vehicle power, performance and emissions to the fuel in the tank. On the horizon, the use of drop-in lower carbon intensity gasoline blends could be used in conjunction with these sophisticated vehicles. Does higher octane with lower carbon intensity deliver real world benefits?

2. Objective

Evaluate the latest **vehicle technology sets** with current range of market fuel comparing 85 AKI to higher octane fuel (87, 91 AKI) at altitude (>5000') and sea-level (<1000') conditions to provide data showing effects on vehicle power and performance. Full load operation for sustained periods of time is one of the most challenging operating conditions for an engine under knock-limited operation. This is typical for a vehicle fully loaded and/or towing a load.

3. Scope of Work - Overview

Phase 1 (altitude):

Vehicles

- 6-10 cars, MY15+

- Include Light Duty (LD) vehicles commonly used for towing, including SUVs and LD trucks.
- Include small LD (SUV or passenger car).
- Option for contractor procurement and/or OEM supplied

Fuels

- 3 fuels (85, and 87, and 91 AKI with typical octane sensitivity)
  - Contractor to provide fuel procurement estimates. It is possible that a member partner company could provide in-kind. Fuels should have similar octane number sensitivity (Sensitivity = RON - MON) and ethanol content (E10) to control these factors.
  - It can be estimated that each vehicle will need x2 tanks of fuel per fuel to conduct the testing. Assume x1 55gal drum of fuel per car per fuel. Total amount of fuel will be determined by the number of cars which will be finalized by the committee after contractor selection.
  - Each drum of fuel to have an aliquot of fuel collected for analysis.
  - Contractor to provide fuel analysis estimates. It is possible that a member partner company could provide in-kind.
  - Fuel prep procedure (Reference SAE 2017-01-0801)
  - Option to run 2-3 lower carbon intensity gasoline blends with varying AKI.

Testing

- <u>Chassis dyno testing:</u> (Reference SAE 2017-01-0801)
  - Replicate chassis dyno testing of FTP75, HWFET, US06 with certification fuel pre and post test program To be performed pre and post Performance Testing to bookend the AKI study (WOT steady-state and dyno acceleration runs). Report FE, CO_2, CO, THC, NMHC, CH_4, NO_x, N_2O, and PM. Ensure vehicle is not reporting a MIL.
- <u>Performance Testing:</u>
  - WOT at various steady-state engine operating conditions to evaluate vehicle power curve (Reference SAE 2017-01-0801)
  - Simulated loaded condition (up to vehicle GVWR) dyno acceleration evaluation
    - ♣ Contractor to show proof of repeatability for the test cycle chosen
      - Ex: 0-60, 20-60, 30-70, or other acceleration run agreed upon by the committee.
    - ♣ This is typically performed in a fixed transmission gear.
- Record ECU and chassis data
  - Accelerator Pedal Position, Throttle Position, Manifold Pressure, Intake Air Temperature, Spark Timing, Knock Value, Calculated Load, Equivalence Ratio, etc.
  - Option: External instrumentation for EGT and lambda sensor(s)
  - Option for external knock sensor and/or spark plug pressure transducer

<u>Phase 2 (sea-level):</u>

- Repeat of Phase 1 at an altitude <1000’

Schedule
Project start target timing is within the 2025 calendar year.

Deliverables
Monthly Reports
ECU and related test data
- Raw format after contractor data quality checks are performed.

Final Report
- Contractor to provide sections in the final report on findings from vehicle check-in/check-out, test facility setup, and technical findings.
- Statistical analysis performed by a committee selected statistician who will compile raw results provided by contractor and complete the Final Report.
  - Statistical analysis is outside the scope of this SOW.

Fuel analysis
- It is possible that a member partner company could provide in-kind.

Key Words
AKI, altitude, octane

References

- CRC Report #669
- SAE Paper 2002-01-1662 (A Fundamental Study of the Relationship Between Altitude and Research Octane Number) 1989 – 1997 vehicles
- SAE Paper 2003-01-2012 (Fleet Tests to Determine the Octane Response at Different Altitudes for Vehicles Equipped with Knock Sensors)
- SAE Journal Paper 2017-01-0801 (Gasoline Anti-Knock Index Effects on Vehicle Net Power at High Altitude)

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 five (5) 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.